Paper-1

JEE Advanced, 2015

Part II: Chemistry

Note: Answers have been highlighted in "<mark>Yellow</mark>" color and Explanations to answers are given at the end

Read the instructions carefully:

General:

1. This sealed booklet is your Question Paper. Do not break the seal till you are instructed to do so.

2. The question paper CODE is printed on the left hand top corner of this sheet and the right hand top corner of the back cover of this booklet.

3. Use the Optical Response Sheet (ORS) provided separately for answering the questions.

4. The ORS CODE is printed on its left part as well as the right part. Ensure that both these codes are identical and same as that on the question paper booklet. If not, contact the invigilator.

5. Blank spaces are provide within this booklet for rough work.

6. Write your name and roll number in the space provided on the back cover of this booklet.

7. After breaking the seal of the booklet. Verify that the booklet contains 32 pages and that all the 60 questions along with the options are legible.

   Question paper format and marking scheme :

8. The question paper has three parts: Physics, Chemistry and Mathematics. Each part has three sections.

9. Carefully read the instructions given at the beginning of each section.

10. Section 1 contains 8 questions. The answer to each question is a single digit integer ranging from 0 to 9 (both inclusive).

    Marking scheme: +4 correct answer and 0 in all other cases.

11. Section 2 contains 10 multiple choice questions with one or more than one correct option.

    Marking scheme: +4 for correct answer, 0 if not attempted and -2 in all other cases.

12. Section 3 contains 2 " match the following" type questions and you will have to match entries in Column I with the entries in Column II.

    Marking scheme: <u>for each entry in Column I,</u> +2 for correct answer, 0 if not attempted and -1 in all other cases.

    OPTICAL RESPONSE SHEET :

13. The ORS consists of an original (top sheet) and its carbon-less copy. (bottom sheet).

14. Darken the appropriate bubbles on the original by applying sufficient pressure. This will leave an impression at the corresponding place on the carbon-less copy.

15. The original is machine-gradable and will be collected by the invigilator at the end of the examination.

16. You will be allowed to take away the carbon-less copy at the end of the examination.

17. Do not tamper with or mutilate the ORS.

18. Write your name, roll number and the name of the examination center and sign with pen in the space provided for this purpose on the original. Do not write any of these details anywhere else. Darken the appropriate bubble under each digit of your roll number.

<u>Note:</u> Answers have been highlighted in "Yellow" color and Explanations to answers are given at the end

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SECTION 1 (Maximum Marks: 32)

- This section contains **EIGHT** questions
- The answer to each question is a **SINGLE DIGIT INTEGER** ranging from 0 to 9, both inclusive
- For each question, darken the bubble corresponding to the correct integer in the ORS
- Marking scheme:
  +4 If the bubble corresponding to the answer is darkened
  0 In all other cases

Q.21 If the freezing point of a 0.01 molal aqueous solution of a cobalt (III) chloride – ammonia complex (which behaves as a strong electrolyte) is – 0.0558 °C, the number of chloride(s) in the coordination sphere of the complex is

[K_f of water = 1.86 K kg mol^{-1}]

Ans..21 (1)

Q.22 All the energy released from the reaction $X \rightarrow Y$, $\Delta G° = -193$ KJ mol^{-1} is used for oxidizing M^+ as $M^+ \rightarrow M^{3+} + 2e^-$, $E° = -0.25V$.

Under standard conditions, the number of moles of M^+ oxidized when one mole of X is converted to Y is

[F = 96500 C mol^{-1}]

Ans..22 <mark>(4)</mark>

Q.23 For the octahedral complexes of Fe^{3+} in SCN^- (thiocyanato) and in CN^- ligand environments, the difference between the spin-only magnetic moments in Bohr magnetons (when approximated to the nearest integer) is

[Atomic number of Fe = 26]

Ans..23 <mark>(4)</mark>

Q.24 The total number of lone pairs of electrons in N_2O_3 is

Ans..24 <mark>(8)</mark>

Q.25 Among the triatomic molecules/ions, BeCl2, N_3^-, N_2O, NO_2^+ O_3, SCI_2, ICI_2^-, I_3^- and XeF_2, the total number of linear molecule(s)/ion(s) where the hybridization of the central atom does not have contribution from the d-orbital(s) is
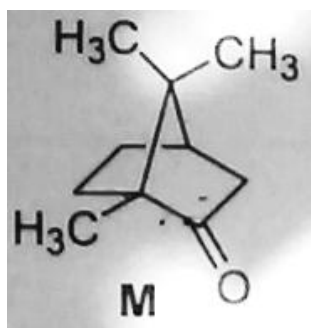
[Atomic number: S = 16, Cl = 17, I = 53 and Xe = 54]

Ans..25 <mark>(3)</mark>

Q.26 Not considering the electronic spin, the degeneracy of the second excited state (n = 3) of H atom is 9, while the degeneracy of the second excited state of H$^-$ is
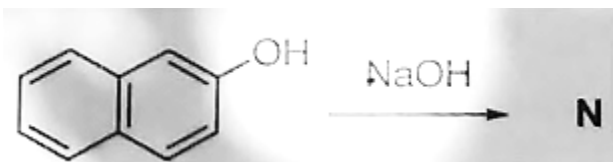
Ans..26 <mark>(3)</mark>

Q.27 The total number of stereoisomers that can exist for M is

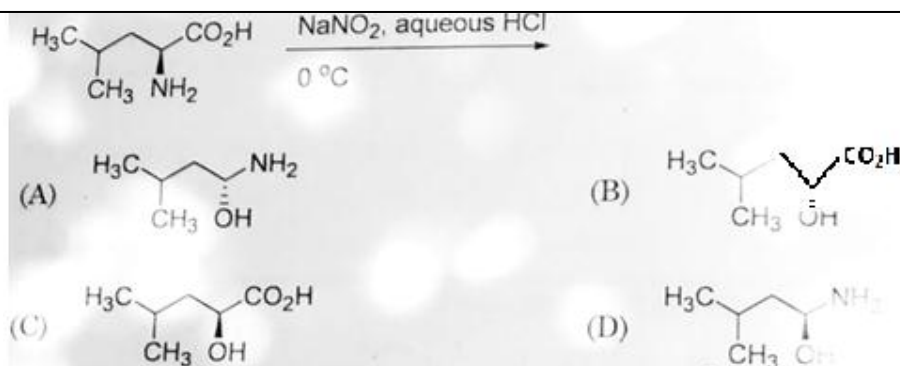**Ans..27** <mark>(2)</mark>

Q.28 The number of resonance structures for N is

Ans.28 (9)

Ans.29 (B)

Q.30 The correct statement(s) about Cr^{2+} and Mn^{3+} is(are)

[Atomic number of Cr = 24 and Mn = 25]

(A) Cr^{2+} is a reducing agent

(B) Mn^{3+} is an oxidizing agent

(C) Both Cr^{2+} and Mn^{3+} exhibit d^4 electronic configuration

(D) When Cr^{2+} is used as a reducing agent, the chromium ion attains d^5 electronic configuration

Ans.30 (A,B,C)

Q.31 Copper is purified by electrolytic refining of blister copper, The correct statement(s) about this process is (are)

(A) Impure Cu strip is used as cathode

(B) Acidified aqueous $CuSO_4$ is used as electrolyte

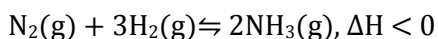(C) Pure copper deposits at cathode

(D) Impurities settle as anode-mud

Ans.31 (B,C,D)

Q.32 Fe^{3+} is reduced to Fe^{2+} by using

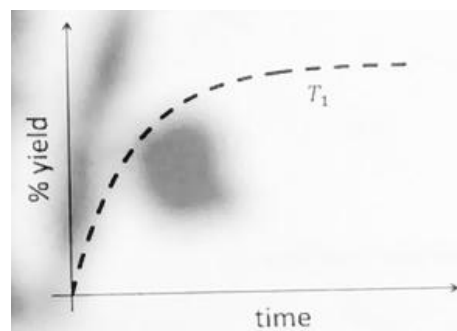(A) H_2O_2 in presence of NaOH   (B) Na_2O_2 in water

(C) H_2O_2 in presence of H_2SO_4 (D) Na_2O_2 presence of H_2SO_4

Ans.32 (A,B)

Q.33 The %yield of ammonia as a function of time in the reaction

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$, $\Delta H < 0$

At (P, T_1) is given below.

If this reaction is conducted at (P,T_2), with $T_2 > T_1$, the %yield of ammonia as a function of time is represented by

Ans.33 (C)

Q.34 If the unit cell of a mineral has cubic close packed (ccp) array of oxygen atoms with m fraction of octahedral holes occupied by aluminium ions and n fraction of tetrahedral holes occupied by magnesium ions, m and n, respectively, are

(A) $\frac{1}{2}, \frac{1}{8}$　　　　　　　　(B) $1, \frac{1}{4}$

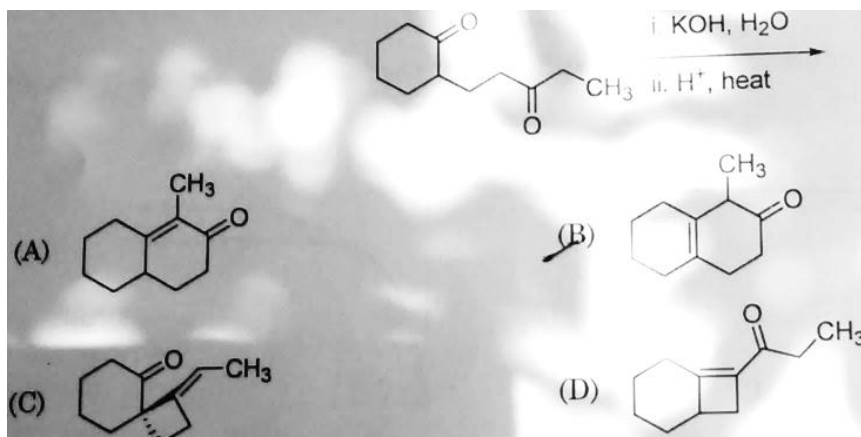(C) $\frac{1}{2}, \frac{1}{2}$　　　　　　　　(D) $\frac{1}{4}, \frac{1}{8}$

Ans.34 (A)

Q.35 Compound(s) that on hydrogenation produce(s) optically inactive compound(s) is(are)
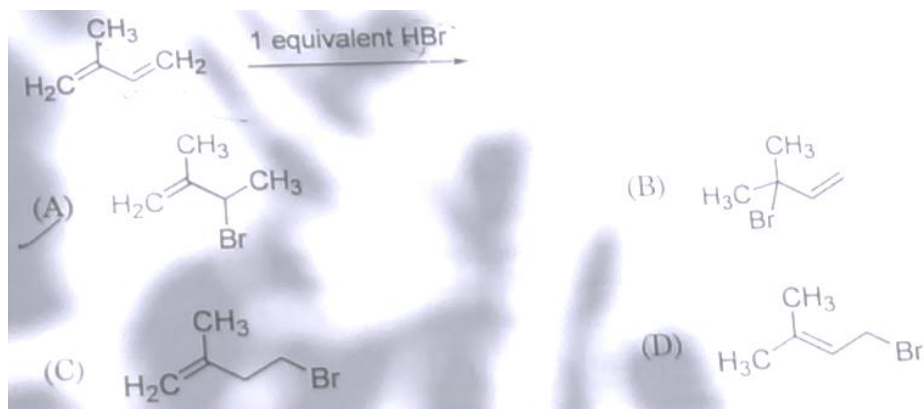

Ans.35 (B,D)

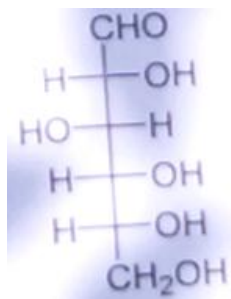**Q.36** The major product of the following reaction is

Ans.36 (B)

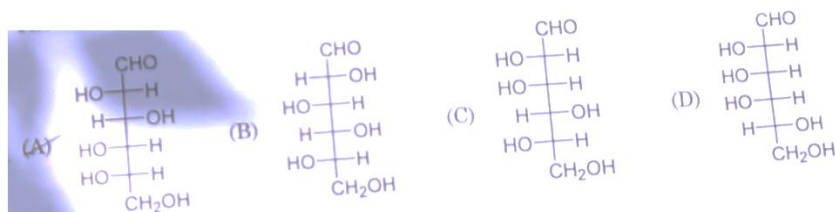**Q.37** In the following reaction, the major product is

Ans.37 (B)

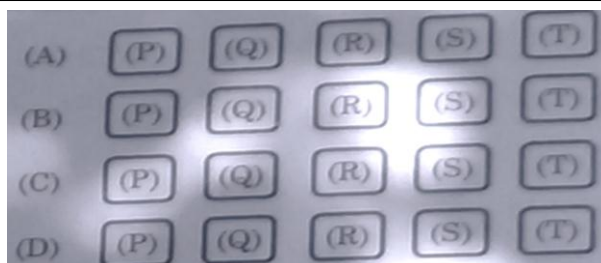**Q.38** The structure of D.(+)-glucose is

The structure of L-(-)-glucose is

Ans.38 (A)

SECTION 3 (Maximum Marks: 16)

- This section contains **TWO** questions
- Each question contains two columns, **Column I and Column II**
- Column I has four entries (A), (B), (C) and (D)
- Column II has five entries (P), (Q), (R), (S) and (T)
- Match the entries in **Column I** with the entries in **Column II**
- One or more entries in **Column I** may match will one or more entries in **Column II**
- The ORS Contains a 4 x 5 matrix whose layout will be similar to the one shown below:

- For each entry in **Column I**, darken the bubbles of all the matching entries. For example, if entry (A) in Column **I matches** with entries (Q), (R) and (T), then darken these three bubbles in the ORS. Similarly, for entries (B), (C) and (D).
- Marking scheme:
  For each entry in **Column I**
  +2   if only the bubble(s) corresponding to all the correct match(es) is(are) darkened
   0   If none of the bubbles is darkened
  -1   In all other cases

Q.39 Match the anionic species given in Column I that are present in the ore(s) given in Column II.

Column I	Column II
(A) Carbonate	(P) Siderite
(B) Sulphide	(Q) Malachite
(C) Hydroxide	(R) Bauxite
(D) Oxide	(S) Calamine

Ans.39 (A-P, Q), (B-T),(C-Q, R) and (D-R,S)

Q.40 Match the thermodynamic processes given Column I with the expressions given under Column II.

Column I	Column II
(A) Expansion of water at 273 K and 1 atm	(P) q = 0
(B) Expansion of 1 mol of an ideal gas into a	(Q) w = 0

Vacuum under isolated conditions

(C) Mixing of equal volumes of two ideal gases at Constant   (R) $\Delta S_{sys} < 0$

 temperature and pressure in an isolated container

(D) Reversible heating of H_2 (g) at 1 atm from   (S) $\Delta U = 0$

300 K to 600 K, followed by reversible cooling to 300 K at 1 atm

(T) $\Delta U = 0$

Ans.40 (A) → Q, R, T

(B) → P, Q, S

(C) → P, Q, S

(D) → P, Q, S, T

Answer Keys and Explanations

Sol.21 (1)

Given that the complex is a strong electrolyte, therefore, it dissociates completely.

According to vant – hoff's equation,
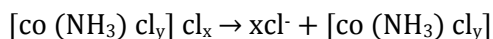
$\Delta T_f = k_f \times m \times i$

$\Delta T_f = 0.0558°C = 0.0558$ K

$\therefore 0.0558$ K $= 1.86$ k kg mol$^{-1} \times .01$m $\times i$

$\qquad i = 3$

$\therefore$ the no. of ions after dissociation $= 3$

Let the no. of chloride ions outside the coordination sphere is x

$[co (NH_3) cl_y] cl_x \rightarrow xcl^- + [co (NH_3) cl_y]$

$i = \dfrac{\text{no.of ions ofter dissociation}}{\text{no.of ions before dissociation}}$
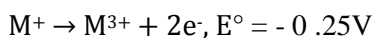
$3 = \dfrac{x+1}{1}$

$x = 2$

$\therefore$ no. of chloride ions outside the sphere $= 2$

$\therefore$ To balance the charge on the complex, 1 chloride ion has to go inside the sphere

$\therefore$ Ans $= 1$

Sol.22 (4)

For the reaction

$M^+ \rightarrow M^{3+} + 2e^-$, $E° = -0.25$V

$\Delta G°$ for the cell

$\Delta G° = - nf E°$ cell

$\qquad = +2 \times 96500$ cmol$^{-1} \times 0.25$V

$\qquad = 48250$ J mol^{-1}

The $\Delta G°$ we are providing by the reaction X $\rightarrow$ Y

$\Delta G°_{rxn}$ = -193000 J mol^{-1}

$\therefore$ no. of moles of M$^+$ oxidised to M^{3+} is

$$\frac{-193000 \ J \ mol^{-1}}{-48250 \ J \ mol^{-1}}$$

$$= 4$$

Sol.23 (4)

Fe^{3+} electronic conf. is 3d^5

SCN$^-$ is a weak field ligand → no pairing

CN^{-is} strong field ligand → causes pairing

for CN$^-$

1↓	1↓	1		

_____ case I

for SCN$^-$

1	1	1	1	1

——— case II

magnetic moment for case I

$$\sqrt{n\,(n+2)} = \sqrt{1\,(1+2)} = \sqrt{3}$$

For case II

$$\sqrt{5(5+2)} = \sqrt{35}$$

Diff. in magnetic moment = 4.184

$$\approx 4$$

Sol.24 (8)

N$_2$O$_3$ is

No. of lone pairs is 8

Sol.25 (3)

Be $Cl_2 \rightarrow \frac{1}{2} \ (2+2) = \frac{4}{2} = 2 \rightarrow sp \rightarrow$ linear.

$N_3^- \rightarrow$ azide $\rightarrow$ Linear

$N_2O \rightarrow$ Linear

$NO_2^+ \rightarrow$ non – Linear

$O_3 \rightarrow$ non – linear

$S\ Cl_2 \rightarrow$ Bent – v

$ICl_2^- , I_3^- , Xef_2 \rightarrow$ all have d orbits in central atom

Sol.26 (3)

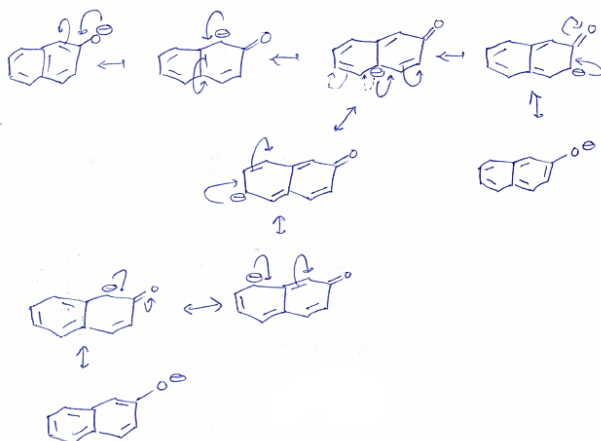$$\text{Degeneracy} = \sum_{l=0}^{n+1} (2L+1)$$

For H atom

For H· ion , degeneracy = 3 (for second excited state).

Sol.27 (2)
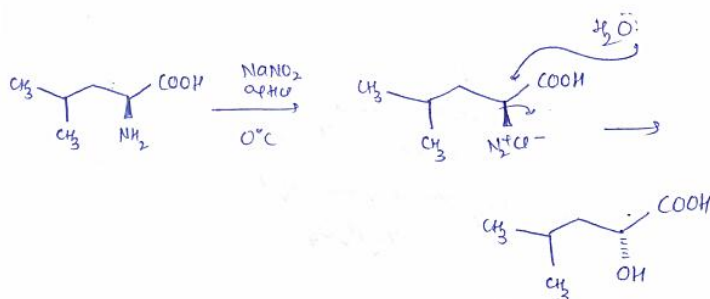
no. of chiral centres = 1

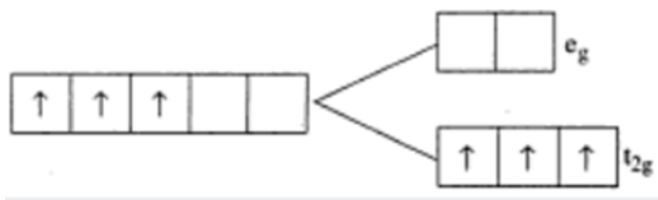$\therefore$ Ans $= 2^n = 2^1 = 2$

Sol.28 (9)

Ans = 9

Sol.29 (B)

Ans (b)

Sol.30 (A,B,C)

Cr^{2+} is strongly reducing is nature. It has a d^4 configuration. While acting as a reducing agent, it gets oxidized to Cr^{3+} (electronic configuration, d^3). This d^3 configuration can be written as t^3_{2g} configuration, which is a more stable configuration,

In the case of Mn^{3+} (d^4) it acts as an oxidizing agent and gets reduced to Mn^{2+} (d^5). This has an exactly half – filled d-orbital and has an extra – stability.

Sol.31 (B,C,D)

Process of electrolytic refining.

Sol.32 (A,B)

Fe^{3+} can be reduced by using either Na_2O_2 or H_2O_2. While using H_2O_2, the presence of basic medium is must.

Hence, Ans. (A), (B)

Sol.33 (C)

Since the rxn is exothermic,

∴ it will be favored at low temp.

On increasing the temp, the rate of the rxn decreases.

∴ at every point of time,

The % yield at temp T_2 < % yield at T_1

The graph (c) explains the answer.

Sol.34 (A)

$O^{2-} \rightarrow$ ccp (4)

$Al^{3+} \rightarrow$ octahedral void (4)

$Mg^{2+} \rightarrow$ tetrahedral void (8)

Considering the mineral of Al, O and Mg as

$$Mg\,Al_2\,O_4$$

$O^{2-} \rightarrow 4$

$Al^{3+} \rightarrow m = \dfrac{2}{4} = \dfrac{1}{2}$

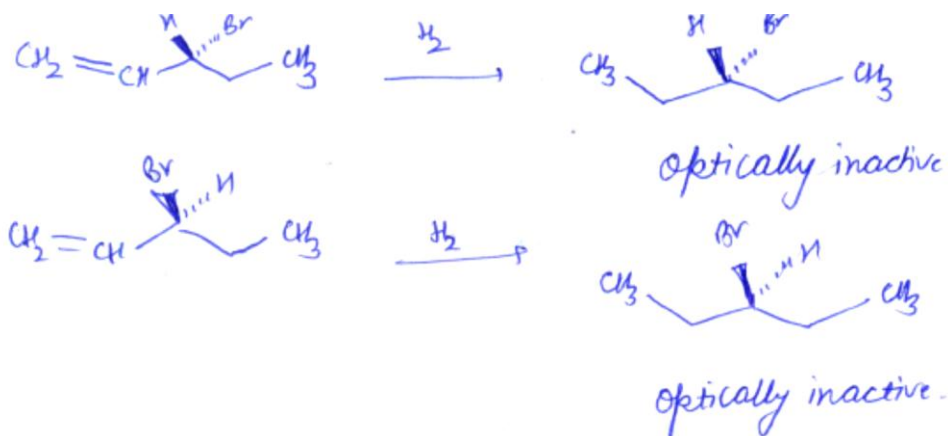$Mg^{2+} \rightarrow n = \dfrac{1}{8}$

∴ the m and n values are
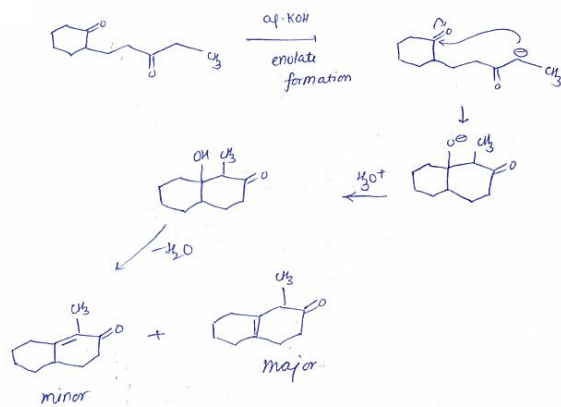
$$\dfrac{1}{2}\ ,\dfrac{1}{8}$$

Ans (A)

Sol.35 (B,D)

The reactions give optically inactive products
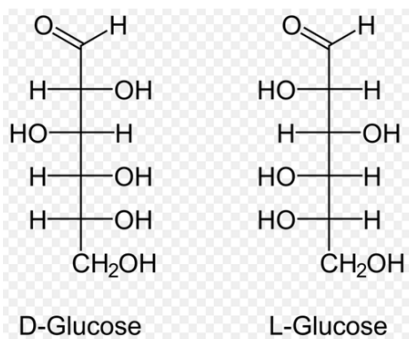
Sol.36 (B)

Ans (B)

Sol.37 (B)

Tertiary carbocation will be more stable.

Sol.38 (A)

Sol.39 (A-P,Q), (B-T),(C-Q,R) and (D-R,S)

The composition of the ores is:

(P) Siderite $\underset{(FeCO_3)}{\longrightarrow}$ carbonate.

(Q) Malachite → carbonate, hydroxide

(R) Bauxite (Al (OH)$_3$), γ – Al O (OH), α – Al O(OH)
$$\downarrow$$
hydroxide, oxide.

(S) calamine (ZnO + ferric oxide) → oxide.

(T) Argentite → Ag_2S → sulphide

∴ Ans is   A → P, Q

B → T

C → Q, R

D → R, S.

Sol.40 (A) → R, T, Q

during the phase change,

work done = w = 0

change in internal energy is less than 0

& since the rxn. occurs at equilibrium,

$$\Delta G = 0$$

(B) → P, Q, S.

(C) → P, Q, S

During the mixing of equal volumes of two ideal gases at constant T and P in an isolated container, heat change taking place is 0,

Work done is zero

& $\Delta U = 0$

(D) → P, Q, S, T.