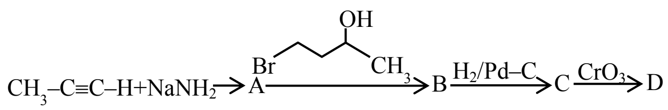
FINAL JEE–MAIN EXAMINATION – AUGUST, 2021

(Held On Friday 27th August, 2021) **TIME : 9 : 00 AM to 12 : 00 NOON**

CHEMISTRY — TEST PAPER WITH SOLUTION

SECTION-A

1. In the following sequence of reactions, the final product D is :



(1) $H_3C-CH_2-CH_2-CH_2-CH_2-\overset{\overset{\displaystyle O}{\|}}{C}-H$

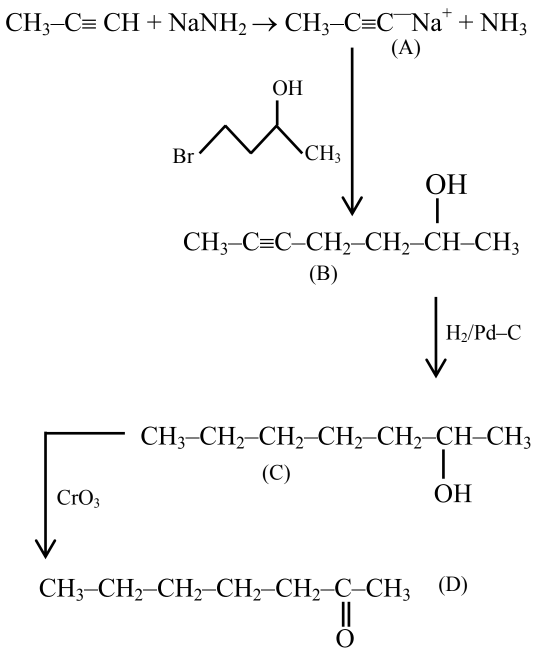
(2) $CH_3-CH=CH-CH_2-CH_2-CH_2-COOH$

(3) $H_3C-CH=CH-CH(OH)-CH_2-CH_2-CH_3$

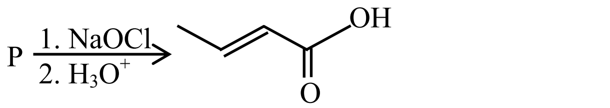
(4) $CH_3-CH_2-CH_2-CH_2-CH_2-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3$

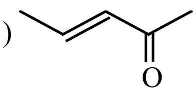
Official Ans. by NTA (4)

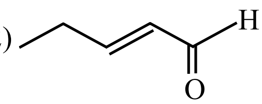
Sol.

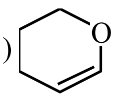


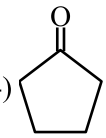
2. The structure of the starting compound **P** used in the reaction given below is :



(1) 

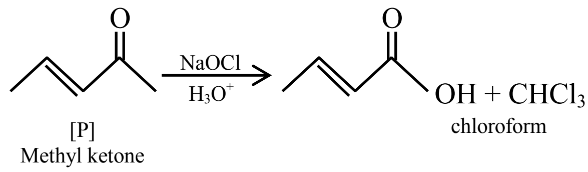
(2) 

(3) 

(4) 

Official Ans. by NTA (1)

Sol.



NaOCl is used in haloform reaction as reagent.

3. Match **List–I** with **List–II** :

List–I	**List–II**
(Species)	**(Number of lone pairs of electrons on the central atom)**
(a) XeF_2	(i) 0
(b) XeO_2F_2	(ii) 1
(c) XeO_3F_2	(iii) 2
(d) XeF_4	(iv) 3

Choose the **most appropriate** answer from the options given below :

(1) (a)–(iv), (b)–(i), (c)–(ii), (d)–(iii)

(2) (a)–(iii), (b)–(iv), (c)–(ii), (d)–(i)

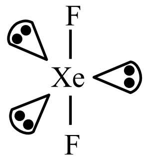
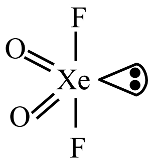
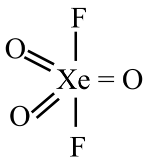
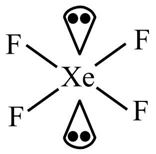
(3) (a)–(iii), (b)–(ii), (c)–(iv), (d)–(i)

(4) (a)–(iv), (b)–(ii), (c)–(i), (d)–(iii)

Official Ans. by NTA (4)

Sol. **Species** **(Number of lone pairs of electrons**

on the central atom)

XeF_2	3	
XeO_2F_2	1	
XeO_3F_2	0	
XeF_4	2	

4. In which one of the following molecules strongest back donation of an electron pair from halide to boron is expected?

(1) BCl_3 (2) BF_3

(3) BBr_3 (4) BI_3

Official Ans. by NTA (2)

Sol. Type of back bonding

BF_3	BCl	BBr_3	BI_3
$(2p\pi-2p\pi)$	$(2p\pi-3p\pi)$	$(2p\pi-4p\pi)$	$(2p\pi-5p\pi)$

Therefore back bonding strength is as follows

BF_3 > BCl > BBr_3 > BI_3

5. Deuterium resembles hydrogen in properties but :

(1) reacts slower than hydrogen

(2) reacts vigorously than hydrogen

(3) reacts just as hydrogen

(4) emits β^+ particles

Official Ans. by NTA (1)

Sol. The bond dissociation energy of D_2 is greater than H_2 and therefore D_2 reacts slower than H_2.

6. Which refining process is generally used in the purification of low melting metals ?

(1) Chromatographic method

(2) Liquation

(3) Electrolysis

(4) Zone refining

Official Ans. by NTA (2)

Sol. Liquation method is used to purify those impure metals which has lower melting point than the melting point of impurities associated.

$\therefore$ This method is used for metal having low melting point.

7. Match items of **List–I** with those of **List–II** :

List–I (Property)	**List–II (Example)**
(a) Diamagnetism	(i) MnO
(b) Ferrimagnetism	(ii) O_2
(c) Paramagnetism	(iii) NaCl
(d) Antiferromagnetism	(iv) Fe_3O_4

Choose the **most appropriate** answer from the options given below :

(1) (a)–(ii), (b)–(i), (c)–(iii), (d)–(iv)

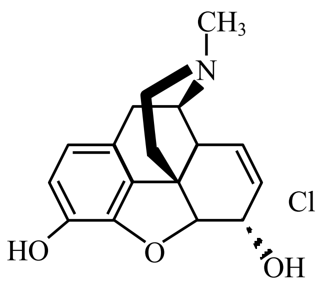
(2) (a)–(i), (b)–(iii), (c)–(iv), (d)–(ii)

(3) (a)–(iii), (b)–(iv), (c)–(ii), (d)–(i)

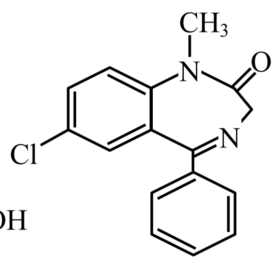
(4) (a)–(iv), (b)–(ii), (c)–(i), (d)–(iii)

Official Ans. by NTA (3)

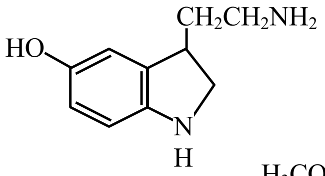
8.



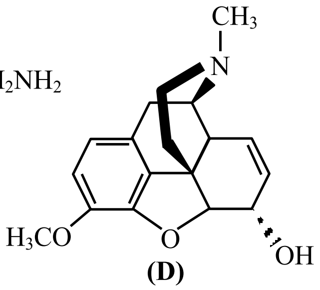
(A)



(B)



(C)



(D)

The correct statement about (A), (B), (C) and (D) is :

(1) (A), (B) and (C) are narcotic analgesics

(2) (B), (C) and (D) are tranquillizers

(3) (A) and (D) are tranquillizers

(4) (B) and (C) are tranquillizers

Official Ans. by NTA (4)

Sol. B and C are tranquilizers

9. The major product of the following reaction is :

$$CH_3-\underset{\displaystyle CH_3}{\overset{}{CH}}-CH_2-CH_2-\overset{\displaystyle O}{\overset{\|}{C}}-Cl \xrightarrow[\text{(iii) } NaNO_2,HCl \text{ (iv) } H_2O]{\text{(i) alcoholic } NH_3 \text{ (ii) } NaOH, Br_2} \text{Major product}$$

(1) $CH_3-\underset{\displaystyle CH_3}{CH}-\overset{\displaystyle Br}{CH}-CH_2OH$

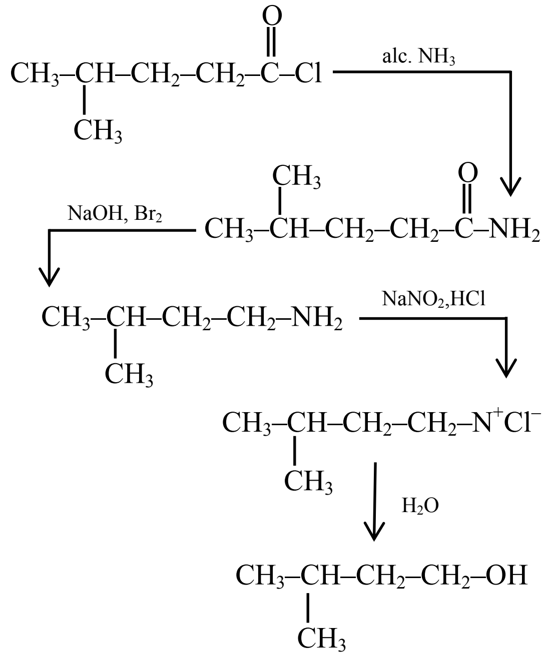
(2) $CH_3-\underset{\displaystyle CH_3}{CH}-CH_2-CH_2-CH_2OH$

(3) $CH_3-\underset{\displaystyle CH_3}{CH}-CH_2-CH_2OH$

(4) $CH_3-\underset{\displaystyle CH_3}{CH}-CH_2-CH_2-Cl$

Official Ans. by NTA (3)

Sol.



10. Which of the following is **not** a correct statement for primary aliphatic amines?

(1) The intermolecular association in primary amines is less than the intermolecular association in secondary amines.

(2) Primary amines on treating with nitrous acid solution form corresponding alcohols except methyl amine.

(3) Primary amines are less basic than the secondary amines.

(4) Primary amines can be prepared by the Gabriel phthalimide synthesis.

Official Ans. by NTA (1)

Sol. The intermolecular association is more prominent in case of primary amines as compared to secondary, due to the availability of two hydrogen atom.

11. Acidic ferric chloride solution on treatment with excess of potassium ferrocyanide gives a Prussian blue coloured colloidal species. It is :

(1) $Fe_4[Fe(CN)_6]_3$ (2) $K_5Fe[Fe(CN)_6]_2$

(3) $HFe[Fe(CN)_6]$ (4) $KFe[Fe(CN)_6]$

Official Ans. by NTA (4)

Sol. $FeCl_3 + K_4[Fe(CN)_6]$ (excess)

$\downarrow$

$K\,Fe[Fe(CN)_6]$

Colloidal species

12. The gas 'A' is having very low reactivity reaches to stratosphere. It is non–toxic and non–flammable but dissociated by UV—radiations in stratosphere. The intermediates formed initially from the gas 'A' are :

(1) $Cl\dot{O}+\dot{C}F_2Cl$ (2) $Cl\dot{O}+\dot{C}H_3$

(3) $\dot{C}H_3+\dot{C}F_2Cl$ (4) $\dot{C}l+\dot{C}F_2Cl$

Official Ans. by NTA (4)

Sol. In stratosphere CFCs get broken down by powerful UV radiations releasing $Cl^{\bullet}$

$$CF_2Cl_2(g)\xrightarrow{\text{U.V.}}Cl^{\bullet}(g)+{}^{\bullet}CF_2Cl(g)$$

13. The number of water molecules in gypsum, dead burnt plaster and plaster of paris, respectively are:

(1) 2, 0 and 1 (2) 0.5, 0 and 2

(3) 5, 0 and 0.5 (4) 2, 0 and 0.5

Official Ans. by NTA (4)

Sol.

Gypsum	$CaSO_4.2H_2O$
Plaster of Paris	$CaSO_4.\frac{1}{2}H_2O$
Dead burnt plaster	$CaSO_4$

14. The nature of oxides V_2O_3 and CrO is indexed as 'X' and 'Y' type respectively. The correct set of X and Y is:

(1) X = basic Y = amphoteric

(2) X = amphoteric Y = basic

(3) X = acidic Y = acidic

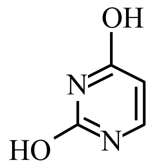
(4) X = basic Y = basic

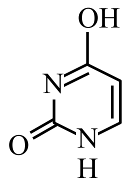
Official Ans. by NTA (4)

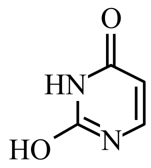
Sol. V_2O_3 basic

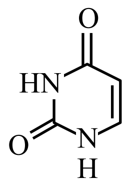
CrO basic

15. Out of following isomeric forms of uracil, which one is present in RNA ?

(1) 

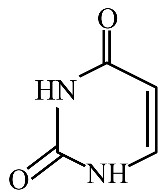
(2) 

(3) 

(4) 

Official Ans. by NTA (4)

Sol. Isomeric form of uracil present in RNA



16. Given below are two statements : one is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**.

Assertion (A): Synthesis of ethyl phenyl ether may be achieved by Williamson synthesis.

Reason (R): Reaction of bromobenzene with sodium ethoxide yields ethyl phenyl ether.

In the light of the above statements, choose the **most appropriate** answer from the options given below:

(1) Both **(A)** and **(R)** are correct and **(R)** is the correct explanation of **(A)**

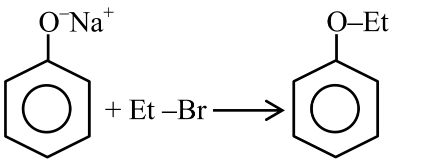
(2) **(A)** is correct but **(R)** is not correct

(3) **(A)** is not correct but **(R)** is correct

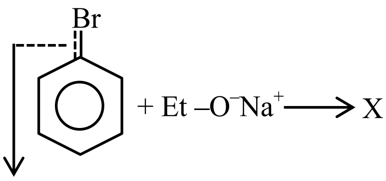
(4) Both **(A)** and **(R)** are correct but **(R)** is NOT the correct explanation of **(A)**

Official Ans. by NTA (2)

Sol.

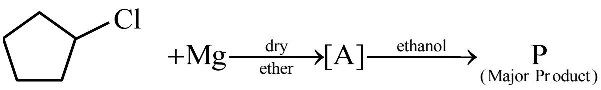


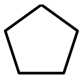
Sodium Phenoxide Ethyl Phenyl ether

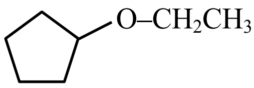


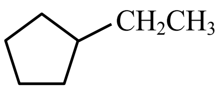
Partial double bond character

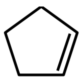
17. In the following sequence of reactions the P is :



(1) 

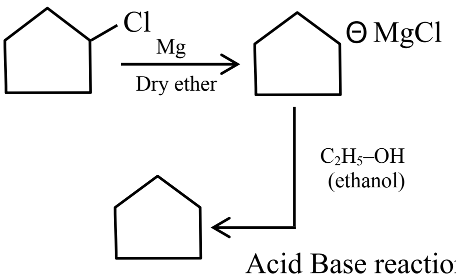
(2) 

(3) 

(4) 

Official Ans. by NTA (1)

Sol.



Acid Base reaction

18. The unit of the van der Waals gas equation parameter 'a' in $\left(P+\frac{an^2}{V^2}\right)(V-nb)=nRT$ is :

(1) $kg\ m\ s^{-2}$ (2) $dm^3\ mol^{-1}$

(3) $kg\ m\ s^{-1}$ (4) $atm\ dm^6\ mol^{-2}$

Official Ans. by NTA (4)

Sol. $\frac{an^2}{V^2}=atm \Rightarrow a = atm\times\frac{dm^6}{mol^2}$

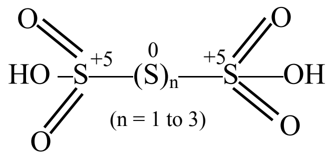
19. In polythionic acid, $H_2S_xO_6$(x = 3 to 5) the oxidation state(s) of sulphur is/are :

(1) + 5 only (2) + 6 only

(3) + 3 and + 5 only (4) 0 and + 5 only

Official Ans. by NTA (4)

Sol.



20. Tyndall effect is more effectively shown by :

(1) true solution (2) lyophilic colloid

(3) lyophobic colloid (4) suspension

Official Ans. by NTA (3)

Sol. Tyndall effect is observed in lyophobic colloids

SECTION-B

1. In Carius method for estimation of halogens, 0.2 g of an organic compound gave 0.188 g of AgBr. The percentage of bromine in the compound is _______. (Nearest integer)

[Atomic mass : Ag = 108, Br = 80]

Official Ans. by NTA (40)

Sol. $n_{AgBr}=\frac{0.188g}{188g/mol}=10^{-3}mol$

$\Rightarrow n_{Br}=n_{AgBr}=0.001\ mol$

$\Rightarrow mass_{Br}=(0.001\times 80)\ gm = 0.08\ gm$

$\Rightarrow mass\ \% = \frac{0.08\times 100}{0.2}=40\%$

2. The reaction that occurs in a breath analyser, a device used to determine the alcohol level in a person's blood stream is

$2K_2Cr_2O_7 + 8H_2SO_4 + 3C_2H_6O \rightarrow 2Cr_2(SO_4)_3 + 3C_2H_4O_2 + 2K_2SO_4 + 11H_2O$

If the rate of appearance of $Cr_2(SO_4)_3$ is 2.67 mol min^{-1} at a particular time, the rate of disappearance of C_2H_6O at the same time is _______ mol min^{-1}. (Nearest integer)

Official Ans. by NTA (4)

Sol. $\left(\dfrac{\text{Rate of disappearance of } C_2H_6O}{3}\right)$

$= \left(\dfrac{\text{Rate of appearance of } Cr_2(SO_4)_3}{2}\right)$

$\Rightarrow \left(\dfrac{2.67\,\text{mol/min} \times 3}{2}\right)$ = rate of disappearance of C_2H_6O.

$\Rightarrow$ Rate of disappearance of C_2H_6O = 4.005 mol/min

3. The kinetic energy of an electron in the second Bohr orbit of a hydrogen atom is equal to $\dfrac{h^2}{xma_0^2}$. The value of 10x is _______ . (a_0 is radius of Bohr's orbit) (Nearest integer) [Given : $\pi = 3.14$]

Official Ans. by NTA (3155)

Sol. $mvr = \dfrac{nh}{2\pi}$

$$K.E. = \frac{n^2h^2}{8\pi^2mr^2} = \frac{4h^2}{8\pi^2m(4a_0)^2}$$

$$= \left(\frac{4}{8\pi^2 \times 16}\right)\frac{h^2}{ma_0^2}$$

$\Rightarrow x = 315.507$

$\Rightarrow 10x = 3155$ (nearest integer)

4. 1 kg of 0.75 molal aqueous solution of sucrose can be cooled up to –4°C before freezing. The amount of ice (in g) that will be separated out is _______ . (Nearest integer)

[Given : $K_f(H_2O) = 1.86$ K kg mol^{-1}]

Official Ans. by NTA (518)

Sol. Let mass of water initially present = x gm

$\Rightarrow$ Mass of sucrose = (1000 - x) gm

$\Rightarrow$ moles of sucrose = $\left(\dfrac{1000-x}{342}\right)$

$$\Rightarrow 0.75 = \frac{\left(\frac{1000-x}{342}\right)}{\left(\frac{x}{1000}\right)} \Rightarrow \frac{x}{1000} = \frac{1000-x}{342 \times 0.75}$$

$\Rightarrow 256.5\,x = 10^6 - 1000x$

$\Rightarrow x = 795.86$ gm

$\Rightarrow$ moles of sucrose = 0.5969

New mass of H_2O = a kg

$\Rightarrow 4 = \dfrac{0.5969}{a} \times 1.86 \Rightarrow a = 0.2775$ kg

$\Rightarrow$ ice separated = (795.86 – 277.5) = 518.3 gm

5. 1 mol of an octahedral metal complex with formula $MCl_3 \cdot 2L$ on reaction with excess of $AgNO_3$ gives 1 mol of AgCl. The denticity of Ligand L is _______ . (Integer answer)

Official Ans. by NTA (2)

Sol. $MCl_3.2L$ octahedral

$\underset{1\,mole}{MCl_3.2L} \xrightarrow{Ex.AgNO_3} 1\text{ mole of AgCl}$

Its means that one Cl^- ion present in ionization sphere.

$\therefore$ formula = $[MCl_2L_2]Cl$

For octahedral complex coordination no. is 6

$\therefore$ L act as bidentate ligand

6. The number of moles of CuO, that will be utilized in Dumas method for estimation nitrogen in a sample of 57.5g of N, N-dimethylaminopentane is _______ $\times 10^{-2}$. (Nearest integer)

Official Ans. by NTA (1125)

Sol. Moles of N in N,N - dimethylaminopentane

$= \left(\dfrac{57.5}{115}\right) = 0.5\text{mol}$

$$\Rightarrow C_7H_{17}N + \frac{45}{2}CuO \rightarrow 7CO_2 + \frac{17}{2}H_2O + \frac{1}{2}N_2 + \frac{45}{2}Cu$$

$$\frac{n_{CuO}\text{ reacted}}{\left(\frac{45}{2}\right)} = \frac{n_{C_7H_{17}N}\text{ reacted}}{1}$$

$$\Rightarrow n_{CuO}\text{ reacted} = \left(\frac{45}{2}\right)\times 0.5 = 11.25$$

7. The number of f electrons in the ground state electronic configuration of Np (Z = 93) is _______. (Nearest integer)

Official Ans. by NTA (4)

Allen Ans. (18)

Sol. Np = $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^2\ 4d^{10}\ 5p^6\ 6s^2$ $\boxed{4f^{14}}$ $5d^{10}\ 6p^6\ 7s^2$ $\boxed{5f^4}$ $6d^1$

Total no. of 'f' electron = 14 e^- + 4e^- = 18

8. 200 mL of 0.2 M HCl is mixed with 300 mL of 0.1 M NaOH. The molar heat of neutralization of this reaction is –57.1 kJ. The increase in temperature in °C of the system on mixing is x × 10^{-2}. The value of x is _______. (Nearest integer)

[Given : Specific heat of water = 4.18 J g^{-1} K^{-1}

Density of water = 1.00 g cm^{-3}]

(Assume no volume change on mixing)

Official Ans. by NTA (82)

Sol. ⇒ Millimoles of HCl = 200 × 0.2 = 40

⇒ Millimoles of NaOH = 300 × 0.1 = 30

$$\Rightarrow \text{ Heat released} = \left(\frac{30}{1000}\times 57.1\times 1000\right) = 1713\text{ J}$$

⇒ Mass of solution = 500 ml × 1 gm/ml = 500 gm

$$\Rightarrow \Delta T = \frac{q}{m\times C} = \frac{1713\text{J}}{500\text{g}\times 4.18\frac{\text{J}}{\text{g}-\text{K}}} = 0.8196\text{K}$$

= 81.96 × 10^{-2} K

9. The number of moles of NH_3, that must be added to 2 L of 0.80 M $AgNO_3$ in order to reduce the concentration of Ag^+ ions to 5.0 × 10^{-8} M ($K_{formation}$ for $[Ag(NH_3)_2]^+$ = 1.0 × 10^8) is _______ . (Nearest integer)

[Assume no volume change on adding NH_3]

Official Ans. by NTA (4)

Sol. Let moles added = a

$$Ag^+_{(aq.)} + 2NH_{3(aq.)} \rightleftharpoons Ag(NH_3)^+_{2(aq.)}$$

t = 0	0.8	$\left(\frac{a}{2}\right)$	
t = ∞	5 × 10^{-8}	$\left(\frac{a}{2}-1.6\right)$	0.8

$$\frac{0.8}{(5\times 10^{-8})\left(\frac{a}{2}-1.6\right)^2} = 10^8$$

$$\Rightarrow \quad \frac{a}{2}-1.6 = 0.4 \ \Rightarrow a = 4$$

10. When 10 mL of an aqueous solution of $KMnO_4$ was titrated in acidic medium, equal volume of 0.1 M of an aqueous solution of ferrous sulphate was required for complete discharge of colour. The strength of $KMnO_4$ in grams per litre is _______ × 10^{-2}. (Nearest integer)

[Atomic mass of K = 39, Mn = 55, O = 16]

Official Ans. by NTA (316)

Sol. Let molarity of $KMnO_4$ = x

$KMnO_4 + FeSO_4 \rightarrow Fe_2(SO_4)_3 + Mn^{2+}$

n = 5   n = 1

(Equivalents of $KMnO_4$ reacted) = (Equivalents of $FeSO_4$ reacted)

⇒ (5 × x × 10 ml) = 1 × 0.1 × 10 ml

⇒ x = 0.02 M

Molar mass of $KMnO_4$ = 158 gm/mol

⇒ Strength = (x × 158) = 3.16 g/ℓ