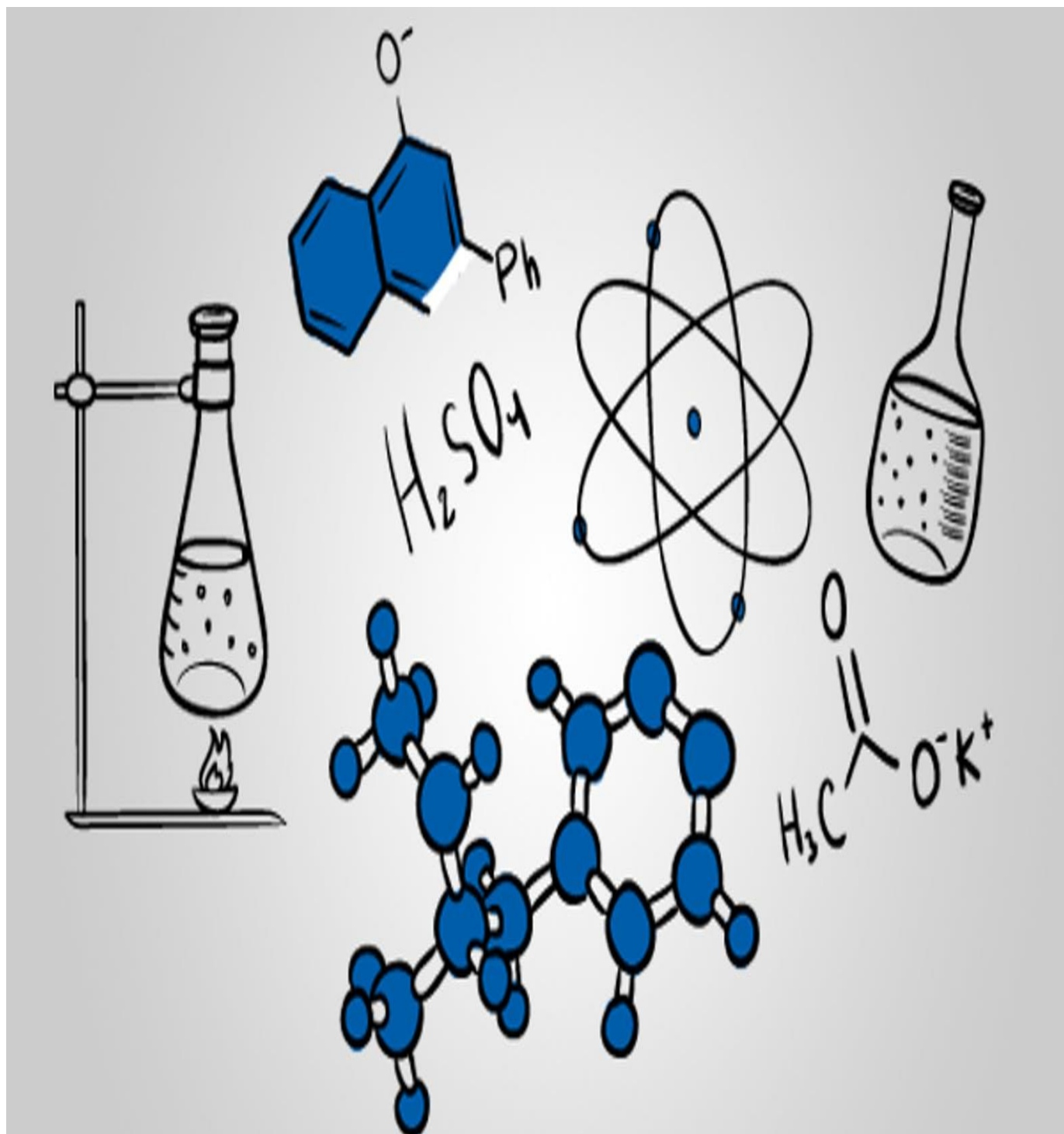




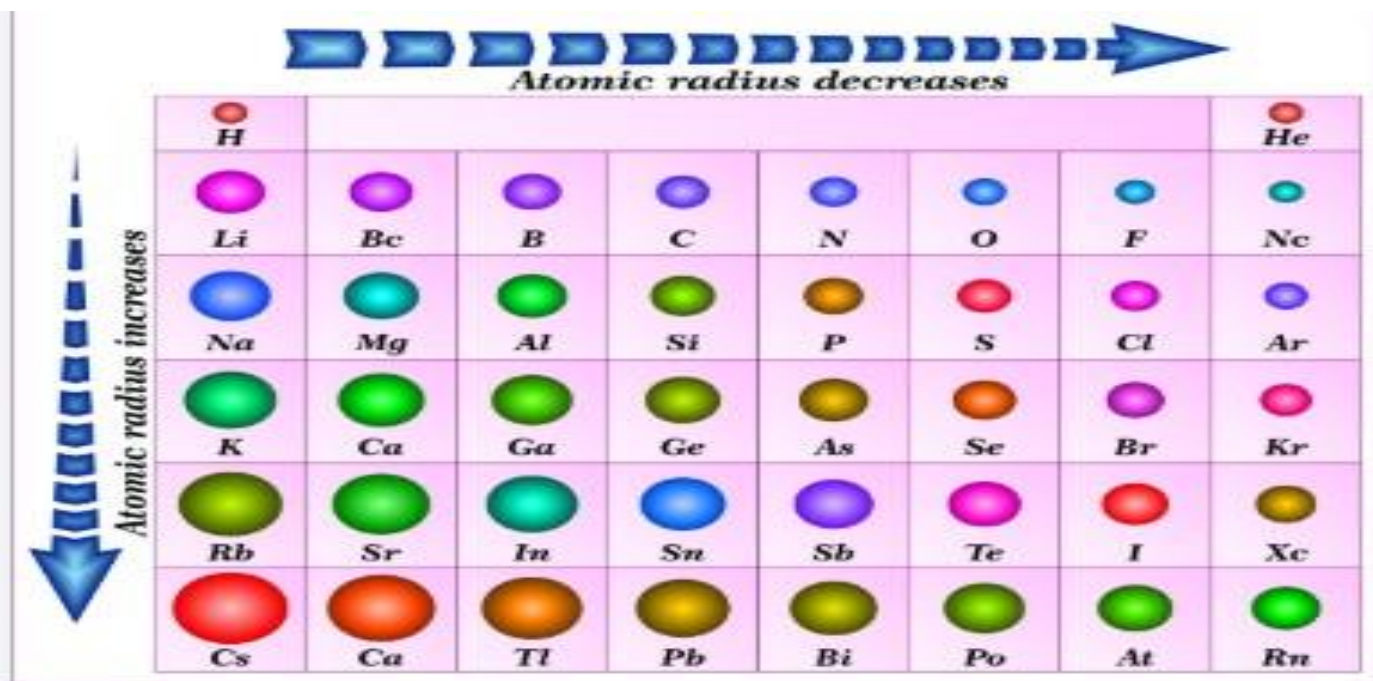
Jahezia Questions

The Periodic Table

Alkali Metals										Noble Gases									
Alkaline Earth		Transition Metals										Halogens							
H																He			
Li	Be											B	C	N	O	F	Ne		
Na	Mg											Al	Si	P	S	Cl	Ar		
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr		
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe		
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn		
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Uun	Uuu	Uub								
Lanthanides		Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu				
Actinides		Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr				

Diagram illustrating the periodic table blocks:

- S Block:** Groups 1 and 2 (Li, Be, Na, Mg, K, Ca, Rb, Sr, Cs, Ba, Fr, Ra).
- D Block:** Groups 3-10 (Transition metals).
- P Block:** Groups 13-18 (Main group elements).
- F Block:** Groups 3 and 4 (Lanthanides and Actinides).

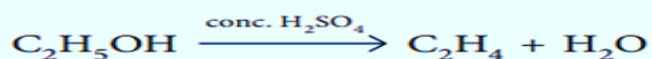


INCREASING ELECTRON AFFINITY

H																	He																														
Li	Be											B	C	N	O	F	Ne																														
Na	Mg											Al	Si	P	S	Cl	Ar																														
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr																														
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe																														
Cs	Ba		Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn																														
Fr	Ra		Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og																														
<table><tr><td>La</td><td>Ce</td><td>Pr</td><td>Nd</td><td>Pm</td><td>Sm</td><td>Eu</td><td>Gd</td><td>Tb</td><td>Dy</td><td>Ho</td><td>Er</td><td>Tm</td><td>Yb</td><td>Lu</td></tr><tr><td>Ac</td><td>Th</td><td>Pa</td><td>U</td><td>Np</td><td>Pu</td><td>Am</td><td>Cm</td><td>Bk</td><td>Cf</td><td>Es</td><td>Fm</td><td>Md</td><td>No</td><td>Lr</td></tr></table>																		La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu																																	
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr																																	

Elimination Reaction

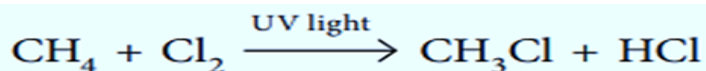
Elimination reactions involve the removal of a small molecule from a larger one.



Dehydration of an alcohol

Substitution Reaction

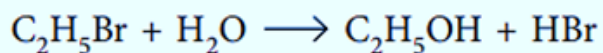
The replacement of one atom, or a group of atoms, by another occurs in substitution reactions.



Free-radical substitution of alkanes

Hydrolysis Reaction

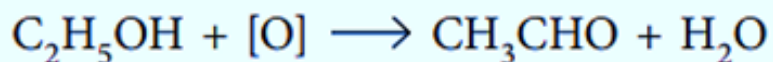
A molecule is broken down by water during hydrolysis. Acid or alkali frequently speed up this kind of reaction.



Hydrolysis of a Halogenoalkane

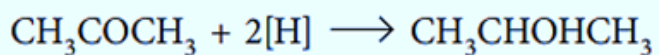
Oxidation-Reduction Reaction

The loss of electrons from a species is referred to as oxidation.

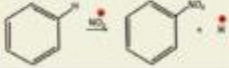
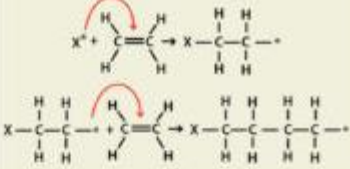
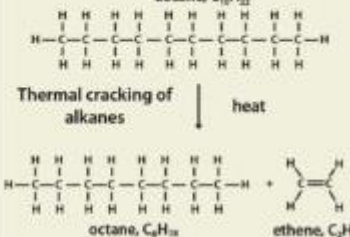


Complete Oxidation of ethanol to ethanoic acid

Changes in the number of oxygen atoms at a specific position in the hydrocarbon skeleton or in the number of bonds between carbon and oxygen at that position are frequently used to identify oxidation-reduction reactions, which are frequent in organic chemistry. An oxidation occurs when either value increases, whereas a reduction occurs when either value decreases. On the other hand, an increase in the proportion of hydrogen atoms in a hydrocarbon is frequently a sign of a decrease.



Reduction of a ketone

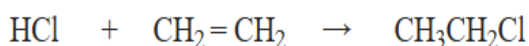
Types of Organic Reactions			
Reagent / Reaction Type	Nucleophilic	Electrophilic	Radical
Substitution $R-X + Y \rightarrow R-Y + X$	Alkyl halides + Cyanide ion or hydroxide ion $R-Br + CN^- \rightarrow R-CN + Br^-$	Benzene electrophilic substitution 	Halogenation of methane UV light $CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$
Addition $C=C + XY \rightarrow C(X)C(Y)$	$C=O + H^- \rightarrow C(O^-)H$	Alkene + HBr $C=C + H-Br \rightarrow C(H)C(H)Br$	
Elimination $C(X)C(Y) \rightarrow C=C + XY$	$C(X)C(Br) + OH^- \rightarrow C=C + Br^- + H_2O$	Alcohol + H ⁺ acid catalysed elimination $C(X)C(OH) \xrightarrow{H^+} C=C + H_2O$	decane, C ₁₀ H ₂₂ 

+ HBr

1. Which type of the following organic reaction?

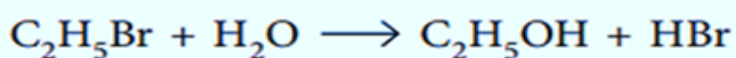
- Elimination reaction
- Addition reaction
- Substitution reaction
- Oxidation reaction

2. Which type of the following organic reaction?



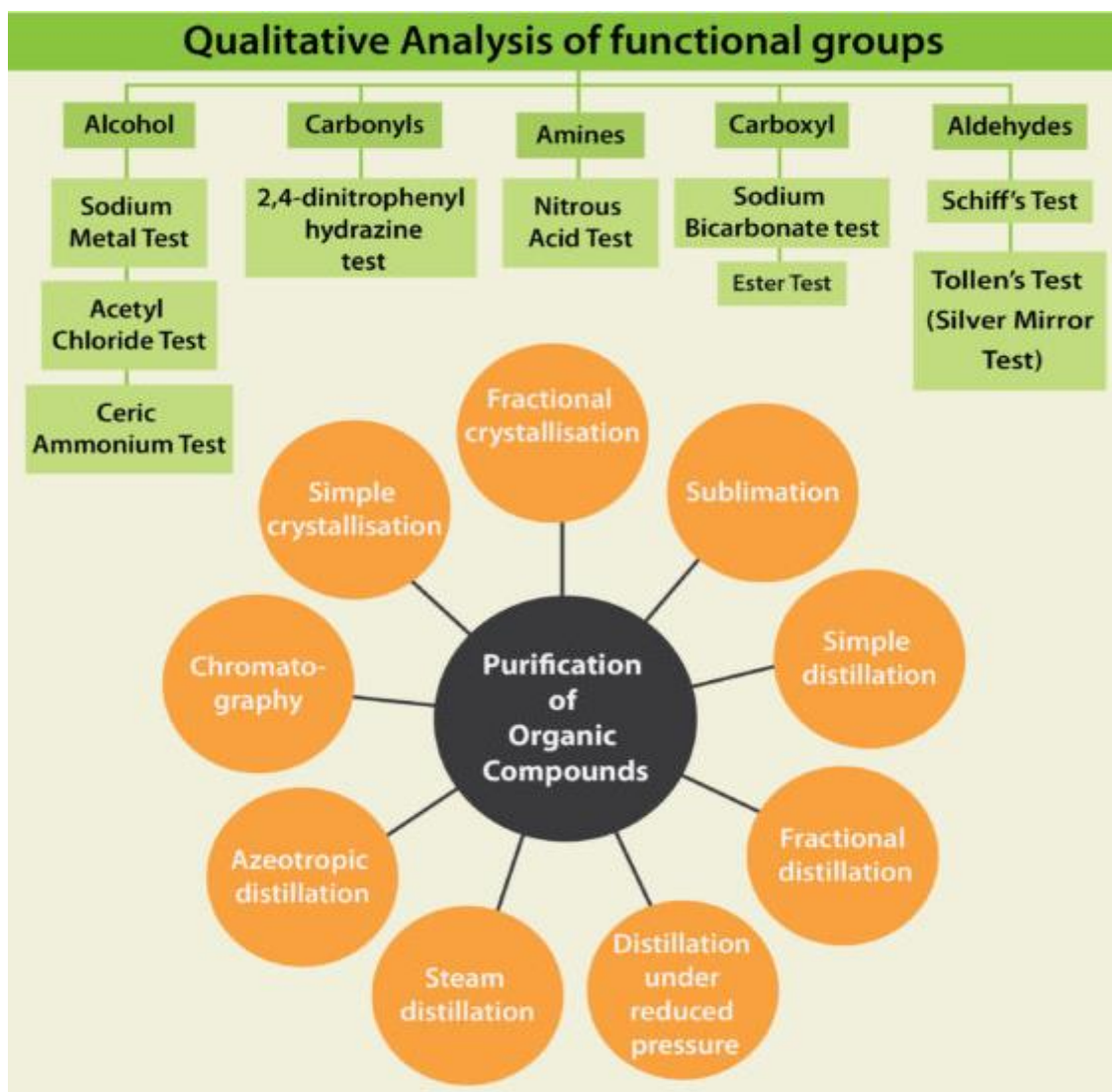
- a) Substitution reaction
- b) Elimination reaction
- c) Addition reaction
- d) Oxidation reaction

3. Which type of the following organic reaction?



- a) Elimination reaction
- b) Substitution reaction
- c) Oxidation reaction

d) Hydrolysis reaction



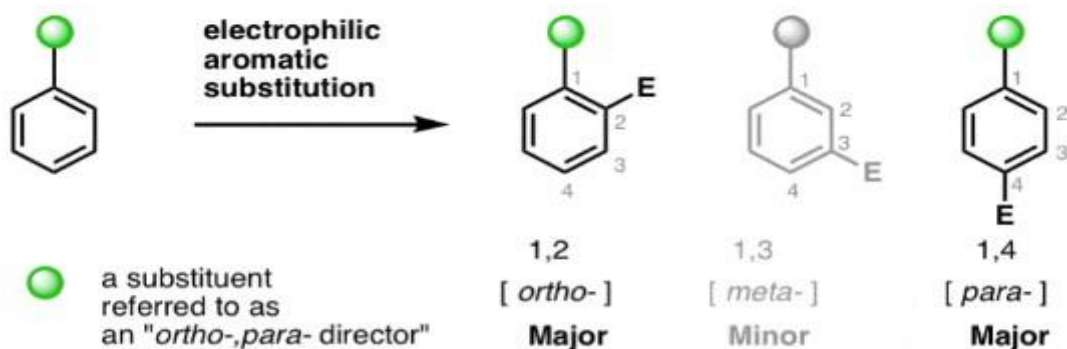
The

4. **Methoxy Group (OCH_3) is**

- a) para and meta - director
- b) ortho and para- director
- c) ortho director

d) meta- director

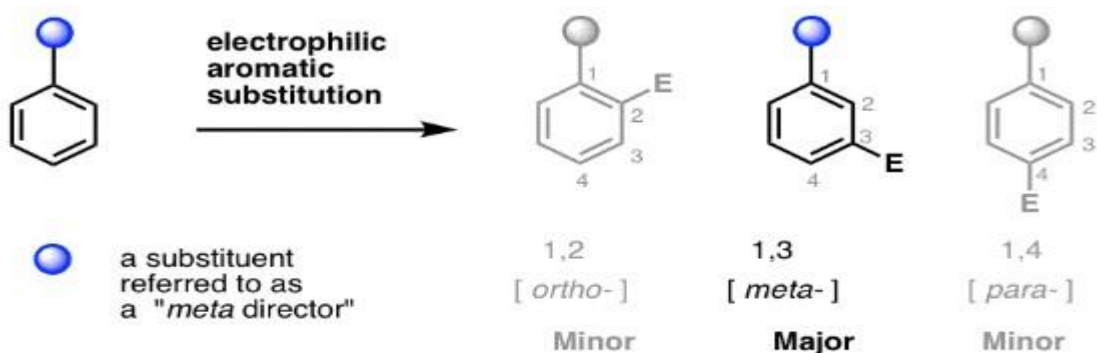
Pattern 1: *ortho*- and *para*- products are major; *meta* product is minor



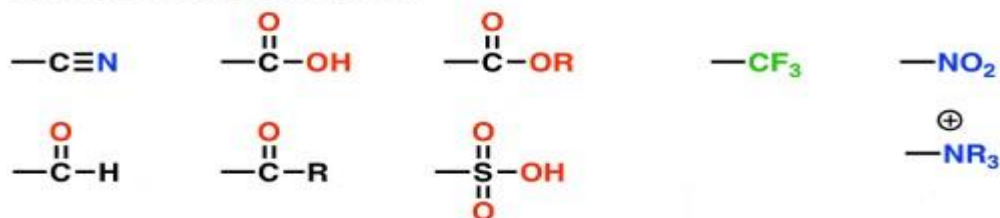
Examples of *ortho*-,*para*- directors:



Pattern 2: meta- product is major; ortho- and para- products minor



Examples of *meta* directors:



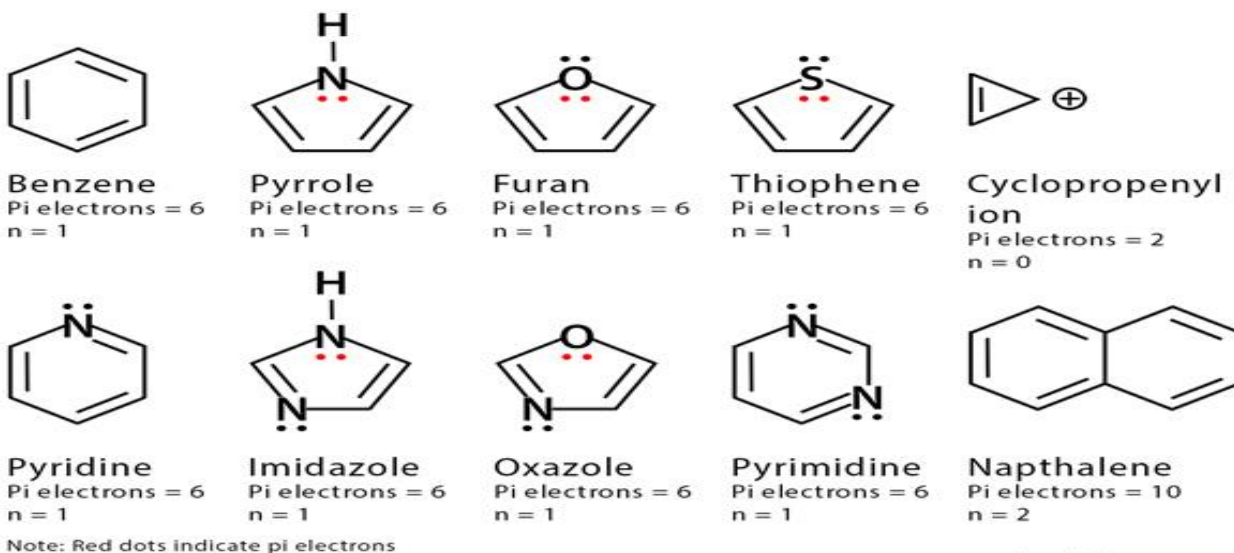
5. Which of the following is an Incorrect description of benzene molecule?
- a) The CCC bond angles are all equal to 120° .
 - b) The molecule can be drawn as a resonance hybrid of two Kekule structures
 - c) The molecule is aliphatic.
 - d) The molecule is planar.

e) The molecule is cyclic.

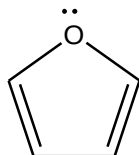
6. Aromatic molecules contain π electrons.

- a) $4n + 1$ (with n an integer)
- b) $4n + 2$ (with n an integer)
- c) Unpaired
- d) $4n$ (with n an integer)

Huckel's Rule for Aromatic Compounds (Number of Pi Electrons = $4n + 2$)

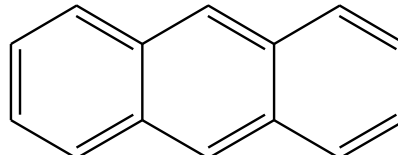


ChemistryLearner.com



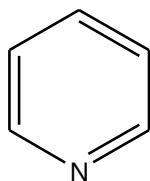
$$4n + 2 = 6$$

$$n = 1 \text{ (Aromatic)}$$



$$4n + 2 = 14$$

$$n = 3 \text{ (Aromatic)}$$



$$4n + 2 = 6$$

$$n = 1 \text{ (Aromatic)}$$



$$4n + 2 = 4$$

$$n = 1/2 \text{ (Non-Aromatic)}$$

7. All of the following are Electron Donating groups EXCEPT:

- a) $-\text{NO}_2$
- b) $-\text{COOH}$
- c) $-\text{OH}$
- d) $-\text{X}$

Electron-Donating Groups	
-R	Alkyl Group
-X	Halide
-OH	Hydroxyl Group
-OR	Alkoxy group
-NH ₂ and -NR ₂	Substituted and Unsubstituted Ammine Groups
-NHCOC-	Amide Group

Electron-Withdrawing Groups	
-NO ₂	Nitryl Group
-NR ₃ ⁺	Ammonium Group
-CHO	Aldehyde Group
-COOH and -COOR	Unsubstituted and substituted Carboxyl Groups
-CN	Cyanide Groups

8. The general formula of alkyne is

- a) C_nH_{2n}
- b) C_{2n}H_{2n}
- c) C_nH_{2n-2}
- d) C_nH_{2n+2}

9. Which of the following is the simplest member of organic compounds?

- a) Methane
- b) Formic acid
- c) Formaldehyde
- d) Methanol

10. Hydrocarbons are organic compounds with element _____

- a) Carbon
- b) Hydrogen
- c) Both hydrogen and carbon
- d) Oxygen

11. Which of the following bond is made up of a large number of organic compounds?

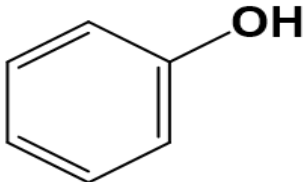
- a) Metallic bond
- b) Dipolar bond
- c) Ionic bond
- d) Covalent bond

12. Which of the following is not a class of organic compounds?

- a) Nitro compound
- b) Amides
- c) Electro compounds
- d) Carbonyl compound

13. Ethanol has the chemical formula.....

- a) CH_3OH
- b) $\text{C}_3\text{H}_7\text{OH}$
- c) $\text{C}_2\text{H}_5\text{OH}$
- d) $\text{C}_4\text{H}_9\text{OH}$

Name	Functional Group	IUPAC Ending
Alcohols	$R-OH$	-ol
Phenols		phenol
Ethers	$R-O-R'$	ether
Aldehydes	$R-\overset{\overset{O}{\parallel}}{C}-H$	-al
Ketones	$R-\overset{\overset{O}{\parallel}}{C}-R'$	-one
Carboxylic Acids	$R-\overset{\overset{O}{\parallel}}{C}-OH$	-oic acid
Esters	$R-\overset{\overset{O}{\parallel}}{C}-O-R'$	-ate

14. A molecule in which a carbon atom has a positive charge and three bonds is called....

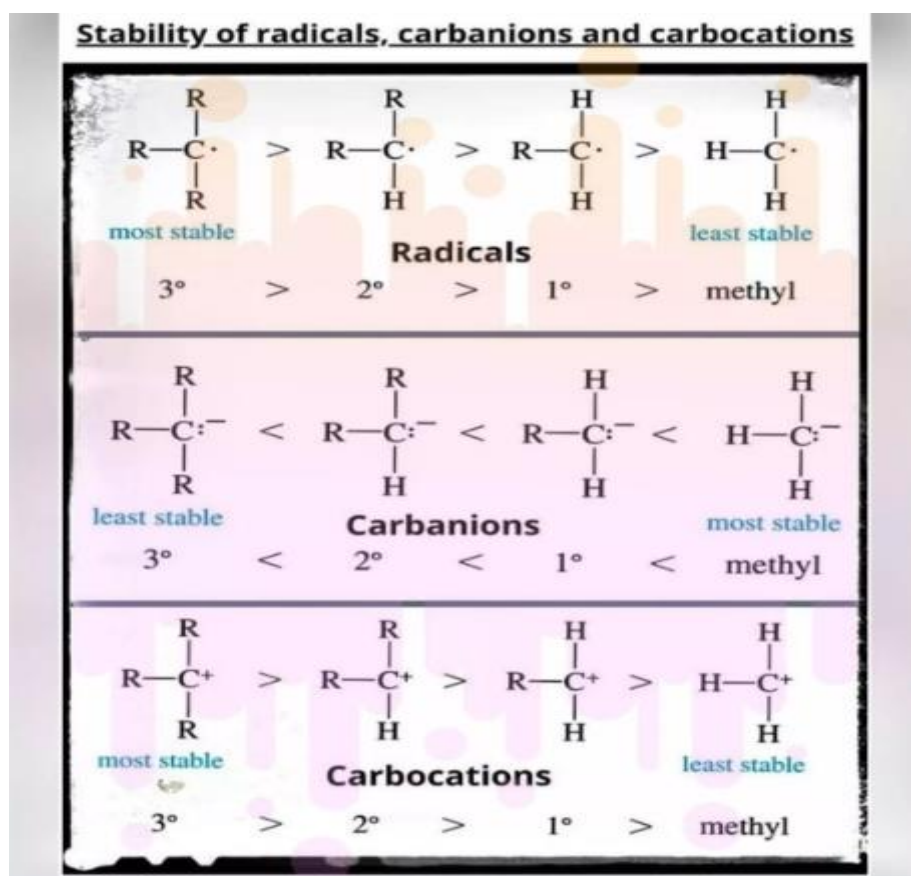
- Methoxy ion
- Carbocation
- Carbanion
- Free radical

15. A molecule in which a carbon atom has a negative charge and lone pair of electron is called....

- a) Hydronium ion
- b) Methoxy ion
- c) Carbocation
- d) Carbanion

16. An atom or group of atoms having an odd or unpaired electron. These results on account of homolytic fission of a covalent bond is called

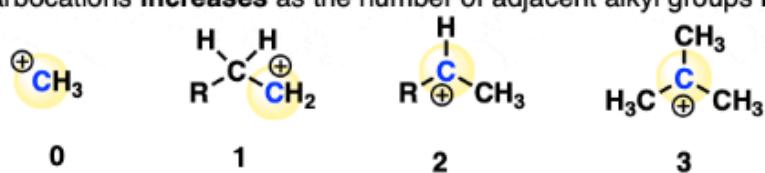
- a) Carbocation
- b) Carbanion
- c) Methoxy ion
- d) Free radical



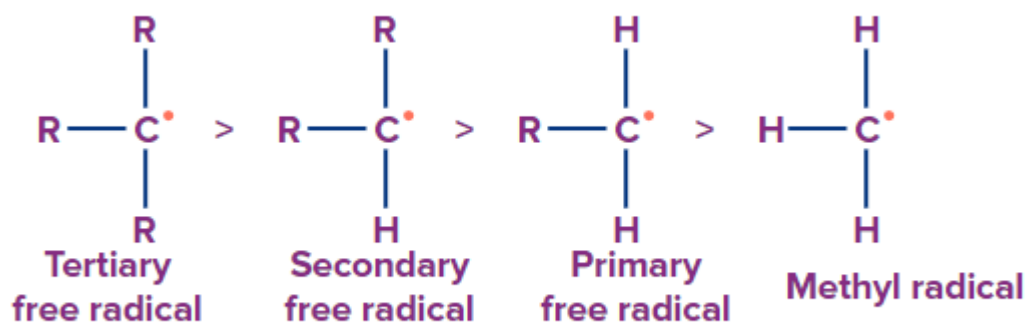
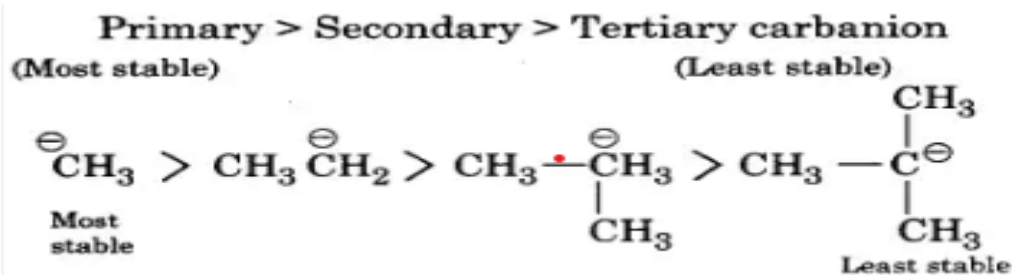
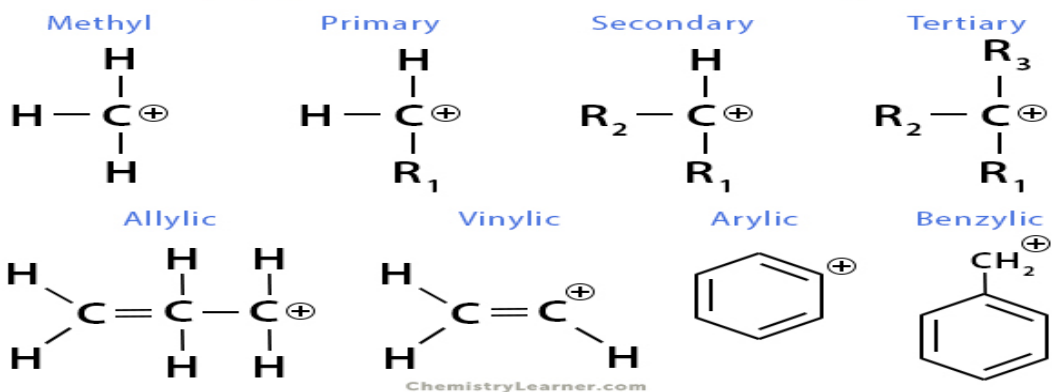
Alkyl substitution

- The stability of carbocations **increases** as the number of adjacent alkyl groups **increases**

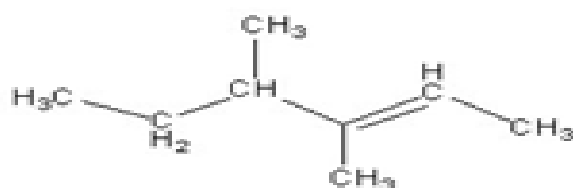
Number of carbons attached to carbocation:



Types of Carbocation

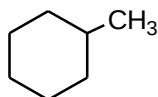


17. The IUPAC name of the following structure is ...



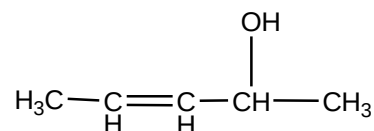
- a) 2,3-methylhex-4 ene
- b) 2,3-dimethylhex-2-ene
- c) 3,4-dimethylpent-2-ene
- d) 3,4-dimethylhex-2-ene

18. The IUPAC name of the below structure is



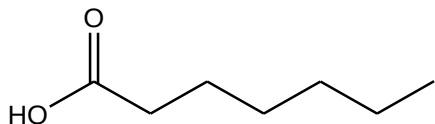
- a) Toluene
- b) Ethyl cyclooctane
- c) Methyl cyclopentane
- d) Methyl cyclohexane

19. The IUPAC name of the below structure is



- a) Pentane
- b) 2-Pentene-3-ol
- c) Pentanol
- d) 3-Pentene-2-ol

20. The IUPAC name of the below structure is ____



- A. Heptanoic Aid
- B. 1-Heptanol
- C. 2-Heptanone
- D. 1- Octane

21. How many isomers are possible for Heptane C_7H_{16} ($2^{n-4} + 1$)

- a) 11
- b) 12
- c) 10
- d) 9

22. The movement of electrons through sigma bond is called

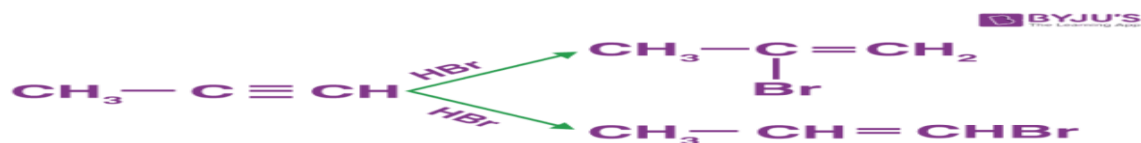
- a) Ionic effect
- b) Doppler effect
- c) Inductive effect
- d) Mesomeric effect

23. The movement of electrons through pi bond is called

- a) Mesomeric effect
- b) Ionic effect
- c) Doppler effect
- d) Inductive effect

24. When an alkene reacts with hydrogen halide (HX), the Hydrogen atom is added to the carbon that has the most hydrogens and the halide atom is added to the carbon that has least hydrogens, According to.....

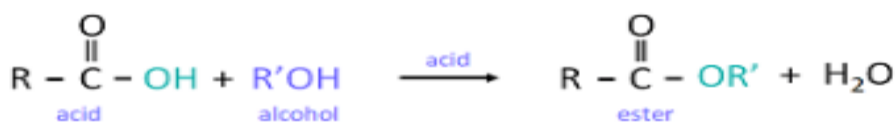
- a) Saytzeff rule
- b) Markovnikov's Rule
- c) Anti- Markovnikov's Rule
- d) Addition rule



25. An organic compound A reacts with B and forms Ester and water under acidic condition. (esterification reaction). What are A and B ?

- a) Carboxylic acid and Aldehyde
- b) Alcohol and ketone
- c) Carboxylic acid and alcohol
- d) Aldehyde and Ketone

Esterification Reaction



26. S_N1 occurs in step (s)

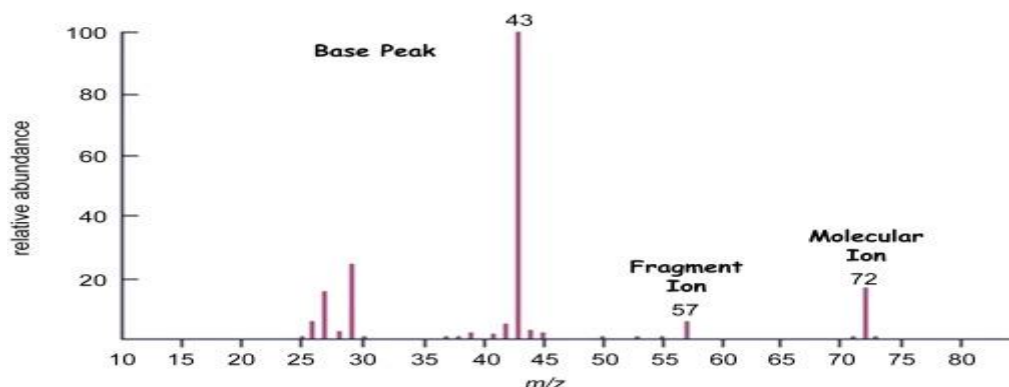
- a) Four
- b) Three
- c) Two
- d) One

27. The fingerprint region in ----- spectrum is between 600-1400 cm⁻¹

- a) Proton NMR
- b) Ultra Violet
- c) Mass
- d) Infrared

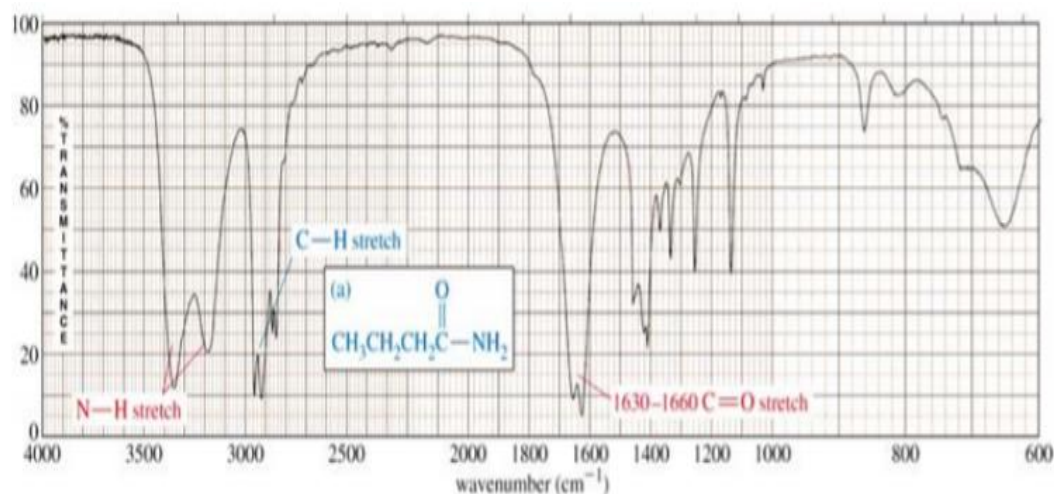
28. The base peak in a mass spectrum is

- a) The highest mass peak.
- b) The lowest mass peak
- c) The peak corresponding to the parent ion.
- d) The peak of 100% relative intensity



29. Which function group has two bands in IR-spectra?

- a) CH₂
- b) NH₂
- c) OH
- d) NH

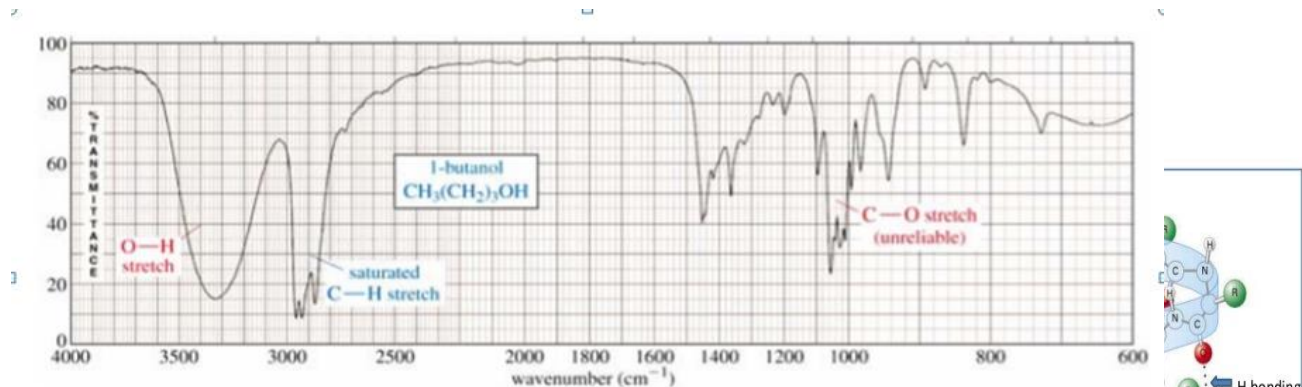


Graphics source: Wade, Jr., L.G. *Organic Chemistry*, 6th ed. Pearson Prentice Hall Inc., 2006

30. OH band is at 3400-3300 cm⁻¹ in IR

- a) doublet peak
- b) broad peak
- c) sharp peak

d) Triplet peak

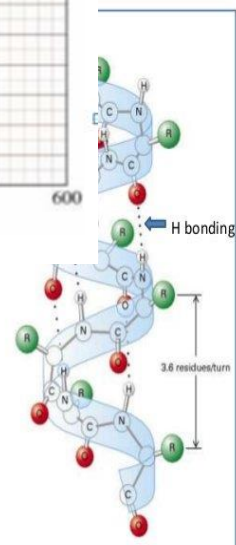


31. The secondary structure of protein α -helix is stabilized by

- Peptide bonds
- Hydrogen bonds
- Van der Waals forces
- Dipole-dipole interactions

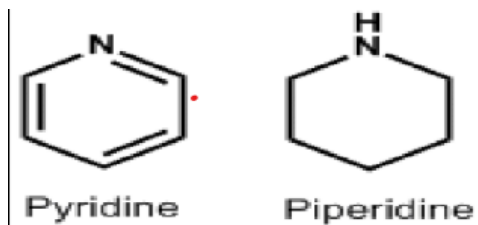
carbonyl oxygen and amide hydrogen.

- Amino acids per turn – 3.6
- Pitch is 5.4 Å
- Alpha helical segments are found in many globular proteins like myoglobins, troponin- C etc.



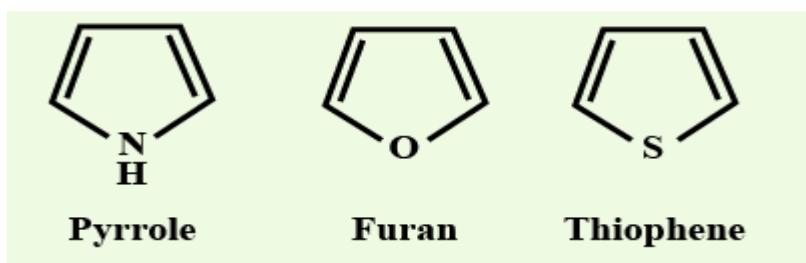
32. Which of the following heterocyclic compounds is not aromatic?

- Furan
- Piperidine
- Pyridine
- Pyrrole



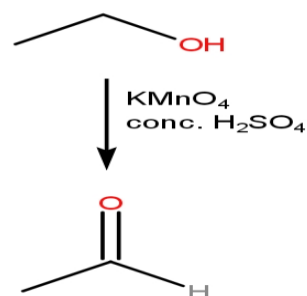
33. Which of the following is not a heterocyclic compound?

- Pyrrole
- Thiophene
- Cyclohexane
- Furan



34. Ethyl alcohol on oxidation with potassium dichromate solution in the presence of conc. sulfuric acid gives-----

- Ethyl acetate
- Acetone
- Acetaldehyde
- Acetamide



35. Oxalic acid on treatment with sodium bicarbonate results the evolution of gas

- NO_2
- CO_2
- CO
- SO_2

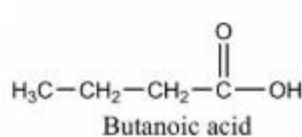
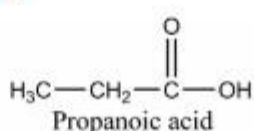
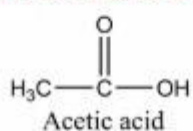
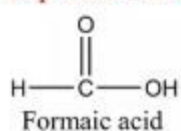
36. All of the following organic acids are insoluble in water EXCEPT:

- Benzoic acids
- Phthalic acid
- Oxalic acid
- Salicylic acid

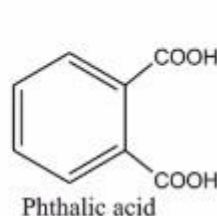
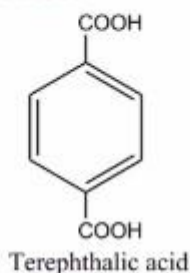
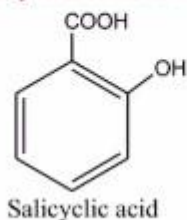
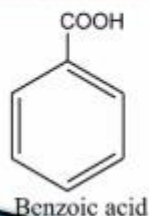
Classification of carboxylic acid

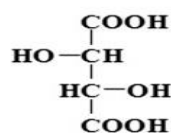
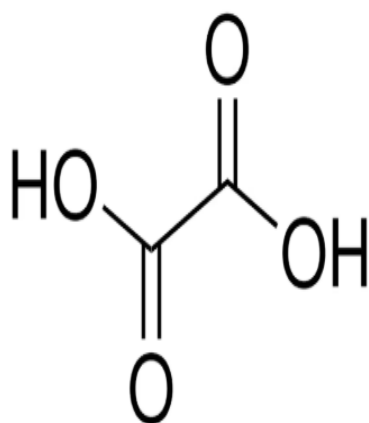
Carboxylic acids are classified according to the substituent that is attached to the carboxyl carbon.

- **Aliphatic Carboxylic acids:** Carboxylic acids have an alkyl group bound to the carboxyl group is known as aliphatic carboxylic acids. The general formula of an aliphatic carboxylic acid is R-COOH .

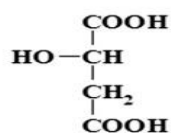


- **Aromatic Carboxylic acids:** Carboxylic acids have an aryl group bound to the carboxyl group is known as aromatic carboxylic acids. The general formula of an aliphatic aromatic carboxylic acid is Ar-COOH .

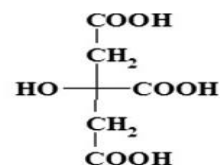




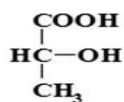
L-(+)-tartaric acid



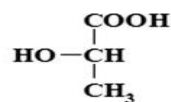
L-(-)-malic acid



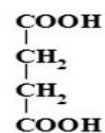
Citric acid



D-(-)-lactic acid



L-(+)-lactic acid



Succinic acid

37. Oxidation of a primary alcohol yields a/an

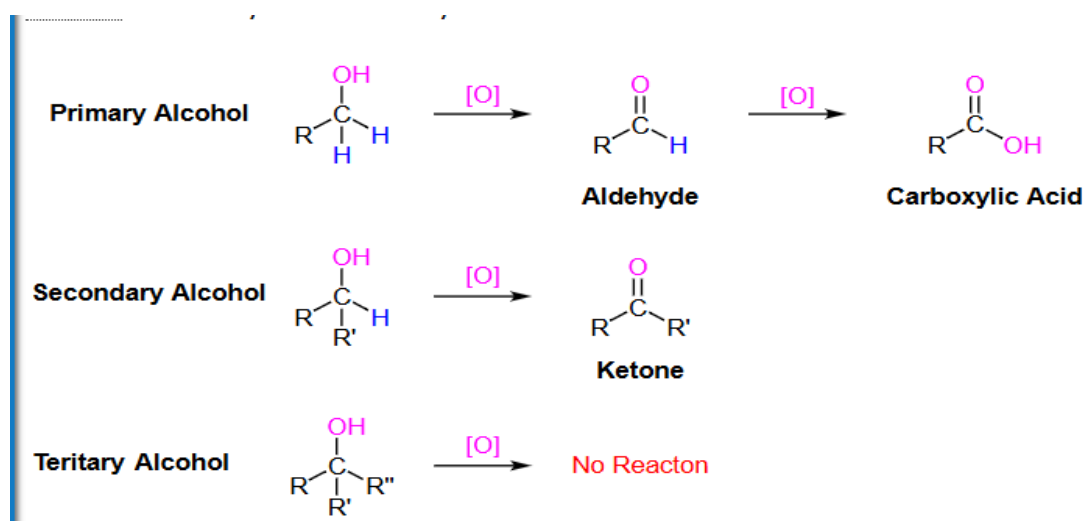
- a) Ketone
- b) Carboxylic acid
- c) Aldehyde
- d) No product

38. Oxidation of a Secondary alcohol yields a/an

- a) Aldehyde
- b) Carboxylic acid
- c) Ketone
- d) No product

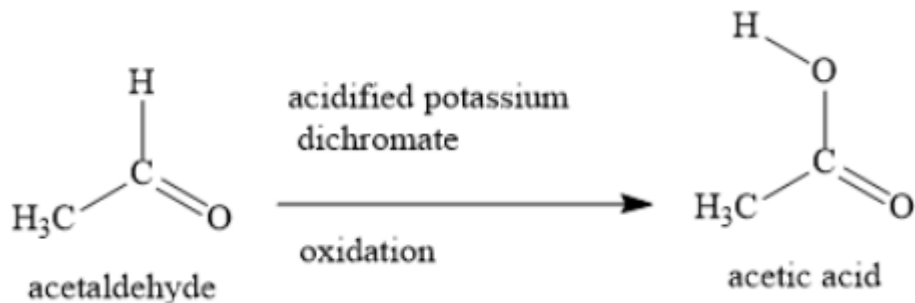
39. Oxidation of a tertiary alcohol yields a/an

- a) Ketone
- b) Carboxylic acid
- c) Aldehyde
- d) No product



40. Ethyl alcohol on oxidation with potassium dichromate solution in the presence of conc. sulfuric acid gives

- a) Acetamide
- b) Acetone
- c) Acetaldehyde
- d) Ethyl acetate



41. The main storage form of carbohydrates in animals & humans

- a) Cellulose
- b) Chitin
- c) Glycogen
- d) Starch

42. Pyridine is a 6-membered heterocyclic compound in which hetero atom is

- a) Sulphur
- b) Phosphorous
- c) Oxygen
- d) Nitrogen

43. Starch gives positive. _____

- a) Phthalein test
- b) Fenton Test
- c) Iodine test
- d) Benedict's Test

44. Glucose and Fructose are classified as

- a) Disaccharides
- b) Polysaccharide
- c) Monosaccharide
- d) None of these

45. The test that is performed to distinguish between reducing monosaccharides (glucose and fructose) and reducing disaccharides (maltose and lactose) is called

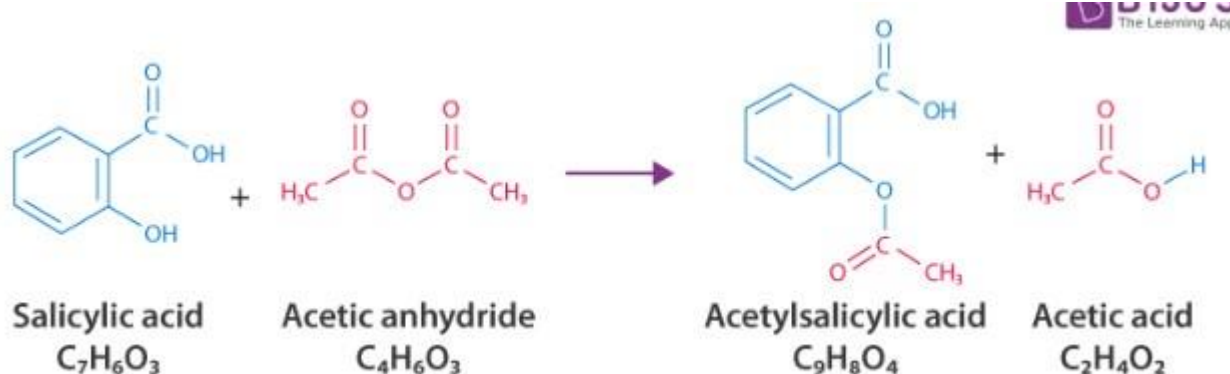
- a) Bial's Test
- b) Barfoed's Test
- c) Molisch's Test
- d) Ninhydrin test

46. The test that is used to distinguish between pentose and hexose monosaccharides is known as

- a) Sulfite Test
- b) Bial's Test
- c) Phthaline Test
- d) Molisch's Test

47. The starting material for the preparation of Aspirin is

- a) Cyclohexenone
- b) Formic acid
- c) Salicylic acid
- d) Acetophenone



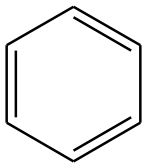
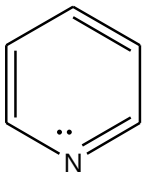
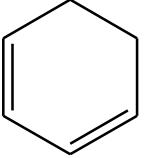
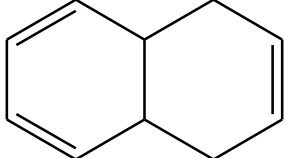
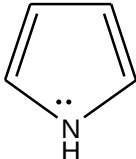
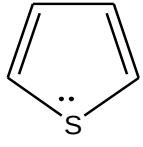
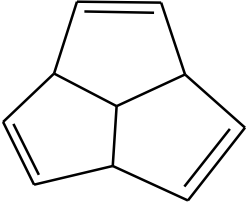
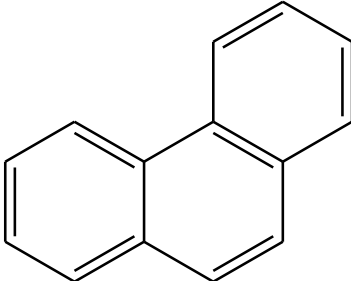
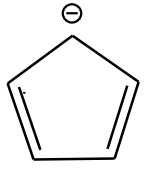
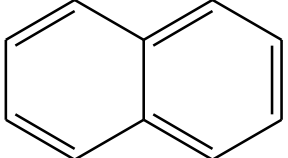
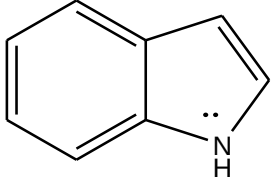
48. If you add FeCl₃ to an Aspirin sample and you see a Purple color, this means

- a) There is still some acetic anhydride present and the sample is impure
- b) There is still some salicylic acid present and the sample is impure
- c) There is no acetic anhydride present and the sample is pure
- d) There is no salicylic acid present and the sample is pure

49. If you add FeCl₃ to an Aspirin sample and you see No color, this means

- a) There is still some acetic anhydride present and the sample is impure
- b) There is still some salicylic acid present and the sample is impure
- c) There is no salicylic acid present and the sample is pure
- d) There is no acetic anhydride present and the sample is pure

Classify the compounds below as Aromatic, Nonaromatic (Aliphatic) or Anti-aromatic using Hukel's rule

Aromatic ($n = 1$) 	Aromatic ($n = 1$) 
Nonaromatic (Aliphatic) 	Nonaromatic (Aliphatic) 
Aromatic ($n = 1$) 	Aromatic ($n = 1$) 
Nonaromatic (Aliphatic) 	Aromatic ($n = 3$) 
Antiaromatic ($n = \frac{1}{2}$) 	Antiaromatic ($n = \frac{1}{2}$) 
Aromatic ($n = 2$) 	Aromatic ($n = 2$) 

Physical Chemistry

1. **Absolute Zero in Celsius scale equals to**

- a. 0 K
- b. 100°C
- c. -273.15°C
- d. +273.15 °C

2. **.....states that entropies of all pure, perfect crystalline materials approach zero as the temperature approaches 0 K .**

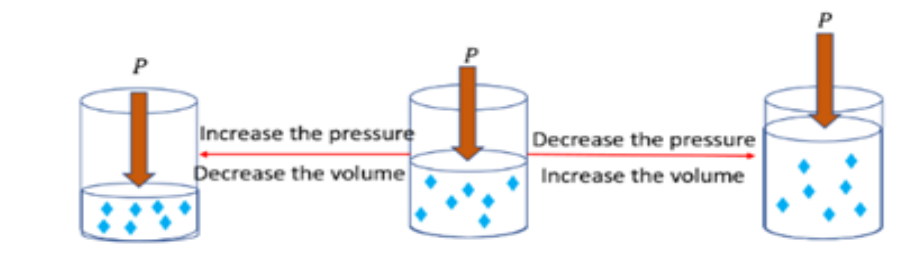
- a. 1st law of Thermodynamic
- b. 2nd law of thermodynamic
- c. 3rd law of thermodynamic
- d. Law of mass action

3. **Free energy it also called Gibbs energy it has the unit of ...**

- a. Newton
- b. Volt
- c. Kelvin
- d. Joules

4. **If the contact angle is more than 90 the surface substrate is**

- a. Hydrophilic
- b. Hydrophobic
- c. Both of a and b
- d. None of a and b



5. **The figure above represents.....**

- a. Ohm's law
- b. Boyle's law
- c. Charles's and Gay-Lussac's Law
- d. Dalton's law

6. **..... is the process when the adsorbate is released from the surface of the bulk substance**

- a. Absorption
- b. Adsorption

- c. Desorption
- d. None of above

7. Physisorption occurred by forces

- a. Double bonds
- b. Chemical
- c. Van der Waals
- d. Bond to bond

8. Acid/base is an example of catalysts

- a. Homogeneous
- b. Heterogeneous
- c. Both a and b
- d. None of the above

9. Bulk catalysts is an example of catalysts

- a. Homogeneous
- b. Heterogeneous
- c. None of a and b
- d. Both a and b

10. $\text{Energy} + 2\text{HgO (s)} \rightarrow 2\text{Hg (l)} + \text{O}_2 \text{ (g)}$, is an example of

- a. Endothermic process
- b. Exothermic process
- c. No process
- d. None of above

11. $\text{H}_2\text{O (g)} \rightarrow \text{H}_2\text{O (l)} + \text{Energy}$, is an example of

- a. Exothermic process
- b. Endothermic process
- c. No process
- d. Both a and b

12. The dispersion of actual particles of one substance throughout a dispersing medium of another substance is called

- a. Solution
- b. Colloid
- c. Crystalloid
- d. Suspension

13. exchange in isolated system.

(There is no exchange of energy with the surrounding. there is exchange of mass and energy with the surrounding)

- a. Energy only
- b. Mass only

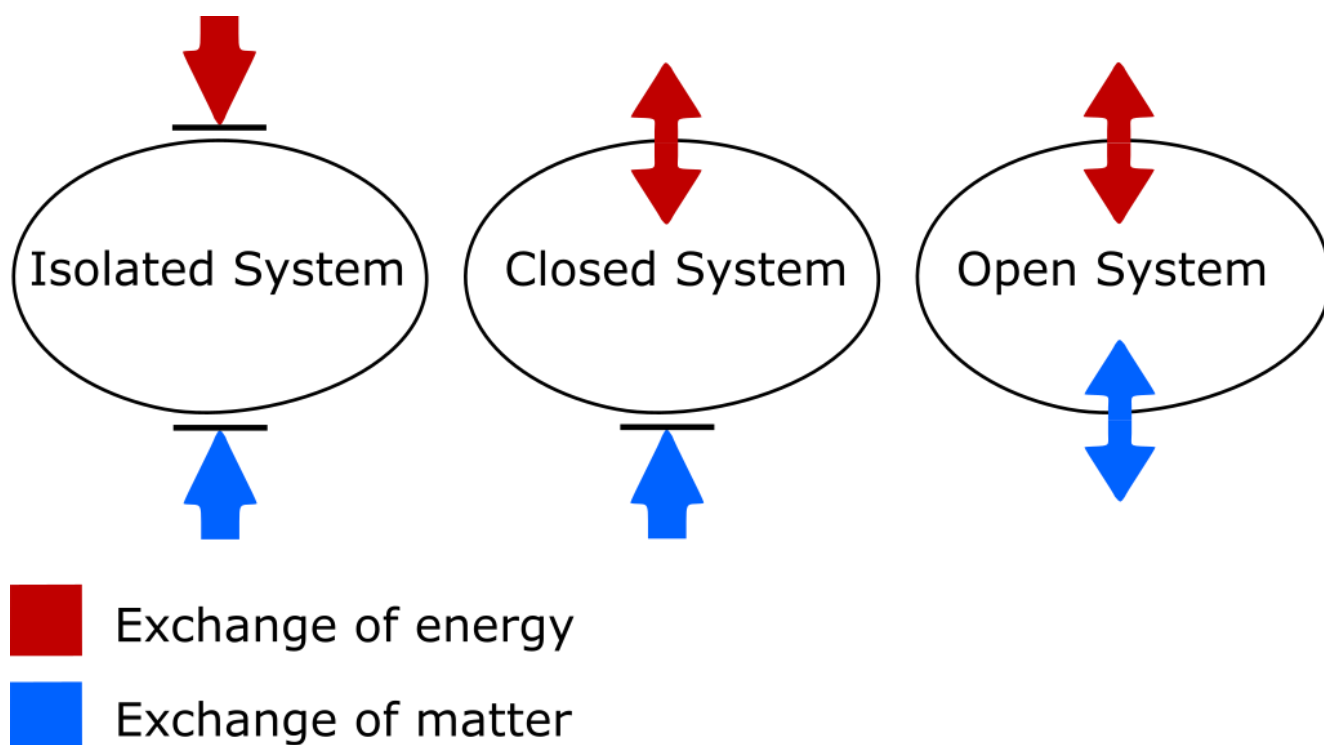
- c. Mass and Energy
- d. Nothing

14. An isolated system is that system in which:

- a. There is exchange of energy and mass with the surroundings
- b. There is no exchange of energy with the surroundings
- c. There is exchange of mass and energy with the surroundings
- d. There is no exchange of energy and mass with the surroundings

15. Only the energy is exchanged in..... system .

- a. Isolated
- b. Closed
- c. Open
- d. None of the above



16. The change in the concentration of a reactant or a product with time (M/s) is known as

- a. Breathing
- b. Hydration
- c. Rate constant
- d. Reaction Rate

17. The reactant presents in quantities greater than necessary to react with the quantity of limiting reagent is called

- a. Limiting reagent
- b. Excess reagent
- c. Stoichiometric amounts
- d. Nonstoichiometric compounds

18. Which of the following equation is balanced ?

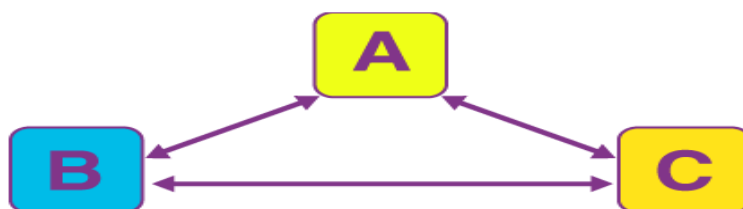
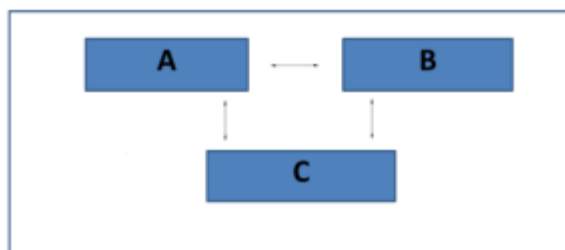
- a. $\text{O}_2 + 2\text{H}_2 \rightarrow \text{H}_2\text{O}$
- b. $\text{KClO}_3 \rightarrow \text{KCl} + 3\text{O}_2$
- c. $4\text{Al} + 3\text{O}_2 \rightarrow 2\text{Al}_2\text{O}_3$
- d. $\text{C}_2\text{H}_6 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$

19. The standard enthalpy of formation of any element in its most stable form is

- a. 500
- b. 300
- c. 100
- d. Zero

20. This Figure represents

- a. The First Law of Thermodynamics
- b. The Zeroth Law of Thermodynamics
- c. The Second Law of Thermodynamics
- d. The Third Law of Thermodynamics



The zeroth law of thermodynamics states that if two thermodynamic systems are each in thermal equilibrium with a third one, then they are in thermal equilibrium with each other.

21. In classical thermodynamics, which law states that energy cannot be created or destroyed?

- a. Zeroth Law of Thermodynamics
- b. First Law of Thermodynamics
- c. Second Law of Thermodynamics
- d. Third Law of Thermodynamics

Laws of Thermodynamics

Zeroeth law

Temperature

Two systems in equilibrium with a third system are in thermal equilibrium with each other.



First law

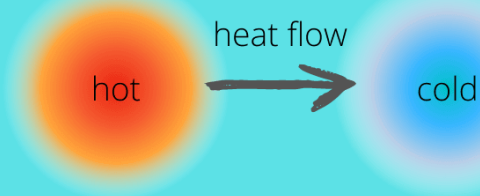
Conservation of Energy

Energy can change forms, but is neither created nor destroyed.



Second law

Entropy of an isolated system always increases.



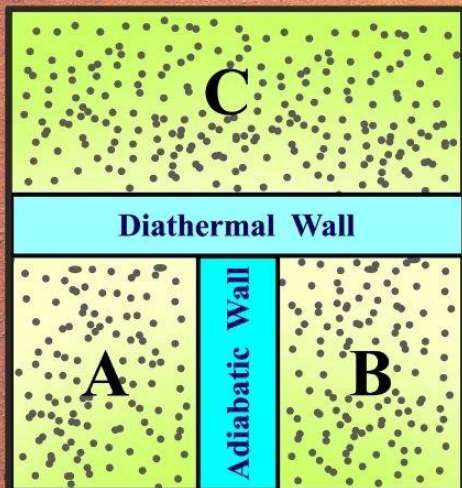
Third law

Entropy of a system approaches a constant as temperature approaches absolute zero.



scincenotes.org

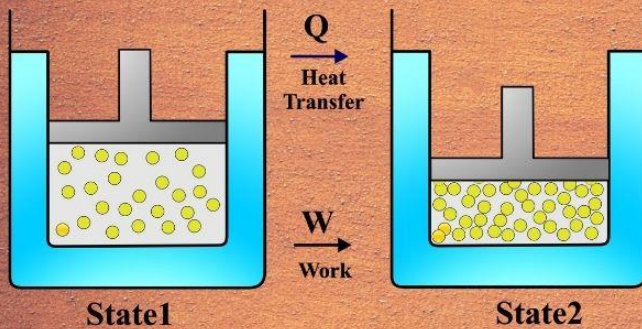
Zeroth law of Thermodynamics



- "If two systems are each in thermal equilibrium with a third system, then they are in thermal equilibrium with each other. "

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First Law of Thermodynamics

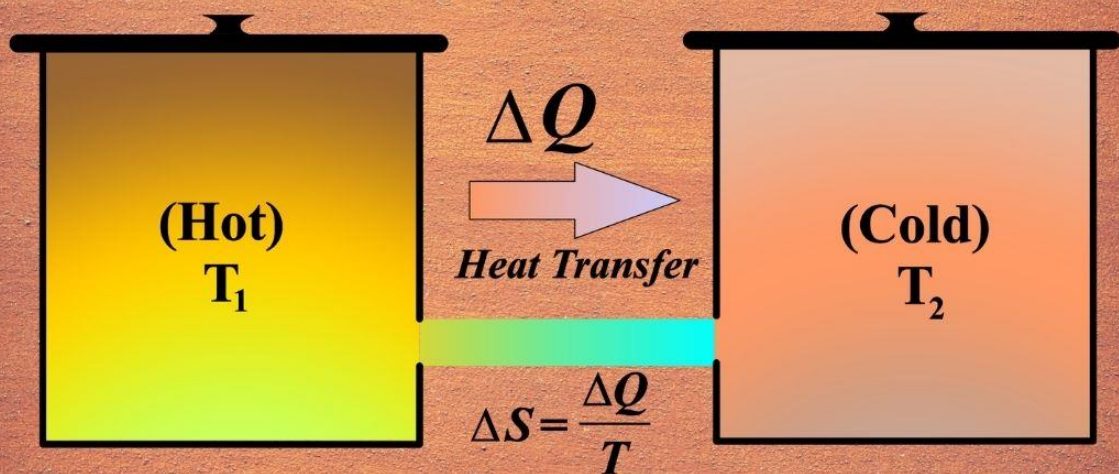


"Energy cannot be created or destroyed; it can only change forms or be transferred from one object to another."

$$dU = U_f - U_i \text{ or } \Delta U = Q - W \quad \Delta Q = \Delta U + P\Delta V$$

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Second Law of Thermodynamics



$\Delta S = 0$; for reversible process

$\Delta S > 0$; for irreversible process

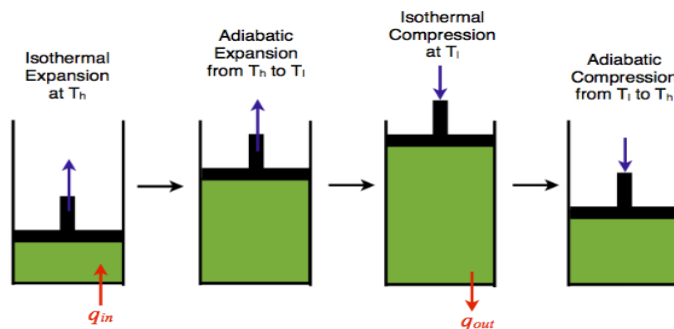
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22. In thermodynamics, what does the term 'enthalpy' refer to?

- The total heat content of a system
- The disorder or randomness in a system
- The energy required to change the temperature of a substance
- The pressure-volume work done by a system

23. This Figure represents

- e. Avogadro's law
- f. Carnot Engine Cycle for Ideal Gas
- g. Charles's and Gay-Lussac's Law
- h. None of Above



24. How is the state of a quantum mechanical system completely specified?

- a. By its time
- b. By its position in space
- c. By its wave function
- d. By its angular momentum

25. What principle does quantum chemistry primarily rely on?

- a. Conservation of mass
- b. Law of definite proportions
- c. Wave-particle duality
- d. Newton's laws of motion

26. Which principle is used in quantum chemistry to approximate the behavior of electrons in atoms?

- a. Boyle's law
- b. Schrödinger equation
- c. Avogadro's hypothesis
- d. Le Chatelier's principle

27. What is the probability density of a wave function $\phi(x,t)$ at time t in element of volume dv ?

- a. $\phi(x,t)$
- b. $\phi(x,t)dv$
- c. $\phi^*(x,t)dv$
- d. $\phi^*(x,t)\phi(x,t)dv$

28. In quantum chemistry, what does the Heisenberg Uncertainty Principle state?

- a. Energy levels are quantized
- b. It is impossible to know both the position and momentum of a particle simultaneously with absolute certainty
- c. Electrons orbit the nucleus in fixed paths
- d. Atoms are indivisible

29. What will happen during the electrolysis of aqueous solution of CuSO_4 by using platinum electrodes ?
- Copper will deposit at anode
 - Copper will deposit at cathode
 - Oxygen will be released at cathode
 - Copper will dissolve at anode
30. The reaction $A \leftrightarrow B$ has an equilibrium constant of $K = 10^{-4}$. Which one of the following statements is always correct ?
- The reaction is very favorable and will have mostly product B at equilibrium
 - The reaction will have 50% product B and 50% reactant A at equilibrium
 - The reaction is unfavorable and will not have very much product B at equilibrium
 - The equilibrium constant only relates to the speed of a reaction and not to the amount of product formed.
 - The reaction is at equilibrium
31. Contact angle is the angle formed in between phases.
- Zero
 - One
 - Three
 - Four
32. Is there a quantum mechanical operator for every observable in classical mechanics?
- Yes, obtained from quantum mechanical coordinates
 - Yes, obtained from classical Cartesian coordinates and conjugate momenta
 - No, only for certain observables
 - No, for no observables at all
33. By what term should the conjugate momenta be replaced by for conversion of classical observables to quantum mechanical operators ?
- $-i\hbar$
 - $-i\hbar \nabla^2$
 - $-\partial/\partial q$
 - $-i\hbar \partial/\partial q$
34. What are the possible measured values of observable A called ?
- Operators of A
 - Functions of A
 - Eigenvalues of A
 - Eigen functions of A
35. What is the mathematical probability of measuring eigenvalue of an observable for wave function ϕ in a volume of space dv ?
- $\phi \times v$
 - $\int \phi^* \phi dv$
 - $\int \phi dv$
 - $\int \phi^* \phi dv$

36. Is it possible for the probability density to ever have a negative value?

- a. Yes, because the square of a function is always positive
- b. No, because the square of a function is not always positive
- c. No, because the square of a function is not always positive
- d. No, because the square of function is always positive

37. Is the manifestation of a wavefunction square (to be probability density) a postulate of quantum mechanics?

- a. No
- b. Yes
- c. Depends on the wavefunction form
- d. Depends whether the wavefunction is a function of position or time

38. Can a wavefunction evolve in time ?

- a. Yes, it can evolve in time, but not in position
- b. No, it can neither evolve in time nor position
- c. Yes, it can evolve in time as well as in position
- d. No, it can only evolve in position

39. The wavefunction of a system changes with time according to the following equation:

$H\phi(x,t) = i\hbar\partial\phi(x,t)/\partial t$. What does the H term stand for ?

- a. Reduced Plank's constant
- b. Kinetic energy operator
- c. Hamiltonian of a wavefunction
- d. Angular momentum operator

40. The wavefunction of a system changes with time according to the following equation:

$H\phi(x,t) = i\hbar\partial\phi(x,t)/\partial t$. What does the $\hbar$ term stand for ?

- a. Angular momentum operator
- b. Kinetic energy operator
- c. Hamiltonian of a wavefunction
- d. Reduced Plank's constant

41. The wavefunction of a system changes with time according to the following equation:

$H\phi(x,t) = i\hbar\partial\phi(x,t)/\partial t$. Can this equation be integrated directly by variable separable ?

- a. No, because $\phi(x,t)$ cannot be integrated
- b. No, because $\phi(x,t)$ is simply a notation and not the wavefunction form itself
- c. Yes, because $\phi(x,t)$ appears on either side with one of them being a differential
- d. Yes, because the wavefunction terms can be moved to the right-hand side and integrated

42. What is the Pauli exclusion principle?

- a. The product of uncertainty of two variable pairs cannot exceed $h/2\pi$
- b. Two electron wavefunction systems must be antisymmetric to one another
- c. Wavefunctions can only exist in superposition of fundamental wavefunctions
- d. Electron wavefunctions must be unique to each individual electron

43. Are the postulates of quantum mechanics derived from other theories?

- a. No, postulates are rules that are not derived
- b. Yes, they are the microscopic cases for general relativity
- c. Yes, they are a special case of classical mechanics
- d. Yes, they are derived from thermodynamics and kinetics of atomic motion

44. Can a classical system's evolution in time depend upon the observer ?

- a. Yes, the system's evolution is purely dependent on the observer
- b. Yes, the system will evolve differently if observed
- c. No, it will evolve independent of the observer
- d. No, it will evolve depending on who the observer is

45. The square of the Schrödinger wave function is

- a. Not integrable.
- b. Equal to one.
- c. A probability density.
- d. Has no physical meaning.

46. What is the potential energy term in the Schrodinger equation for a particle outside the boundaries of a confined one-dimensional box?

- a. $V(x) = 0$
- b. $V(x) = \infty$
- c. $V(x) = -\infty$
- d. $V(x) = 1$

47. What is the shape of the wavefunction for the ground state quantum mechanical harmonic oscillator?

- a. Hermitian
- b. Poisson
- c. Gaussian
- d. Quadratic

- 48. What is the type of polynomial function that is a part of the harmonic oscillator wavefunction?**
- Monomial
 - Trinomial
 - Binominal
 - Hermite
- 49. The energy levels of one dimensional simple harmonic oscillator are**
- Degenerate and not equally spaced
 - Non degenerate and not equally spaced
 - Degenerate and equally spaced
 - Non degenerate and equally spaced
- 50. $\Psi(x,t)$ $2\Psi(x,t)$ represents**
- Probability of finding particle near position x at time t
 - Probability of finding particle at position x at time t
 - Probability density of finding particle at position x at time t
 - None of the above
- 51. in quantum mechanics behaves in same way as observable themselves in classical mechanics**
- Expectation values
 - Eigen functions
 - Eigen values
 - None of above
- 52. Schrodinger wave equation is usually used to determine**
- Momentum
 - Energy
 - Wavefunction
 - Speed of particle
- 53. Which of the following has degenerate energy states?**
- Particle in a cubical box
 - Particle in one dimensional potential well.
 - Three dimensional harmonic oscillator
 - Both A and C

54. Which of the following should be recorded in a laboratory notebook?

- a. Experimental procedures
- b. Raw data and observations
- c. Sources of experimental error
- d. All of the above

55. How can you calculate the rate constant of a reaction using experimental data?

- a. By calculating the pH change
- b. By plotting concentration vs. time and determining the slope
- c. By measuring the temperature change
- d. By weighing the reactants before and after the reaction

56. Which software is commonly used for data analysis in physical chemistry?

- a. Excel
- b. MATLAB
- c. Origin Lab
- d. All of the above

57. What is the first step you should take if a chemical spill occurs in the laboratory?

- a. Clean it up immediately with paper towels
- b. Ignore it and continue working
- c. Notify the instructor or lab supervisor
- d. Leave the lab immediately

58. Which of the following are common sources of experimental error in a physical chemistry lab?

- a. Human observational errors
- b. Instrument calibration errors
- c. Environmental changes
- d. All of the above

59. In kinetics, what does the Arrhenius equation describe?

- a. The equilibrium constant of a reaction
- b. The temperature dependence of reaction rates
- c. The pressure-volume relationship of gases
- d. The energy levels of electrons in an atom

- 60. What is the primary purpose of using a calorimeter in a laboratory setting?**
- To determine the pH of solutions
 - To separate mixtures based on boiling points
 - To analyze the color spectrum of compounds
 - To measure heat changes during chemical reactions
- 61. Which statistical method is commonly used to analyze variance in experimental data?**
- T-test
 - Linear regression
 - Chi-square test
 - ANOVA (Analysis of Variance)
- 62. Which statistical method is used to predict the relationship between variables in physical chemistry experiments?**
- Chi-square test
 - Regression analysis
 - ANOVA
 - T-test
- 63. What is the role of a buffer solution in a chemical experiment?**
- To increase the reaction rate
 - To maintain a stable pH
 - To act as a catalyst
 - To provide nutrients for bacteria
- 64. Which of the following are essential safety equipment in a chemistry laboratory?**
- Safety shower
 - Fume hood
 - Fire extinguisher
 - All of the above
- 65. What is the first step in preparing a laboratory notebook for an experiment?**
- Record the final results
 - Write the date and title of the experiment
 - Draw diagrams of expected outcomes
 - List all potential errors

66. What is the typical range of wavelengths for UV-Vis spectroscopy?

- a. 200-800 nm
- b. 2500-5000 nm
- c. 800-2500 nm
- d. 10-200 nm

67. Which technique would you use to separate components of a mixture based on their boiling points?

- a. Chromatography
- b. Centrifugation
- c. Distillation
- d. Filtration

68. What is the main purpose of using a fume hood in a laboratory?

- a. To store chemicals safely
- b. To protect users from inhaling hazardous fumes
- c. To enhance visibility during experiments
- d. To maintain room temperature

69. Which of the following are essential steps in performing a titration experiment?

- a. Using an appropriate indicator
- b. Standardizing the titrant
- c. Recording the initial and final volume readings
- d. All of the above

70. What is the most important step to take before starting any experiment in a physical chemistry lab?

- a. Prepare all solutions in advance
- b. Ensure all equipment is turned on
- c. Review the safety data sheets (SDS) for all chemicals involved
- d. Record initial observations

71. Which of the following should be included when recording experimental results in a laboratory notebook?

- a. Potential sources of error
- b. Date and time of the experiment
- c. Detailed observations and measurements
- d. All of the above

72. Which instrument would you use to measure the absorbance of a solution in a spectroscopy experiment?
- Calorimeter
 - Spectrophotometer
 - Thermocouple
 - Manometer
73. What is the standard electrode potential of a hydrogen electrode at 25°C?
- 0.76 V
 - 0.00 V
 - 0.34 V
 - 1.23 V
74. When analyzing kinetic data, which plot is typically used to determine the order of a reaction?
- Temperature vs. time plot
 - Rate vs. concentration plot
 - Pressure vs. volume plot
 - Absorbance vs. wavelength plot
75. Which of the following are essential components of a risk assessment in a chemistry laboratory?
- Evaluation of risks
 - Identification of hazards
 - Implementation of control measures
 - All of the above
76. What is the purpose of using a control sample in an experiment?
- To increase the reaction rate
 - To reduce experimental error
 - To provide a baseline for comparison
 - To enhance the color of the solution
77. What is the first step in ensuring safety before starting an experiment in a physical chemistry lab?
- Prepare all chemical solutions
 - Review the laboratory safety guidelines
 - Calibrate all instruments
 - Write down expected results
78. Which of the following should be included when recording experimental data in a laboratory notebook?
- Potential sources of error
 - Date and time of the experiment
 - Detailed observations and measurements
 - All of the above

- 79. Which technique is used to analyze the kinetic data of a reaction?**
- a. Pressure vs. volume plot
 - b. Rate vs. concentration plot
 - c. Temperature vs. time plot
 - d. Absorbance vs. wavelength plot
- 80. Which statistical method is often used to assess the precision of experimental data?**
- a. Dispersion
 - b. Standard deviation
 - c. Mean absolute error
 - d. Correlation coefficient
- 81. What is the primary purpose of a Material Safety Data Sheet (MSDS) in a chemistry laboratory?**
- a. To list the cost of chemicals
 - b. To describe the color and odor of chemicals
 - c. To offer recipes for chemical mixtures
 - d. To provide detailed information on chemical hazards and safe handling practices
- 82. How does an increase in ionic concentration affect the conductivity measured during a reaction?**
- a. Decreases conductivity
 - b. Increases conductivity
 - c. No effect on conductivity
 - d. Fluctuates randomly

General Chemistry

1. Which one of the following is a chemical change?
 - a. Dissolving Table salt in water.
 - b. Freezing water into ice.
 - c. Conversion of liquid water into vapor
 - d. Burning H_2 in O_2 to form H_2O
2. What is the molecular formula of the compound which has contains carbon (C), Hydrogen (H), and oxygen (O) and contains 12 g (C), 1 g (H), and 32 g (O) giving that its molecular mass is 90 amu?
 - a. $C_2H_4O_2$
 - b. $C_2H_4O_4$
 - c. $C_2H_2O_4$
 - d. $C_4H_4O_2$
3. Which of the following compounds has the most ionic characters?
 - a. $MgCl_2$
 - b. $AlCl_3$
 - c. $NaCl$
 - d. $PbCl_2$
4. Which of the following elements is a metalloid?
 - a. F
 - b. Na
 - c. Si
 - d. Ba

[illegible]

5. Which of the following elements is an alkaline earth metals?

- a. Na
- b. Mg
- c. Ne
- d. K

The Periodic Table

The periodic table is color-coded and labeled as follows:

- Alkali Metals:** Group 1 (Li, Na, K, Rb, Cs, Fr)
- Alkaline Earth:** Group 2 (Be, Mg, Ca, Sr, Ba, Ra)
- Transition Metals:** Groups 3-10 (Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, Ge, As, Se, Br, Kr)
- Halogens:** Group 17 (F, Cl, Br, I, At)
- Noble Gases:** Group 18 (He, Ne, Ar, Kr, Xe, Rn)
- Lanthanides:** Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu
- Actinides:** Th, Pa, U, Np, Pu, Am, Cm, Bk, Cf, Es, Fm, Md, No, Lr

6. Which of the following elements has the most basic oxide?

- a. Na
- b. Al
- c. Cs
- d. Mg

Types of Oxides

Li	Be	B	C	N	O	F
Na	Mg	Al	Si	P	S	Cl
K	Ca	Ga	Ge	As	Se	Br
Rb	Sr	In	Sn	Sb	Te	I
Cs	Ba	Th	Pb	Bi	Po	At
Basic		Amphoteric		Acidic		

reacts with oxygen to form basic oxide

reacts with oxygen to form amphoteric oxide

reacts with oxygen to form acidic oxide

no reaction: argon is inert

11	12	13	14	15	16	17	18
Na	Mg	Al	Si	P	S	Cl	Ar
Sodium 22.99	Magnesium 24.31	Aluminum 26.98	Silicon 28.09	Phosphorus 30.97	Sulfur 32.06	Chlorine 35.45	Argon 39.95

7.

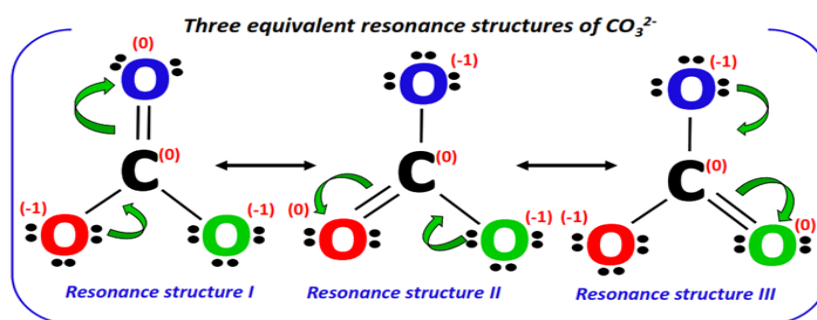
What is the

approximate pH value of 0.1M aqueous solution of acetic acid ($K_a = 1.8 \times 10^{-5} \text{ mol.L}^{-1}$)

- a. 8.2
- b. 5.2
- c. 2.8
- d. 1.8

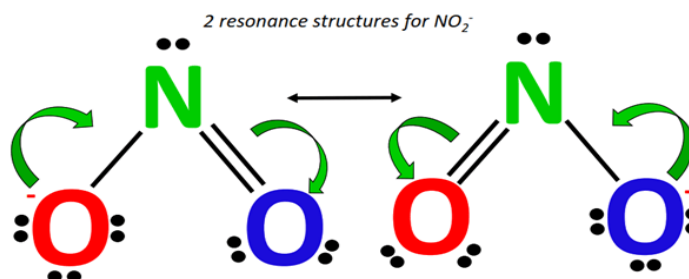
8. How many resonance structures are there for carbonate anion; CO_3^{2-} ?

- a. 5
- b. 4
- c. 3
- d. 2



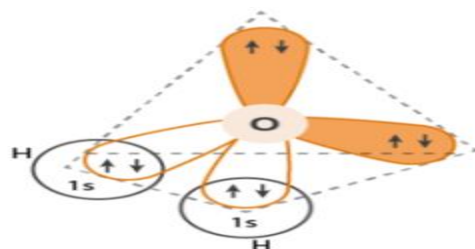
9. How many resonance structures are there for carbonate anion; NO_2^- ?

- a. 2
- b. 3
- c. 4
- d. 5

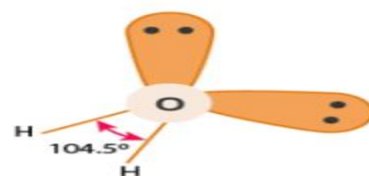


10. What is the molecular structure of water molecule, H_2O ?

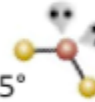
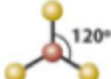
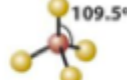
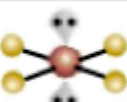
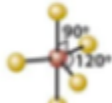
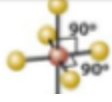
- a. Tetrahedral
- b. Trigonal planar
- c. V-shaped (Bent shaped)
- d. Octahedral

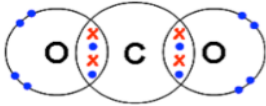
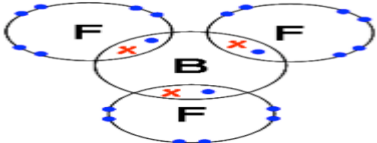
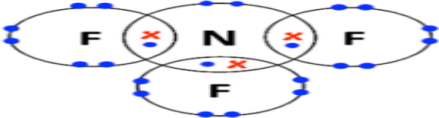
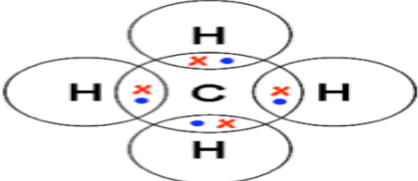
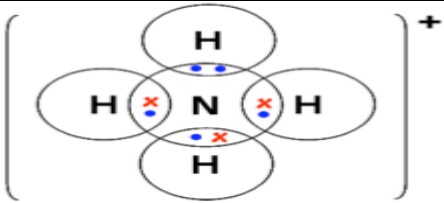
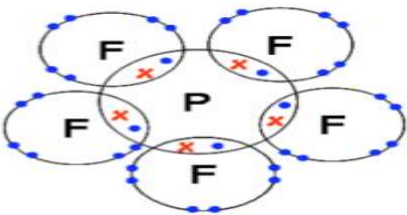
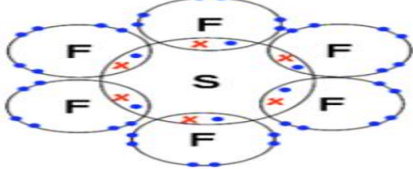


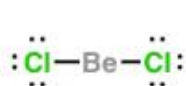
Orbital overlap in H₂O



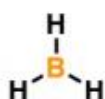
Bent shape

bonding pairs	lone pairs	shape and bond angles
2	0	linear 
2	1	non-linear $120 - 2.5 = 117.5^\circ$ 
2	2	non-linear $109.5 - 2 \times 2.5 = 104.5^\circ$ 
3	0	trig. planar 
3	1	pyramidal $109.5 - 2.5 = 107^\circ$ 
4	0	tetrahedral 
4	2	square planar 
5	0	trig. bipyramidal 
6	0	octahedral 

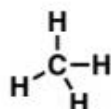
Shape	
	NON-LINEAR
	BENT or V-shaped
	LINEAR
	
	TRIGONAL PLANAR.
	PYRAMIDAL.
	TETRAHEDAL
	
	TRIGONAL BIPYRAMIDAL
	OCTAHEDRAL.



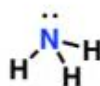
Beryllium
dichloride
 BeCl_2
linear



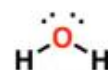
Borane
 BH_3
trigonal planar



Methane
 CH_4
tetrahedral



Ammonia
 NH_3
trigonal pyramidal

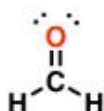


Water
 H_2O
bent

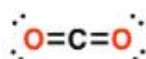


Hydrofluoric
acid
 HF
linear

Also applies to molecules with multiple bonding:



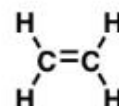
Methanal
(formaldehyde)
trigonal planar



Carbon dioxide
linear

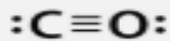


Ethyne
(acetylene)
linear



Ethene
(ethylene)
*both carbons are
trigonal planar*

Lewis Structure Examples



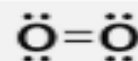
Carbon
monoxide



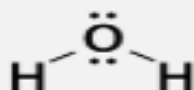
Hydrogen
cyanide



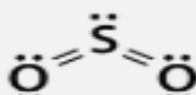
Nitrogen



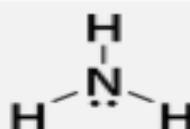
Oxygen



Water



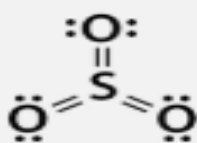
Sulfur dioxide



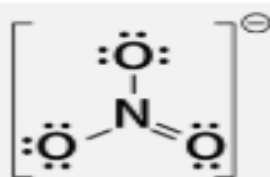
Ammonia



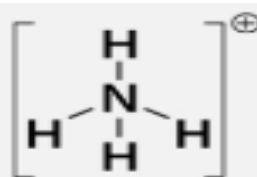
Ozone



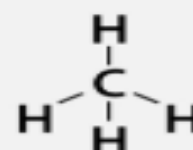
Sulfur trioxide



Nitrate



Ammonium



Methane

11. Which factors can affect the measurement of standard electrode potentials?

- a. Concentration of ions
- b. Temperature
- c. Pressure
- d. All of the above

12. What is the primary function of an electrolyte in a fuel cell?

- a. To act as a catalyst
- b. To conduct ions between the anode and cathode
- c. To conduct electrons between the anode and cathode
- d. To provide structural support

Standard temperature and pressure (STP)

- a. Temperature = 0°C (273 K)
- b. Mole = 1 mole
- c. Pressure = 1 atm
- d. volume = 22.41 L

13. An ideal gas of 10 moles occupies..... volume.

- a. 224 liters
- b. 22.4 liters
- c. 2.24 liters
- d. 2240 liters

$$PV=nRT$$

where,

P is the pressure.

V is the volume.

n is the amount of substance.

R is the ideal gas constant.

Boyle's Law

$$V \propto \frac{1}{P}$$

Charles's Law

$$V \propto T$$

Avagadro's Law

$$V \propto n$$



Always convert the temperature to Kelvin when solving a gas problem:

$$K = ^\circ C + 273$$

14. What is the volume occupied by 2.34 grams of carbon dioxide gas at STP?

$$V=nRT/P$$

$$V=[(2.34g/44g.mol^{-1})(0.08206Latmmol^{-1}K^{-1})(273.0K)]/1.00atm$$

$$V=1.19L$$

15. Calculate the temperature at which 0.654 moles of neon gas occupies 12.30 litres at 1.95 atmospheres.

$$T=PV/nR$$

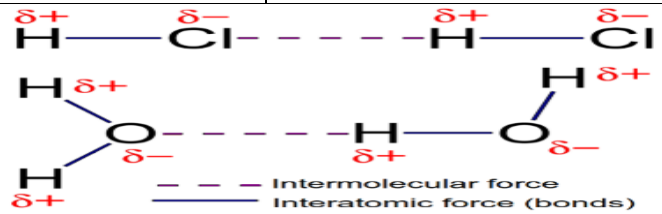
$$T=(1.95atm)(12.30L)/(0.654mol)(0.08206Latmmol^{-1}K^{-1})$$

$$T=447K$$

16. At a constant temperature, the pressure of a gas is given as one atmospheric pressure and 5 liters. When the atmospheric pressure is increased to 2 atm, then what is the volume of the gas?
- 1 liter
 - 2.5 liters
 - 5 liters
 - 10 liters

$$\frac{P_1}{P_2} = \frac{V_1}{V_2}$$

17. What is the name of the graph that is drawn, when the temperature is kept constant?
- Isobar
 - Isotherm
 - Isochoric
 - Isochoric and isobar
18. What are the forces of attraction and repulsion between interacting molecules known as
- attractive forces
 - repulsive forces
 - intermolecular forces
 - intramolecular forces

Intramolecular forces	Intermolecular forces
are the forces that hold atoms together within a molecule.	are forces that exist between molecules.
	

19. London force is also known as
- van der Waals forces
 - dispersion force
 - hydrogen bonding
 - covalent bonds
20. HCl is an example of
- london interaction
 - dipole-dipole interactions
 - dipole-induced dipole interactions
 - van der waals interaction

21. Hydrogen bond plays a vital role in determining substance properties and structure. Which of the following may not an example?

- a. Water
- b. Methane
- c. Proteins
- d. Nucleic acids

22. The value of equilibrium constant for different chemical reactions at a particular temperature is

- a. the same
- b. cannot say
- c. constant
- d. unique

23. What does it indicate having a higher equilibrium constant?

- a. rate of backward reaction is faster
- b. reaction occurs faster
- c. both the backward and forward reactions are equal
- d. reaction may be slower than usual



$$K = \frac{\overbrace{[C]^c [D]^d}^{\text{products}}}{\underbrace{[A]^a [B]^b}_{\text{reactants}}}$$

24. What is the equilibrium constant of the following reaction: $4\text{NH}_3 + 5\text{O}_2 \rightarrow 4\text{NO} + 6\text{H}_2\text{O}$?

- a. $\frac{[\text{NO}][\text{H}_2\text{O}]}{[\text{NH}_3][\text{O}_2]}$
- b. $\frac{[\text{C}]^c [\text{D}]^d}{[\text{A}]^a [\text{B}]^b}$
- c. $\frac{[\text{NO}]^4 [\text{H}_2\text{O}]^6}{[\text{NH}_3]^4 [\text{O}_2]^5}$
- d. $\frac{[\text{NH}_3]^4 [\text{O}_2]^5}{[\text{NO}]^4 [\text{H}_2\text{O}]^6}$

25. If the initial concentrations of reactants in a reaction increase then the equilibrium constant....

- a. decreases
- b. also increases
- c. remains constant
- d. may increase or decrease

26. If we use activities in place of molar concentration in an equilibrium constant expression then what is the dimension of k?

- a. cannot predict it
- b. it becomes dimensionless
- c. the same units of molar concentration
- d. units are related to the activity

27. When analyzing kinetic data, which plot is typically used to determine the order of a reaction?

- a. Temperature vs. time plot
- b. Rate vs. concentration plot
- c. Pressure vs. volume plot
- d. Absorbance vs. wavelength plot

28. The primary reagent of the acidic radicals of 1st group is

- a. Diluted NaOH
- b. Diluted HCl
- c. Concentrated H₂SO₄
- d. Fehling's Solution

29. The separation of the basic radicals into various groups is based on the knowledge of

- a. pH
- b. Atomic Size
- c. Solubility Product
- d. Electronegativity

Number of moles of solute dissolved in 1 Liter of the solution is known as

- a. Actual Yield
- b. Molarity
- c. Molality
- d. Weight Percent

Molarity (M) is defined as the number of moles of a solute per liter of solution

30. How many moles of NaCl are in 1.85 Liter of 0.25 Molar NaCl solution?

- a. 0.25 mol
- b. 0.40 mol
- c. 0.55 mol
- d. 0.46 mol

$$\left. \begin{array}{l} \text{Molarity of} \\ \text{the solution} \end{array} \right\} = \frac{\text{No. of moles of the solute}}{\text{Volume of solution}}$$

31. What is the concentration of a solution prepared by adding water to 25.0 mL of 6.00 Molar NaOH to a total of 500.0 mL?

- a. 0.61 M
- b. 0.30 M
- c. 0.25 M
- d. 0.84 M

$$M_1 V_1 = M_2 V_2$$

- $M_1 = 6.00 \text{ M}$
 - $V_1 = 25.0 \text{ mL} = 0.0250 \text{ L}$
 - $M_2 = ?$
 - $V_2 = 500.0 \text{ mL} = 0.500 \text{ L}$
- $$6.00 \text{ M} \times 0.0250 \text{ L} = M_2 \times 0.500 \text{ L}$$
- $$M_2 = (6.00 \text{ M} \times 0.0250 \text{ L}) / 0.500 \text{ L} = 0.300 \text{ M}$$

32. A solution which resist changes in pH when small amounts of acid or base is added to them is called

- a. Catalyst
- b. Buffers Solution
- c. Indicator
- d. Aqueous Solution

Analytical Chemistry

1. The mass of one atom of the element compared with the mass of an atom of carbon-12 which is arbitrarily assigned as 12.00 amu

- a. Relative molecular mass
- b. Relative atomic mass
- c. Relative molar mass
- d. None of them

2. How many moles are present in 4g of sodium hydroxide?

- a. 0.5 mole
- b. 3 mole
- c. 2 moles
- d. 0.1 mole

- Number of moles = $4 \text{ g} / 39.996 \text{ g/mol}$
- Number of moles of NaOH = 0.100 moles

Number of moles = Mass of substance / Molecular mass of a substance

3. The solution whose concentration is known:

- a. Blank solution
- b. Standard solution
- c. Unknown solution
- d. Buffer solution

4. The difference between end point and equivalence point.

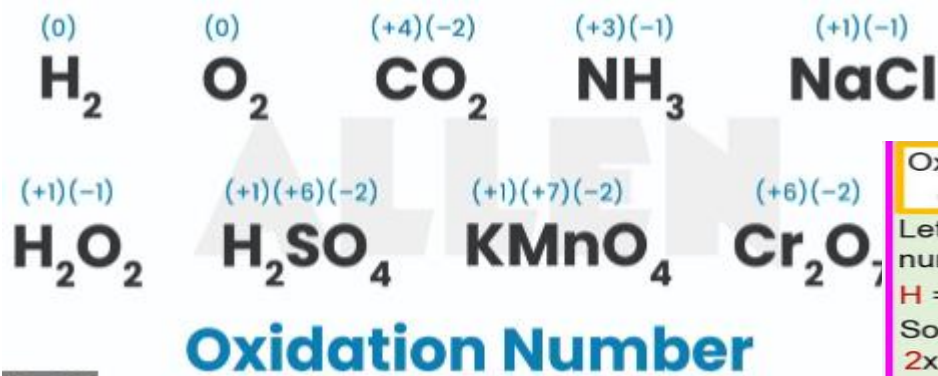
- a. End point
- b. Titration error
- c. Equivalent point
- d. None of them

5. The negative decimal logarithms of the free hydrogen ionic concentration.

- a. p_{Kw}
- b. pH
- c. pOH
- d. K_{Sp}

6. Methyl orange is generally used in the titration of HCl with sodium carbonate.

- a. As methyl orange is sensitive to carbon dioxide.
- b. As methyl red is sensitive to carbon dioxide
- c. As phenolphthalein is sensitive to carbon dioxide.
- d. None of them



Oxidation number of S in H_2SO_4

Let the oxidation number of S be x

H = +1 and O = -2

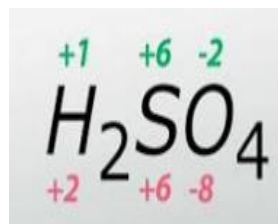
So---

$$2x(+1) + x + 4x(-2) = 0$$

Or, $x = +6$

7. The oxidation number of S in H_2SO_4 is

- a. +4
- b. -6
- c. +6
- d. -8



8. The Oxidation number of S in SO_4^{2-} is

- a. +6
- b. -6
- c. -2
- d. +4

Calculate the oxidation number of S in SO_4^{2-}

$$\begin{aligned}
 &\text{SO}_4^{2-} \\
 &x + 4(-2) = -2 \\
 &x - 8 = -2 \\
 &x = -2 + 8 \\
 &x = +6 \\
 &\text{S} = +6
 \end{aligned}$$

9. AgCl is less soluble in aqueous NaCl than pure water.

- a. Due to the pH effect
- b. Due to the common ion effect
- c. Due to the temperature effect
- d. None of them

10. Indicator electrode

- a. An insensitive electrode for the analyte concentration
- b. An electrode that has constant potential
- c. An electrode that has variable potential
- d. An electrode that has constant temperature

11. Mobility:

- a. A conductance of the equivalent weight of the substance.
- b. A conductance of a one cubic cm of a liquid (1cm^3).
- c. A conductance of the equivalent weight of the substance at infinite dilution.
- d. All of the above

12. The fluorescence intensity of benzene is less than that of naphthalene.

- a. Because the ring number of benzene is higher than that of naphthalene.
- b. Because the ring number of benzene is less than that of naphthalene.
- c. Because the ring number of benzene is equal to than that of naphthalene.
- d. All of the above

13. The equivalent conductance of HCl is higher than that of NaCl because:

- a. The solubility of HCl is higher than that of NaCl.
- b. The equivalent weight of HCl is less than that of NaCl.
- c. The acidity of HCl is higher than that of NaCl.
- d. All of the above

14. The ratio of the number of molecules that luminesce to the total number of excited molecules.

- a. Phosphorimetry
- b. Fluorimetry
- c. Quantum yield .
- d. Excitation

15. A process in which a chemical species in a transparent medium selectively absorbs certain frequencies of electromagnetic radiation.

- a. Relaxation
- b. Absorption
- c. Excitation
- d. Reflection

16. Retention time (R_t)

- a. The required time for an unretained species to pass through the column.
- b. The periodic time between the injections the sample and the appearance of a solute peak at the detector of a chromatographic column.
- c. Parameter that is widely used to describe the migration rates of solutes on columns.
- d. None of them

17. A process that allows the separation of ions and polar molecules based on the charge properties of the molecules.

- a. Column Resolution
- b. Solvent Extraction
- c. Ionic Exchange Chromatography
- d. Chromatogram

18. The ability of chromatographic column increases as the resolution of column is ...

- a. Decreased
- b. Increased
- c. Be constant
- d. None of them

19. The percent extracted when 4.0 mmole of butyric acid dissolved in 40 mL of water and shaken with 20 mL ether if you know that 2.0 mmole of this acid was extracted.

- a. 70%
- b. 92%
- c. 50%
- d. 20%

$$\%E = \frac{100 \times \text{m mol extracted}}{\text{Total m mol in aqueous phase}}$$

$$\% E = \frac{100 \times 2.0}{4} = 50$$

(%E): Percent extraction or efficiency of extraction

20. The extraction technique can be used for separation of solute at any concentration.

- a. To get the reproducible retention time values.
- b. Because the extraction efficiency independent the concentration of solute
- c. Because the extraction efficiency depends on the concentration of solute
- d. None of them

21. The molar absorptivity of colored solution show an absorbance of 0.1 if the concentration of the solution was 0.05 M and bath length = 1 cm.

- a. 10 L/mol. cm
- b. 5 L/mol. cm
- c. 2 L/mol. cm
- d. 7 L/mol. cm

$$\text{Molar Absorptivity} = \frac{\text{Absorbance}}{\text{Concentration} \times \text{Length of Light Path}}$$

$$\epsilon = \frac{0.1}{0.05 \times 1}$$

$$\epsilon = \frac{A}{C \times l}$$

22. Isoelectric point

- a. The pH value at which the net charge on the molecule is -1.
- b. The pH value at which the net charge on the molecule is + 1.
- c. The pH value at which the net charge on the molecule is +2.
- d. The pH value at which the net charge on the molecule is zero.

23. **A chromatogram is useful for**
- Quantitative analysis only
 - Qualitative analysis only
 - Both qualitative and quantitative analysis
 - None of them
24. **Retention factor equals**
- Distance traveled by solvent /distance traveled by solute
 - Distance traveled by solute/distance traveled by solvent
 - Distance traveled by solute - distance traveled by solvent
 - Distance traveled by solute + distance traveled by solvent
25. **The λ_{max} can be determined by plotting**
- Absorbance against speed in graph
 - Absorbance against wavelength in graph
 - Absorbance against frequency in graph
 - Absorbance against wave number in graph
26. **In the spectrophotometric determination of Fe^{3+} , 2 mL of the conc HNO_3 should be added.**
- To increase hydrolysis of Fe^{3+}
 - To decrease hydrolysis of Fe^{3+}
 - To prevent hydrolysis of Fe^{3+}
 - None of them
27. **In the titration mixture of $[\text{HCl} + \text{CH}_3\text{COOH}]$, the analyte solution will be colorless at start point and faint pink at end point in the case of**
- M.R indicator
 - Ph.ph indicator
 - M.O indicator
 - E. B.T indicator
28. **In the titration mixture of $[\text{NaOH} + \text{NH}_4\text{OH}]$, the analyte solution will be pink at start point and colorless at end point in the case of**
- M.R indicator
 - M.O indicator
 - E. B.T indicator
 - Ph.ph indicator

29. The weight of oxalic acid ($\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$) is required to prepare 500 ml 0.10 N solution.

- a. 11.50 g
- b. 15.2 g
- c. 3.15 g
- d. 7.30 g

For hydrated oxalic acid, $(\text{COOH})_2 \cdot 2\text{H}_2\text{O}$, molar mass is 126 g/mol.

Equivalent weight = $M/2 = 63$

Meq. of oxalic acid = $500 \times 0.1 = 50$

$w/E \times 1000 = 50$

$w = 126/2 \times 50 \times 1000 = 3.15 \text{ g}$

Hence, mass of oxalic acid required is 3.15 g.

30. Concentrated hydrochloric acid contains 37% HCl (by mass). The density of this solution is 1.18 g/mL. The molarity of the solution is:

- a. 9 M
- b. 10 M
- c. 12 M
- d. 7.5 M

31. The volume required to prepare 100 ml of HCl 6.0M starting from conc. HCl 37%w/w ,Density =1.18

- a. 100 mL
- b. 75 mL
- c. 50 mL
- d. 25 mL

$$M_1 \times V_1 = M_2 \times V_2$$

$$6.0 \times 100 = 12 \times V_2$$

$$V_2 = \frac{6.0 \times 100}{12} = 50$$

$$\text{Molarity} = \frac{\text{moles of solute}}{\text{volume of solution in litre}}$$

Given : Mass of solute (by mass) = 37%

$$d = 1.18 \text{ g/mL}$$

Molecular mass of $\text{HCl} = 1 + 35.5$

$$= 36.5 \text{ g/mol}$$

$$\text{Volume of solute} = \frac{\text{mass of solute}}{\text{density of solution}}$$

$$= \frac{100 \text{ g}}{1.18 \text{ g/mol}} = 85 \text{ mol}$$

$$= 85 \text{ cm}^3 = 0.85 \text{ dm}^3$$

Moles of solute (HCl)

$$= \frac{\text{mass of solute}}{\text{molecular mass of solute}}$$

$$= \frac{37 \text{ g}}{36.5 \text{ g/mol}}$$

$$= 1.01 \text{ mol}$$

$$\therefore \text{molarity of solution} = \frac{1.01 \text{ mol}}{0.085 \text{ dm}^3}$$

$$= 12.0 \text{ mol dm}^3$$

$$= 12.0 \text{ M}$$

32. The Molarity (M) of 1.50 g of K_2SO_4 (Molecular weight = 174.2) dissolved in a volume of 250 ml is

- a. 0.500 M
- b. 0.024 M
- c. 0.034 M
- d. 0.070 M

Inorganic Chemistry

13. The intense purple color of KMnO_4 is due to.....
- Ligand spectra
 - d-d transition
 - Charge transfer transition
 - Counter ion spectra
14. Which of the following represents the result of substitution reaction of octahedral complexes via dissociative mechanism and square pyramidal intermediate?
- Mixture of isomers
 - Isomerization
 - Retention of configuration
 - Stereochemical change
15. What is the type of isomerism between the following pair of isomers $[\text{Mn}(\text{CO})_5\text{NO}_2]$ and $[\text{Mn}(\text{CO})_5\text{ONO}]$?
- Linkage isomerism
 - Ionization isomerism
 - Hydrate isomerism
 - Coordination isomerism
16. Which of the following organometallic compounds obeys 18-electrons Rule?
- $\text{Mn}(\text{CO})_5$
 - $\text{V}(\text{CO})_6$
 - $\text{MnMe}(\text{CO})_5$
 - $\text{Co}(\text{C}_5\text{H}_5)_2$
17. In the atomic structure, which particles have a positive charge?
- Electrons
 - Neutrons
 - Protons
 - Atoms
18. How many neutrons and protons are in the atom of the isotope of Nitrogen; $^{14}_7\text{N}$?
- 7 neutrons and 6 protons
 - 14 neutrons and 7 protons
 - 7 neutrons and 7 protons
 - 10 neutrons and 7 protons

19. The correct electron configuration for Chlorine is:

- a. $[\text{Kr}]5s^2$
- b. $[\text{Ne}]3s^2 3p^5$
- c. $[\text{Ar}]4s^2$
- d. $[\text{Xe}]6s^2$

20. What is the oxidation state of the elements in the sixth group 6A?

- a. -1
- b. -2
- c. +1
- d. +2

21. Which of the following elements has the lowest ionization energy; (N, P, As, Sb)?

- a. N
- b. P
- c. As
- d. Sb

22. What is the electronic arrangement of central metal in the complex ion $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ according to crystal field theory (CFT)?

- a. $t_{2g}^4 e_g^1$
- b. $t_{2g}^2 e_g^4$
- c. $t_{2g}^3 e_g^3$
- d. $t_{2g}^4 e_g^2$

23. What is the maximum number of bonds can a carbon atom form?

- a. 4
- b. 1
- c. 2
- d. 3

24. What is the type of interaction of hard acid with hard base according to HSAB principle?

- a. Polar covalent interaction
- b. Mostly covalent interaction
- c. Mostly Ionic interaction
- d. None of them

25. What is the number of microstates of p^2 configuration?

- a. 20
- b. 10
- c. 15
- d. 45

26. What is the bond order in N₃ Molecule?

- a. 2
- b. 1
- c. 2.5
- d. 3

27. Which of the following complex ion shows geometrical isomerism?

- a. [Pt(NH₃)₃Cl]
- b. [Cr(H₂O)₄Cl]²⁺
- c. [Co(NH₃)₆]³⁺
- d. [Co(CN)₅(NC)]³⁻

28. What is the Geometrical shape of the [Mn(H₂O)₆]²⁺

- a. Linear
- b. Octahedral
- c. Tetrahedral
- d. Square pyramidal

29. What is the scientific name of the compound K₃[Fe(CN)₆]?

- a. Potassium hexacyanoiron(III)
- b. Sodium hexacyanoiron(II)
- c. Potassium hexacyanoferrate(III)
- d. Sodium tetracyanoferrate(III)

30. Which one of these elements is non-metal in group 4A?

- a. Germanium
- b. Carbon
- c. Silicon
- d. Tin

31. A compound has formula XF₄. Element X cannot be:

- a. Si
- b. Sn
- c. Sc
- d. C

- 32. Which of the following is correct to determine the magnetic behavior of a transition metal complex?**
- The distance between the metal ion and the ligands in the coordination sphere.
 - The number of paired and unpaired electrons in the d-orbitals of the metal ion.
 - The overall size of the transition metal complex and its molecular geometry.
 - The number of ligands surrounding the metal ion, regardless of the electronic configuration.
- 33. What is the cause of the main characteristics of transitions metals (colored compounds - paramagnetic compounds - variable oxidation states)?**
- Empty (d or f) sublevels
 - Completely filled (d or f) sublevels
 - Partially filled (d or f) sublevels
 - Partially filled (s or p) sublevels
- 34. What is the document that contains information on the potential hazards (health, fire, reactivity and environmental) and how to work safely with the chemical product?**
- Heating Safety
 - Material Safety Data Sheet
 - Electrical Safety
 - Glassware's Safety
- 35. What is the color of the copper (II) sulfate pentahydrate solution?**
- Blue
 - Green
 - Red
 - Yellow
- 36. What is the type of Mohar Salt; $(\text{NH}_4)_2\text{SO}_4 \cdot \text{Fe}(\text{SO}_4) \cdot 6\text{H}_2\text{O}$?**
- Simple salt
 - Chelate
 - Double salt
 - Molecular compound
- 37. What is the coordination number of $[\text{Ni}(\text{NH}_3)_2\text{Cl}_2]$ complex?**
- 6
 - 2
 - 4
 - 3

38. What is the instrument used to measure the magnetic susceptibility of the compounds?

- a. Spectrometer
- b. Colorimeter
- c. Thermometer
- d. Gouy Magnetic Balance

39. Electromagnetic radiation in the wavelength range of 200 nm to 390 nm is classified as:

- a. NMR spectrum
- b. Infrared spectrum
- c. Visible spectrum
- d. Ultraviolet spectrum

40. Which of the following high spin complex ions has three absorption bands in UV-visible absorption spectrum?

- a. $[\text{Cr}(\text{H}_2\text{O})_6]^{2+}$
- b. $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$
- c. $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$
- d. $[\text{Sc}(\text{H}_2\text{O})_6]^{2+}$

41. Which of the following techniques is concerned with studying d-d electronic transition?

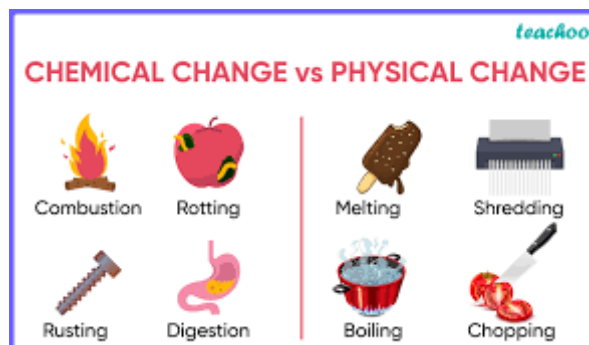
- a. X-ray diffraction
- b. IR spectroscopy
- c. UV-visible spectroscopy

NMR spectr

Inorganic Chemistry

33. Which one of the following is a chemical change?

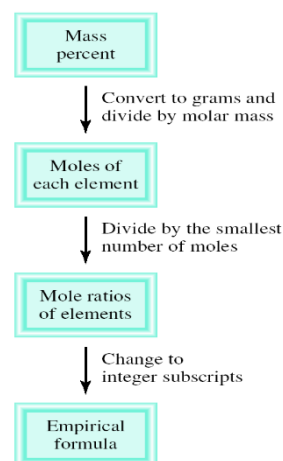
- A. Dissolving Table salt in water.
- B. Freezing water into ice.
- C. Conversion of liquid water into vapor
- D. Burning H_2 in O_2 to form H_2O



34. What is the molecular formula of the compound which contains carbon (C), Hydrogen (H), and oxygen (O) and contains 12 g (C), 1 g (H), and 32 g (O) giving that its molecular mass is 90 amu?

- A. $C_2H_4O_2$
- B. $C_2H_4O_4$
- C. $C_2H_2O_4$
- D. $C_4H_4O_2$

	C	H	O
Mass	12	1	32
Moles	$12/12=1$	$1/1=1$	$32/16=2$
	1	1	2



35. Which of the following compounds has the most ionic characters?

- A. $MgCl_2$
- B. $AlCl_3$
- C. $NaCl$
- D. $PbCl_2$

36. Which of the following elements is a metalloid?

- A. F
- B. Na
- C. Si

D. Ba

Standard periodic table showing elements grouped by color-coded regions: METALS (blue), METALLOIDS (orange), and NONMETALS (green). The table includes all elements from Hydrogen (H) to Oganesson (Og), with Lanthanides and Actinides shown separately at the bottom.

37. Which of the following elements is an alkaline earth metals?

- A. Na
- B. Mg
- C. Ne
- D. K

The Periodic Table

Periodic table with groups labeled: Alkali Metals, Alkaline Earth, Transition Metals, Halogens, and Noble Gases. The table includes all elements from Hydrogen (H) to Oganesson (Og), with Lanthanides and Actinides shown separately at the bottom.

38. Which of the following elements has the most basic oxide?

- A. Na
- B. Al
- C. Cs

Periodic table showing the types of oxides: Basic, Amphoteric, and Acidic. The table includes all elements from Hydrogen (H) to Oganesson (Og), with Lanthanides and Actinides shown separately at the bottom.

D. Mg

reacts with oxygen to form basic oxide		reacts with oxygen to form amphoteric oxide		reacts with oxygen to form acidic oxide			no reaction: argon is inert	
11	12	13	14	15	16	17	18	
Na	Mg	Al	Si	P	S	Cl	Ar	
Sodium 22.99	Magnesium 24.31	Aluminum 26.98	Silicon 28.09	Phosphorus 30.97	Sulfur 32.06	Chlorine 35.45	Argon 39.95	

C. 1.5

D. 2.5

39.

How many moles

are there in 27 g of H₂O?

A. 2.0

B. 1.0

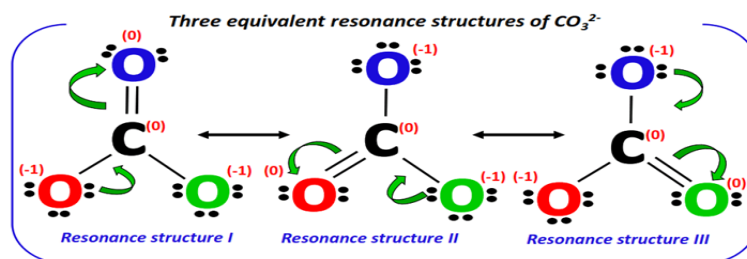
40. How many resonance structures are there for carbonate anion; CO₃²⁻?

A. 5

B. 4

C. 3

D. 2



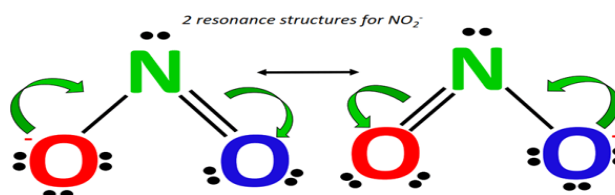
41. How many resonance structures are there for carbonate anion; NO₂⁻?

A. 2

B. 3

C. 4

D. 5



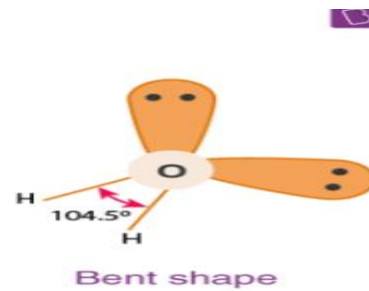
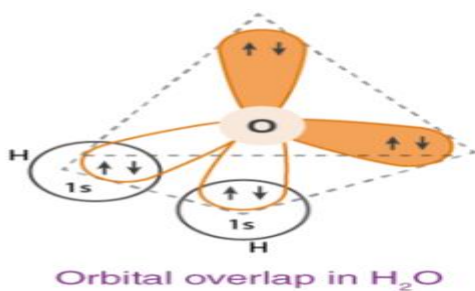
42. What is the molecular structure of water molecule, H₂O?

A. Tetrahedral

B. Trigonal planar

C. V-shaped (Bent shaped)

D. Octahedral



43. What is the electron pair geometry of water molecule, H₂O?

- A. Tetrahedral
- B. Trigonal planar
- C. V-shaped (Bent shaped)
- D. Octahedral

44. What is the molecular structure of SF₆ molecule?

- A. Tetrahedral
- B. Trigonal planar
- C. V-shaped (Bent shaped)

D. Octahedral

42. What is the type of hybridization of the central metal of the complex [Zn(NH₃)₄]²⁺ ?

- A. sp³
- B. sp²
- C. sp³d²
- D. sp

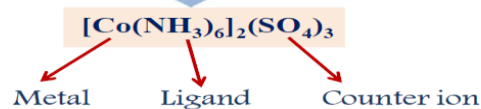
43. How many moles are there in 500 mL of 0.1 M NaOH solution?

- A. 5 moles
- B. 0.5 moles
- C. 50 moles
- D. 0.05 moles

44. The intense purple color of KMnO₄ is due to.....

- A. Ligand spectra
- B. d-d transition
- C. Charge transfer transition
- D. Counter ion spectra

Electronic Spectra Complexes



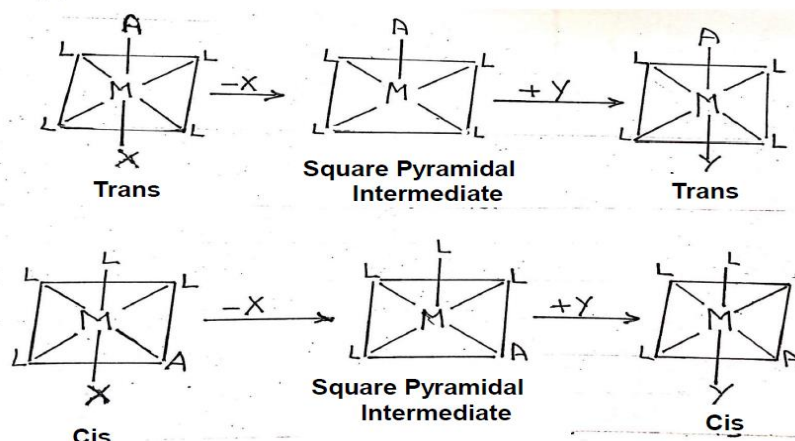
❖ Types of spectra of transition metal complexes

- 1) Ligand Spectra
- 2) Counter-ion Spectra
- 3) Charge transfer spectra
- 4) d-d transition spectra

45. Which of the following represents the result of substitution reaction of octahedral complexes via dissociative mechanism and square pyramidal intermediate?

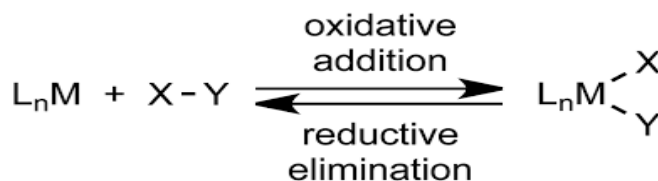
- A. Mixture of isomers
- B. Isomerization
- C. Retention of configuration
- D. Stereochemical change

square-pyramidal intermediate



46. What is the type of the reaction of organometallic compounds that results in increasing the oxidation state increases by 2 units?

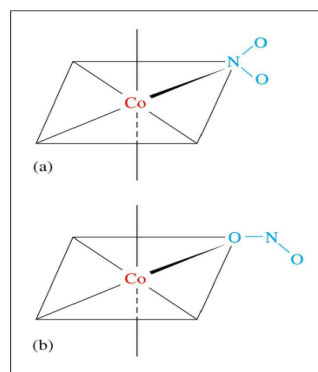
- A. Oxidative addition
- B. Reductive elimination
- C. Attack at ligand
- D. Migration of ligand



47. What is the type of isomerism between the following pair of isomers $[\text{Mn}(\text{CO})_5\text{NO}_2]$ and $[\text{Mn}(\text{CO})_5\text{ONO}]$?

- A. Linkage isomerism
- B. Ionization isomerism
- C. Hydrate isomerism
- D. Coordination isomerism

Linkage Isomerism of NO_2^-



48. What is the type of isomerism between the following pair of isomers $[\text{Co}(\text{NH}_3)_5\text{Br}]\text{SO}_4$ and $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Br}$?

- A. Ionization isomerism
- B. Hydrate isomerism
- C. Linkage isomerism
- D. Coordination isomerism

49. Which of the following organometallic compounds obeys 18-electrons Rule?

- A. $\text{Mn}(\text{CO})_5$
- B. $\text{V}(\text{CO})_6$
- C. $\text{MnMe}(\text{CO})_5$
- D. $\text{Co}(\text{C}_5\text{H}_5)_2$

50. Which of the following organometallic compounds obeys Effective Atomic Rule (EAR) Rule?

- A. $[\text{Fe}(\text{CN})_6]^{3-}$
- B. $[\text{Cu}(\text{CN})_4]^-$
- C. $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$
- D. $[\text{Mn}(\text{CO})_5]$

51. What is the type of interaction of hard acid with hard base according to HSAB principle?

- A. Polar covalent interaction
- B. Mostly covalent interaction
- C. Mostly Ionic interaction
- D. None of them

✓ *hard acids + hard bases* → *strong ionic interaction.*



✓ *soft acids + soft bases* → *stable covalent interaction.*



✓ *hard + soft* → *less stable polar covalent*



52. Which one of the following factors affecting the hardness of Lewis acids and bases?

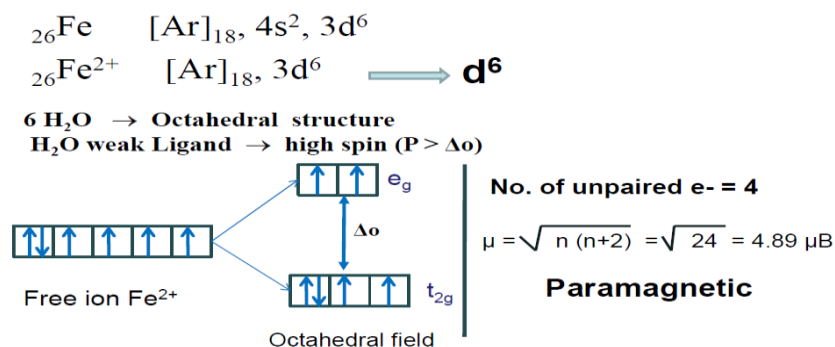
- A. Density
- B. Charge and the oxidation state**
- C. Melting point
- D. Boiling point

53. Chelating ligand may be.....

- A. Monodentate ligand
- B. Ambidentate ligand
- C. Polydentate ligand**
- D. None of them

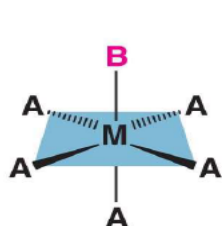
54. What is the electronic arrangement of central metal in the complex ion $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ according to crystal field theory (CFT)?

- e. $t_{2g}^4 e_g^1$
- f. $t_{2g}^2 e_g^4$
- g. $t_{2g}^3 e_g^3$
- h. $t_{2g}^4 e_g^2$**

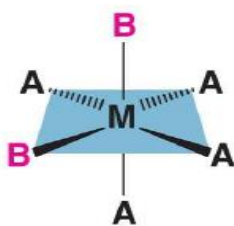


55. Which of the following complex ion shows geometrical isomerism?

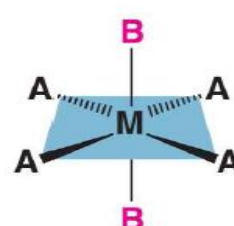
- e. $[\text{Pt}(\text{NH}_3)_3\text{Cl}]$
- f. $[\text{Cr}(\text{H}_2\text{O})_4\text{Cl}_2]^{2+}$**
- g. $[\text{Co}(\text{NH}_3)_6]^{3+}$
- h. $[\text{Co}(\text{CN})_5(\text{NC})]^{3-}$



No Isomerism



Cis



Trans

56. What is the Geometrical shape of the $[\text{Mn}(\text{H}_2\text{O})_6]^{2+}$

- e. Linear
- f. Octahedral**
- g. Tetrahedral
- h. Square pyramidal

57. What is the number of microstates of p^2 configuration?

- e. 20
- f. 10
- g. 15
- h. 45

$$\text{Number of Microstates} = \frac{n!}{r! \cdot (n-r)!}$$

$n = 2 \times \text{no. of orbitals}$

$r = \text{no. of electrons}$

58. Which of the following is not a transition metal?

- A. Cr
- B. Zn
- C. Fe
- D. Pd

59. Which of the following is an example of a bidentate ligand?

- A. Cl^-
- B. NH_3
- C. EDTA
- D. En

60. What is the scientific name of the compound $\text{K}_3[\text{Fe}(\text{CN})_6]$?

- A. Potassium hexacyanoiron(III)
- B. Sodium hexacyanoiron(II)
- C. Potassium hexacyanoferrate(III)
- D. Sodium tetracyanoferrate(III)

61. What is the type of hybridization of SF_6 ?

- A. sp^3
- B. sp^2
- C. sp^3d^2
- D. sp

62. How many lone pairs electrons around central atom in NH_3 ?

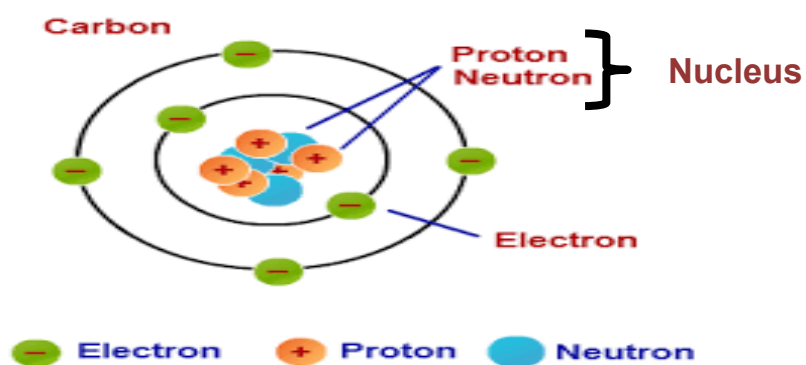
- A. 1
- B. 2
- C. 3
- D. 4

63. What is the oxidation number of nitrogen in NH_3 compound?

- A. +3
- B. +1
- C. -3
- D. -1

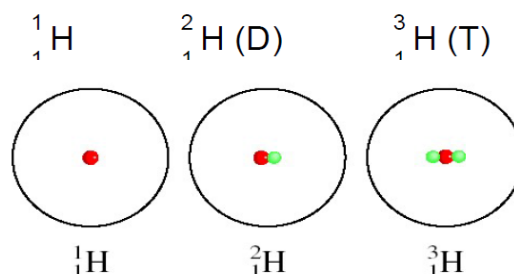
1. In the atomic structure, which particles have a positive charge?

- A. Electrons
- B. Neutrons
- C. Protons
- D. Atoms



2. How many neutrons and protons are in the atom of the isotope of Nitrogen; $^{14}_7\text{N}$?

- Atomic number (Z)** = number of protons in nucleus
Mass number (A) = number of protons + number of neutrons
 = atomic number (Z) + number of neutrons



- [illegible]

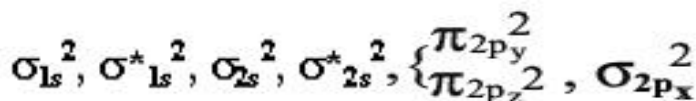
- 78

6. What is the maximum number of bonds can a carbon atom form?

- A. 4
- B. 1
- C. 2
- D. 3

7. What is the bond order in N₃ Molecule?

- A. 2
- B. 1
- C. 2.5
- D. 3



$$\text{Bond order for N}_2 = (10-4)/2 = 1\sigma + 1\pi + 1\pi = 3$$

8. Which one of these elements is non-metal in group 4A?

- A. Germanium
- B. Carbon
- C. Silicon
- D. Tin

1 1A																	18 8A
1 H	2 2A											13 3A	14 4A	15 5A	16 6A	17 7A	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg	3 3B	4 4B	5 5B	6 6B	7 7B	8	9	10	11 1B	12 2B	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112	113	114	115	116	(117)	118

9. A compound has formula XF₄. Element X cannot be:

- A. Si
- B. Sn
- C. Sc
- D. C

10. Which of the following is correct to determine the magnetic behavior of a transition metal complex?

- A. The distance between the metal ion and the ligands in the coordination sphere.
- B. The number of paired and unpaired electrons in the d-orbitals of the metal ion.
- C. The overall size of the transition metal complex and its molecular geometry.
- D. The number of ligands surrounding the metal ion, regardless of the electronic configuration.

11. What is the cause of the main characteristics of transitions metals (colored compounds - paramagnetic compounds - variable oxidation states)?

- A. Empty (d or f) sublevels
- B. Completely filled (d or f) sublevels

C. Partially filled (d or f) sublevels

D. Partially filled (s or p) sublevels

12. What is the document that contains information on the potential hazards (health, fire, reactivity and environmental) and how to work safely with the chemical product?

A. Heating Safety

B. Material Safety Data Sheet

C. Electrical Safety

D. Glassware's Safety

13. What is the color of the copper (II) sulfate pentahydrate solution?

A. Blue

B. Green

C. Red

D. Yellow

14. What is the type of Mohar Salt; $(\text{NH}_4)_2\text{SO}_4 \cdot \text{Fe}(\text{SO}_4) \cdot 6\text{H}_2\text{O}$?

A. Simple salt

B. Chelate

C. Double salt

D. Molecular compound

15. What is the coordination number of $[\text{Ni}(\text{NH}_3)_2\text{Cl}_2]$ complex?

A. 6

B. 2

C. 4

D. 3

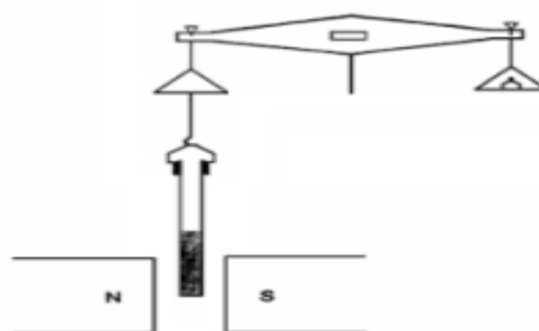
16. What is the instrument used to measure the magnetic susceptibility of the compounds?

A. Spectrometer

B. Colorimeter

C. Thermometer

D. Gouy Magnetic Balance



17. Electromagnetic radiation in the wavelength range of 200 nm to 390 nm is classified as:

A. NMR spectrum

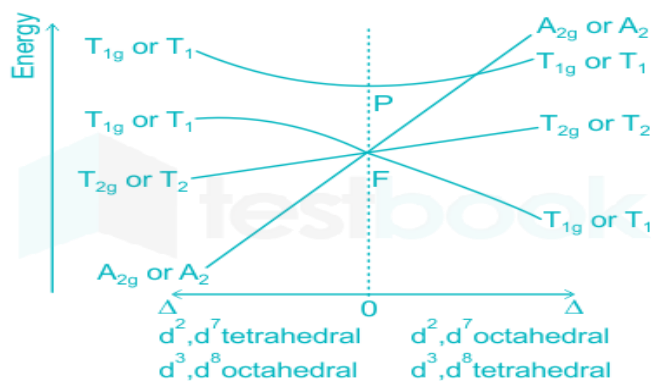
B. Infrared spectrum

C. Visible spectrum

D. Ultraviolet spectrum

18. Which of the following high spin complex ions has three absorption bands in UV-visible absorption spectrum?

- A. $[\text{Cr}(\text{H}_2\text{O})_6]^{2+}$
- B. $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$
- C. $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$
- D. $[\text{Sc}(\text{H}_2\text{O})_6]^{2+}$



19. Which of the following techniques is concerned with studying d-d electronic transition?

- A. X-ray diffraction
- B. IR spectroscopy
- C. UV-visible spectroscopy
- D. NMR spectroscopy

20- Metals have a high ability to.....

- A. lose electrons
- B. gain electrons
- C. share electrons
- D. none of them

21- What is the correct formula for Tin (II) chloride?

- A. SnCl
- B. Sn_2Cl
- C. Sn_2Cl_3
- D. SnCl_2

22- The correct product from the following reaction is



- A. AlO
- B. Al_3O_2
- C. Al_2O_3
- D. AlO_3

23- The general electron configuration for group VII (7A) elements is

- A. ns^2np^2
- B. ns^2np^3
- C. ns^2np^4

D. ns^2np^5

24- Metals, non-metals and metalloids exist only in of periodic table.

A. s-block

B. p-block

C. d-block

D. f-block

25- K^+ ion is a....

A. hard acid

B. hard base

C. soft acid

D. soft base

26- Consider the coordination compound, $[Fe(NH_3)_6]Cl_3$. The Lewis base is:

A. $[Fe(NH_3)_6]^{+3}$

B. Cl^-

C. NH_3

D. Fe^{+3}

27- Consider the coordination compound, $K_2[Cu(CN)_4]$. A coordinate covalent bond exists between:

A. K^+ and CN^-

B. Cu^{+2} and CN^-

C. K^+ and $[Cu(CN)_4]^{2-}$

D. C and N in CN^-

28- What is the highest possible M_L value of term D?

A. 0

B. +1

C. +2

D. +3

29- A transition from ^3F to ^3P is:

- A. Spin forbidden
- B. Spin Allowed
- C. Laport allowed
- D. None of them

30- Elements in Group 8A exist in nature as a

- A. Gases
- B. Liquids
- C. Solids
- D. Colloids

أسئلة جاهزية استرشادية الاختبار الفعلي

Q1, Q2, Q3: Chemistry laboratory& Safety Rules

Safety in a chemistry lab is critical for several reasons. Chemical laboratories include a variety of hazards that require a multi-layered approach of controls to prevent injuries and illnesses. The presence of chemicals could result in exposure to hazardous substances, chemical burns, and fire/explosions. Equipment with physical hazards could result in slips, trips, falls, pinch points, and exposure to extreme temperatures, radiation, noise, electricity, and pressure. Injuries and illnesses can result in lawsuits, medical expenses, and lost productivity. Effective health and safety controls help with preventing these types of losses.

12 Lab Safety Guidelines to Follow

To ensure a safe working environment in labs, adhere to these fundamental safety guidelines:

1. Wear safety glasses in the lab. Always wear eye protection even if you're not conducting an experiment.
2. Always wear appropriate clothing when working in a lab. Protect your skin, avoid open-toed shoes and long/dangling jewelry, and keep sleeves at an appropriate length.
3. Do not eat, drink, smoke, or vape inside the lab.
4. Familiarize yourself with the emergency procedures and the locations of emergency equipment, such as fire extinguishers, fire blankets, safety showers, and eye wash stations.
5. Conduct work inside the fume hood especially when working with hazardous chemicals.
6. Wash your hands thoroughly before and after working in the laboratory. By practicing good hand hygiene in the lab, you're protecting yourself and your colleagues from any cross-contamination.
7. Never use mouth suction to fill a pipette. It's a dangerous and outdated technique of filling a pipette due to the risk of contamination and ingestion of hazardous materials.
8. Don't force glass tubing through cork or rubber stoppers. The glass can shatter and cause lacerations. Use proper lubrication to avoid breakage.
9. Never pour water into acid which can cause a violent reaction. Always add acid to water slowly and carefully.
10. Use appropriately designated waste containers to dispose of liquid and solid waste.
11. Securely replace all caps, lids, and stoppers after removing chemicals from containers. This prevents leakage of liquids, gases, or vapors.
12. Report any accidents or injuries to your supervisor immediately.

لماذا تعتبر السلامة مهمة في مختبر الكيمياء؟

السلامة في مختبر الكيمياء أمر بالغ الأهمية لعدة أسباب. تشمل المختبرات الكيميائية مجموعة متنوعة من المخاطر التي تتطلب نهجًا متعدد الطبقات من الضوابط لمنع الإصابات والأمراض. يمكن أن يؤدي وجود المواد الكيميائية إلى التعرض للمواد الخطرة والحروق الكيميائية والحرائق / الانفجارات. يمكن أن تؤدي المعدات ذات المخاطر المادية إلى الانزلاق والتعثر والسقوط ونقاط الضغط والتعرض لدرجات حرارة شديدة والإشعاع والضوضاء والكهرباء والضغط. يمكن أن تؤدي الإصابات والمرض إلى دعاوى قضائية ونفقات طبية وفقدان الإنتاجية. تساعد ضوابط الصحة والسلامة الفعالة في منع هذه الأنواع من الخسائر.

12 إرشادات لسلامة المختبر يجب اتباعها

لضمان بيئة عمل آمنة في المختبرات، التزم بإرشادات السلامة الأساسية التالية:

1. ارتد نظارات السلامة في المختبر. ارتد دائمًا حماية العين حتى إذا لم تكن تجري تجربة.
2. ارتد دائمًا ملابس مناسبة عند العمل في المختبر. احم بشرتك وتجنب الأحذية المفتوحة من الأمام والمجوهرات الطويلة / المتدلية، واحتفظ بالأكمال بطول مناسب.

3. لا تأكل أو تشرب أو تدخن أو تستخدم السجائر الإلكترونية داخل المختبر.
4. تعرف على إجراءات الطوارئ ومواقع معدات الطوارئ، مثل طفايات الحريق وبطانيات الحريق ودشات الأمان ومحطات غسل العيون.
5. قم بالعمل داخل غطاء الدخان خاصة عند العمل مع المواد الكيميائية الخطرة.
6. اغسل يديك جيدًا قبل وبعد العمل في المختبر. من خلال ممارسة نظافة اليدين الجيدة في المختبر، فإنك تحمي نفسك وزملائك من أي تلوث متبادل.
7. لا تستخدم شفط الفم أبدًا لملء الماصة. إنها تقنية خطيرة وعفا عليها الزمن لملء الماصة بسبب خطر التلوث وابتلاع المواد الخطرة.
8. لا تدفع أنابيب الزجاج بالقوة من خلال الفلين أو السدادات المطاطية. يمكن أن يتحطم الزجاج ويسبب جروحًا. استخدم مواد التشحيم المناسبة لتجنب الكسر.
9. لا تصب الماء أبدًا في الحمض الذي يمكن أن يسبب تفاعلًا عنيفًا. أضف الحمض دائمًا إلى الماء ببطء وباعتناء.
10. استخدم حاويات النفايات المخصصة بشكل مناسب للتخلص من النفايات السائلة والصلبة.
11. أعد تركيب جميع الأغشية والسدادات بشكل آمن بعد إزالة المواد الكيميائية من الحاويات. وهذا يمنع تسرب السوائل أو الغازات أو الأبخرة.
12. أبلغ مشرفك على الفور عن أي حوادث أو إصابات.

Chemical safety refers to the practice of handling, storing, and using chemicals in a manner that minimizes the risks and potential harm associated with their use. It involves the implementation of procedures, protocols, and precautions to ensure the safe handling, storage, transportation, and disposal of chemicals.

Chemical safety aims to protect human health, the environment, and property from the adverse effects of hazardous chemicals. It encompasses various aspects, including:

Risk Assessment: Identifying and evaluating the potential hazards and risks associated with chemicals. This involves assessing toxicity, flammability, reactivity, and other properties of the substances.

Hazard Communication: Proper labeling and documentation of chemicals to ensure clear identification, understanding, and communication of their hazards. This may include safety data sheets (SDS), warning labels, and signage.

You might like to know

Create an auto-grading safety quiz without any coding – [try OnlineExamMaker today!](#)

Safe Handling and Storage: Following appropriate procedures for handling, transferring, and storing chemicals to minimize exposure and prevent accidents. This includes using personal protective equipment (PPE), such as gloves and goggles, and ensuring proper ventilation in work areas.

Emergency Preparedness: Developing plans and procedures to respond effectively to chemical spills, leaks, fires, or other emergencies. This may involve training employees, maintaining emergency response equipment, and establishing evacuation routes.

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- [Part 1: 30 chemical safety quiz questions & answers](#)
- [Part 2: Download chemical safety questions & answers for free](#)

- [Part 3: Free online quiz creator – OnlineExamMaker](#)

Part 1: 30 chemical safety quiz questions & answers

1. What does MSDS stand for in chemical safety?

- a) Material Safety Data Sheet
- b) Mandatory Safety Documentation Standard
- c) Chemical Hazard Assessment Report
- d) Material Storage and Disposal System

Answer: a) Material Safety Data Sheet

2. Which of the following is an example of a chemical hazard?

- a) Slippery floors

- b) Loud noise
- c) High temperature
- d) Toxic fumes

Answer: d) Toxic fumes

3. What is the purpose of using personal protective equipment (PPE) in chemical handling?

- a) To improve communication
- b) To enhance productivity
- c) To prevent chemical reactions
- d) To minimize exposure and protect against hazards

Answer: d) To minimize exposure and protect against hazards

4. What should you do if a chemical spill occurs in the laboratory?

- a) Ignore it and continue working
- b) Inform your colleagues and continue working
- c) Immediately clean it up using appropriate procedures
- d) Report it to your supervisor and evacuate the area

Answer: d) Report it to your supervisor and evacuate the area

5. What does the “flammable” symbol on a chemical container indicate?

- a) The chemical is highly corrosive
- b) The chemical is explosive
- c) The chemical can catch fire easily
- d) The chemical is radioactive

Answer: c) The chemical can catch fire easily

6. What is the purpose of a fume hood in a laboratory?

- a) To store chemicals safely
- b) To provide a comfortable working environment
- c) To prevent chemical spills
- d) To remove harmful fumes and gases

Answer: d) To remove harmful fumes and gases

7. What should you do if you accidentally inhale toxic fumes?

- a) Ignore it and continue working
- b) Wash your face with water
- c) Immediately seek fresh air and medical assistance if necessary
- d) Report it to your supervisor and continue working

Answer: c) Immediately seek fresh air and medical assistance if necessary

8. What does the acronym PPE stand for in chemical safety?

- a) Personal Protective Equipment
- b) Public Protection and Environment
- c) Proper Procedure Enforcement
- d) Physical Property Evaluation

Answer: a) Personal Protective Equipment

9. What is the purpose of conducting a risk assessment in chemical safety?

- a) To eliminate all risks associated with chemicals
- b) To identify and evaluate potential hazards and risks
- c) To ensure proper chemical labeling
- d) To determine the cost of chemical storage

Answer: b) To identify and evaluate potential hazards and risks

10. What should you do before using a chemical for the first time?

- a) Store it in a secure location
- b) Read and understand the label and MSDS
- c) Mix it with other chemicals to enhance its properties
- d) Dispose of any excess chemicals

Answer: b) Read and understand the label and MSDS

11. How should you dispose of hazardous chemical waste?

- a) Pour it down the sink with plenty of water
- b) Place it in the regular trash bin
- c) Follow proper disposal guidelines and regulations
- d) Store it indefinitely for future use

Answer: c) Follow proper disposal guidelines and regulations

12. What should you do if you get a chemical in your eyes?

- a) Rub your eyes vigorously
- b) Flush your eyes with water for at least 15 minutes
- c) Continue working and ignore the discomfort
- d) Apply a chemical-neutralizing agent to your eyes

Answer: b) Flush your eyes with water for at least 15 minutes

13. What does the “corrosive” symbol on a chemical container indicate?

- a) The chemical is explosive
- b) The chemical can cause electrical shocks
- c) The chemical is highly toxic
- d) The chemical can cause severe burns or damage to materials

Answer: d) The chemical can cause severe burns or damage to materials

14. What is the purpose of a safety shower in a laboratory?

- a) To provide drinking water
- b) To rinse laboratory equipment
- c) To cool down the laboratory temperature
- d) To quickly rinse off chemicals from a person's body

Answer: d) To quickly rinse off chemicals from a person's body

15. What is the purpose of grounding containers during chemical transfer?

- a) To increase the weight of the containers
- b) To prevent spills and leaks
- c) To reduce the risk of static electricity discharge
- d) To improve chemical stability

Answer: c) To reduce the risk of static electricity discharge

16. What should you do if you notice a chemical odor or unusual smell in the workplace?

- a) Ignore it unless it becomes unbearable
- b) Report it to your supervisor or safety personnel
- c) Spray air freshener to mask the odor
- d) Open windows and doors for ventilation

Answer: b) Report it to your supervisor or safety personnel

17. What is the purpose of conducting regular inspections of chemical storage areas?

- a) To ensure all chemicals are used up
- b) To identify expired chemicals
- c) To check for leaks or damage in containers

d) To rearrange chemicals for aesthetic purposes

Answer: c) To check for leaks or damage in containers

18. What should you do if a fire breaks out in a chemical laboratory?

a) Use water to extinguish the fire

b) Attempt to contain the fire using nearby materials

c) Evacuate the area and activate the fire alarm

d) Continue working and ignore the fire

Answer: c) Evacuate the area and activate the fire alarm

19. What does the acronym HAZCOM stand for in chemical safety?

a) Hazardous Communication

b) Handling Chemical Compounds

c) Health and Safety Compliance

d) Hazardous Material Composition

Answer: a) Hazardous Communication

20. What is the purpose of a spill kit in chemical safety?

a) To mix different chemicals together

b) To store chemicals in a laboratory

c) To clean up chemical spills effectively

d) To identify unknown chemicals

Answer: c) To clean up chemical spills effectively

21. What is the purpose of ventilation systems in chemical laboratories?

a) To control room temperature

b) To provide a source of natural light

c) To remove hazardous fumes and maintain air quality

d) To prevent unauthorized access to the laboratory

Answer: c) To remove hazardous fumes and maintain air quality

22. What does the acronym WHMIS stand for in chemical safety?

a) Workplace Hazardous Materials Information System

b) Worker Health and Medical Insurance Services

c) Workplace Handling and Management of Industrial Substances

d) Worker Hazards and Material Inspection System

Answer: a) Workplace Hazardous Materials Information System

23. What should you do if you spill a small amount of a corrosive chemical on your skin?

a) Wash it off immediately with water for a few seconds

b) Cover it with a bandage and continue working

c) Wait for it to evaporate naturally

d) Ignore it and continue working

Answer: a) Wash it off immediately with water for a few seconds

24. What does the “oxidizing” symbol on a chemical container indicate?

a) The chemical is highly toxic when inhaled

b) The chemical can cause severe burns

c) The chemical is explosive

d) The chemical can cause or enhance combustion of other substances

Answer: d) The chemical can cause or enhance combustion of other substances

25. What should you do if you accidentally ingest a toxic chemical?

a) Induce vomiting immediately

b) Ignore it and continue working

- c) Rinse your mouth with water
- d) Seek immediate medical attention

Answer: d) Seek immediate medical attention

26. What is the purpose of a safety data sheet (SDS) in chemical safety?

- a) To track the inventory of chemicals in a laboratory
- b) To provide information about the physical and chemical properties of a chemical
- c) To store records of chemical spills and accidents
- d) To communicate hazards and safe handling procedures for a chemical

Answer: d) To communicate hazards and safe handling procedures for a chemical

27. What should you do if you notice damaged or leaking chemical containers?

- a) Ignore it if the container is still usable
- b) Place the container in a more visible location
- c) Report it to your supervisor and follow proper procedures for disposal
- d) Attempt to repair the container yourself

Answer: c) Report it to your supervisor and follow proper procedures for disposal

28. What is the purpose of labeling chemical containers?

- a) To make the containers more visually appealing
- b) To indicate the price of the chemicals
- c) To communicate the identity and hazards of the chemical
- d) To prevent unauthorized access to the chemicals

Answer: c) To communicate the identity and hazards of the chemical

29. What should you do if you are uncertain about the hazards of a chemical?

- a) Use it and observe its effects on your colleagues
- b) Ask your colleagues for their opinions

- c) Research the chemical properties and hazards using reliable sources
- d) Assume it is safe and proceed with normal handling

Answer: c) Research the chemical properties and hazards using reliable sources

30. What is the purpose of conducting regular training on chemical safety?

- a) To ensure employees are aware of the chemicals used in the workplace
- b) To increase the workload of employees
- c) To meet regulatory requirements
- d) To make the workplace more crowded

Answer: a) To ensure employees are aware of the chemicals used in the workplace



Lab Safety Rules

Science labs offer great opportunities for learning, teaching, and research. They also pose hazards that require proper safety precautions.



Stay safe when conducting your labs by maintaining social distancing.



Dress appropriately

Tie back long hair, and wear suitable gloves, goggles, and other personal protective equipment. Avoid touching your eyes, nose, and mouth.

Proper supervision

Don't perform lab experiments without instructor supervision unless given permission to do so.



Know location of emergency numbers & safety equipment

Know the location of safety equipment and emergency phone numbers (such as poison control) so you can access them quickly if necessary.



No food

Don't eat or drink in the lab, and never taste chemicals.



ID hazards

Identify hazardous materials before beginning labs.



Be attentive

Be attentive while in the lab. Don't leave lit Bunsen burners unattended or leave an experiment in progress.

Be careful when handling hot glassware

Turn off all heating appliances when not in use. Keep flammable objects away from your work space.



Keep a clean work space

Don't obstruct work areas, floors, or exits. Keep coats, bags, and other personal items stored in designated areas away from the lab. Don't block sink drains with debris.



Handle glassware carefully

Properly dispose of anything that breaks. Report cuts, spills, and broken glass to your instructor immediately.



Clean up

After completing the lab, carefully clean your work space and the equipment, and wash your hands with soap and warm water for at least 20 seconds.

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www.carolina.com

Sources: Carolina Biological Supply Company, "Lab Safety Dos and Don'ts for Students," <https://www.carolina.com/teacher-resources/interactive/lab-safety-instructions/tr36303.tr>.

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مادة سامة

Toxic



مادة كاوية وحارقة

Corrosive



مادة قابلة للاشتعال

Flammable



مادة متفجرة

Explosive



مادة مؤكسدة

Oxidizing



مادة مهيجة

Irritating



مادة مشعة

Radioactive



مادة ضارة للبيئة

Environmental
hazard



مادة ضارة

Harmful

علامات تحذيرية للمواد الكيميائية Chemical Warning Signs

Emergency Showers

Why is a shower important in a laboratory?



If you get chemical contamination on your skin resulting from an accident, yell for help if someone else is in the lab. Immediately go to the nearest emergency shower and pull the activation handle. Once under the stream of water, begin removing your clothing to wash off all chemicals.

Using a safety shower is a critical safety procedure in labs to:

- 1- when a person has been exposed to hazardous chemicals, such as spills or splashes on the skin or clothing. Here's what generally happens during such an incident

- 2- If you get chemical contamination on your skin resulting from an accident,
- 3- Mitigate the risks associated with chemical exposure and ensure the well-being of individuals.
- 4- Ensure prompt and effective decontamination in case of chemical spills or exposure incidents

إذا تعرضت بشرتك للتلوث الكيميائي نتيجة لحادث،

اصرخ طلبًا للمساعدة إذا كان هناك شخص آخر في المختبر. اذهب فورًا إلى أقرب دش طوارئ واسحب مقبض التنشيط. بمجرد أن تكون تحت تيار الماء، ابدأ في إزالة ملابسك لغسل جميع المواد الكيميائية.

يعد استخدام دش الأمان إجراءً أمنيًا بالغ الأهمية في المختبرات من أجل:

1- عندما يتعرض شخص ما لمواد كيميائية خطيرة، مثل الانسكابات أو البقع على الجلد أو الملابس. إليك ما يحدث عادةً أثناء مثل هذا الحادث

2- إذا تعرضت بشرتك للتلوث الكيميائي نتيجة لحادث،

3- خفف من المخاطر المرتبطة بالتعرض للمواد الكيميائية وضمن سلامة الأفراد.

4- تأكد من إزالة التلوث بسرعة وفعالية في حالة الانسكابات الكيميائية أو حوادث التعرض

1. The safety shower in a chemical laboratory is mainly used for:

- A. Washing glassware
- B. Removing chemical spills from the body
- C. Cooling overheated equipment
- D. Handwashing

2. When should a safety shower be used?

- A. After every experiment
- B. Only during fire drills
- C. Immediately after a chemical spill on skin or clothing
- D. Only when instructed by a supervisor

3. How long should you stay under the safety shower after chemical exposure?

- A. 5 seconds
- B. 15–20 minutes
- C. 1 minute
- D. Until the water stops

4. What should you do when using a safety shower after a spill?

- A. Keep contaminated clothing on
- B. Remove contaminated clothing immediately
- C. Stand outside the shower to avoid getting wet
- D. Wait for medical personnel before using it

5. Which of the following is TRUE about safety showers?

- A. They should be blocked with equipment to save space
- B. They are used only for fire emergencies

C. They must have clear access at all times

D. They operate using hot water only

Fume Hood



CHEMICALS REQUIRING A FUME HOOD



VOLATILE ORGANIC COMPOUNDS (VOCs)

VOCs are chemicals with high vapor pressure at room temperature.



CORROSIVE SUBSTANCES

Corrosive Substances require a fume hood due to their ability to cause severe burns or damage to living tissues.



TOXIC CHEMICALS

Toxic chemicals pose significant health risks even at low concentrations.



FLAMMABLE SUBSTANCES

Flammable substances, including highly volatile solvents, fuels, and gases, require a fume hood due to the risk of fire or explosion.



SENSITIZING AGENTS

Sensitizing agents are substances that can cause allergic reactions or sensitization in individuals upon exposure.

Which of the following should not be placed in a fume hood?

Paper and Cloth Materials

Volatile Organic compounds

Flammable Substances

Corrosive substances

Chemicals requiring a fume hood :

Volatile organic compounds, or VOCs, are chemicals with high vapor pressure at room temperature. They can easily evaporate into the air and pose health risks when inhaled. Common VOCs include solvents like acetone, ethanol, benzene, and toluene. When handling these substances, it is essential to use a fume hood to prevent inhalation and potential long-term health effects.

Corrosive substances, such as strong acids (e.g., hydrochloric acid, sulfuric acid) and bases (e.g., sodium hydroxide, potassium hydroxide), require a fume hood due to their ability to cause severe burns or damage to living tissues. Fume hoods protect against accidental splashes or releases that can occur during the handling or mixing of corrosive materials.

Toxic chemicals, such as certain pesticides, heavy metals, and carcinogens, pose significant health risks even at low concentrations. Examples include lead compounds, mercury, arsenic compounds, and formaldehyde. Working with these substances in a fume hood prevents inhalation, skin contact, and contamination of the laboratory environment.

FLAMMABLE SUBSTANCES

Flammable substances, including highly volatile solvents, fuels, and gases, require a fume hood due to the risk of fire or explosion. These substances have low flashpoints and can ignite easily in the presence of an open flame, spark, or heat source. A fume hood provides ventilation and minimizes the buildup of flammable vapors, reducing the potential for accidents.

Sensitizing agents are substances that can cause allergic reactions or sensitization in individuals upon exposure. Examples include certain dyes, isocyanates, and some pharmaceutical ingredients. A fume hood is necessary when handling these chemicals to prevent inhalation or skin contact, reducing the likelihood of sensitization or allergic responses.



Which of the following should not be placed in a fume hood?

- Paper and Cloth Materials
- Volatile organic compounds
- Flammable substances
- Corrosive substances

Which of the following should not be placed in a fume hood?

2.4. Organic Chemistry Laboratory Why is a shower important in a laboratory?

If you get chemical contamination on your skin resulting from an accident

If you use flammable substances

If you get chemicals with high vapor pressure at room temperature

If you add water to acid

What is the purpose of a safety shower in a laboratory?

- a) To provide drinking water
- b) To rinse laboratory equipment
- c) To cool down the laboratory temperature
- d) To quickly rinse off chemicals from a person's body
- d) To quickly rinse off contamination on your skin resulting from an accident

1. The main purpose of using a fume hood is to:

- A. Keep chemicals cool
- B. Remove hazardous vapors and protect the user
- C. Store chemicals safely
- D. Increase room ventilation

2. When working in a fume hood, the sash (glass window) should be:

- A. Fully open at all times
- B. Fully closed while working
- C. Kept at the recommended working height
- D. Removed if it blocks your view

3. What should NEVER be done inside a fume hood?

- A. Use chemicals that release fumes
- B. Block the air vents with equipment

- C. Perform experiments that produce gases
- D. Keep materials 15 cm inside the hood

5. The proper position of materials inside the fume hood is:

- A. At the front edge
- B. Outside the hood
- C. Near the air vent and at least 15 cm inside
- D. Placed on the sash

The safety of addition of acid to water, not water to acid.

If we add water to acid, it forms a concentrated solution which releases heat. That solution may boil and splash concentrated acid out of the container. All this reaction is called an exothermic reaction which is safer to add acid to water, not water to acid.



The statement is a critical safety rule: **always add acid to water slowly and carefully, never the other way around**. This is because adding water to a concentrated acid can cause a violent, exothermic reaction that releases enough heat to cause the mixture to boil and violently splash, potentially leading to severe burns. When acid is added slowly to a larger volume of water, the water can absorb and dissipate the heat more effectively, preventing this dangerous splattering.

Why adding acid to water is safer

- **Heat dissipation:** The larger volume of water in the container can absorb the heat generated by the reaction, keeping the temperature from rising too quickly.
- **Preventing boiling and splashing:** Since the water can absorb the heat, it is much less likely to boil, which prevents the acid from being violently thrown out of the container.
- **Controlled reaction:** Adding acid slowly and with stirring allows for a controlled dilution process and further helps to manage the heat generated.

Why adding water to acid is dangerous

- **Rapid heat generation:** When you add water to concentrated acid, the water sits on top of the more dense acid. The reaction is extremely fast and creates a lot of heat in a small area.
- **Boiling and splattering:** The intense heat can instantly turn the water on the surface into steam, causing the entire solution to boil and violently splash the acid mixture out of the container.
- **Serious risk of injury:** The resulting splash can cause serious chemical burns on skin and damage eyes.

1. Why is it safer to add acid to water rather than add water to acid?

- A. Because acid evaporates faster in water
- B. Because adding water to acid can cause violent splashing
- C. Because water reacts slower than acid
- D. Because acid becomes non-reactive in water

2. When preparing a diluted acid solution, what is the correct procedure?

- A. Pour water into acid slowly
- B. Pour acid into water slowly
- C. Mix both quickly at the same time
- D. Heat the acid before mixing

3. What happens when water is added to a concentrated acid?

- A. The solution cools down instantly
- B. No reaction occurs
- C. Heat is released rapidly, causing splattering
- D. The acid becomes weaker without any risk

4. The rule “Add Acid to Water” (AAW) helps prevent:

- A. Formation of toxic gases
- B. Sudden boiling and dangerous splashes
- C. Color changes in the acid
- D. Neutralization of the acid

5. What is the best explanation for adding acid to water step-by-step?

- A. Water absorbs the heat gradually, preventing splashing
- B. It makes the acid taste better
- C. It changes the acid into a base
- D. It reduces the concentration instantly

Chemistry Lab Equipment

You should know the name of each piece and its basic use.

For exact volume measurements of liquids. Pipet on the left is a **Volumetric pipet**. It has only one graduation for delivering one exact volume. Pipet on the right is a Mohr pipet. It has graduations for delivering any number of exact volumes.

Pipet



Used to make accurate measurements of liquid volumes. The bumper ring on large cylinders is to prevent breakage if tipped over. Keep it near the top.

Graduated cylinder



Used to transfer drops of liquid

Dropper



The Erlenmeyer flask is the most common flask in the DVHS chemistry lab. It is used to contain reaction solutions.

Erlenmeyer flask



Used in conjunction with a vacuum connection to a water faucet to speed up filtration.

Filter flask



The volumetric flask is used to make solutions. It has a precise graduation line in the neck of the flask. A solute is placed into the flask, then the solvent is used to bring the total volume up to the graduation.

Volumetric flask



The rounded bottom of the Florence flask makes it ideal for boiling liquids. It also makes this flask easy to tip over when sitting on the lab table.

Florence flask



A watch glass can be used like an evaporating dish for very small amounts of liquid. It can also be used to cover beakers.

Watch glass



Beakers are the most versatile glassware in the lab and can be used for just about anything. The volume graduations on beakers should be used only for "ballpark" estimates.

Beaker



Crucibles are used as a container when something requires "strong" heating.

Crucible and cover



This dish is used to recover dissolved solids by evaporation. While it can be heated, it should not be used for "strong" heating.

Evaporating dish



These tongs are used for picking up crucibles and crucible covers **only**.

Crucible tongs



An instrument used in for grasping and holding small objects

Forceps



The ring stand is an item of lab equipment which consists of a solid base used to hold or clamp laboratory glassware and other equipment in place so that it does not fall down or come apart.

Ring stand



Used to hold test tube upright and for drying.

Test tube rack



When attached to the ring stand, this clamp is used to hold a large test tube or Florence flask above the lab table.

Utility clamp



Test tubes are used for small scale laboratory tests and may be heated.

Test tube



When attached to the ring stand, this iron ring is used to support glassware above the lab table.

Support ring



Used to hold test tubes for short periods of "gentle" heating.

Test tube holder



Used as a support for beakers when placed across a support ring.

Wire gauze



Bunsen burner used to heat chemicals/test tubes

Bunsen burner



Used for supporting crucibles when they are heated.

Clay triangle



Used to light a lab burner. Not a toy noisemaker during lab.

Striker



Used to grind solids into powders.

Mortar & Pestle



Used for rinsing solids out of a container when filtering.

Wash bottle



When lined with filter paper, used to filter suspended solids from a liquid.

Filter funnel



Used to transfer solids from their original container to a scale for weighing.

Chemical spoon (scoopula)



Used to stir mixtures and to aid in pouring a liquid

Glass stirring rod



For exact volume measurements of liquid, we should use:

Pipet

Dropper

Volumetric flask

Graduated cylinder

A burette is used in laboratories



To transfer drops of liquids
To determine the concentration of an unknown solution
To make accurate measurements of liquids
To make solutions

A separation funnel is used to separate two immiscible liquids, such as oil and water, based on their different densities. This process is also called a [liquid-liquid extraction](#) and is crucial in organic chemistry, the pharmaceutical industry, environmental science, and biotechnology for purifying substances and isolating compounds.



Using Glassware in the Chemistry Laboratory

1. Which of the following is TRUE when handling glassware in the lab?

- A. Use cracked glassware if the crack is small
- B. Inspect glassware for chips or cracks before use
- C. Heat glassware quickly to save time
- D. Store glassware on the floor

2. What is the main purpose of a volumetric flask?

- A. Heating solutions
- B. Rough volume measurements
- C. Preparing accurate, fixed-volume solutions
- D. Storing strong acids

3. Which glassware is best for heating liquids directly over a flame?

- A. Volumetric flask
- B. Beaker
- C. Graduated cylinder
- D. Büchner flask

4. When reading the volume in a graduated cylinder, you should:

- A. Look from above
- B. Look from the side at eye level
- C. Shake the cylinder first
- D. Tilt the cylinder to get a better view

5. Why should hot glassware be handled carefully?

- A. Hot glass looks the same as cold glass
- B. Hot glass always turns red
- C. Hot glass melts easily
- D. Hot glass is heavier

6. Which glassware provides the highest accuracy for measuring volumes?

- A. Beaker
- B. Erlenmeyer flask
- C. Graduated cylinder
- D. Burette

7. What should you do if glassware breaks in the laboratory?

- A. Pick up the pieces with your hands
- B. Leave it for someone else to clean

- C. Use a brush and dustpan to collect pieces safely
- D. Ignore it if the pieces are small

8. When heating a test tube, you should:

- A. Point the open end toward yourself
- B. Point it toward others
- C. Hold it at an angle away from yourself and others
- D. Heat it with the stopper on

9. Which statement about using a burette is correct?

- A. Fill it above the zero mark and let it drain down
- B. Read the volume from above
- C. Leave air bubbles in the tip
- D. tilt it to drain faster

Correct Answer: A

10. For mixing solutions by swirling, the best glassware to use is:

- A. Erlenmeyer flask
- B. Watch glass
- C. Graduated cylinder
- D. Volumetric pipette

Hazard & Safety Awareness in Chemistry Labs

Question 1:

What does the flam pictogram mean?

- Oxidizing substance
- Flammable substance
- Gas under pressure
- Acute toxicity



Question 2:

What does the skull & crossbones indicate?

- A. Oxidizing substance
- B. Flammable substance
- C. Gas under pressure
- D. Acute toxicity**



Question 3:

What does the pictogram mean?

- A. Exploding bomb
- B. Oxidizing substance
- C. Gas under pressure
- D. Flammable



Question 4:

What does the pictogram indicate?

- A. Oxidizing substance
- B. Flammable substance
- C. Gas under pressure
- D. Corrosive substance



Question 5:

What does the pictogram mean?

- A. Explosive substance
- B. Oxidizing substance
- C. Gas under pressure
- D. Flammable



Question 6:

What does the pictogram indicate?

- A. Health hazard
- B. Environmental hazard
- C. Gas under pressure
- D. Oxidizing substance



Question 7:

What does the pictogram mean?

- A. Explosive substance
- B. Oxidizer
- C. Gas under pressure
- D. Flammable



Question 8:

What does the pictogram indicate?

- A. Health hazard
- B. Environmental hazard
- C. Gas under pressure
- D. Oxidizing substance



NFPA Diamond (National Fire Protection Association)

Question 9:

What is hazard of sodium hypochlorite according to the NFPA diamond that mentions in the sodium hypochlorite bottle?



- A. Health hazards and oxidizer
- B. Fire hazard and radioactive compound
- C. Reactive compound
- D. Radiation hazard

Safe Storage of Chemicals

Question I2:

How should chemicals be properly stored in a laboratory?

- a) In alphabetical order only
- b) According to chemical compatibility and hazard class
- c) Randomly on open shelves
- d) By container size

Question I3:

Why should flammable liquids never be poured down the drain?

- a) Because they can pollute water only
- b) Because they can cause explosion or fire
- c) Because they evaporate quickly
- d) Because they are expensive

Question I4:

Where should bulk chemical stocks be kept?

- a) Inside the laboratory room
- b) On top of lab benches
- c) In a separate, designated chemical storage area
- d) Next to heat sources

Question I5:

Where should flammable liquids be stored?

- a) In the refrigerator
- b) In wooden cabinets

- c) In flammable storage cabinets
- d) On open shelves

Question 16:

Why should acids be separated from bases?

- A. To increase their reactivity
- B. To avoid dangerous reactions
- C. To reduce storage space
- D. To prevent evaporation

Question 17:

Where should flammable solvents be stored?

- A. On open shelves
- B. In a refrigerator
- C. In the flammable storage cabinet
- D. Next to acids

Safe Waste Disposal

Question 18:

What is correct disposal method for diluted acid?

- A. Pour directly into the sink
- B. Neutralize first, then dispose properly
- C. Mix with base and discard
- D. Dilute with alcohol

Question 19:

Can solvents be mixed with general waste?

- A. Yes, if in small amounts
- B. Yes, after dilution
- C. No
- D. Only if labeled

Safety Equipment

Question 20:

Which of the following types of personal protective equipment are frequently used in laboratory environments?

- A. Safety glasses.
- B. Lab coats and gloves

- C. Face shields.
- D. All of the above

Question 21:

Which equipment protects the eyes?

- A. Face mask
- B. Safety goggles
- C. Laboratory coat
- D. Face shield

Question 22:

What is the main function of a Fume Hood?

- A. Store chemicals
- B. Measure air pressure
- C. Vent harmful vapors
- D. Protect from fire

Question 23:

What is name of the following equipment?

- A. Fire extinguisher
- B. Eye wash
- C. Safety shower
- D. Safety blanket



Question 24:

What is name of the following equipment?

- A. Fire extinguisher
- B. Eye wash
- C. Safety shower
- D. Safety blanket



Question 25:

What is name of the following equipment?

- A. Fire extinguisher
- B. Eye wash
- C. Safety shower
- D. Safety blanket



Good habit in the laboratory

Question 26:

What must you do before entering the laboratory?

- A. Bring all chemicals needed
- B. Read the procedure and complete the pre-lab assignment
- C. Wait for the instructor's permission only
- D. Wear gloves and goggles

Question 27:

What should be the last thing you do before leaving the lab?

- A. Turn off the lights
- B. Return all glassware
- C. Wash your hands
- D. Record your results

Question 28:

What is the correct procedure when combining acid and water?

- A. Add water to acid slowly
- B. Add acid to water slowly, cool and swirl
- C. Mix both rapidly
- D. Add base first, then acid

Question 29:

Which of the following will not be permitted in the laboratory?

- A) Long, loose hair
- B) Dangling jewelry
- C) Baggy clothing and sandals
- D) None of the above will be permitted in the laboratory.

Question 30:

Which of the follow should not be a part of the check-out at the end of the lab?

- A) Turn off the water.
- B) Turn off the gas valves.
- C) Rip off your goggles and stuff them into the cabinet.
- D) Clean, and neatly arrange all equipment

Question 31:

Once your heating device (Bunsen burner or hot plate) is on, you should

- A) Go get a friend to make sure you turned it on correctly.
- B) Go get your chemical supplies for the lab.
- C) Clear off the lab top.
- D) **Never leave it unattended.**

Question 32:

If your lab partner and you do not understand a direction or part of a procedure,

- A) Experiment so you do not look foolish.
- B) Skip that part of the procedure.
- C) **Ask the instructor before proceeding.**
- D) Copy another lab group's data.

Emergency Incidents

Question 33:

In an emergency, which of the following actions might you need to take?

- A. Dial 911.
- B. Evacuate premises.
- C. Activate fire alarms.
- D. **All of the above.**

Question 34:

If you come into contact with a hazardous chemical, you should flush the affected area with water for at least how many minutes?

- A. 5 minutes.
- B. 10 minutes.
- C. **15 minutes.**
- D. 2 minutes

Question 35:

If a flammable substance is spilled, what should you do first?

- a) Wipe it immediately with paper towels
- b) Add water to dilute it
- c) Turn off or remove all ignition sources in the area
- d) Continue working carefully

Question 36:

What should you do in case of a fire drill during lab work?

- a) Leave immediately without touching anything
- b) Close all chemical containers, gas valves, and turn off electrical equipment before exiting
- c) Stay inside until the alarm stops
- d) Continue your experiment carefully

Question 37:

What should you do if glassware breaks in the lab?

- a) Pick it up with your hands
- b) Leave it for the janitor
- c) Use the broken-glass dustpan to collect it and dispose of it in the designated container
- d) Sweep it under the bench

Question 38:

What are the correct steps if a caustic chemical spills on the skin?

- a) Wipe it off with a towel immediately
- b) Rinse with water for at least 15 minutes and remove contaminated clothing
- c) Apply alcohol or neutralizer directly
- d) Cover the area with a bandage

Question 39:

What should you do if acid enters the eye?

- a) Blink rapidly to remove it
- b) Use eyewash for 20 minutes and seek medical help

- c) Rinse briefly with tap water
- d) Cover the eye with a cloth

Question 40:

What should you do if toxic gas leaks in the lab?

- a) Stay inside and open windows
- b) **Evacuate the area immediately and activate ventilation**
- c) Spray air freshener
- d) Hold your breath and wait

Chemical Spills in the Laboratory

1. What is the FIRST thing you should do when a chemical spill occurs?

- A. Immediately clean it with paper towels
- B. Leave the lab
- C. Alert people nearby and inform the instructor or supervisor
- D. Pour water on the spill

2. If a chemical spills on your skin, what should you do?

- A. Wait for instructions before acting
- B. Wipe it off with tissue
- C. Rinse the affected area with water for at least 15 minutes
- D. Apply alcohol to disinfect the area

3. For a small, non-hazardous spill on the floor or bench, you should:

- A. Clean it using the proper spill kit
- B. Sweep it with your hands
- C. Ignore it and continue working
- D. Cover it with paper towels only

4. What should you do if a large spill of a toxic or flammable chemical occurs?

- A. Try to clean it as fast as possible alone
- B. Evacuate the area and report it immediately
- C. Pour water to dilute it
- D. Continue the experiment normally

5. Why is it important not to smell or touch spilled chemicals?

- A. Because spills attract insects
- B. Because chemicals may be harmful or release dangerous vapors
- C. Because all chemicals smell bad
- D. Because the spill may stain your gloves

Q4: Rules for significant figures

Determining the number of significant figures in measured quantities is essential when reporting the precision of measured values and the precision that can be reported when measured values are used in calculations. The rules for determining the number of significant figures are as follows:

1. All nonzero digits are significant.

- 211.8 cm = 4 significant figures.
- 38.15 ft = 4 significant figures.
- 5.6 g = 2 significant figures.
- 23458 m = 5 significant figures.

2. Leading zeros to the left of the first nonzero digit are not significant.(zeros in decimal numbers are not significant)

0.0085 = 2 significant figures

0.003 = 1 significant figures

0.0115 = 3 significant figures

0.0049 = 2 significant figures

0.000262 = 3 significant figures

3. All zeros that are found between nonzero digits (Sandwiched Zeros) are significant.

○ 20,007 mm = 5 significant figures.

○ 50.8 min = 3 significant figures.

○ 2001 m = 4 significant figures.

○ 0.0702 g = 3 significant figures.

○ 0.40505 g = 5 significant figures.

How

4. Trailing zeros if a the number contains a decimal point are significant.

○ 50.080 nm = 5 significant figures.

○ 2.001 s = 4 significant figures.

○ 0.4050 s = 4 significant figures.

5. Zeros to the right of the last nonzero digit are not significant.

○ $12,000 = 12 \times 10^3 = 2$ significant figures

○ $200 = 2 \times 10^2 = 1$ significant figures

○ $48600 = 4.86 \times 10^4 = 3$ significant figures

- $2500500 = 2.505 \times 10^6 = 5$ significant figures
- 4.5×10^3 has two significant figures
- 4.50×10^3 has three significant figures
- 4.500×10^3 has four significant figures
- $0.0008542 = 8.542 \times 10^{-3} = 4$ significant figures

HW: Rules for significant figures

6. How many significant figures are there in:

a) $2.00689 \text{ L} = 6$

b) $0.054 \text{ m} = 2$

c) $37.013 \text{ g} = 5$

d) $2506 = 4$

e) $0.000789 = 3$

f) $30033 \text{ sec} = 5$

g) $0.0800 \text{ min} = 3$

h) $0.2080 \text{ m} = 4$

i) $1.23 \times 10^2 \text{ mm} = 3$

j) $8.542 \times 10^{-3} \text{ Kg} = 4$

k) $3.085 \times 10^2 \text{ mL} = 4$

l) $1405 \text{ min} = 4$

m) $0.008 = 1$

n) $0.000979 = 3$

How many significant figures are there in 0.00800?

6

3

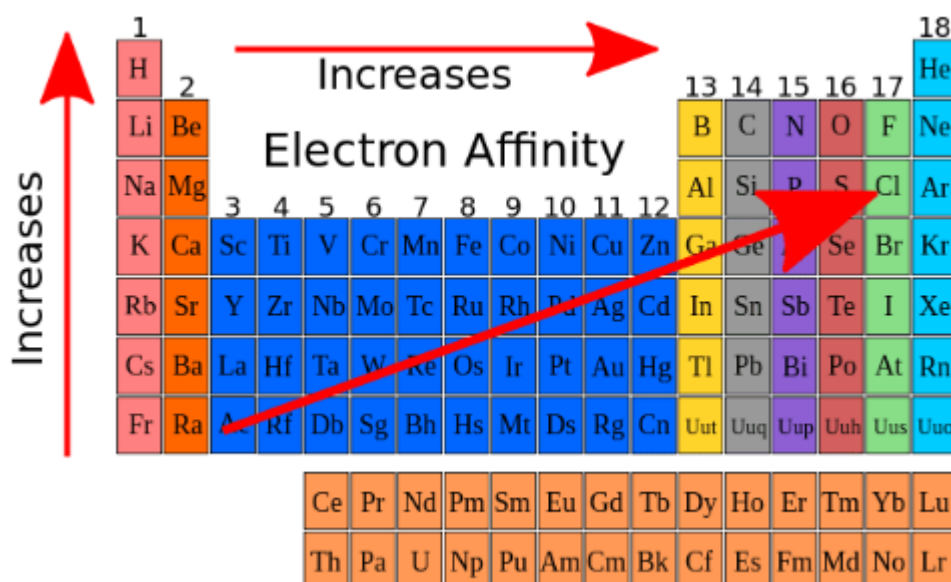
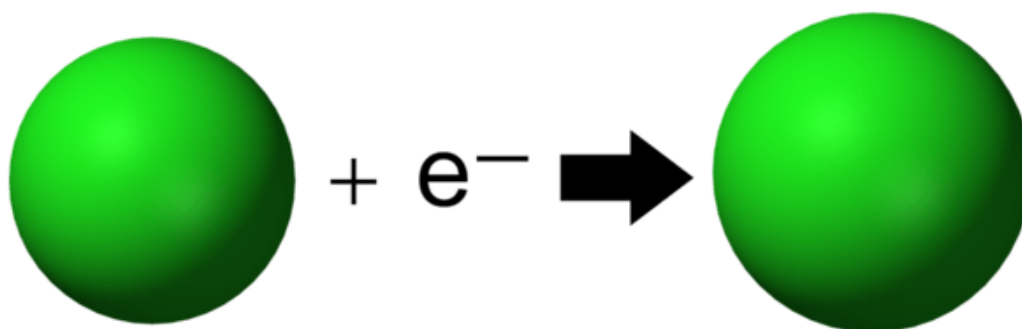
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Q5: Electron affinity

Electron affinity: the change in energy experienced when an electron is added to a gaseous atom. This process creates a negative ion

What is Electron Affinity?



1. Which of the following element has the highest electron affinity?

Al	Si	P	S
----	----	---	---

- a) Si
- b) P
- c) Al
- d) S

2. Which of the following element has the highest electron affinity?

C	N	O	F
---	---	---	---

- a) O
- b) N

- c) C
- d) F

3. Which of the following element has the highest electron affinity?

Li
Na
K
Rb

- a) Na
- b) K
- c) Rb
- d) Li

4. Which of the following element has the highest electron affinity?

Be
Mg
Ca
Sr

- a) Be
- b) Sr
- c) Ca
- d) Mg

5. Which of the following element has the lowest electron affinity?

Cl
Br
I
At

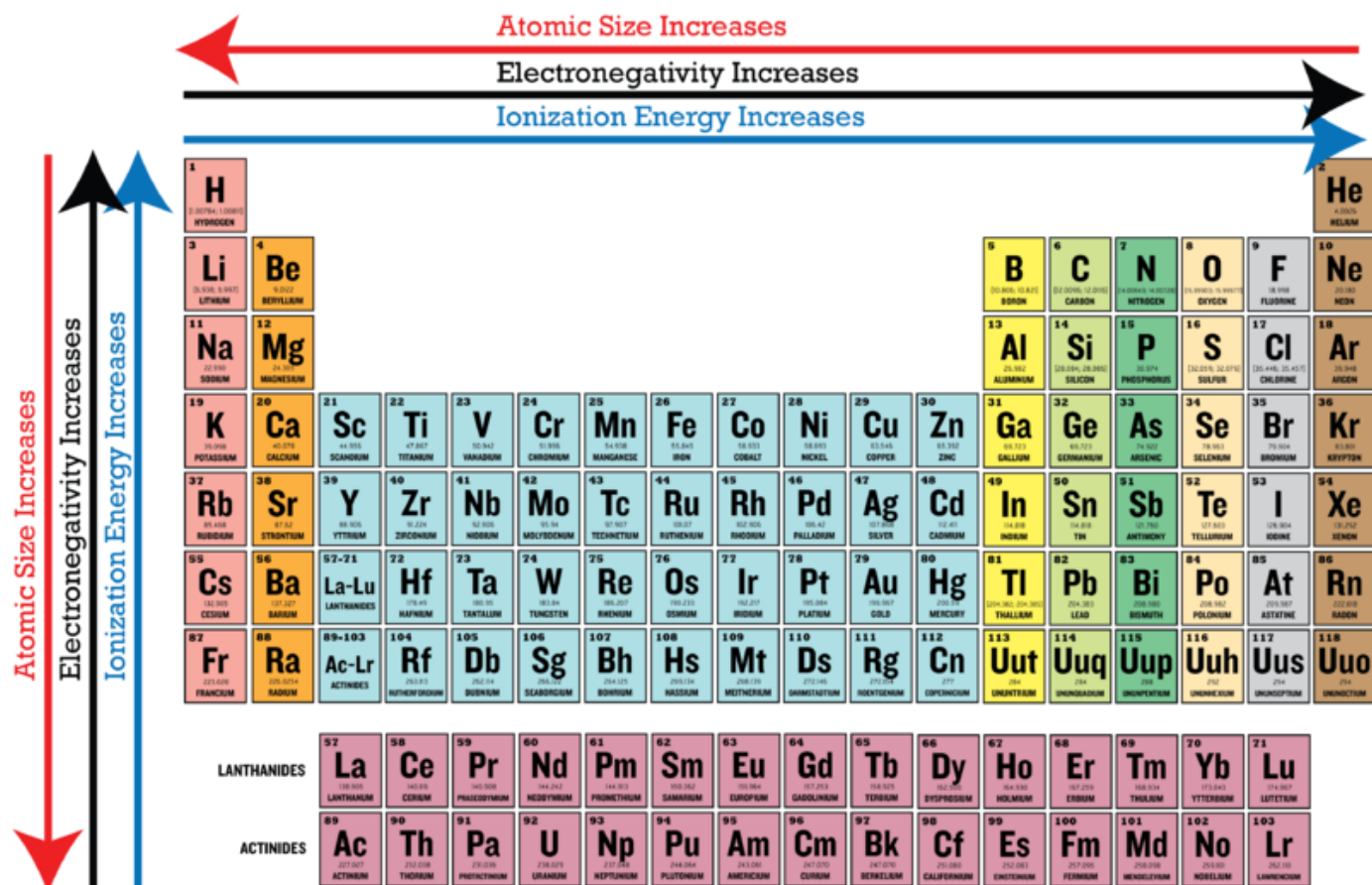
- a) Br
- b) At
- c) I
- d) Cl

6. Which of the following element has the lowest electron affinity?

Si	P	S	Cl
----	---	---	----

- a) P
- b) Cl
- c) Si
- d) S

Q6: Electronegativity



Electronegativity: the ability of an atom to attract an electron toward itself.

Fluorine has the highest electronegativity of any element.

Which element has the highest electronegativity?

- a) He
- b) Ne
- c) Na
- d) F

Which element has the highest electronegativity?

O	F
S	Cl
Se	Br

- a) O
- b) F
- c) Br
- d) Se

Which element has the highest electronegativity?

Na
K
Rb
Cs

- a) Cs
- b) Rb
- c) K
- d) Na

Which element has the highest electronegativity?

Be
Mg
Ca
Sr

- a) Mg
- b) Ca
- c) Sr
- d) Be

Which element has the lowest electronegativity?

N
P
As
Sb

- a) Sb
- b) N
- c) As
- d) P

Which of the following element has the lowest electronegativity?

Al	Si	P	S
----	----	---	---

- a) S
- b) P
- c) Si
- d) Al

Which of the following element has the highest electronegativity?

Si	P	S	Cl
Ge	As	Se	Br

- a) Si
- b) Ge

- c) Br
d) Cl

Which of the following element has the highest electronegativity?

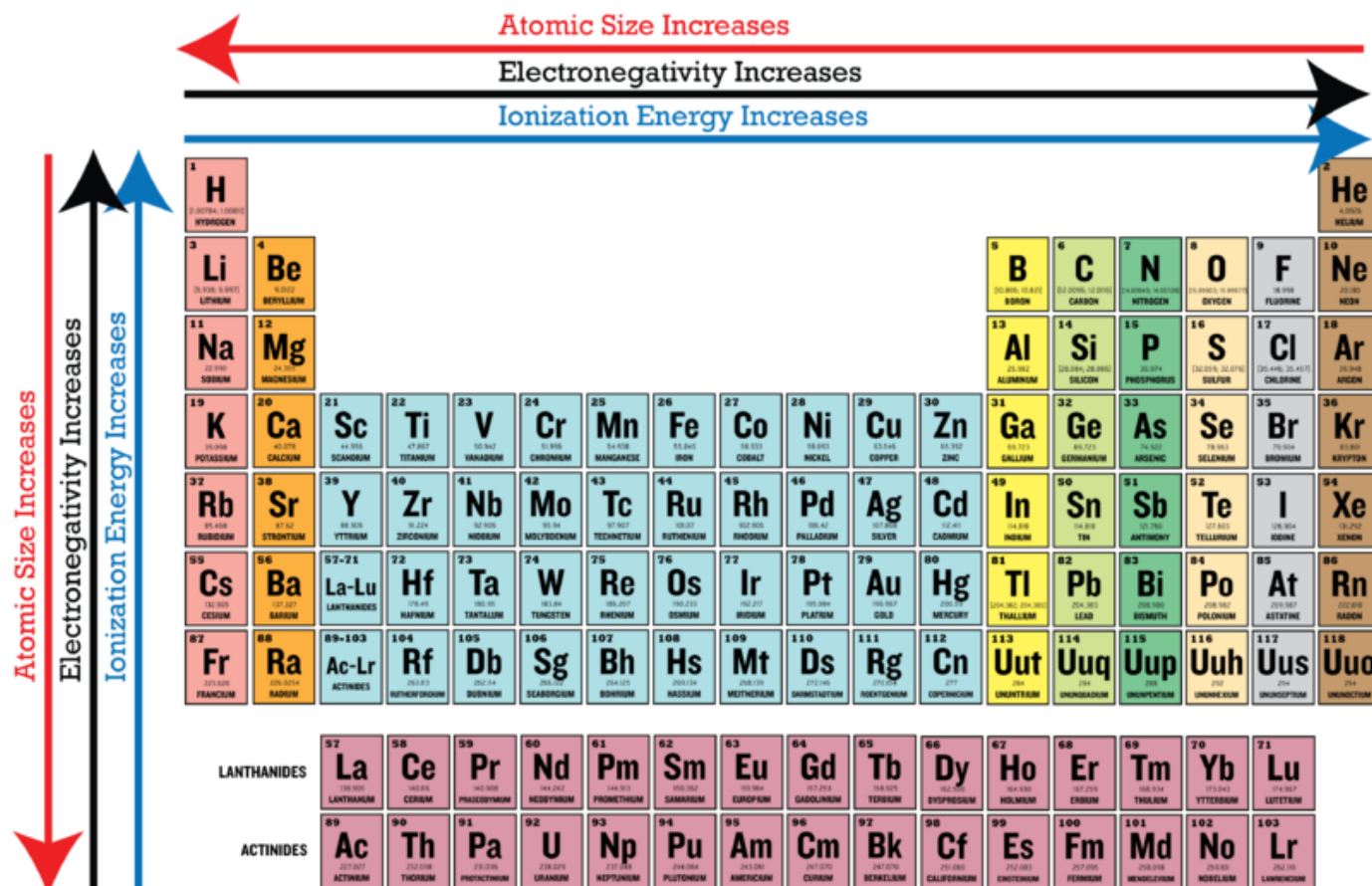
B	C	N	O
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- a) O
b) B
c) C
d) N

Which is the most electronegative element in the periodic table?

- a) Caesium
b) Fluorine
c) Hydrogen
d) Oxygen

Q7: Ionization Energy



Ionization energy: the minimum energy required to remove the most loosely bound electron from a gaseous atom, positive ion, or molecule.

The highest ionization energies are the noble gases because they all have high effective charge due to their octet formation

- **Helium**: Has the highest first ionization energy due to its small size and the strong attraction between its nucleus and electrons.

Which element has the highest ionization energy?

- a) Li
- b) H
- c) Ne
- d) He

H	He
Li	Ne

Which element has the highest ionization energy?

- a) Ne
- b) Br
- c) F
- d) He

	He
F	Ne
Cl	Ar
Br	Kr

Which element has the highest ionization energy?

- a) F
- b) Cl
- c) Ne
- d) Kr

F	Ne
Cl	Ar
Br	Kr

Which element has the highest ionization energy?

C	N	O
Si	P	S

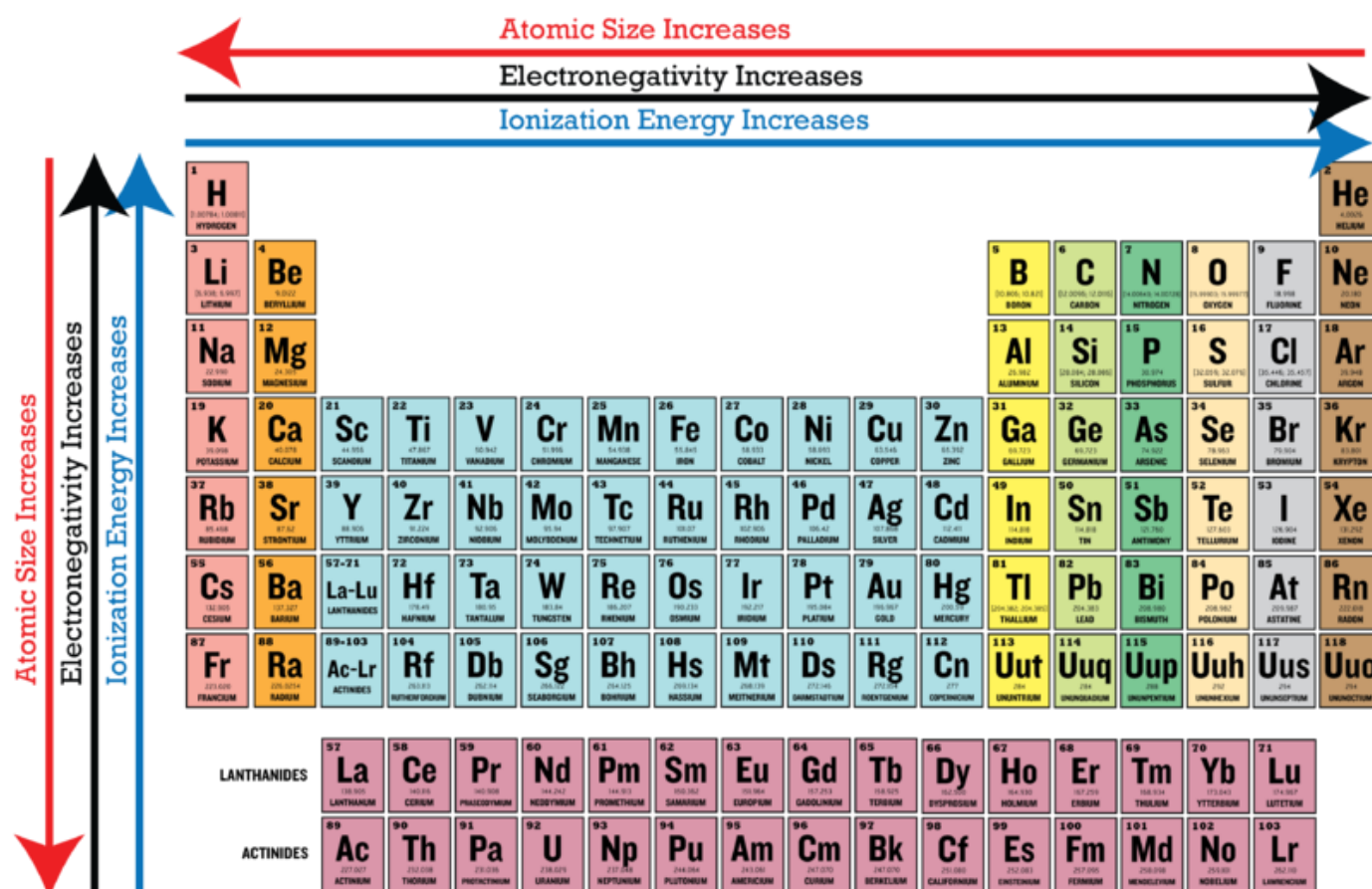
- a) N
- b) C
- c) O
- d) S

Among the given elements, which one has the highest first ionization energy?

- a) Carbon (C)
- b) Oxygen (O)
- c) Nitrogen (N)
- d) Fluorine (F)

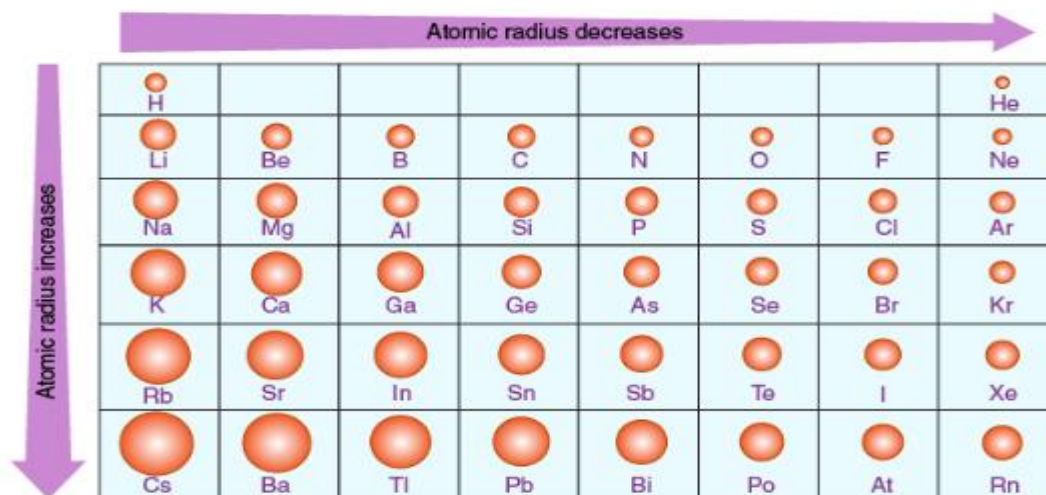
C	N	O	F
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Q8: Atomic Size, Atomic Radius



Atomic Radius: The atomic radius is defined as the distance from the nucleus to the outermost electron shell.

Atomic Size: Atomic size is a more general term that refers to the overall size or effective diameter of an atom. It is influenced by the spread of the electron cloud



Atomic Radius Trends in the Periodic Table

Which of the following elements has the largest atomic size?

Li	Be	B	C	N	O
----	----	---	---	---	---

- a) O
- b) Be
- c) Li
- d) B

Which of the following elements has the largest atomic size?

P	S	Cl	Ar
---	---	----	----

- a) Cl
- b) S
- c) P
- d) Ar

Which of the following elements has the largest atomic size?

B	C	N	O
---	---	---	---

- a) O
- b) B
- c) N
- d) C

Which of the following elements has the largest atomic size?

B
Al
Ga
In

- a) Al

- b) B
- c) In
- d) Ga

Which of the following elements has the largest atomic size?

Be
Mg
Ca
Sr

- a) Sr
- b) Ca
- c) Be
- d) Mg

Arrange the following elements according to increasing atomic size; P,Al, Cl,Na,S.

Na	Al	Si	P	Cl
----	----	----	---	----

- a) Al,Cl,Na,P,S
- b) Cl, S,P,Al,Na
- c) Na,Al,P,S,Cl
- d) S,Cl,P,Na,Al

Arrange according to size of atomic radius; O, C, N, B

B	C	N	O
---	---	---	---

- a) B > C > O > N
- b) B > C > N > O
- c) C > N > B > O
- d) O > N > B > C

Q8: Quantum Numbers

Quantum numbers n, l, m_l, m_s	describe the position of a specific electron on a given energy level.
Principal quantum number (n)	The quantum number which describes the main energy level principal quantum number, $n = 1, 2, 3, \dots, 7$
Secondary quantum number (l)	The quantum number which describes the shape of the orbital = secondary quantum number, $l = 0, 1, \dots, (n-1)$
Magnetic quantum number (m_l)	The quantum number which describes the orientation of the orbital in the space = magnetic quantum number, $m_l = (-l), \dots, 0, \dots, (+l)$
Spin quantum number (m_s)	The quantum number which describes the orientation of the electron spin $m_s = \text{spin quantum number, } m_s = +1/2 \text{ or } -1/2.$

s p d f

n = the number before the last subshell

l = 0 1 2 3

 0 -1 0 +1 -2 -1 0 +1 +2

$m_l =$

--

--	--	--

--	--	--	--	--

$m_s =$  

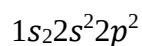
 -1/2 or +1/2

For element X has atomic number equal 6, the magnetic quantum number of the fifth electron will be:

- a) -1, 0, +1
- b) -2, -1, 0, +1, +2
- c) 0
- d) -1

Electronic Configuration

- The atomic number of element X is =6
- The electronic configuration of element X is



Quantum Numbers

- The principal quantum number for the fifth electron $n=2$
- .
- The secondary quantum number $l = 1$
- The magnetic quantum number for the fifth electron $m_l = -1$

	$1s^2$	$2s^2$	$2p^2$
m_l	0	0	-1 0 +1
			

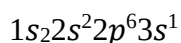
- The spin quantum number for the fifth electron $m_s = +1/2$

For element X has atomic number equal 11, the magnetic quantum number of the last electron will be:

- 1
- 0
- 1, 0, +1
- 2, -1, 0, +1, +2

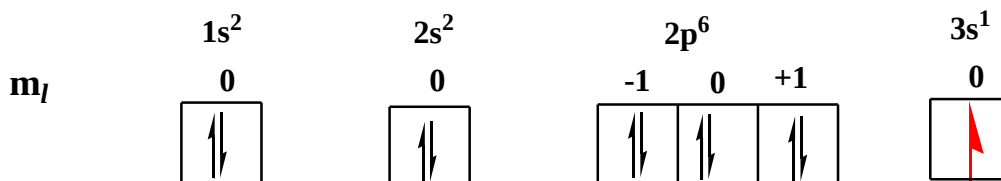
Electronic Configuration

- The atomic number of element X is =11
- The electronic configuration of element X is



Quantum Numbers

- The principal quantum number for the fifth electron $n=3$
- .
- The secondary quantum number $l = 0$
- The magnetic quantum number for the fifth electron $m_l = 0$



- The spin quantum number for the fifth electron $m_s = +1/2$

List the values of quantum number(n, l, m_l) for orbital 4f subshell?

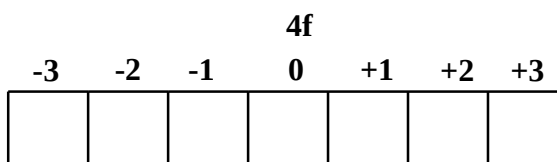
- $n = 4, l = 3, m_l = -3$
- $n = 3, l = 4, m_l = +3$
- $n = 4, l = 4, m_l = -2$
- $n = 2, l = 2, m_l = +2$

Quantum Numbers

The principal quantum number for the fifth electron $n=4$

The secondary quantum number $l = 3$

The magnetic quantum number for the fifth electron $m_l = -3, -2, -1, 0, +1, +2, +3$



List the values of quantum number(n, l, m_l) for 3d orbital?

- a) $n = 3, l = 3, m_l = -3$
- b) $n = 3, l = 2, m_l = +1$
- c) $n = 4, l = 4, m_l = -2$
- d) $n = 2, l = 2, m_l = +2$

Quantum Numbers

The principal quantum number for the fifth electron $n=3$

The secondary quantum number $l = 2$

The magnetic quantum number for the fifth electron $m_l = -2, -1, 0, +1, +2$

3d				
-2	-1	0	+1	+2

Q9: pH, pOH

1. The pH value of a 0.0001 mol L⁻¹ solution of HCl is

- a) 1
- b) 4
- c) 6
- d) 8

$$\begin{aligned}[\text{HCl}] &= [\text{H}^+] = 0.0001 \\ \text{pH} &= -\log[\text{H}^+] \\ \text{pH} &= -\log[0.0001] = 4\end{aligned}$$

2. Determine the pH of a 0.10 M HCl solution.

- a) 4
- b) 10
- c) 1
- d) 7

$$\begin{aligned}[\text{HCl}] &= [\text{H}^+] = 0.10 \\ \text{pH} &= -\log[\text{H}^+] \\ \text{pH} &= -\log[0.10] = 1\end{aligned}$$

3. What is the pH value of a 0.05 mol L⁻¹ solution of HCl?

- a) 5.5
- b) 11.0
- c) 1.3
- d) 4.4

$$\begin{aligned}[\text{HCl}] &= [\text{H}^+] = 0.05 \\ \text{pH} &= -\log[\text{H}^+] \\ \text{pH} &= -\log[0.05] = 1.3\end{aligned}$$

4. The pH value of a 0.0001 mol L⁻¹ solution of NaOH is

- a) 8
- b) 3
- c) 6
- d) 10

$$\begin{aligned}[\text{NaOH}] &= [\text{OH}^-] = 0.0001 \\ \text{pOH} &= -\log [\text{OH}^-] \\ \text{pOH} &= -\log[0.0001] = 4 \\ \text{pH} + \text{pOH} &= 14 \\ \text{pH} &= 14 - 4 = 10\end{aligned}$$

5. What is the pH value of a 0.10 M solution of NaOH?

- a) 6
- b) 8
- c) 3
- d) 10

$$\begin{aligned}[\text{NaOH}] &= [\text{OH}^-] = 0.10 \\ \text{pOH} &= -\log [\text{OH}^-] \\ \text{pOH} &= -\log[0.1] = 1 \\ \text{pH} + \text{pOH} &= 14 \\ \text{pH} &= 14 - 1 = 13\end{aligned}$$

6. Which of following acids is polyprotic?

- a) HCl
- b) HNO₃
- c) H₃PO₄ H₂SO₄ H₂CO₃
- d) CH₃CH₂COOH

7. What is the [H⁺] of a 0.12 M solution of HCl that has a pH of 5.1?

- a) 7.94*10⁻⁶
- b) 1.30*10⁻⁶
- c) 1.36
- d) 1.01*10⁻⁵

$$\begin{aligned}[\text{H}^+] &= 10^{-\text{pH}} \\[\text{H}^+] &= 10^{-5.1} \\[\text{H}^+] &= 7.94 \times 10^{-6}\end{aligned}$$

8. What is the molarity of a HCl solution that has a pH of a 5.0?

- a) 5.5*10⁻¹
- b) 1.50
- c) 1*10⁻⁵
- d) 13.50

$$\begin{aligned}[\text{H}^+] &= 10^{-\text{pH}} \\[\text{H}^+] &= 10^{-5} \\[\text{H}^+] &= 10^{-5}\end{aligned}$$

9. What is the pH of an aqueous solution with a 5.1*10⁻⁶ M hydroxide ion concentration?

- a) 10.1
- b) 4.5
- c) 7.9
- d) 8.7

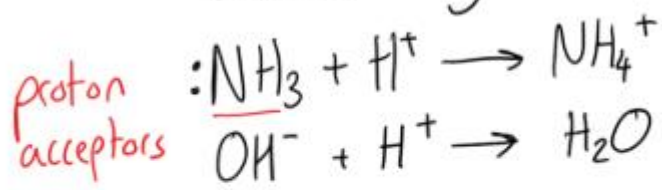
$$\begin{aligned}[\text{NaOH}] &= [\text{OH}^-] = 5.1 \times 10^{-6} \\ \text{pOH} &= -\log [\text{OH}^-] \\ \text{pOH} &= 5 + .3 \\ \text{pH} + \text{pOH} &= 14 \\ \text{pH} &= 14 - 5.3 = 8.7\end{aligned}$$

10. $\text{HCl}_{(aq)} + \text{KOH}_{(aq)} \rightarrow \text{KCl}_{(aq)} + \text{H}_2\text{O}_{(l)}$

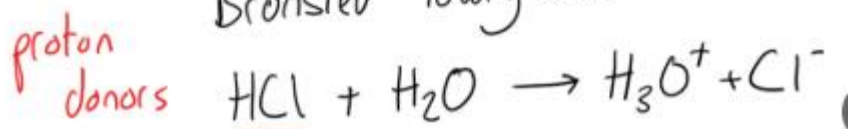
what is the type of a reaction given?

- a) Catalytic Reaction
- b) Neutralization Reaction
- c) Redox Reaction
- d) Sublimation Reaction

Bronsted lowry base



Bronsted lowry acid



Acid-Base Theory	Acid Definition	Base Definition
Arrhenius Theory	Substances releasing H^+ ions in aqueous solutions.	Substances releasing OH^- ions in aqueous solutions.
Bronsted-Lowry Theory	Substances donating protons (H^+ ions) in chemical reactions.	Substances accepting protons (H^+ ions) in chemical reactions.
Lewis Acid-Base Theory	Species that accept electron pairs.	Species that donate electron pairs.

11. What is the definition of a Bronsted – Lowry base?

- a) A compound that accepts an electron pair in solution
- b) A compound that accepts protons in solution
- c) A compound that donates an electron pair in solution
- d) A compound that donates protons in solution

12. What is the definition of a Bronsted – Lowry acid?

- a) A compound that accepts an electron pair in solution
- b) A compound that donates protons in solution
- c) A compound that accepts protons in solution
- d) A compound that donates an electron pair in solution

$$\begin{aligned}K_w &= [\text{H}^+][\text{OH}^-] \\&= (1 \times 10^{-7})(1 \times 10^{-7}) \\&= 1 \times 10^{-14}\end{aligned}$$

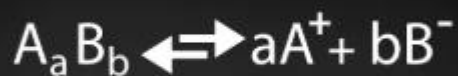
13. Considering the K_a for acetic acid (CH_3COOH) is 1.8×10^{-5} , what is the K_b for acetate (CH_3COO^-)?

- a) 1.1×10^{-8}
- b) 5.6×10^{-10}
- c) 3.5×10^{-4}
- d) 3.0×10^{-3}

$$\begin{aligned}K_w &= K_a \times K_b \\1 \times 10^{-14} &= K_a \times K_b\end{aligned}$$

$$K_b = \frac{K_w}{K_a} = \frac{1 \times 10^{-14}}{1.8 \times 10^{-5}} = 5.6 \times 10^{-10}$$

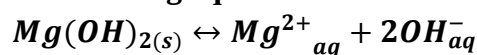
Is the equilibrium constant for a solid substance dissolving in an aqueous solution or (K_{sp})



$$K_{sp} = [A^+]^a [B^-]^b$$

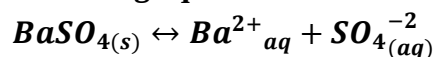
solubility product constant

14. Write the K_{sp} expression for the following equilibria:

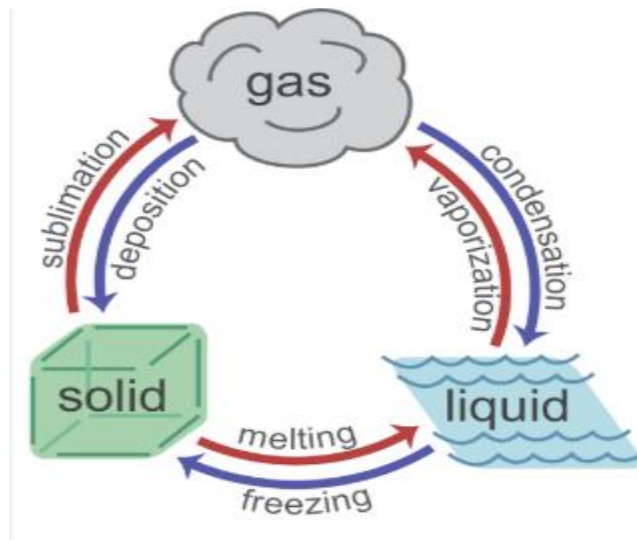


- a) $K_{sp} = [Mg^+]2[OH^-]$
- b) $K_{sp} = [Mg^+][OH^-]$
- c) $K_{sp} = [Mg^+][OH]^-$
- d) $K_{sp} = [Mg^{2+}][OH^-]^2$

15. Write the K_{sp} expression for the following equilibria:



- a) $K_{sp} = [Ba]^{2+}[SO_4]^{2-}$
- b) $K_{sp} = [Ba][SO_4]^{2-}$
- c) $K_{sp} = [Ba][SO_4]$
- d) $K_{sp} = [Ba^{2+}][SO_4^{2-}]$



Melting	solid to liquid
Freezing	liquid to solid
Vaporization	liquid to gas
Condensation	gas to liquid
Sublimation	solid to gas
Deposition	gas to solid

16. How much heat is absorbed when 150g of water goes from 25 °C to 35 °C? (Specific heat of water =4.18 J/g °C)

- a) 12 J
- b) 70 J
- c) 2270 J
- d) 6270 J

$$C = \frac{Q}{m \times \Delta T}$$
$$Q = C \times m \times \Delta T$$
$$Q = 4.18 \times 150 \times (35 - 25)$$
$$Q = 6270 \text{ J}$$

17. How much heat is absorbed when 100g of water goes from 25 °C to 35 °C? (Specific heat of water =4.18 J/g °C)

- e) 418 J
- f) 100 J
- g) 4180 J
- h) 41.80 J

$$C = \frac{Q}{m \times \Delta T}$$
$$Q = C \times m \times \Delta T$$
$$Q = 4.18 \times 100 \times (35 - 25)$$
$$Q = 6270 \text{ J}$$

18. How much heat is absorbed when 50g of water goes from 24.5 °C to 43°C? (Specific heat of water =4.18 J/g °C)

- i) 3867 J
- j) 43J
- k) 166 J
- l) 896 J

$$C = \frac{Q}{m \times \Delta T}$$
$$Q = C \times m \times \Delta T$$
$$Q = 4.18 \times 50 \times (43 - 24.5)$$
$$Q = 3867 \text{ J}$$

Mass (g) →

Heat (J) →

$$q = m \times C_s \times \Delta T$$

Temperature change (°C) →

Specific heat capacity (J/g·°C) →



GAS LAWS

AS EASY AS ABCD!

Avogadro's Law:

$$V = an, \text{ or } \frac{V_1}{n_1} = \frac{V_2}{n_2}$$

Boyle's Law:

$$PV = k, \text{ or } P_1V_1 = P_2V_2$$

Charles' Law:

$$V = bT, \text{ or } \frac{V_1}{T_1} = \frac{V_2}{T_2}$$

Dalton's Law:

$$P_{\text{TOTAL}} = P_1 + P_2 + P_3 \dots$$

IDEAL GAS LAW:

$$PV = nRT$$

$$R = \frac{0.08206 \text{ L} \cdot \text{atm}}{\text{K} \cdot \text{mol}}$$

Conversion Factors

1 atm
 = 760 mm Hg
 = 760 torr
 = 101325 Pa
 = 101.325 kPa
 = 1.01325 bar
 = 29.92 in Hg
 = 14.7 lb/in²
 = 101325 N/m²
 = pressure at sea level

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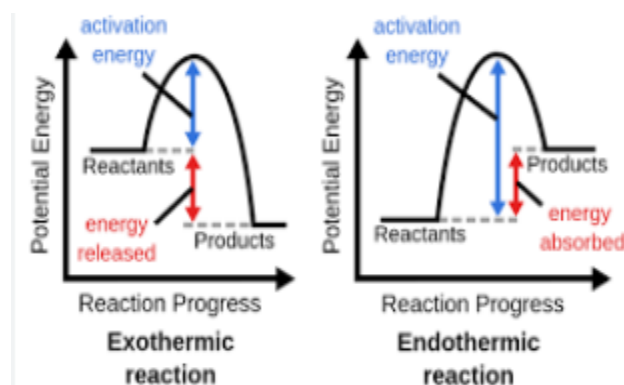
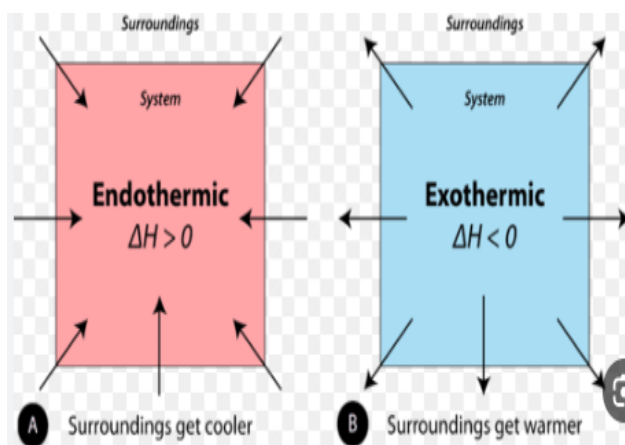
19. A gas sample is contained in a 4 liter vessel at a pressure of 3 atm. What is the new pressure if the volume is reduced to 1.5 L?

- a) 1.12 atm
- b) 8.0 atm
- c) 4.5 atm
- d) 6.0 atm

$$P_1 \times V_1 = P_2 \times V_2$$

$$3 \times 4 = P_2 \times 1.5$$

$$P_2 = \frac{3 \times 4}{1.5} = 8.0 \text{ atm}$$



Endothermic Reaction	Exothermic Reaction
1. Heat is absorbed by the system.	Heat is released by the system.
2. Temperature of the surrounding is decreased.	Temperature of the surrounding is increased.
3. Favoured by a high temperature surrounding.	Favoured by a low temperature surrounding.

20. When the enthalpy of a reaction has a value of -112 kJ, which word is used to describe the reaction?

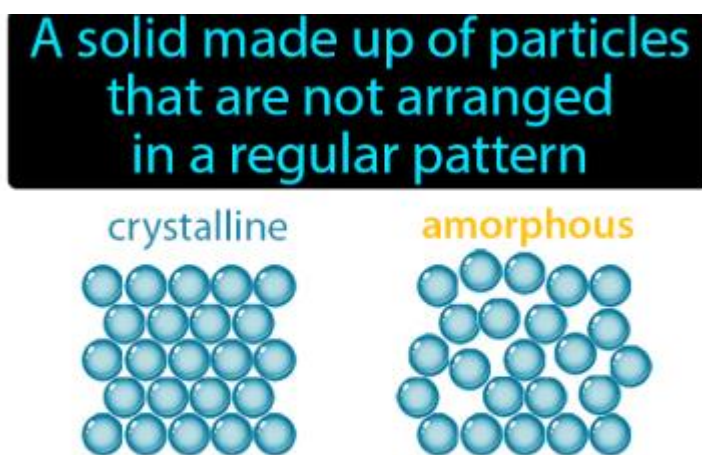
- a) Endergonic

- b) Exothermic
- c) Endothermic
- d) Exergonic

21. When the enthalpy of a reaction has a value of +89.5 kJ, which word is used to describe the reaction?

- a) Exothermic
- b) Endergonic
- c) Endothermic
- d) Exergonic

Q15: amorphous solid



The main difference is that crystalline solids have a highly ordered, repeating, three-dimensional arrangement of atoms, while amorphous solids lack this long-range order and have a random, disordered structure. This structural difference causes crystalline solids to have sharp melting points and distinct geometric shapes, whereas amorphous solids have a gradual melting range and irregular shapes

An amorphous solid is a noncrystalline solid that lacks the long-range order of a crystal, meaning its atoms and molecules are arranged randomly. Unlike crystalline solids, which have a definite melting point, amorphous solids soften over a range of temperatures and lack a specific shape. Examples of amorphous solids include glass, plastic, and rubber.

Key characteristics

- **Structure:**

Lacks long-range molecular or atomic order, but may have short-range order. This means the local arrangement of particles can be similar to a crystal, but this pattern does not extend throughout the solid.

- **Melting point:**

Does not have a sharp, definite melting point; it softens gradually over a temperature range.

- **Physical properties:**

Exhibits isotropic properties, meaning its physical properties are the same in all directions, unlike anisotropic crystalline solids.

- **Cleavage:**

Typically breaks with an unclean, irregular fracture.

- **Thermodynamic properties:**

Generally has higher energy, entropy, and free energy than a corresponding crystalline solid.

Examples

- Glass
- Plastic
- Rubber
- Gels
- Certain pharmaceuticals and proteins
- Some types of metals, like metallic glasses

Which of the following carbon is an examples of amorphous solids?

Diamond

Coke

Graphite

[Fullerenes](#)

Which of the following is an amorphous form of carbon? لم يذكر في الاختبار

Graphite

Charcoal

[Fullerenes](#)

Diamond

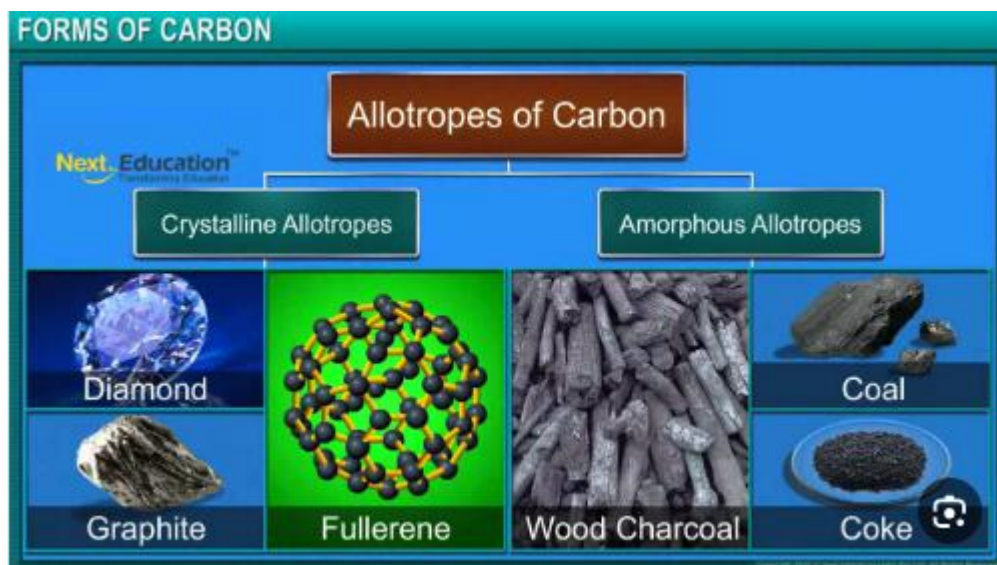
Which of the following carbon is an examples of crystalline solids? لم يذكر في الاختبار

Coke

Diamond Graphite

Carbon Black

Charcoal



Q15: Polar & Nonpolar

1. Which one of the following is polar compounds?

- a) Methane CH_4
- b) Methyl Chloride CH_3Cl
- c) Ethene $\text{H}_2\text{C}=\text{CH}_2$
- d) Cyclohexane

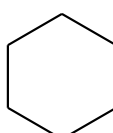
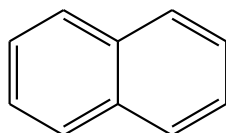
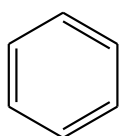
Methyl chloride is the polar molecule. Methane and ethene are nonpolar because their symmetrical structures cause the bond dipoles to cancel out. Methyl chloride is polar because the electronegativity difference between carbon and chlorine creates a polar bond, and the molecule's asymmetrical shape prevents the dipoles from canceling out, resulting in a net dipole moment.

All Aliphatic and Aromatic Hydrocarbons are Nonpolar

Methane CH_4 Ethane C_2H_6 Pentane C_5H_{12}

Ethene C_2H_4 $\text{H}_2\text{C}=\text{CH}_2$ Propene

Benzene C_6H_6 Naphthalene Cyclohexane



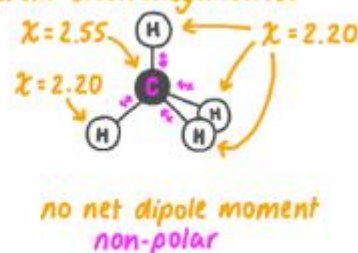
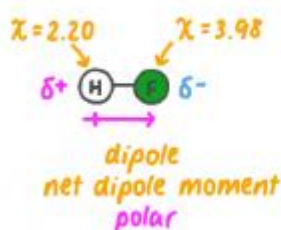
Which of the following molecules is considered a polar molecule?

- A) N_2
- B) H_2
- C) HF
- D) CH_4

has a net dipole moment ↙

↳ molecule has at least 1 dipole but doesn't 'cancel out'

atoms in a molecule have very different electronegativities ↘



Which of the following is a polar molecule ?

- (a) Ammonia (NH_3)
- (b) Methane (CH_4)
- (c) Ethylene (C_2H_4)
- (d) Carbon Tetrachloride (CCl_4)

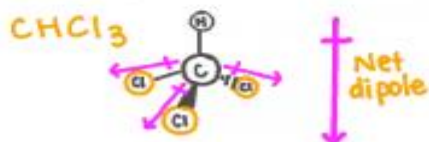
Which of the molecules Br_2^* , HF^* , CHCl_3^* , CCl_4^* , and NH_3^* contains polar bonds but is not a polar molecule?



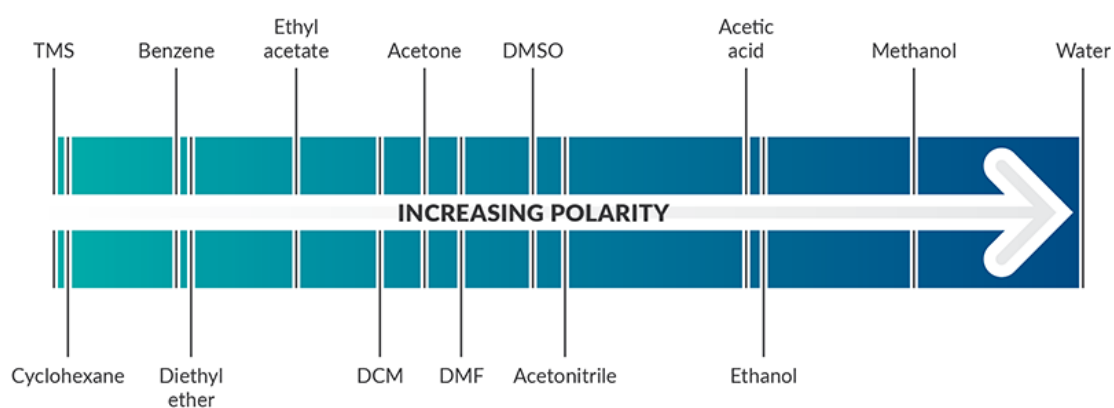
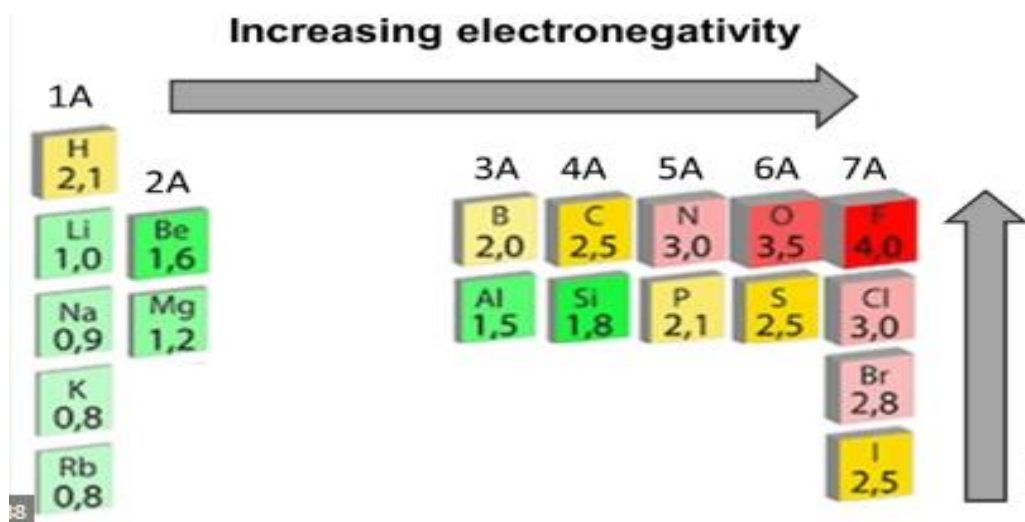
$$\Delta EN = |2.96 - 2.96| = 0$$



$$\Delta EN = |2.20 - 3.98| = 1.78$$



NONPOLAR
 $\Delta EN = |3.16 - 2.55| = 0.61$
polar



Polar Solvents Are Either Protic or Aprotic

Polar protic solvents solvate cations and anions effectively. They are capable of hydrogen bonding because they contain at least one hydrogen atom connected directly to an electronegative atom (such as O-H or N-H bonds). In fact, the most common characteristic of a protic solvent is the presence of an OH group. Polar protic solvents can participate in reactions serving as a source of protons (acid), removing protons (base), or donating a lone pair of electrons as a nucleophile. As strong hydrogen bond donors, protic solvents are very effective at stabilizing ions in nucleophilic substitution reactions and favor reactions where ions are formed, like in S_N1 reactions.

Polar aprotic solvents are not capable of hydrogen bonding, since they do not have hydrogen atoms connected directly to an electronegative atom. They only serve as a reaction medium and do not solvate nucleophiles. Aprotic polar solvents favor reactions where ions are reactants, like in S_N2 reactions. S_N2 reactions are significantly faster in polar aprotic solvents than in protic solvents.

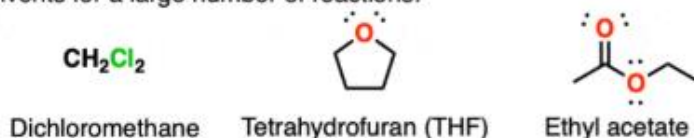
Summary: Common Solvents In Organic Chemistry

- **Nonpolar** solvents have **small or zero dipole moments and low dielectric constants (< 5)** and are typically used for dissolving nonpolar substances.
e.g.

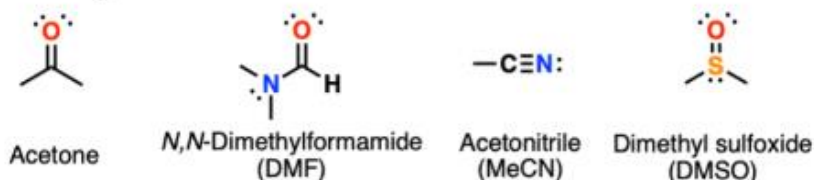


Pentane is used in the formation of organolithium reagents. Diethyl ether is used in the formation of Grignard reagents as its lone pairs are Lewis basic and can help to solvate the Mg cation.

- Some nonpolar solvents with slightly larger dipole moments and dielectric constants are useful solvents for a large number of reactions:

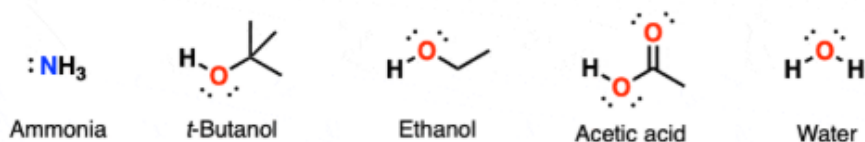


- **Polar Aprotic** solvents have larger dipole moments and higher dielectric constants (>10) along with some water solubility. They **lack** O-H or N-H bonds ("aprotic") and therefore do not participate in hydrogen bonding



Acetone, DMF, acetonitrile, and DMSO are often used as solvents in S_N2 reactions, where they can dramatically increase the reactivity of nucleophiles

• **Polar Protic** solvents have large dipole moments and high dielectric constants ("polar") and contain O-H or N-H bonds ("protic"). They can therefore form **hydrogen bonds**.



All of the above examples can be used as the solvent for their conjugate bases. They can also function as weak nucleophiles, in the presence of strong electrophiles (such as acid).

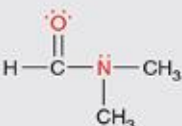
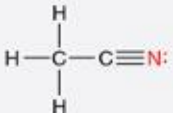
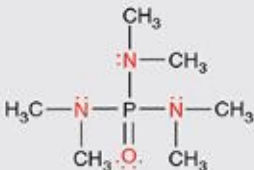
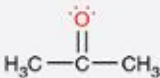
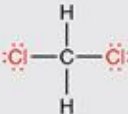
COMMON POLAR PROTIC SOLVENTS

Polar protic solvents have high dielectric constants, high dipole moments, and participate in hydrogen bonding since they possess O-H or N-H bonds. These solvents can also serve as acids and weak nucleophiles, participating directly in reactions. They are most often used as the solvent for their conjugate bases. For example, water is used as the solvent for hydroxide ions.

Solvent	Structure	Dielectric Constant	Dipole Moment	Boiling Point (°C)
Water	<chem>H-O-H</chem>	80.1	1.85	100
Methanol	<chem>H-O-CH3</chem>	33.0	1.69	64.5
Ammonia	<chem>:NH3</chem>	31.6	1.42	-33.34
Ethanol	<chem>H-O-CH2CH3</chem>	25.3	1.69	78.3
n-Propanol	<chem>H-O-CH2CH2CH3</chem>	20.1	1.68	97
Isopropyl alcohol	<chem>CC(C)O</chem>	19.92	1.66	82.5
t-Butanol	<chem>CC(C)(C)O</chem>	10.9	1.70	83
Acetic acid	<chem>CC(=O)O</chem>	6.20	1.74	118

COMMON POLAR APROTIC SOLVENTS

Aprotic solvents with moderately higher dielectric constants than nonpolar solvents (between 5 and 20) make adequate general-purpose solvents for a wide range of reactions. Aprotic solvents with dielectric constants greater than 20 and large dipole moments can dissolve charged species such as various anions used as nucleophiles. Without hydrogen bonding in the solvent, these nucleophiles are relatively free in solution, making them more reactive.

Solvent	Structure	Dielectric Constant	Dipole Moment	Boiling Point (°C)
Dimethylsulfoxide (DMSO)		46.68	3.96	189
Dimethylformamide (DMF)		36.71	3.86	153
Acetonitrile (MeCN)		38.8	3.92	81.6
Hexamethylphosphoric acid (HMPA)		30.0	5.54	233
Acetone		20.7	2.88	56
Dichloromethane		8.93	1.60	39.6

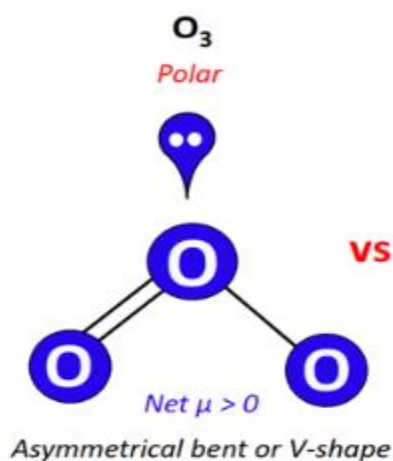
COMMON NONPOLAR SOLVENTS

Nonpolar solvents have low dielectric constants and are poor solvents for charged species. Diethyl ether, used for Grignard reactions, is one notable exception since its lone pairs can help to solvate the Mg cation.

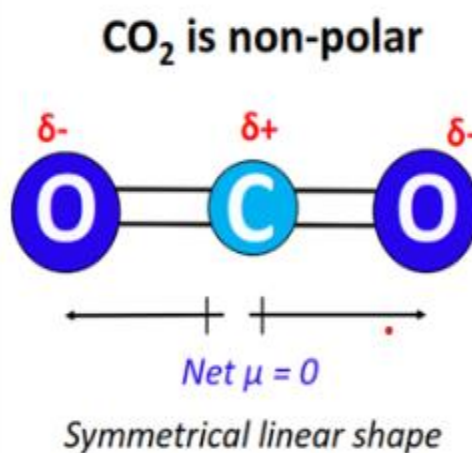
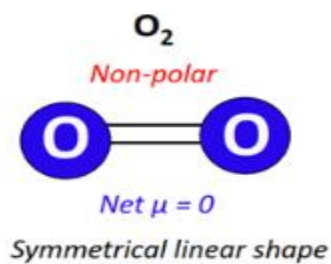
Solvent	Structure	Dielectric Constant	Dipole Moment	Boiling Point (°C)
Chloroform		4.81	1.15	61.7
Diethyl ether	$\text{H}_3\text{CH}_2\text{C}-\ddot{\text{O}}-\text{CH}_2\text{CH}_3$	4.33	1.15	34.6
Toluene		2.38	0.375	110.6
Benzene		2.28	0	80.1
1,4-Dioxane		2.25	0.45	102
Cyclohexane		2.02	0	80.7
Hexane		1.88	1.08	69

Which of the following polar or nonpolar: NO₂ CO₂ SO₂ SO₃ BH₃ CS₂ H₂S O₃ CHCl₃ CH₂Cl₂ HCl
HF HBr CCl₄ with geometry

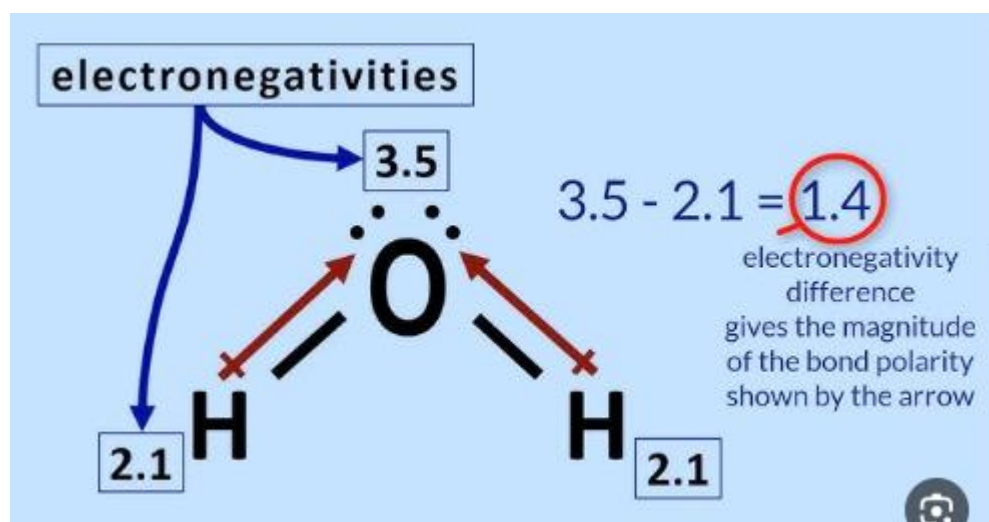
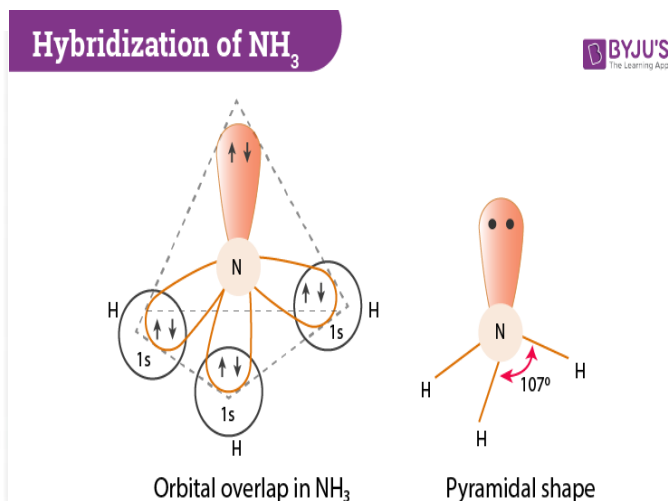
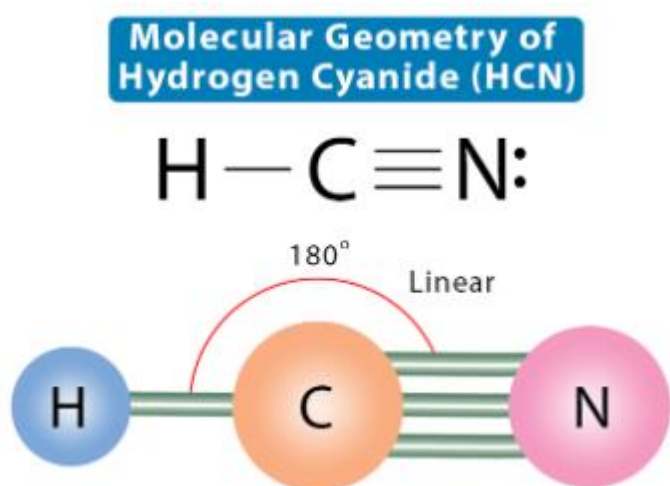
Molecule	Geometry	Polarity
H ₂ O	Bent (V- shape)	Polar
NH ₃	Trigonal pyramidal	Polar
HCN	Linear	Polar
NO ₂	Bent	Polar
SO ₂	Bent	Polar
H ₂ S	Bent	Polar
HCl	Linear	Polar
HF	Linear	Polar
HBr	Linear	Polar
CHCl ₃	Tetrahedral	Polar
O ₃		Polar
O ₂		Nonpolar
CCl ₄	Tetrahedral	Nonpolar
CS ₂	Linear	Nonpolar
BH ₃	Trigonal Planar	Nonpolar
SO ₃	Trigonal Planar	Nonpolar
CO ₂ ,	Linear	Nonpolar



VS



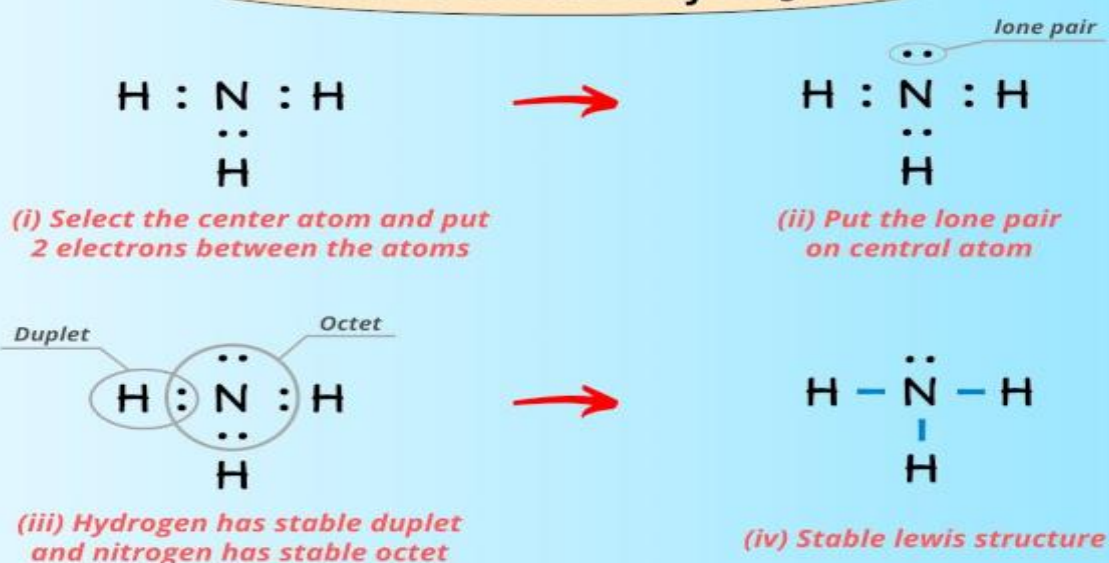
Which of the following polar or nonpolar: NH_3 H_2O HCN (Draw Lewis structure)



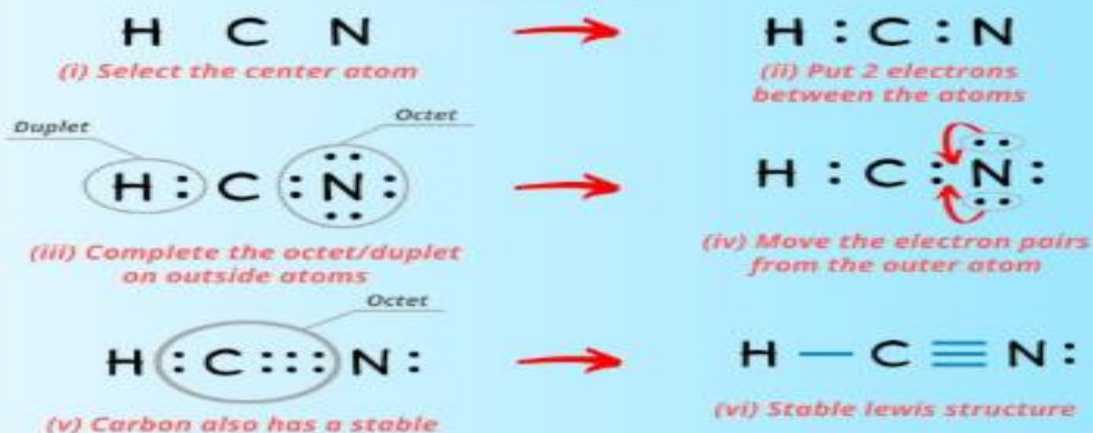
A molecule is considered polar if it has a net dipole moment, which depends on both bond polarities (electronegativity differences) and molecular geometry.

- **H_2O (Water):** The molecule has a **bent shape** and the oxygen atom is more electronegative than the hydrogen atoms. The dipole moments of the O-H bonds do not cancel out, resulting in a large net dipole moment, making it highly polar.
- **NH_3 (Ammonia):** Ammonia has a **trigonal pyramidal shape** with a lone pair of electrons on the central nitrogen atom. The N-H bond dipoles, combined with the effect of the lone pair, result in a net dipole moment, making it a polar molecule.
- **HCN (Hydrogen Cyanide):** Although it has a **linear shape**, the electronegativity differences between the hydrogen, carbon, and nitrogen atoms are significant. The dipole moments from the C-H and $\text{C}\equiv\text{N}$ bonds do not cancel each other out due to this asymmetry, giving the molecule a strong net dipole moment and making it polar.

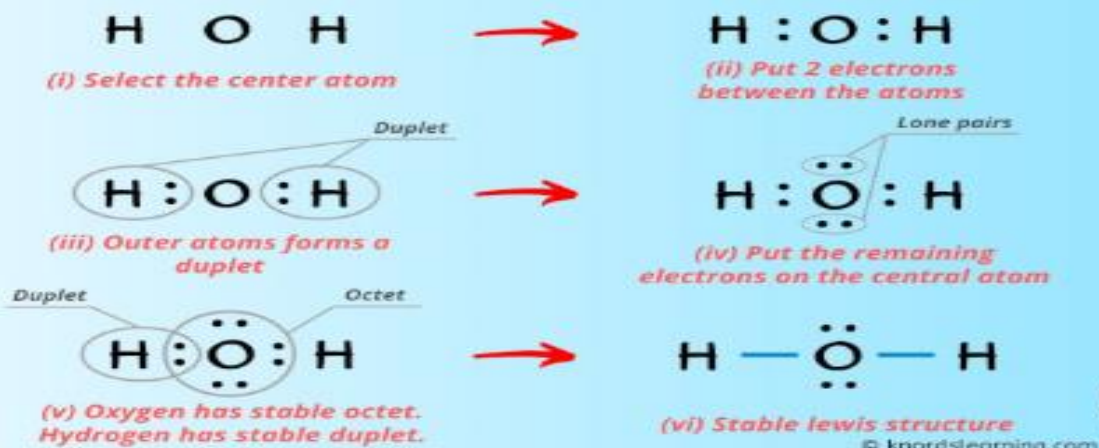
Lewis structure of NH_3

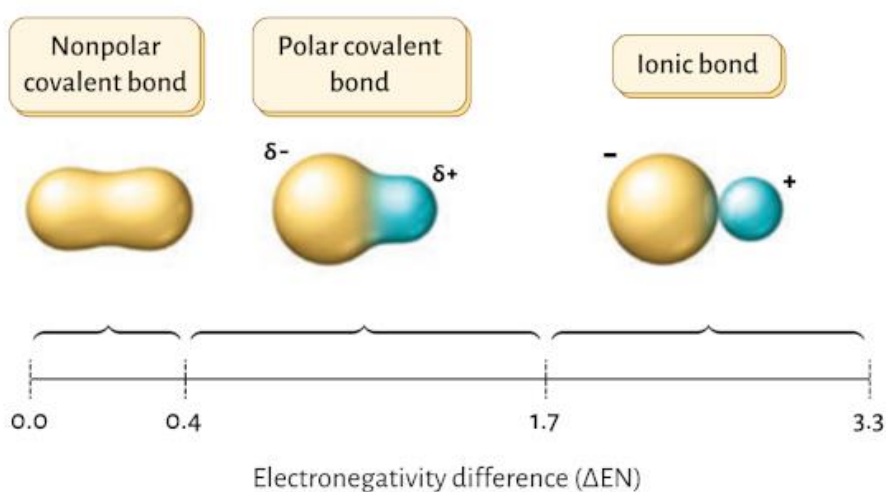
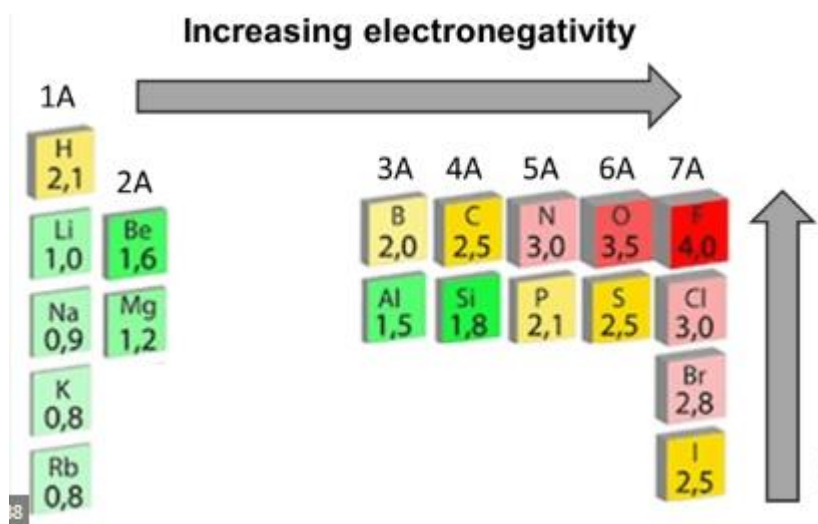


Lewis structure of HCN



Lewis structure of H_2O

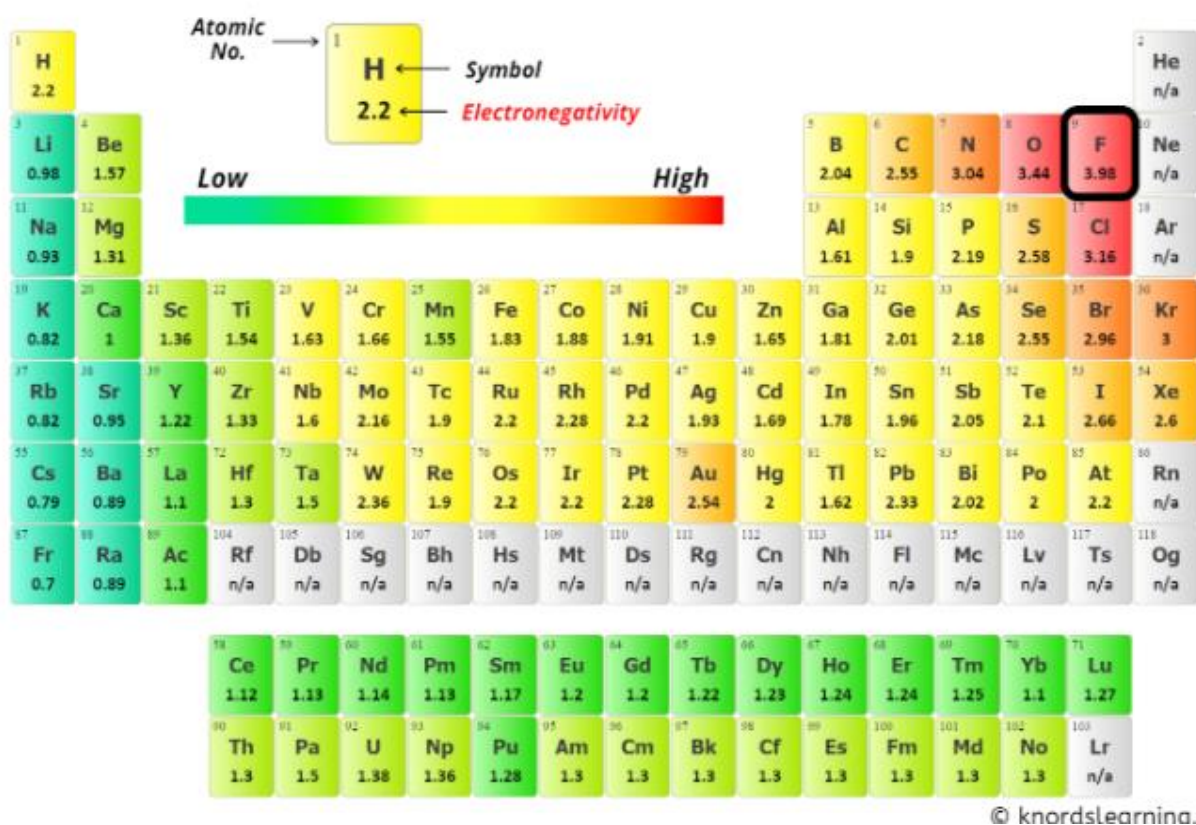




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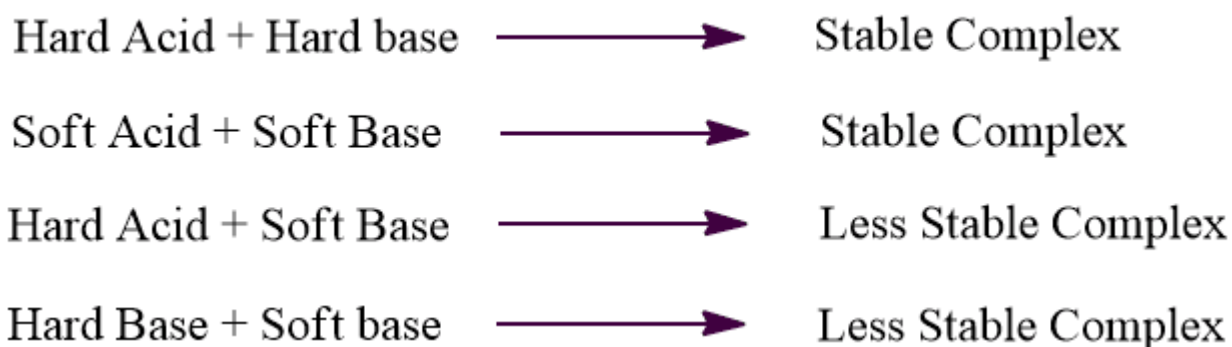
Have a look at the above image.

- If the electronegativity difference (ΔEN) is **less than 0.4**, then the bond is **nonpolar** covalent bond.
- If the electronegativity difference (ΔEN) is **between 0.4 to 1.7**, then the bond is **polar** covalent bond.
- If the electronegativity difference (ΔEN) is **greater than 1.7**, then the bond is an **ionic** bond. ^{[1] [2] [3] [4]}



Q15: HSAB principle

According to the HSAB principle, hard acid prefers to combine with a hard base and soft acid prefers to combine with a soft base in order to form a stable acid-base complex. Ralph G. Pearson proposed the HSAB concept, where hard acids interact strongly with a hard base to form stable ionic complexes, while soft acids interact strongly with a soft base to form covalent complexes. It is widely used in explaining the stability of complexes, reaction mechanisms, and their pathways. Moreover, it is also applicable in predicting the product of metathesis reactions.



HSAB Principle

According to the **HSAB principle**, hard acid binds most strongly with a hard base and soft acid binds most strongly with soft bases i.e. hardness prefers hard-hard interactions and softness prefers soft-soft interactions. The combination between hard acid and soft base or hard base and soft acid will produce a less stable acid-base complex.

Q15: Hydrocarbons, IUPAC

Differentiate between alkanes alkenes alkynes

	Alkanes	Alkenes	Alkynes
Bonds	Only single (C-C) bonds	At least one double (C=C) bond	At least one triple (C≡C) bond
Saturation	Saturated hydrocarbons	Unsaturated hydrocarbons	Unsaturated hydrocarbons
General Formula	C_nH_{2n+2}	C_nH_{2n}	C_nH_{2n-2}
Reactivity	Least reactive/most stable	More reactive than alkanes, less than alkynes	Most reactive/least stable
Nomenclature Suffix	-ane Methane	-ene Ethene	-yne Ethyne
Example	CH ₄	C ₂ H ₄	C ₂ H ₂
Hyberdization	SP ³	SP ²	SP

Which of the following organic compound has sp hybridization?

- a) CH₄
- b) C₂H₂
- c) C₂H₆
- d) C₆H₆

CH₄(Methane): sp³ hybridized.

C₂H₂(Ethyne): sp hybridized

C₂H₆(Ethane): sp³ hybridized.

C₆H₆ (Benzene) :sp² hybridized.

Which of the following organic compound has sp² hybridization?

- a) CH₄
- b) C₂H₂
- c) C₂H₆
- d) C₂H₄

Organic compounds made up of carbon and hydrogen only are called____

- A) Hydrocarbons
- B) Carboxylic acids
- C) Esters
- D) Alcholols

Organic compounds which contain at least one benzene ring are called _____

- A) Aromatic Compounds
- B) Aliphatic Compounds
- C) Cycloalkanes
- D) Cycloalkenes

The organic compounds that have open chain are called____

- A) Aliphatic Compounds
- B) Aromatic Compounds
- C) Phenlos
- D) Benzene

Saturated hydrocarbons are known as _____

- Alkanes
- Alkenes
- Alkynes
- Methanes

Unsaturated hydrocarbons are known as _____

- Alkanes and Alkenes
- Alkenes and Alkynes
- Alkynes Only
- Alkenes Only

Unsaturated hydrocarbons with C=C are known as _____

- Alkanes
- Alkenes
- Alkynes
- Alkenes and Alkynes

Unsaturated hydrocarbons with C≡C are known as _____

- Alkanes
- Alkenes
- Alkynes
- Alkenes and Alkynes

What is the general formula for an alkene?

- C_nH_{2n-2}
- $C_{2n}H_n$
- C_nH_{2n+2}
- C_nH_{2n}

What is the general formula for an alkyne?

C_nH_{2n-2}

$C_{2n}H_n$

C_nH_{2n+2}

C_nH_{2n}

What is the general formula for an alkane?

C_nH_{2n-2}

$C_{2n}H_n$

C_nH_{2n+2}

C_nH_{2n}

What is the general formula of the cycloalkane?

C_nH_{2n-2}

$C_{2n}H_n$

C_nH_{2n+2}

C_nH_{2n}

What is the general name of compounds that contain a hydroxyl group (OH)?

Ethers

Alcohols

Carboxylic acids

Amines

What is the general name of compounds that contain a carboxyl group (COOH)?

Ethers

Alcohols

Carboxylic acids

Amines

What is the general name of compounds that contain a carbonyl group (C=O)?

Ethers

Alcohols

Aldehydes and Ketons

Amines

What is the general name of compounds that contain an amino group (NH₂)?

Ethers

Alcohols

Carboxylic acids

Amines

What is the general name for the group of compounds that contain a double bond (C=C)?

Alkene

Alkane

Alkyne

Ethers

What is the general name for the group of compounds that contain a triple bond ($C\equiv C$)?

Alkene

Alkane

Alkyne

Ethers

What is the general name for the group of compounds that contain a single bond ($C-C$)?

Alkene

Alkane

Alcohols

Ethers

How many structural isomers exist for C_4H_{10} ? ($2^{n-4} + 1$ n = no of carbon atoms)

2

3

4

5

How many structural isomers exist for C_5H_{12} ?

2

3

4

5

What is the general name for the group of compounds $R-OH$?

Alcohol

Ketone

Aldehyde

Ether

What is the general name for the group of compounds $R-COOH$?

Carboxylic acid

Ketone

Aldehyde

Amine

What is the general name for the group of compounds $R-NH_2$?

Primary alcohol

Primary amine

Secondary amine

Ether

What is the general name for the group of compounds $R-O-R$?

Alcohol

Ketone

Aldehyde

Ether

What is the general name for the group of compounds R-CHO?

Alcohol

Ketone

Aldehyde

Ether

What is the general name for the group of compounds R-CO-R?

Alcohol

Ketone

Aldehyde

Ether

What is the general name for the group of compounds R-O-R?

Alcohol

Ketone

Aldehyde

Ether

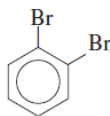
What is the systematic (IUPAC) name of this compound?

bromobenzene

para-dibromobenzene

meta-dibromobenzene

ortho-dibromobenzene



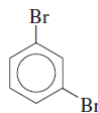
What is the systematic (IUPAC) name of this compound?

bromobenzene

para-dibromobenzene

meta-dibromobenzene

ortho-dibromobenzene



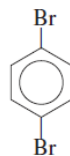
What is the systematic (IUPAC) name of this compound?

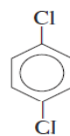
bromobenzene

para-dibromobenzene

meta-dibromobenzene

ortho-dibromobenzene





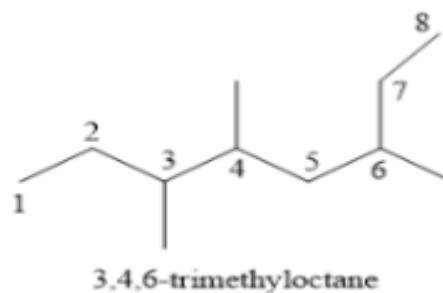
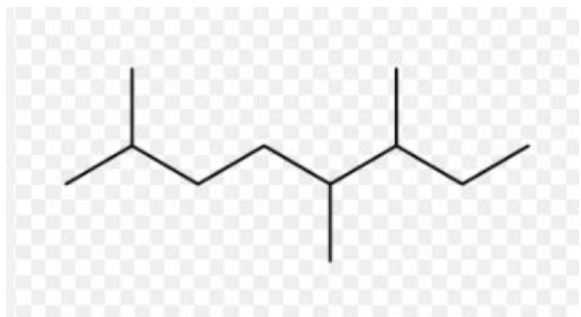
What is the systematic (IUPAC) name of this compound?

bromobenzene

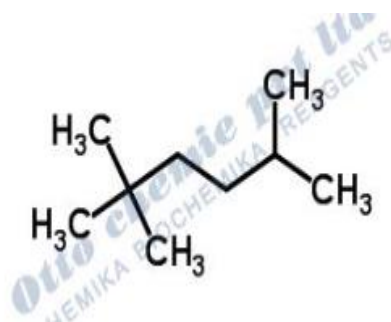
para-dichlorobenzene

meta-dichlorobenzene

ortho-dichlorobenzene

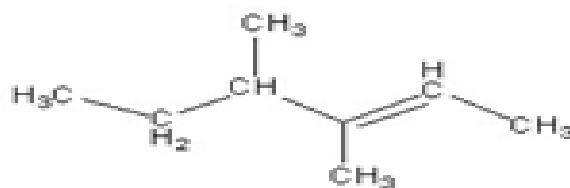


2,5,6-trimethyloctane



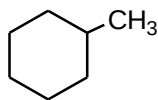
2,2,5-trimethylhexane

The IUPAC name of the following structure is ...



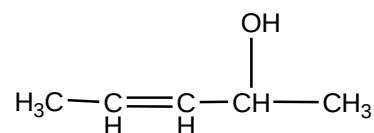
- a) 2,3-dimethylhex-2-ene
- b) 2,3-methylhex-4 ene
- c) 3,4-dimethylpent-2-ene
- d) 3,4-dimethylhex-2-ene

The IUPAC name of the below structure is



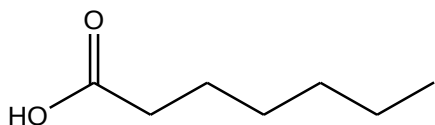
- a) Ethyl cyclooctane
- b) Toluene
- c) Methyl cyclopentane
- d) Methyl cyclohexane

The IUPAC name of the below structure is

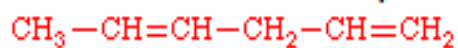


- a) 2-Pentene-3-ol
- b) Pentene
- c) Pentanol
- d) 3-Pentene-2-ol

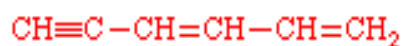
The IUPAC name of the below structure is ____



- A. 2-Heptanone
- B. Heptanoic Acid
- C. 1-Heptanol
- D. 1-Octane



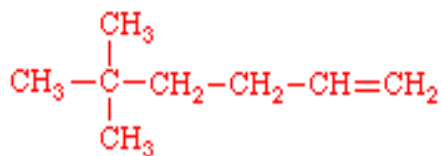
1,4-hexadiene



1,3-hexadien-5-yne

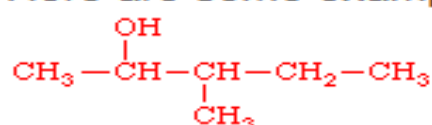


3-penten-1-yne

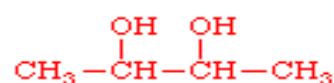


5,5-dimethyl-1-hexene

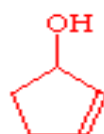
Here are some examples:



3-methyl-2-pentanol



2,3-butanediol



2-cyclopenten-1-ol



diethyl ether



ethyl methyl ether



propanal



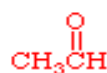
3-methylbutanal



3-methyl-3-butenal



methanal
(common name: formaldehyde)



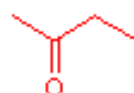
ethanal
(common name: acetaldehyde)



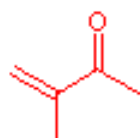
Benzaldehyde



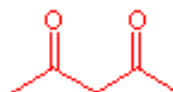
propanone
(common name: acetone)



2-butanone



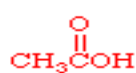
3-methyl-3-buten-2-one



2,4-pentanedione



methanoic acid
(common name: formic acid)



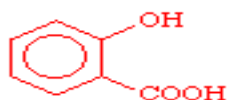
ethanoic acid
(common name: acetic acid)



3-methylpentanoic acid



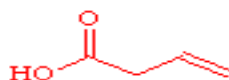
benzoic acid



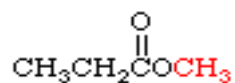
salicylic acid
(common name)



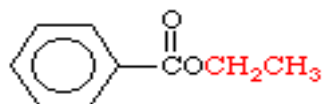
ethanedioic acid
(common name: oxalic acid)



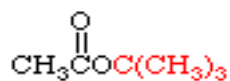
3-butenic acid



methyl propanoate



ethyl benzoate



tert-butyl acetate

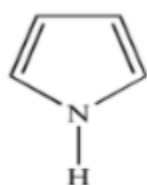
Q16: Order of Basicity

Which of the following is the most basic?

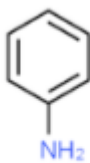
- a) Aniline
- b) Pyrrole
- c) Pyridine
- d) Piperidine

Write the order of basicity of Pyrrole, pyridine, Aniline and piperidine

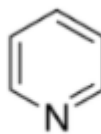
- **Piperidine:** The most basic. The nitrogen atom is sp^3 hybridized, and its lone pair is in an orbital that is oriented away from the ring, making it easily available to accept a proton
- **Pyridine:** Moderately basic. The nitrogen atom is sp^2 hybridized, and its lone pair is in an orbital. While it can accept a proton, its basicity is decreased compared to piperidine because it must remain in the ring's aromatic system.
- **Aniline:** Less basic than pyridine. The lone pair on the nitrogen is delocalized into the benzene ring through resonance, making it less available for protonation compared to pyridine.
- **Pyrrole:** The least basic. The nitrogen's lone pair is not in an sp^2 orbital but is delocalized within the ring to maintain aromaticity. This makes the lone pair unavailable for protonation, making pyrrole a very weak base



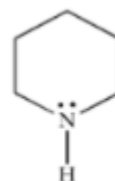
Pyrrole



Aniline



Pyridine

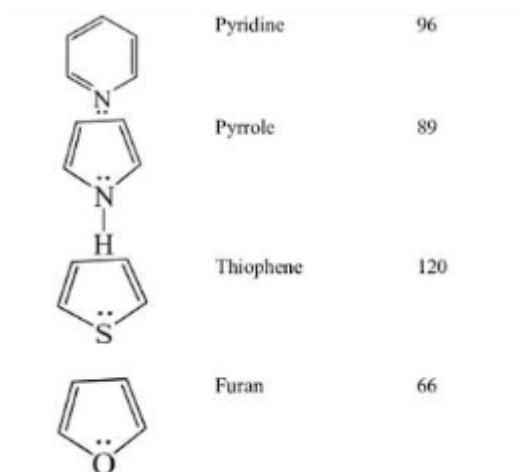
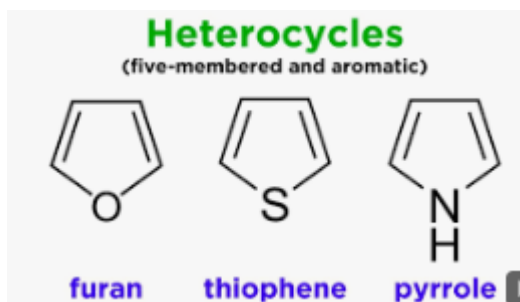


Piperidine

Which of the following is the most basic?

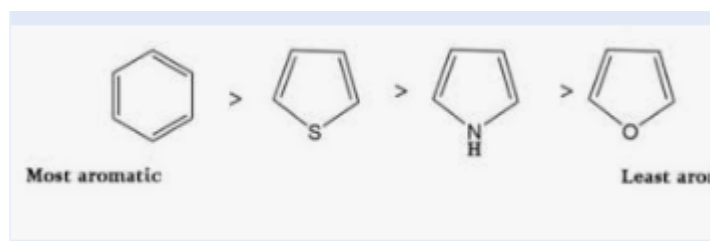
- a) Pyrrole
- b) Furan
- c) Thiophene
- d) Pyridine

- Pyridine is the most basic of the four compounds because its lone pair of electrons is in an sp^2 hybridized orbital and is not delocalized in the aromatic system, making it readily available for protonation. The lone pairs on the nitrogen atom in pyrrole are involved in the aromatic system, making it the least basic. Thiophene is more basic than furan because the sulfur atom is less electronegative than oxygen, allowing its lone pair to be more available for protonation. The general order of basicity is **Pyridine > Thiophene > Furan > Pyrrole**.

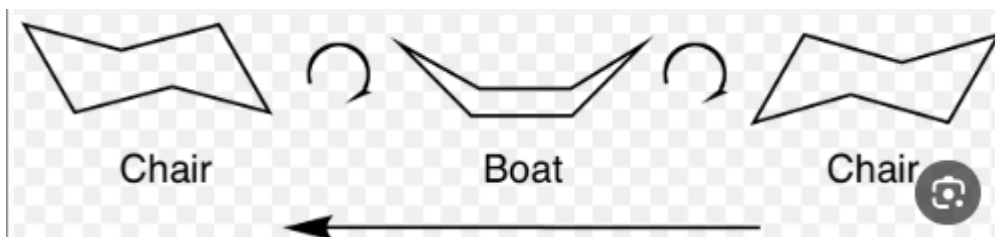


Which of the following is the most aromatic?

- Thiophene
- Pyrrole
- Furan
- Benzene



Q16: chair form and boat form of cyclohexane



The **chair form** of cyclohexane is the most stable conformation with no angle strain and minimal steric strain,

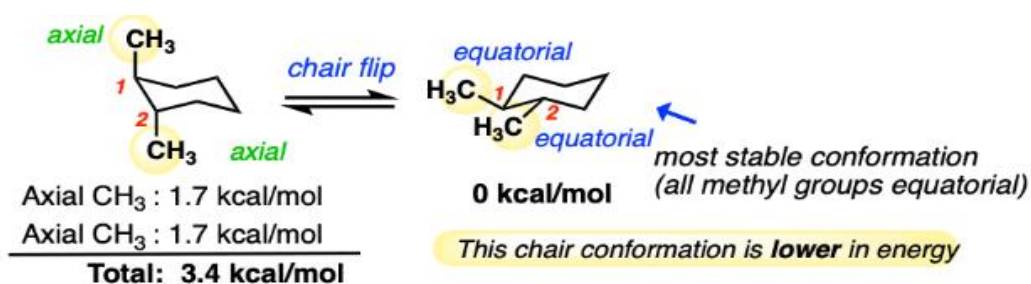
The **boat form** is less stable due to steric repulsion between "flagpole" hydrogens and eclipsing strain. The chair form achieves ideal 109.5° bond angles, whereas the boat form has two hydrogens pointing inward, causing strain.

3. Example: Determining The Most Stable Conformation Of *cis*- And *trans*- 1,2-Dimethylcyclohexane

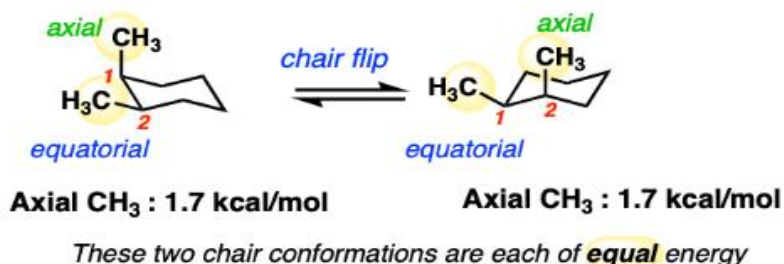
That's nice, you might say, but when might we ever want to do that? The key example is **when we are examining two chair conformers of the same molecule**. A-values are essential in helping us figure out which one is most stable.

Here's an example of the type of question we might be asked: draw the two chair conformations of *cis*-1,2-dimethylcyclohexane and *trans*-1,2-dimethylcyclohexane, and determine which is most stable.

- Draw the **two chair conformations** each of *cis*-1,2-dimethylcyclohexane and *trans*-1,2-dimethylcyclohexane.
- Which conformation is the most stable?

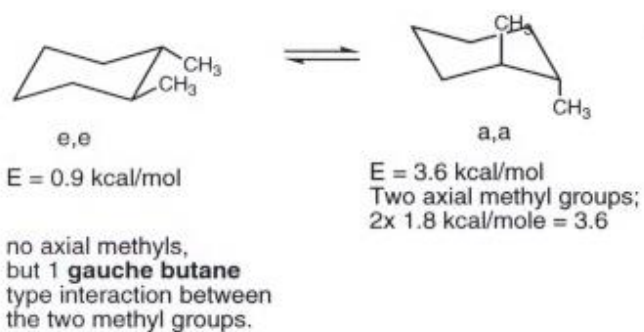


Again, notice in each chair flip that all axial become equatorial and all equatorial become axial (but all "up" remain "up" and all "down" remain "down").



CONFORMATIONS OF 1,2-DIMETHYLCYCLOHEXANE

Trans isomer



The *trans* isomer is more stable in the e,e conformation, but even this conformation has a steric destabilization.

CIS ISOMER.



Note that the more stable *trans*-1,2 diastereoisomer is less stable than the *cis*-1,3 and *trans*-1,4 isomers (all of which are diequatorial), because the 1,2 isomer uniquely has a *gauche butane* steric interaction.

Summary: Which Cyclohexane Chair Is More Stable?

• A table of **A-values** allows you to calculate the relative stability of cyclohexane chair conformations

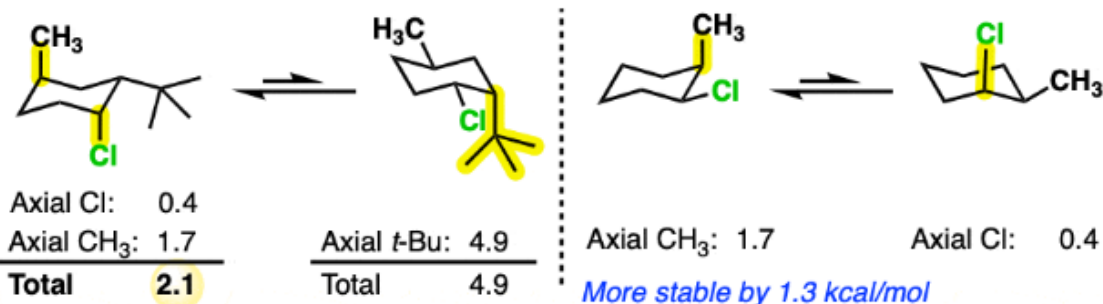
• **First**, draw both chair forms of the given molecule.

• **Next**, total up A-values for all **axial groups** in each conformation

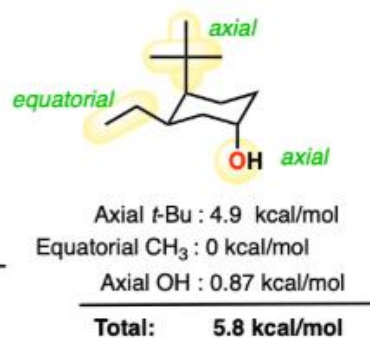
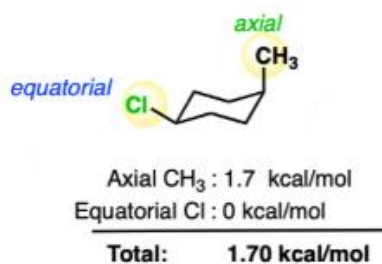
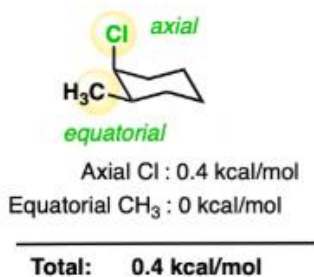
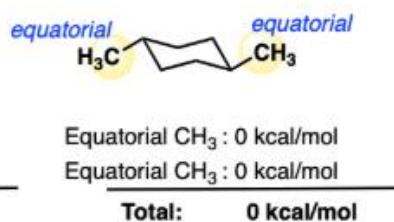
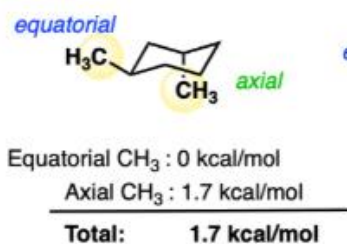
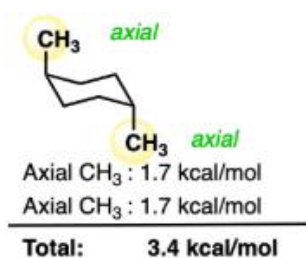
• The chair conformation with the **lowest total** will be the **most stable**.

A-values

Cl	0.4
CH ₃	1.7
t-Bu	4.9



• Furthermore, using the formula $\Delta G = -RT \ln K$ we can calculate the value of the equilibrium constant K to tell us the ratio of conformations present at equilibrium



Q16: Order of Reaction

$$\text{rate} = k \cdot [A]^0 \dots \text{order of reaction} = 0$$

$$\text{rate} = k \cdot [A]^0 [B]^1 \dots \text{overall order of reaction} = 1$$

$$\text{rate} = k \cdot [A]^1 [B]^0 \dots \text{overall order of reaction} = 1$$

$$\text{rate} = k \cdot [A]^0 [B]^2 \dots \text{overall order of reaction} = 2$$

$$\text{rate} = k \cdot [A]^2 [B]^0 \dots \text{overall order of reaction} = 2$$

$$\text{rate} = k \cdot [A]^1 [B]^1 \dots \text{overall order of reaction} = 2$$

326 x 584

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Orders of reaction

$$\text{rate} = k [A]^x$$

Order of reaction	Effect on rate of reaction	Rate expression
zero	no effect	$\text{rate} = k$
first	directly proportional	$\text{rate} = k [A]$
second	proportional to the square of the change	$\text{rate} = k [A]^2$

For Zero-order reactions

$$\text{rate} = k[A]$$

$$\text{rate} = k$$

$$\text{rate} = k[A]^2$$

$$\text{rate} = k[A][B]$$

Q25: Calculation of Absorbance

$$A = 2 - \log_{10}(\%T)$$

The given percent transmittance is 70%

$$A = 2 - \log_{10}(70)$$

$$A = 2 - 1.845 = 0.155$$

The given percent transmittance is 50%

$$A = 2 - \log_{10}(50)$$

$$A = 2 - 1.698 = 0.301$$

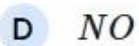
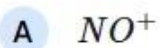
. The given percent transmittance is 10%

$$A = 2 - \log_{10}(10)$$

$$A = 2 - 1 = 1$$

Q26: Bond order

Among the following species highest bond order is of



642924681

Among the following species highest bond order is of

- Option1 $NO^+ \rightarrow 7+8-1 \Rightarrow 14=3$
- Option2 $O_2^+ \Rightarrow 8+8-1 = 15 = 2.5$
- Option3 $O_2^- \rightarrow 8+8+1 \Rightarrow 17 = 1.5$
- Option4 $NO \rightarrow 7+8 = 15 = 2.5$

$$B.O = \frac{N_B - N_A}{2}$$

$$14e^- \Rightarrow 3$$

$$N_2 = 3 \uparrow$$

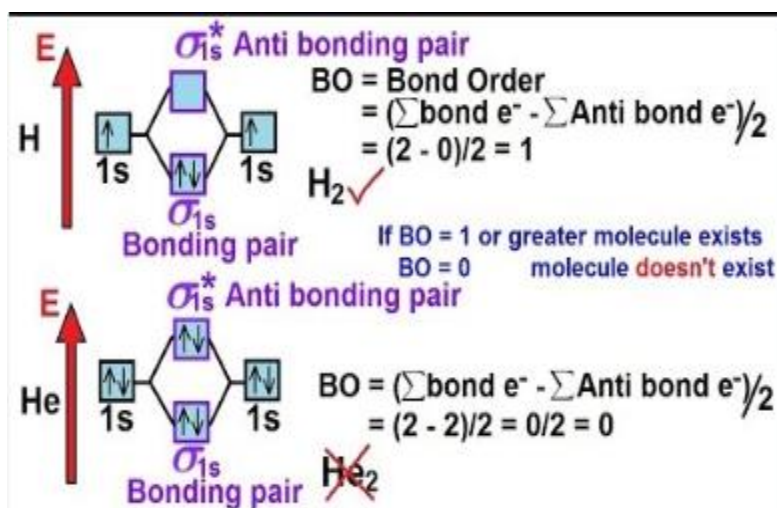
$$7+7 = 14$$

$$\begin{matrix} 11 & 12 & 13 & 14 & 15 & 16 & 17 & 18 \\ 1.5 & 2 & 2.5 & 3 & 2.5 & 2 & 1.5 & 1 \end{matrix}$$

Which of the following has the highest Bond order

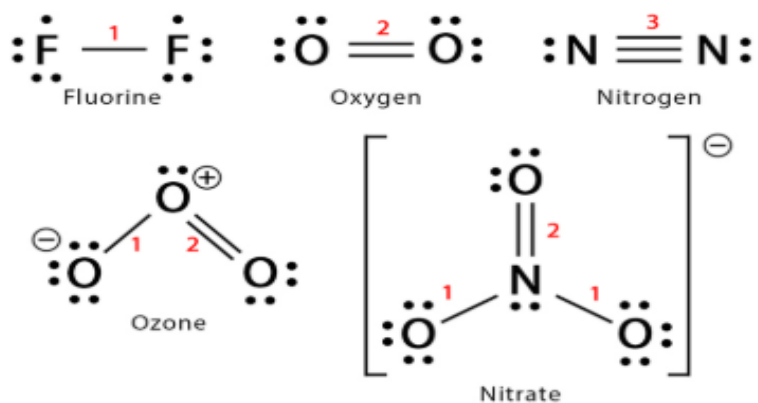
- A) O_2
- B) H_2
- C) N_2
- D) He_2

- N_2 : Bond Order = 3 (Triple Bond) = $7+7=14$
- O_2 : Bond Order = 2 (Double Bond) = $8+8=16$
- H_2 : Bond Order = 1 (Single Bond) = $1+1=2$
- He_2 : Bond Order = 0 (No bond, unstable) = $2+2=4$



Bond Order

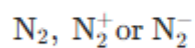
Bond order (in red) is the number of bonds between two atoms



Q: Which of the following has the highest Bond order?

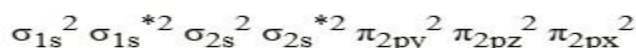
Question

53. Which one of the following has highest bond order?



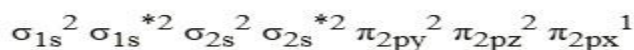
i. N_2

$$\text{N}_2 = 14$$



$$\text{Bond order} = \frac{6}{2} = 3$$

ii. N_2^+



$$\text{Bond order} = \frac{5}{2} = 2.5$$

iii. N_2^-



$$\text{Bond order} = \frac{5}{2} = 2.5$$

The highest bond order is N_2 .

Calculate the bond order of O_2^+ and O_2^-

Answer ✓ Verified



512.7k+ views

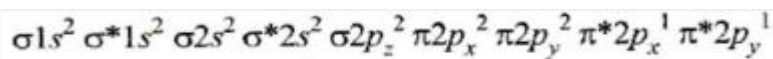


Hint : We know that first draw a molecular orbital diagram (MOT) where the atomic orbitals combine to form molecular orbitals. The total electrons associated with the molecules are filled in the MOT diagram. To solve this question, we need to write the molecular orbital configuration. To find out the bond order from the molecular orbital configuration is:

$$\text{Bond order} = \frac{1}{2} [\text{Bonding} - \text{antibonding}]$$

Complete Step By Step Answer:

Let's first draw the MOT of the oxygen molecule. The oxygen molecule contains the 16 electrons. The bond order may be defined as half the difference between the number of electrons in bonding molecular orbitals (Nonbonding) and the number of electrons in the antibonding molecular orbital.



No. of e^- in No. of e^- in

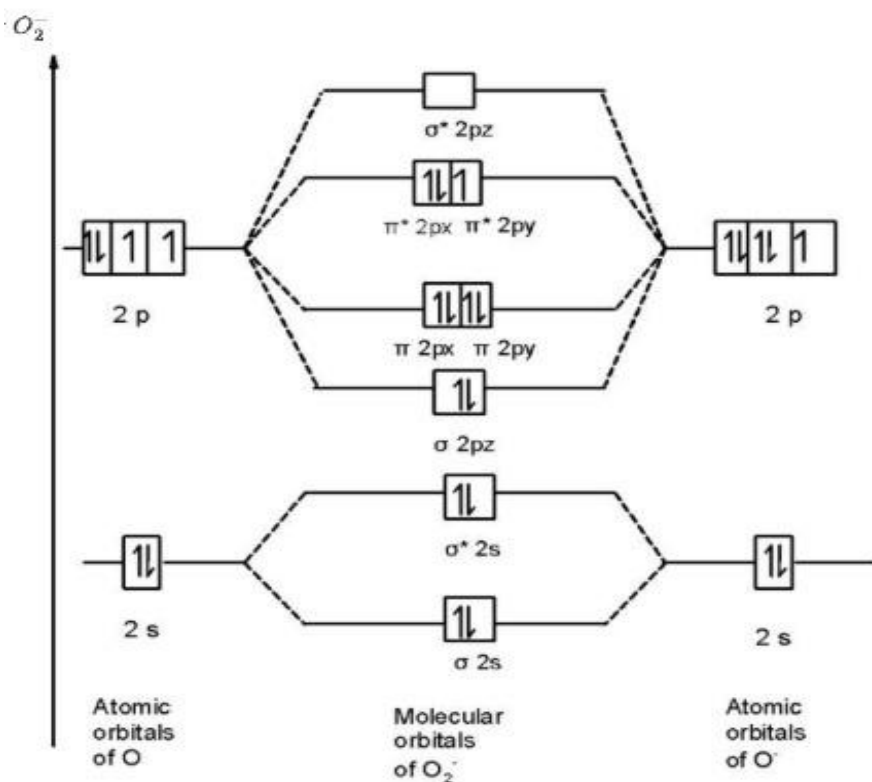
$$\text{Bond order} = \frac{\text{bonding M.O.} - \text{antibonding M.O.}}{2}$$

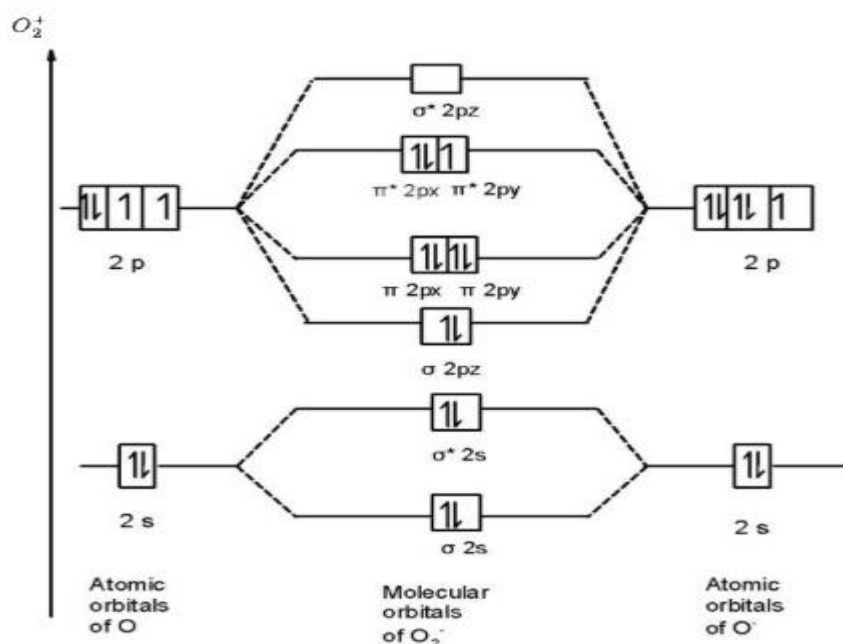
$$\text{Bond order of } O_2^+ = \frac{10 - 5}{2} = 2.5$$

$$\text{Bond order of } O_2^- = \frac{10 - 7}{2} = 1.5$$

$$\text{Bond order of } O_2^{2-} = \frac{10 - 8}{2} = 1.0$$

$$\text{Bond order of } O_2 = \frac{10 - 6}{2} = 2$$





Let us calculate the bond order

Bond order (B.O) $\frac{1}{2} \times [\text{Number of an electron in antibonding molecular orbitals}] - [\text{Number of electrons in bonding molecular orbitals}]$

The higher the order of the bond the greater the pull between the two atoms and the shorter the length of the bond.

$$\text{B.O for } O_2 = \frac{1}{2} \times [10] = 2.$$

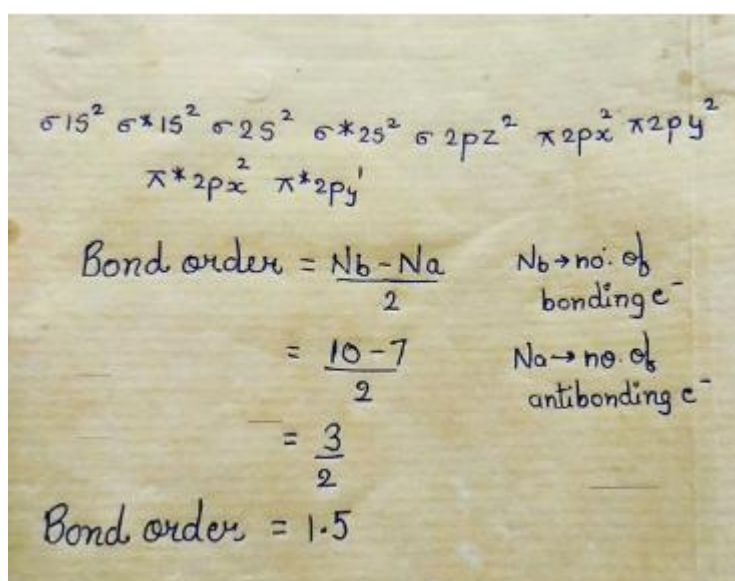
$$\text{B.O for } O_2^- = \frac{1}{2} \times [10 - 7] = 1.5$$

$$\text{B.O for } O_2^+ = \frac{1}{2} \times [10 - 5] = 2.5$$

$$\text{B.O for } O_2^{2-} = \frac{1}{2} \times [10] = 1$$

Therefore, the increasing order of bond length for these species is $O_2^+ < O_2 < O_2^- < O_2^{2-}$

Note :



	Bond order
$C - C$	1
$C = C$	2
$C \equiv C$	3

Q26: UV spectroscopy

i) Ultra Violet Spectroscopy:

- It measures the wavelength of the compound
- It determines unsaturated sites in compound
- Draw relation between wavelength λ and absorptivity A or ϵ

ii) Infrared Spectroscopy:

- It measures the frequency of the bond
- It determines functional group in compound
- Draw relation between frequency μ and Transmittance $T\%$

iii) Infrared Spectroscopy:

- It measures the chemical shift δ of hydrogen atoms
- It determines the number and types of hydrogen in molecule
- Draw relation between chemical shift δ and % of peak

iv) Mass Spectroscopy:

- It measures the mass-to-charge ratio (m/z) of one or more molecules present in a sample.
- It determines the molecular weight
- Draw relation between (m/z) and % abundance (relative intensity) for each peak

1. Absorbance of the solution is directly proportional to:

- A) Molar Absorptivity
- B) Length of sample tube
- C) Concentration of the sample

D) All of them

2. **The Lower wavelength is called**

- A) Blank Shift
- B) Blue Shift
- C) Red Shift
- D) Black Shift

3. **The Higher wavelength is called**

- A) Blank Shift
- B) Blue Shift
- C) Red Shift
- D) Black Shift

4. **The absorption of UV/Vis spectrum affected by**

- A) The oxidizing agent
- B) The pH of the solution
- C) The brand of machine
- D) The reducing agent

5. **An example of the solvents that are used in UV instrument**

- A) Dimethyl Ether
- B) Methanol
- C) Benzene
- D) Hexene

6. **The wavelength of the solvents that used in UV spectrophotometer**

- A) More than 300 nm
- B) Less than 200 nm
- C) Less than 300 nm
- D) More than 220 nm

7. **Which one of the following groups is homo chromophore?**

- A) C=S
- B) C=O
- C) C=N
- D) C=C

8. **All of the following groups are Acidic Auxochrome EXCEPT:**

- A) -NH₂
- B) -COOH
- C) -SO₃H
- D) -OH

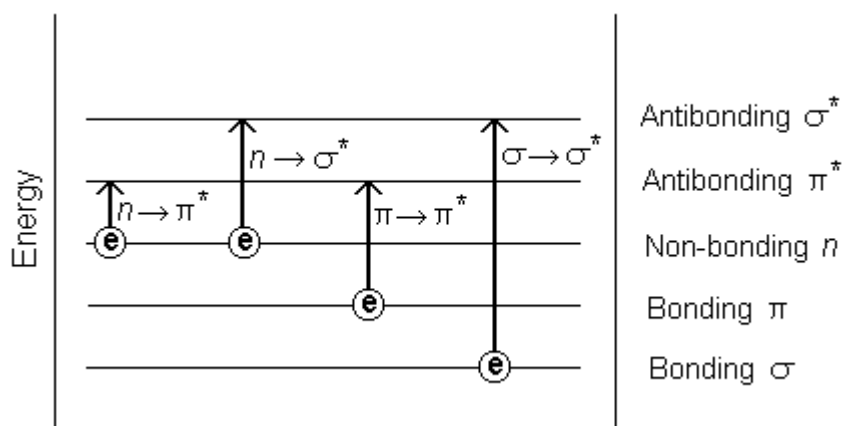
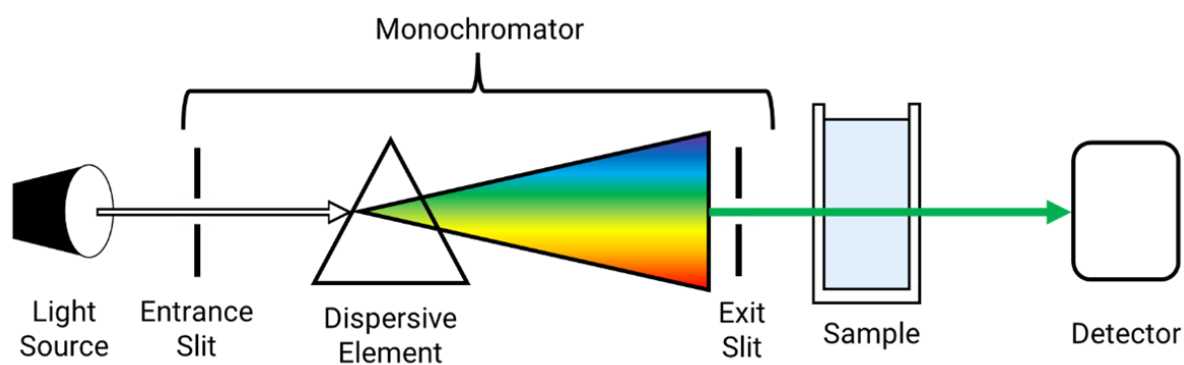
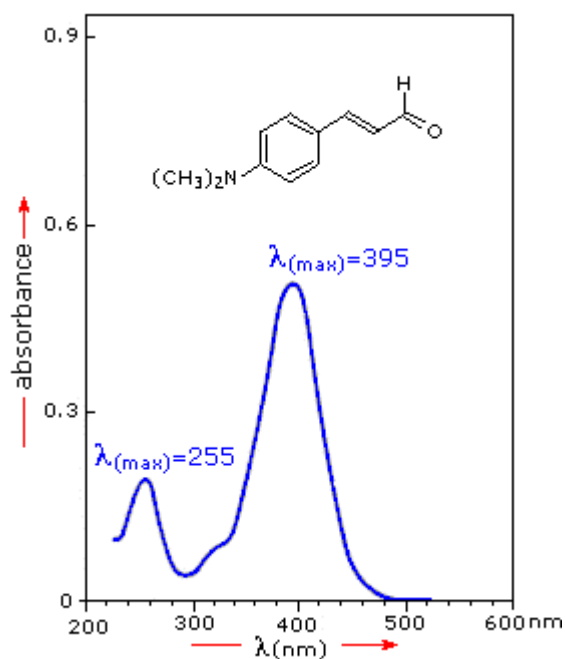
9. **The solvent has wavelength less than 200 nm**

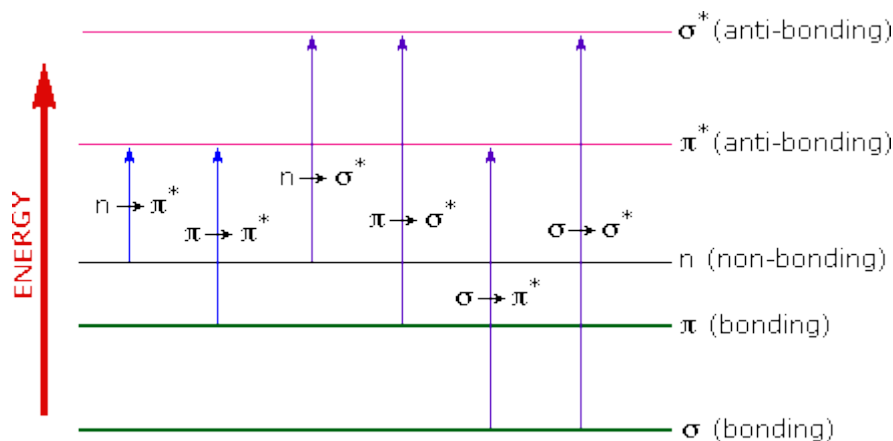
- A) To increase Solubility
- B) To Decrease Molar absorptivity
- C) To avoid interference between its wavelength and wavelength of the sample

D) To avoid interference between its concentration and concentration of the sample

10. The Higher resonance of the compounds leads to

- A) High Stability
- B) Higher Wavelength
- C) Lower Energy
- D) Higher solubility





1. Ultraviolet–Visible spectroscopy mainly involves which type of transitions?

- A. Vibrational transitions
- B. Rotational transitions
- C. Electronic transitions
- D. Nuclear transitions

2. The typical wavelength range for UV–Visible spectroscopy is:

- A. 10–200 nm
- B. 200–800 nm
- C. 800–2500 nm
- D. 4000–400 cm^{-1}

UV (200–400 nm) and visible (400–800 nm) regions are used.

3. Which type of electrons are excited during UV–Vis absorption?

- A. Core electrons
- B. σ , π , and nonbonding electrons
- C. Neutrons
- D. Inner-shell electrons

4. Which electronic transition requires the highest energy?

- A. $n \rightarrow \pi^*$
- B. $\pi \rightarrow \pi^*$
- C. $\sigma \rightarrow \sigma^*$

5. The Beer–Lambert law relates absorbance to:

- A. Wavelength only
- B. Concentration only
- C. Concentration and path length
- D. Temperature and pressure

$A = \epsilon cl$, where ϵ is molar absorptivity.

6. In a UV–Vis spectrum, absorbance is plotted against:

- A. Frequency
- B. Wavenumber
- C. Wavelength
- D. Energy

7. Which functional group strongly absorbs UV radiation?

- A. Alkane
- B. Alcohol
- C. Conjugated double bonds
- D. Ether

10. A bathochromic shift refers to:

- A. Shift to shorter wavelength
- B. Shift to longer wavelength
- C. Decrease in absorbance
- D. Increase in concentration

11. A hypsochromic shift is also known as:

- A. Red shift
- B. Blue shift
- C. Hyperchromic effect
- D. Hypochromic effect

13. Which compound will show UV absorption at the longest wavelength?

- A. Ethane
- B. Ethene
- C. 1,3-butadiene
- D. Methane

Increased conjugation causes absorption at longer wavelengths.

14. The intensity of absorption in UV–Vis spectroscopy is expressed as:

- A. Transmittance only
- B. Absorbance
- C. Refractive index
- D. Conductivity

17. A hyperchromic effect refers to:

- A. Decrease in absorbance
- B. Increase in absorbance
- C. Shift to shorter wavelength
- D. Shift to longer wavelength

✓ **Answer: B. Increase in absorbance**

Explanation: Hyperchromic effect increases absorption intensity.

19. UV–Vis spectroscopy is widely used for:

- A. Molecular weight determination
- B. Quantitative analysis
- C. Crystal structure determination
- D. Elemental analysis

Q26: IR spectroscopy

1. Infrared spectroscopy is mainly used to identify which of the following?

- A. Molecular weight
- B. Functional groups
- C. Molecular geometry
- D. Atomic number

2. The region most commonly used in IR spectroscopy is:

- A. Near-infrared region
- B. Far-infrared region
- C. Mid-infrared region (4000–400 cm^{-1})
- D. Ultraviolet region

3. Which type of molecular vibration is observed in IR spectroscopy?

- A. Electronic transitions
- B. Nuclear transitions
- C. Vibrational transitions
- D. Rotational transitions only

4. For a vibration to be IR-active, the molecule must show:

- A. A change in mass
- B. A change in dipole moment
- C. A change in volume
- D. A change in bond length only

5. The typical absorption range of an O–H stretching vibration is:

- A. 1600–1800 cm^{-1}
- B. 2100–2300 cm^{-1}
- C. 3200–3600 cm^{-1} O–H stretching vibrations appear as strong, broad peaks in this region.
- D. 400–600 cm^{-1}

6. A sharp absorption band near 1700 cm^{-1} usually indicates the presence of:

- A. Alkene ($\text{C}=\text{C}$)
- B. Carbonyl group ($\text{C}=\text{O}$) $1650\text{--}1750\text{ cm}^{-1}$.
- C. Alcohol ($\text{O}-\text{H}$)
- D. Amine ($\text{N}-\text{H}$)

7. Which of the following bonds absorbs at the highest frequency in IR spectroscopy?

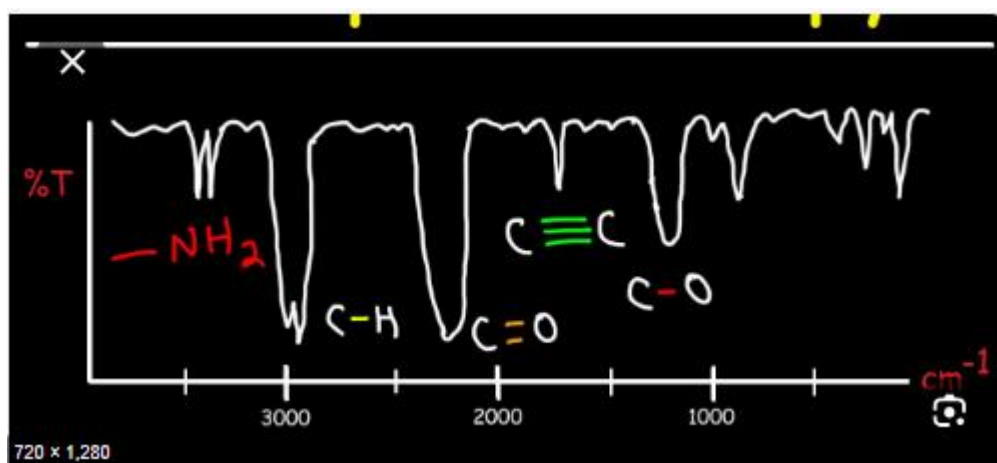
- A. $\text{C}-\text{C}$
- B. $\text{C}-\text{O}$
- C. $\text{C}-\text{H}$
- D. $\text{O}-\text{H}$

8. The “fingerprint region” in an IR spectrum lies between:

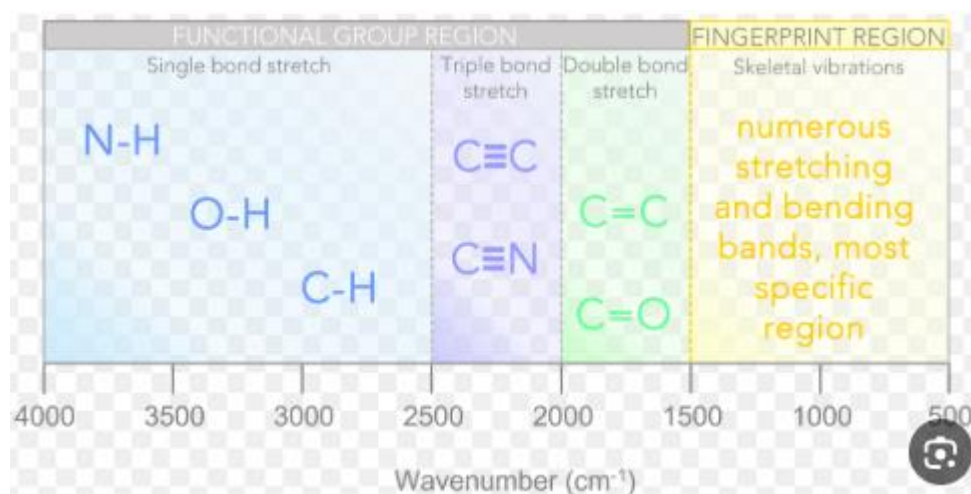
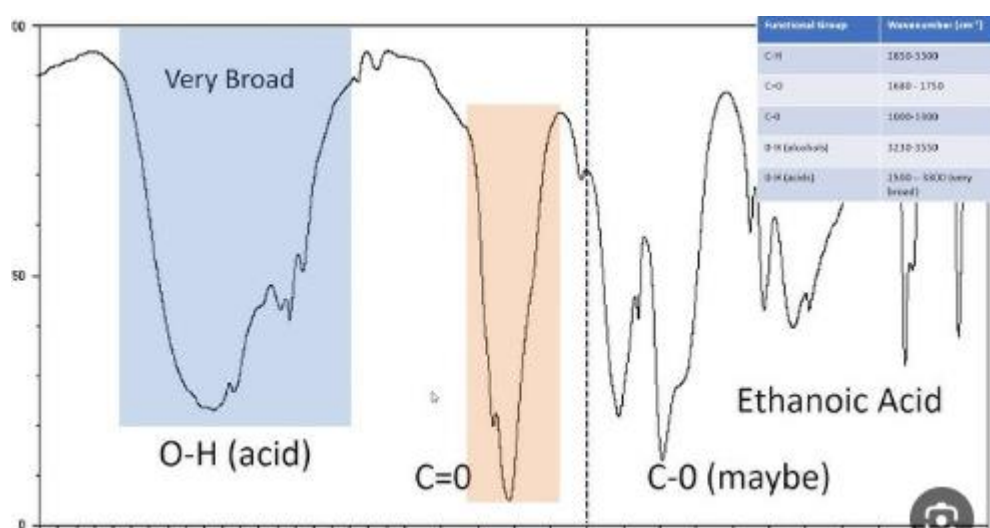
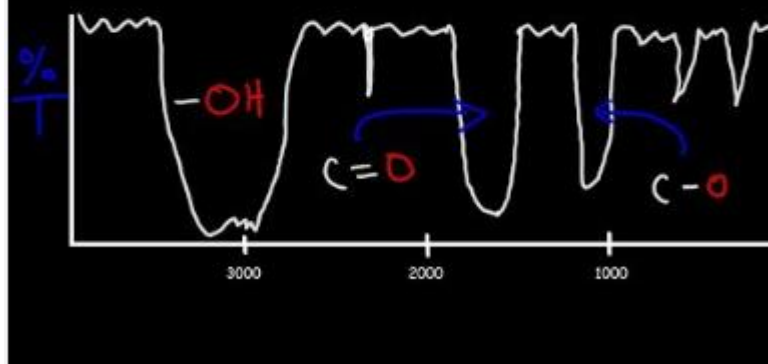
- A. $4000\text{--}2500\text{ cm}^{-1}$
- B. $2500\text{--}2000\text{ cm}^{-1}$
- C. $2000\text{--}1500\text{ cm}^{-1}$
- D. $1500\text{--}400\text{ cm}^{-1}$

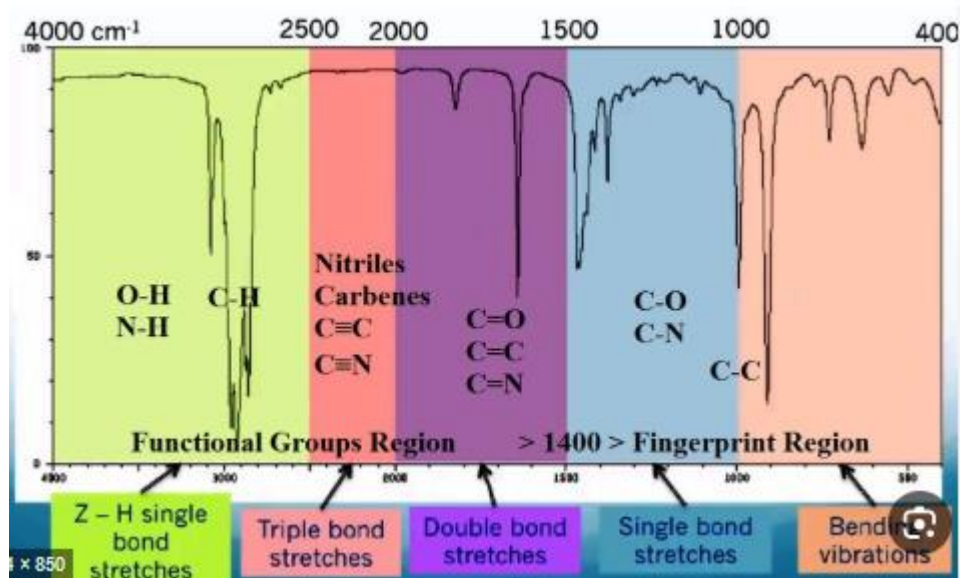
9. Which functional group produces a broad IR absorption peak?

- A. Alkene
- B. Alkane
- C. Alcohol
- D. Alkyne



IR Spectroscopy





11. H-bonding lead to _____ in IR spectroscopy.

- A. Increase frequency
- B. Decrease frequency
- C. No effect

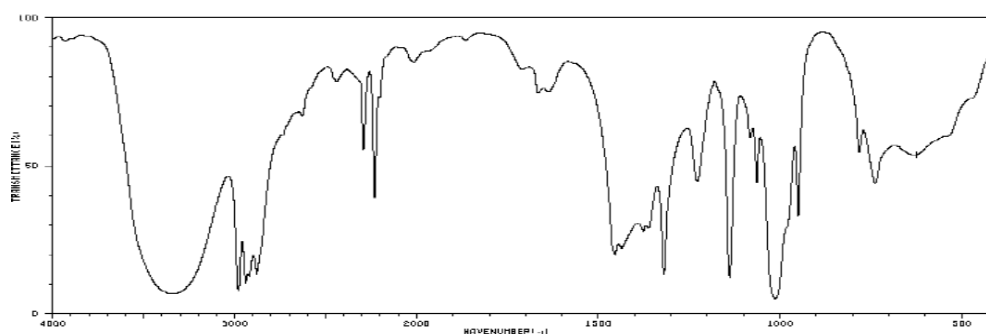
12. OH band is at $3400\text{--}3300\text{ cm}^{-1}$ in IR spectra

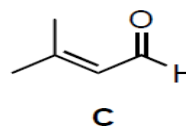
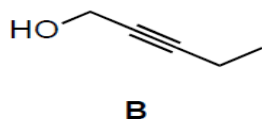
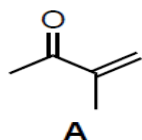
- A. broad peak (strong)
- B. sharp peak
- C. doublet peak
- D. Triplet peak

13. have two bands in IR-spectra

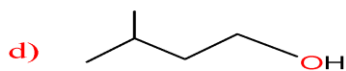
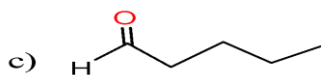
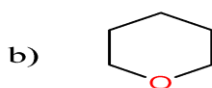
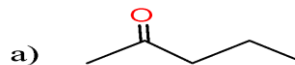
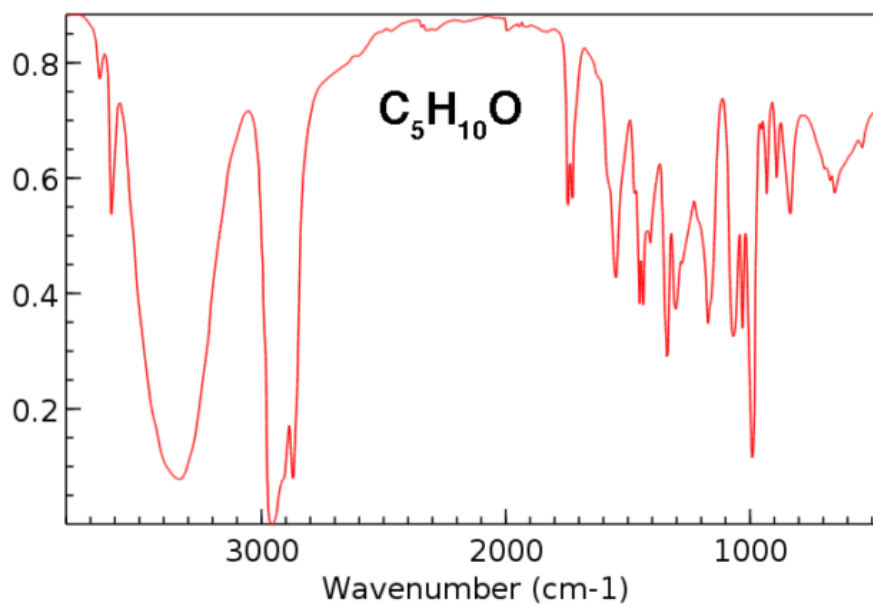
- A. OH
- B. NH
- C. NH₂
- D. CH₂

14. Predict the structure for the following IR spectroscopy

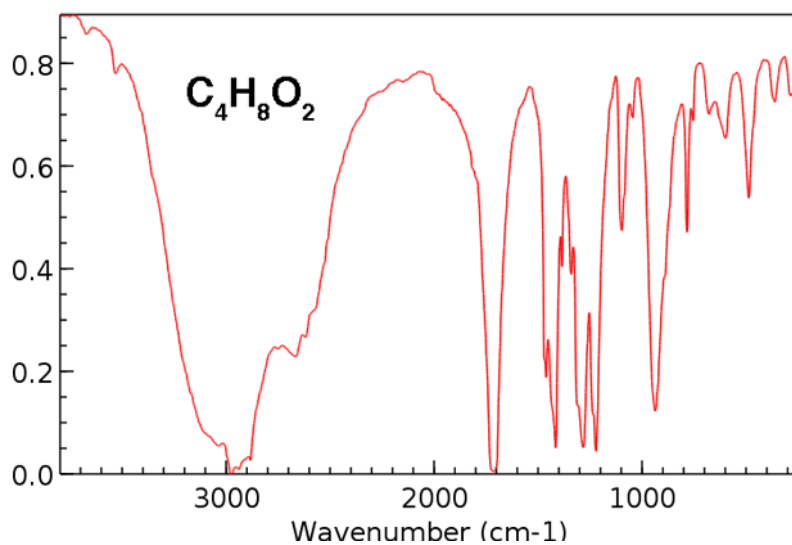




15. Unknown molecule with molecular formula $C_5H_{10}O$. Which of these five molecules is it most likely to be using the IR Spectrum?



Unknown molecule with molecular formula $C_5H_{10}O$. Which of these four molecules is it most likely to be using the IR Spectrum?



- A)
- B)
- C)
- D)

16. Which spectrum provides the information of functions groups?

- A. ^1H NMR
- B. IR
- C. UV
- D. Mass Spectroscopy

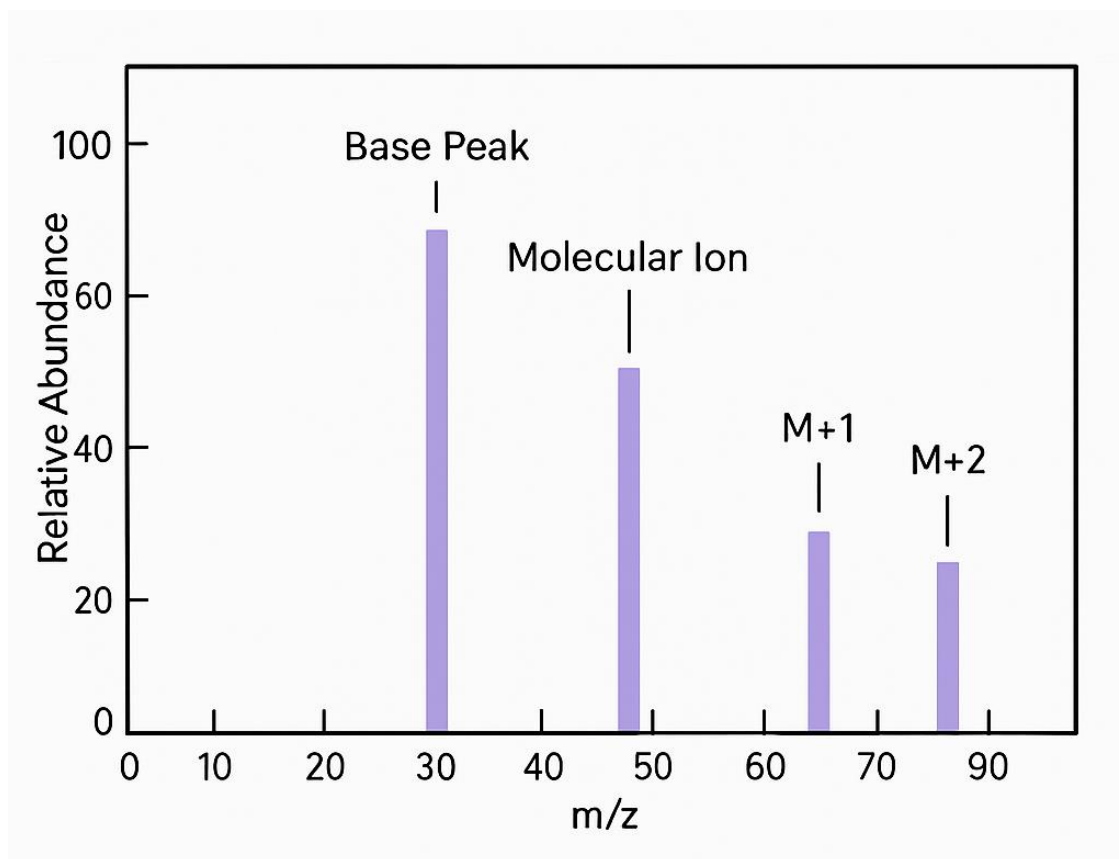
17. Infra-Red Spectroscopy determine of the organic compounds

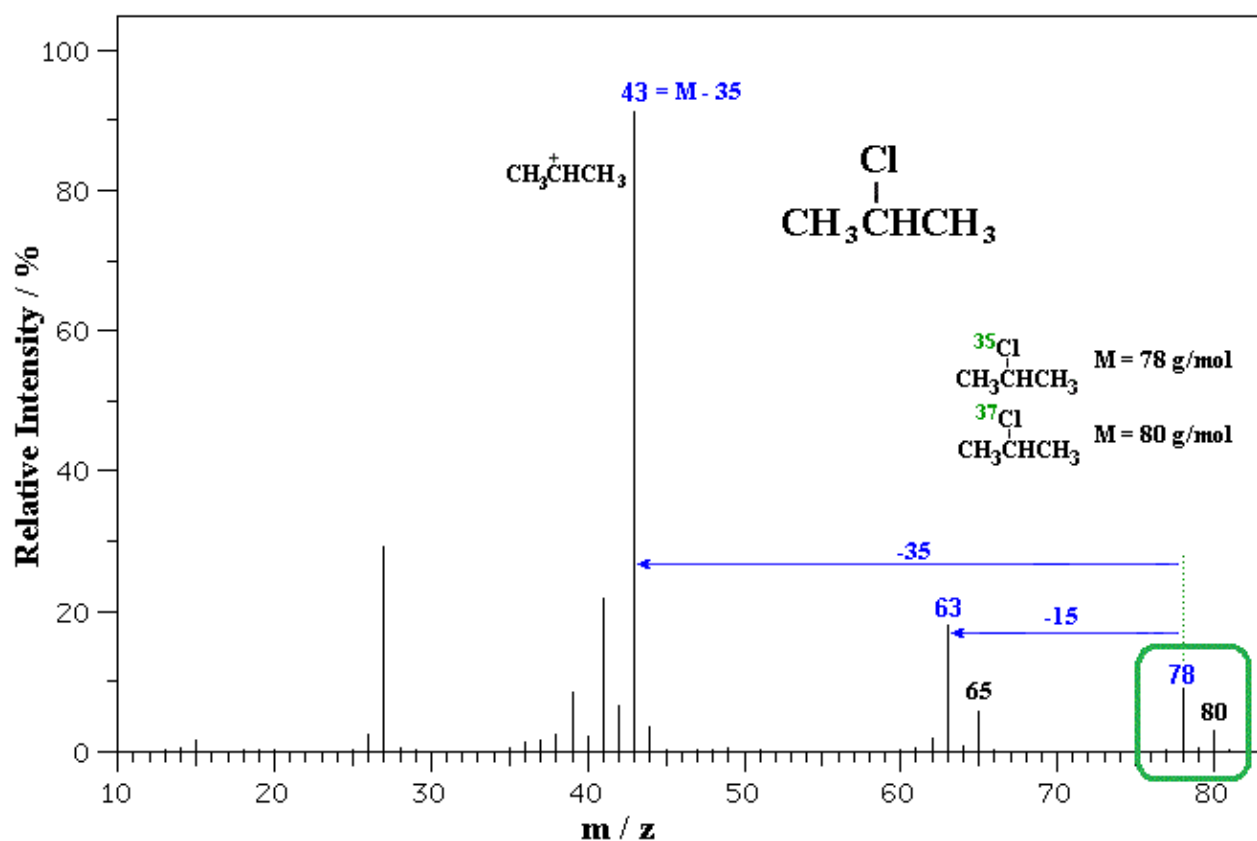
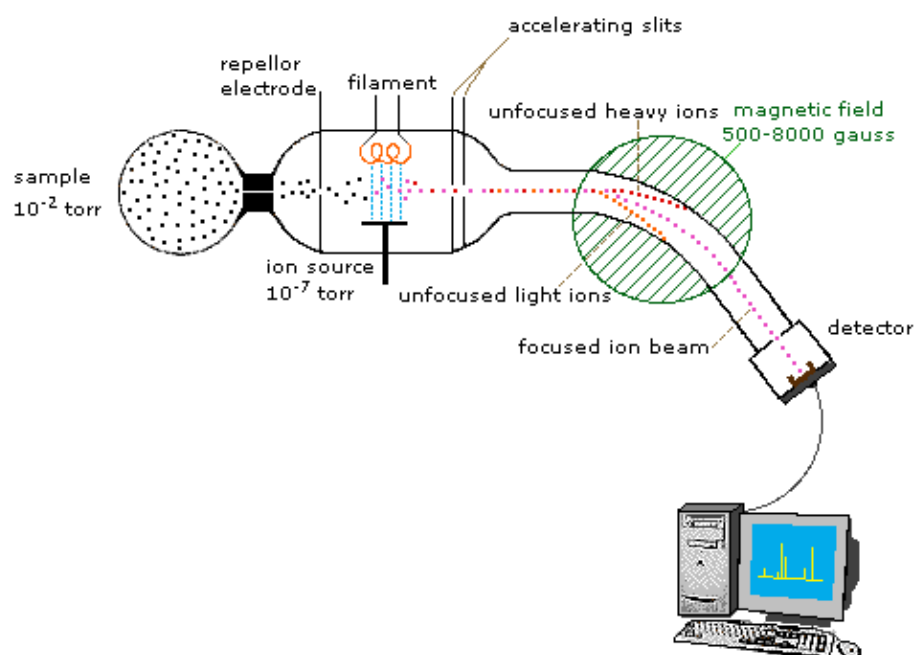
- A) Functional groups
- B) Unsaturated sites
- C) Number and Types of Hydrogen
- D) Molecular weight

18. Primary amines (R-NH_2) appears as band (s) in IR Spectroscopy

- A) One
- B) Two
- C) Three
- D) Broad

Q26: Mass spectroscopy





The largest (most intense) peak in the mass spectrum is called the

- a- **base** peak b- parent peak c- molecular ion

In a mass spectrum, peak of high molecular weight which represents the molecular weight of compound is called-

- a- Base peak b- **Parent** peak c- Isotope peak

1. The basic principle of mass spectrometry is separation based on:

- A. Molecular size
- B. Polarity
- C. Mass-to-charge ratio
- D. Boiling point

2. In a mass spectrum, the x-axis represents:

- A. Intensity
- B. Energy
- C. Mass-to-charge ratio (m/z)

3. The y-axis of a mass spectrum indicates:

- A. Molecular mass
- B. Relative abundance
- C. Charge
- D. Velocity of ions

4. The molecular ion peak (M^+) corresponds to:

- A. The most intense peak
- B. A fragment ion
- C. The intact molecule with one positive charge
- D. A neutral molecule

5. The base peak in a mass spectrum is:

- A. The peak with highest m/z value
- B. The peak with lowest m/z value
- C. The most intense peak
- D. The molecular ion peak

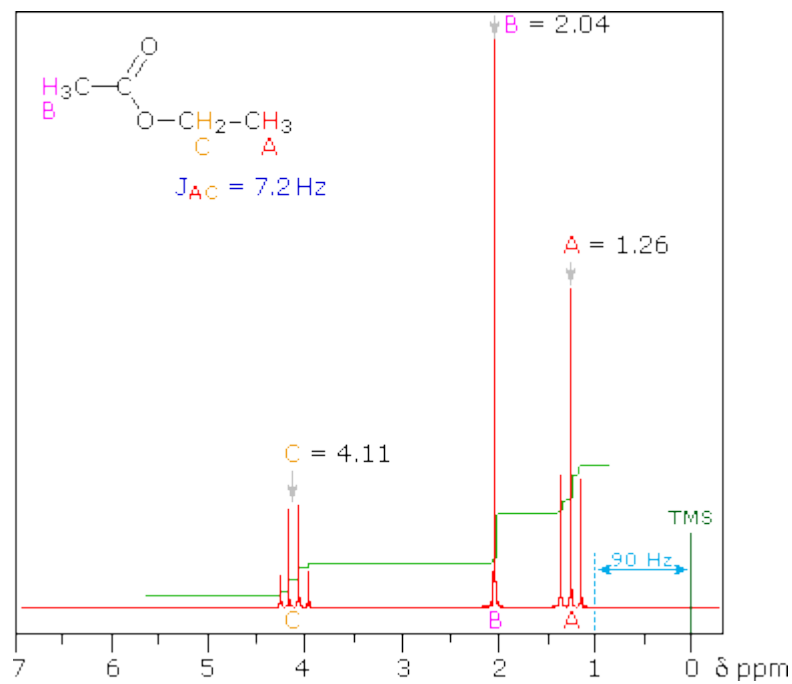
12. A peak at m/z = 15 is most likely due to:

- A. CH_3^+
- B. $C_2H_5^+$
- C. CO^+
- D. NH_4^+

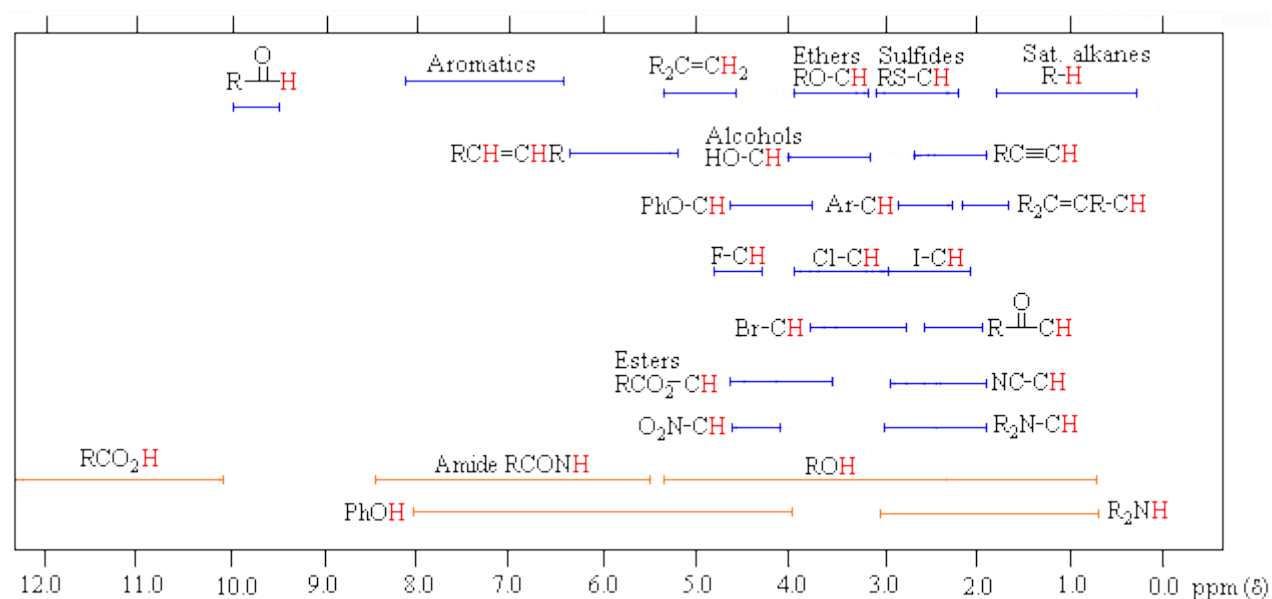
13. Which detector is commonly used in mass spectrometry?

- A. Photomultiplier tube
- B. Faraday cup
- C. Electron multiplier

Q27: NMR



c1ccccc1O c1ccccc1N



Type of Proton	Chemical Shift (ppm)	Type of Proton	Chemical Shift (ppm)
$R-CH_3$	0.9 – 1.2	$X-CH_2R$ (X: Cl, Br, I)	3.1 – 3.8
$R-\overset{\overset{R}{ }}{CH_2}$	1.2 – 1.5	$R-OH$	variable, 1 – 5
$R-\overset{\overset{R}{ }}{\underset{\underset{R}{ }}{CH}}$	1.4 – 1.9	$R-NH_2$	variable, 1 – 5
$\begin{array}{c} R & & R \\ & \diagdown & / \\ & C = C \\ & / & \diagdown \\ R & & CHR_2 \end{array}$	1.5 – 2.5	$\begin{array}{c} R & & R \\ & \diagdown & / \\ & C = C \\ & / & \diagdown \\ R & & H \end{array}$	4.5 – 6.0
$\begin{array}{c} O \\ \\ R-C-CH_3 \end{array}$	2.0 – 2.6	$Ar-H$	6.0 – 8.5
$Ar-CH_3$	2.2 – 2.5	$\begin{array}{c} O \\ \\ R-C-H \end{array}$	9.5 – 10.5
$R-C\equiv C-H$	2.5 – 3.0	$\begin{array}{c} O \\ \\ R-C-OH \end{array}$	10 – 13
$(H)R-O-CH_3$	3.3 – 4.0		

1- The difference in the absorption position of particular proton from absorption position of a reference point (zero point) is called-

- a- Resonance point b- **Chemical shift** c- Coupling constant

2- What is the splitting for a underline proton on the sec-butyl bromide $CH_3CHBrCH_2\text{CH}_3$

- a- **Triplet** (t) b- singlet (s) c- doublet (d)

3- What is the splitting for a underline proton/s on the sec-butyl bromide $CH_3CHBrCH_2CH_3$

- a- Multiple (m) b- singlet (s) c- **doublet** (d)

4- What is the splitting for a underline proton/s on the sec-butyl bromide CH_3COOH

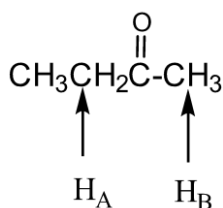
- a- Triplet (t) b- **singlet** (s) c- doublet (d)

5- Which one of the following molecule doesn't show splitting?

- CH_3CH_2OH b- **$ClCH_2CH_2Cl$** c- CH_3CH_2Br

1. is not NMR active

- A. ^{13}C
- B. ^1H
- C. ^{12}C
- D. ^{20}Ca



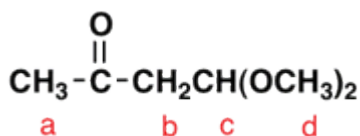
2. Which of the following gives the multiplicities of the signals for the protons H_A and H_B in the ^1H NMR spectrum of the compound shown above?

H_A

H_B

- | | |
|-------------------|----------------|
| A) Singlet | Doublet |
| B) Triplet | Doublet |
| C) <u>Quartet</u> | <u>Singlet</u> |
| D) Quartet | Triplet |

3. Which of hydrogens a-d in the following molecule gives a doublet signal in a normal ^1H NMR spectrum?

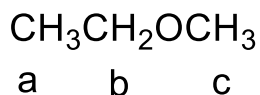


- A) Hydrogen a
- B) Hydrogen b
- C) Hydrogen c
- D) Hydrogen d

4. lower electron density around a nucleus de-shields the nucleus from the external magnetic field and the signals are down-field in the NMR

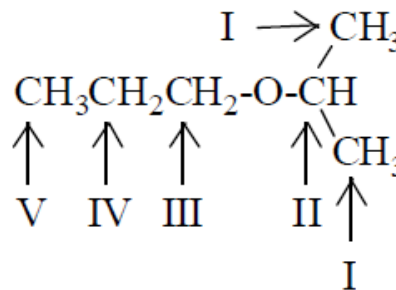
- A. Shielding of proton
- B. de- shielding of proton
- C. Chemical shift
- D. None of the above

5. Which of hydrogens a-c in the following Molecule gives a triplet signal in a normal ^1H NMR spectrum?



- A. Hydrogen a
 B. Hydrogen c
 C. Hydrogen b
 D. Both of hydrogen a & c
6. Which spectrum provides the environment of the hydrogen in the molecule and number of hydrogens?
- A. ^{13}C NMR
 B. ^1H NMR
 C. UV
 D. IR
7. used as a solvent in NMR spectroscopy?
- A. H_2O
 B. Dimethyl Ether
 C. TMS
 D. DMSO

8. Which proton(s) of the compound below would appear as a triplet in the ^1H NMR spectrum?



- A. The protons on carbon II
 B. The protons on carbon III and V
 C. The protons on carbon III and IV
 D. The protons on carbon I

9. Spectroscopy measures the chemical shift δ of hydrogen

- A) Infra-Red
- B) Mass Spectroscopy
- C) ^1H NMR
- D) Ultra Violet

1. Nuclear Magnetic Resonance spectroscopy is based on the interaction of nuclei with:

- A. Electric field
- B. Magnetic field
- C. Gravitational field
- D. Acoustic waves

2. Which nucleus is most commonly studied in NMR spectroscopy?

- A. ^{12}C
- B. ^{14}N
- C. ^1H
- D. ^{16}O

3. For a nucleus to be NMR-active, it must have:

- A. Even mass number
- B. Odd number of neutrons only
- C. Non-zero nuclear spin

4. The x-axis of a typical NMR spectrum represents:

- A. Frequency (Hz)
- B. Magnetic field strength
- C. Chemical shift (δ) ppm
- D. Signal intensity

5. Chemical shift values are reported relative to which standard compound?

- A. Methanol
- B. Benzene
- C. Tetramethylsilane (TMS)
- D. Chloroform

7. A proton absorbing at high ppm value is described as:

- A. Shielded
- B. Upfield
- C. Deshielded
- D. Saturated

8. The splitting of NMR signals is caused by:

- A. Instrument noise
- B. Chemical shift differences
- C. Spin-spin coupling
- D. Hydrogen bonding

9. According to the $n + 1$ rule, a proton with two neighboring protons will appear as a:

- A. Singlet
- B. Doublet
- C. Triplet $n = 2 \rightarrow n + 1 = 3$ peaks
- D. Quartet

11. A singlet in a proton NMR spectrum indicates:

- A. One proton only
- B. No neighboring protons
- C. High molecular weight
- D. Aromatic proton

13. Which NMR technique is commonly used to study carbon atoms in organic compounds?

- A. ^1H NMR
- B. ^{13}C NMR
- C. ^{12}C NMR
- D. ^{14}N NMR

14. In ^{13}C NMR spectra, signals are usually:

- A. Split into multiplets
- B. Very broad
- C. Singlets
- D. Not observed

16. Which solvent is most commonly used in ^1H NMR spectroscopy?

- A. H_2O
- B. CDCl_3 Deuterated chloroform
- C. CCl_4
- D. Methanol

17. Aromatic protons typically appear in the range:

- A. 0–1 ppm
- B. 1–3 ppm
- C. 4–6 ppm
- D. 6–8 ppm

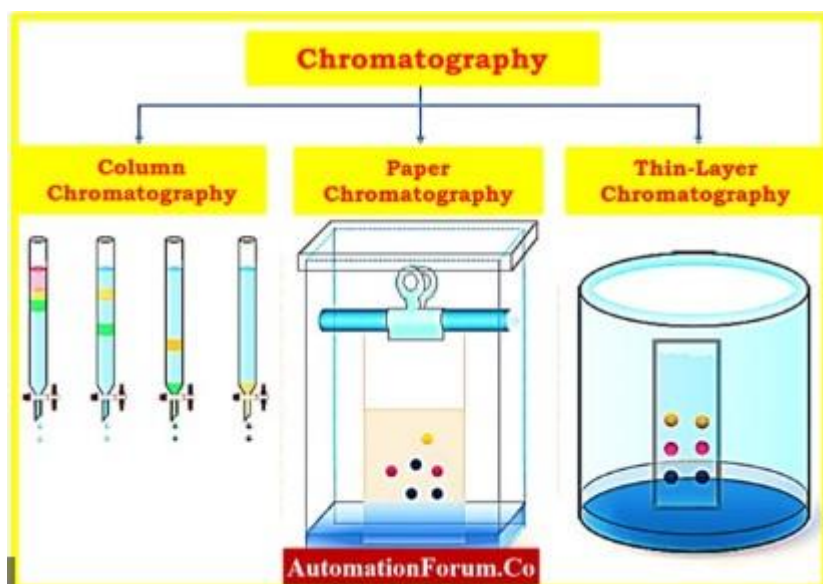
18. An aldehyde proton usually appears around:

- A. 1 ppm
- B. 3 ppm
- C. 7 ppm
- D. 9–10 ppm

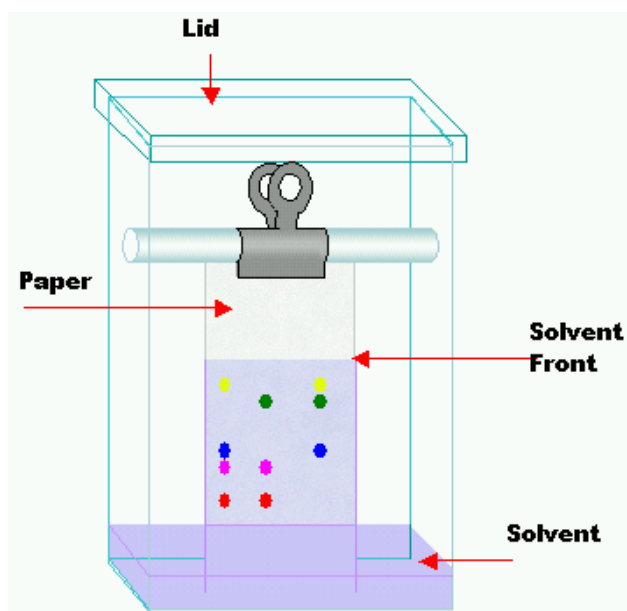
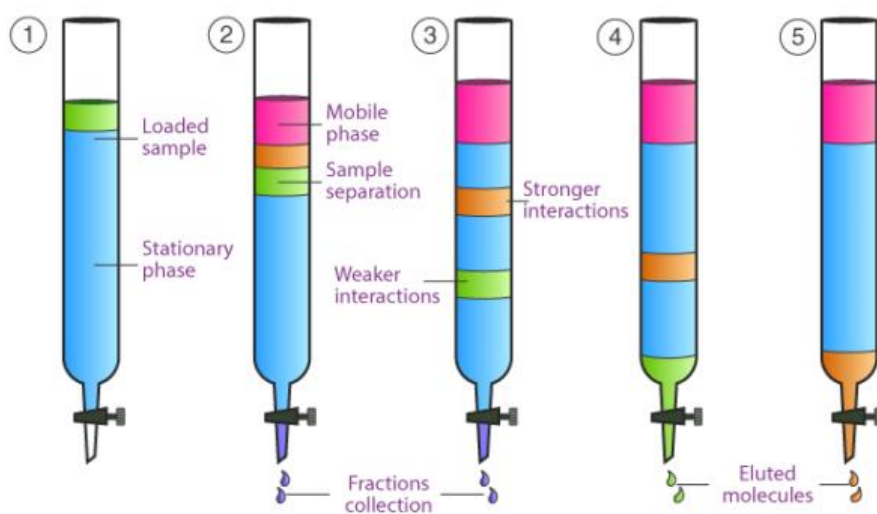
19. Which technique provides information about proton connectivity in a molecule?

- A. UV–Visible spectroscopy
- B. IR spectroscopy
- C. Mass spectrometry
- D. NMR spectroscopy

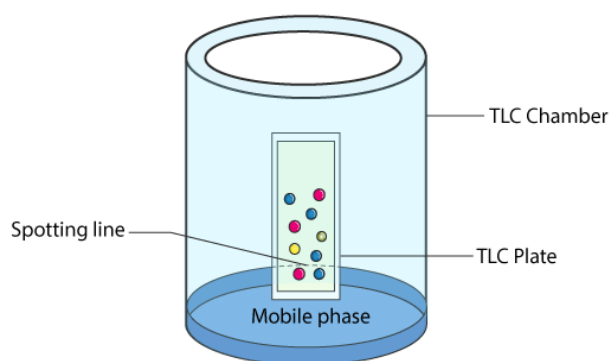
Q28: Chromatography



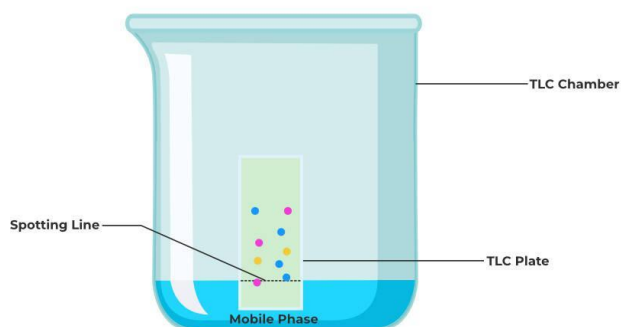
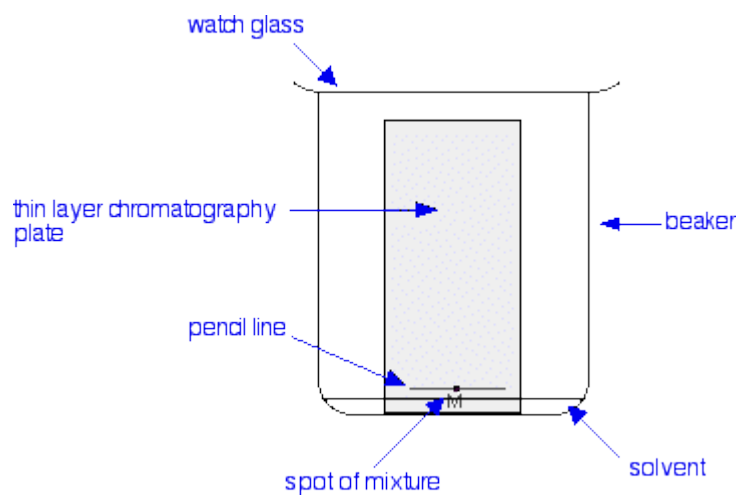
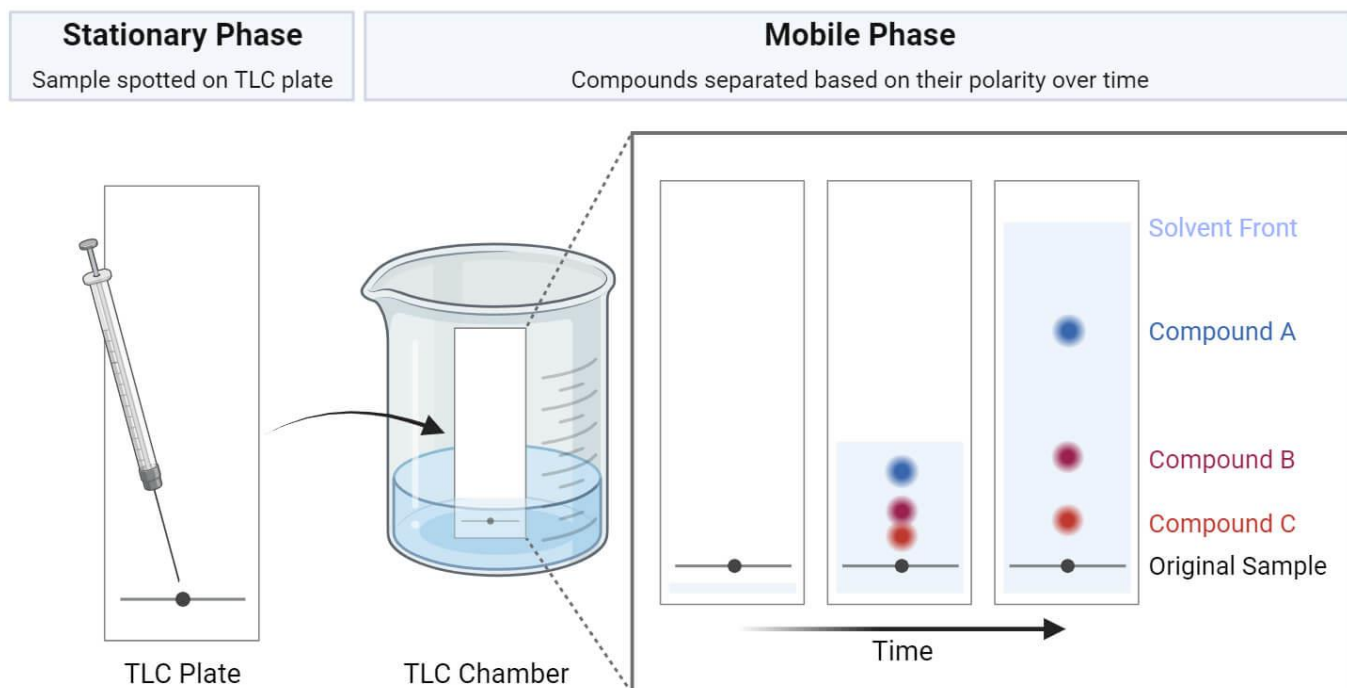
COLUMN CHROMATOGRAPHY



THIN LAYER CHROMATOGRAPHY



Thin Layer Chromatography



1. Chromatography is primarily used to:

- A. Measure molecular weight
- B. Separate components of a mixture
- C. Determine melting point
- D. Study molecular vibrations

3. The stationary phase in paper chromatography is:

- A. Cellulose paper
- B. Water held in paper fibers
- C. Organic solvent
- D. Silica gel

4. The mobile phase in chromatography is also called the:

- A. Adsorbent
- B. Eluent
- C. Detector
- D. Support

5. Which chromatography technique uses silica gel or alumina as stationary phase?

- A. Gas chromatography
- B. Paper chromatography
- C. Thin-layer chromatography
- D. Ion-exchange chromatography

6. In thin-layer chromatography, the R_f value is defined as:

- A. Distance traveled by solvent / distance by solute
- B. Distance traveled by solute / distance by solvent front
- C. Time taken for separation
- D. Area of spot

$R_f = \text{distance solute} \div \text{distance solvent front}.$

7. R_f value depends on:

- A. Temperature only
- B. Nature of compound and solvent
- C. Size of TLC plate only
- D. Detector type

8. Which chromatography is mainly used for volatile compounds?

- A. HPLC
- B. Paper chromatography
- C. Gas chromatography
- D. Ion-exchange chromatography

9. In gas chromatography, the mobile phase is:

- A. Liquid
- B. Solid
- C. Gas
- D. Supercritical fluid

11. High-Performance Liquid Chromatography (HPLC) uses:

- A. Gravity flow
- B. Capillary action
- C. High pressure
- D. Vacuum

17. The chromatogram is a plot of:

- A. Concentration vs time
- B. Absorbance vs wavelength
- C. Detector response vs time
- D. R_f vs distance

18. Retention time is defined as the:

- A. Time solvent takes to reach end
- B. Time for analyte to elute
- C. Time detector responds
- D. Time sample is injected

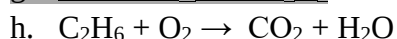
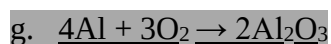
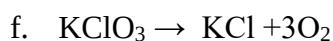
22. Which chromatography is best for amino acids separation?

- A. Gas chromatography
- B. Paper chromatography
- C. Ion-exchange chromatography Amino acids are charged species.
- D. Size-exclusion chromatography

Physical Chemistry

1.2 Principle of Physical Chemistry

83. Which of the following equation is balanced ?



84. The standard enthalpy of formation of any element in its most stable form is

e. 500

f. 300

g. 100

h. Zero

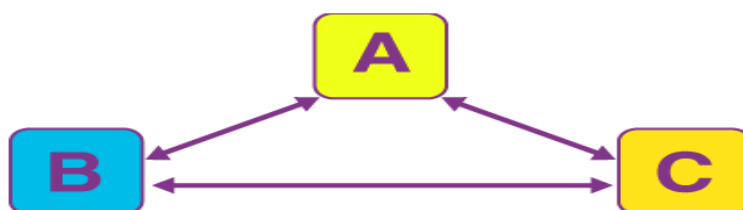
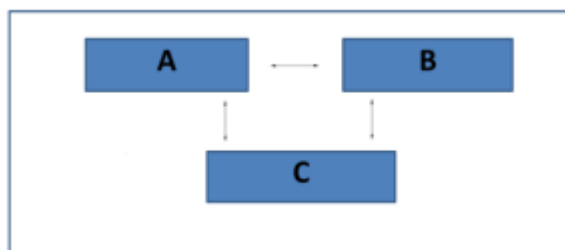
85. This Figure represents

e. The Zeroth Law of Thermodynamics

f. The First Law of Thermodynamics

g. The Second Law of Thermodynamics

h. The Third Law of Thermodynamics



The zeroth law of thermodynamics states that if two thermodynamic systems are each in thermal equilibrium with a third one, then they are in thermal equilibrium with each other.

86. In classical thermodynamics, which law states that energy cannot be created or destroyed?

e. Zeroth Law of Thermodynamics

f. First Law of Thermodynamics

g. Second Law of Thermodynamics

h. Third Law of Thermodynamics

Laws of Thermodynamics

Zeroeth law

Temperature

Two systems in equilibrium with a third system are in thermal equilibrium with each other.



First law

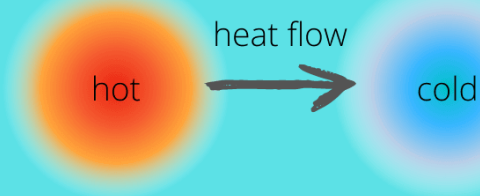
Conservation of Energy

Energy can change forms, but is neither created nor destroyed.



Second law

Entropy of an isolated system always increases.



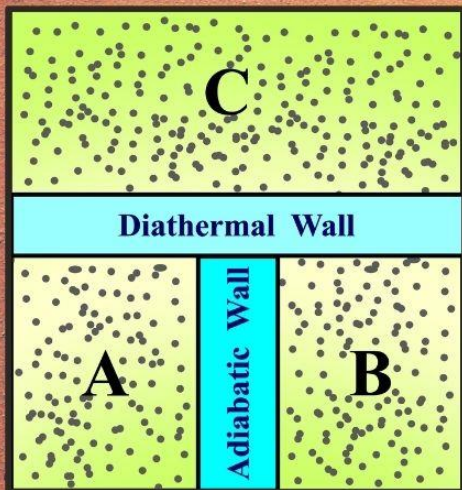
Third law

Entropy of a system approaches a constant as temperature approaches absolute zero.



scincenotes.org

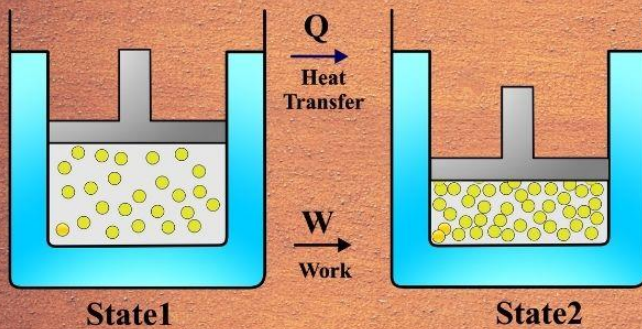
Zeroth law of Thermodynamics



- "If two systems are each in thermal equilibrium with a third system, then they are in thermal equilibrium with each other. "

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First Law of Thermodynamics

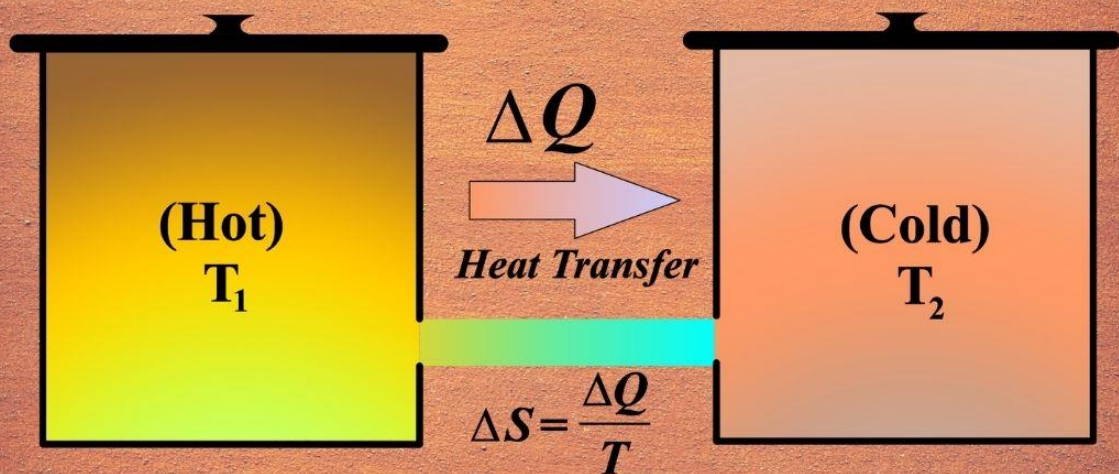


"Energy cannot be created or destroyed; it can only change forms or be transferred from one object to another."

$$dU = U_f - U_i \text{ or } \Delta U = Q - W \quad \Delta Q = \Delta U + P\Delta V$$

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Second Law of Thermodynamics



$\Delta S = 0$; for reversible process

$\Delta S > 0$; for irreversible process

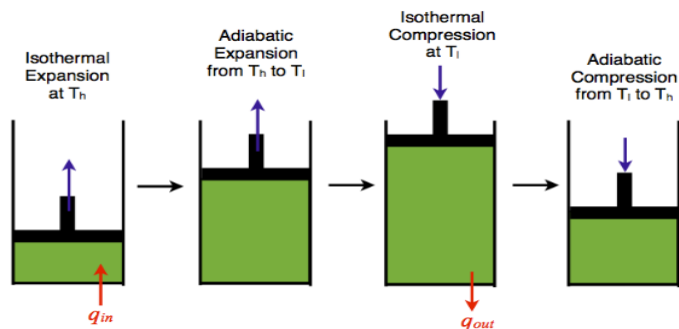
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87. In thermodynamics, what does the term 'enthalpy' refer to?

- The total heat content of a system
- The disorder or randomness in a system
- The energy required to change the temperature of a substance
- The pressure-volume work done by a system

88. This Figure represents

- a. Avogadro's law
- b. Carnot Engine Cycle for Ideal Gas
- c. Charles's and Gay-Lussac's Law
- d. None of Above



3.1 Physical Chemistry of Bulk Matter

89. Absolute Zero in Celsius scale equals to

- a. Zero K
- b. 100°C
- c. -273.15°C
- d. +273.15 °C

90. states that entropies of all pure, perfect crystalline materials approach zero as the temperature approaches zero K .

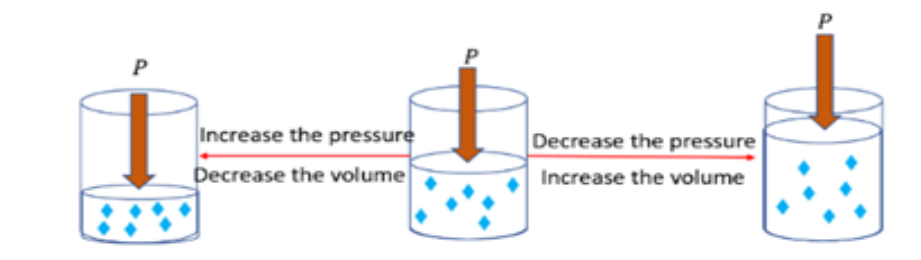
- e. 1st law of Thermodynamic
- f. 2nd law of thermodynamic
- g. 3rd law of thermodynamic
- h. Law of mass action

91. Free energy it also called Gibbs energy it has the unit of ...

- e. Newton
- f. Volt
- g. Kelvin
- h. Joules

92. If the contact angle is more than 90° the surface substrate is

- e. Hydrophilic
- f. Hydrophobic
- g. Hydrostatic
- h. None of them



93. The figure above represents.....

- e. Ohm's law
- f. Boyle's law
- g. Charles's and Gay-Lussac's Law
- h. Dalton's law

94. is the process when the adsorbate is released from the surface of the bulk substance

- e. Absorption
- f. Adsorption
- g. Desorption
- h. None of above

95. Physisorption occurred by forces

- e. Double bonds
- f. Chemical
- g. Van der Waals
- h. Bond to bond

96. Acid/base is an example of catalysts

- e. Homogeneous
- f. Heterogeneous
- g. Both a and b
- h. None of the above

97. Bulk catalysts is an example of catalysts

- e. Homogeneous
- f. Heterogeneous
- g. None of a and b
- h. Both a and b

98. $\text{Energy} + 2\text{HgO (s)} \rightarrow 2\text{Hg (l)} + \text{O}_2 \text{ (g)}$, is an example of

- e. Endothermic process
- f. Exothermic process
- g. No process
- h. None of above

99. $\text{H}_2\text{O (g)} \rightarrow \text{H}_2\text{O (l)} + \text{Energy}$, is an example of

- e. Exothermic process
- f. Endothermic process
- g. No process
- h. Both a and b

100. The dispersion of actual particles of one substance throughout a dispersing medium of another substance is called

- e. Solution
- f. Colloid
- g. Crystalloid
- h. Suspension

**101. exchan
ge in isolated system.**

(There is no exchange of energy with the surrounding. there is exchange of mass and energy with the surrounding)

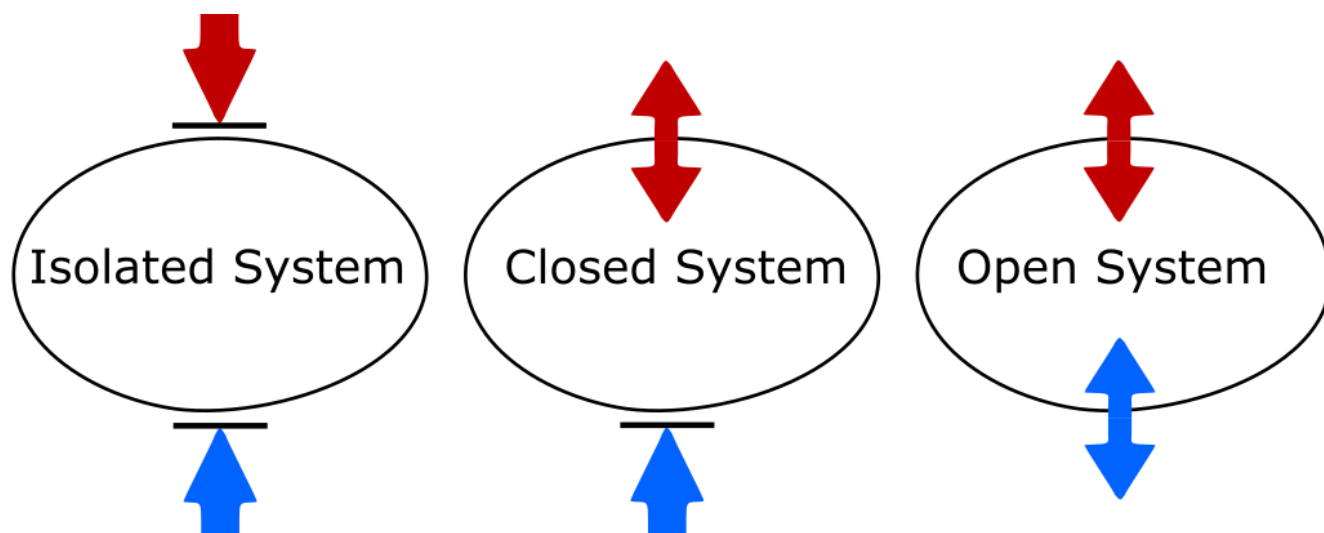
- e. Energy only
- f. Mass only
- g. Mass and Energy
- h. Nothing

**102. An isolated
system is that system in which:**

- e. There is exchange of energy and mass with the surroundings
- f. There is no exchange of energy with the surroundings
- g. There is exchange of mass and energy with the surroundings
- h. There is no exchange of energy and mass with the surroundings

**103. Only the energy
is exchanged in..... system .**

- e. Isolated
- f. Closed
- g. Open
- h. None of the above



Exchange of energy

Exchange of matter

104. The change in
the concentration of a reactant or a product with time (M/s) is known as

- e. Breathing
- f. Hydration
- g. Rate constant
- h. Reaction Rate

105. The reactant
presents in quantities greater than necessary to react with the quantity of limiting reagent is called

- e. Limiting reagent
- f. Excess reagent
- g. Stoichiometric amounts
- h. Nonstoichiometric compounds

3.2 Physical Chemistry of Microscopic Matter

106. How is the state
of a quantum mechanical system completely specified?

- e. By its time
- f. By its position in space
- g. By its wave function
- h. By its angular momentum

107. What principle
does quantum chemistry primarily rely on?
e. Conservation of mass
f. Law of definite proportions
g. Wave-particle duality
h. Newton's laws of motion
108. Which principle
is used in quantum chemistry to approximate the behavior of electrons in atoms?
e. Boyle's law
f. Schrödinger equation
g. Avogadro's hypothesis
h. Le Chatelier's principle
109. What is the
probability density of a wave function $\phi(x,t)$ at time t in element of volume dv ?
e. $\phi(x,t)$
f. $\phi(x,t)dv$
g. $\phi^*(x,t)dv$
h. $\phi^*(x,t)\phi(x,t)dv$
110. In quantum
chemistry, what does the Heisenberg Uncertainty Principle state?
e. Energy levels are quantized
f. It is impossible to know both the position and momentum of a particle simultaneously with absolute certainty
g. Electrons orbit the nucleus in fixed paths
h. Atoms are indivisible
111. What will
happen during the electrolysis of aqueous solution of CuSO_4 by using platinum electrodes ?
e. Copper will deposit at anode
f. Copper will deposit at cathode
g. Oxygen will be released at cathode
h. Copper will dissolve at anode
112. The reaction A
 $\leftrightarrow$ B has an equilibrium constant of $K = 10^{-4}$. Which one of the following statements is always correct ?
e. The reaction is very favorable and will have mostly product B at equilibrium
f. The reaction will have 50% product B and 50% reactant A at equilibrium
g. The reaction is unfavorable and will not have very much product B at equilibrium

- h. The equilibrium constant only relates to the speed of a reaction and not to the amount of product formed. E The reaction is at equilibrium

113.

Contact angle is

the angle formed in between phases.

- e. Zero
- f. One
- g. Three
- h. Four

114.

Is there a

quantum mechanical operator for every observable in classical mechanics?

- e. Yes, obtained from quantum mechanical coordinates
- f. Yes, obtained from classical Cartesian coordinates and conjugate momenta
- g. No, only for certain observables
- h. No, for no observables at all

115.

By what term

should the conjugate momenta be replaced by for conversion of classical observables to quantum mechanical operators ?

- e. $-i\hbar$
- f. $-i\hbar\nabla^2$
- g. $-\partial/\partial q$
- h. $-i\hbar\partial/\partial q$

116.

What are the

possible measured values of observable A called ?

- e. Operators of A
- f. Functions of A
- g. Eigenvalues of A
- h. Eigen functions of A

117.

What is the

mathematical probability of measuring eigenvalue of an observable for wave function ϕ in a volume of space dv ?

- e. $\phi \times v$
- f. $\int \phi^* \phi dv$
- g. $\int \phi dv$
- h. $\int \phi^* \phi dv$

118.

Is it possible for

the probability density to ever have a negative value?

- e. Yes, because the square of a function is always positive
- f. No, because the square of a function is not always positive
- g. No, because the square of a function is not always positive
- h. No, because the square of function is always positive

119. Is the
manifestation of a wavefunction square (to be probability density) a postulate of quantum mechanics?
 e. No
 f. Yes
 g. Depends on the wavefunction form
 h. Depends whether the wavefunction is a function of position or time
120. Can a
wavefunction evolve in time ?
 e. Yes, it can evolve in time, but not in position
 f. No, it can neither evolve in time nor position
 g. Yes, it can evolve in time as well as in position
 h. No, it can only evolve in position
121. The
wavefunction of a system changes with time according to the following equation:
 $H\psi(x,t) = i\hbar \partial \psi(x,t) / \partial t$. **What does the H term stand for ?**
 e. Reduced Plank's constant
 f. Kinetic energy operator
 g. Hamiltonian of a wavefunction
 h. Angular momentum operator
122. The
wavefunction of a system changes with time according to the following equation:
 $H\psi(x,t) = i\hbar \partial \psi(x,t) / \partial t$. **What does the $\hbar$ term stand for ?**
 e. Angular momentum operator
 f. Kinetic energy operator
 g. Hamiltonian of a wavefunction
 h. Reduced Plank's constant
123. The
wavefunction of a system changes with time according to the following equation:
 $H\psi(x,t) = i\hbar \partial \psi(x,t) / \partial t$. **Can this equation be integrated directly by variable separable ?**
 e. No, because $\psi(x,t)$ cannot be integrated
 f. No, because $\psi(x,t)$ is simply a notation and not the wavefunction form itself
 g. Yes, because $\psi(x,t)$ appears on either side with one of them being a differential
 h. Yes, because the wavefunction terms can be moved to the right-hand side and integrated

124. **Pauli exclusion principle?** **What is the**
- e. The product of uncertainty of two variable pairs cannot exceed $h/2\pi$
 - f. Two electron wavefunction systems must be antisymmetric to one another
 - g. Wavefunctions can only exist in superposition of fundamental wavefunctions
 - h. Electron wavefunctions must be unique to each individual electron
125. **postulates of quantum mechanics derived from other theories?** **Are the**
- e. No, postulates are rules that are not derived
 - f. Yes, they are the microscopic cases for general relativity
 - g. Yes, they are a special case of classical mechanics
 - h. Yes, they are derived from thermodynamics and kinetics of atomic motion
126. **system's evolution in time depend upon the observer ?** **Can a classical**
- e. Yes, the system's evolution is purely dependent on the observer
 - f. Yes, the system will evolve differently if observed
 - g. No, it will evolve independent of the observer
 - h. No, it will evolve depending on who the observer is
127. **the Schrödinger wave function is** **The square of**
- e. Not integrable.
 - f. Equal to one.
 - g. A probability density.
 - h. Has no physical meaning.
128. **potential energy term in the Schrodinger equation for a particle outside the boundaries of a confined one-dimensional box?** **What is the**
- e. $V(x) = 0$
 - f. $V(x) = \infty$
 - g. $V(x) = -\infty$
 - h. $V(x) = 1$
129. **shape of the wavefunction for the ground state quantum mechanical harmonic oscillator?** **What is the**
- e. Hermitian
 - f. Poisson
 - g. Gaussian

h. Quadratic

130. What is the type
of polynomial function that is a part of the harmonic oscillator wavefunction?

- e. Monomial
- f. Trinomial
- g. Binominal
- h. Hermite

131. The energy
levels of one dimensional simple harmonic oscillator are

- e. Degenerate and not equally spaced
- f. Non degenerate and not equally spaced
- g. Degenerate and equally spaced
- h. Non degenerate and equally spaced

132. $\Psi(x,t)^2$
represents

- e. Probability of finding particle near position x at time t
- f. Probability of finding particle at position x at time t
- g. Probability density of finding particle at position x at time t
- h. None of the above

133. in quantum
mechanics behaves in same way as observable themselves in classical mechanics

- e. Expectation values
- f. Eigen functions
- g. Eigen values
- h. None of above

134. Schrodinger
wave equation is usually used to determine

- e. Momentum
- f. Energy
- g. Wavefunction
- h. Speed of particle

135. Which of the following has degenerate energy states?
- e. Particle in a cubical box
 - f. Particle in one dimensional potential well.
 - g. Three dimensional harmonic oscillator
 - h. Both A and C

3.3 Physical Chemistry Laboratory

136. Which of the following should be recorded in a laboratory notebook?
- e. Experimental procedures
 - f. Raw data and observations
 - g. Sources of experimental error
 - h. All of the above

137. How can you calculate the rate constant of a reaction using experimental data?
- e. By calculating the pH change
 - f. By plotting concentration vs. time and determining the slope
 - g. By measuring the temperature change
 - h. By weighing the reactants before and after the reaction

138. Which software is commonly used for data analysis in physical chemistry?
- e. Excel
 - f. MATLAB
 - g. Origin Lab
 - h. All of the above

139. What is the first step you should take if a chemical spill occurs in the laboratory?
- e. Clean it up immediately with paper towels
 - f. Ignore it and continue working
 - g. Notify the instructor or lab supervisor
 - h. Leave the lab immediately

140. Which of the following are common sources of experimental error in a physical chemistry lab?
- e. Human observational errors

- f. Instrument calibration errors
- g. Environmental changes
- h. All of the above

141.

In kinetics, what

does the Arrhenius equation describe?

- e. The equilibrium constant of a reaction
- f. The temperature dependence of reaction rates
- g. The pressure-volume relationship of gases
- h. The energy levels of electrons in an atom

142.

What is the

primary purpose of using a calorimeter in a laboratory setting?

- e. To determine the pH of solutions
- f. To separate mixtures based on boiling points
- g. To analyze the color spectrum of compounds
- h. To measure heat changes during chemical reactions

143.

Which statistical

method is commonly used to analyze variance in experimental data?

- e. T-test
- f. Linear regression
- g. Chi-square test
- h. ANOVA (Analysis of Variance)

144.

Which statistical

method is used to predict the relationship between variables in physical chemistry experiments?

- e. Chi-square test
- f. Regression analysis
- g. ANOVA
- h. T-test

145.

What is the role

of a buffer solution in a chemical experiment?

- e. To increase the reaction rate
- f. To maintain a stable pH
- g. To act as a catalyst
- h. To provide nutrients for bacteria

146. **Which technique would you use to separate components of a mixture based on their boiling points?**
- e. Chromatography
 - f. Centrifugation
 - g. Distillation
 - h. Filtration
147. **What is the standard electrode potential of a hydrogen electrode at 25°C?**
- e. -0.76 V
 - f. 0.00 V
 - g. 0.34 V
 - h. 1.23 V
148. **Which instrument would you use to measure the absorbance of a solution in a spectroscopy experiment?**
- e. Calorimeter
 - f. Spectrophotometer
 - g. Thermocouple
 - h. Manometer
149. **Which of the following are essential safety equipment in a chemistry laboratory?**
- e. Safety shower
 - f. Fume hood
 - g. Fire extinguisher
 - h. All of the above
150. **What is the first step in preparing a laboratory notebook for an experiment?**
- e. Record the final results
 - f. Write the date and title of the experiment
 - g. Draw diagrams of expected outcomes
 - h. List all potential errors
151. **What is the typical range of wavelengths for UV-Vis spectroscopy?**
- e. 200-800 nm
 - f. 2500-5000 nm
 - g. 800-2500 nm

- h. 10-200 nm

What is the main purpose of using a fume hood in a laboratory?

- e. To store chemicals safely
- f. To protect users from inhaling hazardous fumes
- g. To enhance visibility during experiments
- h. To maintain room temperature

Which of the following are essential steps in performing a titration experiment?

- e. Using an appropriate indicator
- f. Standardizing the titrant
- g. Recording the initial and final volume readings
- h. All of the above

What is the most important step to take before starting any experiment in a physical chemistry lab?

- e. Prepare all solutions in advance
- f. Ensure all equipment is turned on
- g. Review the safety data sheets (SDS) for all chemicals involved
- h. Record initial observations

152. Which of the following should be included when recording experimental results in a laboratory notebook?

- e. Potential sources of error
- f. Date and time of the experiment
- g. Detailed observations and measurements
- h. All of the above

153. When analyzing kinetic data, which plot is typically used to determine the order of a reaction?

- e. Temperature vs. time plot
- f. Rate vs. concentration plot
- g. Pressure vs. volume plot
- h. Absorbance vs. wavelength plot

154. Which of the following are essential components of a risk assessment in a chemistry laboratory?
- e. Evaluation of risks
 - f. Identification of hazards
 - g. Implementation of control measures
 - h. All of the above
155. What is the purpose of using a control sample in an experiment?
- e. To increase the reaction rate
 - f. To reduce experimental error
 - g. To provide a baseline for comparison
 - h. To enhance the color of the solution
156. What is the first step in ensuring safety before starting an experiment in a physical chemistry lab?
- e. Prepare all chemical solutions
 - f. Review the laboratory safety guidelines
 - g. Calibrate all instruments
 - h. Write down expected results
157. Which of the following should be included when recording experimental data in a laboratory notebook?
- e. Potential sources of error
 - f. Date and time of the experiment
 - g. Detailed observations and measurements
 - h. All of the above
158. Which technique is used to analyze the kinetic data of a reaction?
- e. Pressure vs. volume plot
 - f. Rate vs. concentration plot
 - g. Temperature vs. time plot
 - h. Absorbance vs. wavelength plot
159. Which statistical method is often used to assess the precision of experimental data?
- e. Dispersion
 - f. Standard deviation
 - g. Mean absolute error
 - h. Correlation coefficient
160. What is the primary purpose of a Material Safety Data Sheet (MSDS) in a chemistry laboratory?
- e. To list the cost of chemicals
 - f. To describe the color and odor of chemicals

- g. To offer recipes for chemical mixtures
- h. To provide detailed information on chemical hazards and safe handling practices

How does an increase in ionic concentration affect the conductivity measured during a reaction?

- a. Fluctuates randomly
- b. Decreases conductivity
- c. Increases conductivity
- d. No effect on conductivity

General concepts in analytical chemistry

- 1) The area of chemistry that deals with determination the type and amount of the substances in a given sample.
 - a- Organic Chemistry
 - b- Analytical Chemistry
 - c- Physical Chemistry
 - d- Inorganic chemistry

- 2) The process of isolating and weighing an element or compound in a pure form.
 - a- Volumetric analysis
 - b- Gravimetric analysis
 - c- Chromatographic analysis
 - d- Spectroscopic analysis

- 3) The amount of a substance that contains the same number of entities as there are atoms in exactly 12 g of carbon-12.
 - a- Relative atomic mass
 - b- Relative molecular mass
 - c- Relative molar mass
 - d- Mole

- 4) The molecular mass of O_2 is.....
 - a- 32 amu
 - b- 64 amu
 - c- 24 amu
 - d- 16 amu

- 5) The molecular mass of Cl_2 is.....
 - a- 32 amu
 - b- 71 amu
 - c- 54 amu
 - d- 26 amu

- 6) The molecular mass of HNO_3 is.....
 - a- 63 amu
 - b- 31 amu
 - c- 44 amu
 - d- 36 amu

- 7) The molecular mass of CH_3CH_2-OH is.....
 - a- 46 amu
 - b- 51 amu
 - c- 84 amu

d- 96 amu

8) The molar mass of NH_3 is.....

a- 26 g

b- 17 g

c- 84 g

d- 66 g

9) The molar mass of CO_2 is.....

e- 44 g

f- 27 g

g- 84 g

h- 16 g

10) The molar mass of CH_4 is.....

a- 24 g

b- 16 g

c- 44 g

d- 36 g

11) The molar mass of HCl is.....

a- 44 g

b- 27 g

c- 36.5 g

d- 16 g

12) Number of moles in 22 g of Carbon dioxide (CO_2) is.....

a- 2 moles

b- 0.1 mole

c- 0.5 mole

d- 3 mole

13) Number of Carbon dioxide (CO_2) molecules present in 22 g of it is equals to.....

a- Avogadro's number

b- Half of Avogadro's number

c- Double Avogadro's number

d- Three times Avogadro's number

14) Number of Oxygen atoms (O) present in 22 g of Carbon dioxide (CO_2) is equals to.....

a- Avogadro's number

b- Half of Avogadro's number

c- Double Avogadro's number

d- Three times Avogadro's number

15) Number of moles are present in 142 g of Chloride gas (Cl_2) is.....

- a- 2 moles
- b- 0.1 mole
- c- 0.5 mole
- d- 3 mole

16) Number of Chloride (Cl_2) molecules present in 142 g of it is equals to.....

- e- Avogadro's number
- f- Half of Avogadro's number
- g- Double Avogadro's number
- h- Three times Avogadro's number

17) Number of Chloride atoms (Cl) present in 142 g of Chloride gas (Cl_2) is equals to.....

- e- Avogadro's number
- f- Half of Avogadro's number
- g- Double Avogadro's number
- h- Four times Avogadro's number

18) Number of equivalents of solute dissolved in one liter of solution.

- a- Molarity
- b- Molality
- c- Normality
- d- Strength of solution

19) Number of grams of the solute per liter of solution..

- a- Molarity
- b- Molality
- c- Normality
- d- Strength of solution

20) Number of moles of the solute per liter of solution.

- a- Molarity
- b- Molality
- c- Normality
- d- Strength of solution

21) Molarity (M) of 4 g of Sodium Hydroxide (NaOH) dissolved in 250 ml distilled water.

- a- 4M
- b- 0.4M
- c- 2M
- d- 1M
- e- 3.5 M

Classical analytical chemistry

22) Normality (N) of 55.5 g of Calcium Chloride (CaCl_2) dissolved in 500 ml distilled water.

- a- 4M
- b- 0.4M
- c- 2M
- d- 1M

23) IF the density of 95.2 % (weight percent) of H_2SO_4 is 1.53 g/ml, the molarity (M) of this solution will be

- a- 14.9 M
- b- 23.2 M
- c- 55.3M
- d- 7.23M

24) IF the density of 95.2 % (weight percent) of H_2SO_4 is 1.53 g/ml, the normality (N) of this solution will be

- a- 14.9 N
- b- 29.7 N
- c- 55.3N
- d- 7.23N

25) The equivalent weight of NaOH is

- a- **40g**
- b- **20g**
- c- **80g**
- d- **10g**

26) The equivalent weight of Ca(OH)_2 is

- a- **40g**
- b- **37g**
- c- **80g**
- d- **10g**

27) The equivalent weight of Al(OH)_3 is

- a- **40g**
- b- **26g**
- c- **80g**
- d- **10g**

28) The equivalent weight of Al(OH)_3 is

- a- **40g**
- b- **26g**
- c- **80g**
- d- **10g**

29) The equivalent weight of HNO_3 is

- a- **40g**
- b- **68g**
- c- **80g**
- d- **10g**

30) The equivalent weight of H_2SO_4 is

- a- **40g**
- b- **49g**
- c- **80g**
- d- **10g**

31) The equivalent weight of H_3PO_4 is

- a- **40g**
- b- **32.7g**
- c- **80g**
- d- **10g**

32) The equivalent weight of CH_3COOH is

- e- **40g**
- f- **60g**
- g- **80g**
- h- **10g**

33) A point at which an equivalent of analyte reacts with an equivalent of titrant.

- a- End point
- b- Equivalent point
- c- Critical point
- d- Isoelectric point

34) Blank titration is used to estimate the

- a- End point
- b- Equivalent point
- c- Titration error
- d- Critical point

35) The pH value of a $0.0001 \text{ mol L}^{-1}$ solution of HCl is

- a- 1
- b- 4
- c- 6
- d- 8

36) The pH value of a $0.0001 \text{ mol L}^{-1}$ solution of NaOH is

- a- 3
- b- 6
- c- 8
- d- 10

37) The pH value of NaCl solution is

- a- =7
- b- < 7
- c- > 7
- d- > 14

38) The pH value of NH_4Cl solution is

- a- =7
- b- < 7
- c- > 7
- d- > 14

39) The pH value of CH_3COONa solution is

- a- =7
- b- < 7
- c- > 7
- d- > 14

40) A substance that produced Hydrogen ion in water solution.

- a- Acid
- b- Base
- c- Salt
- d- None of them

41) A process which involves loss of electrons

- a- Oxidation
- b- Reduction
- c- Oxidant
- d- Reductant

42) The substance lost electrons

- a- Oxidation
- b- Reduction
- c- Oxidant
- d- Reductant

43) The oxidation number of N in HNO_3 is

- a- 5
- b- 4
- c- 6
- d- 7

44) The oxidation number of H_2SO_4 is

- a- 0
- b- 5
- c- 6
- d- 7

45) The oxidation number of Cl atom in Cl_2 molecule is

- a- 0
- b- 1
- c- -1
- d- -2

46) The oxidation number of O atom in H_2O_2 molecule is

- a- 0
- b- -2
- c- -1
- d- 2

47) The oxidation number of H atom in LiH molecule is

- a- 0
- b- 1
- c- -1
- d- +2

48) The oxidation number of Mg^{+2} is

- a- 0
- b- +2
- c- -2

d- +3

49) The oxidation number of S^{2-} is

a- 0

b- +2

c- -2

d- +3

50) The oxidation number of SO_4^{2-} is

a- 0

b- +2

c- -2

d- +3

51) The oxidation number of NH_4^+ is

a- 0

b- +1

c- -2

d- -1

52) A reaction in which the analyte and titrant form an insoluble precipitate.

a- **Precipitation reactions**

b- **Neutralization reactions**

c- **Redox reactions**

d- **Complex formation reactions**

53) The EDTA titration in which the metal solution is adjusted to the desired pH and titrated directly with a standard EDTA solution.

a- **Direct Titration**

b- **Back-Titration**

c- **Replacement or Substitution Titration**

d- **Alkalimetric Titration**

Instrumental analytical chemistry

54) Reference (standard) electrode

a- **An electrode that has constant potential.**

b- **An electrode that has variable potential.**

c- **A sensitive electrode for the analyte concentration**

d- **None of them**

55) Equivalent Conductance

- a- A conductance of a one cubic cm of a liquid (1cm^3).
- b- A conductance of the equivalent weight of the substance at infinite dilution.
- c- A conductance of one-gram equivalent of solute contained between two electrodes spaced one centimetre apart.
- d- All of the above

56) The fluorescence intensity of naphthalene is less than that of anthracene.

- a- Because the ring number of naphthalene is less than that of anthracene.
- b- Because the ring number of benzene is higher than that of naphthalene.
- c- Because the ring number of benzene is equal to than that of naphthalene.
- d- Due to formation of chelate

57) The conductance of the copper sulfate solution (CuSO_4) is higher than that of sodium chloride (NaCl) solution.

- a- The equivalent weight of HCl is higher than that of NaCl .
- b- The solubility of CuSO_4 is higher than that of NaCl .
- c- The acidity of CuSO_4 is higher than that of NaCl .
- d- Because the charges number on the copper and sulfate ions is higher than that of sodium and chloride ions.

58) The number of oscillations that occur in one second.

- a- Velocity of radiation
- b- Frequency
- c- Wave number
- d- Wave length

59) The wave number of a beam of infrared radiation with a wavelength of $5.00\ \mu\text{m}$ is

- a- $100\ \text{cm}^{-1}$
- b- $2000\ \text{cm}^{-1}$
- c- $500\ \text{cm}^{-1}$
- d- $800\ \text{cm}^{-1}$

60) A particle of electromagnetic radiation having zero mass and energy of $h\nu$.

- a- Electron
- b- Proton
- c- Neuron
- d- Photon

61) Tungsten lamp can be used

- a- Only in the UV-region (200-400 nm)
- b- Only in the Visible- region (400-700 nm)
- c- UV-Visible region (200-700 nm)
- d- Over visible region (800-1200 nm)

62) A process in which the chemical species absorbs thermal, electrical, or radiant energy and promoted to a higher energy state.

- a- Absorption
- b- Excitation
- c- Relaxation
- d- Transmittance

63) The absorbance of solution with 70% transmittance is

- a- 2.3
- b- 0.16
- c- 5.2
- d- 0.05

64) A compound has an absorption maximum at 235 nm, 20 % of the incident light was transmitted by a 2.0×10^{-4} M solution of the sample in a 1.0 cm cell. The molar absorptivity ($\epsilon_{\max}$) in this case will be

- a- 13.6×10^5
- b- 20.5×10^8
- c- 3.5×10^3
- d- 33.5×10^6

65) The radiation source of the Atomic Absorption Spectroscopy (AAS) is

- a- Hydrogen (H₂) or deuterium (D₂) lamp
- b- Hollow cathode lamp
- c- Tungsten lamp
- d- Laser lamp

66) Conductance of solution is increased by increase of temperature, because increasing temperature will

- a- Increase the energy of ions
- b- Decrease the viscosity of the solution
- c- Decrease hydration
- d- All of the above

67) If the measured conductance of 0.1 N solution of a drug is 0.0563 ohm^{-1} at 25°C and the cell constant is 0.52 cm^{-1} , the equivalent conductance at this concentration will be

- a- $543 \text{ ohm}^{-1}\text{cm}^2/\text{eq}$
- b- $293 \text{ ohm}^{-1}\text{cm}^2/\text{eq}$
- c- $123 \text{ ohm}^{-1}\text{cm}^2/\text{eq}$
- d- $786 \text{ ohm}^{-1}\text{cm}^2/\text{eq}$

68) A field of electro-analytical chemistry in which the electrodes are used to measure the potential that provide chemical information.

- a- Conductometry
- b- Potentiometry
- c- Calorimetry
- d- Florimetry

69) If the current with intensity 40 mA is passed through NiCl₂ solution for 2 minute and 15 second, the weight of Ni deposited will be

- a- $2.3 \times 10^{-3} \text{ g}$

- b- $\frac{1.6 \times 10^{-4}}{\text{g}}$
- c- $9.2 \times 10^{-5} \text{ g}$
- d- $4.4 \times 10^{-6} \text{ g}$

70) The instrumental analysis method that depends on the measurement of the fluorescence.

- a- Fluorimetry
- b- Phosphorimetry
- c- Calorimetry
- d- Conductometry

Analytical Chemistry Laboratory

71) The chemical technique that involves the distribution of a solute between two immiscible liquid phases.

- a- Solvent Extraction
- b- Ionic Exchange Chromatography
- c- Column Resolution
- d- Chromatogram

- 72) An analytical method that is widely used for the separation, identification and determination the chemical components in complexes mixtures.
- a- Solvent Extraction
 - b- Ionic Exchange Chromatography
 - c- Column Resolution
 - d- Chromatography
- 73) The required time for an unretained species to pass through the column.
- a- Retention time
 - b- Dead time
 - c- periodic time
 - d- Critical time
- 74) In the chromatography, the selectivity factor α is always-----
- a- Greater than unity
 - b- Equals to unity
 - c- Smaller than unity
 - d- Smaller than zero
- 75) The resolution for a given stationary phase can be improved by lengthening the column.
- a- Because increasing the length of column increases the number of plates
 - b- Because increasing the length of column decreases the number of plates
 - c- Because decreasing the length of column increases the number of plates
 - d- Because increasing the length of column increases the selectivity factor of the chromatographic technique
- 76) If 1 g of Calcium chloride (CaCl_2) dissolved in 100 mL distilled water (H_2O) and if you know that the distribution ratio (D) of this solute between water and solvent is 10, the percent extracted in the case of three time extractions with 30 mL of solvent is
- a- 58.4 %
 - b- 98.4 %
 - c- 38.4 %
 - d- 48.4 %
- 77) In the ion exchange chromatography, isoelectric point is
- a- The pH value at which the net charge on the molecule is + 1.
 - b- The pH value at which the net charge on the molecule is zero.
 - c- The pH value at which the net charge on the molecule is 5.
 - d- The pH value at which the net charge on the molecule is -1.
- 78) The principle of separation in High-Performance Liquid Chromatography (HPLC) is
- a- Adsorption
 - b- Desorption
 - c- Absorption
 - d- None of them
- 79) In the chromatographic column, the ideal separations can be obtained, when the retention factors for the solutes in a mixture lie in the range between
- a- 20 and 40

- b- 2 and 10
- c- 50 and 100
- d- 200 and 1000

80) The apparatus used for solvent extraction is the

- a- Separatory funnel
- b- Volumetric flask
- c- Conical flask
- d- Water condenser

اختبار جاهزية

General Chemistry

Periodic table trend

Q1: Which of the following ions has 123.38 neutrons?

- a) Ge^{4+}
- b) Ga^{3+}
- c) Tl^{3+}
- d) B^{3+}

Q2. Which of the following atomic symbols represents an isotope of ${}_{59}\text{Co}$?

- a) ${}_{64}\text{Zn}$
- b) ${}_{63}\text{Cu}$
- c) ${}_{60}\text{Ni}$
- d) ${}_{60}\text{Co}$

Q3. Which of the following atomic symbols represents an isotope of ${}^{94}\text{Mo}$?

- a) ${}_{93}\text{Nb}$
- b) ${}_{95}\text{Tc}$
- c) ${}_{94}\text{Tc}$
- d) ${}_{95}\text{Mo}$

Bonding

Q4. What type of intramolecular and intermolecular forces are present in N_2 ?

- a) Covalent bonding, hydrogen bonding
- b) Covalent bonding, dispersion forces
- c) Metallic bonding, dipole-dipole forces
- d) Ionic bonding, ionic forces

Q5. What type of intramolecular and intermolecular forces are present in H_2O ?

- a) Covalent bonding, hydrogen bonding
- b) Covalent bonding, dispersion forces
- c) Metallic bonding, dipole-dipole forces
- d) Ionic bonding, ionic forces

Q6. Hydrogen bonding is available among:

- a) CH_4 molecules
- b) PH_3 molecules
- c) HF molecules
- d) Br_2 molecules

Q7. In which pair do both compounds exhibit predominantly ionic bonding?

- a) PCl_5 and HF
- b) KI and H_2O
- c) NaNO_3 and CO_2
- d) RbCl and CaO

Q8. Which one of the following bonds is the least polar?

a) As-H

b) H-Br

c) As-O

d) Br-O

Q9. Arrange the following species in order of increasing size.

Na⁺, P, S²⁻, and Al³⁺

a) $\text{Al}^{3+} < \text{P} < \text{Na}^{+} < \text{S}^{2-}$

b) $\text{S}^{2-} < \text{Na}^{+} < \text{P} < \text{Al}^{3+}$

c) $\text{Al}^{3+} < \text{Na}^{+} < \text{P} < \text{S}^{2-}$

d) $\text{P} < \text{S}^{2-} < \text{Al}^{3+} < \text{Na}^{+}$

Q10. Arrange the following species in order of decreasing size **Ar, Se, S**

a) $\text{Ar} < \text{S} < \text{Se}$

b) $\text{Ar} > \text{S} > \text{Se}$

c) $\text{Se} > \text{S} > \text{Ar}$

d) $\text{S} > \text{Se} > \text{Ar}$

Q11. Arrange Mg^{2+} , Ca^{2+} and Ca in order of decreasing size?

a) $\text{Ca} > \text{Ca}^{2+} > \text{Mg}^{2+}$

b) $\text{Mg}^{2+} > \text{Ca} > \text{Ca}^{2+}$

c) $\text{Ca} < \text{Ca}^{2+} < \text{Mg}^{2+}$

d) $\text{Ca} > \text{Ca}^{2+} < \text{Mg}^{2+}$

Q12. Arrange the ions K^{+} , Cl^{-} , Ca^{2+} and S^{2-} in order of decreasing size

a) $\text{S}^{2-} > \text{Cl}^{-} > \text{K}^{+} > \text{Ca}^{2+}$

b) $\text{S}^{2-} < \text{Cl}^{-} < \text{K}^{+} < \text{Ca}^{2+}$

c) $\text{S}^{2-} > \text{K}^{+} > \text{Ca}^{2+} > \text{Cl}^{-}$

d) $\text{K}^{+} < \text{S}^{2-} < \text{Cl}^{-} < \text{Ca}^{2+}$

Arrange the following elements according to their electron affinity; (C, N, O).

A. $\text{O} > \text{N} > \text{C}$

B. $\text{C} > \text{N} > \text{O}$

C. $\text{N} > \text{O} > \text{C}$

D. $\text{O} > \text{C} > \text{N}$

Arrange the following elements according to their ionization energy; (Be, Mg, Ca).

A. $\text{Ca} < \text{Be} < \text{Mg}$

B. $\text{Ca} < \text{Mg} < \text{Be}$

C. $\text{Mg} < \text{Be} < \text{Ca}$

D. $\text{Be} < \text{Mg} < \text{Ca}$

Electron configuration &

Q13. Which of the following represents the electron configuration for a manganese cation (Mn^{2+})?

- a) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$
- b) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3$
- c) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$
- d) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$

Q14. Atoms of an element X have the ground-state electron configuration $1s^2 2s^2 2p^6 3s^2 3p^4$. What type of ion is X most likely to form?

- a) X^{2-}
- b) X^{6-}
- c) X^+
- d) X^{4+}

Q15. The angular quantum number (l) is associated with sublevels(subshells). When l equals one ($l=1$), the subshell orbital is:

- a) s and it has one orbital
- b) p and it has three orbitals
- c) d and it has five orbitals
- d) f and it has seven orbitals

Q 16. Which one can conduct electricity upon dissolution in water?

- a) PH_3
- b) CH_4
- c) F_2
- d) KClO_4

Q 17. Atom X lost 3 electrons from its valence shell to form:

- a) Isotope
- b) Isoelectronic
- c) Ion
- d) Allotrope

Naming

Q 19. The name of $\text{Al}_2(\text{SO}_4)_3$ is:

- a) Aluminium Carbonate
- b) Aluminium Sulfate
- c) Aluminium phosphate
- d) Aluminium phosphite

Q 20. What is the correct name of Fe_2O_3

- a) Iron (II) Oxide

- b) Iron (III) Oxide
- c) Iron dioxide
- d) Iron monoxide

Q21. What is the correct name of NaNO_3

- a) Sodium phosphite
- b) Sodium Nitrate
- c) Sodium Nitrite
- d) Sodium phosphate

Q 22. What is the correct name of SF_6

- a) Sulfur pentafluoride
- b) Sulfur hexafluoride
- c) Sulfur hexachloride
- d) Sulfur fluoride

Q 23. What is the correct name of CdS

- a) Calcium chloride
- b) Cesium fluoride
- c) Cadmium sulfide
- d) Calcium iodide

Acid & Base

Q 24. Which of the following is a strong base in an aqueous solution?

- a) H_3PO_4
- b) HF
- c) $\text{Ba}(\text{OH})_2$
- d) NH_3

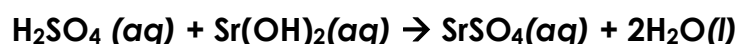
Q 25. Which one is an acid salt?

- a) NaNO_3
- b) NaClO_4
- c) KHCO_3
- d) KF

Q 26. Which of the following ions is most likely to form an insoluble sulfate?

- a) K^+
- b) Sr^{2+}
- c) Li^+
- d) NH_4^+

Q27. Which of the following best describes this reaction?



- a) Combination reaction
- b) Precipitation reaction
- c) Neutralization reaction

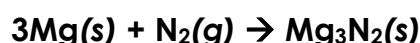
d) Combustion reaction

Oxidation number & Redox reactions

Q28. What is the oxidation number of **P** in **H₄P₂O₇**?

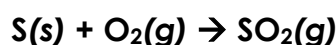
- a) +4
- b) +5
- c) +6
- d) +7

Q29. What is the reduction half-reaction for the reaction of magnesium with nitrogen?



- a) $\text{Mg} \rightarrow \text{Mg}^{2+} + 2\text{e}^-$
- b) $\text{Mg} + 2\text{e}^- \rightarrow \text{Mg}^{2+}$
- c) $\text{N}_2 + 6\text{e}^- \rightarrow 2\text{N}^{3-}$
- d) $\text{N}_2 \rightarrow 2\text{N}^{3-} + 6\text{e}^-$

Q30. What species is the oxidizing agent in the following reaction?

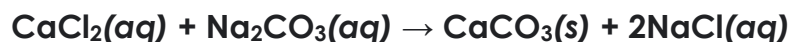


- a) O_2
- b) S
- c) S^{4+}
- d) O^{2-}

Q31. Which of the following statements concerning a catalyst is correct?

- a) A catalyst does not affect the activation energy of a reaction
- b) A catalyst is not used in the reaction
- c) A catalyst does not react with the reactants
- d) A catalyst decreases the rate of reaction

Q32. How can the rate for the reaction below be increased?



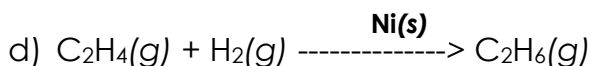
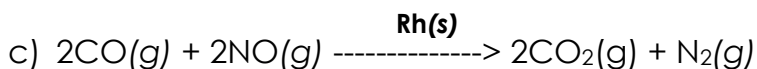
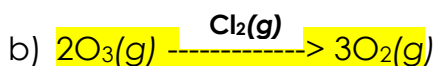
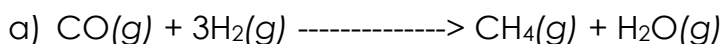
- a) Put it in an ice bath
- b) Adding CaCO_3
- c) Adding CaCl_2
- d) Increasing the pressure

Q33. The rate of chemical reactions increases as the pressure increases because:

- a) Does not affect the rate of reaction
- b) The space between gas particles enlarged
- c) The frequency of collision increases
- d) Decrease the activation energy of the reaction

Q34. Which of the following reactions is **NOT** an example of heterogeneous catalysis?

Co(s)



Q35. How many moles of hexachlorobenzene, C_6Cl_6 , are in 6.44 g of C_6Cl_6 ?

- a) 0.039 mol
- b) 0.075 mol
- c) 0.023 mol
- d) 1.52 mol

Q36. How many molecules are there in 104 g of pentylene glycol, $\text{HO(CH}_2)_5\text{OH}$?

- a) 7.54×10^{-24} molecules
- b) 5.47×10^{20} molecules
- c) 6.02×10^{23} molecules
- d) 6.02×10^{-23} molecules

Q37. What is the percentage by mass of Nitrogen in $\text{K}_3\text{Fe(CN)}_6$?

- a) 73.1%
- b) 25.53%
- c) 69.6%
- d) 28.86%

Q38. A compound is composed of only C and Cl. It contains 18.42 % C and 81.58% Cl by mass and has a molar mass of 260.76 g/mol. What is its molecular formula?

- a) CCl
- b) C_4Cl_6
- c) CCl_2
- d) C_2Cl_3

Question 39:

According to the following reaction, how many moles of aluminium sulfate ($\text{Al}_2(\text{SO}_4)_3$) will be produced if 23.76 g of Al is reacted with H_2SO_4 ?



- a) 0.44 mol
- b) 0.31 mol
- c) 0.68 mol
- d) 0.08 mol

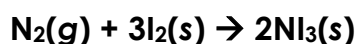
Question 40:

A sample of nitrogen gas at 20 °C and 760 mmHg has a volume of 6.06 L. What is the volume at -9 °C and 1 atm pressure? (1 atm=760 mmHg)

- a) 7.34 L
- b) 5.46 L
- c) 22.5 L
- d) 15.2 L

Question 41:

0.673 L of nitrogen gas, measured at 560.9 mmHg and 26.5 °C, reacts with excess iodine according to the following reaction. Calculate the mass of nitrogen in the reaction.



- a) 13.3 g
- b) 0.566 g
- c) 0.764 g
- d) 0.987 g

Question 42:

A balloon is filled with 140 grams of nitrogen gas (N₂) at STP. What is the volume in litres of this balloon?

- a) 202.4 L
- b) 211.1 L
- c) 140.9 L
- d) 112.0 L

Question 43:

Calculate the density of a balloon filled with acetylene gas (C₂H₂) at STP.

- a) 1.16 g/L
- b) 2.15 g/L
- c) 0.91 g/L
- d) 0.67 g/L

Question 44:

How many moles of LiOH are present in 67.2 mL of 0.487 M LiOH?

- a) 1.68 mol
- b) 0.58 mol
- c) 3.3 mol
- d) 0.033 mol

Hazard & Safety Awareness in Chemistry Labs

Question 1:

What does the flam pictogram mean?

- A. Oxidizing substance
- B. Flammable substance
- C. Gas under pressure
- D. Acute toxicity



Question 2:

What does the skull & crossbones indicate?

- A. Oxidizing substance
- B. Flammable substance
- C. Gas under pressure
- D. Acute toxicity



Question 3:

What does the pictogram mean?

- C. Exploding bomb
- D. Oxidizing substance
- C. Gas under pressure
- D. Flammable



Question 4:

What does the pictogram indicate?

- A. Oxidizing substance
- B. Flammable substance
- C. Gas under pressure
- D. Corrosive substance



Question 5:

What does the pictogram mean?

- A. Explosive substance
- B. Oxidizing substance
- C. Gas under pressure
- D. Flammable



Question 6:

What does the pictogram indicate?

- C. Health hazard
- D. Environmental hazard
- C. Gas under pressure
- D. Oxidizing substance



Question 7:

What does the pictogram mean?

- A. Explosive substance
- B. Oxidizer
- C. Gas under pressure
- D. Flammable



Question 8:

What does the pictogram indicate?

- C. Health hazard
- D. Environmental hazard
- C. Gas under pressure
- D. Oxidizing substance



NFPA Diamond (National Fire Protection Association)

Question 9:

What is hazard of sodium hypochlorite according to the NFPA diamond that mentions in the sodium hypochlorite bottle?



- E. Health hazards and oxidizer
- F. Fire hazard and radioactive compound
- G. Reactive compound
- H. Radiation hazard

Safe Storage of Chemicals

Question 12:

How should chemicals be properly stored in a laboratory?

- a) In alphabetical order only
- b) According to chemical compatibility and hazard class
- c) Randomly on open shelves
- d) By container size

Question 13:

Why should flammable liquids never be poured down the drain?

- a) Because they can pollute water only
- b) Because they can cause explosion or fire

- c) Because they evaporate quickly
- d) Because they are expensive

Question 14:

Where should bulk chemical stocks be kept?

- a) Inside the laboratory room
- b) On top of lab benches
- c) In a separate, designated chemical storage area
- d) Next to heat sources

Question 15:

Where should flammable liquids be stored?

- a) In the refrigerator
- b) In wooden cabinets
- c) In flammable storage cabinets
- d) On open shelves

Question 16:

Why should acids be separated from bases?

- A. To increase their reactivity
- B. To avoid dangerous reactions
- C. To reduce storage space
- D. To prevent evaporation

Question 17:

Where should flammable solvents be stored?

- A. On open shelves
- B. In a refrigerator
- C. In the flammable storage cabinet
- D. Next to acids

Safe Waste Disposal

Question 18:

What is correct disposal method for diluted acid?

- E. Pour directly into the sink
- F. Neutralize first, then dispose properly
- G. Mix with base and discard
- H. Dilute with alcohol

Question 19:

Can solvents be mixed with general waste?

- E. Yes, if in small amounts
- F. Yes, after dilution
- G. **No**
- H. Only if labeled

Safety Equipment

Question 20:

Which of the following types of personal protective equipment are frequently used in laboratory environments?

- A. Safety glasses.
- B. Lab coats and gloves
- C. Face shields.
- D. **All of the above**

Question 21:

Which equipment protects the eyes?

- A. Face mask
- B. **Safety goggles**
- C. Laboratory coat
- D. Face shield

Question 22:

What is the main function of a Fume Hood?

- A. Store chemicals
- B. Measure air pressure
- C. **Vent harmful vapors**
- D. Protect from fire

Question 23:

What is name of the following equipment?

- E. Fire extinguisher
- F. Eye wash
- G. Safety shower



H. Safety blanket

Question 24:

What is name of the following equipment?

- E. Fire extinguisher
- F. Eye wash
- G. Safety shower
- H. Safety blanket



Question 25:

What is name of the following equipment?

- E. Fire extinguisher
- F. Eye wash
- G. Safety shower
- H. Safety blanket



Good habit in the laboratory

Question 26:

What must you do before entering the laboratory?

- A. Bring all chemicals needed
- B. Read the procedure and complete the pre-lab assignment
- C. Wait for the instructor's permission only
- D. Wear gloves and goggles

Question 27:

What should be the last thing you do before leaving the lab?

- A. Turn off the lights
- B. Return all glassware
- C. Wash your hands
- D. Record your results

Question 28:

What is the correct procedure when combining acid and water?

- A. Add water to acid slowly
- B. Add acid to water slowly, cool and swirl
- C. Mix both rapidly
- D. Add base first, then acid

Question 29:

Which of the following will not be permitted in the laboratory?

- A) Long, loose hair
- B) Dangling jewelry
- C) Baggy clothing and sandals
- D) None of the above will be permitted in the laboratory.

Question 30:

Which of the follow should not be a part of the check-out at the end of the lab?

- A) Turn off the water.
- B) Turn off the gas valves.
- C) Rip off your goggles and stuff them into the cabinet.
- D) Clean, and neatly arrange all equipment

Question 31:

Once your heating device (Bunsen burner or hot plate) is on, you should

- A) Go get a friend to make sure you turned it on correctly.
- B) Go get your chemical supplies for the lab.
- C) Clear off the lab top.
- D) Never leave it unattended.

Question 32:

If your lab partner and you do not understand a direction or part of a procedure,

- A) Experiment so you do not look foolish.
- B) Skip that part of the procedure.
- C) Ask the instructor before proceeding.
- D) Copy another lab group's data.

Emergency Incidents

Question 33:

In an emergency, which of the following actions might you need to take?

- E. Dial 911.
- F. Evacuate premises.
- G. Activate fire alarms.
- H. All of the above.

Question34:

If you come into contact with a hazardous chemical, you should flush the affected area with water for at least how many minutes?

- E. 5 minutes.
- F. 10 minutes.
- G. 15 minutes.
- H. 2 minutes

Question 35:

If a flammable substance is spilled, what should you do first?

- a) Wipe it immediately with paper towels
- b) Add water to dilute it
- c) Turn off or remove all ignition sources in the area
- d) Continue working carefully

Question 36:

What should you do in case of a fire drill during lab work?

- a) Leave immediately without touching anything
- b) Close all chemical containers, gas valves, and turn off electrical equipment before exiting
- c) Stay inside until the alarm stops
- d) Continue your experiment carefully

Question 37:

What should you do if glassware breaks in the lab?

- a) Pick it up with your hands
- b) Leave it for the janitor

- c) Use the broken-glass dustpan to collect it and dispose of it in the designated container
- d) Sweep it under the bench

Question 38:

What are the correct steps if a caustic chemical spills on the skin?

- a) Wipe it off with a towel immediately
- b) Rinse with water for at least 15 minutes and remove contaminated clothing
- c) Apply alcohol or neutralizer directly
- d) Cover the area with a bandage

Question 39:

What should you do if acid enters the eye?

- a) Blink rapidly to remove it
- b) Use eyewash for 20 minutes and seek medical help
- c) Rinse briefly with tap water
- d) Cover the eye with a cloth

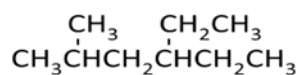
Question 40:

What should you do if toxic gas leaks in the lab?

- a) Stay inside and open windows
- b) Evacuate the area immediately and activate ventilation
- c) Spray air freshener
- d) Hold your breath and wait

2.1. Principles of organic chemistry

1- IUPAC name of the following compound is a/an



- a) 2-methyl-4-ethylhexane

- b) 3-ethyl-5-methylhexane
- c) 5-methyl-3-ethylhexane
- d) 3-ethyl-5-methylhexene

2- Example of functional structural isomer is a/an _____

- a) $\text{CH}_3\text{CH}_2\text{CHO}$ & CH_3COCH_3
- b) CH_3COOH & CH_3COOBr
- c) $\text{CH}_3\text{CHCHCH}_3$ & $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$
- d) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$ & $(\text{CH}_3)_2\text{CHCH}_3$

3- Reduction of Aldehyde is a/an _____

- a) Primary amid
- b) Secondary amine
- c) Primary alcohol
- d) Carboxylic acid

4- Example of symmetrical ketone is a/an _____

- a) Ethanol
- b) Acetone
- c) Acetylene
- d) Acetate

5- The type of hybrid orbital of alkanol is a/an _____ orbital

- a) sp
- b) sp^2
- c) sp^3
- d) s & p

6- Example of aromatic compound is a/ an _____

- a) Toluene
- b) Cyclopentane
- c) Hexane
- d) Acetic anhydride

7- ortho-dichlorobenzene is also called a/an _____

- a) 1,3-dichlorobenzene
- b) 1,4-dichlorobenzene
- c) 1,2-dichlorobenzene
- d) 1,2-dichlorophenol

8- _____ makes benzene ring more electron-rich

- a) Nitro group
- b) Amino group
- c) Carbonyl group
- d) Amide group

9- Benzaldehyde orient E^+ to _____ position

- a) Ortho & para
- b) Para & meta
- c) Meta & ortho
- d) Ortho & meta

10- Toluene is a _____

- a) C_6H_5OH
- b) $C_6H_5CH_3$
- c) $C_6H_5CH_2CH_3$
- d) $C_6H_5COCH_3$

2.2. Organo-physical chemistry

1- The reaction order of $A \rightarrow \text{Products}$ is a _____

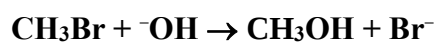
- a) zero
- b) First
- c) Second
- d) Tertiary

2- The Type of reaction mechanism of the following reaction is a/an _____



- a) E2
- b) SN1
- c) E1
- d) SN2

3- The rate of the following reaction is a _____



- a) K [Nucleophile]
- b) K [Alkyl halide]
- c) $K [\text{Alkyl halide}]^2 [\text{Nucleophile}]$

d) K [Alkyl halide] [Nucleophile]

4- The products of SN1 is a _____

- a) Racemic mixture
- b) Wolden inversion
- c) Willamson Product
- d) Wolden mixture

5- The highest (λ_{max}) in UV-Visible spectrum is a/an _____

- a) Ethene
- b) But-1,3-diene
- c) Hex-1,3,5-triene
- d) Ethane

6- Example of solvent use in NMR is _____

- a) CH₃OH
- b) CHCl₃
- c) H₂O
- d) CCl₄

7- _____ NMR used to determine the type and number of H atom in molecule

- a) Hydrogen-1
- b) Hydrogen-2
- c) Carbon-12
- d) Carbon-13

8- $n \rightarrow \sigma^*$ transition can be in _____ compounds

- a) Cyclopentane
- b) Propanol
- c) Propane
- d) Propene

2.3. Bioorganic chemistry

1- Furan is a _____

- a) Five-membered aromatic with one heteroatom which is Oxygen
- b) Five-membered Saturated with one heteroatom which is Oxygen
- c) Five-membered aromatic with one heteroatom which is Nitrogen

- d) Six-membered aromatic with one heteroatom which is Oxygen

2- The order of aromaticity from high to low is a _____

- a) Benzene > Thiophene > Pyrrole > Furan
- b) Furan > Thiophene > Pyrrole > Benzene
- c) Pyrrole > Benzene > Thiophene > Furan
- d) Benzene > Pyrrole > Furan > Thiophene

3- _____ have not basic property

- a) Ethyl amine
- b) Pyrrole
- c) Dimethyl amine
- d) Pyridine

4- Azacyclobentane is _____ Azacyclopropane

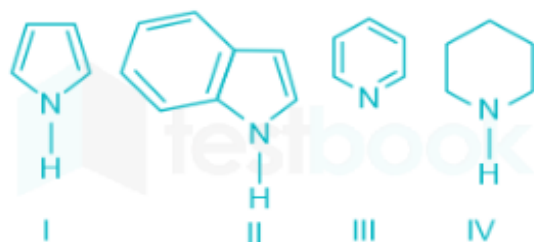
- a) less reactive than
- b) a same reactive as
- c) more reactive than
- d) a same stable as

5- Diazines have a _____ isomer

- a) two chain structural
- b) three functional structural
- c) three positional structural
- d) two optical stereo

Heterocyclic Compounds Question 1:

The correct order of basicity of the following compounds is



1. IV>III>II>I

2. III>IV>II>I

Heterocyclic Compounds Question 1 Detailed Solution

Concept:-

Lewis concept of acids and bases:

- **Species** that can accept a pair of electrons is a **lewis acid**.
- Lewis acid has a generally positive charge.
- Lewis acids have an **empty orbital**.
- **Electron pairs** from donor atoms are accepted in these orbitals.
- **Species** that can donate a pair of electrons are called **lewis bases**.
- It is the **ability** of a **compound** to **donate** its pair of **electrons**.

Bronsted Lowry's theory of acids and bases:

According to this theory,

- A **base** is a substance that is **capable of accepting a proton** from another compound in a reaction.
- The **new protonated compound** thus formed is called **its conjugate acid**.
- An **acid** is a substance that is **capable of donating a proton** in a **solution** or to

According to this theory,

- A **base** is a substance that is **capable of accepting a proton** from another compound in a reaction.
- The **new protonated compound** thus formed is called **its conjugate acid**.
- An **acid** is a substance that is **capable of donating a proton** in a **solution** or to other compounds.
- Molecules, where the electron pair is **delocalized** by **resonance**, will be **less basic**.

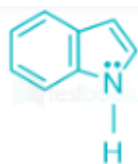
Explanation:-

- **Basicity is proportional to the Ease of donation of lone pair of electron**
- Basicity is directly **proportional to the ease of donation of lone pair of electrons** as

$$\text{Basicity} \propto \frac{1}{\% \text{ of } s\text{-character of } N}$$

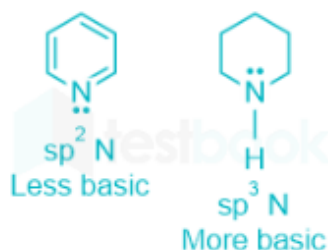
$$\propto \frac{1}{\text{Electronegativity of } N}$$

- **Electronegativity** is a chemical property that describes the tendency of an atom to attract a shared pair of electrons or electron density toward itself.
- An **atom's electronegativity** is affected by both its atomic number and the



- Similarly for the above compound, **the lone pair of electrons of the N atom is involved in the aromaticity of the ring and hence, compound II is also less basic.**
- In compound II, **the lone pair of electrons of the N atom is involved in delocalization with the two aromatic ring in compare to compound I, where it is involved in delocalization with only one ring.**
- Hence, compound II is the least basic.

III and IV.

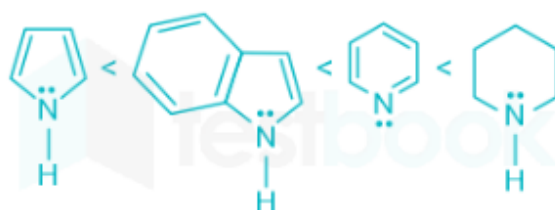


Conclusion:-

- Hence, option 3 is the correct answer.

Additional Information

Indole is **more basic** than pyrrole because in N-protonated indolium cation aromaticity of benzene is retained while aromaticity of pyrrolium ion is lost after the protonation of indole & pyrrole respectively. Among **pyridine & piperidine**; piperidine is more basic (localized lone pair on sp^3 hybridized atom is more basic than the localized lone pair on sp^2 hybridized atom. Order of the basicity:-

**Heterocyclic Compounds Question 2:**

Which of the following statement is not correct regarding five membered heterocyclic compounds?

- Furan is least aromatic in nature among furan, thiophene and pyrrole.
- Thiophene can have more number of canonical structures using 3d-orbitals.
- Pyrrole has maximum double bond character among furan, thiophene and pyrrole.
- Furan, thiophene and pyrrole can be synthesized using Paal-Knorr synthesis.

Answer (Detailed Solution Below)

Option 3 : Pyrrole has maximum double bond character among furan, thiophene and pyrrole.

Heterocyclic Compounds Question 2 Detailed Solution

Concept:

Aromaticity and Resonance in Five-Membered Heterocyclic Compounds

- Five-membered heterocyclic compounds such as **furan, thiophene, and pyrrole** exhibit aromaticity due to delocalized π -electrons.
- **Furan** is the least aromatic because oxygen is highly electronegative and withdraws electron density, reducing resonance stabilization.
- **Thiophene** is more aromatic than furan due to sulfur's lower electronegativity and ability to participate in resonance with 3d-orbitals.
- **Pyrrole** is highly aromatic due to strong delocalization of the lone pair on nitrogen into the π -system.
- The **Paal-Knorr synthesis** is a method for synthesizing furan, thiophene, and pyrrole from 1,4-diketone compounds.

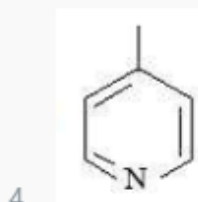
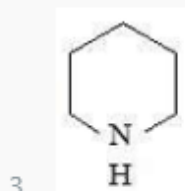
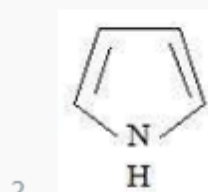
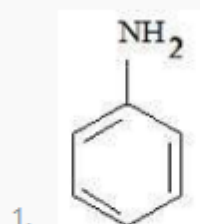
pyrrole from 1,4-diketone compounds.

Explanation:

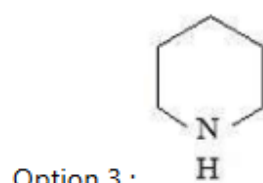
- **Statement 1: "Furan is least aromatic in nature among furan, thiophene, and pyrrole."**
 - Correct, because furan's oxygen withdraws electron density, reducing its aromatic stability.
- **Statement 2: "Thiophene can have more number of canonical structures using 3d-orbitals."**
 - Correct, because sulfur can utilize its 3d-orbitals, allowing additional resonance structures.
- **Statement 3: "Pyrrole has maximum double bond character among furan, thiophene, and pyrrole."**
 - Incorrect, because in pyrrole, the nitrogen lone pair is highly delocalized into the ring.
 - This reduces the double bond character compared to thiophene, which has stronger resonance stabilization.
- **Statement 4: "Furan, thiophene, and pyrrole can be synthesized using Paal-Knorr synthesis."**
 - Correct, as the Paal-Knorr synthesis efficiently produces these heterocycles from 1,4-diketones.

Therefore, the incorrect statement is "Pyrrole has maximum double bond

In nonpolar aprotic solvent which of the following will act as strongest base?



Answer ([Detailed Solution Below](#))



Heterocyclic Compounds Question 3 Detailed Solution

Concept:

Basicity in Nonpolar Aprotic Solvent

- In a nonpolar aprotic solvent, the strength of a base is determined by the availability of the lone pair of electrons on the nitrogen atom. The less the nitrogen

Basicity in Nonpolar Aprotic Solvent

- In a nonpolar aprotic solvent, the strength of a base is determined by the availability of the lone pair of electrons on the nitrogen atom. The less the nitrogen is involved in resonance or electron-withdrawing effects, the stronger the base is, as the lone pair is more readily available for protonation.
- In nonpolar aprotic solvents, the solvent does not solvate anions well, allowing the basicity of the compound to be more influenced by the structure of the base itself.
- The compounds to be compared are:
 - In option 1 (aniline, $C_6H_5NH_2$), the nitrogen's lone pair is somewhat involved in resonance with the aromatic ring, reducing its availability for protonation.
 - In option 2 (pyrrole, C_4H_4N), the nitrogen's lone pair is involved in the aromatic system, making it less available for protonation, thus a weaker base.
 - In option 3 (pyrrolidine, C_4H_9N), the nitrogen is not involved in resonance, and its lone pair is readily available, making it the strongest base among the options.
 - In option 4 (pyridine, C_5H_5N), the nitrogen's lone pair is not involved in an aromatic system, although less basic than non-aromatic amines due to the sp^2 hybridization of the nitrogen atom.

Hence, the correct answer is Pyrrolidine (option 3).

Heterocyclic Compounds Question 5:

Identify the incorrect statement regarding pyridine from the following

1. Pyridine is less basic than pyrrole
2. All carbon-carbon bond lengths in pyridine are of equal length
3. Pyridine has resonance energy of $125.5 \text{ kJ mol}^{-1}$
4. All atoms in pyridine are sp^2 -hybridized

Answer (Detailed Solution Below)

Option 1 : Pyridine is less basic than pyrrole

Heterocyclic Compounds Question 5 Detailed Solution

Concept:

Pyridine and its Properties

- Pyridine is an aromatic compound similar to benzene but with one of its carbons replaced by a nitrogen atom, making it a basic heterocyclic compound.

Concept:

Pyridine and its Properties

- Pyridine is an aromatic compound similar to benzene but with one of its carbons replaced by a nitrogen atom, making it a basic heterocyclic compound.
- It is less basic than pyrrole because the nitrogen atom in pyridine has a lone pair of electrons that are not involved in the aromaticity of the ring, making them available for protonation, but the nitrogen in pyrrole is part of the ring's aromatic system and thus less available for protonation.
- The carbon-carbon bonds in pyridine are of equal length, and the atoms in pyridine are sp^2 hybridized, meaning the carbon atoms in the ring form bonds with 120° angles between them.
- Pyridine has a 117 kJ/mol (close to 125.5) resonance energy. The value can vary depending on the source.

Explanation:

- The statement "Pyridine is less basic than pyrrole" is incorrect because pyridine is generally more basic than pyrrole due to the availability of the nitrogen's lone pair for protonation, unlike pyrrole where the lone pair is involved in the aromatic system and is less available for protonation.
- The other statements are correct:
 - Carbon-carbon bonds in pyridine are of equal length due to resonance in the

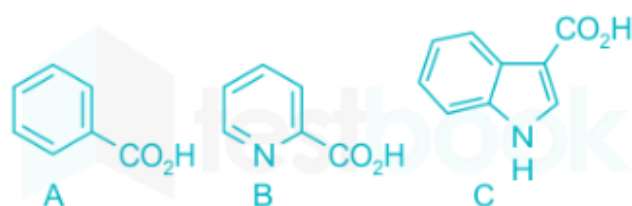
- The carbon-carbon bonds in pyridine are of equal length, and the atoms in pyridine are sp^2 hybridized, meaning the carbon atoms in the ring form bonds with 120° angles between them.
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Explanation:

- The statement "Pyridine is less basic than pyrrole" is incorrect because pyridine is generally more basic than pyrrole due to the availability of the nitrogen's lone pair for protonation, unlike pyrrole where the lone pair is involved in the aromatic system and is less available for protonation.
- The other statements are correct:
 - Carbon-carbon bonds in pyridine are of equal length due to resonance in the ring.
 - Pyridine's atoms are sp^2 hybridized, and the lone pair of electrons on nitrogen is in an sp^2 orbital.

Therefore, the incorrect statement is: Pyridine is less basic than pyrrole.

The following carboxylic acids undergo decarboxylation upon heating. The ease of decarboxylation is in the order



1. $B > A > C$

2. $C > B > A$

3. $A > C > B$

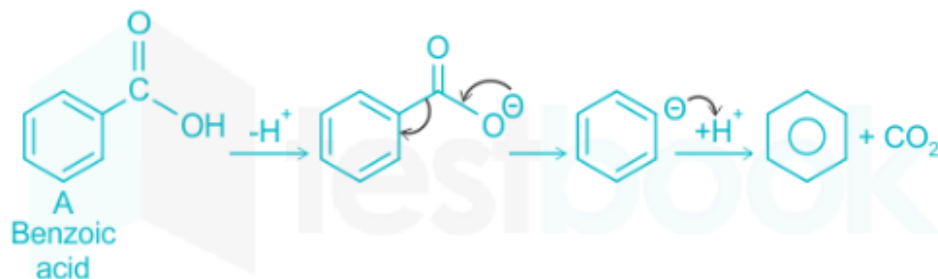
4. $C > A > B$

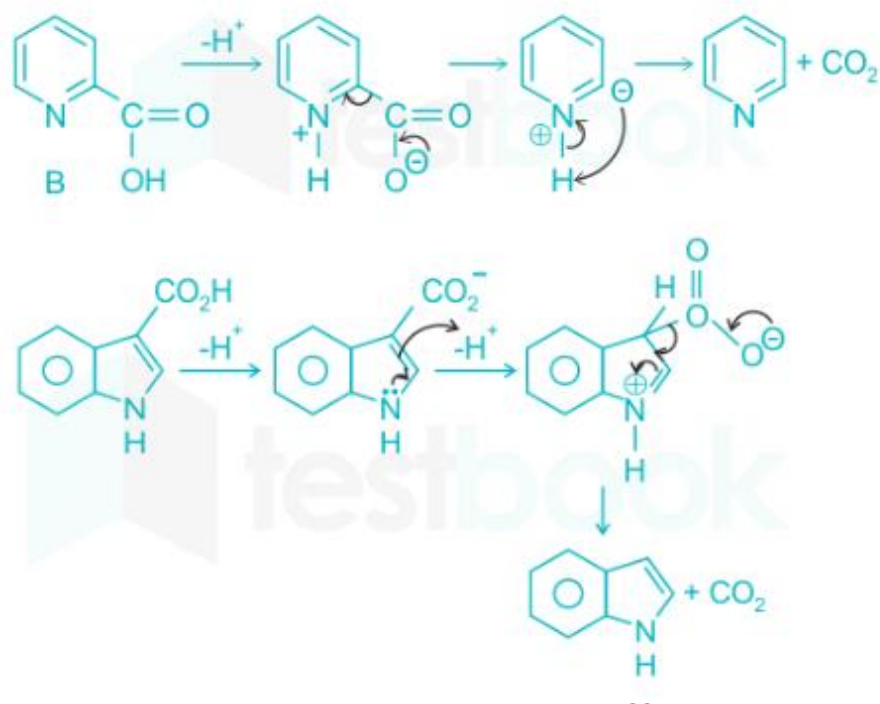
Concept:**Decarboxylation:**

- **Decarboxylation** is the process of **removal of a molecule of carbon dioxide from a compound**.
- The **rate of decarboxylation** may be different for different molecules depending upon the nature of the **substituent** present in the molecule.
- **The decarboxylation reaction is a kind of reverse Friedel craft reaction, in which a proton (provided by the carboxylic acid) itself acts as an electrophile.** The **protonation** may occur anywhere, but it leads to **decarboxylation** only if it occurs where there is a $-\text{CO}_2\text{H}$ group.

Explanation:**Explanation:**

- The **electrophilic aromatic substitution reaction works best for indole in 3-position**. The $-\text{CO}_2\text{H}$ group is present at the 3-position in indole.
- The **electrophilic aromatic substitution reaction works best for pyridine in the 3-position**. The $-\text{CO}_2\text{H}$ group is present at the 2-position in pyridine. This concludes **the decarboxylation reaction will be fast for indol than for pyridine**.
- The N atom present at the beta position facilitates the decarboxylation reaction.
- **Due to the absence of an N atom at the beta position, benzoic acid will undergo decarboxylation at the slowest rate.**
- The mechanism of the decarboxylation reaction is





Conclusion:

- Hence, **the ease of decarboxylation is in the order**

C > B > A.

Select the false statement

1. Pyrrole is more reactive than Furan
2. Some pyrimidines are found in nucleic acid
3. Pyridine is less basic than pyrrole
4. Electrophilic substitution in pyrrole occurs in 2 or 5 Positions

Answer (Detailed Solution Below)

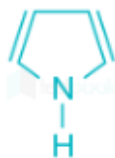
Option 3 : Pyridine is less basic than pyrrole

Heterocyclic Compounds Question 15 Detailed Solution

[Download Solution PDF](#)

Concept:

- **Pyrrole** is a **heterocyclic compound** and a **much weaker base** than secondary amines.
- It has a weak **acidic character** with pK_a value of 17.5.
- The structure of Pyrrole is:



- The **proton bound to the nitrogen atom** is **acidic in nature** and can be abstracted by strong bases such as sodium amide, ammonia, and n-butyl lithium in n-hexane.
- Pyrrole can react with **Grignard reagents**. Pyrrole is an **aromatic system** and undergoes **electrophilic substitution** reactions easily.
- Pyrrole **does not** undergo nucleophilic substitution reactions.

Explanation:

- **Pyrrole and furan** undergo electrophilic substitution reactions.
- They are more reactive towards electrophilic substitution reaction than benzene.
- Electrophiles majorly **attack the 2 positions** rather than the third position in these compounds.
- This occurs because when the electrophile attacks on the **2nd position**, the intermediate is **more resonance stabilized**.
- When the electrophile attacks on the 3rd position, only two resonating structures are possible.



- Hence, the false statement is: **Pyridine is less basic than pyrrole.**

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