

+ 2 CHEMISTRY


Volume - 1



Question Bank *

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+2 CHEMISTRY QUESTION PAPER ANALYSIS MARCH 2020

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**UNIT-1: METALLURGY****EVALUATE YOURSELF**

1. Write the equation for the extraction of silver by leaching with sodium cyanide and show that the leaching process is a redox reaction.
2. Magnesite (Magnesium carbonate) is calcined to obtain magnesia, which is used to make refractory bricks. Write the decomposition reaction.
3. Using Ellingham diagram (fig 1.4) indicate the lowest temperature at which ZnO can be reduced to Zinc metal by carbon. Write the overall reduction reaction at this temperature.
4. Metallic sodium is extracted by the electrolysis of brine (aq. NaCl). After electrolysis the electrolytic solution becomes basic in nature. Write the possible electrode reactions.

EVALUATION**Choose the Best Answer**

1. Bauxite has the composition
(a) Al_2O_3 (b) $\text{Al}_2\text{O}_3 \cdot n\text{H}_2\text{O}$ (c) $\text{Fe}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$ (d) None of these
2. Roasting of sulphide ore gives the gas (A). (A) is a colourless gas. Aqueous solution of (A) is acidic. The gas (A) is
(a) CO_2 (b) SO_3 (c) SO_2 (d) H_2S
3. Which one of the following reaction represents calcinations?
(a) $2\text{Zn} + \text{O}_2 \rightarrow 2\text{ZnO}$ (b) $2\text{ZnS} + 3\text{O}_2 \rightarrow 2\text{ZnO} + 2\text{SO}_2$
(c) $\text{MgCO}_3 \rightarrow \text{MgO} + \text{CO}_2$ (d) Both (a) and (c)
4. The metal oxide which cannot be reduced to metal by carbon is
(a) PbO (b) Al_2O_3 (c) ZnO (d) FeO



5. Which of the metal is extracted by Hall-Heroult process?
 (a) Al (b) Ni (c) Cu (d) Zn
6. Which of the following statements, about the advantage of roasting of sulphide ore before reduction is not true?
 (a) ΔG_f^0 of sulphide is greater than those for CS_2 and H_2S
 (b) ΔG_r^0 is negative for roasting of sulphide ore to oxide
 (c) Roasting of the sulphide to its oxide is thermodynamically feasible.
 (d) Carbon and hydrogen are suitable reducing agents for metal sulphides.
7. Match items in column - I with the items of column - II and assign the correct code.

Column-I		Column-II	
A	Cyanide process	(i)	Ultrapure Ge
B	Froth floatation process	(ii)	Dressing of ZnS
C	Electrolytic reduction	(iii)	Extraction of Al
D	Zone refining	(iv)	Extraction of Au
		(v)	Purification of Ni

	A	B	C	B
(a)	(i)	(ii)	(iii)	(iv)
(b)	(iii)	(iv)	(v)	(i)
(c)	(iv)	(ii)	(iii)	(i)
(d)	(ii)	(iii)	(i)	(v)

8. Wolframite ore is separated from tinstone by the process of
(PTA MQ, MAR 20)
 (a) Smelting (b) Calcination
 (c) Roasting (d) Electromagnetic separation
9. Which one of the following is not feasible?
 (a) $Zn_{(s)} + Cu^{2+}_{(aq)} \rightarrow Cu_{(s)} + Zn^{2+}_{(aq)}$



- (b) $\text{Cu}_{(s)} + \text{Zn}^{2+}_{(aq)} \rightarrow \text{Zn}_{(s)} + \text{Cu}^{2+}_{(aq)}$
- (c) $\text{Cu}_{(s)} + 2\text{Ag}^{+}_{(aq)} \rightarrow \text{Ag}_{(s)} + \text{Cu}^{2+}_{(aq)}$
- (d) $\text{Fe}_{(s)} + \text{Cu}^{2+}_{(aq)} \rightarrow \text{Cu}_{(s)} + \text{Fe}^{2+}_{(aq)}$
10. Electrochemical process is used to extract
(a) Iron (b) Lead (c) Sodium (d) silver
11. Flux is a substance which is used to convert
(a) Mineral into silicate
(b) Infusible impurities to soluble impurities
(c) Soluble impurities to infusible impurities (d) All of these
12. Which one the following ores is best concentrated by froth – floatation method?
(a) Magnetite (b) Hematite (c) Galena (d) Cassiterite
13. In the extraction of aluminium from alumina by electrolysis, cryolite is added to
(a) Lower the melting point of alumina
(b) Remove impurities from alumina
(c) Decrease the electrical conductivity
(d) Increases the rate of reduction
14. Zinc is obtained from ZnO by
(a) Carbon reduction (b) Reduction using silver
(c) Electrochemical process (d) Acid leaching
15. Cupellation is a process used for the refining of
(a) Silver (b) Lead (c) Copper (d) iron
16. Extraction of gold and silver involves leaching with cyanide ion. Silver is later recovered by **(NEET-2017)**
(a) Distillation (b) Zone refining
(c) Displacement with zinc (d) liquation
17. Considering Ellingham diagram, which of the following metals can be used to reduce alumina? **(NEET-2018)**
(a) Fe (b) Cu (c) Mg (d) Zn



18. The following set of reactions are used in refining Zirconium

$$\text{Zr (impure)} + 2\text{I}_2 \xrightarrow{523\text{K}} \text{ZrI}_4$$
This method is known as

$$\text{ZrI}_4 \xrightarrow{1800\text{K}} \text{Zr (pure)} + 2\text{I}_2$$
- (a) Liquation (b) van Arkel process
(c) zone refining (d) Mond's process
19. Which of the following is used for concentrating ore in metallurgy?
(a) Leaching (b) Roasting
(c) Froth floatation (d) Both (a) and (c)
20. This incorrect statement among the following is
(a) Nickel is refined by Mond's process
(b) Titanium is refined by Van Arkel's process
(c) Zinc blende is concentrated by froth floatation
(d) In the metallurgy of gold, the metal is leached with dilute sodium chloride solution
21. In the electrolytic refining of copper, which one of the following is used as anode?
(a) Pure copper (b) Impure copper
(c) Carbon rod (d) Platinum electrode
22. Which of the following plot gives Ellingham diagram?
(a) ΔS Vs T (b) ΔG^0 Vs T (c) ΔG^0 Vs $\frac{1}{T}$ (d) ΔG^0 Vs T^2
23. In the Ellingham diagram, for the formation of carbon monoxide
(a) $\left(\frac{\Delta S^0}{\Delta T}\right)$ is negative (b) $\left(\frac{\Delta G^0}{\Delta T}\right)$ is positive
(c) $\left(\frac{\Delta G^0}{\Delta T}\right)$ is negative



- (d) initially $\left(\frac{\Delta T}{\Delta G^0}\right)$ is positive, after 700°C , $\left(\frac{\Delta G^0}{\Delta T}\right)$ is negative
24. Which of the following reduction is not thermodynamically feasible?
- (a) $\text{Cr}_2\text{O}_3 + 2\text{Al} \longrightarrow \text{Al}_2\text{O}_3 + 2\text{Cr}$
- (b) $\text{Al}_2\text{O}_3 + 2\text{Cr} \longrightarrow \text{Cr}_2\text{O}_3 + 2\text{Al}$
- (c) $3\text{TiO}_2 + 4\text{Al} \longrightarrow 2\text{Al}_2\text{O}_3 + 3\text{Ti}$ (d) none of these
25. Which of the following is not true with respect to Ellingham diagram?
- (a) Free energy, changes follow a straight line. Deviation occurs when there is a phase change.
- (b) The graph for the formation of CO_2 is a straight line almost parallel to free energy axis.
- (c) Negative slope of CO shows that it becomes more stable with increase in temperature.
- (d) Positive slope of metal oxides shows that their stabilities decrease with increase in temperature.

ADDITIONAL QUESTIONS

26. The method of zone refining of metals is based on the principle of:
- (a) Greater mobility of the pure metal than that of impurity.
- (b) Higher melting point of the impurity than that of pure metal.
- (c) greater noble character of the solid metal than that of the impurity.
- (d) Greater solubility of the impurity in the molten state than in the solid.



27. Which of the following pairs of metal is purified by Van-Arkel method?
 (a) Ga and In (b) Ni and Fe (c) Ag and Au (d) Anglesite
28. Aluminium is extracted from alumina (Al_2O_3) by electrolysis of molten mixture of?
 (a) $Al_2O_3 + KF + Na_3AlF_6$ (b) $Al_2O_3 + HF + NaAlF_4$
 (c) $Al_2O_3 + Na_3AlF_6 + CaF_2$ (d) $Al_2O_3 + CaF_2 + NaAlF_4$
29. **Assertion (A)** : Pine Oil act as frothing agent in froth floatation.
Reason (R) : Sulphide Ores are concentrated by froth floatation method.
 (a) If A and R both are correct and R is correct explanation of A
 (b) If A and R both are correct and R is not correct explanation of A
 (c) Assertion if true but Reason is false
 (d) Assertion if false but Reason is true
30. Zinc can be coated on iron to produce galvanised iron but the reverse is not possible it is because?
 (a) Zn has lower melting point than iron
 (b) Zn has lower negative electrode potential than iron
 (c) Zinc has higher negative electrode potential than iron
 (d) Zinc is lighter than iron
31. Elements like silicon and Germanium to be used as a semi conductor is purified by **(PTA MQ)**
 (a) heating under vacuum (b) Van-Arkel Method
 (c) zone refining (d) Electrolysis
32. Which method of purification represented by the equation?

$$Ti \text{ (impure)} + 2I_2 \xrightarrow{550K} TiI_4 \xrightarrow{1800K} Ti \text{ (Pure)} + 2I_2$$
(PTA MQ)
 (a) Cupellation (b) Zone refining



- (c) Van-Arkel method (d) Mond's process
33. The process of converting hydrated alumina into anhydrous alumina is called. **(PTA MQ)**
- (a) Roasting (b) Smelting
- (c) Auto-reduction (d) Calcination

EVALUATION (BOOK BACK)

2, 3 and 5 Mark Question and Answers

- What is the difference between minerals and ores?
- What are the various steps involved in extraction of pure metals from their ores?
- What is the role of Limestone in the extraction of Iron from its oxide Fe_2O_3 ?
- Which type of ores can be concentrated by froth floatation method? Give two examples for such ores.
- Out of coke and CO, which is better reducing agent for the reduction of ZnO? Why? **(PTA MQ)**
- Describe a method for refining nickel. **(PTA MQ)**
- Explain zone refining process with an example using the Ellingham diagram given below. **(PTA MQ, MAR 20)**
- (A) Predict the conditions under which
 - Aluminium might be expected reduce magnesia.
 - Magnesium could reduce alumina.
 (B) Carbon monoxide is more effective reducing agent than carbon below 983K but, above this temperature, the reverse is true – Explain.
- Give the uses of Zinc. **(PTA MQ)**
- Explain the electrometallurgy of aluminium. **(PTA MQ)**



11. Explain the following terms with suitable example. **(PTA MQ)**
12. Give the basic requirement for vapour phase refining.
13. Describe the role of the following in the process mentioned.
 - (i) Silica in the extraction of copper
 - (ii) Cryolite in the extraction of aluminum.
 - (iii) Iodine in the refining of Zirconium.
 - (iv) Sodium cyanide in froth floatation
14. Explain the principle of electrolytic refining with an example. **(PTA MQ)**
15. The selection of reducing agent depends on the thermodynamic factor: Explain with an example.
16. Give the limitations of Ellingham diagram.
17. Write a short note on electrochemical principles of metallurgy.

ADDITIONAL QUESTIONS

2 and 3 Mark Question and Answers

1. What is Gangue? **(PTA MQ)**
2. Write a note on Gravity separation or Hydraulic wash.
3. Write a note on Leaching with an example.
4. What is Alkali Leaching? Give e.g.
5. What are the steps involved in extracting crude metal from concentrated ore?
6. What is roasting? **(PTA MQ)**
7. Define calcination. **(PTA MQ)**



8. What is smelting?
9. What is auto reduction? Give e.g.
10. What is Ellingham Diagram?
11. Write the application of Ellingham diagram.
12. Explain refining process of metal by distillation method.
13. Explain liquation with an example.
14. Write the applications of aluminium.
15. Write the applications of Iron.
16. Write the uses of copper.
17. Write the applications of gold.

Five Mark Question and Answers

1. Explain froth flotation process. **(PTA MQ)**
2. Explain Magnetic Separation.
3. Explain the reduction of metal oxides in different methods.

**UNIT-2: p-BLOCK ELEMENTS-I****EVALUATE YOURSELF**

1. Why group 18 elements are called inert gases? Write the general electronic configuration of group 18 elements.

EVALUATION**Choose the Best Answer**

1. An aqueous solution of borax is
(a) neutral (b) acidic (c) basic (d) amphoteric
2. Boric acid is an acid because its molecule. **(NEET)**
(a) contains replaceable H^+ ion (b) gives up a proton
(c) combines with proton to form water molecule
(d) accepts OH^- from water, releasing proton.
3. Which among the following is not a borane?
(a) B_2H_6 (b) B_3H_6 (c) B_4H_{10} (d) none of these
4. Which of the following metals has the largest abundance in the earth's crust?
(a) Aluminium (b) calcium (c) Magnesium (d) Sodium
5. In diborane, the number of electrons that accounts for banana bonds is
(a) Six (b) two (c) four (d) three
6. The element that does not show catenation among the following p-block elements is
(a) Carbon (b) silicon (c) Lead (d) germanium
7. Carbon atoms in fullerene with formula C_{60} have
(a) sp^3 hybridised (b) sp hybridised (c) sp^2 hybridised
(d) partially sp^2 and partially sp^3 hybridised



8. Oxidation state of carbon in its hydrides
 (a) +4 (b) -4 (c) +3 (d) +2
9. The basic structural unit of silicates is **(NEET), (PTA MQ)**
 (a) $(\text{SiO}_3)^{2-}$ (b) $(\text{SiO}_4)^{2-}$ (c) $(\text{SiO})^-$ (d) $(\text{SiO}_4)^{4-}$
10. The repeating unit in silicone is
- (a) SiO_2 (b) $\begin{array}{c} \text{R} \\ | \\ -\text{Si}-\text{O} \\ | \\ \text{R} \end{array}$
- (c) $\begin{array}{c} | \\ \text{R}-\text{O}-\text{Si}-\text{O} \\ | \\ \text{R} \end{array}$ (d) $\begin{array}{c} | \\ -\text{Si}-\text{O}-\text{O}-\text{R} \\ | \\ \text{R} \end{array}$
11. Which of these is not a monomer for a high molecular mass silicone polymer?
 (a) Me_3SiCl (b) PhSiCl_3 (c) MeSiCl_3 (d) Me_2SiCl_2
12. Which of the following is not sp^2 hybridised?
 (a) Graphite (b) Graphene (c) Fullerene (d) Dry ice
13. The geometry at which carbon atom in diamond are bonded to each other is
 (a) Tetrahedral (b) hexagonal (c) Octahedral (d) none of these
14. Which of the following statements is not correct?
 (a) Beryl is a cyclic silicate (b) Mg_2SiO_4 is an orthosilicate
 (c) SiO_4^{4-} is the basic structural unit of silicates
 (d) Feldspar is not aluminosilicate
15. AlF_3 is soluble in HF only in the presence of KF. It is due to the formation of **(NEET)**
 (a) $\text{K}_3[\text{AlF}_3\text{H}_3]$ (b) $\text{K}_3[\text{AlF}_6]$ (c) AlH_3 (d) $\text{K}[\text{AlF}_3\text{H}]$



16. Match items in column-I with the items of column-II and assign the correct code.

Column-I		Column-II	
A	Borazole	1	$B(OH)_3$
B	Boric acid	2	$B_3N_3H_6$
C	Quartz	3	$Na_2[B_4O_5(OH)_4] \cdot 8H_2O$

	A	B	C	D
(a)	2	1	4	3
(b)	1	2	4	3
(c)	1	2	4	3
(d)	None of these			

17. Duralumin is an alloy of
 (a) Cu, Mn (b) Cu, Al, Mg (c) Al, Mn (d) Al, Cu, Mn, Mg
Solution: Al-95%, Cu-4%, Mn-0.5%, Mn – 0.5%
18. Thermodynamically the most stable form of carbon is
 (a) Diamond (b) graphite (c) Fullerene (d) none of these
19. The compound that is used in nuclear reactors as protective shields and control rods is
 (a) Metal borides (b) metal oxides
 (c) Metal carbonates (d) metal carbide
20. The stability of +1 oxidation state increases in the sequence
 (a) $Al < Ga < In < Tl$ (b) $Tl > In < Ga < Al$
 (c) $In < Tl < Ga < Al$ (d) $Ga < In < Al < Tl$

ADDITIONAL QUESTIONS

Choose the Best Answer

21. In borax bead test which compound is formed?
 (a) Double Oxide (b) Tetra borate
 (c) Meta-borate (d) Ortho-borate



22. The stability of +1 oxidation state increase in the sequence:
 (a) $\text{Al} < \text{Ga} < \text{In} < \text{Tl}$ (b) $\text{Tl} < \text{In} < \text{Ga} < \text{Al}$
 (c) $\text{In} < \text{Tl} < \text{Ga} < \text{Al}$ (d) $\text{Ga} < \text{In} < \text{Al} < \text{Tl}$
23. Which one of the following anions is present in the chain structure of silicates?
 (a) $\text{Si}_2\text{O}_7^{6-}$ (b) $(\text{Si}_2\text{O}_5^{2-})_n$ (c) $(\text{SiO}_3^{2-})_n$ (d) SiO_4^{4-}
24. Which of the following oxide is amphoteric?
 (a) SiO_2 (b) CO_2 (c) SnO_2 (d) CaO
25. Which of these is not a monomer for a high molecular mass silicon polymer?
 (a) MeSiCl_3 (b) Me_2SiCl_2 (c) Me_3SiCl (d) PhSiCl_3
26. The oxidising power of oxo acids follows the order **(PTA MQ)**
 (a) $\text{HOX} > \text{HXO}_2 > \text{HXO}_3 > \text{HXO}_4$
 (b) $\text{HXO}_4 > \text{HXO}_3 > \text{HXO}_2 > \text{HOX}$
 (c) $\text{HXO}_3 > \text{HXO}_4 > \text{HXO}_2 > \text{HOX}$
 (d) $\text{HOX} > \text{HXO}_4 > \text{HXO}_3 > \text{HXO}_2$
27. **Assertion** : Aqueous solution of potash Alum is acidic.
Reason : Aluminium sulphate undergo hydrolysis. **(PTA MQ)**
 (a) Both assertion and reason are true and reason is the correct explanation of assertion
 (b) Both assertion and reason are true but reason is not the correct explanation of assertion
 (c) Assertion is true but reason is false
 (d) Both assertion and reason are false
28. Which of the following statement about H_3BO_3 is not correct? **(PTA MQ)**
 (a) It is a strong tribasic acid
 (b) It is prepared by acidifying an aqueous solution of borax



10. Describe the structure of diborane. **(PTA MQ)**
11. Write a short note on hydroboration.
12. Give one example for each of the following.
i) icosogens ii) tetragen iii) prictogen iv) chalcogen
13. Write a note on metallic nature of p-block elements.
14. Complete the following reactions.
- a. $B(OH)_3 + NH_3 \rightarrow$
- b. $Na_2B_4O_7 + H_2SO_4 + H_2O \longrightarrow$
- c. $B_2H_6 + 2NaOH + 2H_2O \longrightarrow$
- d. $B_2H_6 + CH_5OH \longrightarrow$
- e. $BF_3 + 9H_2O \longrightarrow$
- f. $HCOOH + H_2SO_4 \longrightarrow$
- g. $SiCl_4 + NH_3 \longrightarrow$
- h. $SiCl_4 + C_2H_5OH \longrightarrow$
- i. $B + NaOH \longrightarrow$
- j. $H_2B_4O_7 \xrightarrow{\text{Red hot}}$
15. How will you identify borate radical? **(PTA MQ)**
16. Write a note on zeolites. **(PTA MQ)**
17. How will you convert boric acid to boron nitride? **(PTA MQ)**
18. A hydride of 2nd period alkali metal (A) on reaction with compound of Boron (B) to give a reducing agent (C). identify A, B and C.
19. A double salt which contains fourth period alkali metal (A) on heating at 500K gives (B). Aqueous solution of (B)



gives white precipitate with BaCl_2 and gives a red colour compound with alizarin. Identify A and B.

20. CO is a reducing agent, justify with an example. **(PTA MQ)**

ADDITIONAL QUESTIONS

2 and 3 Mark Question and Answers

1. 18^{th} -group elements are called as inert gases. Why? Write the electronic configuration.
2. Write the ores of Boron.
3. Write the reduction of Boron trihalides.
4. Write the action of oxygen with boron on heating?
5. What is action of boron with acids and bases?
6. Write the uses of boron.
7. How borax is obtained from its ore?
8. What is the action of heat on borax?
9. Write the uses of Borax.
10. Write preparation of Boric acid.
11. What is the action of heat on Boric acid?
12. Explain the structure of Boric acid.
13. Write the uses of Boric acid.
14. Write the industrial manufacture of diborane?
15. What is inorganic benzene? How is it produced? **(PTA MQ)**
16. Write the uses of Diborane?
17. Explain the preparation of boron trifluoride.
18. Give the uses of boron trifluoride.



19. Explain McAfee process of preparation of Aluminium chloride.
20. Write the uses of aluminium chloride.
21. Write the preparation of Alum. **(PTA MQ)**
22. What is Burnt alum? How is it prepared?
23. Write the uses of alum.
24. Graphite conducts electricity. Why?
25. What are carbon nanotubes?
26. What is producer gas?
27. What is water gas (or) Synthetic gas?
28. What is phosgene? How is it prepared?
29. Write the uses of carbon monoxide.
30. How silicic esters are prepared?
31. Write the uses of silicon tetra chloride.
32. What are silicones? How is it prepared?
33. Explain the types of silicones.
34. What is water gas equilibrium? **(PTA MQ)**
35. There is only a marginal difference in decrease in ionisation enthalpy form Aluminium to Thallium – Explain. Why? **(MAR 2020)**

Five Mark Question and Answers

1. Write the action of heat on diborane at different temperature?
2. Write a note on Diamond.
3. Explain the carbon allotrope fullerenes.
4. Explain the types of silicates. (Any two types may be asked in board exam)

**UNIT - 3: p-BLOCK ELEMENTS-II****EVALUATE YOURSELF**

1. Write the products formed in the reaction of nitric acid (both dilute and concentrated) with zinc.

EVALUATION**Choose the Best Answer**

1. In which of the following, NH_3 is not used?
- (a) Nessler's reagent
 - (b) Reagent for the analysis of IV group basic radical
 - (c) Reagent for the analysis of III group basic radical
 - (d) Tollen's reagent
2. Which is true regarding nitrogen?
- (a) Least electronegative element
 - (b) has low ionisation enthalpy than oxygen
 - (c) d-orbitals available
 - (d) ability to form $p\pi-p\pi$ bonds with itself
3. An element belongs to group 15 and 3 rd period of the periodic table, its electronic configuration would be
- (a) $1s^2 2s^2 2p^4$
 - (b) $1s^2 2s^2 2p^3$
 - (c) $1s^2 2s^2 2p^6 3s^2 3p^2$
 - (d) $1s^2 2s^2 2p^6 3s^2 3p^3$
4. Solid (A) reacts with strong aqueous NaOH liberating a foul smelling gas (B) which spontaneously burn in air giving smoky rings. A and B are respectively.
- (a) P_4 (red) and PH_3
 - (b) P_4 (white) and PH_3
 - (c) S_8 and H_2S
 - (d) P_4 (white) and H_2S
5. In the brown ring test, brown colour of the ring is due to
- (a) a mixture of NO and NO_2
 - (b) Nitroso ferrous sulphate
 - (c) Ferrous nitrate
 - (d) Ferric nitrate



6. On hydrolysis, PCl_3 gives
(a) H_3PO_3 (b) PH_3 (c) H_3PO_4 (d) POCl_3
7. P_4O_6 reacts with cold water to give
(a) H_3PO_3 (b) $\text{H}_4\text{P}_2\text{O}_7$ (c) HPO_3 (d) H_3PO_4
8. The basicity of pyrophosphorous acid ($\text{H}_4\text{P}_2\text{O}_5$) is
(a) 4 (b) 2 (c) 3 (d) 5
9. The molarity of given orthophosphoric acid solution is 2M. Its normality is
(a) 6N (b) 4N (c) 2N (d) none of these
10. **Assertion** : Bond dissociation energy of fluorine is greater than chlorine gas
Reason : Chlorine has more electronic repulsion than fluorine
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true and reason is the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Both assertion and reason are false.
11. Among the following, which is the strongest oxidizing agent?
(a) Cl_2 (b) F_2 (c) Br_2 (d) I_2
12. The correct order of the thermal stability of hydrogen halide is **(PTA MQ)**
(a) $\text{HI} > \text{HBr} > \text{HCl} > \text{HF}$ (b) $\text{HF} > \text{HCl} > \text{HBr} > \text{HI}$
(c) $\text{HCl} > \text{HF} > \text{HBr} > \text{HI}$ (d) $\text{HI} > \text{HCl} > \text{HF} > \text{HBr}$
13. Which one of the following compounds is not formed?
(a) XeOF_4 (b) XeO_3 (c) XeF_2 (d) NeF_2
14. Most easily liquefiable gas is
(a) Ar (b) Ne (c) He (d) Kr
15. XeF_6 on complete hydrolysis produces
(a) XeOF_4 (b) XeO_2F_2 (c) XeO_3 (d) XeO_2



16. On oxidation with iodine, sulphite ion is transformed to
 (a) $S_4O_6^{2-}$ (b) $S_2O_6^{2-}$ (c) SO_4^{2-} (d) SO_3^{2-}
17. Which of the following is strongest acid among all?
 (a) HI (b) HF (c) HBr (d) HCl
18. Which one of the following orders is correct for the bond dissociation enthalpy of halogen molecules? **(NEET)**
 (a) $Br_2 > I_2 > F_2 > Cl_2$ (b) $F_2 > Cl_2 > Br_2 > I_2$
 (c) $I_2 > Br_2 > Cl_2 > F_2$ (d) $Cl_2 > Br_2 > F_2 > I_2$
19. Among the following the correct order of acidity is **(NEET)**
 (a) $HClO_2 < HClO < HClO_3 < HClO_4$
 (b) $HClO_4 < HClO_2 < HClO < HClO_3$
 (c) $HClO_3 < HClO_4 < HClO_2 < HClO$
 (d) $HClO < HClO_2 < HClO_3 < HClO_4$
20. When copper is heated with conc. HNO_3 it produces
 (a) $Cu(NO_3)_2$, NO and NO_2 (b) $Cu(NO_3)_2$ and N_2O
 (c) $Cu(NO_3)_2$ and NO_2 (d) $Cu(NO_3)_2$ and NO

ADDITIONAL QUESTIONS

21. Which of the following species has a linear shape?
 (a) NO_2^- (b) O_3 (c) NO_2^- (d) SO_2
22. Which of the following statement is incorrect?
 (a) HF is a stronger acid than HCl.
 (b) Among halide ions, iodide is the most powerful reducing agent.
 (c) Fluorine is the only halogen that does not show a variable oxidation state.
 (d) HOCl is a stronger acid than HOBr.
23. Which of the following order is correct for the bond dissociation energy of halogen molecules?
 (a) $F_2 > Cl_2 > Br_2 > I_2$ (b) $Cl_2 > Br_2 > F_2 > I_2$
 (c) $Br_2 > I_2 > Cl_2 > F_2$ (d) $I_2 > Br_2 > Cl_2 > F_2$



24. The correct geometry and hybridisation for XeF_4 are?
 (a) Trigonal Bipyramidal sp^3d (b) Octahedral, sp^3d^2
 (c) Square Planar, sp^3d^2 (d) Planar Triangle sp^3d^3
25. The basicity of hypophosphorous acid is **(PTA MQ)**
 (a) 1 (b) 2 (c) 3 (d) 4
26. Which of the following is caro's acid? **(PTA MQ)**
 (a) $\text{H}_2\text{S}_2\text{O}_8$ (b) $\text{H}_2\text{S}_2\text{O}_7$ (c) H_2SO_5 (d) H_2SO_3
27. The acid having O – O bond in its structure **(PTA MQ)**
 (a) H_2SO_3 (b) $\text{H}_2\text{S}_2\text{O}_6$ (c) $\text{H}_2\text{S}_2\text{O}_8$ (d) $\text{H}_2\text{S}_4\text{O}_6$
28. Formula for hyponitrous acid: **(MAR 2020)**
 (a) HOONO (b) $\text{H}_2\text{N}_2\text{O}_2$ (c) HNO_2 (d) HNO_4
29. Match the following: **(MAR 2020)**
- | | |
|---------------|--|
| (1) Fluorine | (i) Identification of coloured metal ions |
| (2) Borax | (ii) Strong oxidising agent |
| (3) Aluminium | (iii) Chalcogens Present in volcanic ashes |
| (4) Sulphur | (iv) Most abundant element |
- (a) (1)-iii, (2)-(ii), (3)-(iv), (4)-(i)
 (b) (1)-ii, (2)-(i), (3)-(iv), (4)-(iii)
 (c) (1)-iv, (2)-(iii), (3)-(ii), (4)-(i)
 (d) (1)-ii, (2)-(iv), (3)-(i), (4)-(iii)

EVALUATION (BOOK BACK)

2, 3 and 5 Mark Question and Answers

- What is inert pair effect?
- Chalcogens belongs to p-block. Give reason.
- Explain why fluorine always exhibit an oxidation state of -1?
- Give the oxidation state of halogen in the following.
 a) OF_2 b) O_2F_2 c) Cl_2O_3 d) I_2O_4



5. What are interhalogen compounds? Give examples. **(PTA MQ)**
6. Why fluorine is more reactive than other halogens?
7. Give the uses of helium.
8. What is the hybridisation of iodine in IF_7 ? Give its structure.
9. Give the balanced equation for the reaction between chlorine with cold NaOH and hot NaOH.
10. How will you prepare chlorine in the laboratory? **(PTA MQ)**
11. Give the uses of sulphuric acid.
12. Give a reason to support that sulphuric acid is a dehydrating agent. **(PTA MQ)**
13. Write the reason for the anomalous behaviour of Nitrogen.
14. Write the molecular formula and structural formula for the following molecules.
- (a) Nitric acid (b) Dinitrogen pentoxide
- (c) Phosphoric acid (d) Phosphine
15. Give the uses of argon. **(PTA MQ)**
16. Write the valence shell electronic configuration of group-15 elements.
17. Give two equations to illustrate the chemical behaviour of phosphine. **(PTA MQ)**
18. Give a reaction between nitric acid and a basic oxide.
19. What happens when PCl_5 is heated?
20. Suggest a reason why HF is a weak acid, whereas binary acids of all other halogens are strong acids.



21. Deduce the oxidation number of oxygen in hypofluorous acid-HOF.
22. What type of hybridisation occur in
(a) BrF_5 (b) BrF_3
23. Complete the following reactions.
- $\text{NaCl} + \text{MnO}_2 + \text{H}_2\text{SO}_4 \longrightarrow$
 - $\text{NaNO}_2 + \text{HCl} \longrightarrow$
 - $\text{IO}_3^- + \text{I}^- + \text{H}^+ \longrightarrow$
 - $\text{I}_2 + \text{S}_2\text{O}_3^{2-} \longrightarrow$
 - $\text{P}_4 + \text{NaOH} + \text{H}_2\text{O} \longrightarrow$ **(PTA MQ)**
 - $\text{AgNO}_3 + \text{PH}_3 \longrightarrow$
 - $\text{Mg} + \text{HNO}_3 \longrightarrow$
 - $\text{KClO}_3 \xrightarrow{\Delta}$
 - $\text{Cu} + \text{H}_2\text{SO}_4 \xrightarrow{\text{Hot conc}}$
 - $\text{Sb} + \text{Cl}_2 \longrightarrow$
 - $\text{HBr} + \text{H}_2\text{SO}_4 \longrightarrow$
 - $\text{XeF}_6 + \text{H}_2\text{O} \longrightarrow$
 - $\text{XeO}_6^{4-} + \text{Mn}^{2+} + \text{H}^+ \longrightarrow$
 - $\text{XeOF}_4 + \text{SiO}_2 \longrightarrow$
 - $\text{Xe} + \text{F}_2 \xrightarrow[400^\circ\text{C}]{\text{Ni}/200\text{ atm}}$

ADDITIONAL QUESTIONS

2 and 3 Mark Question and Answers

- Nitrogen has inert nature – Give Reason.
- Write the uses of Nitrogen.
- Write the preparation of ammonia.



4. Explain the reduction property of ammonia.
5. Explain the reduction property of ammonia.
6. Write the structure of ammonia.
7. How nitric acid is prepared?
8. Explain the nitration reaction of nitric acid.
9. What is the action of copper with dil. HNO_3 and Con HNO_3 ?
10. Write the use of Nitric acid.
11. What is the oxidation number of nitrous oxide? Write its preparation.
12. Write the different allotropic forms of phosphorus
13. What is the action of air with phosphorus?
14. Explain phosphorus is powerful reducing agent (or) Write the preparation of phosphine?
15. Write the uses of phosphorus.
16. Explain the reduction property of phosphine.
17. Write the uses of phosphine.
18. Write the preparation of phosphorus trichloride.
19. Write the uses of PCl_3 and PCl_5 . PCl_3 :
20. Write the preparation of phosphorus penta chloride.
21. Write the structures and basicity of H_3PO_3 and H_3PO_4 .
22. Explain the preparation of ortho phosphoric acid (H_3PO_4).
23. Prove ozone is powerful oxidising agent (or) write the test to estimate ozone.
24. Write the uses of oxygen.



25. Write the allotrope of sulphur.
26. Explain oxidizing property and reducing property of sulphur dioxide.
27. Write the uses of sulphur dioxide.
28. Prove that sulphuric acid is dibasic.
29. Write a test for detection of sulphuric acid.
30. Explain the preparation of chlorine.
31. How bleaching powder is prepared? **(MAR 20)**
32. Write the use of chlorine.
33. What is aqua regia? Write the action of aqua regia on gold.
34. The thermal stability of hydrogen halides decreases along the group why?
35. What is action of HF on glass? (or) Why HF cannot be stored in glass bottles? **(MAR 20)**
36. Write the oxidising order of oxyacids of halogen.
37. Write the preparation of xenon fluoride compounds.
38. Write the uses of krypton.
39. Write the uses of xenon.
40. Write the uses of Radon.
41. What is the hybridisation in XeOF_2 ? Give its structure. **(PTA MQ)**
42. Ozone (O_3) acts as a powerful agent why? **(PTA MQ)**
43. What type of hybridisation occurs in the following compounds?
 - a) BrF_5
 - b) IF_7**(PTA MQ)**



44. Nitrogen does not form any penta halides like phosphorus why?
45. How is pure phosphine prepared from phosphorus acid?
(PTA MQ)
46. List any five compounds of Xenon and mention the type of hybridisation and structure of the compounds?
(PTA MQ)
47. Write the molecular formula and draw the structure of sulphurous acid and Marshall's acid.
(MAR 20)

Five Mark Question and Answers

1. Explain Ostwald's process of preparation of Nitric acid.
2. Explain the manufacture of sulphuric acid by contact process.
3. Explain the manufacture of chlorine by Deacon's process.
4. Write the properties of interhalogen compounds.



UNIT - 4: TRANSITION AND INNER TRANSITION ELEMENTS

EVALUATE YOURSELF

1. Compare the stability of Ni^{4+} and Pt^{4+} from their ionisation enthalpy value.
2. Why iron is more stable in +3 oxidation state than in +2 and the reverse is true for manganese?

EVALUATION

Choose the Best Answer

1. Sc ($Z = 21$) is a transition element but Zinc ($Z = 30$) is not because
 - (a) both Sc^{3+} and Zn^{2+} ions are colourless and form white compounds.
 - (b) in case of Sc, 3d orbital partially filled but in Zn these are completely filled
 - (c) last electron as assumed to be added to 4s level in case of zinc
 - (d) both Sc and Zn do not exhibit variable oxidation states
2. Which of the following d block element has half filled penultimate d sub shell as well as half filled valence sub shell?
 - (a) Cr (b) Pd (c) Pt (d) none of these
3. Among the transition metals of 3d series, the one that has highest negative $\left(\frac{M^{2+}}{M}\right)$
 - (a) Ti (b) Cu (c) Mn (d) Zn
4. Which one of the following ions has the same number of unpaired electrons as present in V^{3+} ?



- (a) Ti^{3+} (b) Fe^{3+} (c) Ni^{2+} (d) Cr^{3+}
5. The magnetic moment of Mn^{2+} ion is
 (a) 5.92BM (b) 2.80BM (c) 8.95BM (d) 3.90BM
6. Which of the following compounds is colourless?
 (a) Fe^{3+} (b) Ti^{4+} (c) Co^{2+} (d) Ni^{2+}
7. The catalytic behaviour of transition metals and their compounds is ascribed mainly due to
 (a) their magnetic behaviour (b) their unfilled d orbitals
 (c) their ability to adopt variable oxidation states
 (d) their chemical reactivity
8. The correct order of increasing oxidizing power in the series
 (a) $VO_2^+ < Cr_2O_7^{2-} < MnO_4^-$ (b) $Cr_2O_7^{2-} < VO_2^+ < MnO_4^-$
 (c) $Cr_2O_7^{2-} < MnO_4^- < VO_2^+$ (d) $MnO_4^- < Cr_2O_7^{2-} < VO_2^+$
9. The alloy of copper that contain Zinc is
 (a) Monel metal (b) Bronze (c) bell metal (d) brass
10. Which of the following does not give oxygen on heating?
 (a) $K_2Cr_2O_7$ (b) $(NH_4)_2Cr_2O_7$ (c) $KClO_3$ (d) $Zn(ClO_3)_2$
11. In acid medium, potassium permanganate oxidizes oxalic acid to
 (a) Oxalate (b) Carbon dioxide (c) acetate (d) acetic acid
12. Which of the following statements is not true?
 (a) on passing H_2S , through acidified $K_2Cr_2O_7$ solution, a milky colour is observed.
 (b) $Na_2Cr_2O_7$ is preferred over $K_2Cr_2O_7$ in volumetric analysis
 (c) $K_2Cr_2O_7$ solution in acidic medium is orange in colour
 (d) $K_2Cr_2O_7$ solution becomes yellow on increasing the P^H beyond 7
13. Permanganate ion changes to in acidic medium
 (a) MnO_4^{2-} (b) Mn^{2+} (c) Mn^{3+} (d) MnO_2



14. A white crystalline salt (A) react with dilute HCl to liberate a suffocating gas (B) and also forms a yellow precipitate. The gas (B) turns potassium dichromate acidified with dil H_2SO_4 to a green coloured solution (C). Identify A, B and C are respectively.
- (a) $\text{Na}_2\text{SO}_3, \text{SO}_2, \text{Cr}_2(\text{SO}_4)_3$ (b) $\text{Na}_2\text{S}_2\text{O}_3, \text{SO}_2, \text{Cr}(\text{SO}_4)_3$
 (c) $\text{Na}_2\text{S}, \text{SO}_2, \text{Cr}_2(\text{SO}_4)_3$ (d) $\text{Na}_2\text{SO}_4, \text{SO}_2, \text{Cr}_2(\text{SO}_4)_3$
15. MnO_4^- react with Br^- in alkaline pH to give
- (a) $\text{BrO}_3^-, \text{MnO}_2$ (b) $\text{Br}_2, \text{MnO}_4^{2-}$ (c) $\text{Br}_2, \text{MnO}_2$ (d) $\text{BrO}^-, \text{MnO}_4^{2-}$
16. How many moles of I_2 are liberated when 1 mole of potassium dichromate react with potassium iodide?
- (a) 1 (b) 2 (c) 3 (d) 4
17. The number of moles of acidified KMnO_4 required to oxidize 1 mole of ferrous oxalate (FeC_2O_4) is
- (a) 5 (b) 3 (c) 0.6 (d) 1.5
18. When a brown compound of Mn (A) treated with HCl, it gives a gas (B). The gas (B) taken in excess reacts with NH_3 to give an explosive compound (C). The compound A, B and C are
- (a) $\text{MnO}_2, \text{Cl}_2, \text{NCl}_3$ (b) $\text{MnO}, \text{Cl}_2, \text{NH}_4\text{Cl}$
 (c) $\text{Mn}_3\text{O}_4, \text{Cl}_2, \text{NCl}_3$ (d) $\text{MnO}_3, \text{Cl}_2, \text{NCl}_2$
19. Which one of the following statements related to lanthanons is incorrect?
- (a) Europium shows +2 oxidation state.
 (b) The basicity decreases as the ionic radius decreases from Pr to Lu.
 (c) All the lanthanons are much more reactive than aluminium
 (d) Ce^{4+} solutions are widely used as oxidising agents in volumetric analysis.



Ans: (c) All the lanthanons are much more reactive than aluminium

20. Which of the following lanthanoid ions is diamagnetic?
(a) Eu^{2+} (b) Yb^{2+} (c) Ce^{2+} (d) Sm^{2+}
21. Which of the following oxidation states is most common among the lanthanoids?
(a) 4 (b) 2 (c) 5 (d) 3
22. **Assertion** : Ce^{4+} is used as an oxidizing agent in volumetric analysis.
Reason : Ce^{4+} has the tendency of attaining +3 oxidation state.
- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Both assertion and reason are false.
23. The most common oxidation state of actinoids is **(PTA MQ)**
(a) +2 (b) +3 (c) +4 (d) +6
24. The actinoid elements which show the highest oxidation state of +7 are
(a) Np, Pu, Am (b) U, Fm, Th (c) U, Th, Md (d) Es, No, Lr
25. Which one of the following is not correct? **(PTA MQ)**
(a) $\text{La}(\text{OH})_3$ is less basic than $\text{Lu}(\text{OH})_3$
(b) In lanthanoid series ionic radius of Ln^{3+} ions decreases
(c) La is actually an element of transition metal series rather than lanthanide series
(d) Atomic radii of Zr and Hf are same because of lanthanide contraction.

**ADDITIONAL QUESTIONS**

26. Which of the following shows maximum number of oxidation states?
(a) Mn (b) V (c) Cr (d) Fe
27. Which one of the following characteristics of the transition metal is associated with their catalytic activity?
(a) variable oxidation states (b) Colour of hydrated ions
(c) Paramagnetic behaviour (d) High enthalpy of atomization
28. The aqueous solution containing which one of the following ions will be colourless?
(a) Sc^{3+} (b) Fe^{3+} (c) Fe^{2+} (d) Mn^{2+}
29. In which of the following pairs both the ions are coloured in aqueous solution?
(a) Sc^{3+} , Co^{2+} (b) Ni^{2+} , Cu^{+} (c) Ni^{2+} , Ti^{3+} (d) Sc^{3+} , Ti^{3+}
(Atomic Number. Sc = 21, Ti = 22, Ni = 28, Cu = 29, Co = 27)
30. Reason of Lanthanide contraction is-
(a) Decreasing nuclear charge (b) Decreasing screening effect
(c) Increasing nuclear charge
(d) negligible screening effect of γ – orbitals
31. In the dichromate anion $(\text{Cr}_2\text{O}_7)^{2-}$ **(PTA MQ)**
(a) 4 Cr – O bonds are equivalent
(b) 6 Cr – O bonds are equivalent
(c) All Cr – O bonds are equivalent
(d) All Cr – O bonds are non-equivalent
32. Chromyl chloride when dissolved in NaOH solution gives yellow solution. The yellow solution contains **(PTA MQ)**
(a) $\text{Cr}_2\text{O}_7^{2-}$ (b) CrO_4^{2-} (c) CrO_5 (d) Cr_2O_3
33. **Assertion :** A small piece of Zinc dissolved in dilute nitric acid but hydrogen gas is not evolved.



Reason : HNO_3 is an oxidising agent and this oxidizes hydrogen. **(PTA MQ)**

- (a) Both Assertion and Reason is true. Reason is a correct explanation for Assertion.
- (b) Both Assertion and Reason is true. Reason is not correct explanation for the Assertion.
- (c) Assertion is correct but Reason is wrong
- (d) Both assertion and Reason are wrong
34. Which of the following ions of salt is white in colour? **(PTA MQ)**
- (a) Cd^{2+} (b) Cu^{2+} (c) Co^{3+} (d) V^{3+}
35. For the four successive transition elements (Cr, Mn, Fe & Co) the stability of +2 oxidation state will be there in which of the following order? **(PTA MQ)**
- (a) $\text{Fe} > \text{Mn} > \text{Co} > \text{Cr}$ (b) $\text{Co} > \text{Mn} > \text{Fe} > \text{Cr}$
- (c) $\text{Cr} > \text{Mn} > \text{Co} > \text{Fe}$ (d) $\text{Mn} > \text{Fe} > \text{Cr} > \text{Co}$
36. The transition element which has only + 3 oxidation state is: **(MAR 2020)**
- (a) Ni (b) Mn (c) Cr (d) Sc

EVALUATION (BOOK BACK)

2, 3 and 5 Mark Question and Answers

1. What are transition metals? Give four examples. **(PTA MQ)**
2. Explain the oxidation states of 4d series elements.
3. What are inner transition elements?
4. Justify the position of lanthanides and actinides in the periodic table. **(PTA MQ)**
5. What are actinides? Give three examples.



6. Why Gd^{3+} is colourless?
7. Explain why compounds of Cu^{2+} are coloured but those of Zn^{2+} are colourless.
8. Describe the preparation of potassium dichromate. **(PTA MQ)**
9. What is lanthanide contraction and what are the effects of lanthanide contraction? **(PTA MQ)**
10. Complete the following:
 - a) $MnO_4^{2-} + H^+ \longrightarrow ?$
 - b) $C_6H_5CH_3 \xrightarrow[\text{KMnO}_4]{\text{acidified}} ?$
 - c) $MnO_4^- + Fe^{2+} \longrightarrow ?$
 - d) $KMnO_4 \xrightarrow[\text{Red hot}]{\Delta} ?$
 - e) $Cr_2O_7^{2-} + I^- + H^+ \longrightarrow ?$
 - f) $Na_2Cr_2O_7 + KCl \longrightarrow ?$
11. What are interstitial compounds? **(PTA MQ)**
12. Calculate the number of unpaired electrons in Ti^{3+} , Mn^{2+} and calculate the spin only magnetic moment.
13. Write the electronic configuration of Ce^{4+} and Co^{2+} .
14. Explain briefly how +2 states becomes more and more stable in the first half of the first row transition elements with increasing atomic number.
15. Which is more stable? Fe^{3+} or Fe^{2+} - explain.
16. Explain the variation in $E_{M^{3+}/M^{2+}}^0$ 3d series.
17. Compare lanthanides and actinides. **(PTA MQ)**
18. Explain why Cr^{2+} is strongly reducing while Mn^{3+} is strongly oxidizing. **(PTA MQ)**



19. Compare the ionization enthalpies of first series of the transition elements.
20. Actinoid contraction is greater from element to element than the lanthanoid contraction, why?
21. Out of $\text{Lu}(\text{OH})_3$ and $\text{La}(\text{OH})_3$ which is more basic and why?
(PTA MQ)
22. Why Europium (II) is more stable than Cerium (II)?
23. Why do zirconium and Hafnium exhibit similar properties?
24. Which is stronger reducing agent Cr^{2+} or Fe^{2+} ?
25. The $E^0_{\text{M}^{3+}/\text{M}^{2+}}$ value for copper is positive. Suggest a possible reason for this.
26. Predict which of the following will be coloured in aqueous solution Ti^{2+} , V^{3+} , Sc^{4+} , Cu^+ , Sc^{3+} , Fe^{3+} , Ni^{2+} and Co^{3+} .
27. Describe the variable oxidation state of 3d series elements.
28. Which metal in the 3d series exhibits +1 oxidation state most frequently and why?
29. Why first ionization enthalpy of chromium is lower than that of zinc?
30. Transition metals show high melting points why?

ADDITIONAL QUESTIONS

2 and 3 Mark Question and Answers

1. Write the common electronic configuration of d-block and f-block element.
2. In 3d-series, the atomic radius does not decrease from Left to Right. Give reason.



3. The atomic radius of 5d-series elements resembles with 4d-series elements. Why?
4. Define: Standard electrode potential of transition metals
5. Explain Magnetic moment.
6. What is Zigler–Natta catalyst? How poly propylene polymer is obtained.
7. Write the properties of interstitial compounds.
8. Why d-block elements form co-ordination complexes?
9. Write the thermal decomposition of potassium dichromate.
10. Potassium dichromate is a powerful oxidising agent in acidic medium. Explain.
11. Write chromyl chloride test. (or) write the test for detection of chloride ions in qualitative analysis. **(MAR 2020)**
12. Write the uses of potassium dichromate.
13. Explain the preparation of potassium permanganate.
(i) Ore: Pyrolusite (MnO_2)
14. Draw the structure of permanganate ion.
15. What is the action of heat on potassium permanganate?
16. Write the oxidation states of Actinoides.
17. Classify the following elements into d-block and f-block element: **(MAR 2020)**
 - (i) Tungsten
 - (ii) Ruthenium
 - (iii) Promethium
 - (iv) Einsteinium



Five Mark Question and Answers

1. Explain the oxidation of potassium permanganate in different medium.
2. Write the uses of potassium permanganate.
3. Find out the equivalent weight of KMnO_4 in different medium.
4. Write the causes of Lanthanide contraction.



**UNIT - 5: COORDINATION CHEMISTRY****EVALUATE YOURSELF**

- When a coordination compound $\text{CrCl}_3 \cdot 4\text{H}_2\text{O}$ is mixed with silver nitrate solution, one mole of silver chloride is precipitated per mole of the compound. There are no free solvent molecules in that compound. Assign the secondary valence to the metal and write the structural formula of the compound.
- In the complex, $[\text{Pt}(\text{NO}_2)(\text{H}_2\text{O})(\text{NH}_3)_2]\text{Br}$, identify the following.
- Write the IUPAC name for the following compounds.
- Give the structure for the following compounds.
- A solution of $[\text{Co}(\text{NH}_3)_4\text{I}_2]\text{Cl}$ when treated with AgNO_3 gives a white precipitate. What should be the formula of isomer of the dissolved complex that gives yellow precipitate with AgNO_3 . What are the above isomers called?
- Three compounds A, B and C have empirical formula $\text{CrCl}_3 \cdot 6\text{H}_2\text{O}$. They are kept in a container with a dehydrating agent and they lost water and attaining constant weight as shown below.

Compound	Initial weight of the compound (in g)	Constant weight after dehydration (in g)
A	4	3.46
B	0.5	0.466
C	3	3

- Indicate the possible type of isomerism for the following complexes and draw their isomers.



8. Draw all possible stereo isomers of a complex $\text{Ca}[\text{Co}(\text{NH}_3)\text{Cl}(\text{Ox})_2]$.
9. The spin only magnetic moment of Tetrachloridomanganate(II) ion is 5.9 BM. On the basis of VBT, predict the type of hybridisation and geometry of the compound.
10. Predict the number of unpaired electrons in $[\text{CoCl}_4]^{2-}$ ion on the basis of VBT.
11. A metal complex having composition $\text{Co}(\text{en})_2\text{Cl}_2\text{Br}$ has been isolated in two forms A and B. (B) reacted with silver nitrate to give a white precipitate readily soluble in ammonium hydroxide. Whereas A gives a pale yellow precipitate. Write the formula of A and B. state the hybridization of Co in each and calculate their spin only magnetic moment.
12. The mean pairing energy and octahedral field splitting energy of $[\text{Mn}(\text{CN})_6]^{3-}$ are $28,800\text{cm}^{-1}$ and $38,500\text{cm}^{-1}$ respectively. Whether this complex is stable in low spin or high spin?
13. Draw energy level diagram and indicate the number of electrons in each level for the complex $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$. Whether the complex is paramagnetic or diamagnetic?
 $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$
14. For the $[\text{CoF}_6]^{3-}$ ion the mean pairing energy is found to be 21000cm^{-1} . The magnitude of Δ_0 is 13000cm^{-1} . Calculate the crystal field stabilization energy for this complex ion corresponding to low spin and high spin states.

**EVALUATION****Choose the Best Answer**

- The sum of primary valency and secondary valency of the metal M in the complex $[M(en)_2(Ox)]Cl$ is
 (a) 3 (b) 6 (c) -3 (d) 9
- An excess of silver nitrate is added to 100 ml of a 0.01 M solution of pentaquachloridochromium (III) chloride. The number of moles of AgCl precipitated would be
 (a) 0.02 (b) 0.002 (c) 0.01 (d) 0.2
- A complex has a molecular formula $MSO_4Cl \cdot 6H_2O$. The aqueous solution of it gives white precipitate with Barium chloride solution and no precipitate is obtained when it is treated with silver nitrate solution. If the secondary valency of the metal is six, which one of the following correctly represents the complex?
 (a) $[M(H_2O)_4Cl]SO_4 \cdot 2H_2O$ (b) $[M(H_2O)_6]SO_4$
 (c) $[M(H_2O)_5Cl]SO_4 \cdot H_2O$ (d) $[M(H_2O)_3Cl]SO_4 \cdot 3H_2O$
- Oxidation state of Iron and the charge on the ligand NO in $[Fe(H_2O)_5NO]SO_4$ are
 (a) +2 and 0 respectively (b) +3 and 0 respectively
 (c) +3 and -1 respectively (d) +1 and +1 respectively
- As per IUPAC guidelines, the name of the complex $[Co(en)_2(ONO)Cl]Cl$ is
 (a) Chlorobisethylenediaminenitritocobalt(III) chloride
 (b) chlorobis(ethane-1,2-diamine)nitro k-Ocobaltate(III) chloride
 (c) chloridobis(ethane-1,2-diammine) nitrito k-Ocobalt(II) chloride
 (d) chloridobis(ethane-1,2-diamine) nitro k-Ocobalt(III) chloride



6. IUPAC name of the complex $K_3 [Al(C_2O_4)_3]$ is
 (a) potassiumtrioxalatoaluminium(III)
 (b) potassiumtrioxalatoaluminate(II)
 (c) potassiumtrioxalatoaluminate(III)
 (d) potassiumtrioxalatoaluminate(III)
7. A magnetic moment of 1.73BM will be shown by one among the following **(NEET)**
 (a) $TiCl_4$ (b) $[CoCl_6]^{4-}$ (c) $[Cu(NH_3)_4]^{2+}$ (d) $[Ni(CN)_4]^{2-}$
8. Crystal field stabilization energy for high spin d^5 octahedral complex is
 (a) $-0.6\Delta_0$ (b) 0 (c) $2(P-\Delta_0)$ (d) $2(P+\Delta_0)$
9. In which of the following coordination entities the magnitude of Δ_0 will be maximum?
 (a) $[Co(CN)_6]^{3-}$ (b) $[Co(C_2O_4)_3]^{3-}$
 (c) $[Co(H_2O)_6]^{3+}$ (d) $[Co(NH_3)_6]^{3+}$
10. Which one of the following will give a pair of enantiomorphs?
 (a) $[Cr(NH_3)_6][Co(CN)_6]$ (b) $[Co(en)_2Cl_2]Cl$
 (c) $[Pt(NH_3)_4][PtCl_4]$ (d) $[Co(NH_3)_4Cl_2]NO_2$
11. Which type of isomerism is exhibited by $[Pt(NH_3)_2Cl_2]$?
 (a) Coordination isomerism (b) Linkage isomerism
 (c) Optical isomerism (d) Geometrical isomerism
12. How many geometrical isomers are possible for $[Pt(Py)(NH_3)(Br)(Cl)]$?
 (a) 3 (b) 4 (c) 0 (d) 15
13. Which one of the following pairs represents linkage isomers?
 (a) $[Cu(NH_3)_4][PtCl_4]$ and $[Pt(NH_3)_4][CuCl_4]$
 (b) $[Co(NH_3)_5(NO_3)]SO_4$ and $[Co(NH_3)_5(ONO)]$



- (c) $[\text{Co}(\text{NH}_3)_4(\text{NCS})_2]\text{Cl}$ and $[\text{Co}(\text{NH}_3)_4(\text{SCN})_2]\text{Cl}$
 (d) both (b) and (c)
14. Which kind of isomerism is possible for a complex $[\text{Co}(\text{NH}_3)_4\text{Br}_2]\text{Cl}$? **(PTA MQ)**
 (a) geometrical and ionization (b) geometrical and optical
 (c) optical and ionization (d) geometrical only
15. Which one of the following complexes is not expected to exhibit isomerism?
 (a) $[\text{Ni}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$ (b) $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$
 (c) $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Cl}$ (d) $[\text{Fe}(\text{en})_3]^{3+}$
16. A complex in which the oxidation number of the metal is zero is
 (a) $\text{K}_4[\text{Fe}(\text{CN})_6]$ (b) $[\text{Fe}(\text{CN})_3(\text{NH}_3)_3]$
 (c) $[\text{Fe}(\text{CO})_5]$ (d) both (b) and (c)
17. Formula of tris (ethane-1,2-diamine) iron (II) phosphate
 (a) $[\text{Fe}(\text{CH}_3 - \text{CH}(\text{NH}_2)_2)_3](\text{PO}_4)_3$
 (b) $[\text{Fe}(\text{H}_2\text{N} - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{NH}_2)_3](\text{PO}_4)$
 (c) $[\text{Fe}(\text{H}_2\text{N} - \text{CH}_2 - \text{CH}_2 - \text{NH}_2)_3](\text{PO}_4)_2$
 (d) $[\text{Fe}(\text{H}_2\text{N} - \text{CH}_2 - \text{CH}_2 - \text{NH}_2)_3]_3(\text{PO}_4)_2$
18. Which of the following is paramagnetic in nature? **(PTA MQ)**
 (a) $[\text{Zn}(\text{NH}_3)_4]^{2+}$ (b) $[\text{Co}(\text{NH}_3)_6]^{3+}$
 (c) $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$ (d) $[\text{Ni}(\text{CN})_4]^{2-}$
 (b) Co^{3+} (d^6 Low spin $\Rightarrow t_{2g}^6, e_g^0$; diamagnetic)
 (c) Ni^{2+} (d^8 Low spin $\Rightarrow t_{2g}^6, e_g^2$; paramagnetic)
 (d) $[\text{Ni}(\text{CN})_4]^{2-}$ (dsp^2 ; square planar, diamagnetic)



19. Fac-mer isomerism is shown by
- (a) $[\text{Co}(\text{en})_3]^{3+}$ (b) $[\text{Co}(\text{NH}_3)_4(\text{Cl})_2]^+$
 (c) $[\text{Co}(\text{NH}_3)_3(\text{Cl})_3]$ (d) $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{SO}_4$
20. Choose the correct statement.
- (a) Square planar complexes are more stable than octahedral complexes.
- (b) The spin only magnetic moment of $[\text{Cu}(\text{Cl})_4]^{2-}$ is 1.732 BM and it has square planar structure.
- (c) Crystal field splitting energy (Δ_0) of $[\text{FeF}_6]^{4-}$ is higher than the (Δ_0) of $[\text{Fe}(\text{CN})_6]^{4-}$
- (d) Crystal field stabilization energy of $[\text{V}(\text{H}_2\text{O})_6]^{2+}$ is higher than the crystal field stabilization of $[\text{Ti}(\text{H}_2\text{O})_6]^{2+}$

ADDITIONAL QUESTIONS

Choose the Best Answer

21. Coordination number of Ni in $[\text{Ni}(\text{C}_2\text{O}_4)_3]^{4-}$ is: **(PTA MQ)**
 (a) 2 (b) 4 (c) 6 (d) 8
22. Which of the following does not show optical isomerism?
 (a) $[\text{Co}(\text{en})_2\text{Cl}_2]^+$ (b) $[\text{Co}(\text{NH}_3)_3\text{Cl}_3]^0$
 (c) $[\text{Co}(\text{en})\text{Cl}_2(\text{NH}_3)_2]^+$ (d) $[\text{Co}(\text{en})_3]^{3+}$
 (en = ethylenediamine)
23. Which one of the following complexes is not expected to exhibit isomerism?
 (a) $[\text{Ni}(\text{NH}_3)_4](\text{H}_2\text{O})_2]^{2+}$ (b) $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$
 (c) $[\text{Ni}(\text{NH}_3)_2\text{Cl}_2]$ (d) $[\text{Ni}(\text{en})_3]^{2+}$
24. Which of the following complexes is used to be as an anticancer agent?
 (a) Na_2COCl_4 (b) Cis – $\text{K}_2[\text{PtCl}_2\text{Br}_2]$



- (c) Cis – $[\text{PtCl}_2(\text{NH}_3)_2]$ (d) Mer – $[\text{Co}(\text{NH}_3)_3\text{Cl}_3]$
25. Number of possible isomers for the complex $[\text{Co}(\text{en})_2\text{Cl}_2]\text{Cl}$ will be (en = ethylene diammine)
- (a) 1 (b) 2 (c) 3 (d) 4
26. According spectrochemical series which of the following ligand produces strongest field and cause maximum splitting?
- (PTA MQ)**
- (a) F^- (b) CO (c) H_2O (d) Cl^-
27. Which statement is incorrect?
- (PTA MQ)**
- (a) $[\text{Ni}(\text{CO})_4]$ – Tetrahedral, Paramagnetic
 (b) $[\text{Ni}(\text{CN})_4]^{2-}$ - Square planar, diamagnetic
 (c) $[\text{Ni}(\text{CO})_4]$ – Tetrahedral, diamagnetic
 (d) $[\text{Ni}(\text{Cl})_4]^{2-}$ - Tetrahedral, paramagnetic
28. Among the following complexes, which one shows Zero Crystal field stabilization energy (CFSE) is
- (PTA MQ)**
- (a) $[\text{Mn}(\text{H}_2\text{O})_3]^{3+}$ (b) $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$
 (c) $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ (d) $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$

EVALUATION (BOOK BACK)

2, 3 and 5 Mark Question and Answers

- Write the IUPAC names for the following complexes.
- Write the formula for the following coordination compounds.
- Arrange the following in the order of increasing molar conductivity.
 - $\text{Mg}[\text{Cr}(\text{NH}_3)(\text{Cl})_5]$ ii) $[\text{Cr}(\text{NH}_3)_5\text{Cl}]_3[\text{CoF}_6]_2$
 - $[\text{Cr}(\text{NH}_3)_3\text{Cl}_3]$
- Ni^{2+} is identified using alcoholic solution of dimethyl glyoxime. Write the structural formula for the rosy red precipitate of a complex formed in the reaction.



5. $[\text{CuCl}_4]^{2-}$ exists while $[\text{CuI}_4]^{2-}$ does not exist why?
6. Calculate the ratio of $\frac{[\text{Ag}^+]}{[\text{Ag}(\text{NH}_3)_2]^+}$ in 0.2 M solution of NH_3 . If the stability constant for the complex $[\text{Ag}(\text{NH}_3)_2]^+$ is 1.7×10^7
7. Give an example of coordination compound used in medicine and two example of biologically important coordination compounds.
8. Based on VB theory explain why $[\text{Cr}(\text{NH}_3)_6]^{3+}$ is paramagnetic, while $[\text{Ni}(\text{CN})_4]^{2-}$ is diamagnetic.
9. Draw all possible geometrical isomers of the complex $[\text{Co}(\text{en})_2\text{Cl}_2]^+$ and identify the optically active isomer.
Cis isomer – optically active
10. $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ is coloured, while $[\text{Sc}(\text{H}_2\text{O})_6]^{3+}$ is colourless – explain. **(PTA MQ, MAR 20)**
11. Give an example for complex of the type $[\text{Ma}_2\text{b}_2\text{c}_2]$ where a, b, c are monodentate ligands and give the possible isomers.
Example for $[\text{Ma}_2\text{b}_2\text{c}_2]$ is $[\text{Co}(\text{CN})_2\text{Cl}_2(\text{NO}_2)_2]$
12. Give one test to differentiate $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{SO}_4$ and $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Cl}$.
13. In an octahedral crystal field, draw the figure to show splitting of d orbitals.



14. What is linkage isomerism? Explain with an example.
15. Write briefly about the applications of coordination compounds in volumetric analysis.
16. Classify the following ligand based on the number of donor atoms.
- (a) NH_3 (b) en (c) ox^{2-}
(d) triaminotriethylamine (e) pyridine
17. Give the difference between double salts and coordination compounds.
18. Write the postulates of Werner's theory.
19. $[\text{Ni}(\text{CN})_4]^{2-}$ is diamagnetic, while $[\text{NiCl}_4]^{2-}$ is paramagnetic, explain using crystal field theory.
20. Why tetrahedral complexes do not exhibit geometrical isomerism.
21. Explain optical isomerism in coordination compounds with an example.
22. What are hydrate isomers? Explain with an example. (or) Write any two hydrate isomers of the complex with the molecular formula $\text{CrCl}_3 \cdot 6\text{H}_2\text{O}$. **(PTA MQ, MAR 20)**
23. What is crystal field splitting energy?
24. What is crystal field stabilization energy (CFSE)? **(PTA MQ)**
25. A solution of $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$ is green, whereas a solution of $[\text{Ni}(\text{CN})_4]^{2-}$ is colourless Explain.
 $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$



26. Discuss briefly the nature of bonding in metal carbonyls.
27. What is the coordination entity formed when excess of liquid ammonia is added to an aqueous solution of copper sulphate?
28. On the basis of VB theory explain the nature of bonding in $[\text{Co}(\text{C}_2\text{O}_4)_3]^{3-}$.
29. What are the limitations of VB theory?
30. Write the oxidation state, coordination number, nature of ligand, magnetic property and electronic configuration in octahedral crystal field for the complex $\text{K}_4[\text{Mn}(\text{CN})_6]$.

ADDITIONAL QUESTIONS

2 and 3 Mark Question and Answers

1. Explain the calculation of CFSE for Iron complex $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$.
2. What are metal carbonyls?
3. Explain the classification of metal carbonyls based on the number of metal atoms present in the complex.
4. Write the relation between dissociation equilibrium constant and formation equilibrium constant.
5. Define stability constant **(PTA MQ)**
6. Write the IUPAC name of the following: **(MAR 2020)**
(A) $[\text{Ag}(\text{NH}_3)_2]^+$ (B) $[\text{Co}(\text{NH}_3)_5\text{Cl}]^{2+}$
7. Calculate the magnetic moment and magnetic property of $[\text{CoF}_6]^{3-}$. **(MAR 2020)**



Five Mark Question and Answers

1. Explain the definition of important terms pertaining to co-ordination compounds.
2. Explain types of complexes.
3. Explain the nomenclature of co-ordination compounds.
4. What is Co-ordination Isomerism? Give e-g.
5. Explain Ionization isomerism with example.
6. Explain geometrical isomers of co-ordination compounds with example.
7. Write the postulates of valence bond theory. **(PTA MQ)**
8. Explain salient features of crystal field theory.
9. Explain co-ordination compound with bridged carbonyls. **(PTA MQ)**
10. Relate Step wise formation constant and overall formation constant.
11. Write the applications of co-ordination complexes.

**UNIT – 6: SOLID STATE****EVALUATE YOURSELF**

1. An element has a face centered cubic unit cell with a length of 352.4 pm along an edge. The density of the element is 8.9 g cm^{-3} . How many atoms are present in 100 g of an element?
2. Determine the density of CsCl which crystallizes in a bcc type structure with an edge length 412.1 pm.
3. A face centered cubic solid of an element (atomic mass 60) has a cube edge of $4A^\circ$. Calculate its density.
4. Barium has body centered cubic unit cell with a length of 508 pm along an edge. What is the density of barium in g. cm^{-3} ?

EVALUATION**Choose the Best Answer**

1. Graphite and diamond are
(a) covalent and molecular crystals (b) ionic and covalent crystals
(c) both covalent crystals (d) both molecular crystals
2. An ionic compound $A_x B_y$ crystallizes in fcc type crystal structure with B ions at the centre of each face and A ion occupying centre of the cube the correct formula of $A_x B_y$
(a) AB (b) AB_3 (c) A_3B (d) $A_8 B_6$
3. The ratio of close packed atoms to tetrahedral hole in cubic packing is
(a) 1:1 (b) 1:2 (c) 2:1 (d) 1:4



4. Solid CO_2 is an example of
- (a) Covalent solid (b) metallic solid
(c) molecular solid (d) ionic solid
5. **Assertion** : monoclinic sulphur is an example of monoclinic crystal system.
- Reason** : for a monoclinic system, $a \neq b \neq c$ and $\alpha = \gamma = 90^\circ$, $\beta \neq 90^\circ$
- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Both assertion and reason are false.
6. In calcium fluoride, having the fluorite structure the coordination number of Ca^{2+} ion and F^- ion are **(NEET)**
- (a) 4 and 2 (b) 6 and 6 (c) 8 and 4 (d) 4 and 8
7. The number of unit cells in 8gm of an element X (atomic mass 40) which crystallizes in bcc pattern is (N_A is the Avogadro number)
- (a) 6.023×10^{23} (b) 6.023×10^{22}
(c) 60.23×10^{23} (d) $\left(\frac{6.023 \times 10^{23}}{8 \times 40}\right)$
8. The number of carbon atoms per unit cell of diamond is
- (a) 8 (b) 6 (c) 1 (d) 4
9. In a solid atom M occupies ccp lattice and $\left(\frac{1}{3}\right)$ of tetrahedral voids are occupied by atom N. Find the formula of solid formed by M and N.
- (a) MN (b) M_3N (c) MN_3 (d) M_3N_2



10. The composition of a sample of wurtzite is $\text{Fe}_{0.93} \text{O}_{1.00}$ what % of Iron present in the form of Fe^{3+} ?
 (a) 16.05% (b) 15.05% (c) 18.05% (d) 17.05%
11. The ionic radii of A^+ and B^- are 0.98×10^{-10} m and 1.81×10^{-10} m. The coordination number of each ion in AB is
 (a) 8 (b) 2 (c) 6 (d) 4
12. CsCl has bcc arrangement, its unit cell edge length is 400pm, its inter atomic distance
 (a) 400pm (b) 800pm (c) $\sqrt{3} \times 100$ pm (d) $\left(\frac{\sqrt{3}}{2}\right) \times 400$ pm
13. A solid compound XY has NaCl structure. If the radius of the cation is 100 pm, the radius of the anion will be
 (a) $\left(\frac{100}{0.414}\right)$ (b) $\left(\frac{0.732}{100}\right)$ (c) 100×0.414 (d) $\left(\frac{0.414}{100}\right)$
14. The vacant space in bcc lattice unit cell is **(MAR 20)**
 (a) 48% (b) 23% (c) 32% (d) 26%
15. The radius of an atom is 300 pm, if it crystallizes in a face centered cubic lattice, the length of the edge of the unit cell is
 (a) 488.5pm (b) 848.5pm (c) 884.5pm (d) 484.5pm
16. The fraction of total volume occupied by the atoms in a simple cubic is
 (a) $\left(\frac{\pi}{4\sqrt{2}}\right)$ (b) $\left(\frac{\pi}{6}\right)$ (c) $\left(\frac{\pi}{4}\right)$ (d) $\left(\frac{\pi}{3\sqrt{2}}\right)$
17. The yellow colour in NaCl crystal is due to
 (a) excitation of electrons in F centers
 (b) reflection of light from Cl ion on the surface
 (c) refraction of light from Na^+ ion (d) all of the above



18. If 'a' stands for the edge length of the cubic system; sc, bcc, and fcc. Then the ratio of radii of spheres in these systems will be respectively.
- (a) $\left(\frac{1}{2}a : \frac{\sqrt{3}}{2}a : \frac{\sqrt{2}}{2}a\right)$ (b) $(\sqrt{1}a : \sqrt{3}a : \sqrt{2}a)$
- (c) $\left(\frac{1}{2}a : \frac{\sqrt{3}}{4}a : \frac{1}{2\sqrt{2}}a\right)$ (d) $\left(\frac{1}{2}a : \sqrt{3}a : \frac{1}{\sqrt{2}}a\right)$
19. If 'a' is the length of the side of the cube, the distance between the body centered atom in one corner atom in the cube will be
- (a) $\left(\frac{2}{\sqrt{3}}\right)a$ (b) $\left(\frac{4}{\sqrt{3}}\right)a$ (c) $\left(\frac{\sqrt{3}}{4}\right)a$ (d) $\left(\frac{\sqrt{3}}{2}\right)a$
20. Potassium has a bcc structure with nearest neighbour distance 4.52\AA . Its atomic weight is 39. Its density will be
 (a) 915 kg m^{-3} (b) 2142 kg m^{-3} (c) 452 kg m^{-3} (d) 390 kg m^{-3}
21. Schottky defect in a crystal is observed when
- (a) unequal number of cations and anions are missing from the lattice
 (b) equal number of cations and anions are missing from the lattice
 (c) an ion leaves its normal site and occupies an interstitial site
 (d) no ion is missing from its lattice.
22. The cation leaves its normal position in the crystal and moves to some interstitial position, the defect in the crystal is known as
- (a) Schottky defect (b) F center
 (c) Frenkel defect (d) non-stoichiometric defect



23. **Assertion** : Due to Frenkel defect, density of the crystalline solid decreases.
Reason : In Frenkel defect cation and anion leaves the crystal.
- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
 (b) Both assertion and reason are true but reason is not the correct explanation of assertion.
 (c) Assertion is true but reason is false.
 (d) Both assertion and reason are false.
24. The crystal with a metal deficiency defect is **(PTA MQ)**
 (a) NaCl (b) FeO (c) ZnO (d) KCl
25. A two dimensional solid pattern formed by two different atoms X and Y is shown below. The black and white squares represent atoms X and Y respectively. The simplest formula for the compound based on the unit cell from the pattern is
 (a) XY_8 (b) $X_4 Y_9$ (c) XY_2 (d) XY_4

ADDITIONAL QUESTIONS

26. The fraction of total volume occupied by the atoms present in a simple cube is:
 (a) $\frac{\pi}{6}$ (b) $\frac{\pi}{3\sqrt{2}}$ (c) $\frac{\pi}{4\sqrt{2}}$ (d) $\frac{\pi}{4}$
27. Which of the following statements is not correct?
 (a) The number of carbon atoms in an unit cell of diamond is 4.
 (b) The number of Bravais lattices in which a crystal can be categorized is 14
 (c) The fraction of the total volume occupied by the atoms in a primitive cell is 0.48
 (d) Molecular solids are generally volatile.



28. If 'a' stands for the edge length of the cubic systems: simple cubic, body centered cubic and face centered cubic, then the ratio of radii of the spheres in these systems will be respectively.

(a) $\frac{1}{2}a : \frac{\sqrt{3}}{2}a : \frac{\sqrt{2}}{2}a$

(b) $1a : \sqrt{3}a : \sqrt{2}a$

(c) $\frac{1}{2}a : \frac{\sqrt{3}}{4}a : \frac{1}{2\sqrt{2}}a$

(d) $\frac{1}{2}a : \sqrt{3}a : \frac{1}{2\sqrt{2}}a$

29. AB crystallizes in a body centred cubic lattice with edge length 'a' equal to 387 pm. The distance between two oppositely charged ions in the lattice is:

(a) 300 pm (b) 335 pm (c) 250 pm (d) 200 pm

30. A metal crystallises within a face centred cubic lattice. The edge of the unit cell is 408 pm. The diameter of the metal atom is:

(a) 204 pm (b) 144 pm (c) 408 pm (d) 288 pm

31. The packing efficiency of a face centered cubic structure is

(PTA MQ)

(a) 74% (b) 68% (c) 52.38% (d) 48%

32. In FCC unit cell of the edge length is $8\sqrt{2}$ pm. The radius of the metal atom is Å

(PTA MQ)

(a) 0.04 (b) 0.02 (c) 8×10^{-2} (d) $\frac{8}{\sqrt{2}}$

33. The arrangement of crystallographic axes and angles respectively in hexagonal crystal systems is

(PTA MQ)

(a) $a \neq b \neq c$ $\alpha = \beta = \gamma = 90^\circ$

(b) $a = b \neq c$ $\alpha = \beta = \gamma = 90^\circ$



$$(c) a = b \neq c \quad \alpha = \beta = 90^\circ \quad \gamma = 120^\circ$$

$$(d) a = b = c \quad \alpha \neq \beta \neq \gamma = 90^\circ$$

34. The crystal with a metal deficiency defect is **(PTA MQ)**
 (a) NaCl (b) KCl (c) ZnO (d) FeO

EVALUATION (BOOK BACK)

2, 3 and 5 Mark Question and Answers

1. Define unit cell. **(PTA MQ)**
2. Give any three characteristics of ionic crystals. **(PTA MQ)**
3. Differentiate crystalline solids and amorphous solids. **(PTA MQ)**
4. Classify the following solids
 (a) P_4 (b) Brass (c) diamond (d) NaCl (e) Iodine
5. Explain briefly seven types of unit cell.
6. Distinguish between hexagonal close packing and cubic close packing.
7. Distinguish tetrahedral and octahedral voids.
8. What are point defects?
9. Explain Schottky defect. **(PTA MQ)**
10. Write short note on metal excess ('f' centers) and metal deficiency defect with an example. **(PTA MQ)**
11. Sketch face centred cubic unit cell (FCC) Calculate the number of atoms in a fcc unit cell. **(PTA MQ)**
12. Explain AAAA and ABABA and ABCABC type of three dimensional packing with the help of neat diagram.
 (i) AAA type
13. Why ionic crystals are hard and brittle?



14. Calculate the percentage efficiency of packing in case of body centered cubic crystal.
15. What is the two dimensional co-ordination number of molecule in square close packed layer?
16. Experiment shows that Nickel oxides has the formula $\text{Ni}_{0.96}\text{O}_{1.00}$. What fraction of Nickel exists as of Ni^{2+} and Ni^{3+} ions?
17. What is meant by the term “Coordination number”? What is the coordination number of atoms in a bcc structure?
18. An element has bcc structure with a cell edge of 288 pm. the density of the element is 7.2 g cm^{-3} . How many atoms are present in 208 g of the element?
19. Aluminium crystallizes in a cubic close packed structure. Its metallic radius is 125 pm. calculate the edge length of unit cell.
20. If NaCl is doped with 10^{-2} mol percentage of strontium chloride, what is the concentration of cation vacancy?
21. KF crystallizes in fcc structure like sodium chloride. Calculate the distance between K^+ and F^- in KF. (Given: density of KF is 2.48 g cm^{-3}) **(PTA MQ)**
22. An atom crystallizes in fcc crystal lattice and has a density of 10 g cm^{-3} with unit cell edge length of 100 pm. Calculate the number of atoms present in 1 g of crystal. **(PTA MQ)**
23. Atoms X and Y form bcc crystalline structure. Atom X is present at the corners of the cube and Y is at the centre of the cube. What is the formula of the compound? **(PTA MQ)**
24. Sodium metal crystallizes in bcc structure with the edge length of the unit cell $4.3 \times 10^{-8} \text{ cm}$. Calculate the radius of sodium atom.



25. Write a note on Frenkel defect. **(PTA MQ, MAR 20)**

ADDITIONAL QUESTIONS

2 and 3 Mark Question and Answers

1. Define: Isotropy, anisotropy.
2. Write the classification of crystal defects.
3. What are covalent solids?
4. What are Non-polar molecular solids?
5. What are polar molecular solids?
6. What is primitive unit cell?
7. What is non-primitive unit cell?
8. Write the co-ordination number of sc, bcc, and fcc.
9. Find out the total number atoms in bcc unit cell?
10. Write Bragg equation and explain the term. **(PTA MQ)**
11. Write the formula for density of unit cell.
12. Define packing fraction or packing efficiency.
13. Define crystal lattice.
14. If the no. of close packed sphere is 6, calculate the number of Octahedral voids and Tetrahedral voids generated.

(MAR 2020)

Five Mark Question and Answers

1. Write the characteristics of solids.
2. Write the classification of solids.
3. Explain the classification of point defect with example.
4. Explain the impurity defects in crystals.

**UNIT – 7: CHEMICAL KINETICS****EVALUATE YOURSELF**

- In a first order reaction $A \rightarrow$ products 60% of the given sample of 'A' decomposes in 40 min. what is the half life of the reaction?
- The rate constant for a first order reaction is $2.3 \times 10^{-4} \text{ s}^{-1}$. If the initial concentration of the reactant is 0.01 M. What concentration will remain after 1 hour?
- Hydrolysis of an ester in an aqueous solution was studied by titrating the liberated carboxylic acid against sodium hydroxide solution. The concentrations of the ester at different time intervals are given below.

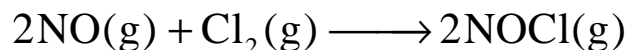
Time (min)	0	30	60	90
Ester concentration mol L ⁻¹	0.85	0.80	0.754	0.71

Show that, the reaction follows first order kinetics.

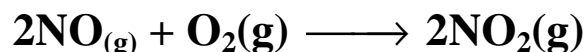
- For a first order reaction the rate constant at 500 K is $8 \times 10^{-4} \text{ s}^{-1}$. Calculate the frequency factor, if the energy of activation for the reaction is 190 kJ mol⁻¹.
- For a reaction, $X + Y \longrightarrow$ product; quadrupling [x], increases the rate by a factor of 8. Quadrupling both [x] and [y], increases the rate by a factor of 16. Find the order of the reaction with respect to x and y. What is the overall order of the reaction?



6. Find the individual and overall order of the following reactions using the given data.



7. Consider the oxidation of nitric oxide to form NO_2



- (a) Express the rate of the reaction in terms of changes in the concentration of NO , O_2 and NO_2 .
- (b) At a particular instant, when $[\text{O}_2]$ is decreasing at $0.2 \text{ mol L}^{-1} \text{ s}^{-1}$ at what rate is $[\text{NO}_2]$ increasing at that instant?
8. Write the rate expression for the following reactions, assuming them as elementary reactions.
- i) $3\text{A} + 5\text{B}_2 \longrightarrow 4\text{CD}$
- ii) $\text{X}_2 + \text{Y}_2 \longrightarrow 2\text{XY}$
9. Consider the decomposition of $\text{N}_2\text{O}_5(\text{g})$ to form $\text{NO}_2(\text{g})$ and $\text{O}_2(\text{g})$. At a particular instant N_2O_5 disappears at a rate of $2.5 \times 10^{-2} \text{ mol. dm}^{-3} \text{ s}^{-1}$. At what rates are NO_2 and O_2 formed? What is the rate of the reaction?
10. What is the order with respect to each of the reactant and overall order of the following reactions?
- (a) $5\text{Br}^-(\text{aq}) + \text{BrO}_3^-(\text{aq}) + 6\text{H}^+(\text{aq})$
 $\longrightarrow 3\text{Br}_2(\text{l}) + 3\text{H}_2\text{O}(\text{l})$
- The experimental rate law is
 $\text{Rate} = k [\text{Br}^-][\text{BrO}_3^-][\text{H}^+]^2$
- (b) $\text{CH}_3\text{CHO}(\text{g}) \xrightarrow{\Delta} \text{CH}_4(\text{g}) + \text{CO}(\text{g})$ the experimental rate law is



$$\text{Rate} = k[\text{CH}_3\text{CHO}]^{\frac{3}{2}}$$

11. The rate of the reaction $x + 2y \rightarrow \text{product}$ is $4 \times 10^{-3} \text{ mol L}^{-1}\text{s}^{-1}$, if $[x] = [y] = 0.2 \text{ M}$ and rate constant at 400K is $2 \times 10^{-2} \text{ s}^{-1}$, What is the overall order of the reaction.
12. A first order reaction takes 8 hours for 90% completion. Calculate the time required for 80% completion. ($\log 5 = 0.6989$; $\log 10 = 1$)
13. The half life period of a first order reaction $x \longrightarrow \text{products}$ is $6.932 \times 10^4 \text{ s}$ at 500 K . What percentage of x would be decomposed on heating at 500 K for 100 min. ($e^{0.06} = 1.06$)
14. Show that in case of first order reaction, the time required for 99.9% completion is nearly ten times the time required for half completion of the reaction.
15. The rate constant of a reaction at 400 K and 200 K are 0.04 and 0.02 s^{-1} respectively. Calculate the value of activation energy.
16. Rate constant of a reaction varies with temperature T according to the following Arrhenius equation

$$\log k = \log A - \frac{E_a}{2.303R} \left(\frac{1}{T} \right)$$

Where E_a is the activation energy. When a graph is plotted for $\log k$ Vs $\frac{1}{T}$ is a straight line with a slope of -4000 K is obtained. Calculate the activation energy.

17. For a first order reaction the rate constant at 500 K is $8 \times 10^{-4} \text{ s}^{-1}$. Calculate the frequency factor, if the energy of activation for the reaction is 190 kJ mol^{-1} .



$$k = 8 \times 10^{-1} \text{ s}^{-1};$$

$$T = 500\text{K}$$

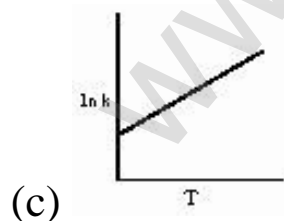
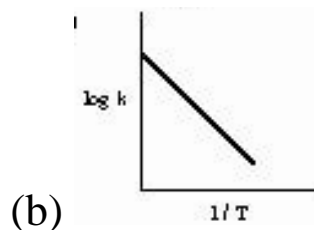
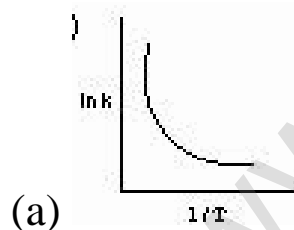
$$R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$$

$$A = ?$$

EVALUATION

Choose the Best Answer

- For a first order reaction $A \rightarrow B$, the rate constant is $x \text{ min}^{-1}$. If the initial concentration of A is 0.01M, the concentration of A after one hour is given by the expression.
(a) $0.01 e^{-x}$ (b) $1 \times 10^{-2} (1 - e^{-60x})$ (c) $(1 \times 10^{-2})e^{-60x}$ (d) none of these
- A zero order reaction $X \rightarrow \text{Product}$, with an initial concentration 0.02 M has a half life of 10 min. If one starts with concentration 0.04 M, then the half life is
(a) 10s (b) 5 min (c) 20 min
(d) cannot be predicted using the given information
- Among the following graphs showing variation of rate constant with temperature (T) for a reaction, the one that exhibits Arrhenius behavior over the entire temperature range is



(d) both (b) and (c)

- For a first order reaction $A \rightarrow \text{product}$ with initial concentration $x \text{ mol L}^{-1}$, has a half life period of 2.5 hours. For the same



reaction with initial concentration $\left(\frac{x}{2}\right)$ mol L⁻¹ the half life is

(a) (2.5×2) hours (b) $\left(\frac{2.5}{2}\right)$ hours (c) 2.5 hours

(d) Without knowing the rate constant, $t_{1/2}$ cannot be determined from the given data

5. For the reaction, $2\text{NH}_3 \rightarrow \text{N}_2 + 3\text{H}_2$, if $\frac{-d[\text{NH}_3]}{dt} = k_1[\text{NH}_3]$,

$\frac{d[\text{N}_2]}{dt} = k_2[\text{NH}_3]$, $\frac{d[\text{H}_2]}{dt} = k_3[\text{NH}_3]$ then the relation between

k_1 , k_2 and k_3 is

(a) $k_1 = k_2 = k_3$ (b) $k_1 = 3k_2 = 2k_3$

(c) $1.5 k_1 = 3k_2 = k_3$ (d) $2k_1 = k_2 = 3k_3$

6. The decomposition of phosphine (PH_3) on tungsten at low pressure is a first order reaction. It is because the **(NEET)**

(a) rate is proportional to the surface coverage

(b) rate is inversely proportional to the surface coverage

(c) rate is independent of the surface coverage

(d) rate of decomposition is slow

7. For a reaction $\text{Rate} = k [\text{acetone}]^{3/2}$ then unit of rate constant and rate of reaction respectively is

(a) $(\text{mol L}^{-1}\text{s}^{-1}), (\text{mol}^{-1/2}\text{L}^{1/2}\text{s}^{-1})$ (b) $(\text{mol}^{-1/2}\text{L}^{1/2}\text{s}^{-1}), (\text{mol L}^{-1}\text{s}^{-1})$

(c) $(\text{mol}^{1/2}\text{L}^{1/2}\text{s}^{-1}), (\text{mol L}^{-1}\text{s}^{-1})$ (d) $(\text{mol L s}^{-1}), (\text{mol}^{1/2}\text{L}^{1/2}\text{s})$

8. The addition of a catalyst during a chemical reaction alters which of the following quantities? **(NEET)**



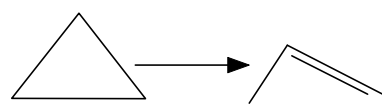
- (a) Enthalpy (b) Activation energy
(c) Entropy (d) Internal energy

9. Consider the following statements:

- (i) increase in concentration of the reactant increases the rate of a zero order reaction.
(ii) rate constant k is equal to collision frequency A if $E_a = 0$
(iii) rate constant k is equal to collision frequency A if $E_a = 0$
(iv) a plot of $\ln(k)$ Vs T is a straight line.
(v) a plot of $\ln(k)$ Vs $\left(\frac{1}{T}\right)$ is a straight line with a positive slope.

Correct statements are:

- (a) (ii) only (b) (ii) and (iv) (c) (ii) and (v) (d) (i), (ii) and (v)
10. In a reversible reaction, the enthalpy change and the activation energy in the forward direction are respectively $-x \text{ kJ mol}^{-1}$ and $y \text{ kJ mol}^{-1}$. Therefore, the energy of activation in the backward direction is
- (a) $(y - x) \text{ kJ mol}^{-1}$ (b) $(x + y) \text{ J mol}^{-1}$
(c) $(x - y) \text{ kJ mol}^{-1}$ (d) $(x + y) \times 10^3 \text{ J mol}^{-1}$
11. What is the activation energy for a reaction if its rate doubles when the temperature is raised from 200 K to 400 K? ($R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$)
- (a) $234.65 \text{ kJ mol}^{-1} \text{ K}^{-1}$ (b) $434.65 \text{ kJ mol}^{-1} \text{ K}^{-1}$
(c) $434.65 \text{ J mol}^{-1} \text{ K}^{-1}$ (d) $334.65 \text{ J mol}^{-1} \text{ K}^{-1}$

12.  This reaction follows first order kinetics. The rate constant at particular temperature is $2.303 \times 10^{-2} \text{ hour}^{-1}$. The initial concentration of cyclopropane is 0.25 M.



What will be the concentration of cyclopropane after 1806 minutes? ($\log 2 = 0.3010$)

(a) 0.125M (b) 0.215M (c) $0.25 \times 2.303M$ (d) 0.05M

13. For a first order reaction, the rate constant is 6.909 min^{-1} the time taken for 75% conversion in minutes is **(PTA MQ)**

(a) $\left(\frac{3}{2}\right) \log 2$ (b) $\left(\frac{2}{3}\right) \log 2$ (c) $\left(\frac{3}{2}\right) \log\left(\frac{3}{4}\right)$ (d) $\left(\frac{2}{3}\right) \log\left(\frac{4}{3}\right)$

14. In a first order reaction $x \rightarrow y$; if k is the rate constant and the initial concentration of the reactant x is 0.1 M, then, the half life is

(a) $\left(\frac{\log 2}{k}\right)$ (b) $\left(\frac{0.693}{(0.1)k}\right)$ (c) $\left(\frac{\ln 2}{k}\right)$ (d) none of these

15. Predict the rate law of the following reaction based on the data given below $2A + B \rightarrow C + 3D$.

Reaction number	[A] (min)	[B] (min)	Initial rate ($M \text{ s}^{-1}$)
1	0.1	0.1	x
2	0.2	0.1	2x
3	0.1	0.2	4x
4	0.2	0.2	8x

(a) rate = $k [A]^2 [B]$

(b) rate = $k [A] [B]^2$

(c) rate = $k [A] [B]$

(d) rate = $k [A]^{1/2} [B]^{3/2}$

16. **Assertion** : rate of reaction doubles when the concentration of the reactant is double if it is a first order reaction.

Reason : rate constant also doubles.

(a) Both assertion and reason are true and reason is the correct explanation of assertion.



- (b) Both assertion and reason are true but reason is not the correct explanation of assertion.
- (c) Assertion is true but reason is false.
- (d) Both assertion and reason are false.
17. The rate constant of a reaction is $5.8 \times 10^{-2} \text{ s}^{-1}$. The order of the reaction is **(PTA MQ)**
- (a) First order (b) Zero order (c) Second order (d) Third order
18. For the reaction $\text{N}_2\text{O}_5(\text{g}) \rightarrow 2\text{NO}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g})$, the value of rate of disappearance of N_2O_5 is given as $6.5 \times 10^{-2} \text{ mol L}^{-1} \text{ s}^{-1}$. The rate of formation of NO_2 and O_2 is given respectively is
- (a) $(3.5 \times 10^{-2} \text{ mol L}^{-1} \text{ s}^{-1})$ and $(1.3 \times 10^{-2} \text{ mol L}^{-1} \text{ s}^{-1})$
- (b) $(1.3 \times 10^{-2} \text{ mol L}^{-1} \text{ s}^{-1})$ and $(3.25 \times 10^{-2} \text{ mol L}^{-1} \text{ s}^{-1})$
- (c) $(1.3 \times 10^{-1} \text{ mol L}^{-1} \text{ s}^{-1})$ and $(3.25 \times 10^{-2} \text{ mol L}^{-1} \text{ s}^{-1})$
- (d) None of these
19. During the decomposition of H_2O_2 to give dioxygen, 48 g O_2 is formed per minute at certain point of time. The rate of formation of water at this point is
- (a) $0.75 \text{ mol min}^{-1}$ (b) 1.5 mol min^{-1}
- (c) $2.25 \text{ mol min}^{-1}$ (d) 3.0 mol min^{-1}
20. If the initial concentration of the reactant is doubled, the time for half reaction is also doubled. Then the order of the reaction is
- (a) Zero (b) one (c) Fraction (d) none
21. In a homogeneous reaction $\text{A} \rightarrow \text{B} + \text{C} + \text{D}$, the initial pressure was P_0 and after time 't' it was P. expression for rate constant in terms of P_0 , P and t will be



$$(a) k = \left(\frac{2.303}{t} \right) \log \left(\frac{2P_0}{3P_0 - P} \right)$$

$$(b) k = \left(\frac{2.303}{t} \right) \log \left(\frac{2P_0}{P_0 - P} \right)$$

$$(c) k = \left(\frac{2.303}{t} \right) \log \left(\frac{3P_0 - P}{2P_0} \right)$$

$$(d) k = \left(\frac{2.303}{t} \right) \log \left(\frac{2P_0}{3P_0 - 2P} \right)$$

22. If 75% of a first order reaction was completed in 60 minutes, 50% of the same reaction under the same conditions would be completed in

(a) 20 minutes (b) 30 minutes (c) 35 minutes (d) 75 minutes

23. The half life period of a radioactive element is 140 days. After 560 days, 1 g of element will be reduced to

(a) $\left(\frac{1}{2} \right)$ g (b) $\left(\frac{1}{4} \right)$ g (c) $\left(\frac{1}{8} \right)$ g (d) $\left(\frac{1}{16} \right)$ g

24. The correct difference between first and second order reactions is that **(NEET)**

(a) A first order reaction can be catalysed; a second order reaction cannot be catalysed.

(b) The half life of a first order reaction does not depend on $[A_0]$; the half life of a second order reaction does depend on $[A_0]$.

(c) The rate of a first order reaction does not depend on reactant concentrations, the rate of a second order reaction does depend on reactant concentrations.



(d) The rate of a first order reaction does depend on reactant concentrations: the rate of a second order reaction does not depend on reactant concentrations.

25. After 2 hours, a radioactive substance becomes $\left(\frac{1}{16}\right)^{\text{th}}$ of original amount. Then the half life (in min) is
 (a) 60 minutes (b) 120 minutes (c) 30 minutes (d) 15 minutes

ADDITIONAL QUESTIONS

26. Graph between $\log_{10} K$ and $(1/T)$ is linear of slope S . hence E_a is:

(a) $R \times S$ (b) S/R (c) R/S (d) $2.303 RS$

27. For the reaction



Which of the following does not express the reaction rate?

(a) $\frac{d[D]}{dt}$ (b) $-\frac{d[A]}{2 dt}$ (c) $-\frac{d[C]}{3 dt}$ (d) $-\frac{d[B]}{dt}$

28. If 60% of a first order reaction was completed in 60 minutes, 50% of the same reaction would be completed in approximately:
 (a) 50 minutes (b) 45 minutes (c) 60 minutes (d) 40 minutes

29. For the reaction



If $\frac{d[NH_3]}{dt} = 2 \times 10^{-4} \text{ mol L}^{-1} \text{ S}^{-1}$, the value of $\frac{-d[H_2]}{dt}$ would

be?

(a) $3 \times 10^{-4} \text{ mol, L}^{-1} \text{ S}^{-1}$ (b) $4 \times 10^{-4} \text{ mol L}^{-1} \text{ S}^{-1}$
 (c) $6 \times 10^{-4} \text{ mol L}^{-1} \text{ S}^{-1}$ (d) $1 \times 10^{-4} \text{ mol L}^{-1} \text{ S}^{-1}$

30. The addition of a catalyst during a chemical reaction alters which of the following quantities?



- (a) Enthalpy (b) Entropy
(c) Activation energy (d) Internal energy
31. The half life period of a first order reaction is 5 minutes, the time required for 99.9% completion is nearly equal to **(PTA MQ)**
(a) 99.9 minutes (b) 49.95 minutes
(c) 50 minutes (d) 10 minutes
32. The rate constant of a reaction at temperature 200 K is 10 times less than the rate constant at 400 K. What is the activation energy of the reaction ($R =$ gas constant) **(PTA MQ)**
(a) $1842.4 R$ (b) $921.2 R$ (c) $460.6 R$ (d) $230.3 R$
33. What is the rate law of the reaction $2A + 2B \longrightarrow C + 2D$. If the concentration of A is doubled at constant [B] the rate of the reaction increases by factor 4. If the concentration of B is doubled at constant [A], the rate is doubled. **(PTA MQ)**
(a) Rate = $k[A][B]^2$ (b) Rate = $k[A][B]$
(c) Rate = $k[A]^{1/2} [B]^2$ (d) Rate = $k[A]^2 [B]$
34. Time required for the reactant concentration to reach one half of its initial value is called: **(MAR 2020)**
(a) half life period (b) first order
(c) zero order (d) second order

EVALUATION (BOOK BACK)**2, 3 and 5 Mark Question and Answers**

- Define average rate and instantaneous rate.
- Define rate law and rate constant.
- Derive integrated rate law for a zero order reaction $A \rightarrow$ product.



4. Define half life of a reaction. Show that for a first order reaction half life is independent of initial concentration. (Or) Derive an equation for half life period of First order equation. **(PTA MQ)**
5. What is an elementary reaction? Give the difference between order and molecularity of a reaction. **(PTA MQ)**
6. Explain the rate determining step with an example. **(PTA MQ)**
7. Describe the graphical representation of first order reaction.
8. Write the rate law for the following reactions.
9. Explain the effect of catalyst on reaction rate with an example.
10. The rate law for a reaction of A, B and C has been found to be $\text{rate} = k[A]^2 [B][L]^{3/2}$. How would the rate of reaction change when
11. The rate of formation of a dimer in a second order reaction is $7.5 \times 10^{-3} \text{ mol L}^{-1} \text{ s}^{-1}$ at 0.05 mol L^{-1} monomer concentration. Calculate the rate constant. **(PTA MQ)**
12. For a reaction $x + y + z \rightarrow \text{products}$ the rate law is given by $\text{rate} = k[x]^{3/2} [y]^{1/2}$ what is the overall order of the reaction and what is the order of the reaction with respect to z.
13. Explain briefly the collision theory of bimolecular reactions.
14. Write Arrhenius equation and explains the terms involved.
Arrhenius equation



15. The decomposition of Cl_2O_7 at 500K in the gas phase to Cl_2 and O_2 is a first order reaction. After 1 minute at 500 K, the pressure of Cl_2O_7 falls from 0.08 to 0.04 atm. Calculate the rate constant in s^{-1} .
16. Give three example for Zero order reaction.
17. Explain pseudo first order reaction with an example.

(PTA MQ)

18. Identify the order for the following reactions.
19. A gas phase reaction has energy of activation 200 kJ mol^{-1} . If the frequency factor of the reaction is $1.6 \times 10^{13} \text{ s}^{-1}$. Calculate the rate constant at 600 K. ($e^{-40.09} = 3.8 \times 10^{-18}$)
20. For the reaction $2x + y \rightarrow L$ find the rate law from the following data.

[x] (min)	[y] (min)	rate (M s^{-1})
0.2	0.02	0.15
0.4	0.02	0.30
0.4	0.08	1.20

21. How do concentrations of the reactant influence the rate of reaction?
22. How do nature of the reactant influence rate of reaction.
23. The rate constant for a first order reaction is $1.54 \times 10^{-3} \text{ s}^{-1}$. Calculate its half life time. **(PTA MQ)**
24. The half life of the homogeneous gaseous reaction $\text{SO}_2\text{Cl}_2 \rightarrow \text{SO}_2 + \text{Cl}_2$ which obeys first order kinetics is



- 8.0 minutes. How long will it take for the concentration of $\text{SO}_2 \text{Cl}_2$ to be reduced to 1% of the initial value?
25. The time for half change in a first order decomposition of a substance A is 60 seconds. Calculate the rate constant. How much of A will be left after 180 seconds?
- (i) Order = 1, $t_{1/2} = 60$ seconds: $K = ?$
- (ii) $[A_0] = 100\%$ $t = 180\text{s}$
 $K_1 = 0.01155\text{S}^{-1}$ $[A] = ?$
26. A zero order reaction is 20% complete in 20 minutes. Calculate the value of the rate constant. In what time will the reaction be 80% complete?
27. The activation energy of a reaction is $225 \text{ k Cal mol}^{-1}$ and the value of rate constant at 40°C is $1.8 \times 10^{-5} \text{ s}^{-1}$. Calculate the frequency factor, A.
28. Benzene diazonium chloride in aqueous solution decomposes according to the equation $\text{C}_6\text{H}_5\text{N}_2\text{Cl} \rightarrow \text{C}_6\text{H}_5\text{Cl} + \text{N}_2$. Starting with an initial concentration of 10 g L^{-1} , the volume of N_2 gas obtained at 50°C at different intervals of time was found to be as under:

t (min):	6	12	18	24	30	∞
Vol. of N_2 (ml):	19.3	32.6	41.3	46.5	50.4	58.3

- Show that the above reaction follows the first order kinetics. What is the value of the rate constant?
29. From the following data, show that the decomposition of hydrogen peroxide is a reaction of the first order:

t (min)	0	10	20
V (ml)	46.1	29.8	19.3



Where t is the time in minutes and V is the volume of standard KMnO_4 solution required for titrating the same volume of the reaction mixture.

30. A first order reaction is 40% complete in 50 minutes. Calculate the value of the rate constant. In what time will the reaction be 80% complete? **(PTA MQ)**

ADDITIONAL QUESTIONS

2 and 3 Mark Question and Answers

1. Write the difference between Rate and Rate constant of a reaction. **(PTA MQ)**
2. Give example for first order reactions
3. Derive the equation for half life period of zero order reaction. **(PTA MQ)**
4. Show that in case of first order reaction, the time required for 99.9% completion is nearly ten times the time required for half completion of the reaction.
5. What are the factors affecting the rate of the reaction? **(PTA MQ)**
6. Explain the rate of reaction is affected by surface area of the reactant.
7. Derive Arrhenius equation to calculate activation energy from the rate constant K_1 and K_2 at temperature T_1 and T_2 respectively.

Five Mark Question and Answers

1. Derive integrated rate equation of first order reaction.
 $A \rightarrow \text{product}$. **(PTA MQ, MAR 20)**