



**PAPER-1(B.E./B. TECH.)**

# **JEE (Main) 2021**

**Questions & solutions**

(Reproduced from memory retention)

**Date : 24 February, 2021 (SHIFT-2) Time ; (3.00 pm to 6.00 pm)**

**Duration : 3 Hours | Max. Marks : 300**

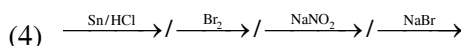
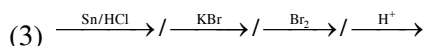
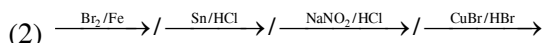
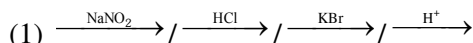
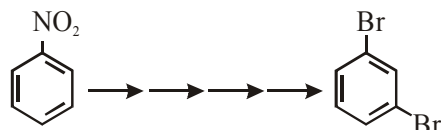
**SUBJECT : CHEMISTRY**

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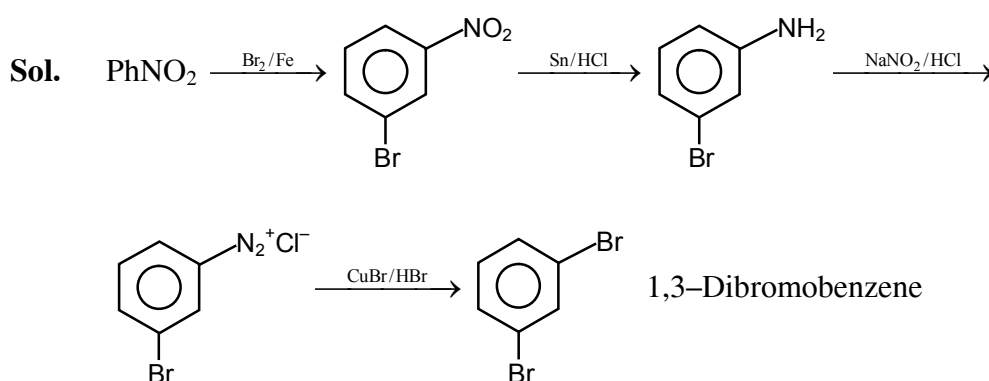
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## CHEMISTRY

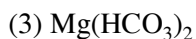
1. What is the correct sequence of reagents used for converting nitrobenzene into *m*-dibromobenzene ?



Ans. (2)



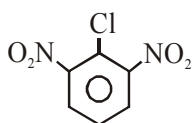
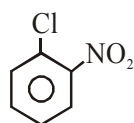
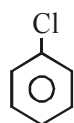
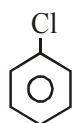
2. Most suitable salt which can be used for efficient clotting of blood will be :-



Ans. (4)

Sol.  $\text{FeCl}_3$

3. The correct order of the following compounds showing increasing tendency towards nucleophilic substitution reaction is :-

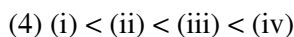
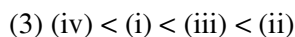
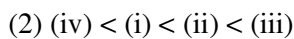
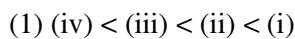


(i)

(ii)

(iii)

(iv)



Ans. (4)

Sol. Rate of aromatic nucleophilic substitution reaction depends upon type of halogens and electronic effect of the group present on the ring. Electron withdrawing groups ( $-I$ ,  $-M$ ) increases rate of aromatic nucleophilic substitution reaction.

4. According to Bohr's atomic theory :-

(A) Kinetic energy of electron is  $\propto \frac{Z^2}{n^2}$ .

(B) The product of velocity (v) of electron and principal quantum number (n), 'vn'  $\propto Z^2$ .

(C) Frequency of revolution of electron in an orbit is  $\propto \frac{Z^3}{n^3}$ .

(D) Coulombic force of attraction on the electron is  $\propto \frac{Z^3}{n^4}$ .

Choose the most appropriate answer from the options given below :

(1) (C) Only

(2) (A) Only

(3) (A), (C) and (D) only

(4) (A) and (D) only

Ans. (4), NTA Answer : (3)

Sol. KE of electron  $\propto \frac{Z^2}{n^2}$

$V_n \propto Z$

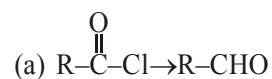
$f \propto \frac{Z^2}{n^3}$

Coulombic force of attraction  $\propto \frac{Z^3}{n^4}$

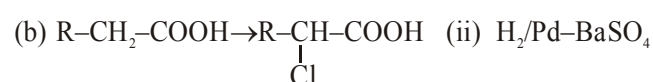
5. Match List - I and List - II.

**List-I**

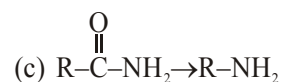
**List-II**



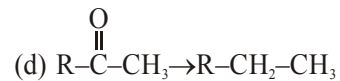
(i)  $\text{Br}_2/\text{NaOH}$



(ii)  $\text{H}_2/\text{Pd}-\text{BaSO}_4$



(iii)  $\text{Zn}(\text{Hg})/\text{Conc. HCl}$



(iv)  $\text{Cl}_2/\text{Red P}, \text{H}_2\text{O}$

Choose the correct answer from the options given below :

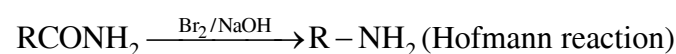
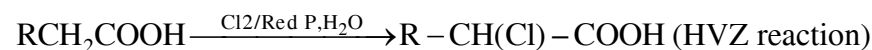
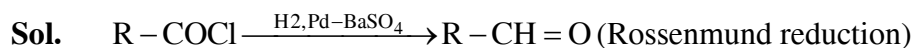
(1) (a)-(ii), (b)-(i), (c)-(iv), (d)-(iii)

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

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

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

Ans. (3)



6. The calculated magnetic moments (spin only value) for species  $[\text{FeCl}_4]^{2-}$ ,  $[\text{Co}(\text{C}_2\text{O}_4)_3]^{3-}$  and  $\text{MnO}_4^{2-}$  respectively are :
- (1) 5.82, 0 and 0 BM (2) 4.90, 0 and 1.73 BM  
(3) 5.92, 4.90 and 0 BM (4) 4.90, 0 and 2.83 BM

Ans. (2)

Sol.	Complex	Configuration	$\mu_s$
	$[\text{FeCl}_4]^{2-}$	$e_g^{2,1} t_{2g}^{1,1,1}$	4.90
	$[\text{Co}(\text{ox})_3]^{3-}$	$t_{2g}^{2,2,2} e_g^{0,0}$	0
	$\text{MnO}_4^{2-}$	$e_g^{1,0} t_{2g}^{0,0,0}$	1.73

7. Match List-I with List-II :

List-I (Salt)		List-II (Flame colour wavelength)	
(a) LiCl	(i)	455.5 nm	
(b) NaCl	(ii)	670.8 nm	
(c) RbCl	(iii)	780.0 nm	
(d) CsCl	(iv)	589.2 nm	

Choose the correct answer from the options given below :

- (1) (a)–(iv), (b)–(ii), (c)–(iii), (d)–(i) (2) (a)–(ii), (b)–(i), (c)–(iv), (d)–(iii)  
(3) (a)–(i), (b)–(iv), (c)–(ii), (d)–(iii) (4) (a)–(ii), (b)–(iv), (c)–(iii), (d)–(i)

Ans. (4)

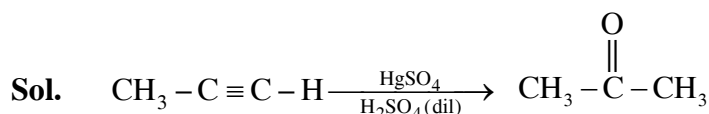
Sol.

Metal	Li	Na	Rb	Cs
Colour	Crimson red	Yellow	Red violet	Blue
$\lambda/\text{nm}$	670.8	589.2	780.0	455.5

8. Which one of the following carbonyl compounds cannot be prepared by addition of water on an alkyne in the presence of  $\text{HgSO}_4$  and  $\text{H}_2\text{SO}_4$  ?

- (1)  $\text{CH}_3\text{-}\overset{\text{O}}{\parallel}\text{C}\text{-H}$  (2)   
(3)  $\text{CH}_3\text{-CH}_2\text{-}\overset{\text{O}}{\parallel}\text{C}\text{-H}$  (4)  $\text{CH}_3\text{-}\overset{\text{O}}{\parallel}\text{C}\text{-CH}_2\text{CH}_3$

Ans. (3)

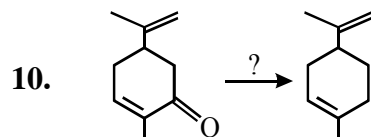


9. In polymer Buna-S: 'S' stands for :-

- (1) Sulphonation      (2) Strength      (3) Sulphur      (4) Styrene

Ans. (4)

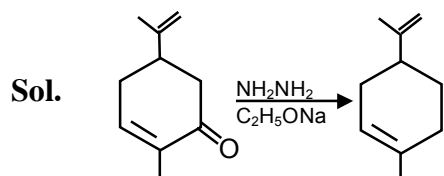
Sol. Buna-S is the co-polymer of buta-1,3-diene and styrene.



Which of the following reagent is suitable for the preparation of the product in the above reaction ?

- (1)  $\text{NaBH}_4$       (2)  $\text{NH}_2\text{-NH}_2/\text{C}_2\text{H}_5\text{O}^-\text{Na}^\oplus$   
(3)  $\text{Ni}/\text{H}_2$       (4)  $\text{Red P} + \text{Cl}_2$

Ans. (2)



It is Wolff-Kishner reduction of carbonyl compounds.

11. Match List-I and List-II.

- | List-I                      | List-II                 |
|-----------------------------|-------------------------|
| (a) Valium                  | (i) Antifertility drug  |
| (b) Morphine                | (ii) Pernicious anaemia |
| (c) Norethindrone           | (iii) Analgesic         |
| (d) Vitamin B <sub>12</sub> | (iv) Tranquilizer       |

- (1) (a)–(iv), (b)–(iii), (c)–(ii), (d)–(i)  
(2) (a)–(iv), (b)–(iii), (c)–(i), (d)–(ii)  
(3) (a)–(ii), (b)–(iv), (c)–(iii), (d)–(i)  
(4) (a)–(i), (b)–(iii), (c)–(iv), (d)–(ii)

Ans. (2)

Sol. Valium → Tranquilizer

Morphine → Analgesic

Norethindrone → Antifertility drug

Vitamin B<sub>12</sub> → Pernicious anaemia

12. Match List-I with List-II.

List-I (Metal)		List-II (Ores)	
(a)	Aluminium	(i)	Siderite
(b)	Iron	(ii)	Calamine
(c)	Copper	(iii)	Kaolinite
(d)	Zinc	(iv)	Malachite

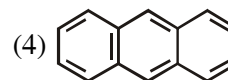
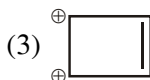
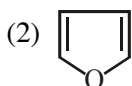
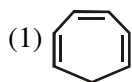
Choose the correct answer from the options given below :

- (1) (a)–(iv), (b)–(iii), (c)–(ii), (d)–(i)                      (2) (a)–(ii), (b)–(iv), (c)–(i), (d)–(iii)  
 (3) (a)–(i), (b)–(ii), (c)–(iii), (d)–(iv)                      (4) (a)–(iii), (b)–(i), (c)–(iv), (d)–(ii)

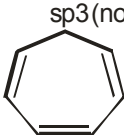
Ans. (4)

Sol. Siderite ( $\text{FeCO}_3$ )  
 Calamine ( $\text{ZnCO}_3$ )  
 Kaolinite ( $\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$ )  
 Malachite ( $\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$ )

13. Which one of the following compounds is non-aromatic ?



Ans. (1)

Sol.   $\text{sp}^3$  (non planar)

It is non aromatic because this compound is non planar

14. What is the correct order of the following elements with respect to their density ?

- (1)  $\text{Cr} < \text{Zn} < \text{Co} < \text{Cu} < \text{Fe}$                       (2)  $\text{Zn} < \text{Cu} < \text{Co} < \text{Fe} < \text{Cr}$   
 (3)  $\text{Zn} < \text{Cr} < \text{Fe} < \text{Co} < \text{Cu}$                       (4)  $\text{Cr} < \text{Fe} < \text{Co} < \text{Cu} < \text{Zn}$

Ans. (3)

Sol. Density ( $\text{g/cm}^3$ )

Zn 7.1

Cr 7.19

Fe 7.8

Co 8.7

Cu 8.9

15. Given below are two statements :-

**Statement I :** The value of the parameter "Biochemical Oxygen Demand (BOD)" is important for survival of aquatic life.

**Statement II :** The optimum value of BOD is 6.5 ppm.

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

- (1) Statement I is false but Statement II is true
- (2) Both Statement I and Statement II are true
- (3) Statement I is true but Statement II is false
- (4) Both Statement I and Statement II are false

**Ans. (3)**

**Sol.** Statement 1 is correct & statement 2 is false. The optimum value of BOD is 5.

16. The **incorrect** statement among the following is :-

- (1)  $\text{VO}_2$  is a reducing agent
- (2)  $\text{Cr}_2\text{O}_3$  is an amphoteric oxide
- (3)  $\text{RuO}_4$  is an oxidizing agent
- (4) Red colour of ruby is due to the presence of  $\text{Co}^{3+}$

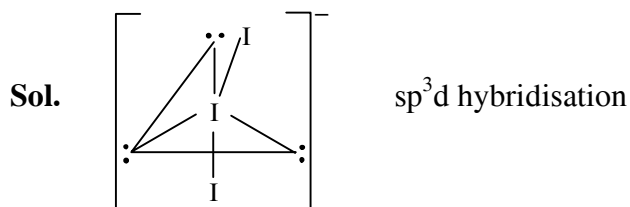
**Ans. (4)**

**Sol.** Ruby is  $\text{Al}_2\text{O}_3$  containing about 0.5-1%  $\text{Cr}^{3+}$  ions ( $d^3$ ), which are randomly distributed in positions normally occupied by  $\text{Al}^{3+}$ . We may view these chromium (III) species as octahedral chromium(III) complexes incorporated into the alumina lattice ; d-d transitions at these centres give rise to the colour.

17. The correct shape and I-I-I bond angles respectively in  $\text{I}_3^-$  ion are :-

- (1) Distorted trigonal planar;  $135^\circ$  and  $90^\circ$
- (2) T-shaped;  $180^\circ$  and  $90^\circ$
- (3) Trigonal planar;  $120^\circ$
- (4) Linear;  $180^\circ$

**Ans. (4)**



Linear shape  $\angle \text{I-I-I} = 180^\circ$

18. Given below are two statements : one is labelled as **Assertion A** and the other is labelled as **Reason R**.  
**Assertion A** : Hydrogen is the most abundant element in the Universe, but it is not the most abundant gas in the troposphere.

**Reason R** : Hydrogen is the lightest element.

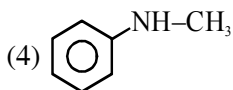
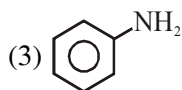
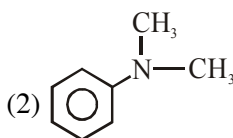
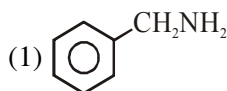
In the light of the above statements, choose the correct answer from the options given below :

- (1) **A** is true but **R** is false
- (2) Both **A** and **R** are true and **R** is the correct explanation of **A**
- (3) **A** is false but **R** is true
- (4) Both **A** and **R** are true but **R** is NOT the correct explanation of **A**

**Ans.** (2)

**Sol.** Fact

19. The diazonium salt of which of the following compounds will form a coloured dye on reaction with  $\beta$ -Naphthol in NaOH ?



**Ans.** (3)

**Sol.** Only aromatic primary amines will give Azo dye test.

20. The correct set from the following in which both pairs are in correct order of melting point is :-

- (1) LiF > LiCl ; MgO > NaCl
- (2) LiCl > LiF ; NaCl > MgO
- (3) LiF > LiCl ; NaCl > MgO
- (4) LiCl > LiF ; MgO > NaCl

**Ans.** (1)

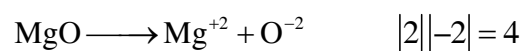
**Sol.** Lattice energy  $\propto \frac{1}{r^+ + r^-}$

$$\propto \frac{1}{r^+ + r^-}$$



Size  $F^- < Cl^-$  [charge are same]

Lattice energy  $\boxed{LiF > LiCl}$



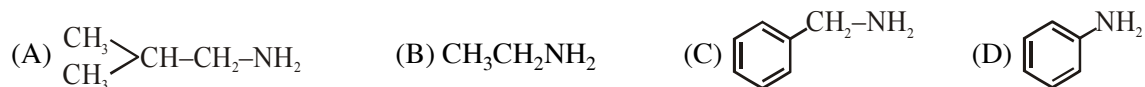
Lattice energy  $\boxed{MgO > NaCl}$

Charge dominate over size



**Numerical**

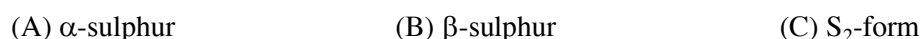
1. The total number of amines among the following which can be synthesized by Gabriel synthesis is \_\_\_\_\_.



**Ans. 3**

**Sol.** Aromatic amines cannot synthesised by Gabriel synthesis method because aromatic halides cannot give substitution reaction.

2. Among the following allotropic forms of sulphur, the number of allotropic forms, which will show paramagnetism is \_\_\_\_\_.

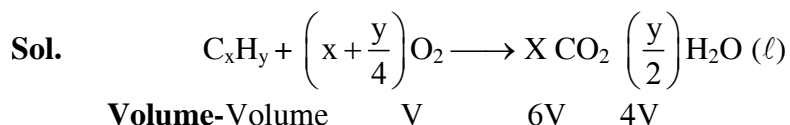


**Ans. 1**

**Sol.** In  $\text{S}_2$ , like  $\text{O}_2$  two unpaired electron are present,  $\alpha$  &  $\beta$ - sulphur have  $\text{S}_8$  ring which are diamagnetic

3. The formula of a gaseous hydrocarbon which requires 6 times of its own volume of  $\text{O}_2$  for complete oxidation and produces 4 times its own volume of  $\text{CO}_2$  is  $\text{C}_x\text{H}_y$ . The value of y is \_\_\_\_\_.

**Ans. 8**



**Analysis**

$$\frac{V_{\text{C}_x\text{H}_y}}{1} = \frac{V_{\text{CO}_2}}{x}$$

$$\frac{v}{1} = \frac{4v}{x} \quad x = 4$$

$$\frac{V_{\text{C}_x\text{H}_y}}{1} = \frac{V_{\text{O}_2}}{x + \frac{y}{4}}$$

$$\frac{V}{1} = \frac{6V}{x + \frac{y}{4}}$$

$$x + \frac{y}{4} = 6$$

$$4 + \frac{y}{4} = 6$$

$$\frac{y}{4} = 2$$

$$y = 8$$

Formula  $\text{C}_4\text{H}_8$

4. The volume occupied by 4.75 g of acetylene gas at 50°C and 740 mmHg pressure is \_\_\_\_\_ L. (Rounded off to the nearest integer)

[Given R = 0.0826 L atm K<sup>-1</sup> mol<sup>-1</sup>]

**Ans. 5**

**Sol.** 
$$V = \frac{nRT}{P} = \frac{\left(\frac{4.75}{26}\right) \times 0.0826 \times 323}{\left(\frac{740}{760}\right)} \approx 5L$$

5. C<sub>6</sub>H<sub>6</sub> freezes at 5.5°C. The temperature at which a solution 10 g of C<sub>4</sub>H<sub>10</sub> in 200 g of C<sub>6</sub>H<sub>6</sub> freeze is \_\_\_\_\_ °C. (The molal freezing point depression constant of C<sub>6</sub>H<sub>6</sub> is 5.12°C/m.)

**Ans. 1**

**Sol.** 
$$\Delta T_f = k_f \times m$$

$$= 5.12 \times \frac{10}{58} \times \frac{1000}{200} = 4.41^\circ\text{C}$$

$$\Delta T_f = (T_f)_{\text{Solvent}} - (T_f)_{\text{Solution}}$$

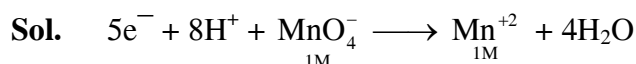
$$4.41^\circ\text{C} = 5.5 - (T_f)_{\text{Solution}}$$

$$(T_f)_{\text{Solution}} = 5.5 - 4.41 = 1.09^\circ\text{C}$$

6. The magnitude of the change in oxidising power of the MnO<sub>4</sub><sup>-</sup> / Mn<sup>2+</sup> couple is x × 10<sup>-4</sup> V, if the H<sup>+</sup> concentration is decreased from 1 M to 10<sup>-4</sup> M at 25°C. (Assume concentration of MnO<sub>4</sub><sup>-</sup> and Mn<sup>2+</sup> to be same on change in H<sup>+</sup> concentration). The value of x is \_\_\_\_\_.

(Rounded off to the nearest integer) [Given :  $\frac{2.303 RT}{F} = 0.059$ ]

**Ans. 3776**



$$E_1 = E^\circ - \frac{0.0591}{5} \log_{10} \left[ \frac{[Mn^{+2}]}{[MnO_4^-]} \right]$$

(as [H<sup>+</sup>] = 1)

$$E_2 = E^\circ - \frac{0.0591}{5} \left[ \log_{10}(10^{32}) \times \log \frac{[Mn^{+2}]}{[MnO_4^-]} \right]$$

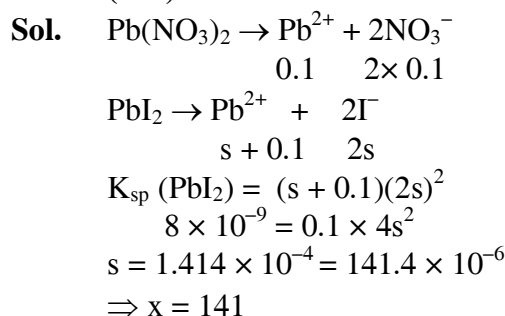
$$= E^\circ - \frac{0.0591}{5} \times 32 - \frac{0.059}{5} \log \left[ \frac{Mn^{2+}}{MnO_4^-} \right]$$

$$E_1 - E_2 = E^\circ - E^\circ + \frac{0.059}{5} \times 32$$

$$= 0.3776 \text{ V} = 3776 \times 10^{-4} \text{ V}$$

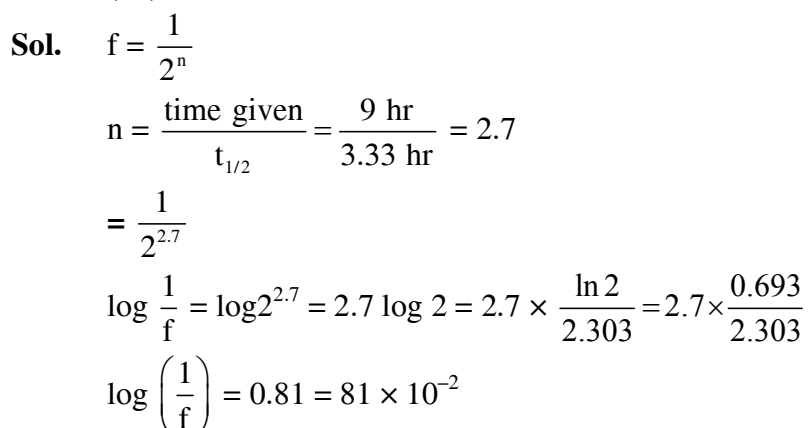
7. The solubility product of  $\text{PbI}_2$  is  $8.0 \times 10^{-9}$ . The solubility of lead iodide in 0.1 molar solution of lead nitrate is  $x \times 10^{-6}$  mol/L. The value of  $x$  is \_\_\_\_\_. (Rounded off to the nearest integer)  
[Given :  $\sqrt{2} = 1.41$ ]

**Ans. (141)**



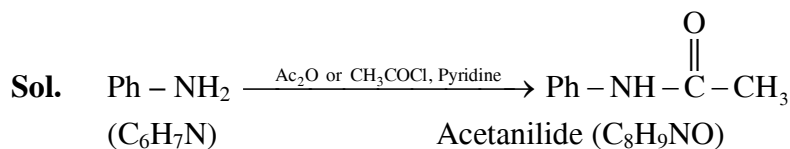
8. Sucrose hydrolyses in acid solution into glucose and fructose following first order rate law with a half-life of 3.33 h at  $25^\circ\text{C}$ . After 9 h, the fraction of sucrose remaining is  $f$ . The value of  $\log_{10}\left(\frac{1}{f}\right)$  is \_\_\_\_\_  $\times 10^{-2}$ . (Rounded off to the nearest integer)  
[Assume :  $\ln 10 = 2.303$ ,  $\ln 2 = 0.693$ ]

**Ans. (81)**



9. 1.86 g of aniline completely reacts to form acetanilide. 10% of the product is lost during purification. Amount of acetanilide obtained after purification (in g) is \_\_\_\_\_  $\times 10^{-2}$ .

**Ans. 243**



1.86 g

Molar mass = 93

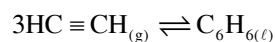
Molar mass = 135

\* 93 g aniline produces 135 g acetanilide

$$1.86 \text{ g aniline produces } \frac{135 \times 1.86}{93} = 2.70 \text{ g}$$

\* At 90% efficiency of reaction it produces =  $\frac{2.70 \times 90}{100} = 2.43 \text{ g}$

- 10.** Assuming ideal behaviour, the magnitude of  $\log K$  for the following reaction at  $25^\circ\text{C}$  is  $x \times 10^{-1}$ . The value of  $x$  is \_\_\_\_\_. (Integer answer)



[Given:  $\Delta_f G^\circ(\text{HC} \equiv \text{CH}) = -2.04 \times 10^5 \text{ J mol}^{-1}$ ;  $\Delta_f G^\circ(\text{C}_6\text{H}_6) = -1.24 \times 10^5 \text{ J mol}^{-1}$ ;  $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$ ]

**Ans. 855**

**Sol.**

$$\begin{aligned} \Delta G^\circ_{\text{reaction}} &= \Delta_f G^\circ_{\text{C}_6\text{H}_6} - 3\Delta_f G^\circ_{\text{CH}=\text{CH}} \\ &= -1.24 \times 10^5 - 3 \times (-2.04 \times 10^5) \\ &= -4.88 \times 10^5 \text{ Joule} \\ -2.303RT \log_{10} k &= -4.88 \times 10^5 \\ -2.303 \times 8.314 \times 298 \log_{10} k &= -4.88 \times 10^5 \\ \log_{10} k &= 85.52 = 855.2 \times 10^{-1} \end{aligned}$$