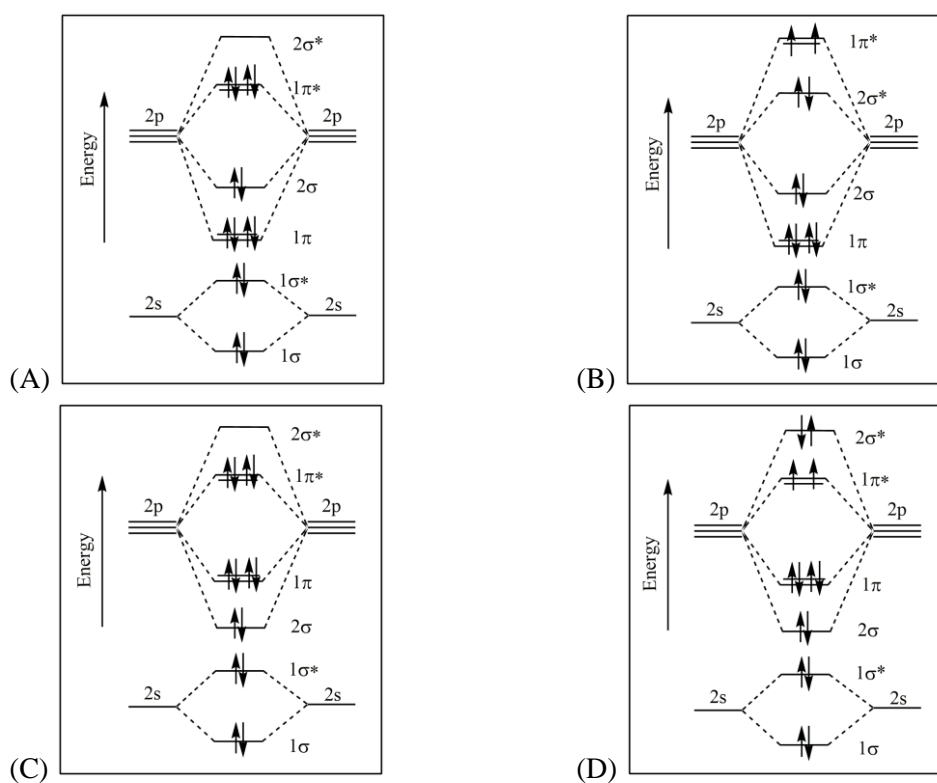


Chemistry

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.

Q.1 The correct molecular orbital diagram for F_2 molecule in the ground state is



Answer: C

Q.2 Consider the following statements related to colloids.

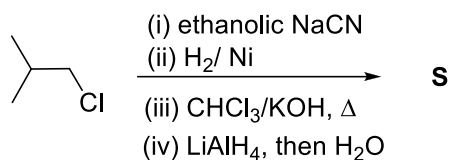
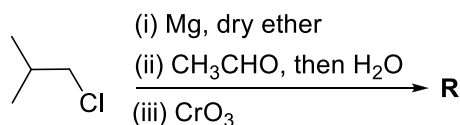
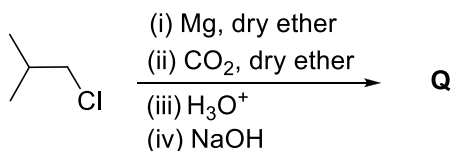
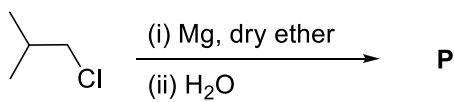
- (I) Lyophobic colloids are **not** formed by simple mixing of dispersed phase and dispersion medium.
 (II) For emulsions, both the dispersed phase and the dispersion medium are liquid.
 (III) Micelles are produced by dissolving a surfactant in any solvent at any temperature.
 (IV) Tyndall effect can be observed from a colloidal solution with dispersed phase having the same refractive index as that of the dispersion medium.

The option with the correct set of statements is

- (A) (I) and (II)
 (B) (II) and (III)
 (C) (III) and (IV)
 (D) (II) and (IV)

Answer: A

Q.3 In the following reactions, **P**, **Q**, **R**, and **S** are the major products.

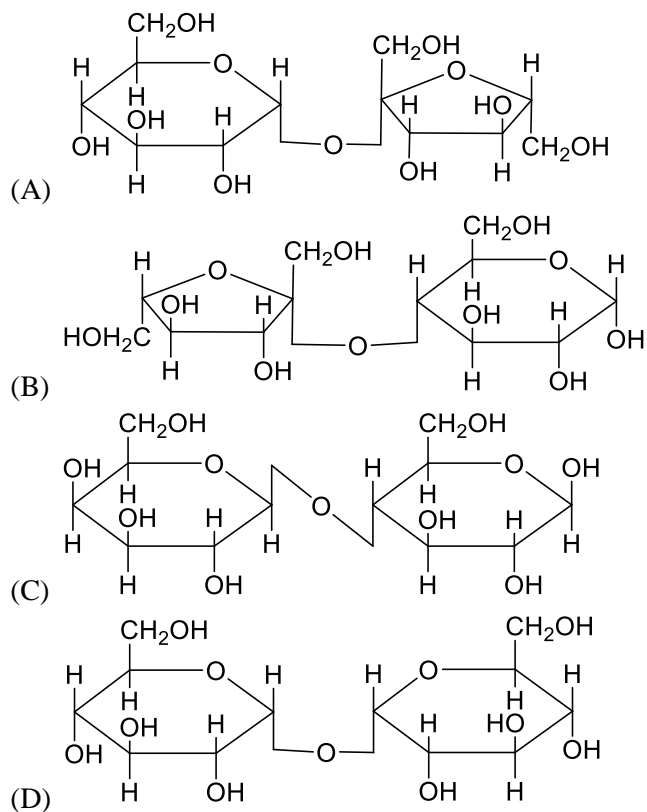


The correct statement about **P**, **Q**, **R**, and **S** is

- (A) **P** is a primary alcohol with four carbons.
 (B) **Q** undergoes Kolbe's electrolysis to give an eight-carbon product.
 (C) **R** has six carbons and it undergoes Cannizzaro reaction.
 (D) **S** is a primary amine with six carbons.

Answer: B

- Q.4 A disaccharide **X** cannot be oxidised by bromine water. The acid hydrolysis of **X** leads to a laevorotatory solution. The disaccharide **X** is



Answer: A

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.
- 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 The complex(es), which can exhibit the type of isomerism shown by $[\text{Pt}(\text{NH}_3)_2\text{Br}_2]$, is(are)
[en = $\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2$]
- (A) $[\text{Pt}(\text{en})(\text{SCN})_2]$ (B) $[\text{Zn}(\text{NH}_3)_2\text{Cl}_2]$
(C) $[\text{Pt}(\text{NH}_3)_2\text{Cl}_4]$ (D) $[\text{Cr}(\text{en})_2(\text{H}_2\text{O})(\text{SO}_4)]^+$

Answer: C, D

- Q.6 Atoms of metals x, y, and z form face-centred cubic (fcc) unit cell of edge length L_x , body-centred cubic (bcc) unit cell of edge length L_y , and simple cubic unit cell of edge length L_z , respectively.

If $r_z = \frac{\sqrt{3}}{2} r_y$; $r_y = \frac{8}{\sqrt{3}} r_x$; $M_z = \frac{3}{2} M_y$ and $M_z = 3M_x$, then the correct statement(s) is(are)

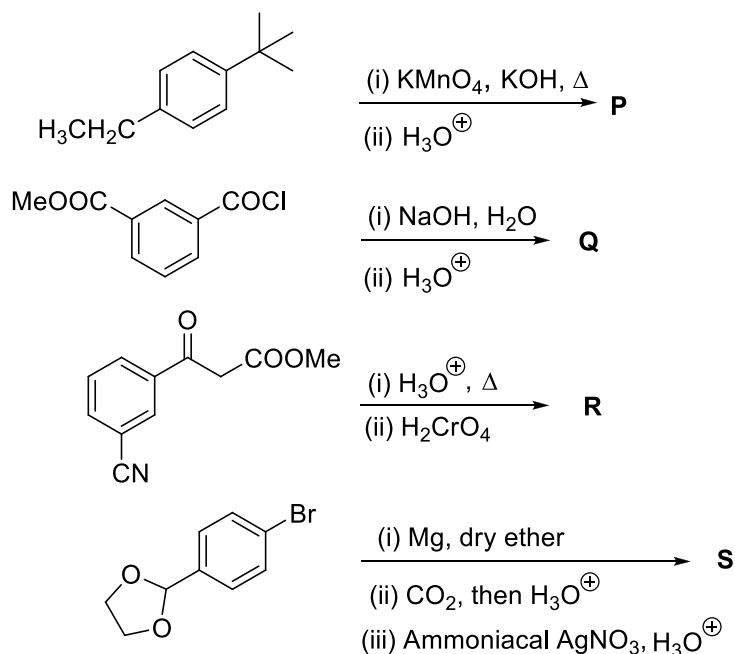
[Given: M_x , M_y , and M_z are molar masses of metals x, y, and z, respectively.

r_x , r_y , and r_z are atomic radii of metals x, y, and z, respectively.]

- (A) Packing efficiency of unit cell of x > Packing efficiency of unit cell of y > Packing efficiency of unit cell of z
 (B) $L_y > L_z$
 (C) $L_x > L_y$
 (D) Density of x > Density of y

Answer: A, B, D

- Q.7 In the following reactions, **P**, **Q**, **R**, and **S** are the major products.



The correct statement(s) about **P**, **Q**, **R**, and **S** is(are)

- (A) **P** and **Q** are monomers of polymers dacron and glyptal, respectively.
 (B) **P**, **Q**, and **R** are dicarboxylic acids.
 (C) Compounds **Q** and **R** are the same.
 (D) **R** does **not** undergo aldol condensation and **S** does **not** undergo Cannizzaro reaction.

Answer: C, 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.

- Q.8 H_2S (5 moles) reacts completely with acidified aqueous potassium permanganate solution. In this reaction, the number of moles of water produced is **x**, and the number of moles of electrons involved is **y**. The value of (**x** + **y**) is 18.
- Q.9 Among $[\text{I}_3]^+$, $[\text{SiO}_4]^{4-}$, SO_2Cl_2 , XeF_2 , SF_4 , ClF_3 , $\text{Ni}(\text{CO})_4$, XeO_2F_2 , $[\text{PtCl}_4]^{2-}$, XeF_4 , and SOCl_2 , the total number of species having sp^3 hybridised central atom is 5.
- Q.10 Consider the following molecules: Br_3O_8 , F_2O , $\text{H}_2\text{S}_4\text{O}_6$, $\text{H}_2\text{S}_5\text{O}_6$, and C_3O_2 .
Count the number of atoms existing in their zero oxidation state in each molecule.
Their sum is 6.
- Q.11 For He^+ , a transition takes place from the orbit of radius 105.8 pm to the orbit of radius 26.45 pm.
The wavelength (in nm) of the emitted photon during the transition is 30.

[Use:

Bohr radius, $a = 52.9$ pm

Rydberg constant, $R_H = 2.2 \times 10^{-18}$ J

Planck's constant, $h = 6.6 \times 10^{-34}$ J s

Speed of light, $c = 3 \times 10^8$ m s $^{-1}$]

- Q.12 50 mL of 0.2 molal urea solution (density = 1.012 g mL^{-1} at 300 K) is mixed with 250 mL of a solution containing 0.06 g of urea. Both the solutions were prepared in the same solvent. The osmotic pressure (in Torr) of the resulting solution at 300 K is [682](#).

[Use: Molar mass of urea = 60 g mol^{-1} ; gas constant, $R = 62 \text{ L Torr K}^{-1} \text{ mol}^{-1}$;

Assume, $\Delta_{\text{mix}}H = 0$, $\Delta_{\text{mix}}V = 0$]

- Q.13 The reaction of 4-methyloct-1-ene (**P**, 2.52 g) with HBr in the presence of $(\text{C}_6\text{H}_5\text{CO})_2\text{O}_2$ gives two isomeric bromides in a 9 : 1 ratio, with a combined yield of 50%. Of these, the entire amount of the primary alkyl bromide was reacted with an appropriate amount of diethylamine followed by treatment with aq. K_2CO_3 to give a non-ionic product **S** in 100% yield.

The mass (in mg) of **S** obtained is [1791](#).

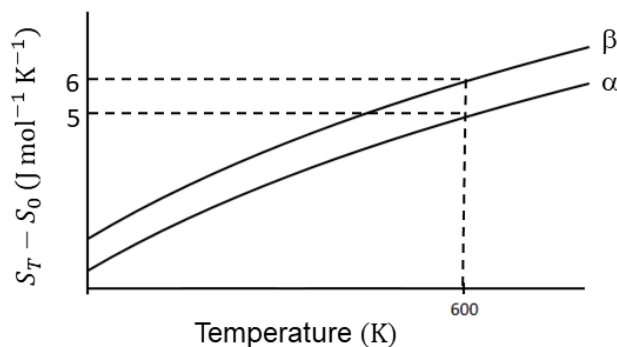
[Use molar mass (in g mol^{-1}): H = 1, C = 12, N = 14, Br = 80]

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”

The entropy versus temperature plot for phases α and β at 1 bar pressure is given. S_T and S_0 are entropies of the phases at temperatures T and 0 K, respectively.



The transition temperature for α to β phase change is 600 K and $C_{p,\beta} - C_{p,\alpha} = 1 \text{ J mol}^{-1} \text{ K}^{-1}$. Assume $(C_{p,\beta} - C_{p,\alpha})$ is independent of temperature in the range of 200 to 700 K. $C_{p,\alpha}$ and $C_{p,\beta}$ are heat capacities of α and β phases, respectively.

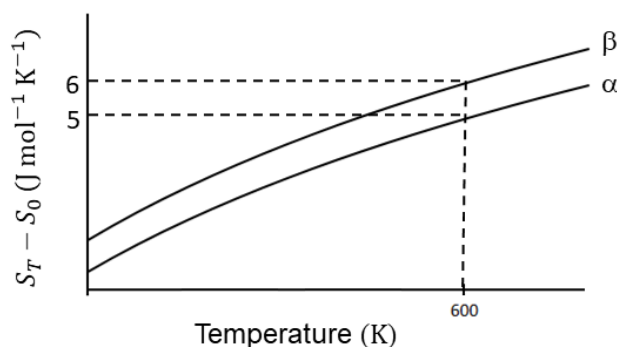
Q.14 The value of entropy change, $S_\beta - S_\alpha$ (in $\text{J mol}^{-1} \text{ K}^{-1}$), at 300 K is 0.31. Range (0.30 to 0.32)

[Use: $\ln 2 = 0.69$

Given: $S_\beta - S_\alpha = 0$ at 0 K]

"PARAGRAPH I"

The entropy versus temperature plot for phases α and β at 1 bar pressure is given. S_T and S_0 are entropies of the phases at temperatures T and 0 K, respectively.



The transition temperature for α to β phase change is 600 K and $C_{p,\beta} - C_{p,\alpha} = 1 \text{ J mol}^{-1} \text{ K}^{-1}$. Assume $(C_{p,\beta} - C_{p,\alpha})$ is independent of temperature in the range of 200 to 700 K. $C_{p,\alpha}$ and $C_{p,\beta}$ are heat capacities of α and β phases, respectively.

Q.15 The value of enthalpy change, $H_\beta - H_\alpha$ (in J mol^{-1}), at 300 K is 300.00. Range (300.00 to 300.00)

"PARAGRAPH II"

A trinitro compound, 1,3,5-tris-(4-nitrophenyl)benzene, on complete reaction with an excess of Sn/HCl gives a major product, which on treatment with an excess of NaNO_2/HCl at 0°C provides **P** as the product. **P**, upon treatment with excess of H_2O at room temperature, gives the product **Q**. Bromination of **Q** in aqueous medium furnishes the product **R**. The compound **P** upon treatment with an excess of phenol under basic conditions gives the product **S**.

The molar mass difference between compounds **Q** and **R** is 474 g mol^{-1} and between compounds **P** and **S** is 172.5 g mol^{-1} .

Q.16 The number of heteroatoms present in one molecule of **R** is 9.00. Range (9.00 to 9.00)

[Use: Molar mass (in g mol^{-1}): H = 1, C = 12, N = 14, O = 16, Br = 80, Cl = 35.5
Atoms other than C and H are considered as heteroatoms]