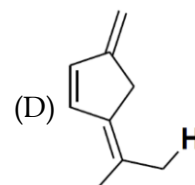
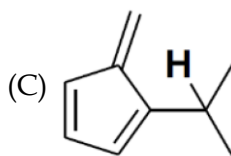
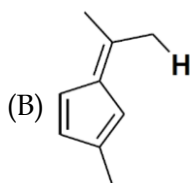
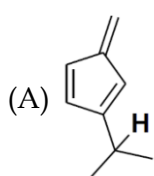


## Chemistry

## 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 <b>ONLY</b> 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.   |

- The heating of  $\text{NH}_4\text{NO}_2$  at  $60-70^\circ\text{C}$  and  $\text{NH}_4\text{NO}_3$  at  $200-250^\circ\text{C}$  is associated with the formation of nitrogen containing compounds **X** and **Y**, respectively. **X** and **Y**, respectively, are  
 (A)  $\text{N}_2$  and  $\text{N}_2\text{O}$   
 (B)  $\text{NH}_3$  and  $\text{NO}_2$   
 (C)  $\text{NO}$  and  $\text{N}_2\text{O}$   
 (D)  $\text{N}_2$  and  $\text{NH}_3$
- The correct order of the wavelength maxima of the absorption band in the ultraviolet-visible region for the given complexes is  
 (A)  $[\text{Co}(\text{CN})_6]^{3-} < [\text{Co}(\text{NH}_3)_6]^{3+} < [\text{Co}(\text{NH}_3)_5(\text{H}_2\text{O})]^{3+} < [\text{Co}(\text{NH}_3)_5(\text{Cl})]^{2+}$   
 (B)  $[\text{Co}(\text{NH}_3)_5(\text{Cl})]^{2+} < [\text{Co}(\text{NH}_3)_5(\text{H}_2\text{O})]^{3+} < [\text{Co}(\text{NH}_3)_6]^{3+} < [\text{Co}(\text{CN})_6]^{3-}$   
 (C)  $[\text{Co}(\text{CN})_6]^{3-} < [\text{Co}(\text{NH}_3)_5(\text{Cl})]^{2+} < [\text{Co}(\text{NH}_3)_5(\text{H}_2\text{O})]^{3+} < [\text{Co}(\text{NH}_3)_6]^{3+}$   
 (D)  $[\text{Co}(\text{NH}_3)_6]^{3+} < [\text{Co}(\text{CN})_6]^{3-} < [\text{Co}(\text{NH}_3)_5(\text{Cl})]^{2+} < [\text{Co}(\text{NH}_3)_5(\text{H}_2\text{O})]^{3+}$
- One of the products formed from the reaction of permanganate ion with iodide ion in neutral aqueous medium is  
 (A)  $\text{I}_2$  (B)  $\text{IO}_3^-$  (C)  $\text{IO}_4^-$  (D)  $\text{IO}_2^-$
- Consider the depicted hydrogen (H) in the hydrocarbons given below. The most acidic hydrogen (H) is



## 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	<b>ONLY</b> if (all) the correct option(s) is(are) chosen;
Partial Marks	: +3	If all the four options are correct but <b>ONLY</b> three options are chosen;
Partial Marks	: +2	If three or more options are correct but <b>ONLY</b> two options are chosen, both of which are correct;
Partial Marks	: +1	If two or more options are correct but <b>ONLY</b> 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.
- 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 (i.e. the question is unanswered) will get 0 marks; and choosing any other combination of options will get -2 marks.

5. Regarding the molecular orbital (MO) energy levels for homonuclear diatomic molecules, the **INCORRECT** statement(s) is(are)
- (A) Bond order of  $\text{Ne}_2$  is zero.  
 (B) The highest occupied molecular orbital (HOMO) of  $\text{F}_2$  is  $\sigma$ -type.  
 (C) Bond energy of  $\text{O}_2^+$  is smaller than the bond energy of  $\text{O}_2$ .  
 (D) Bond length of  $\text{Li}_2$  is larger than the bond length of  $\text{B}_2$ .

6. The pair(s) of diamagnetic ions is(are)
- (A)  $\text{La}^{3+}, \text{Ce}^{4+}$       (B)  $\text{Yb}^{2+}, \text{Lu}^{3+}$       (C)  $\text{La}^{2+}, \text{Ce}^{3+}$       (D)  $\text{Yb}^{3+}, \text{Lu}^{2+}$

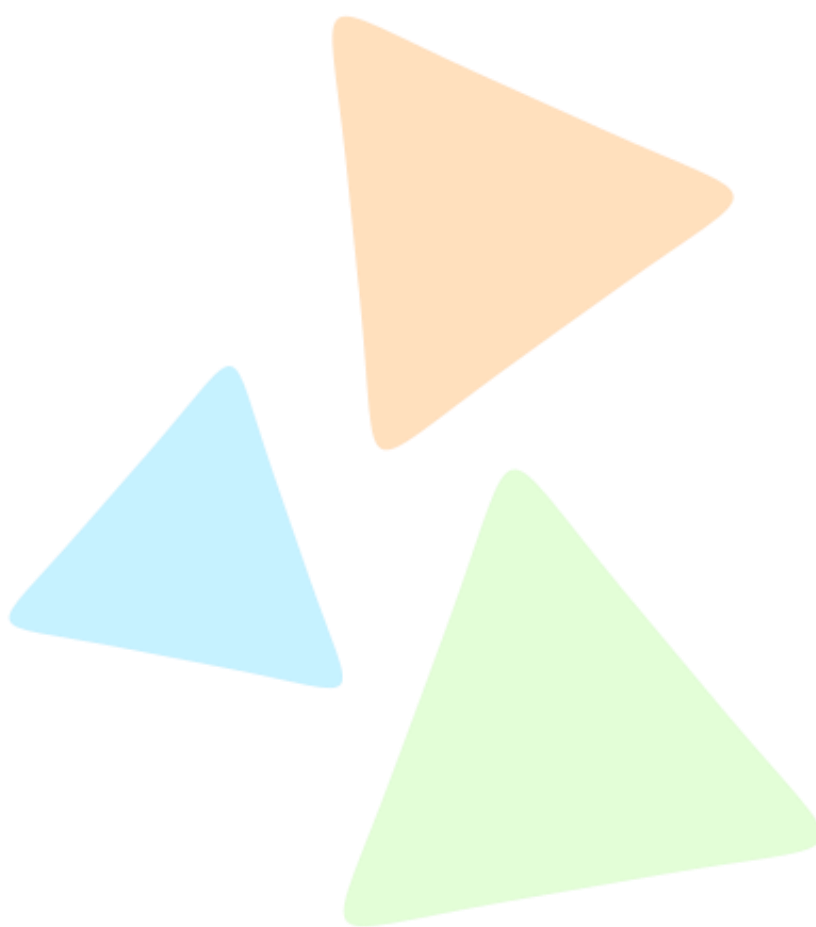
7. For the reaction sequence given below, the correct statement(s) is (are)



- (In the options, X is any atom other than carbon and hydrogen, and it is different in P, Q and R)
- (A) C–X bond length in P, Q and R follows the order  $Q > R > P$ .  
 (B) C–X bond enthalpy in P, Q and R follows the order  $R > P > Q$ .  
 (C) Relative reactivity toward  $\text{S}_{\text{N}}2$  reaction in P, Q and R follows the order  $P > R > Q$ .  
 (D)  $\text{pK}_{\text{a}}$  value of the conjugate acids of the leaving groups in P, Q and R follows the order  $R > Q > P$ .

8. In an electrochemical cell, dichromate ions in aqueous acidic medium are reduced to  $\text{Cr}^{3+}$ . The current (in amperes) that flows through the cell for 48.25 minutes to produce 1 mole of  $\text{Cr}^{3+}$  is \_\_\_\_\_.

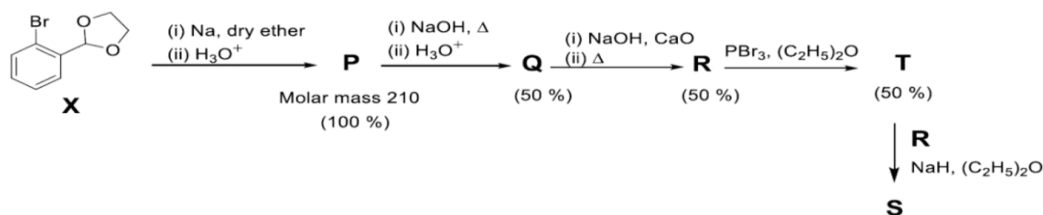
**Use:** 1 Faraday =  $96500\text{Cmol}^{-1}$



**SECTION 3 (Maximum Marks: 24)**

- This section contains SIX (06) 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 onscreen virtual numeric keypad in the place designated to enter the answer. If the numerical value has more than two decimal places, truncate/roundoff the value to TWO decimal places.
- Answer to each question will be evaluated according to the following marking scheme:  
Full Marks : +4 ONLY if the correct numerical value is entered;  
Zero Marks : 0 In all other cases.

9. At  $25^\circ\text{C}$ , the concentration of  $\text{H}^+$  ions in  $1.00 \times 10^{-3}\text{M}$  aqueous solution of a weak monobasic acid having acid dissociation constant ( $K_a$ ) of  $4.00 \times 10^{-11}$  is  $X \times 10^{-7}\text{M}$ . The value of  $X$  is \_\_\_\_\_.  
Use: Ionic product of water ( $K_w$ ) =  $1.00 \times 10^{-14}$  at  $25^\circ\text{C}$
10. Molar volume ( $V_m$ ) of a van der Waals gas can be calculated by expressing the van der Waals equation as a cubic equation with  $V_m$  as the variable. The ratio (in  $\text{mol dm}^{-3}$ ) of the coefficient of  $V_m^2$  to the coefficient of  $V_m$  for a gas having van der Waals constants  $a = 6.0\text{dm}^6\text{ atm mol}^{-2}$  and  $b = 0.060\text{dm}^3\text{ mol}^{-1}$  at 300 K and 300 atm is \_\_\_\_\_.  
Use: Universal gas constant ( $R$ ) =  $0.082\text{dm}^3\text{atmmol}^{-1}\text{ K}^{-1}$
11. Considering ideal gas behavior, the expansion work done (in kJ) when 144 g of water is electrolyzed completely under constant pressure at 300 K is \_\_\_\_\_.  
Use: Universal gas constant ( $R$ ) =  $8.3\text{ J K}^{-1}\text{ mol}^{-1}$ ; Atomic mass (in amu):  $\text{H} = 1, \text{O} = 16$
12. The monomer (X) involved in the synthesis of Nylon 6,6 gives positive carbylamine test. If 10 moles of X are analyzed using Dumas method, the amount (in grams) of nitrogen gas evolved is \_\_\_\_\_.  
Use: Atomic mass of N (in amu) = 14
13. The reaction sequence given below is carried out with 16 moles of X. The yield of the major product in each step is given below the product in parentheses. The amount (in grams) of S produced is \_\_\_\_\_.



**SECTION 4 (Maximum Marks: 12)**

- This section contains THREE (03) 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 (P), (Q), (R) and (S) and List-II has Five entries (1), (2), (3), (4) and (5).
- 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 according to the following marking scheme:  
Full Marks : +4 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.

14. The correct match of the group reagents in List-I for precipitating the metal ion given in List-II from solutions, is

**List-I**

- (P) Passing  $H_2S$  in the presence of  $NH_4OH$   
 (Q)  $(NH_4)_2CO_3$  in the presence of  $NH_4OH$   
 (R)  $NH_4OH$  in the presence of  $NH_4Cl$   
 (S) Passing  $H_2S$  in the presence of dilute  $HCl$

**List-II**

- (1)  $Cu^{2+}$   
 (2)  $Al^{3+}$   
 (3)  $Mn^{2+}$   
 (4)  $Ba^{2+}$   
 (5)  $Mg^{2+}$

- (A)  $P \rightarrow 3; Q \rightarrow 4; R \rightarrow 2; S \rightarrow 1$   
 (B)  $P \rightarrow 4; Q \rightarrow 2; R \rightarrow 3; S \rightarrow 1$   
 (C)  $P \rightarrow 3; Q \rightarrow 4; R \rightarrow 1; S \rightarrow 5$   
 (D)  $P \rightarrow 5; Q \rightarrow 3; R \rightarrow 2; S \rightarrow 4$

15. The major products obtained from the reactions in List-II are the reactants for the named reactions mentioned in List-I. Match each entry in List-I with the appropriate entry in List-II and choose the correct option.

**List-I**

- (P) Stephen reaction  
 (Q) Sandmeyer reaction  
 (R) Hoffmann bromamide degradation reaction  
 (S) Cannizzaro reaction

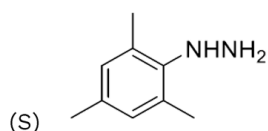
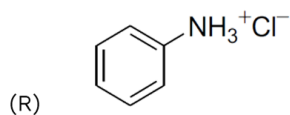
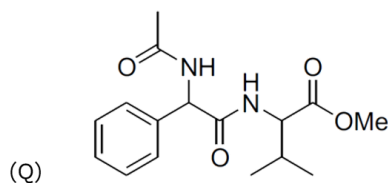
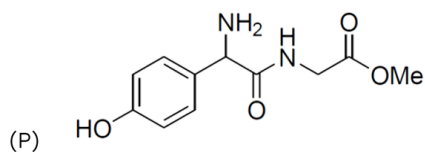
**List-II**

- (1) Toluene  $\xrightarrow[(ii) H_3O^+]{(i) CrO_2Cl_2/CS_2}$   
 (2) Benzoic acid  $\xrightarrow[(iii) P_4O_{10}, \Delta]{(i) PCl_5, (ii) NH_3}$   
 (3) Nitrobenzene  $\xrightarrow[(273-278K), H_2O]{(i) Fe, HCl, (ii) HCl, NaNO_2}$   
 (4) Toluene  $\xrightarrow[(iv) NH_3]{(i) Cl_2/h\nu, H_2O, (ii) Tollen's reagent, (iii) SO_2, Cl_2}$   
 (5) Aniline  $\xrightarrow[(iii) aq. NaOH]{(i) (CH_3CO)_2O, Pyridine, (ii) HNO_3, H_2SO_4, 288K}$

- (A)  $P \rightarrow 2; Q \rightarrow 4; R \rightarrow 1; S \rightarrow 3$   
 (B)  $P \rightarrow 2; Q \rightarrow 3; R \rightarrow 4; S \rightarrow 1$   
 (C)  $P \rightarrow 5; Q \rightarrow 3; R \rightarrow 4; S \rightarrow 2$   
 (D)  $P \rightarrow 5; Q \rightarrow 4; R \rightarrow 2; S \rightarrow 1$

16. Match the compounds in List-I with the appropriate observations in List-II and choose the correct option.

## List-I



## List-II

(1) Reaction with phenyl diazonium salt gives yellow dye.

(2) Reaction with ninhydrin gives purple color and it also reacts with  $\text{FeCl}_3$  to give violet color.

(3) Reaction with glucose will give corresponding hydrazone.

(4) Lassaigne extract of the compound treated with dilute HCl followed by addition of aqueous  $\text{FeCl}_3$  gives blood red color.

(5) After complete hydrolysis, it will give ninhydrin test and it DOES NOT give positive phthalein dye test.

- (A)  $P \rightarrow 1; Q \rightarrow 5; R \rightarrow 4; S \rightarrow 2$   
 (B)  $P \rightarrow 2; Q \rightarrow 5; R \rightarrow 1; S \rightarrow 3$   
 (C)  $P \rightarrow 5; Q \rightarrow 2; R \rightarrow 1; S \rightarrow 4$   
 (D)  $P \rightarrow 2; Q \rightarrow 1; R \rightarrow 5; S \rightarrow 3$