

CHEMISTRY

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer :

1. A commercially sold conc. HCl is 35% HCl by mass. If the density of this commercial acid is 1.46 g/mL, the molarity of this solution is :

(Atomic mass : Cl = 35.5 amu, H = 1 amu)

- (A) 10.2 M (B) 12.5 M
(C) 14.0 M (D) 18.2 M

Answer (C)

Sol. Molarity = $\frac{35}{(36.5) \times \frac{100}{1.46}} \times 1000 = 14.0 \text{ M}$

2. An evacuated glass vessel weighs 40.0 g when empty, 135.0 g when filled with a liquid of density 0.95 g mL⁻¹ and 40.5 g when filled with an ideal gas at 0.82 atm at 250 K. The molar mass of the gas in g mol⁻¹ is:

(Given : R = 0.082 L atm K⁻¹ mol⁻¹)

- (A) 35
(B) 50
(C) 75
(D) 175

Answer (Bonus)

Sol. Weight of liquid = 135.0 – 40.0 = 95.0 g

Volume of liquid = $\frac{95}{0.95} = 100 \text{ ml} = 0.1 \text{ L}$

Weight of gas = 0.5 g

Moles of gas = $\frac{0.5}{M}$

PV = nRT

$0.82 \times 0.1 = \frac{0.5}{M} \times 0.082 \times 250$

M = 0.5 × 250 = 125 g mol⁻¹

3. If the radius of the 3rd Bohr's orbit of hydrogen atom is r₃ and the radius of 4th Bohr's orbit is r₄. Then :

- (A) $r_4 = \frac{9}{16} r_3$ (B) $r_4 = \frac{16}{9} r_3$
(C) $r_4 = \frac{3}{4} r_3$ (D) $r_4 = \frac{4}{3} r_3$

Answer (B)

Sol. $r_n = r_0 \frac{n^2}{Z}$

$r_4 = r_0 \times \frac{4^2}{1}$

and $r_3 = r_0 \times \frac{3^2}{1}$

Therefore $\frac{r_4}{r_3} = \frac{4^2}{3^2} \Rightarrow r_4 = \frac{16}{9} r_3$

4. Consider the ions/molecules



For increasing bond order the correct option is:

- (A) O₂²⁻ < O₂⁻ < O₂ < O₂⁺
(B) O₂⁻ < O₂²⁻ < O₂ < O₂⁺
(C) O₂⁻ < O₂²⁻ < O₂⁺ < O₂
(D) O₂⁻ < O₂⁺ < O₂²⁻ < O₂

Answer (A)

Sol. Species	Bond order
O ₂ ⁺	2.5
O ₂	2
O ₂ ⁻	1.5
O ₂ ²⁻	1

5. The $\left(\frac{\partial E}{\partial T}\right)_p$ of different types of half cells are as follows:

A	B	C	D
1×10^{-4}	2×10^{-4}	0.1×10^{-4}	0.2×10^{-4}

(Where E is the electromotive force)

Which of the above half cells would be preferred to be used as reference electrode?

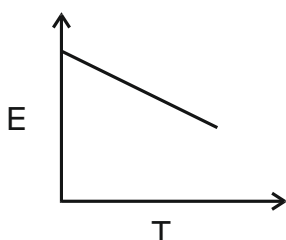
- (A) A (B) B
(C) C (D) D

Answer (C)

Sol. We know that

$$E = E^\circ - \frac{2.303RT}{nF} \log \left[\frac{1}{(\text{oxidized form})} \right]$$

$$\text{Slope} = \frac{-2.303 R}{nF} \log \left[\frac{1}{(\text{oxidized form})} \right]$$



Higher the value of slope $\left(\frac{\partial E}{\partial T} \right)_p$, more the deviation between E and E° . Thus, half cell with least value of $\left(\frac{\partial E}{\partial T} \right)_p$ can be used as reference electrode.

6. Choose the correct stability order of group 13 elements in their +1 oxidation state.

- (A) $\text{Al} < \text{Ga} < \text{In} < \text{Tl}$ (B) $\text{Tl} < \text{In} < \text{Ga} < \text{Al}$
(C) $\text{Al} < \text{Ga} < \text{Tl} < \text{In}$ (D) $\text{Al} < \text{Tl} < \text{Ga} < \text{In}$

Answer (A)

Sol. Due to inert pair effect, stability of +3 oxidation state decreases and that of +1 oxidation state increases for (down the group) group 13 elements.

So, the correct order of stability of group 13 elements in their +1 oxidation state is $\text{Al} < \text{Ga} < \text{In} < \text{Tl}$.

7. Given below are two statements:

Statement I : According to the Ellingham diagram, any metal oxide with higher ΔG° is more stable than the one with lower ΔG° .

Statement II : The metal involved in the formation of oxide placed lower in the Ellingham diagram can reduce the oxide of a metal placed higher in the diagram.

In the light of the above statements, choose the **most appropriate** answer from the options given below:

- (A) Both **Statement I** and **Statement II** are correct.
(B) Both **Statement I** and **Statement II** are incorrect.
(C) **Statement I** is correct but **Statement II** is incorrect.
(D) **Statement I** is incorrect but **Statement II** is correct.

Answer (D)

Sol. Ellingham diagram is plot of ΔG vs T .

The criterion for the feasibility of a thermal reduction is that at a given temperature Gibbs energy change of a reaction must be negative. The change in Gibbs energy, ΔG for any process at any specified temperature, is given by the equation

$$\Delta G = \Delta H - T\Delta S$$

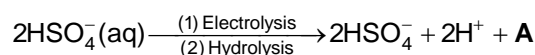
where ΔH = enthalpy change and

ΔS = entropy change

According to the ellingham diagram, any metal oxide with higher ΔG° has a tendency of getting reduced by the metal whose metal oxide has lower value of ΔG° .

Therefore, Statement I is incorrect but Statement II is correct.

8. Consider the following reaction:



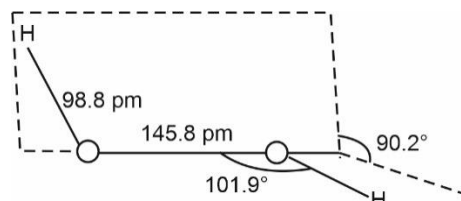
The dihedral angle in product **A** in its solid phase at 110 K is :

- (A) 104° (B) 111.5°
(C) 90.2° (D) 111.0°

Answer (C)

Sol. A should be H_2O_2

Structure of H_2O_2 is solid phase



Dihedral angle = 90.2°

9. The correct order of melting point is :

- (A) $\text{Be} > \text{Mg} > \text{Ca} > \text{Sr}$
- (B) $\text{Sr} > \text{Ca} > \text{Mg} > \text{Be}$
- (C) $\text{Be} > \text{Ca} > \text{Mg} > \text{Sr}$
- (D) $\text{Be} > \text{Ca} > \text{Sr} > \text{Mg}$

Answer (D)

Sol. Element	M.P.
Be	1560 K
Mg	924 K
Ca	1124 K
Sr	1062

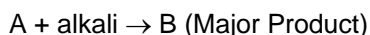
10. The correct order of melting points of hydrides of group 16 elements is:

- (A) $\text{H}_2\text{S} < \text{H}_2\text{Se} < \text{H}_2\text{Te} < \text{H}_2\text{O}$
- (B) $\text{H}_2\text{O} < \text{H}_2\text{S} < \text{H}_2\text{Se} < \text{H}_2\text{Te}$
- (C) $\text{H}_2\text{S} < \text{H}_2\text{Te} < \text{H}_2\text{Se} < \text{H}_2\text{O}$
- (D) $\text{H}_2\text{Se} < \text{H}_2\text{S} < \text{H}_2\text{Te} < \text{H}_2\text{O}$

Answer (A)

Sol. Hydride	M.P.
H_2O	273 K
H_2S	188 K
H_2Se	208 K
H_2Te	222 K

11. Consider the following reaction:

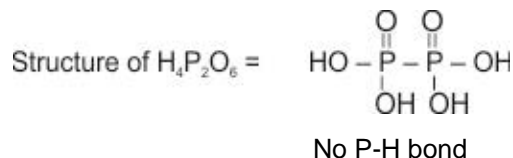


If B is an oxoacid of phosphorus with no P-H bond, then A is:

- (A) White P_4
- (B) Red P_4
- (C) P_2O_3
- (D) H_3PO_3

Answer (B)

Sol. White $\text{P}_4 + \text{alkali} \rightarrow \text{H}_3\text{PO}_2$

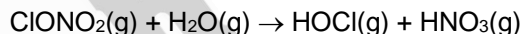
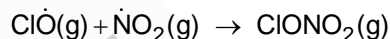


12. Polar stratospheric clouds facilitate the formation of:

- (A) ClONO_2
- (B) HOCl
- (C) ClO
- (D) CH_4

Answer (B)

Sol. In summer season nitrogen dioxide and methane react with chlorine monoxide and chlorine atoms forming, Chlorine sinks, preventing much ozone depletion, whereas in winter, special types of clouds called polar stratospheric clouds are formed over Antarctica. These polar stratospheric clouds provide surface on which chlorine nitrate formed gets hydrolysed to form hypochlorous acid.



13. Given below are two statements:

Statement I: In 'Lassaigne's Test', when both nitrogen and sulphur are present in an organic compound, sodium thiocyanate is formed.

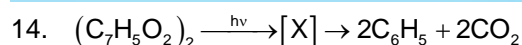
Statement II: If both nitrogen and sulphur are present in an organic compound, then the excess of sodium used in sodium fusion will decompose the sodium thiocyanate formed to give NaCN and Na_2S .

In the light of the above statements, choose the **most appropriate** answer from the options given below:

- (A) Both **Statement I** and **Statement II** are correct.
- (B) Both **Statement I** and **Statement II** are incorrect.
- (C) **Statement I** is correct but **Statement II** is incorrect.
- (D) **Statement I** is incorrect but **Statement II** is correct.

Answer (A)

Sol. $\text{NaSCN} + 2\text{Na} \rightarrow \text{NaCN} + \text{Na}_2\text{S}$

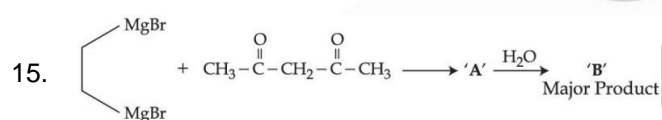
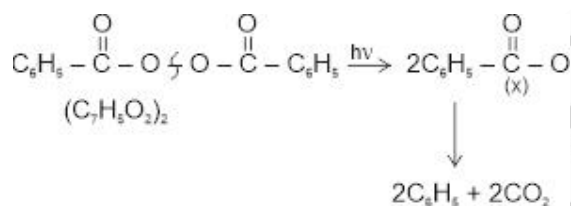


Consider the above reaction and identify the intermediate 'X'

- (A) $C_6H_5-\overset{\overset{O}{\parallel}}{C}-\oplus$
- (B) $C_6H_5-\overset{\overset{O}{\parallel}}{C}-O^{\ominus}$
- (C) $C_6H_5-\overset{\overset{O}{\parallel}}{C}-\ddot{O}:$
- (D) $C_6H_5-\overset{\overset{O}{\parallel}}{C}-\ddot{O}:$

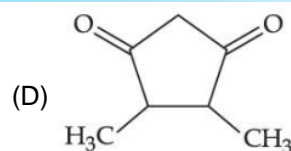
Answer (D)

Sol.



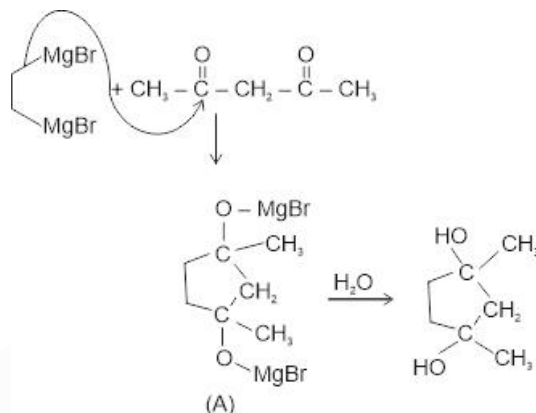
Consider the above reaction sequence and identify the product B.

- (A)
- (B)
- (C)



Answer (A)

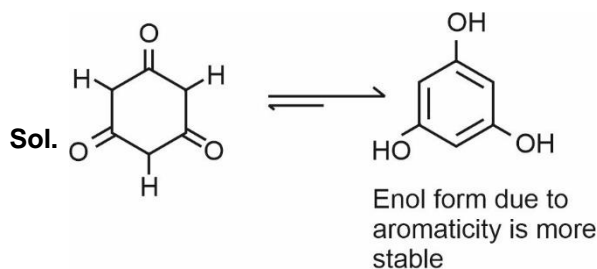
Sol.



16. Which will have the highest enol content?

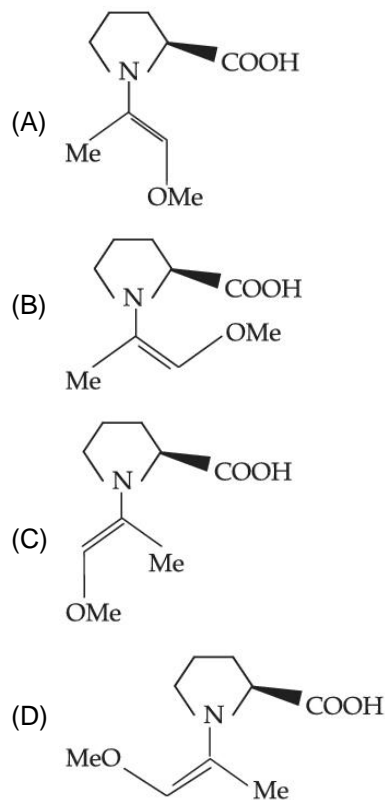
- (A)
- (B)
- (C)
- (D)

Answer (C)



17. Among the following structures, which will show the most stable enamine formation?

(Where Me is $-\text{CH}_3$)



Answer (C)

Sol. The most appropriate option is (C) as one group is far enough from $-\text{COOH}$ group.

18. Which of the following sets are correct regarding polymer?

- (A) Copolymer : Buna-S
(B) Condensation polymer : Nylon-6,6
(C) Fibres : Nylon-6,6
(D) Thermosetting polymer : Terylene
(E) Homopolymer : Buna-N

Choose the correct answer from given options below:

- (A) (A), (B) and (C) are correct
(B) (B), (C) and (D) are correct
(C) (A), (C) and (E) are correct
(D) (A), (B) and (D) are correct

Answer (A)

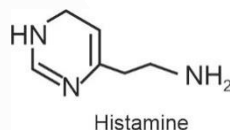
- Sol.** (A) Buna-S – Copolymer
(B) Nylon-6,6 – Condensation polymer
(C) Nylon-6,6 – Fibre
(D) Terylene – Thermoplastic
(E) Buna-N – Copolymer
(A) A, B and C are correct.

19. A chemical which stimulates the secretion of pepsin is:

- (A) Anti-histamine (B) Cimetidine
(C) Histamine (D) Zantac

Answer (C)

Sol. Histamine stimulates the secretion of pepsin and hydrochloric acid in the stomach.

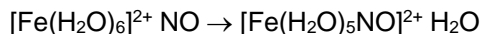
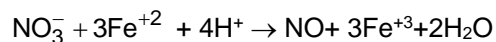


20. Which statement is **not** true with respect to nitrate ion test?

- (A) A dark brown ring is formed at the junction of two solutions.
(B) Ring is formed due to nitroferrous sulphate complex.
(C) The brown complex is $[\text{Fe}(\text{H}_2\text{O})_5(\text{NO})]\text{SO}_4$.
(D) Heating the nitrate salt with conc. H_2SO_4 , light brown fumes are evolved.

Answer (B)

Sol. Brown ring test

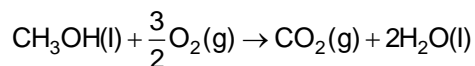


Brown ring

SECTION - B

Numerical Value Type Questions: This section contains 10 questions. In Section B, attempt any five questions out of 10. The answer to each question is a **NUMERICAL VALUE**. For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g. 06.25, 07.00, -00.33, -00.30, 30.27, -27.30) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.

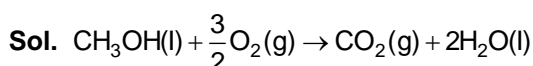
1. For complete combustion of methanol



the amount of heat produced as measured by bomb calorimeter is 726 kJ mol^{-1} at 27°C . The enthalpy of combustion for the reaction is $-x \text{ kJ mol}^{-1}$, where x is _____. (Nearest integer)

(Given : $R = 8.3 \text{ JK}^{-1} \text{ mol}^{-1}$)

Answer (727)



$$\Delta H = \Delta U + \Delta n_g RT$$

$$= -726 \text{ kJ} + \left(\frac{-1}{2}\right) \times 8.3 \times 300$$

$$\approx -727 \text{ kJ mol}^{-1}$$

2. A 0.5 percent solution of potassium chloride was found to freeze at -0.24°C . The percentage dissociation of potassium chloride is _____. (Nearest integer)

(Molal depression constant for water is $1.80 \text{ K kg mol}^{-1}$ and molar mass of KCl is 74.6 g mol^{-1})

Answer (98)

Sol. $\Delta T_f = iK_b m$

$$i = \frac{0.24 \times 99.5 \times 74.6}{1.80 \times 0.5 \times 1000}$$

$$= 1.98$$

$$\alpha = \frac{i-1}{n-1} = \frac{0.98}{1} = 0.98$$

3. 50 mL of 0.1 M CH_3COOH is being titrated against 0.1 M NaOH. When 25 mL of NaOH has been added, the pH of the solution will be ____ $\times 10^{-2}$. (Nearest integer)

(Given : $\text{pK}_a (\text{CH}_3\text{COOH}) = 4.76$)

$$\log 2 = 0.30$$

$$\log 3 = 0.48$$

$$\log 5 = 0.69$$

$$\log 7 = 0.84$$

$$\log 11 = 1.04$$

Answer (476)



at initially $\frac{50 \times 0.1}{\text{m moles}}$ $\frac{25 \times 0.1}{\text{m mole}}$

at time t 2.5 m moles 0 2.5 m mol

$$\text{pH} = \text{pK}_a + \log \left| \frac{(\text{salt})}{(\text{acid})} \right|$$

$$\text{pH} = 4.76 + \log \left| \frac{2.5}{2.5} \right|$$

$$\text{pH} = 4.76$$

4. A flask is filled with equal moles of A and B. The half lives of A and B are 100 s and 50 s respectively and are independent of the initial concentration. The time required for the concentration of A to be four times that of B is _____ s.

(Given : $\ln 2 = 0.693$)

Answer (200)

Sol.

	A	+	B
at initially	1		1
	mole		mole

after 100 s	$\frac{1}{2}$		$\frac{1}{4}$
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after 200 s	$\frac{1}{4}$		$\frac{1}{16}$
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Ans. 200 seconds

5. 2.0 g of H_2 gas is adsorbed on 2.5 g of platinum powder at 300 K and 1 bar pressure. The volume of the gas adsorbed per gram of the adsorbent is _____ mL.

(Given : $R = 0.083 \text{ L bar K}^{-1} \text{ mol}^{-1}$)

Answer (9960)

Sol. $PV = nRT$

$$V = \frac{2 \times 0.083 \times 300}{2 \times 1} = 24.9 \text{ litre}$$

\therefore Volume of the gas adsorbed per gram of the

$$\text{adsorbent} = \frac{24.9}{2.5} = 9.96 \text{ L}$$

$$= 9960 \text{ ml}$$

6. The spin-only magnetic moment value of the most basic oxide of vanadium among V_2O_3 , V_2O_4 and V_2O_5 is _____ B.M. (Nearest integer)

Answer (3)

Sol. The most basic oxide among V_2O_3 , V_2O_4 and V_2O_5 is V_2O_3

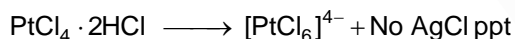
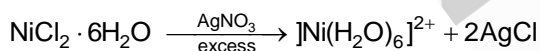
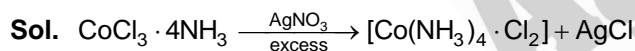
$$V_2O_3 = V^{+3}(d^2)$$

$$\text{Magnetic moment} = \sqrt{2(2+2)} = \sqrt{8}$$

$$= 2.83 \approx 3$$

7. The spin-only magnetic moment value of an octahedral complex among $CoCl_3 \cdot 4NH_3$, $NiCl_2 \cdot 6H_2O$ and $PtCl_4 \cdot 2HCl$, which upon reaction with excess of $AgNO_3$ gives 2 moles of $AgCl$ is _____ B.M. (Nearest Integer)

Answer (3)



$$[Ni^{+2}(H_2O)_6] = d^8 = t_{2g}^6 e_g^2 = 2 \text{ unpaired electrons}$$

$$\text{Magnetic moment} = \sqrt{2(2+2)}$$

$$2\sqrt{8} \approx 3$$

8. On complete combustion 0.30 g of an organic compound gave 0.20 g of carbon dioxide and 0.10 g of water. The percentage of carbon in the given organic compound is _____.

(Nearest Integer)

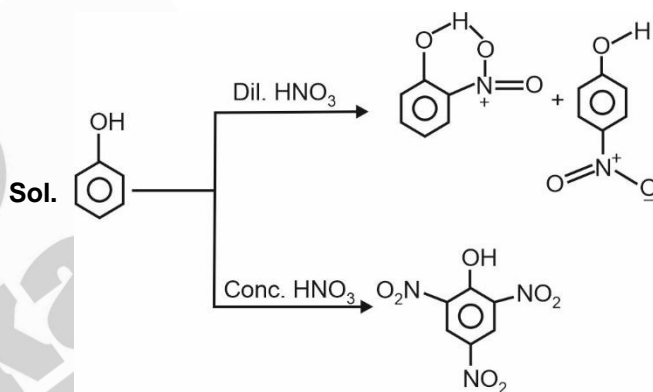
Answer (18)

$$\text{Sol. } C\% = \frac{12}{44} \times \frac{0.20}{0.30} \times 100$$

$$= \frac{200}{11} = 18.18 \approx 18$$

9. Compound 'P' on nitration with dil. HNO_3 yields two isomers (A) and (B) show the intramolecular and intermolecular hydrogen bonding respectively. Compound (P) on reaction with conc. HNO_3 yields a yellow compound 'C', a strong acid. The number of oxygen atoms is present in compound 'C' _____.

Answer (7)

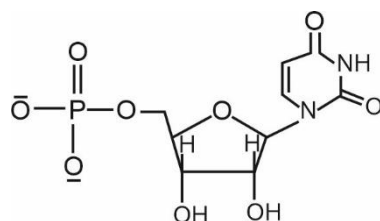


The number of oxygen atoms = 7

10. The number of oxygens present in a nucleotide formed from a base, that is present only in RNA is _____.

Answer (9)

Sol. Nucleotide formed by Uracil, the base present in RNA, is



The number of oxygen = 9