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.

Q.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^+

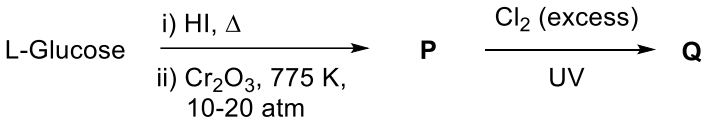
(C) second orbit of He^+

(D) second orbit of Li^{2+}

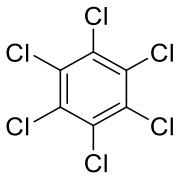
Q.2 In a metal deficient oxide sample, $\mathbf{M_XY_2O_4}$ (**M** and **Y** are metals), **M** is present in both +2 and +3 oxidation states and **Y** is in +3 oxidation state. If the fraction of $\mathbf{M^{2+}}$ ions present in **M** is $\frac{1}{3}$, the value of **X** is _____.

(A) 0.25 (B) 0.33 (C) 0.67 (D) 0.75

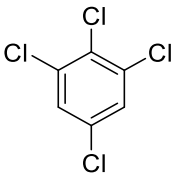
Q.3 In the following reaction sequence, the major product **Q** is



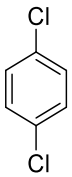
(A)



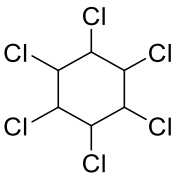
(B)



(C)



(D)



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

(A) $[PF_4]^+[PF_6]^-$ and $[PCl_4]^+[PF_6]^-$

(B) $[PCl_4]^+[PCl_4F_2]^-$ and $[PCl_4]^+[PF_6]^-$

(C) PF_3 and PCl_3

(D) PF_5 and PCl_3

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 <u>according to the following marking 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 unanswered;
  Negative Marks : -2 In all other cases.
- For example, in a question, if (A), (B) and (D) are the ONLY three options corresponding to correct answers, then
  choosing ONLY (A), (B) and (D) will get $+4$ marks;
  choosing ONLY (A) and (B) will get $+2$ marks;
  choosing ONLY (A) and (D) will get $+2$marks;
  choosing ONLY (B) and (D) will get $+2$ marks;
  choosing ONLY (A) will get $+1$ mark;
  choosing ONLY (B) will get $+1$ mark;
  choosing ONLY (D) will get $+1$ mark;
  choosing no option(s) (i.e. the question is unanswered) will get 0 marks and
  choosing any other option(s) will get -2 marks.

Q.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

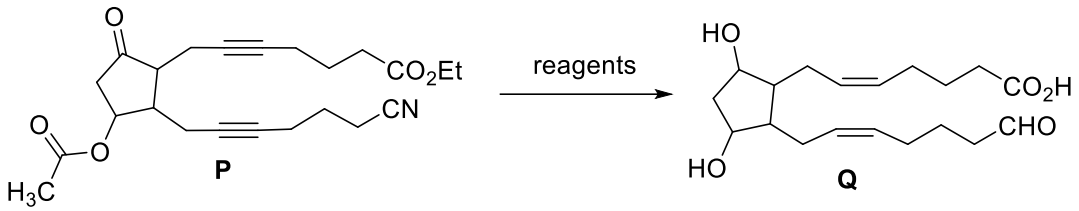
(A) OH^- ions react with N_2H_4 at the anode to form $N_2(g)$ and water, releasing 4 electrons to the anode.

(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.

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



(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^+

Q.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

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.

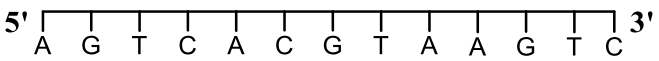
Q.8 To form a complete monolayer of acetic acid on 1g of charcoal, 100 mL of 0.5 M acetic acid was used. Some of the acetic acid remained unadsorbed. To neutralize the unadsorbed acetic acid, 40 mL of 1 M NaOH solution was required. If each molecule of acetic acid occupies **P** x 10^{-23} m^2 surface area on charcoal, the value of **P** is _____.

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

Q.9 Vessel-1 contains $\mathbf{w_2}$ g of a non-volatile solute **X** dissolved in $\mathbf{w_1}$ g of water. Vessel-2 contains $\mathbf{w_2}$ g of another non-volatile solute **Y** dissolved in $\mathbf{w_1}$ 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.

Q.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.]

Q.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** $x10^8$ 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 $x10^9$ years; $\log_e 2 = 0.693$]

Q.12 Among $[Co(CN)_4]^{4-}$, $[Co(CO)_3(NO)]$, XeF_4, $[PCl_4]^+$, $[PdCl_4]^{2-}$, $[ICl_4]^-$, $[Cu(CN)_4]^{3-}$ and P_4 the total number of species with tetrahedral geometry is _____.

Q.13 An organic compound **P** having molecular formula $C_6H_6O_3$ 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 ($-CH_3$) group(s) in compound **S** is _____.

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]

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

"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]

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

"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**.

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

"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**.

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

END OF THE QUESTION PAPER