JEE Advanced (2025)

PAPER 1

Chemistry

General Instructions:

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. The heating of NH_4NO_2 at 60–70° C and NH_4NO_3 at 200– 250°C is associated with the formation of nitrogen containing compounds **X** and **Y** respectively. **X** and **Y** respectively, are:

(A) N_2 and N_2O (B) NH_3 and NO_2
(C) NO and N_2O (D) N_2 and NH_3

2. The correct order of the wavelength maxima of the absorption band in the ultraviolet-visible region for the given complexes is:

(A) $[Co(CN)_6]^{3-} < [Co(NH_3)_6]^{3+} < [Co(NH_3)_5(H_2O)]^{3+} < [Co(NH_3)_5(Cl)]^{2+}$

(B) $[Co(NH_3)_5(Cl)]^{2+} < [Co(NH_3)_5(H_2O)]^{3+} < [Co(NH_3)_6]^{3+} < [Co(CN)_6]^{3-}$

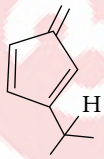
(C) $[Co(CN)_6]^{3-} < [Co(NH_3)_5(Cl)]^{2+} < [Co(NH_3)_5(H_2O)]^{3+} < [Co(NH_3)_6]^{3+}$

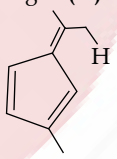
(D) $[Co(NH_3)_6]^{3+} < [Co(CN)_6]^{3-} < [Co(NH_3)_5(Cl)]^{2+} < [Co(NH_3)_5(H_2O)]^{3+}$

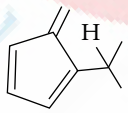
3. One of the products formed from the reaction of permanganate ion with iodide ion in neutral aqueous medium is:

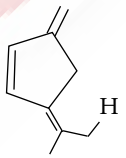
(A) I_2 (B) IO_3^-
(C) IO_4^- (D) IO_2^-

4. Consider the depicted hydrogen **(H)** in the hydrocarbons given below. The most acidic hydrogen **(H)** is:

(A) 

(B) 

(C) 

(D) 

General Instructions:

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:

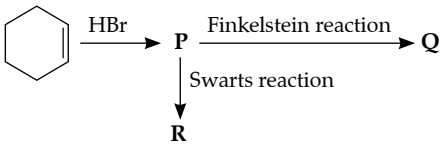
Full Marks : +4 ONLY if (all) the correct option(s) is(are) chosen;
Partial Marks : +3 If all the four options are correct but ONLY three options are chosen;
Partial Marks : +2 If three or more options are correct but ONLY two options are chosen, both of which are correct;
Partial Marks : +1 If two or 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 (i.e., the question is unanswered) will get 0 marks; and
choosing any other option(s) 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 Ne_2 is zero.
(B) The highest occupied molecular orbital (HOMO) of F_2 is σ-type.
(C) Bond energy of O_2^+ is smaller than the bond energy of O_2.
(D) Bond length of Li_2 is larger than the bond length of B_2.

6. The pair(s) of diamagnetic ions is(are)
(A) La^{3+}, Ce^{4+} (B) Yb^{2+}, Lu^{3+}
(C) La^{2+}, Ce^{3+} (D) Yb^{3+}, 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 towards S_N2 reaction in **P**, **Q** and R follows the order P > R > Q.
(D) pK_a value of the conjugate acids of the leaving groups in **P**, **Q** and **R** follows the order **R** > **Q** > **P.**

General Instructions:

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 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 : +4 If **ONLY** the correct numerical value is entered in the designated place;
Zero Marks : 0 in all other cases.

8. In an electrochemical cell, dichromate ions in aqueous acidic medium are reduced to Cr^{3+}. The current (in amperes) that flows through the cell for 48.25 minutes to produce 1 mole of Cr^{3+} is _____.
Use: 1 Faraday = 96500 C mol^{-1}

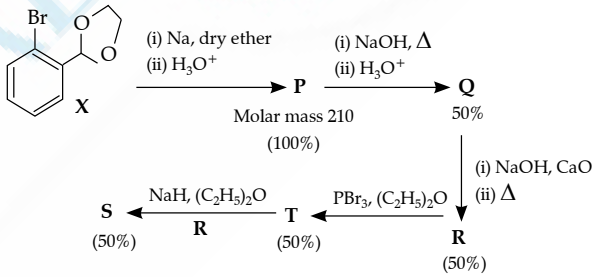
9. At 25°C, the concentration of H^+ ions in 1.00×10^{-3} M aqueous solution of a weak monobasic acid having acid dissociation constant (K_a) of 4.00×10^{-11} is $X \times 10^{-7}$ M. The value of X is _____.
Use: Ionic product of water (K_w) = 1.00×10^{-14} at 25°C

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 mol dm^{-3}) of the coefficient of V^2_m to the coefficient of V_m for a gas having van der Waals constants a = 6.0 dm^6 atm mol^{-2} and b = 0.060 dm^3 mol^{-1} at 300 K and 300 atm is _____.
Use: Universal gas constant (R) = 0.082 dm^3 atm mol^{-1} K^{-1}

11. Considering ideal gas behaviour, the expansion work done (in kJ) when 144 g of water is electrolysed completely under constant pressure at 300 K is _____.
Use: Universal gas constant (R) = 8.3 J K^{-1} mol^{-1}; Atomic mass (in amu): H = 1, O = 16

12. The monomer **(X)** involved in the synthesis of nylon 6, 6 gives positive carbylamine test. If 10 moles of **X** are analysed 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_____.



Use: Atomic mass (in amu): H = 1, C = 12, O = 16, Br = 80

General Instructions:

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		List-II
(P)	Passing H_2S in the presence of NH_4OH	**(1)** Cu^{2+}
(Q)	$(NH_4)_2CO_3$ in the presence of NH_4OH	**(2)** Al^{3+}
(R)	NH_4OH in the presence of NH_4Cl	**(3)** Mn^{2+}
(S)	Passing H_2S in the presence of dilute HCl	**(4)** Ba^{2+}
		(5) Mg^{2+}

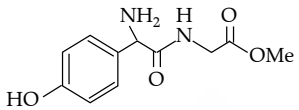
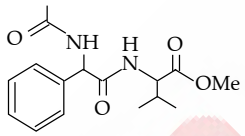
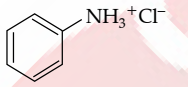
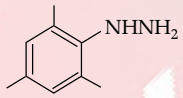
(A) P → 3; Q → 4; R → 2; S → 1
(B) P → 4; Q → 2; R → 3; S → 1
(C) P → 3; Q → 4; R → 1; S → 5
(D) P → 5; Q → 3; R → 2; S → 4

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		List-II
(P)	Stephen reaction	**(1)** (i) CrO_2Cl_2/CS_2 (ii) H_3O^+ Toluene →
(Q)	Sandmeyer reaction	**(2)** (i) PCl_5 (ii) NH_3 (iii) P_4O_{10}, Δ Benzoic acid →
(R)	Hoffmann bromamide degradation reaction	**(3)** (i) Fe, HCl (ii) HCl, $NaNO_2$ (273–278K), H_2O Nitrobenzene →
(S)	Cannizzaro reaction	**(4)** (i) $Cl_2/h\nu$, H_2O (ii) Tollen's reagent (iii) SO_2Cl_2 (iv) NH_3 Toluene →
		(5) (i) $(CH_3CO)_2O$, Pyridine (ii) HNO_3, H_2SO_4, 288K (iii) aq. NaOH Aniline →

(A) P → 2; Q → 4; R → 1; S → 3
(B) P → 2; Q → 3; R → 4; S → 1
(C) P → 5; Q → 3; R → 4; S → 2
(D) P → 5; Q → 4; R → 2; S → 1

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

List-I		List-II
(P)		**(1)** Reaction with phenyl diazonium salt gives yellow dye.
(Q)		**(2)** Reaction with ninhydrin gives purple colur and it also reacts with $FeCl_3$ to give violet colur.
(R)		**(3)** Reaction with glucose will give corresponding hydrazone.
(S)		**(4)** Lassiagne extract of the compound treated with dilute HCl followed by addition of aqueous $FeCl_3$ gives blood red colur.
		(5) After complete hydrolysis, it will give ninhydrin test and it does not give positive phthalein dye test.

(A) P → 1; Q → 5; R → 4; S → 2
(B) P → 2; Q → 5; R → 1; S → 3
(C) P → 5; Q → 2; R → 1; S → 4
(D) P → 2; Q → 1; R → 5; S → 3

Answer Key

Q.No.	Answer key	Chapter name	Topic's name
1	(A)	Group 15 Elements	*p* Block
2	(A)	CFSE	Coordination Compounds
3	(B)	Important Compounds of D Block	*d* and *f* Blocks Elements
4	(B)	Acidity	Organic Chemistry - Principle and Techniques
5	(B, C)	Molecular Orbital Theory	Chemical Bonding and Molecular Structure
6	(A, B)	*f* Block Elements	*d* and *f* Block Elements
7	(B)	Preperation and Properties of Haloalkane	Haloalkane
8	[100]	Faraday Laws	Electrochemistry
9	[2.2–2.3]	Equilibrium Constant	Equilibrium
10	[–7.2 to –7.0]	Real Gas Equation	States of Matter
11	[–29.95 to –29.8] or [29.8 to 29.95]	First Law of Thermodynamics	Thermodynamics
12	[280]	Dumo Method	Organic Chemistry Principle and Technique
13	[175]	Mole Concept	Some Basic Concepts of Chemistry
14	(A)	Practical Chemistry	Practical Chemistry
15	(B)	Name Reaction	Aldehyde, Ketone and Carboxylic Acid
16	(B)	Chemical Properties of Amines	Amines

ANSWERS WITH EXPLANATIONS

1. Correct option is (A).

$NH_4NO_2 \xrightarrow{\Delta} N_2 + 2H_2O$

(A) $NH_4NO_3 \xrightarrow[y]{\Delta} N_2O + 2H_2O$

$X \rightarrow N_2$

$Y \rightarrow N_2O$

2. Correct option is (A).

The Strength of the Ligand is inversly related with the wavelength of the light racliation obsorbed

$\Delta_0 \propto \frac{1}{\lambda}$

The Strength of the Ligand are follows-

$^-CN > NH_3 > H_2O > ^-Cl$

On the basic of strength of the Ligand, the correct value of the CFSE is as follows–

$[Co(CN)_6]^{3-} > [Co(NH_3)_6]^{3+} > [Co(NH_3)_5H_2O]^{3+} > [Co(NH_3)_5Cl]^{2+}$

Value of CFSE of $Co^{3+} \downarrow$ value of $\lambda\uparrow$es

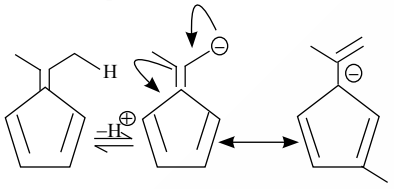
3. Correct option is (B).

The balanced chemical equation of I^- with MnO_4^- in neutrol aqucous medi ion is as follows–

$I^- + 2MnO_4^- + H_2O \xrightarrow{\text{netralSol}^n} 2MnO_2 + IO_3^- + 2^-OH$

4. Correct option is (B).

Option (B) has most acidic hydrogen (H) as on ionisation aromatic species is formed.



Conjugate base

Aromatic Species
$(4n + 2)\pi e^-$

5. Correct options are (B, C).

(A) Bond order of Ne_2 is zero as number of e^- in bonding and anti bonding are same.

$Ne_2 \Rightarrow \sigma1s^2, \sigma^*1s^2, \sigma2s^2, \sigma^*2s^2, \sigma2p_z^2, \pi2p_x^2 = \pi2p_y^2,$

$\pi^*2p_x^2 = \pi^*2p_y^2, \sigma^*2p_z^2$

Bond order $= \frac{N_b - N_a}{2} = \frac{10-10}{2} = 0$

option (a) is correct

(B) $F_2 \Rightarrow \sigma1s^2, \sigma^*1s^2, \sigma2s^2, \sigma^*2s^2, \sigma2p_z^2, \pi^*2p_x^2 = \pi^*2p_y^2$

$\pi2p_x^2 = \pi2p_y^2$ Highest occupied molecular orbital (HOMO) is of π^* type

Option (B) is incorrect

(C) $O_2^+ \Rightarrow \sigma1s^2, \sigma^*1s^2, \sigma2s^2, \sigma^*2s^2, \sigma2p_z^2, \pi2p_x^2 = \pi2p_y^2$

$\pi^*2p_x^1 = \pi^*2p_y$

Bond order $= \frac{N_b - N_a}{2} = \frac{10-5}{2} = 2.5$

$O_2 \Rightarrow \sigma1s^2, \sigma^*1s^2, \sigma2s^2, \sigma^*2s^2, \sigma2p_z^2, \pi2p_x^2 = \pi2p_y^2\,\pi^*2p_x^1$

$= \pi^*2p_y^{\mathbf{1}}$

Bond order $= \frac{N_b - N_a}{2} = \frac{10-6}{2} = 2.0$

Bond order of O_2^+ is greater then O_2 $\therefore$ Bond energy of O_2^+ is also greater then O_2. Bond order α Bond energy

Option (C) is incorrect

(D) $Li_2 \Rightarrow \sigma1s^2, \sigma^*1s^2, \sigma2s^2$, Bond order $= \frac{4-2}{2} = 1$

$B_2 \Rightarrow \sigma1s^2, \sigma^*1s^2, \sigma2s^2, \sigma^*2s^2, \left[\pi2p_x^1 = \pi2p_y^1\right]$

Bond order $= \frac{6-4}{2} = 1$

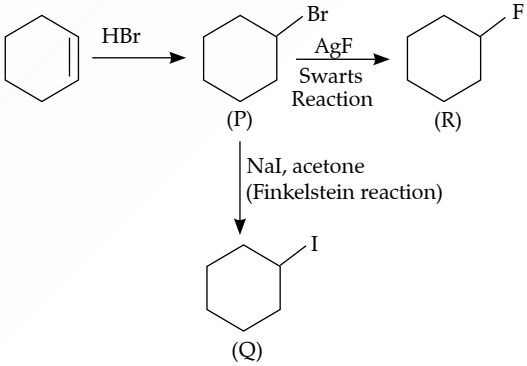
Bond order of both B_2 and Li_2 is same but the size of Li –atom is greater than the size of Boron atom. $\therefore$ Bond length of Li_2 is greater than the bond length of B_2. Bond length α size of the atom.

6. Correct options are (A, B).

The species which contain unpaired e^- are paramagnetic in nature because paramagnetism depends on the number of unpaired e^- while the species which do not contain unpaired e^- are diamagnetic in nature

Ions	Electronic Configuration	Nature
(Z = 57) La^{3+}	$[Xe]4f^0$	diamagnetic
(Z = 70) Yb^{2+}	$[Xe]4f^{14}$	diamagnetic
(Z = 71) Lu^{3+}	$[Xe]4f^{14}$	diamagnetic
(Z = 57) La^{2+}	$[Xe]5d^1$	paramagnetic
(Z = 58) Ce^{4+}	$[Xe]4f^0$	diamagnetic
(Z = 58) Ce^{3+}	$[Xe]4f^1$	paramagnetic
(Z = 70) Yb^{3+}	$[Xe]4f^{13}$	paramagnetic
(Z = 71) Lu^{2+}	$[Xe]4f^{14}5d^1$	paramagnetic

7. Correct option is (B).



S_N2 reaction order of alkyl halide-

R – I > R – Br > R – Cl > R – F

So, relative reactivity towards S_N2 reaction is Q > P > R

Order of C – X bond length

R – I > R – Br > R – Cl > R – F

So, order $\Rightarrow$ Q > P > R

Order of C – X bond enthalpy $\rightarrow$ R > P > Q

Order of P*ka* value $\rightarrow$ R > P > Q

8. Correct answer is [100.00].

$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$

6 mole of electron produce = 2 mole of Cr^{3+}

So, 3 moles of electron will produce = 1 mole of Cr^{3+}

So, $Q = 3F = 3 \times 96500$

$I \times t = 3 \times 96500$

$I = \frac{3 \times 96500}{48.25 \times 60} = 100$ amperes

9. Correct answer is [2.24].

The acid dissociation constant of weak monobasic acid is small. $\therefore$ we have to consider $[H^+]$ ion from both weak acid due to self ionization of H_2O

$HX \rightleftharpoons H^+ + X^-$

$10^{-3} \quad - \quad -$

$-x \quad +x \quad +x$

$10^{-3}-x \quad x \quad x$

$H_2O \rightleftharpoons H^+ + OH^-$

$-y \quad y \quad y$

$[H^+]_{total} = x + y$

for acid $Ka = \frac{[H^+][X^-]}{[HX]}$

$4 \times 10^{-11} = \frac{x(x+y)}{10^{-3}-x}$

Let us consider $10^{-3} - x \approx 10^{-3}$

$4 \times 10^{-11} = \frac{x(x+y)}{10^{-3}}$ ...(i)

for H_2O $k_w = [H^+][OH^-]$

$10^{-14} = y(x + y)$ ...(ii)

add (i) and (ii) $(x + y)^2 = 5 \times 10^{-14}$

$[H^+] = x + y = \sqrt{5 \times 10^{-14}}$

$= 2.24 \times 10^{-7}$

$X = 2.24$

10. Correct answer is [−7.10].

$\left(P + \frac{a}{V_m^2}\right)(V_m - b) = RT$

$PV_m - Pb + \frac{a}{V_m} - \frac{ab}{V_m^2} = RT$

Multiply V_m^2 on both side

$PV_m^3 + PbV_m^2 + aV_m - ab = RTV_m^2$

$PV_m^3 - (Pb + RT)V_m^2 + aV_m - ab = 0$

$\frac{\text{Coefficient of } V_m^2}{\text{Coefficient of } V_m} = \frac{-(Pb+RT)}{a}$

$= -\left[\frac{0.06 \times 300 + 0.082 \times 300}{6}\right] = -7.1$

11. Correct answer is [–29.88].

$H_2O(l) \rightarrow H_2(g) + \frac{1}{2}O_2(g)$

8mol – –

– 8mol 4mol

So, according to stoichiometry

$nH_2 = 8$, $nO_2 = 4$

So, total mole = 8 + 4 = 12

Isobaric process,

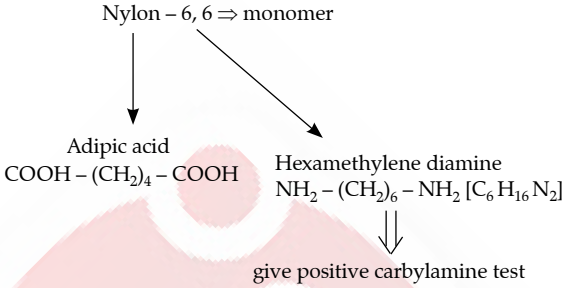
$W = -P\Delta V = -(\Delta n)RT$

$= -12 \times 8.3 \times 300$

$W = -29880 = -29.88$ kJ

12. Correct answer is [280].

Nylon − 6, 6 ⇒ monomer



$C_x H_y N_z + \left(2x + \frac{y}{2}\right), CuO \rightarrow xCO_2 + y/2\ H_2O + z/2\ N_2$

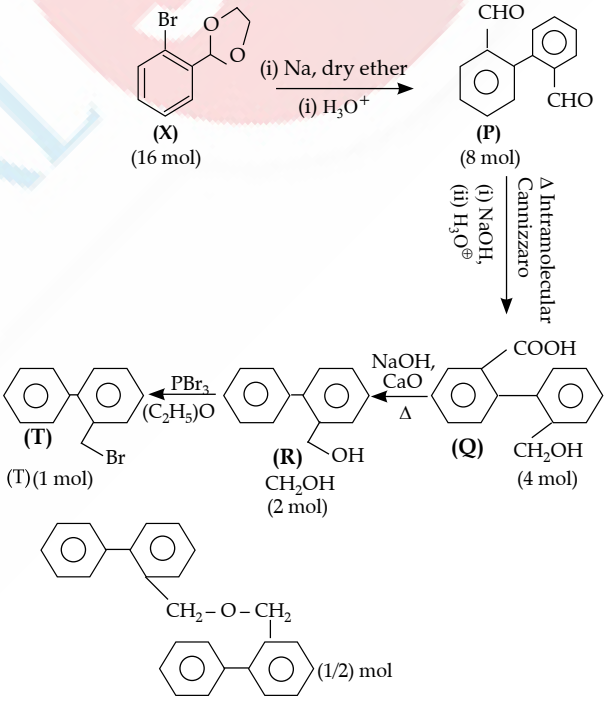
(Dumamethod)

for $C_6H_{12}N_2$ $\frac{z}{2}N_2 = \frac{2}{2} = 1$ mole

1 mole N_2 = 28g

So, 10 moles of N_2 gas evolved. So, $W_{N_2} = 10 \times 28 = 280$ g

13. Correct answer is [175.00].



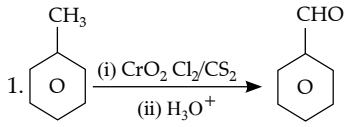
Molecular weight of compound S = 350

Amount of S produced (in g) = $350 \times \frac{1}{2} = 175$ g

14. Correct option is (A).

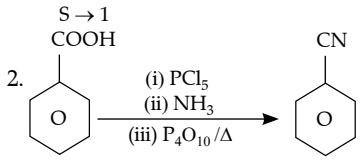
	Group Regents	Metal ion precipitated
(P)	Passing H_2S in the presence of NH_4OH	**(3)** Mn^{2+}(MnS)
(Q)	$(NH_4)_2CO_3$ in the presence of NH_4OH	**(4)** Ba^{2+} ($BaCO_3$)
(R)	NH_4OH in the presence of NH_4Cl	**(2)** Al^{3+} [$Al(OH)_3$]
(S)	Passing H_2S in the presence of dilute HCl	**(1)** Cu^{2+} (CuS)

15. Correct option is (B).

1. 

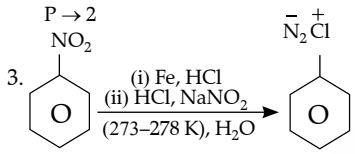
This is reactant for Cannizzaro Reaction.

S → 1

2. 

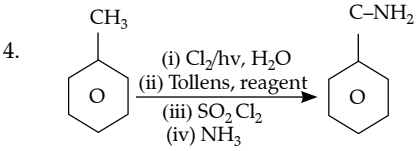
Reactant for Stephen Reaction.

P → 2

3. 

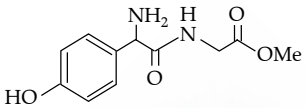
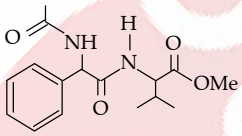
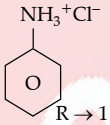
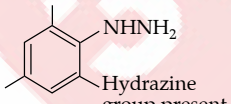
Reactant for Sandmeyer Reaction.

Q → 3

4. 

Reactant for Hoffmann bromamide degradation reaction (R → 4).

16. Correct option is (B).

	Compounds	Observations
(P)	 There is phenol So, it will give $FeCl_3$ test, also secondary amine present P → 2	**(2)** Reaction with ninhydrin gives purple colur and it also reacts with $FeCl_3$ to give violet colur.
(Q)	 Secondary amine present Q → 5	**(5)** After complete hydrolysis it will give ninhydrin test and it does not give positive phthalein dye test.
(R)	 R → 1	**(1)** Reaction with. Phenyl diazonium salt gives yellow dye.
(S)	 Hydrazine group present Q → 3	**(3)** Reaction with glucose will give corresponding hydraozone.