JEE Advanced (2022) PAPER-I

Chemistry

General Instructions:

SECTION 1 (Maximum Marks: 24)

- This section contains **EIGHT (08)** questions.
- The answer to each question is a **NUMERICAL VALUE**
- For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the anwer. If the numerical value has more than two decimal places, **truncate/round -off** the value to **TWO** decimal places.
- Answer to each question will be evaluated <u>according to the following markeing scheme:</u>

  Full Marks : +3 **ONLY** is the correct numerical value is entered;

  Zero Marks : 0 In all other cases.

Q. 1. 2 mol of Hg(*g*) is combusted in a fixed volume bomb calorimeter with excess of O_2 at 298 K and 1 atm into HgO(*s*). During the reaction, temperature increases from 298.0 K to 312.8 K. If heat capacity of the bomb calorimeter and enthalpy of formation of Hg(*g*) are 20.00 kJ K^{-1} and 61.32 kJ mol^{-1} at 298 K, respectively, the calculated standard molar enthalpy of formation of HgO(*s*) at 298 K is X kJ mol^{-1}. The value of |X| is _____ .

[Given: Gas constant R = 8.3 J K^{-1} mol^{-1}]

Q. 2. The reduction potential (E°, in V) of $MnO_4^-(aq)$/ Mn(*s*) _____.

[Given: $E°_{(MnO_4^-(aq)/MnO_2(S))}$ = 1.68 V;

$E°_{(MnO_2(s)/\ Mn^{2+}(aq))}$ = 1.21 V;

$E°_{(Mn^{2+}(aq)/Mn(s))}$ = –1.03 V]

Q. 3. A solution is prepared by mixing 0.01 mol each of H_2CO_3, $NaHCO_3$, Na_2CO_3, and NaOH in 100 mL of water. pH of the resulting solution is _____.

[Given: pK_{a1} and pK_{a2} of H_2CO_3 are 6.37 and 10.32, respectively; log 2 = 0.30]

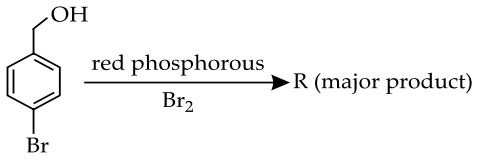
Q. 4. The treatment of an aqueous solution of 3.74 g of $Cu(NO_3)_2$ with excess KI results in a brown solution along with the formation of a precipitate. Passing H_2S through this brown solution gives another precipitate **X**. The amount of **X** (in g) is _____.

[Given: Atomic mass of H = 1, N = 14, O = 16, S = 32, K = 39, Cu = 63, I = 127]

Q. 5. Dissolving 1.24 g of white phosphorous in boiling NaOH solution in an inert atmosphere gives a gas Q. The amount of $CuSO_4$ (in g) required to completely consume the gas **Q** is _____.

[Given: Atomic mass of H = 1, O = 16, Na = 23, P = 31, S = 32, Cu = 63]

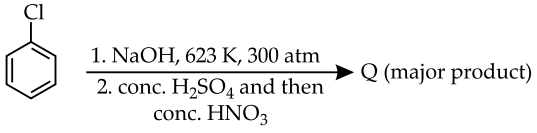
Q. 6. Consider the following reaction.



On estimation of bromine in 1.00 g of **R** using Carius method, the amount of AgBr formed (in g) is _____.

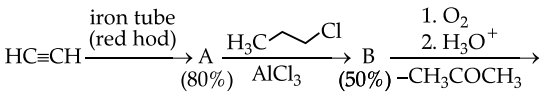
[Given Atomic mass of H = 1, C = 12, O = 16, P = 31, Br = 80, Ag = 108]

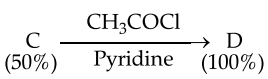
Q. 7. The weight percentage of hydrogen in **Q**, formed in the following reaction sequence, is _____.



[Given: Atomic mass of H = 1, C = 12, N = 14, O = 16, S = 32, Cl = 35]

Q. 8. If the reaction sequence given below is carried out with 15 moles of acetylene, the amount of the product **D** formed (in g) is _____.





The yields of **A**, **B**, **C** and **D** are given in parentheses.

[Given: Atomic mass of H = 1, C = 12, O = 16, Cl = 35]

***General Instructions*:**

SECTION 2 (Maximum Marks: 24)

- This section contains **SIX (06)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated <u>according to the following markeing scheme:</u>

Full Marks	:	+4 **ONLY** if (all) the correct option(s) is (are) chosen;
Partial Marks	:	+3 if all the four options are correct but **ONLY** three options are chosen;
Partial Marks	:	+2 if three or more options are correct but **ONLY** two options are chosen, both of which are correct;
Partial Marks	:	+1 if two or more options are correct but **ONLY** one option is chosen and it is a correct option;
Zero Marks	:	0 if none of the options is chosen (i.e., the question is unanswered);
Negative Marks	:	–2 in all other cases.

Q. 9. For diatomic molecules, the correct statement(s) about the molecular orbitals formed by the overlap of two $2p_z$ orbitals is(are)

(A) σ orbital has a total of two nodal planes.

(B) σ orbital has one node in the *xz*-plane containing the molecular axis.

(C) π orbital has one node in the plane which is perpendicular to the molecular axis and goes through the center of the molecule.

(D) π orbital has one node in the *xy*-plane containing the molecular axis.

Q. 10. The correct option(s) related to adsorption processes is(are)

(A) Chemisorption results in a unimolecular layer.

(B) The enthalpy change during physisorption is in the range of 100 to 140 kJ mol^{-1}.

(C) Chemisorption is an endothermic process.

(D) Lowering the temperature favors physisorption processes.

Q. 11. The electrochemical extraction of aluminium from bauxite ore involves

(A) the reaction of Al_2O_3 with coke (C) at a temperature > 2500° C.

(B) the neutralisation of aluminate solution by passing CO_2 gas to precipitate hydrated alumina ($Al_2O_3.3H_2O$).

(C) the dissolution of Al_2O_3 in hot aqueous NaOH.

(D) the electrolysis of Al_2O_3 mixed with Na_3AlF_6 to give Al and CO_2.

Q. 12. The treatment of galena with HNO_3 produces a gas that is

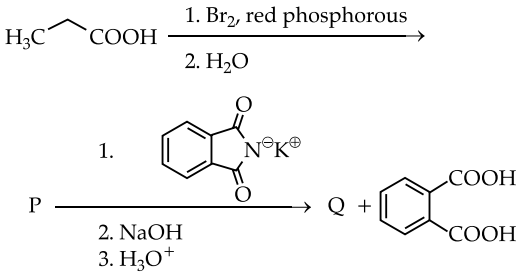
(A) paramagnetic

(B) bent in geometry

(C) an acidic oxide

(D) colourless

Q. 13. Considering the reaction sequence given below, the correct statement(s) is(are)



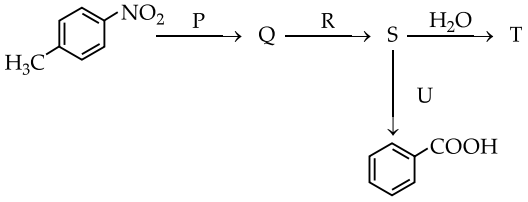
(A) **P** can be reduced to a primary alcohol using $NaBH_4$.

(B) Treating **P** with conc. NH_4OH solution followed by acidification gives **Q**.

(C) Treating **Q** with a solution of $NaNO_2$ in aq. HCl liberates N_2.

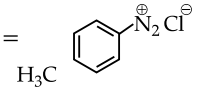
(D) **P** is more acidic than CH_3CH_2COOH.

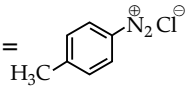
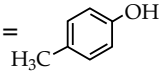
Q. 14. Considering the following reaction sequence,

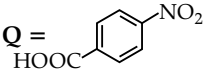
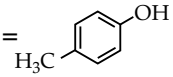


the correct option(s) is(are)

(A) **P** = H_2/Pd, ethanol **R** = $NaNO_2$/HCl **U** = **1.** H_3PO_2 **2.** $KMnO_4$ **-** KOH, heat

(B) **P** = Sn/HCl **R** = HNO_2 **S** = 

(C) **S** =  **T** =  **U** = **1.** CH_3CH_2OH **2.** $KMnO_4$ - KOH, heat

(D) **Q** =  **R** = H_2/Pd, ethanol **T** = 

***General Instructions*:**

SECTION 3 (Maximum Marks: 12)

- This section contains **FOUR (04)** Matching List Sets.
- Each set has **ONE** Multiple Choice Question.
- Each set has **TWO** lists: **List-I** and **List-II**.
- **List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Five** entries (P), (Q), (R), (S) and (T).
- **FOUR** options are given in each Multiple Choice Question based on **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.
- Answer to each question will be evaluated <u>according to the following marking scheme:</u>

Full Marks : +3 **ONLY** if the option corresponding to the correct combination is chosen;

Zero Marks : 0 if none of the options is chosen (i.e., the question is unanswered);

Negative Marks : –1 in all other cases.

Q. 15. Match the rate expressions in **LIST-I** for the decomposition of X with the corresponding profiles provided in **LIST-II**. X_S and k are constants having appropriate units.

LIST-I

(I) $\text{rate} = \dfrac{k[X]}{X_S + [X]}$

under all possible initial concentrations of X

(II) $\text{rate} = \dfrac{k[X]}{X_S + [X]}$

where initial concentrations of X are much less than X_S

(III) $\text{rate} = \dfrac{k[X]}{X_S + [X]}$

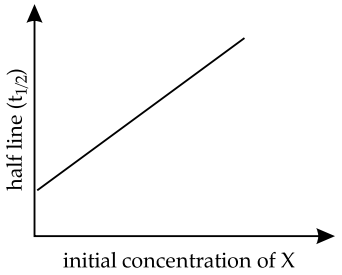
where initial concentrations of X are much higher than X_S

(IV) $\text{rate} = \dfrac{k[X]^2}{X_S + [X]}$

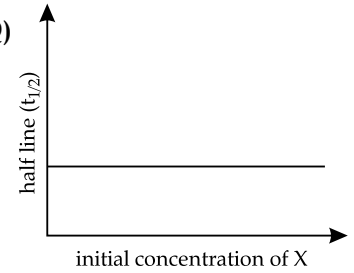
where initial concentration of X is much higher than X_S

LIST-II

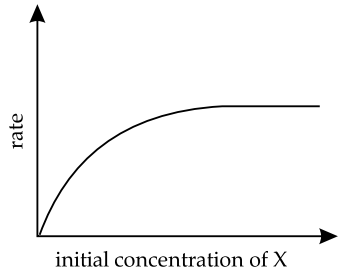
(P)



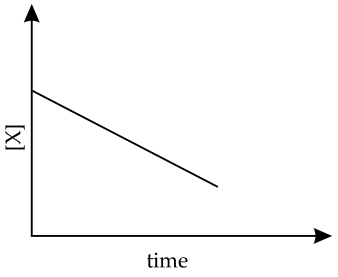
(Q)



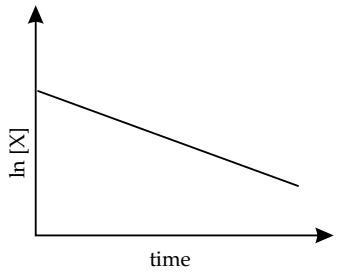
(R)



(S)



(T)



(A) I→P; II→Q; III→S; IV→T

(B) I→R; II→S; III→S; IV→T

(C) I→P; II→Q; III→Q; IV→R

(D) I→R; II→S; III→Q; IV→R

Q. 16. **LIST-I** contains compounds and **LIST-II** contains reactions

LIST-I	**LIST-II**
(I) H_2O_2	**(P)** $Mg(HCO_3)_2 + Ca(OH)_2 \rightarrow$
(II) $Mg(OH)_2$	**(Q)** $BaO_2 + H_2SO_4 \rightarrow$
(III) $BaCl_2$	**(R)** $Ca(OH)_2 + MgCl_2 \rightarrow$
(IV) $CaCO_3$	**(S)** $BaO_2 + HCl \rightarrow$
	(T) $Ca(HCO_3)_2 + Ca(OH_2) \rightarrow$

Match each compound in **LIST-I** with its formation reaction(s) in **LIST-II**, and choose the correct option

(A) I→Q; II→P; III→S; IV→R

(B) I→T; II→P; III→Q; IV→R

(C) I→T; II→R; III→Q; IV→P

(D) I→Q; II→R; III→S; IV→P

Q. 17. **LIST-I** contains metal species and **LIST-II** contains their properties.

LIST-I	**LIST-II**
(I) $[Cr(CN)_6]^{4-}$	**(P)** t_{2g} orbitals contain 4 electrons
(II) $[RuCl_6]^{2-}$	**(Q)** μ (spin-only) = 4.9 BM
(III) $[Cr(H_2O)_6]^{2+}$	**(R)** low spin complex ion
(IV) $[Fe(H_2O)_6]^{2+}$	**(S)** metal ion in 4+ oxidation state
	(T) d^4 species

[Given: Atomic number of Cr = 24, Ru = 44, Fe = 26]

Match each metal in **LIST-I** with their properties in **LIST-II**, and choose the correct option

(A) I→R, T; II→P, S; III→Q, T; IV→P, Q

(B) I→R, S; II→P, T; III→P, Q; IV→Q, T

(C) I→P, R; II→R, S; III→R, T; IV→P, T

(D) I→Q, T; II→S, T; III→P, T; IV→Q, R

Q. 18. Match the compounds in **LIST-I** with the observations in **LIST-II**, and choose the correct option.

LIST-I	**LIST-II**
(I) Aniline	**(P)** Sodium fusion extract of the compound on boiling with $FeSO_4$, followed by acidification with conc. H_2SO_4, gives Prussian blue color.
(II) *o*-Cresol	**(Q)** Sodium fusion extract of the compound on treatment with sodium nitroprusside gives blood red color.
(III) Cysteine	**(R)** Addition of the compound to a saturated solution of $NaHCO_3$ results in effervescence.
(IV) Caprolactam	**(S)** The compound reacts with bromine water to give a white precipitate.
	(T) Treating the compound with neutral $FeCl_3$ solution produces violet color.

(A) I→P, Q; II→S; III→Q, R; IV→P

(B) I→P; II→R, S; III→R; IV→Q, S

(C) I→Q, S; II→P, T; III→P; IV→S

(D) I→P, S; II→T; III→Q, R; IV→P

❑❑

Q.No.	Answer key	Topic's name	Chapter's name
Section -I			
1	90.39	Enthalpy	Thermodynamics
2	0.77	Relation between Gibb's free energy and standard electrode potential	Electrochemistry
3	10.02	Buffer solution	Equilibrium
4	0.32	Reaction of 3*d* series and mass determination	*d*- and *f*- block elements
5	2.39	Allotropic forms of phosphorus and its chemical reactions	*p*- block elements
6	1.5	Reactions of alcohol and Carius method	Alcohols, phenols and ethers and Some basic prinnciples and techniques
7	1.31	Chemical reactions of haloarenes and mass determination	Haloalkanes and Haloarenes
8	136	Chemical reactions of benzene and mass determination	Reactions of benzene
Section -II			
9	A,D	Linear combinations of atomic orbitals	Chemical bonding and molecular structure
10	A,D	Adsorption	Surface Chemistry
11	B,C,D	Electrochemical extraction of aluminium	Extractive metallurgy
12	A,D	Properties and chemical reactions of group 15 elements	*p*- block elements
13	C,D	Chemical reactions of organic compounds containing oxygen	Chemical reactions of organic compounds containing oxygen
14	A,B,C	Chemical reactions of nitrobenzene	Organic compounds containing Nitrogen
Section -III			
15	A	Rate and order of reactions	Chemical Kinetics
16	D	Chemical reactions of group 2 elements	*s*-block elements
17	A	Crystal field theory	Coordination compounds
18	D	Characteristics reactions	Characteristics reactions

Answers

1. Correct answer is [90.39]

Explanation : Given, that capacity of bomb calorimeter (C_v) = 20 kJ K^{-1}

T_1 = 298 K, T_2 = 312.8 K

Since, $\Delta U^\circ = -C_V \Delta T$

$\Delta U^\circ = -20 \times (312.8 - 298)$

$\Delta U^\circ = -20 \times 14.8$

$\Delta U^\circ = -296$ kJ mol^{-1}

Now, $2\,Hg\,(g) + O_2(g) \rightarrow 2\,HgO(s)$

Here, $\Delta n_g = 0 - (2 + 1)$

$= 0 - 3$

$= -3$

Now, $\Delta H^\circ = \Delta U^\circ + \Delta n_g RT$

$= -296$ kJ $mol^{-1} + (-3) \times (8.3) \times 298 \times 10^{-3}$ kJ mol^{-1}

$= -296 - 7.4202$ kJ mol^{-1}

$= -303.42$ kJ mol^{-1}

Since, $\Delta H^\circ = \Sigma \Delta H^\circ_{Products} - \Sigma \Delta H^\circ_{Reactants}$

$\Delta H^\circ = 2\,\Delta_f H^\circ_{HgO_{(s)}} - 2\Delta_f H^\circ_{Hg(g)}$

$-303.42 = 2\Delta_f H^\circ_{HgO_{(s)}} - 2 \times 61.32$

$2\,\Delta_f H^\circ_{HgO_{(s)}} = -303.42 + 122.64$ kJ mol^{-1}

$\Delta_f H^\circ_{HgO_{(s)}} = \dfrac{-180.78}{2}$ kJ mol^{-1}

$\Delta_f H^\circ_{HgO_{(s)}} = -90.39$ kJ mol^{-1}

$|\Delta_f H^\circ_{HgO_{(s)}}| = 90.39$ kJ mol^{-1}

2. Correct answer is [0.77]

Explanation : Given,

$E^\circ_{MnO_4^-/MnO_2} = 1.68$ V

$E^\circ_{MnO_2/Mn^{2+}} = 1.21$ V

$E^\circ_{Mn^{2+}/Mn} = 1.03$ V

$\overset{+7}{MnO_4^-} \xrightarrow[(1)]{+3e^-} \overset{+4}{MnO_2} \xrightarrow[(1)]{+3e^-} \overset{+2}{Mn^{2+}} \xrightarrow[(1)]{+2e^-} \overset{0}{Mn}$

$\Delta G^\circ_{Total} = \Delta G^\circ_1 + \Delta G^\circ_2 + \Delta G^\circ_3$

$-n_{Total}\, FE^\circ_{MnO_4^-/Mn}$

$= -n_1\, FE^\circ_{MnO_4^-/MnO_2} + (-n_2\, FE^\circ_{MnO_2/Mn^{2+}}) + (-n_3 F\, E^\circ_{Mn^{2+}/Mn})$

$7E^\circ_{MnO_4^-/Mn} = (3 \times 1.68) + (2 \times 1.121) + (2 \times -1.03)$

$7E^\circ_{MnO_4^-/Mn} = 5.04 + 2.42 - 2.06$

$E^\circ_{MnO_4^-/Mn} = \dfrac{5.4}{7}$ V

$E^\circ_{MnO_4^-/Mn} = 0.77$ V

3. Correct answer is [10.02]

Explanation :

$H_2CO_3 + NaOH \rightarrow NaHCO_3 + H_2O$

Initial	0.01	0.01	—	—
After time t	—	—	—	0.01

A mixture of $NaHCO_3$ (0.01) and Na_2CO_3 (0.01) is also formed.

So, the final mixture contains 0.02 moles of $NaHCO_3$ and 0.01 moles of Na_2CO_3.

Since, $NaHCO_3$ is a weak acid and Na_2CO_3 is a salt of weak acid, so basically use get a buffer solution.

Now $H_2CO_3 \rightarrow HCO_3^- + H^+$ $\quad pK_{a_1} = 6.37$

$HCO_3^- \rightarrow CO_3^{2-} + H^+$ $\quad pK_{a_2} = 10.32$

Since, $pH = pK_a + \log \dfrac{[salt]}{[acid]}$

We will use pK_{a_2} as use have acid $NaHCO_3$ which will dissociate to give HCO_3^- ion.

$pH = pK_{a_2} + \log \dfrac{[salt]}{[acid]}$

$pH = 10.32 + \log \dfrac{0.01}{0.02}$

$pH = 10.32 + \log \dfrac{1}{2}$

$pH = 10.32 - 0.3$

$pH = 10.02$

So, the pH of the resulting solution is 10.02.

4. Correct answer is [0.32]

Explanation : Since,

$2Cu(NO_3)_2 + 4\,KI \rightarrow Cu_2I_2\downarrow + I_2 + 4KNO_3$

$Cu_2I_2 + H_2S \rightarrow Cu_2S\downarrow + 2HI$

Molecular mass of $Cu(NO_3)_2$

$= 63 + 2\,(14 + 3 \times 16)$

$= 63 + 2\,(14 + 48)$

$= 63 + 2\,(62)$

$= 63 + 124$

$= 187$ g mol^{-1}

Number of moles of $Cu(NO_3)_2$

$= \dfrac{\text{Given mass}}{\text{Molecular mass}}$

$$= \frac{3.74}{187} = 0.0_2$$

Now, $2Cu(NO_3)_2 + 4KI \rightarrow Cu_2I_2\downarrow + I_2 + 4KNO_3$

Initial	0.02	—
Final	—	0.01

$Cu_2I_2 + H_2S \rightarrow Cu_2S\downarrow + 2HI$

Initial	0.01	—
Final	—	0.01

So, Number of moles of sulphur obtained = 0.01

Since, Number of moles $= \frac{\text{Mass}}{\text{Molecular mass of sulphur}}$

$$0.1 = \frac{\text{Mass}}{32}$$

$$\text{Mass of sulphur} = 0.01 \times 32$$
$$= 0.32 \text{ g}$$

5. Correct answer is [2.39]

Explanation : Given mass of white phosphorus (P_4) = 1.24 g

Molocular mass of

$$P_4 = 4 \times 31 \text{ g mol}^{-1}$$
$$= 124 \text{ mol}^{-1}$$

So, number of moles of $P_4(n_{P_4})$

$$= \frac{1.24}{124} = 0.01$$

$P_4 + 3NaOH + 3H_2O \rightarrow PH_3 + 3NaH_2PO_2$

0.01 mole of P_4 when reacts with boiling NaOH solution will give 0.01 moles of PH_3.

$2PH_3 + 3CuSO_4 \rightarrow Cu_3P_2 + 3H_2SO_4$

According to above reaction,

1 mole of PH_3 reacts with $\frac{3}{2}$ moles of $CuSO_4$.

So, 0.01 mole of PH_3 will react with $\frac{3}{2} \times 0.01$ mole of $CuSO_4$.

$$= \frac{0.03}{2} \text{ moles of CusO}_4$$

Molecular mass of $CuSO_4$

$$= 63 + 32 + (4 \times 16) \text{ g mol}^{-1}$$
$$= 63 + 32 + 64 \text{ g mol}^{-1}$$
$$= 159 \text{ g mol}^{-1}$$

Now, number of mole of $CuSO_4$

$$= \frac{\text{Weight of CuSO}_4}{\text{Molecular mass of CuSO}_4}$$

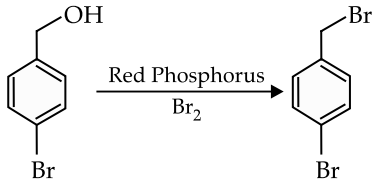
$$\frac{0.03}{2} = \frac{W_{CuSO_4}}{159}$$

$$W_{CuSO_4} = \frac{0.03}{2} \times 159 \text{ g}$$

$$W_{CuSO_4} = 2.385 \text{ g}$$
$$= 2.39 \text{ g}$$

6. Correct answer is [1.50]

Explanation :



(R)
(Major Product)

Molecular mass of R formed

$$= (12 \times 7) + (6 \times 1) + (2 \times 80)$$
$$= 84 + 6 + 160$$
$$= 250 \text{ g mol}^{-1}$$

Number of moles is 1g of R $= \frac{1}{250}$

No. of moles of AgBr formed from R $= \frac{2}{250}$

So, mass of AgBr formed

$$= \frac{\text{Number of moles of AgBr formed}}{\text{Molecular mass of AgBr}}$$

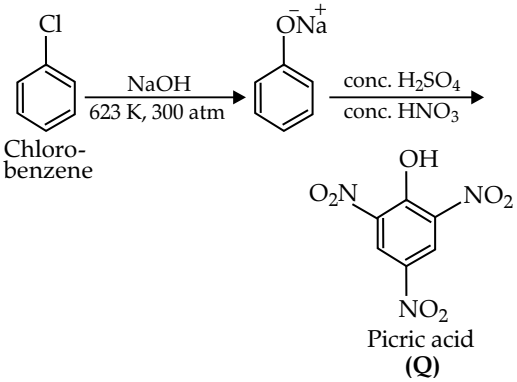
$$= \frac{2}{\frac{250}{188}} \text{g}$$

$$= \frac{2 \times 188}{250}$$

$$= 1.504 \text{ g}$$

7. Correct answer is [1.31]

Explanation :



Chloro-benzene

Picric acid
(Q)

Molecular formule of Q is $C_6H_3N_3O_7$

Molar mass of

$$Q = (6 \times 12) + (3 \times 1) + (3 \times 14) + (7 \times 16)$$
$$= (72 + 3 + 42 + 112)\ g\ mol^{-1}$$
$$= 229\ g\ mol^{-1}$$

Weight % of Hydrogen

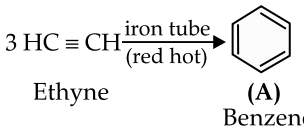
$$= \frac{\text{Mass of hydrogen in Q}}{\text{Molar mass of Q}} \times 100\%$$

$$= \frac{3}{229} \times 100\%$$

$$= 1.31\%$$

8. Correct answer is [136]

Explanation : e

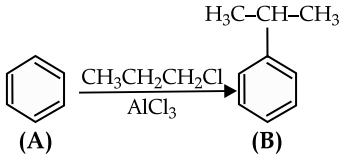


In the above reaction, 3 moles of ethyne forms 1 mole of benzene.

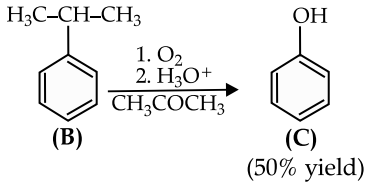
So, 15 moles of ethyne will form $\frac{15}{3} = 5$ moles of benzene

But according to question yield of (A) is 80%

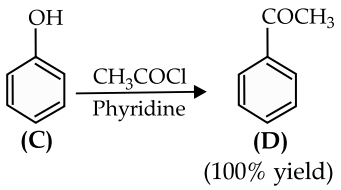
So, amount of A formed is $5 \times \frac{80}{100} = 4$ moles.



Yield of B is 50%. So from 4 moles of (A), 2 moles of (B) is formed.



From 2 moles of (B), 1 mole of (C) will formed as the yield of (C) is 50%



Since, yield of (D) is 100%, so 1 mole of (C) will from 1 mole of (D).

Molecular fromula of D is $C_8H_8O_2$.

Molecular mass of

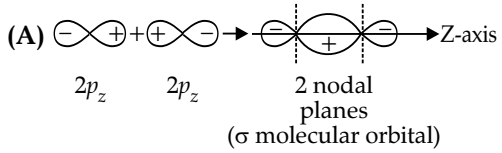
$$D = (8 \times 12) + (8 \times 1) + (2 \times 16)$$
$$= 96 + 8 + 32$$
$$= 136\ g$$

So, amount of product D formed is 136 g.

9. Option A, D are correct.

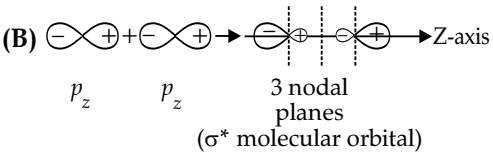
Explanation :

(A)



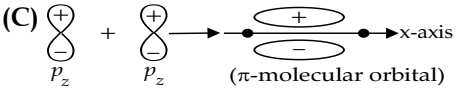
Option **(A)** is correct.

(B)



Option **(B)** is incorrect.

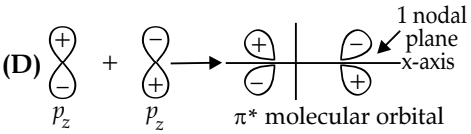
(C)



π* orbital has zero node is the plane which is perpendicular to the molecular axis and goes through the center of molecule.

So, option (C) is incorrect.

(D)



π^* Orbital has one node in the *xy* – plane containing the molecular axis.

Option **(D)** is correct.

10. Option A, D are correct.

Explanation :

(A) Chemisorption results in a unimolecular layer.

(B) The enthalpy change during physisorption.

(C) Chemisorption is an exothermic process.

(D) Lowering the temperature favours physisorption processes.

11. Correct answer is [90.39].

Explanation :

(A) Electrochemical extraction of aluminium

from bauxite ore involves the reaction of Al_2O_3 with coke (C) at a temperature below 2500°C.

(B) The electrochemical extraction of aluminate from bauxite ore involves the neutralisation of aluminate solution by passing CO_2 gas to precipitate hydrated alumina ($Al_2O_3.3H_2O$)

$$2Na[Al(OH)_4]\ (aq) + 2\ CO_2(g) \rightarrow Al_2O_3.3H_2O(s)\downarrow + 2NaHCO_3(aq)$$

(C) It involves the dissolution of Al_2O_3 in hot aqueous NaOH.

$$Al_2O_3 + 2NaOH + 3H_2O \xrightarrow{\text{(Hot)}} 2Na[Al(OH)_4]$$

(D) The electrochemical extraction of aluminium from bauxite ore involves the electrolysis of Al_2O_3 mixed with $Na_3Al\ F_6$ to give Al and CO_2.

12. Option A, D are correct.

Explanation : The reaction of treatment of galena (PbS) with HNO_3 is given below :

$$3PbS + 8HNO_3 \rightarrow 3Pb(NO_3)_2 + 2NO\uparrow + 4H_2O + S$$

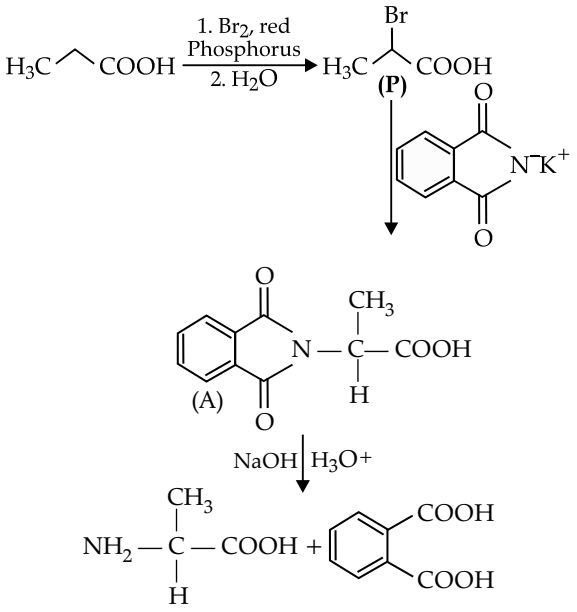
The gas produced by the above reaction is NO. Since, No is an odd electron species, so it is paramagnetic in nature. It has one unpaired electron.

NO is linear and is a neutral oxide.

NO is colourless.

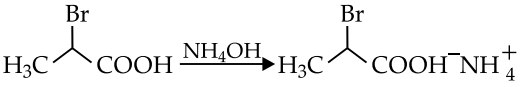
13. Option (C) and (D) are correct.

Explanation :

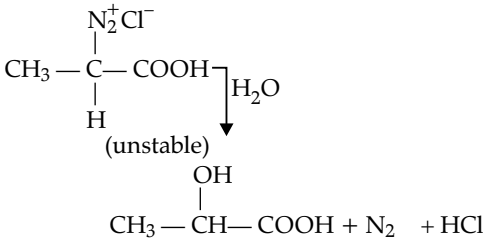


(A) (P) cannot be reduced to a primary alcohol using $NaBH_4$ while $LiAlH_4$ can reduce P to primary alcohol.

(B) (P) is an acid while NH_4OH is a base. So, on the reaction of (P) with NH_4OH, a salt is product Q will not be formed.

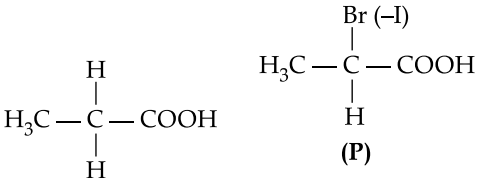


(C)



N_2 gas is liberated in teh above reaction.

(D)

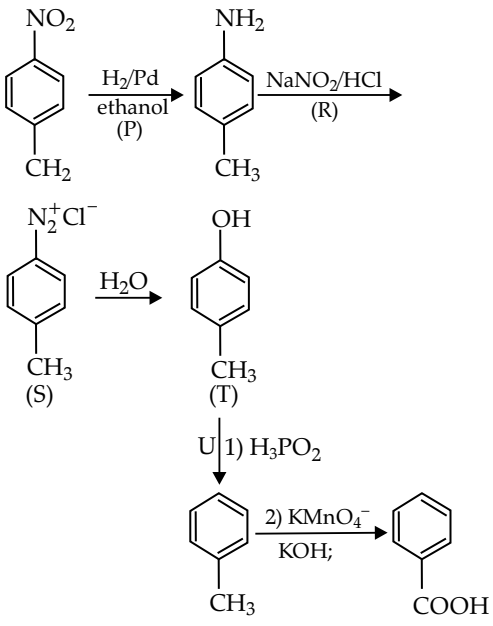


Due to the presence of electron withdrawing group in (P), it is more acidic than CH_3CH_2COOH.

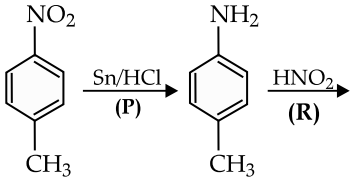
14. Option (A), (B) and (C) correct.

Explanation :

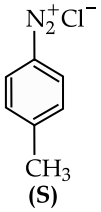
(A)



(B)

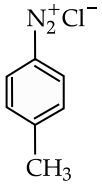
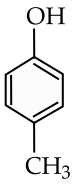


(Q)

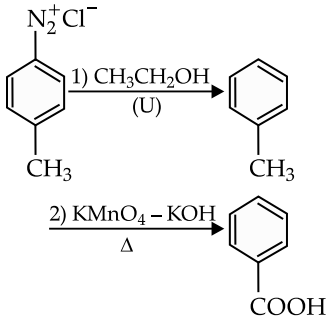


(S)

(C) From (A) and (B), we get

S =  and T = 

Now



Option (A), (B) and (C) are correct.

15. Option (A) is correct.

(I) Rate $= \dfrac{k[X]}{X_s + [X]}$ under all possible initial concentrations of X.

So, (I) can be of zero order or first order and fraction also so, (I) can be (P), (Q), (R), (S) and (T)

(II) $$\text{Rate} = \frac{k[X]}{X_s + [X]}$$

where $[X] << X_s$

So, $$\text{rate} = \frac{k[X]}{X_s}$$

But X_s = constant (given)

rate = k[X]

1st order reaction.

(II) can be (Q) and (T).

(III) $$\text{Rate} = \frac{k[X]}{X_s + [X]}$$

where $X >> X_s$, So neglecting X_s form denominater

$$\text{rate} = \frac{k[X]}{[X]}$$

$$\text{rate} = k$$

$\Rightarrow$ zero order reaction.

(III) can be (S) and (P)

(IV) $$\text{Rate} = \frac{k[X]^2}{X_s + [X]}$$

Where $X >> X_s$, so neglecting X_s from denominater.

So, $$\text{rate} = \frac{k[X]^2}{[X]}$$

$$\text{rate} = k[X]$$

$\Rightarrow 1^{st}$ order.

So, (IV) can be (Q) and (T).

From elimination method, we get,

I $\rightarrow$ P, II $\rightarrow$ Q, III $\rightarrow$ S, IV $\rightarrow$ T

So, option (A) is correct.

16. Option (D) is correct.

Explanation : Let us see the reactions taking place in list-II.

(P) $Mg(HCO_3)_2 + 2Ca(OH)_2 \rightarrow Mg(OH)_2 + 2CaCO_3 + 2H_2O$

Since, the above reactions leads to the formation of $CaCO_3$. So, (P) $\rightarrow$ (iv).

(Q) $BaO_2 + H_2SO_4 \rightarrow H_2O_2 + BaSO_4$

Formation of H_2O_2 takes place.

So, (Q) $\rightarrow$ (I)

(R) $Ca(OH)_2 + MgCl_2 \rightarrow Mg(OH)_2 + CaCl_2$

So, (R) $\rightarrow$ (II)

(S) $BaO_2 + HCl \rightarrow BaCl_2 + H_2O_2$

(S) $\rightarrow$ (III)

(T) $Ca(HCO_3)_2 + Ca(OH)_2 \rightarrow 2CaCO_3 + 2H_2O$

(T) $\rightarrow$ (IV)

From combining all the results, we get

I $\rightarrow$ Q, II $\rightarrow$ R, III $\rightarrow$ S, IV $\rightarrow$ P.

So, option (D) is correct.

17. Option (A) is correct.

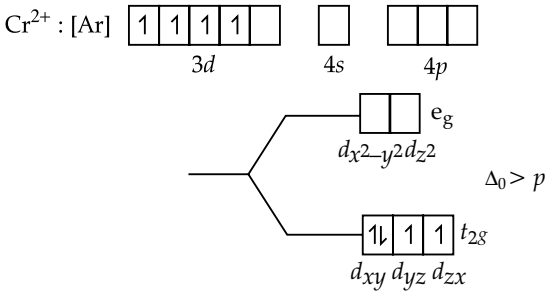
Explanation : **$[Cr(CN)_6]^{4-}$**

Cr is present in +2 oxidation state

$Cr = [Ar]\ 3d^5\ 4s^1$

$Cr^{2+} = [Ar]\ 3d^4$

Since, CN^- is a strong field ligand, so back pairing will occur and the compound will be low spin.



Given complex is d^4 species, has 4 electrons in t_{2g} orbital and forms a low spin complex ion.

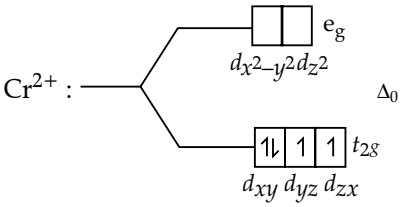
So, (1) → (P), (R), (T)

$[Cr(H_2O)_6]^{2+}$

Cr is in +2 oxidation state.

Cr^{2+} = [Ar] $3d^4$

H_2O is a weak field ligand, so the complex will be high spin



4 unpaired electron are there.

So, $n = 4$

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

$$\mu = \sqrt{4(4+2)} = \sqrt{24} = 4.89 \approx 4.9$$

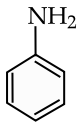
So, (III) → (Q), (T)

So, from the elemination of options method, we get (I) → R, T; (II) → P_1 S; (III) → (Q), T and (IV) → P_1 Q

So, option (A) is correct.

18. Option (D) is correct.

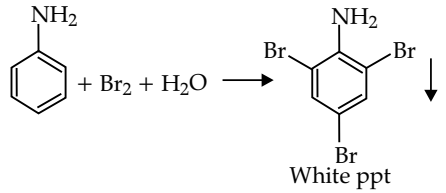
Explanation :



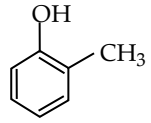
Aniline

Since, it contains carbon as well as hydrogen, so its fusion extract of the compound on boiling with $FeSO_4$, followed by acidification gives prussian blue colour.

Also,



(I) → P_1 S.



o-cresol

Since, it contain phenolic OH, so on treating it with neutral $FeCl_3$ solution, it gives violet colour.

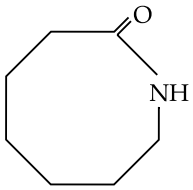
(II) T.

(III) Cysteine $HS—CH_2—\underset{\displaystyle NH_2}{\underset{|}{CH}}—COOH$

Cysteine contains S and N. So when its sodium extract is treated with sodium nitropresside, it will give blood red colour. Addidtion of the cysteine the saturated solution of $NaHCO_3$ results in effervescence as it contains a carboxylic group.

(III) → Q, R

(IV) Caprolactum



It will give blue colour with hassaizne test as it contains N atom.

So, from the combenation of above observation, are get I → P_1 S; II → T; III → Q_1 R; IV → P

Option (D) is correct.

❑❑