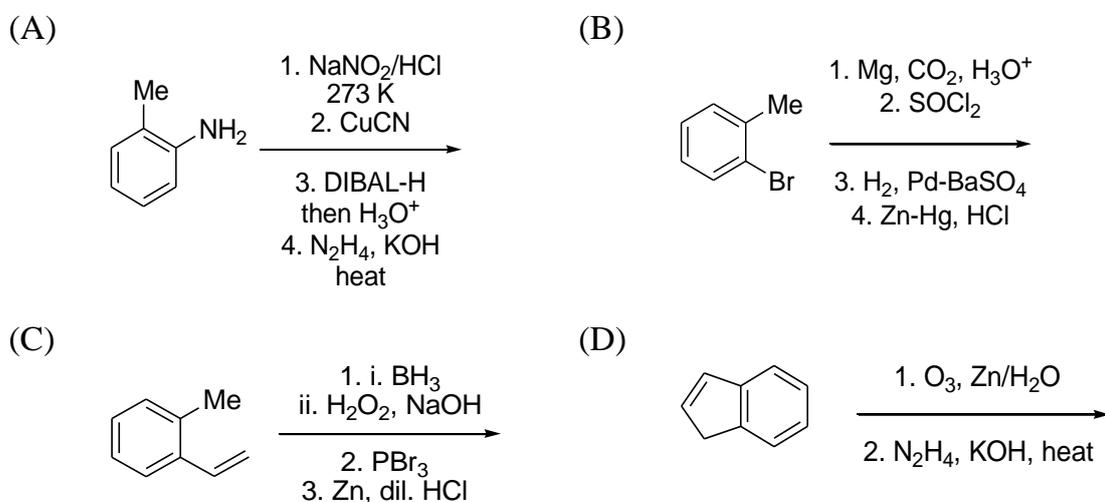


SECTION 1

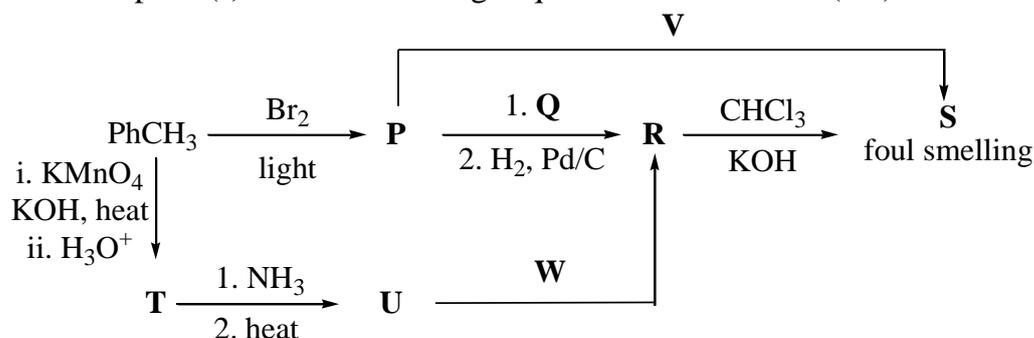
- This section contains **SIX (06)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:
 - Full Marks* : +4 If only (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.1 The reaction sequence(s) that would lead to *o*-xylene as the major product is(are)



Q.1. PROVISIONAL ANSWER: A, B

Q.2 Correct option(s) for the following sequence of reactions is(are)



- (A) **Q** = KNO₂, **W** = LiAlH₄ (B) **R** = benzenamine, **V** = KCN
 (C) **Q** = AgNO₂, **R** = phenylmethanamine (D) **W** = LiAlH₄, **V** = AgCN

Q.2. PROVISIONAL ANSWER: C, D

Q.3 For the following reaction



the rate of reaction is $\frac{d[\mathbf{P}]}{dt} = k[\mathbf{X}]$. Two moles of **X** are mixed with one mole of **Y** to make 1.0 L of solution. At 50 s, 0.5 mole of **Y** is left in the reaction mixture. The correct statement(s) about the reaction is(are)

(Use: $\ln 2 = 0.693$)

- (A) The rate constant, k , of the reaction is $13.86 \times 10^{-4} \text{ s}^{-1}$.
 (B) Half-life of **X** is 50 s.
 (C) At 50 s, $-\frac{d[\mathbf{X}]}{dt} = 13.86 \times 10^{-3} \text{ mol L}^{-1} \text{ s}^{-1}$.
 (D) At 100 s, $-\frac{d[\mathbf{Y}]}{dt} = 3.46 \times 10^{-3} \text{ mol L}^{-1} \text{ s}^{-1}$.

Q.3. PROVISIONAL ANSWER: B, C, D

Q.4 Some standard electrode potentials at 298 K are given below:



To a solution containing 0.001 M of X^{2+} and 0.1 M of Y^{2+} , the metal rods **X** and **Y** are inserted (at 298 K) and connected by a conducting wire. This resulted in dissolution of **X**. The correct combination(s) of **X** and **Y**, respectively, is(are)

(Given: Gas constant, $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$,
Faraday constant, $F = 96500 \text{ C mol}^{-1}$)

- (A) Cd and Ni
- (B) Cd and Fe
- (C) Ni and Pb
- (D) Ni and Fe

Q.4. PROVISIONAL ANSWER: A, B, C

Q.5 The pair(s) of complexes wherein both exhibit tetrahedral geometry is(are)

(Note: py = pyridine)

Given: Atomic numbers of Fe, Co, Ni and Cu are 26, 27, 28 and 29, respectively)

- (A) $[\text{FeCl}_4]^-$ and $[\text{Fe}(\text{CO})_4]^{2-}$
- (B) $[\text{Co}(\text{CO})_4]^-$ and $[\text{CoCl}_4]^{2-}$
- (C) $[\text{Ni}(\text{CO})_4]$ and $[\text{Ni}(\text{CN})_4]^{2-}$
- (D) $[\text{Cu}(\text{py})_4]^+$ and $[\text{Cu}(\text{CN})_4]^{3-}$

Q.5. PROVISIONAL ANSWER: A, B, D

Q.6 The correct statement(s) related to oxoacids of phosphorous is(are)

- (A) Upon heating, H_3PO_3 undergoes disproportionation reaction to produce H_3PO_4 and PH_3 .
- (B) While H_3PO_3 can act as reducing agent, H_3PO_4 cannot.
- (C) H_3PO_3 is a monobasic acid.
- (D) The H atom of P–H bond in H_3PO_3 is not ionizable in water.

Q.6. PROVISIONAL ANSWER: A, B, D

SECTION 2

- This section contains **THREE (03)** question stems.
- There are **TWO (02)** questions corresponding to each question stem.
- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value corresponding to the answer in the designated place using the mouse and the on-screen virtual numeric keypad.
- 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 : +2 If ONLY the correct numerical value is entered at the designated place;
Zero Marks : 0 In all other cases.

Question Stem for Question Nos. 7 and 8**Question Stem**

At 298 K, the limiting molar conductivity of a weak monobasic acid is $4 \times 10^2 \text{ S cm}^2 \text{ mol}^{-1}$. At 298 K, for an aqueous solution of the acid the degree of dissociation is α and the molar conductivity is $y \times 10^2 \text{ S cm}^2 \text{ mol}^{-1}$. At 298 K, upon 20 times dilution with water, the molar conductivity of the solution becomes $3y \times 10^2 \text{ S cm}^2 \text{ mol}^{-1}$.

Q.7 The value of α is ____.

Q.7. PROVISIONAL RANGE OF ANSWER: [0.20 to 0.22]

Q.8 The value of y is ____.

Q.8. PROVISIONAL RANGE OF ANSWER: [0.80 to 0.90]

Question Stem for Question Nos. 9 and 10**Question Stem**

Reaction of x g of Sn with HCl quantitatively produced a salt. Entire amount of the salt reacted with y g of nitrobenzene in the presence of required amount of HCl to produce 1.29 g of an organic salt (quantitatively).

(Use Molar masses (in g mol^{-1}) of H, C, N, O, Cl and Sn as 1, 12, 14, 16, 35 and 119, respectively).

Q.9 The value of x is ____.

Q.9. PROVISIONAL RANGE OF ANSWER: [3.57 to 3.57]

Q.10 The value of y is ____.

Q.10. PROVISIONAL RANGE OF ANSWER: [1.23 to 1.23]

Question Stem for Question Nos. 11 and 12

Question Stem

A sample (5.6 g) containing iron is completely dissolved in cold dilute HCl to prepare a 250 mL of solution. Titration of 25.0 mL of this solution requires 12.5 mL of 0.03 M KMnO_4 solution to reach the end point. Number of moles of Fe^{2+} present in 250 mL solution is $x \times 10^{-2}$ (consider complete dissolution of FeCl_2). The amount of iron present in the sample is $y\%$ by weight.

(Assume: KMnO_4 reacts only with Fe^{2+} in the solution

Use: Molar mass of iron as 56 g mol^{-1})

Q.11 The value of x is ____.

Q.11. PROVISIONAL RANGE OF ANSWER: [1.87 to 1.88]

Q.12 The value of y is ____.

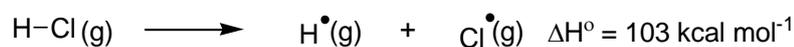
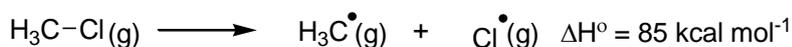
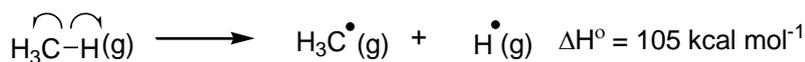
Q.12. PROVISIONAL RANGE OF ANSWER: [18.70 to 18.80]

SECTION 3

- This section contains **TWO (02) paragraphs**. Based on each paragraph, there are **TWO (02)** 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.

Paragraph

The amount of energy required to break a bond is same as the amount of energy released when the same bond is formed. In gaseous state, the energy required for *homolytic cleavage* of a bond is called Bond Dissociation Energy (BDE) or Bond Strength. BDE is affected by *s*-character of the bond and the stability of the radicals formed. Shorter bonds are typically stronger bonds. BDEs for some bonds are given below:



Q.13 Correct match of the **C–H** bonds (shown in bold) in Column **J** with their BDE in Column **K** is

Column J Molecule	Column K BDE (kcal mol ⁻¹)
(P) H –CH(CH ₃) ₂	(i) 132
(Q) H –CH ₂ Ph	(ii) 110
(R) H –CH=CH ₂	(iii) 95
(S) H –C≡CH	(iv) 88

- (A) P – iii, Q – iv, R – ii, S – i (B) P – i, Q – ii, R – iii, S – iv
 (C) P – iii, Q – ii, R – i, S – iv (D) P – ii, Q – i, R – iv, S – iii

Q.13. PROVISIONAL ANSWER: A

Q.14 For the following reaction



the correct statement is

- (A) Initiation step is exothermic with $\Delta H^\circ = -58 \text{ kcal mol}^{-1}$.
 (B) Propagation step involving $\bullet\text{CH}_3$ formation is exothermic with $\Delta H^\circ = -2 \text{ kcal mol}^{-1}$.
 (C) Propagation step involving CH_3Cl formation is endothermic with $\Delta H^\circ = +27 \text{ kcal mol}^{-1}$.
 (D) The reaction is exothermic with $\Delta H^\circ = -25 \text{ kcal mol}^{-1}$.

Q.14. PROVISIONAL ANSWER: D

Paragraph

The reaction of $\text{K}_3[\text{Fe}(\text{CN})_6]$ with freshly prepared FeSO_4 solution produces a dark blue precipitate called Turnbull's blue. Reaction of $\text{K}_4[\text{Fe}(\text{CN})_6]$ with the FeSO_4 solution in complete absence of air produces a white precipitate **X**, which turns blue in air. Mixing the FeSO_4 solution with NaNO_3 , followed by a slow addition of concentrated H_2SO_4 through the side of the test tube produces a brown ring.

Q.15 Precipitate **X** is



Q.15. PROVISIONAL ANSWER: C

Q.16 Among the following, the brown ring is due to the formation of

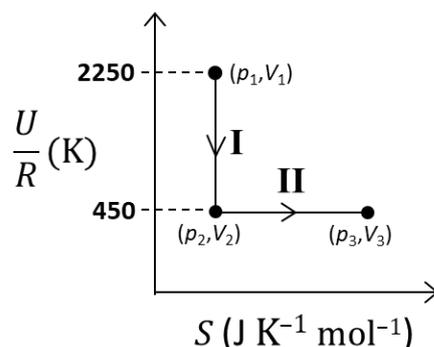


Q.16. PROVISIONAL ANSWER: D

SECTION 4

- This section contains **THREE (03)** 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.17 One mole of an ideal gas at 900 K, undergoes two reversible processes, **I** followed by **II**, as shown below. If the work done by the gas in the two processes are same, the value of $\ln \frac{V_3}{V_2}$ is ____.



(U : internal energy, S : entropy, p : pressure, V : volume, R : gas constant)

(Given: molar heat capacity at constant volume, $C_{V,m}$ of the gas is $\frac{5}{2}R$)

Q.17. PROVISIONAL ANSWER: 10

- Q.18 Consider a helium (He) atom that absorbs a photon of wavelength 330 nm. The change in the velocity (in cm s^{-1}) of He atom after the photon absorption is ____.

(Assume: Momentum is conserved when photon is absorbed.)

Use: Planck constant = 6.6×10^{-34} J s, Avogadro number = 6×10^{23} mol^{-1} , Molar mass of He = 4 g mol^{-1})

Q.18. PROVISIONAL ANSWER: 30

- Q.19 Ozonolysis of ClO_2 produces an oxide of chlorine. The average oxidation state of chlorine in this oxide is ____.

Q.19. PROVISIONAL ANSWER: 6

END OF THE QUESTION PAPER