## II YEAR PUC

### Chapter 1: Metallurgy II

| Sl. No. | Question | Obj/ Spec./ Diff. Level |
|---|---|---|
| 1. | Partition coefficient of Iodine between $CCl_4$ and water is 85 at 298K. What does it mean?<br><br>$I_2$ is 85 times more soluble in $CCl_4$ than in water at 298 K. | A<br>Drawing inference<br>Average |
| 2. | State Nernst's Distribution law.<br><br>Correct statement<br>Distribution of a solid between two immiscible solvents at constant temperature. | K<br>Recall<br>Easy |
| 3. | Mention one application of Nernst's distribution law.<br><br>Any suitable application | K<br>Recall<br>Easy |
| 4. | In Parke's process molten Zn is mixed with molten argentiferrous lead. Why ?<br><br>Silver is 300 times more soluble in molten Zn than in molten Pb. | U<br>Discriminate<br>Average |
| 5. | How many times is Ag more soluble in molten Zn than in molten Pb at 800°C ?<br><br>300 times | K<br>Mention<br>Easy |
| 6. | Mention the method for the separation of Ag from Zn – Ag alloy.<br><br>By distillation | K<br>Mention<br>Easy |
| 7. | What is argentiferrous lead?<br><br>Lead containing Ag and Fe etc as impurities. | K<br>Recognize<br>Easy |

8. What are Ellingham diagrams? — K, Define, Easy

Correct definition

9. Mention one application of Ellingham diagram in Metallurgy. — K, Mention, Easy

Any one suitable application

10. Why does the Ellingham curve for the formulation of HgO show steep rise at 356° C ? — U, Interpret, Average

Mercury boils or phase change

11. $\Delta G^\circ$ for the formation of metal oxides of metals A and B is –225J and –300J respectively. Which one of these metals is a good reducing agent? — A, Predict, Average

B. $\Delta G^\circ$ value for B is lower.

12. Which oxide of carbon is more stable at temperature more than 983K? — U, Compare, Average

Ans: CO

13. Why is the Ellingham curve for $C_{(s)} + O_{2\,(g)} \longrightarrow CO_{2(g)}$ is a straight line almost parallel to temperature axis? — A, Analyse, Average

Ans: $\Delta G^\circ$ is almost constant.

14. E.D. for the formation of metal oxides of metals A and B is given in diagram. Which one of these metal oxides is least stable? — S, Judge, Difficult

Ans: Metal oxide of A.

15. Al reduces $Cr_2O_3$ to Cr. What is the sign of $\Delta G^\circ$ for the reaction? — K, Recall, Easy

Ans: $\Delta G^\circ$ for the reaction is negative.

16. In Ellingham diagram, there is a sudden change in the slope of the curve for the formation of some metal oxides. Why ? — A, Generalize, Difficult

Ans: Phase change

17. Arrange the following metals in the increasing order of affinity towards oxygen.
Hg, Mg, Cr and Fe

A
Drawing inference
Difficult

Ans: Hg < Fe < Cr < Mg

18. Ellingham diagram for the formation of an oxide shows a negative slope. Name the oxide.

K
Recognise
Easy

Ans: CO (carbon monoxide)

19. Metal oxides are less stable at high temperatures. Why ?

A
Generalize
Difficult

Ans: $\Delta G^{\circ}$ becomes less negative. $\Delta G^{\circ}$ value increases.

20. When do curves in Ellingham diagram show a steep rise?

U
Interpret
Average

Because metal melts or boils/ phase change

21. Write the equation that occurs at around 900 K in the metallurgy of Fe.

K
Recall
Easy

Ans: $Fe_2O_3 + 3CO \longrightarrow 2FE + 3CO_2$

22. What is the role of calcium carbonate in the metallurgy of iron?

K
Recall
Easy

Ans: Acts as flux

23. Name the zone in the blast furnace when calcium silicate is formed.

K
Name
Easy

Ans: Slag formation zone

24. Which is the Principal reducing agent in the metallurgy of iron?

U
Identify
Average

Ans: Carbon monoxide

25. Using Ellingham diagram, show that $Cr_2O_3$ is more stable than $Fe_2O_3$.

S
Draw / compare / judge
Difficult

Because $Cr_2O_3$ lies below $Fe_2O_3$ in Ellingham diagram.

26. At a temperature less than 983 K, CO is a better reducing agent than carbon. Explain with the help of Ellingham Diagram.

S
Drawing/ Judging
Difficult

At low temperature, the plot of CO lies below the plot of carbon.

27. Ag and Hg can be obtained by thermal decomposition of their oxides. Assign reason with the help of Ellingham Diagram.

A
Reasons/ Drawing inference
Average

At lower temperature the plots Ag and Hg crosses $\Delta G^o = O$ line.

28. With the help of Ellingham diagram, explain why chromium does not reduce $Al_2O_3$ ?

S
Judging / drawing
Difficult

Because $Al_2O_3$ is more stable than $Cr_2O_3$ at all temperatures.

29. Mention any two salient features of Ellingham Diagram.

K
Mention
Easy

Any two features.

30. What is the role of ingredients in the metallurgy of iron?

U
Explain
Average

Lime stone – Flux
Coke – Fuel / reducing agent

31. Ellingham diagram for the formation of metal oxides of A, B and C is given in the diagram.
    a) Which is the most effective reducing agent to reduce 'C' ?
    b) Which is the least stable metal oxide?

S
Judging
Average

a) A
b) C

32. Explain with an example, the selection of a reducing agent for a metal oxide based on Ellingham diagram.

S
Drawing/ Judging
Difficult

Lower the E.C. for the formation of a metal oxide, greater is the reducing property of the metal. From the diagram we infer that $Al_2O_3$ is more stable than $Cr_2O_3$ and hence Al can reduce $Cr_2O_3$ to chromium.

33. Using Ellingham diagram, compare the relative stability of MgO and $Al_2O_3$.

S
Compare and drawing
Difficult

Below 1500° C MgO is more stable than $Al_2O_3$. Above 1500°C, $Al_2O_3$ is more stable than MgO.

34. "CO reduces $Fe_2O_3$ below 983 K". Justify it with help of Ellingham diagram.

S
Compare/ drawing/ judging
Difficult

Below 983 K the plot of CO lies below $Fe_2O_3$.
Therefore, CO has greater affinity to get oxidized and hence acts as a reducing agent, to reduce $Fe_2O_3$.

35. Mention the energetics. Write the equations occurring in combustion zone of metallurgy of iron.

U
Mention / explain
Average

$\Delta H$ is negative. $C + O_2 \longrightarrow CO_2$

36. Draw a neat labeled diagram of blast furnace.

S
Drawing and labeling
Average

Neat diagram with labeling

37. With equations explain the reaction occurring in different zones with temperature ranges during the extraction of cast iron. — U, Explain, Average

* Combustion zone – 1400° C to 1600° C

$C + O_2 \longrightarrow CO_2 \uparrow$

$CO_2 + C \longrightarrow 2CO$

With explanation.

* Reduction zone – 500° C – 700° C

$Fe_2O_3 + 3CO \longrightarrow 2Fe + 3\ CO_2 \uparrow$

With explanation

* Slag formation – 800° – 1000° C

$CaCO_3 \longrightarrow CaO + CO_2$

$CaO + SiO_2 \longrightarrow CaSiO_3$

With explanation

38. State Nernst's distribution law. Describe Parke's process of disilverisation of lead. — U, Explain, Average

Correct statement / procedure.

Molten Zn is added to molten lead at 800° C. Ag in molten lead passes into molten Zn forms Zn – Ag alloy. On distillation Ag is removed. By repeating the process 3 or 4 times to get more yield of Ag.

39. What are Ellingham diagrams? Sketch the Ellingham diagram for the formation of MgO, HgO and CO. — S, Drawing/ judging, Difficult

Statement for Ellingham Diagram - 1 mark

## Chapter 2: Industrial Important Compounds

| Sl. No. | Question | Obj/ Spec./ Diff. Level |
|---|---|---|
| 1. | "$H_2S$ gas cannot be dried by using conc. $H_2SO_4$". Assign reasons. | A, Assign reasons, Average |

Conc. $H_2SO_4$ oxidises $H_2S$ to yellow precipitate of sulphur.

2. Name the chemical used to remove Arsenic impurity in the reacting gases in manufacture of $H_2SO_4$ by contact process. — K, Cite, Average

Ans: Ferric hydroxide

3. $NH_3$ gas is not dried by using conc. $H_2SO_4$. Why ? — U, Explain, Average

$NH_3$ is base reacts with conc. $H_2SO_4$.

4. Name the catalyst used in the manufacture of $NH_3$ by Haber's process. — K, Mention, Easy

Ans: Finely divided iron

5. Name the reagent used in the purification Bauxite ore by Bayer's method. — U, Identify

Ans: Sodium hydroxide

6. Name the electrolytic cell used in the manufacture of caustic soda. — U, Identify, Average

Ans: Nelson's cell

7. What is brine? — K, Recall, Easy

Saturated solution of sodium chloride.

8. Mention the optimum temperature in the manufacture of $NH_3$ by Haber's process. — K, Mention, Easy

Ans: 450° C to 500° C

9. Name the gas liberated when Zn reacts with conc. $H_2SO_4$. — K, Recall, Easy

Ans: Sulphur dioxide

10. Name the gas liberated when Mg reacts with dil. $H_2SO_4$. — K, Recall, Easy

Ans: Hydrogen gas

11. What is Oleum?

Ans: Conc. $H_2SO_4$

K
Recall
Easy

12. Name the gaseous product formed when conc. $H_2SO_4$ react with formic acid.

Ans: Carbon monoxide

U
Explain
Average

13. Account for the use of asbestos diaphragm in the manufacture of NaOH by Nelson cell.

It prevents the recombination of products formed at Anode and Cathode.

A
Assign reason
Average

14. Name the byproducts formed in the manufacture of NaOH by Nelson cell.

Hydrogen
Chlorine

K
Recall
Easy

15. "Solid sodium hydroxide is stored in air-tight containers". Give reason.

Ans: NaOH is deliquescent.

A
Assign reason
Average

16. $H_2$ gas is liberated at cathode in preference of sodium in Nelson cell. Assign reason.

Discharge potential of $H_2$ is less than sodium.

U
Compare
Average

17. A colourless crystalline dicarboxylic acid on heating with conc. $H_2SO_4$ gives carbon monoxide and carbon dioxide. Identify the acid.

Ans: Oxalic acid

U
Identify
Average

18. An yellow residue of sulphur is obtained when a colourless gas treated with conc. $H_2SO_4$. Identify the gas. U Identify Average

Ans: ($H_2S$) Hydrogen gas

19. "Water is not added to conc. $H_2SO_4$". Assign reason. U Explain Average

Due to extensive hydration, large amount of energy is liberated.

20. Give the comparison of chromite ore. K Mention Easy

Ans: $FeOCr_2O_3$

21. Which radical is detected by chromyl chloride test? U Identify Average

Ans: Chloride ion

22. Name the two gases formed when conc. $H_2SO_4$ oxidises carbon. U Identify Average

Carbon dioxide, Sulphur dioxide

23. What is the role of conc. $H_2SO_4$ in the following equation? U Identify Average

$$HCOOH \xrightarrow[\Delta]{conc.\ H_2SO_4} CO + H_2O$$

Dehydrating agent

24. What is the colour change noticed when Pot. Dichromate is treated with potassium hydroxide? K Recall Easy

Orange red to yellow.

25. $SO_2$ gas is passed through acidified $K_2Cr_2O_7$ turns it green. Why ? U Identify Average

Ans: Chromic sulphate

26. "Conc. $H_2SO_4$ acts as oxidizing agent". Illustrate.

U
Explain
Average

Explanation with a suitable example.

27. What happens with conc. $H_2SO_4$ is added to KBr crystals?

U
Explain
Average

Explanation with equation

28. Steam is passed in manufacture of NaOH using Nelson cell. Give reasons.

U
Explain

1. To clear the pores of U-shaped tube.
2. To warm up the electrolyte thereby increases the conductivity.

29. Write the cell reactions occurring in Nelson cell in the manufacture of caustic soda.

A
Predict
Average

$NaCl \longrightarrow Na^+ + Cl^-$
$H_2O \quad H^+ + OH^-$
At cathode, $2H^+ + 2C^- \longrightarrow H_2$ (reduction)
At anode, $2Cl^- \longrightarrow Cl_2 + 2C^-$ (oxidation)

30. Give two uses of $NH_3$.

K
Recall
Easy

Any two uses.

31. What are the effects of pressure and temperature on the yield of $NH_3$ in Haber's process?

U
Explain
Average

High pressure and low temperature increase the yield of $NH_3$.

32. "Potassium dichromate acts as a very good oxidizing agent in acidic medium". Illustrate.

U
Explain
Average

Explanation with suitable example.

33. Write the cathodic reaction in Nelson cell.

U
Explain
Average

$NaCl \longrightarrow Na^+ + Cl^-$
$H_2O \qquad H^+ + OH^-$
At cathode, $2H^+ + 2C^- \longrightarrow H_2$ (reduction)

34. Give two industrial applications of potassium dichromate.

K
Recall
Easy

Any two suitable uses

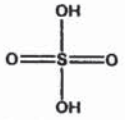
35. How do you convert potassium dichromate to chromyl chloride?

U
Explain
Average

Explanation and equation
$K_2Cr_2O_7 + 4\,KCl + 6H_2SO_4 \longrightarrow 2CrO_2Cl_2 + 6KHSO_4 + 3H_2O$

36. Show that conc. $H_2SO_4$ contains two OH groups using $PCl_5$.

U
Explain
Average




$H_2SO_4 + PCl_5 \longrightarrow$ .....$+ POCl_3 + HCl$
Chlorosulphonic acid
$HSO_3Cl + PCl_5 \longrightarrow SO_2Cl_2 + POCl_3 + HCl$
Sulpholyl chloride

37. Give two industrial applications of $H_2SO_4$.

K
Recall
Easy

Any two industrial applications.

38. Convert sodium chromate to sodium dichromate. How is sodium dichromate separated?

U
Explain
Average

Explanation and equation
$2Na_2CrO_4 + H_2SO_4 \longrightarrow Na_2Cr_2O_7 + Na_2SO_4 + H_2O$
On cooling the solution, less soluble $Na_2S$ separates out leaving behind $Na_2Cr_2O_7$.

39. Convert sodium dichromate to potassium dichromate.

U
Explain
Average

Explanation

$Na_2Cr_2O_7 + 2KCl \longrightarrow K_2Cr_2O_7 + 2NaCl$

40. Draw the flow chart diagram for the purification of reacting gases in the manufacture of $H_2SO_4$ by contact process.

S
Drawing
Average

Correct flow chart – 3 marks

41. What is the role of lime during the roasting of chromite ore with soda ash?

K
Recall
Easy

It makes the mass porous.

42. Describe the manufacture of caustic soda by Nelson cell.

U
Describe
Average

Diagram – 1 mark
Construction – 1 mark
Cell reaction- 1 mark
Working – 1 mark

43. Write the reactions involved in the manufacture of $H_2SO_4$ starting from sulphur.

U
Explain
Average

Each equation- 1 mark

44. Describe the manufacture of $H_2SO_4$ by contact process starting from pure reacting gases or purified gases.

U
Describe
Average

Each step – 1 mark

45. How is $NH_3$ manufactured by Haber's process?

U
Explain
Average

Diagram – 1 mark
Principle – 1 mark
Each step – 1 mark
Explanation – 2 marks

46. How is potassium dichromate manufactured from chromite ore? U Explain Average

Every step – 1 mark

47. Why is potassium dichromate called primary standard in volumetric analysis? U Explain Average

1. $K_2Cr_2O_7$ is available in 100% pure crystalline state.
2. The solution of $K_2Cr_2O_7$ is unaffected by air and sunlight. Hence its normality remains unchanged for long time.

**Chapter 3 : Noble Gases**

| Sl. No. | Question | Obj/ Spec./ Diff. Level |
|---|---|---|
| 1. | Who isolated the first Noble gas compound? | K Recall Easy |
| | Neil Bartlett | |
| 2. | What is the principle behind in Dewar's adsorption method for separation of Noble gases? | U Explain Average |
| | The extent of Adsorption increases with increase in atomic mass and decrease in temperature | |
| 3. | Which is the least abundant Noble gas in the atmosphere? | U Recall Easy |
| | Xenon | |

4. Name the Noble gas which is not adsorbed by Activated coconut charcoal.

K
Recall
Easy

Helium

5. Name the noble bas whose compound gas was first prepared by Neil Bartlett.

K
Recall
Easy

Xenon

6. Name the Noble gas which does not have octet electronic configuration.

U
Identify
Easy

Helium

7. Why Neon bulbs are used as beacon lights?

A
Drawing inference
Average

Neon light penetrate through fog and mist.

8. Name the reagent used to remove traces of $O_2$ from rare gas mixture.

K
Recall
Easy

Alk pyrogallol

9. Name the Noble gas which is least abundant in atmosphere.

K
Recall
Easy

Xenon

10. Name the Noble gas which has the greatest extent of adsorption on coconut charcoal.

K
Recall
Easy

Xenon

11. Name the noble gas which is radioactive.

K
Recall
Easy

Radon

12. Name the Noble gas which is the most abundant in atmosphere. K Recall Easy

Argon

13. How is $XePtF_6$ prepared? U Explain Average

Correct explanation with equation

14. How are Helium and Neon separated from the mixture of Noble gases? U Explain Average

Mixture of Noble gases kept in contact with $Ch^{-1}$ at $-100°C$, He, Ne are unadsorbed. Mixture of He and Ne now passed another $Ch^{-}$ unit at 93 K. He is unadsorbed and pumped out. On heating the charcoal unit Ne gets desorbed and collected separately.

15. Give two uses of He / Ne / Ar / Kr / Xe / Rn. (Any one) K Recall Easy

Any two uses (each)

16. Give reason why Helium is not adsorbed by Activated Coconut charcoal. A Assign reason Difficult

1. Low Van der waals forces of attraction between He atoms.
2. Low critical temperature
3. very low at mass

17. A mixture of $O_2$ and He is used by deep sea diver for breathing. Give reason. U Explain Average

Use of He avoids the formation of "bends".

18. Name the Noble gas that does not occur in the atmosphere. K Recall Easy

Radon

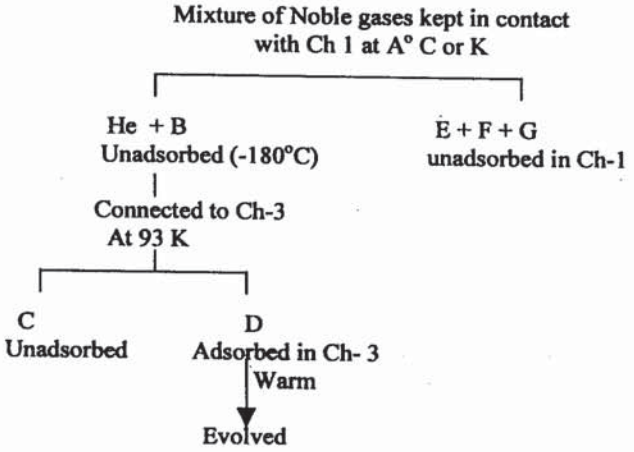
19. Neon bulbs are used in botanical gardens. Why ?

U
Explain
Average

It stimulates the growth of the plants.

20. Identify A, B, C and D in the following flow chart.

S
Judging
Average




A = 173 K or –100° C
B = Neon [Ne]
C = He [Helium]
D = Ne [Neon]

21. In Rayleigh-Ramsay method of isolation of noble gases from air.

i) Show the need for an electric arc is struck between the platinum electrodes.

ii) What is the role of sodium hydroxide in the above process? Write the equations involved.

A
Reasons
Average

i) To combine $N_2$ with $O_2$ to form Nitric oxide $N_2 + O_2 \rightarrow 2NO$

ii) NaOH is used to absorb $NO_2$ formed

$2NO_2 + 2NaOH \longrightarrow NaNO_2 + NaNO_3 + H_2O$

22. How are Noble gases isolated from air by Ramsay – Rayleigh method?

U
Explain
Average

Correct explanation with diagram.

| | | |
|---|---|---|
| 23. | How are Noble gases separated by Dewar's charcoal adsorption method? | U<br>Explain<br>Average |
| | Correct explanation<br>Mentioning temperature | |

**Chapter 4: d-block Elements**

| Sl. No. | Question | Obj/ Spec./ Diff. Level |
|---|---|---|
| 1. | What are d-block elements? | K<br>Define<br>Easy |
| | Correct definition – partially filled d-subshell. | |
| 2. | Give the general electronic configuration of 3d – series elements. | K<br>Recall<br>Easy |
| | $[Ar]3d^{1-10}\ 4S^{1-2}$ | |
| 3. | Give the electronic configuration of chromium. | K<br>Recall<br>Easy |
| | $[Ar]3d^{5}\ 4S^{1}$ | |
| 4. | Which elements shows highest oxidation state among 3d – series elements? | K<br>Name<br>Average |
| | Mn | |
| 5. | Name a compound in which manganese shows +7 oxidation state. | K<br>Name<br>Average |
| | Potassium Permanganate | |

6. Mention the oxidation state that exhibited by all the 3d-series elements.

K
Mention
Average

+2

7. Zinc is not considered as transition element. Assign reason.

U
Explain
Average

No partially filled 3d- subshell in ground state or common oxidation state.

8. $Fe^{3+}$ ion is more stable than $Fe^{2+}$ ion. Assign reasons.

A
Assign
reason
Average

1. $Fe^{3+}$ - [Ar] $3d^5$ – half filled orbitals
2. $Fe^{2+}$ - [Ar] $3d^6$ – four 3d orbitals

Ans: 5

9. Give an example for a transition metal compound in which transition metal exhibits zero oxidation state.

K
Name
Difficult

$[Ni(CO)_4]$ or $K_2[Ni(CN)_4]$

10. Most of the 3d-series metal compounds are colour. Why ?

U
Explain
Average

They have partially filled d-subshells.

11. What type of magnetic behaviour is shown by the transition elements containing unpaired electrons?

K
Recognize
Average

Paramagnetic behaviour

12. Write the formula used to calculate the spin only magnetic moment.

K
Recall
Easy

$\mu = \sqrt{n\,(n+2)}$ Bm

13. What is the unit of magnetic moment?

K
Mention
Easy

Bohr Magnaton Or (B.M.)

14. Mention the magnetic behaviour of $Ti^{3+}$.

U
Interpret
Average

Paramagnetic

15. Which one of the following will be coloured in aqueous solution? $Ti^{3+}$, $V^{3+}$, $Cu^{+}$

U
Identify
Difficult

$Ti^{3+}$

16. What is the trend in atomic size noticed among 3d-series of transition elements?

K
Recognize
Average

Decreases first, remains constant and then increases.

17. Write a note on the catalytic behaviour of transition metals.

K
Recall
Average

1. Variable oxidation states
2. Vacant d-orbitals
3. Larger surface area (any two)

18. Mention two factors that are responsible for the formation of complexes by 3d-series elements.

K
Recall
Average

1. High charge and small size
2. Vacant d-orbitals

19. $CuSO_4$ . $5H_2O$ is coloured compound and $ZnSO_4$. $7H_2O$ is a colourless compound. Why ?

U
Explain
Average

1. $CuSO_4 . 5H_2O - Cu^{2+}$ - contain unpaired electrons.
2. $ZnSO_4 . 7H_2O - Zn^{2+}$ - does not contain unpaired electrons.

20. Calculate the magnetic moment of $Fe^{2+}$. — S, Solve, Average

$Fe^{2+}$ - $3d^6\ 5s^o$ n = 4 ( ½ + ½ marks)
$M = \sqrt{n(n+2)}$ ( ½ mark)
$= \sqrt{4(4+2)}$
$= \sqrt{24}$
= 4.90 B.M. ( ½ mark)

21. Atomic radii of transition metals first decreases remains constant and then increases as we move from left to right along 3d-series. Explain. — U, Explain, Average

1. due to increase in effective nuclear charge
2. increase in screening effect of nuclear charge
3. repulsive interaction between added electrons is more.

## Chapter 5 : Co-ordination Compounds

| Sl. No. | Question | Obj/ Spec./ Diff. Level |
|---|---|---|
| 1. | Give the IUPAC name of $[Co(en)_3]Br_3$. | U, Naming, Easy |
| | Tri ethylenediamine cobalt (III) bromide | |
| 2. | What is the geometry of ferrocyanide ion? | K, Recall, Easy |
| | Octahedral | |
| 3. | $K_2[Ni(CN)_4]$ has square planar geometry. What is the hybridization of the concentrated ion? | U, Identify, Difficult |
| | $dsp^2$ | |

4. In $K_3[Fe(CN)_6]$ identify the species that satisfies both the primary and secondary valency of central metal ion.

U
Identify
Average

$CN^-$ ion

5. Which one of these is an ligand?
$H_2O$, $SCN^-$, $SO_4^{-2}$, ambidentate

U
Identify
Average

$SCN^-$

6. $K_2[HgI_4]$ is dissolved in water. How many ions per molecule of the complex is released in aqueous solution?

A
Predict
Average

Three (3)

7. Which one of these is a cationic complex?
$[Aq(NH_3)_2]NO_3$, $K_3[Fe(CN)_6]$, $[Ni(CO)_4]$

A
Classify
Easy

$[Aq\ (NH_3)_2]\ NO_3$

8. Give an example for a bidentate ligand.

K
Cite example
Easy

Any one correct example. Eg. Ethylene diamine oxalate ion

9. What is the coordination number of chromium in $[Cr(Cn)_2Cl_2]Br$ ?

U
Identify
Average

Six

10. Potassium cyanide ionizes to give $CN^-$, but $K_4\ [Fe(CN)_6]$ does not, when dissolved in water. Assign reasons.

A
Reason
Easy

$K_4[Fe(CN)_6]$ contains ($CN^-$) in coordination sphere that is non-ionisable.

11. Name the species that satisfies the secondary valency of the metal ion in cuprammonium sulphate.

U
Identify
Average

$NH_3$

12. The coordination number of the following compounds is six. Which one of the following gives a white ppt. will aqueous silver nitrate?
i) $Co(NH_3)_4Cl_3$ ii) $CO(NH_3)_3Cl_3$

A
Drawing
inference
Difficult

$CO(NH_3)_4Cl_3$

13. $K_3[Fe(CN)_6] \overset{\text{in water}}{\rightleftharpoons} 3K^+ + .....$
What is missing ion?

U
Identify
Average

$[Fe(CN)_6]^{-3}$

14. Identify the oxidation state of the metal in $[Ni(CN)_5]^{3-}$.

U
Identify
Easy

O. state is +2.
(O. No. of Ni = +2)

15. Which one of the following complex has tetrahedral geometry?
$[Ni(CO)_4]$, $[Cu(NH_3)_4]SO_4$, $[Zn(H_2O)_6]SO_4$

U
Identify
Average

$[Ni(CO)_4]$

16. Give an example for abidentate neutral ligand.

K
Recall
Average

Any one eg. Ethylenediamine

17. What type of isomerism is exhibited by the following compounds ?
$[Co(CN)_2BrONO]Cl$ and $[Co\ (en)_2BrNO_2]Cl$

A
Interpret
Average

Linkage isomerism – 1 mark

18. Write a hydrate isomer for $[Cr(H_2O)_6]Cl_3$.

U
Relationship
Average

Any one eg. $[Cr(H_2O)_5Cl]\ Cl_2.H_2O$

19. For $K_3[CoCl_6]$, identify the following :
i) central metal ion, ii) the ligand, iii) coordination number of central metal ion, iv) type of complex

Difficult

i) $CO^{+3}$ ii) chloride (chloro) iii) 6 iv) anionic complex

20. Show that $[Ni(Co)_4]$ satisfies EAN rule.

A
Drawing
inference
Difficult

Count the e's around nickel atom - 1 mark.
Match that with atomic number of nearest noble gas – 1 mark

21. Mention two limitations of VBT for coordination compounds.

K
Recall
Easy

1. Cannot account for spectral properties.
2. Relative stabilities of complexes.

22. Mention the magnetic behaviour of the following :
i) $[Ni(Co)_4]$ ii) $[Cu(NH_3)_4]SO_4$

K
Mention
Easy

i) Diamagnetic, ii) paramagnetic

23. Distinguish between primary and secondary valencies of a metal in a complex.

U
Discriminate
Easy

Any two differences.

24. What is linkage isomerism of Coordination compounds? Give an example.

U
Define/ cite
example

Statement – 1 mark, Example – 1 mark

25. Calculate the EAN of the central metal ion in the complex $K_2[NiCl_4]$.

S
Solve
Average

At. $NONI_{(28)}$ O. State $Ni_{(+2)}$ + No.l of electrons from ligands (8)
Answer – 1 mark

26. Draw the structure and state the hybridization of the central atom of potassium ferrocyanide.

S
Draw
Easy

Structure – 1 mark, hybridization – 1 mark

27. Write the postulates of valence bond theory of coordination compounds.

K
Mention
Easy

Any four points – (one mark each)

28. With respect to potassium ferrocyanide mention
    i) the oxidation state of CMI
    ii) type of hybridization involved
    iii) the ligand
    iv) geometry
    v) magnetic property
    vi) coordination number

U
Identify
Average

+2, $d^2sp^3$, $CN^-$, octahedral, diamagnetic, 6 - ½ value point each

29. Using VBT, account for the shape and magnetic property of $[Ni(CO)_4]$.

A
Drawing inference
Easy

Hybridization – 1 mark, shape – 1 mark, magnetic property – 1 mark

30. Write the postulates of Werner's theory for coordination compounds.

K
Recall
Easy

Three points – 1 value point each

**Chapter 6 : Chemical Bonding**

| Sl. No. | Question | Obj/ Spec./ Diff. Level |
|---|---|---|
| 1. | How are molecular orbitals formed? | K<br>Recall<br>Easy |
| | By linear combination of atomic particles | |
| 2. | Name the two types of molecular orbitals formed. | K<br>Name<br>Easy |

1. Bonding Molecular Orbital
2. Antibonding Molecular Orbital

3. Mention the maximum number of electrons that can be accommodated in a molecular orbital.

K
Mention
Easy

Two

4. Two atomic orbitals undergo additive linear combination. What type of molecular orbitals are formed?

U
Identify
Easy

Bonding molecular orbital

5. How does asymmetric combination of atomic orbitals take place?

U
Describe
Easy

It is formed by subtraction of the wave functions of two atomic orbitals.

6. Which type of molecular orbital is formed by symmetric combination of atomic orbitals?

K

Bonding molecular orbital

7. Which type of molecular orbital is formed by asymmetric combination of atomic orbitals?

K
Name
Easy

Antibonding Molecular Orbital

8. What is bond order?

K
Recall
Easy

Number of covalent bonds between two atoms in a molecule.

9. Sketch $\sigma^*$ is molecular orbital.

S
Drawing
Easy


$\sigma^*$ 1s

10. Oxygen molecule is paramagnetic. Why ?

A
Assign
reason
Easy

It contains unpaired electrons in $\pi^*$ 2py and $\pi^*$2px orbitals.
Or it contains unpaired electrons.

11. Write the electronic configuration of lithium molecule.

K
Recall
Easy

$\sigma 1s^2\ \sigma^* 1s^2\ \sigma 2s^2$

12. What is metallic bond?

K
Recall
Average

The force that keeps the metal atoms together in a metal as a result of the attraction between positive ions and surrounding freely moving electrons
Or correct definition

13. Valence electrons of metal atoms are freely moving in metals. Why?

A
Assign
reason

Due to low ionisation energy

14. Bond order of hydrogen molecule ($H_2$) is 1, $H_2^+$ is ½ . Which is more stable?

A
Predict
Easy

Hydrogen molecule

15. Write electronic configuration of hydrogen molecule.

K
Recall
Easy

$\sigma 1s^2$

16. $\pi^*$2py and $\pi^*$2pz orbitals of oxygen molecule have one electron each. Name the rule that expalins this arrangement.

K
Name
Easy

Hund's rule

17. Write electronic configuration of helium molecule.

K
Recall
Easy

$\sigma 1s^2\ \sigma^* 1s^2$

18. Sketch the $\sigma 1s$ molecular orbital.

S
Drawing
Easy

$\sigma 1s$

19. $He_2$ does not exist. Why ?

U
Explain
Average

Calculation of bond order (1 mark)
Inference (1 mark)

20. Give any two differences between bondingand antibonding molecular orbitals.

U
Compare
Average

Each difference ( 1 mark)

21. How does electron gas theory explain electrical conductivity of metals?

U
Explain
Average

According to electron gas theory, how electrons are present in metals (1 mark)
After applying electric field, how those electrons arrange (1 mark)

22. Calculate the bond order in lithium molecule.

S
Solve
Average

Equation for calculating bond order (1 mark)
Substitution and answer (1 mark)

23. With the help of electron gas theory, explain why metals are lustrous?

U
Explain

Definition of electron gas theory (1 mark)
On falling light, what happens (1 mark)

24. How does electron gas theory explain malleability and ductility of metals? — U, Explain

Definition of gas theory (1 mark)
Explanation (1 mark)

25. Explain thermal conductivity of metals on the basis of electron sea model. — U, Explain

Definition of electron gas theory (1 mark)
Explanation (1 mark)

26. Draw the energy level diagram for molecular orbitals of lithium molecule. — S, Draw

Energy level diagram (2 marks)

27. Draw the energy level diagram of molecular orbitals of hydrogen molecule. Calculate the bond order. — S, Drawing, Average

Energy level diagram (1 mark)
Bond order (1 mark)

28. Explain electron sea model of metallic bond. — U, Explain, Average

Explanation (2 marks)

29. Describe the formation of bonding molecular orbitals by the linear combination of atomic orbitals. — U, Describe, Average

Additive combination (1 mark)
Wave equation (1 mark)

30. Describe the formation of antibonding molecular orbitals by the linear combination of atomic orbitals. — U, Describe, Average

Substractive combination (1 mark)
Wave equation (1 mark)

31. Draw the energy level diagram for oxygen molecule. Calculate its bond order and predict the magnetic property.

S
Drawing
Average

Energy level diagram (2 marks)
Bond order (1 mark)
Magnetic property (1 mark)

## Chapter 7 : Chemical Kinetics

| Sl. No. | Question | Obj/ Spec./ Diff. Level |
|---|---|---|
| 1. | What is the unit of rate of reaction?<br><br>$mol\ dm^{-3}\ s^{-1}$ | K<br>Recall<br>Easy |
| 2. | Write the relation between energy of activation and velocity constant of a reaction.<br><br>$k = A\ e^{-Ea/RT}$ | K<br>Recall<br>Average |
| 3. | What is the unit of concentration in reaction kinetics?<br><br>$mol\ dm^{-3}$ | K<br>Recall<br>Easy |
| 4. | Define Order of a Reaction.<br><br>It is the sum of the powers of concentration terms in the experimentally determined rate equation for the reaction. | K<br>Definition<br>Average |
| 5. | How is half-period related to the initial concentration for nth order reaction?<br><br>$t_{1/2} \propto \frac{1}{a^{n-1}}$ | U<br>Relationship<br>Average |

6. Mention the order for alkali hydrolysis of methyl acetate. K Recall Easy

2

7. Half-life period of a reaction is inversely proportional to the initial concentration of the reactant. What is the order of the reaction? A Analyse Average

1

8. Define Threshold Energy. K Define Average

The minimum amount of energy possessed by the reactant molecules to react to form products upon collision is called Threshold Energy.

9. The rate of reaction increases 4 times when the concentration of the reactant is doubled. What is the order of the reaction? A Analyse Average

2 (two)

10. Define half life period. K Definition Average

The time at which the molar concentration of a reactants gets reduced to exactly half of its initial value.

11. Define Activation Energy. K Definition Average

The minimum extra energy that the normal reacting molecules should acquire to attain threshold energy to form products upon collision.

12. Define temperature coefficient of a reaction. K Definition Average

It is the ratio of velocity constant at (T + 10) k to velocity constant Tk.

13. Define Zero Order Reaction.

K
Definition
Average

A Zero Order Reaction is one in which velocity of the reaction is independent of the concentration of any of the reactants.

14. What is First Order Reaction?

K
Definition
Average

A chemical reaction in which the rate is directly proportional to the first power of the concentration of the reactant is a first order reaction.

15. Give an example for pseudo-first order reaction.

U
Example
Easy

$CH_3 + COOCH_3 + H_2O \xrightarrow{H^+} CH_3 - COOH + CH_3OH$
Or any other suitable example .
Explanation in words, that is acid hydrolysis of methyl acetate.

16. Find the overall order of a reaction with a rate equation
$V = k [A]^2 [B]^1$

A
Calculation
Easy

3

17. Define pseudo first order reaction,

K
Definition
Average

A chemical reaction of higher order can be converted into first order by taking the other reactants except one in large excess.

18. What is the effect of temperature on the rate of reaction?

U
Interpret
Easy

Increases

19. Give an example for $2^{nd}$ order reaction.

U
Cite example
Average

$CH_3COOCH_3 + NaOH \longrightarrow CH_3COONa + CH_3OH$ or explanation or any other suitable example.

20. Give an example for fractional order reaction.

U
Cite example
Average

$CH_3CHO \longrightarrow CH_4 + CO$
Or $H_2 + Br_2 \longrightarrow 2HBr$
Or any other suitable example

21. Give an example for zero order reaction.

U
Cite example
Average

Formation of hydrogen chloride in diffused sunlight
Or $H_2 + Cl_2 \xrightarrow{Diffused\ sunlight} 2HCl$
Or any other suitable example.

22. How is half life period related to velocity constant of a first order reaction?

U
Relation
Average

$t_{1/2} = \frac{0.693}{k}$

23. When the temperature of a reaction increases by 20 degrees, by what factor does the rate increase if the temperature coefficient is 2?

A
Analyse
Average

4 times

24. If the rate of a reaction is independent of concentration of the reactant, what is the order of the reaction?

U
Identify

Zero

25. What is the order of the following reaction ?
$R - COO- R' + NaOH \longrightarrow R - COONa + R' - OH$

U
Identify
Average

2 (two)

26. Give the expression for the rate of reaction for a reaction,
$2A \longrightarrow$ products, which follows zero order kinetics.

A
Predict
Easy

$V = k [A]^0$

27. Rate equation for a reaction is $r = k [A]^{1/2} [B]^{3/2}$ what is overall order of the reaction?

A
Calculation
Easy

2

28. If the reaction between A and B gives C, and shows first order kinetics with respect to A and second order kinetics with respect to b, write rate equation.

A
Calculation
Average

$r = k [A]^1 [B]^2$

29. What is the unit for velocity constant of a first order reaction?

K
Recognize
Easy

$Sec^{-1}$

30. Mention any two factors deciding the order of the reaction.

K
Mention

1. Mechanism (1 mark)
2. Concentration (1 mark) or pressure

31. A first order reaction has a rate constant $3.2 \times 10^{-3}$ $min^{-1}$ calculate half-life period of the reaction.

A
Calculation
Average

$t_{1/2} = \frac{0.693}{k}$ ( ½ mark)
Substitution ( ½ mark)
Correct answer ( ½ mark)
Unit ( ½ mark)

32. What is zero order reaction? Give an example.

U
Cite example
Average

Definition (1 mark)
Example (1 mark)

33. The rate constant of a first order reaction is 0.002 $sec^{-1}$. Calculate half life period.

A
Calculation
Average

$t_{1/2} = \frac{0.693}{k}$ ( ½ mark)
Substitution ( ½ mark)
Answer ( ½ mark)
Unit ( ½ mark)

34. What is pseudo first order reaction? Give an example.

U
Cite example
Average

Definition (1 mark)
Example (1 mark)

35. Show that the rate of a first order reaction doubles when the concentration of the reactants doubled.

S
Justify
Average

$r_1 = k [A]^1$ (1) ( ½ mark)
$r_2 = k [2a]^1$ (2) ( ½ mark)
$\Rightarrow r_2 = 2 . k [A]^1$ ( ½ mark)
$r_2 = 2r_1$ ( ½ mark)

36. The time for half –life of a first order reaction is found to be 30 min. Calculate the rate constant of a reaction.

A
Calculation
Average

$k = \frac{0.693}{t_{1/2}}$ ( ½ mark)
Substitution ( ½ mark)
Correct answer ( ½ mark)
Unit ( ½ mark)

37. The rate constant of a first order reaction is 0.01386 $min^{-1}$. Calculate the time required for the initial concentration of 1 mol $dm^{-3}$ to get reduced to 0.5 mol $dm^{-3}$.

A
Calculation
Average

$\left( t_{1/2} = \frac{0.693}{k} \right)$
Equation ( ½ mark)
Substitution ( ½ mark)
Correct answer ( ½ mark)
Unit ( ½ mark)

38. If half life of a first order reaction is 100 secs, calculate the rate constant of a reaction at 298 K.

A
Simple problem
Average

$K = \frac{0.693}{t_{1/2}}$ ( ½ mark)
Substitution ( ½ mark)
Answer ( ½ mark)
Unit ( ½ mark)

39. The rate of reaction increases 4 times, when the concentration of the reactant is doubled. Calculate the order of the reaction.

A
Calculation

$r \propto [A]^n$ ( ½ mark)
$4 \propto [2]^n$ ( ½ mark)
$2^2 \propto [2]^n$ ( ½ mark)
$\therefore n = 2$ ( ½ mark)

40. A first order reaction takes 50 minutes for 50% completion. Calculate velocity constant.

A
Simple calculation
Average

Formula – ½ mark
Substitution – ½ mark
Correct answer – ½ mark
Unit – ½ mark

41. In a first order reaction, the concentration of reactant reduced from 10 $mol/dm^3$ to 5 $mol/dm^3$ in 40 minutes. Calculate rate constant.

A
Simple calculation

Formula ( ½ mark)
Substitution ( ½ mark)
Correct answer ( ½ mark)
Unit ( ½ mark)

42. Describe the graphical method for the determination of order of the reaction.

U
Describe
Average

1. Graph for the determination of order ( 1 mark)
2. Explanation (2 marks)

43. Describe the Ostwald isolation method for the determination of order of the reaction.

U
Describe
Average

1. for r × 4 having two or more reactants with general equation ( 1 mark)
2. Explanation (2 marks)

44. Explain the influence of +ve catalyst on the rate of reaction with the help of energy profile diagram.

S
Drawing
Difficult

Energy profile diagram ( 1 mark)
Catalyst provides alternate path (1 mark)
Ea decreases ( 1 mark)

45. Calculate the energy of activation if rate constant of a reaction is doubled when the temperature is increased from 300 to 310 k. [R = 8.8324 $Jk^{-1}$ $mol^{-1}$]

S
Solve
Average

$$\text{Log}\ \frac{k_2}{k_1} = \frac{Ea}{2.303\ R}\left[\frac{T_2 - T_1}{T_1 T_2}\right]$$ ( 1 mark)

Substitution ( 1 mark)
Correct answer with unit (1 mark)
(53598 s/mole = 53.598 kJ/mole)

46. Derive an expression for velocity constant for a first order reaction.

U
Derivation
Average

Upto rate equation with concentration of the reaction
$r = k[A]^1$ (1 mark)
Upto - $\text{Ln}\ (a - x) = kT + C$ ( 1 mark)
Finding C. (1 mark)
Final expression (1 mark)

47. Show that for an I-order reaction, the value of $t_{3/4}$ is twice the value of $t_{1/2}$.

S
Solve
Difficult

$$k_{3/4} = \frac{2.303}{t_{3/4}} \log \frac{a}{(a - x)}$$ (1 mark)

$$= \frac{2.303}{t_{3/4}} \log 4$$

$$k_{1/2} = \frac{2.303}{t_{1/2}} \log \frac{100}{50}$$ (1 mark)

$$= \frac{2.303}{t_{1/2}} \log 2$$

Relation (1 mark)

$t_{3/4} = 2\, t_{1/2}$ (1 mark)

48. The rate constant for a reaction at 298 K and 318 K are 0.00325 $sec^{-1}$ and 0.01325$s^{-1}$ respectively. Calculate the energy of activation ($k = 8.314\ J\ k^{-1}\ mol^{-1}$)

S
Solve
Average

$$\log \frac{k_2}{k_1} = \frac{Ea}{2.303\ R} \left[ \frac{T_2 - T_1}{T_1 T_2} \right]$$ (1 mark)

Substitution and simplification (2 marks)

Answer and unit (1 mark)

49. 75% of first order r × n is completed in 72 min. Calculate the half life period of the reaction.

S
Solve
Difficult

$$k = \frac{2.303}{7} \log \frac{a}{a - x}$$ ( ½ mark)

Substitution ( ½ mark)

Correct answer with unit for k ( 1 mark)

$$t_{1/2} = \frac{0.693}{k}$$ ( ½ mark)

Substitution ( ½ mark)

Correct answer with unit (1 mark)

50. A first order r × n is 25% completed in 30 min. Calculate a) specific r × n rate, b) time required for 75% r × n to be completed.

S
Solve
Difficult

Equation, $k = \frac{2.303}{7} \log \frac{a}{a - x}$ ( ½ mark)

Substitution ( ½ mark)

Correct value of k with unit ( 1 mark)

Equation ½ M $\left[ t_{75\%} = \frac{2.303}{k} \log \frac{a}{ax} \right]$

Substitution ( ½ mark)

Correct answer with unit (1 mark)

51. Show that the time required for 99% completion of reaction is twice the time taken for 90% completion.

A
Calculation
Difficult

$$k = \frac{2.303}{t_{99}} \log \frac{a}{a-x}$$

$$k = \frac{2.303}{t_{99}} \log \frac{100}{1}$$

$$k = \frac{2.303}{t_{99}} \times 2 \quad .....(1)$$

$$k = \frac{2.303}{t_{90}} \log \frac{100}{10}$$

$$k = \frac{2.303}{t_{90}} \times 1 \quad .... \quad (2)$$

(4 marks)

Relate (1) and (2)

$$\frac{2.303}{t_{99}} \times 2 = \frac{2.39}{t_{90}} \times 1$$

$\therefore t_{99} = 2t_{90}$ ( 1 mark)

52. A first order reaction is 40% completed at the end of 50 minutes. What is the value of rate constraint? In how many minutes will be the reaction 80% completed?

A
Calculation
Average

Calculation of k :
Formula = ½ mark
Substitution = ½ mark
Correct answer = ½ mark
Unit = ½ mark

Calculation of t :

Formula = ½ $\Rightarrow$ $t_{80-1} = \frac{2.303}{t} \log \frac{100}{(100-20)}$

Substitution = ½ mark
Correct answer = ½ mark
Unit = ½ mark

53. The rate constant of a first order r × n is $2.3 \times 10^{-4}$ $s^{-1}$. Calculate the time taken for completion of 2/3rd of the r × n.

A
Calculate

Equation (1 mark)
Substitution and simplification (2 marks)
Correct answer ( ½ mark)
Unit ( ½ mark)

54. A first order r × n 50% completed in 30 min. at 27° C and 10 min at 47° C. Calculate energy of activation(R = 8.314 $Jk^{-1}$ $mol^{-1}$). A Calculate Average

Calculation of rate constant

$k_1 = \frac{0.693}{t_{1/2}}$ ( ½ mark)

Answer ( ½ mark)

Similarly $k_2$ (1 mark)

Calculation of Ea with unit (2 marks)

55. The rate constant of a reaction at 25° C is $3.5 \times 10^{-3}$. Calculate the temperature coefficient and rate constant at 35° C, given Ea = 52.3 kJ. A Calculation Difficult

$\log \frac{k_2}{k_1} = \frac{Ea}{2.303\ R}\left[\frac{T_2 - T_1}{T_1 T_2}\right]$ ( 1 mark)

Substitution and calculation ( ½ mark + ½ mark)

$\log \frac{k_2}{k_1} = 0.2975$

$\frac{k_2}{k_1}$ = Antilog 0.2975 } (1 mark)

$\frac{k_2}{k_1} = 1.984$

$k_2 = 1.984 \times 3.5 \times 10^{-3} = 6.94 \times 10^{-3}$ (1 mark)

56. The energy of activation of a certain reaction is 11400 J. Velocity constant at 373 k is $0.75 \times 10^{-1}$ $min^{-1}$. What is velocity constant at 473 k? A Calculation Average

Formula (1 mark)

Substitution (1 mark)

Calculation of $k_2$ ( 2 marks)