

PART-III : CHEMISTRY

SECTION 1 (Maximum Marks : 12)

- This section contains **FOUR (04)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +3 If **ONLY** the correct option 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.

1. According to Bohr's model, the highest kinetic energy is associated with the electron in the
 - (A) First orbit of H atom
 - (B) First orbit of He⁺
 - (C) Second orbit of He⁺
 - (D) Second orbit of Li²⁺

Answer (B)

2. In a metal deficient oxide sample, $M_xY_2O_4$ (M and Y are metals), M is present in both +2 and +3 oxidation states and Y is in +3 oxidation state. If the fraction of M^{2+} ions present in M is $\frac{1}{3}$, the value of X is _____.
 - (A) 0.25
 - (B) 0.33
 - (C) 0.67
 - (D) 0.75

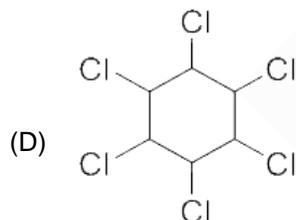
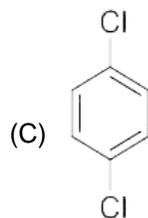
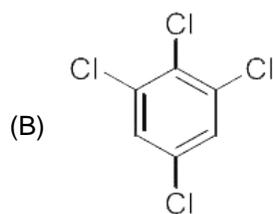
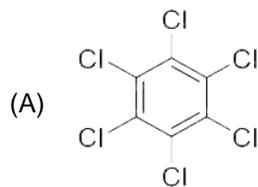
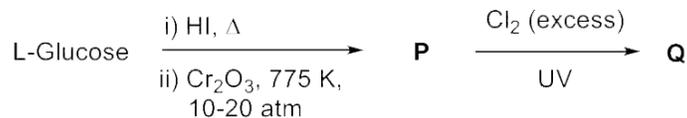
Answer (D)

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3. In the following reaction sequence, the major product **Q** is



Answer (D)

4. The species formed on fluorination of phosphorus pentachloride in a polar organic solvent are

- (A) $[\text{PF}_4]^+[\text{PF}_6]^-$ and $[\text{PCl}_4]^+[\text{PF}_6]^-$
- (B) $[\text{PCl}_4]^+[\text{PCl}_4\text{F}_2]^-$ and $[\text{PCl}_4]^+[\text{PF}_6]^-$
- (C) PF_3 and PCl_3
- (D) PF_5 and PCl_3

Answer (B)

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SECTION 2 (Maximum Marks : 12)

- This section contains **THREE (03)** 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 according to the following marking scheme:

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 unanswered;

Negative Marks : -2 In all other cases.

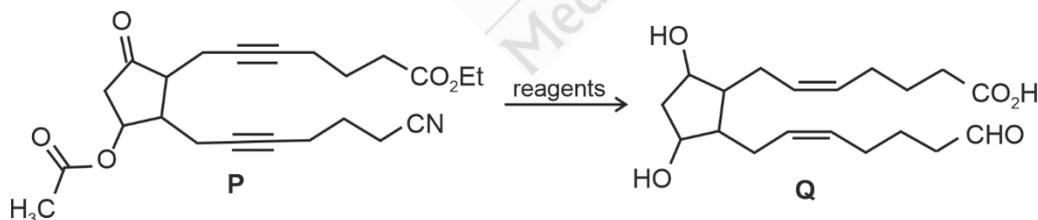
5. An aqueous solution of hydrazine (N_2H_4) is electrochemically oxidized by O_2 , thereby releasing chemical energy in the form of electrical energy. One of the products generated from the electrochemical reaction is $N_2(g)$.

Choose the correct statement(s) about the above process

- (A) OH^- ions react with N_2H_4 at the anode to form $N_2(g)$ and water, releasing 4 electrons to the anode.
 (B) At the cathode, N_2H_4 breaks to $N_2(g)$ and nascent hydrogen released at the electrode reacts with oxygen to form water.
 (C) At the cathode, molecular oxygen gets converted to OH^- .
 (D) Oxides of nitrogen are major by-products of the electrochemical process.

Answer (A, C)

6. The option(s) with correct sequence of reagents for the conversion of **P** to **Q** is(are)



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- (A) i) Lindlar's catalyst, H_2 ; ii) $SnCl_2/HCl$; iii) $NaBH_4$; iv) H_3O^+
 (B) i) Lindlar's catalyst, H_2 ; ii) H_3O^+ ; iii) $SnCl_2/HCl$; iv) $NaBH_4$
 (C) i) $NaBH_4$; ii) $SnCl_2/HCl$; iii) H_3O^+ ; iv) Lindlar's catalyst, H_2
 (D) i) Lindlar's catalyst, H_2 ; ii) $NaBH_4$; iii) $SnCl_2/HCl$; iv) H_3O^+

Answer (A, C, D)

7. The compound(s) having peroxide linkage is(are)

- (A) $H_2S_2O_7$ (B) $H_2S_2O_8$
 (C) $H_2S_2O_5$ (D) H_2SO_5

Answer (B, D)

SECTION 3 (Maximum Marks : 24)

- This section contains **SIX (06)** questions.
- The answer to each question is a **NON-NEGATIVE INTEGER**.
- For each question, enter the correct integer corresponding to the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 If **ONLY** the correct integer is entered;

Zero Marks : 0 In all other cases.

8. To form a complete monolayer of acetic acid on 1 g of charcoal, 100 mL of 0.5 M acetic acid was used. Some of the acetic acid remained unadsorbed. To neutralize the unadsorbed acetic acid, 40 mL of 1 M NaOH solution was required. If each molecule of acetic acid occupies $P \times 10^{-23}$ m² surface area on charcoal, the value of P is _____.

[Use given data : Surface area of charcoal = 1.5×10^2 m²g⁻¹; Avogadro's number (N_A) = 6.0×10^{23} mol⁻¹]

Answer (2500)

9. Vessel-1 contains w_2 g of a non-volatile solute X dissolved in w_1 g of water. Vessel-2 contains w_2 g of another non-volatile solute Y dissolved in w_1 g of water. Both the vessels are at the same temperature and pressure. The molar mass of X is 80% of that of Y. The van't Hoff factor for X is 1.2 times of that of Y for their respective concentrations.

The elevation of boiling point for solution in Vessel-1 is _____ % of the solution in Vessel-2.

Answer (150)

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10. For a double strand DNA, one strand is given below:



The amount of energy required to split the double strand DNA into two single strands is _____ kcal mol⁻¹.

[Given: Average energy per H-bond for A-T base pair = 1.0 kcal mol⁻¹, G-C base pair = 1.5 kcal mol⁻¹, and A-U base pair = 1.25 kcal mol⁻¹. Ignore electrostatic repulsion between the phosphate groups.]

Answer (41)

11. A sample initially contains only U-238 isotope of uranium. With time, some of the U-238 radioactively decays into Pb-206 while the rest of it remains undisintegrated.

When the age of the sample is $P \times 10^8$ years, the ratio of mass of Pb-206 to that of U-238 in the sample is found to be 7. The value of P is _____.

[Given : Half-life of U-238 is 4.5×10^9 years; $\log_e 2 = 0.693$]

Answer (143)

12. Among $[\text{Co}(\text{CN})_4]^{4-}$, $[\text{Co}(\text{CO})_3(\text{NO})]$, XeF_4 , $[\text{PCl}_4]^+$, $[\text{PdCl}_4]^{2-}$, $[\text{ICl}_4]^-$, $[\text{Cu}(\text{CN})_4]^{3-}$ and P_4 the total number of species with tetrahedral geometry is _____.

Answer (3)

13. An organic compound P having molecular formula $\text{C}_6\text{H}_6\text{O}_3$ gives ferric chloride test and does not have intramolecular hydrogen bond. The compound P reacts with 3 equivalents of NH_2OH to produce oxime Q . Treatment of P with excess methyl iodide in the presence of KOH produces compound R as the major product. Reaction of R with excess *iso*-butylmagnesium bromide followed by treatment with H_3O^+ gives compound S as the major product.

The total number of methyl ($-\text{CH}_3$) group(s) in compound S is _____.

Answer (12)

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SECTION 4 (Maximum Marks : 12)

- This section contains **TWO (02)** paragraphs.
- Based on each paragraph, there are **TWO (02)** 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 answer.
- 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 according to the following marking scheme:

Full Marks : +3 If **ONLY** the correct numerical value is entered in the designated place;

Zero Marks : 0 In all other cases.

PARAGRAPH I

An organic compound **P** with molecular formula $C_9H_{18}O_2$ decolorizes bromine water and also shows positive iodoform test. **P** on ozonolysis followed by treatment with H_2O_2 gives **Q** and **R**. While compound **Q** shows positive iodoform test, compound **R** does not give positive iodoform test. **Q** and **R** on oxidation with pyridinium chlorochromate (PCC) followed by heating give **S** and **T**, respectively. Both **S** and **T** show positive iodoform test.

Complete copolymerization of 500 moles of **Q** and 500 moles of **R** gives one mole of a single acyclic copolymer **U**.

[Given, atomic mass: H = 1, C = 12, O = 16]

14. Sum of number of oxygen atoms in **S** and **T** is _____.

Answer (2)

PARAGRAPH I

An organic compound **P** with molecular formula $C_9H_{18}O_2$ decolorizes bromine water and also shows positive iodoform test. **P** on ozonolysis followed by treatment with H_2O_2 gives **Q** and **R**. While compound **Q** shows positive iodoform test, compound **R** does not give positive iodoform test. **Q** and **R** on oxidation with pyridinium chlorochromate (PCC) followed by heating give **S** and **T**, respectively. Both **S** and **T** show positive iodoform test.

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15. The molecular weight of **U** is _____.

Answer (102018)

PARAGRAPH II

When potassium iodide is added to an aqueous solution of potassium ferricyanide, a reversible reaction is observed in which a complex **P** is formed. In a strong acidic medium, the equilibrium shifts completely towards **P**. Addition of zinc chloride to **P** in a slightly acidic medium results in a sparingly soluble complex **Q**.

16. The number of moles of potassium iodide required to produce two moles of **P** is _____.

Answer (2)

PARAGRAPH II

When potassium iodide is added to an aqueous solution of potassium ferricyanide, a reversible reaction is observed in which a complex **P** is formed. In a strong acidic medium, the equilibrium shifts completely towards **P**. Addition of zinc chloride to **P** in a slightly acidic medium results in a sparingly soluble complex **Q**.

17. The number of zinc ions present in the molecular formula of **Q** is _____.

Answer (3)



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