

**SAMPLE PAPER (2023 -24)**  
**CHEMISTRY THEORY (043)**  
**MARKING SCHEME**

**SECTION A**

1. (b) 0.1 M HCl solution, conductivity is higher for strong electrolyte, conductivity decreases with dilution
2. (c) A= Benzaldehyde , B= Acetophenone. This is an example of crossed Aldol condensation.
3. (d) Vitamin A,D, E and K These are fat soluble vitamins
4. (a) 3-Methylpent-3-en-2-one
5. (b) The carbon-magnesium bond is covalent and non-polar in nature .
6. (a) (i) (r) , (ii) (q), (iii) (p)  
Zinc has no unpaired electrons in 3d or 4s orbitals, so enthalpy of atomization is low  
Mn = 3d<sup>5</sup>4s<sup>2</sup> shows +2,+3,+4,+5,+6 and+7 oxidation state , maximum number in 3d series
7. (b) molecularity has no meaning for complex reactions.
8. (c) water
9. (b) no turbidity will be observed, given compound is a primary alcohol
10. (a) 0.00625 molL<sup>-1</sup>s<sup>-1</sup> for zero order  $k = \frac{[R_0] - [R]}{t} = \frac{1.5 - 0.75}{120}$
11. (a) Due to the activation of benzene ring by the methoxy group.
12. (b) atomic radii

**for visually challenged learners**

12. (d) Zinc
13. (c) A is true but R is false
14. (b) Both A and R are true but R is not the correct explanation of A
15. (b) Both A and R are true and R is not the correct explanation of A.
16. (d) A is false but R is true.

Cu will deposit at cathode

**SECTION B**

17. (a) for first order reaction

half life of X = 12 hours

2 days = 48 hours means 4 half lives , amount of X left = 1/16 of initial value

half life of Y = 16 hours ( 1/2)

2 days = 48 hours means 3 half lives, amount left = 1/8 of initial value

Ratio of X:Y = 1:2 ( 1/2)

(b)  $\text{mol}^{1/2}\text{L}^{-1/2}\text{s}^{-1}$  as Rate =  $k [P]^{1/2}$  (1)

18.  $\pi_1 = \pi_2$  (1/2)

$iC_1RT = C_2RT$  (1/2)

$$\frac{3 \times 5}{322} = \frac{2}{M} \quad (1/2)$$

$$M = \frac{2 \times 322}{3 \times 5} \quad (1/2)$$

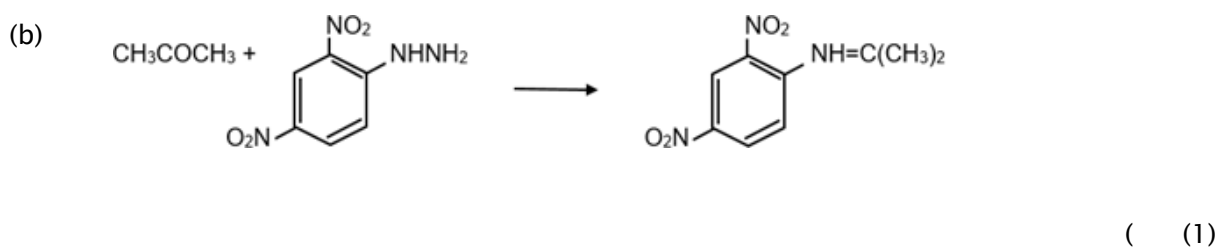
$$M = 42.9 \text{ g}$$

19. (a) m-dichlorobenzene < o-dichlorobenzene < p-dichlorobenzene (1/2)  
 symmetrical structure and close packing in para isomer

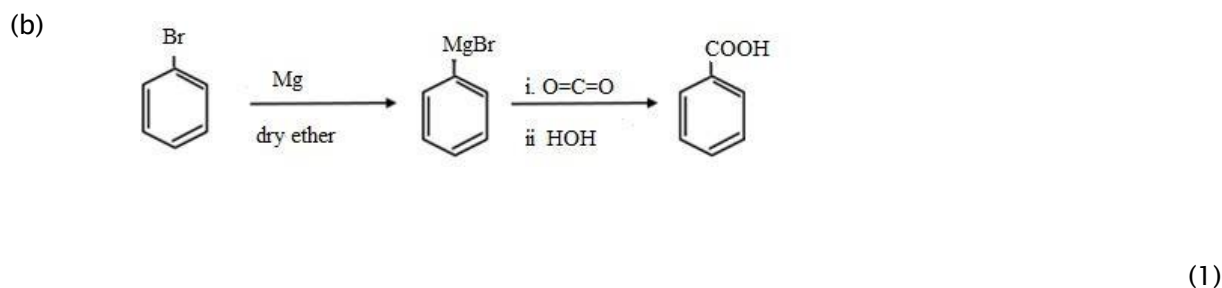
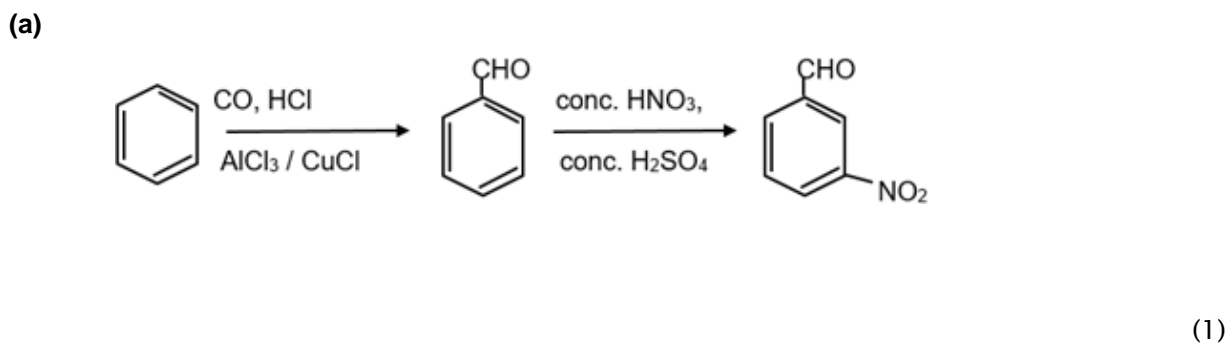
ortho has a stronger dipole dipole interaction as compared to meta (1/2)

(b) the halogen atom because of its -I effect has some tendency to withdraw electrons from the benzene ring. As a result, the ring gets somewhat deactivated as compared to benzene and hence the electrophilic substitution reactions in haloarenes occur slowly and require more drastic conditions as compared to those in benzene. (1)

20. (a) p-nitrobenzaldehyde is more reactive towards the nucleophilic addition reaction than p-tolualdehyde as Nitro group is electron withdrawing in nature . Presence of nitro group decrease electron density, hence facilitates the attack of nucleophile . Presence of -CH<sub>3</sub> leads to +I effect as -CH<sub>3</sub> is electron releasing group. (1)



OR

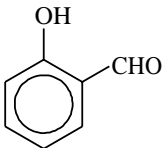


21. (a) Replication

A sequence of bases on DNA is unique for a person and is the genetic material transferred to the individual from the parent which helps in the determination of paternity. (1)

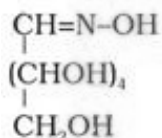
- (b) During denaturation secondary and tertiary structures are destroyed but the primary structure remains intact. (1)

**SECTION C**

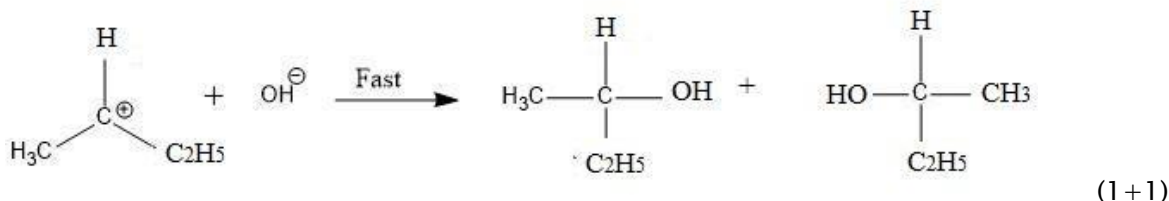
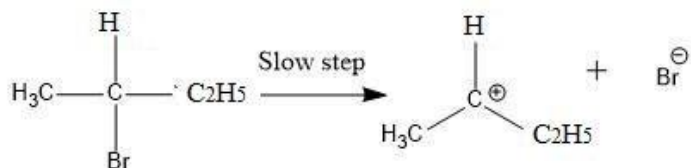
22. (a)  $[\text{Cr}(\text{en})_2(\text{OH})_2]\text{Cl}$  or  $[\text{Cr}(\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2)_2(\text{OH})_2]\text{Cl}$  (1)
- (b) No, ionization isomers are possible by exchange of ligand with counter ion only and not by exchange of central metal ion. (1)
- (c) The central atom is electron pair acceptor so it is a Lewis acid. (1)
23. (a) Yes, if the concentration of  $\text{ZnSO}_4$  in the two half cell is different, the electrode potential will be different making the cell possible. (1)
- (b)  $\Lambda_m^0(\text{MgCl}_2) = \lambda_m^0(\text{Mg}^{2+}) + 2\lambda_m^0(\text{Cl}^-)$   
 $258.6 = 106 + 2\lambda_m^0(\text{Cl}^-)$   
 $\lambda_m^0(\text{Cl}^-) = 76.3 \text{ Scm}^2\text{mol}^{-1}$  (1)
- (c) cell constant  $G^* = k \times R$   
 $k = G^*/R = 0.146/1000 = 1.46 \times 10^{-4} \text{ Scm}^{-1}$ . (1)
24. (a) Reimer Tiemann, (1/2)
- 

2-Hydroxybenzaldehyde

(1/2+1/2)
- (b) Williamson synthesis,  $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}(\text{CH}_3)\text{O C}_2\text{H}_5$   
 2-Ethoxy-3-methylpentane (1/2+1/2+1/2)
- (c) Stephen reaction,  $\text{CH}_3\text{CH}_2\text{CHO}$ , Propanal (1/2+1/2+1/2)
25. A, B and C contain carbonyl group as they give positive 2,4 DNP test
- A and B are aldehydes as aldehydes reduce Tollen's reagent
- C is a ketone, as it contains carbonyl group but does not give positive Tollen's test (1/2)
- C is a methyl ketone as it gives positive iodoform test
- B is an aldehyde that gives positive iodoform test (1/2)
- D is a carboxylic acid
- Since the number of carbons in the compounds A,B,C and D is three or two
- B is  $\text{CH}_3\text{CHO}$  as this is only aldehyde which gives a positive iodoform test (1/2)
- The remaining compounds A, C and D have three carbons
- A is  $\text{CH}_3\text{CH}_2\text{CHO}$ , C is  $\text{CH}_3\text{COCH}_3$  and D is  $\text{CH}_3\text{CH}_2\text{COOH}$  (1/2 each)
26. (a) The reactant Sucrose is dextrorotatory. On hydrolysis it give glucose dextrorotatory and fructose which is levorotatory. The specific rotation of fructose is higher than glucose (1)
- Sucrose is dextrorotatory but after hydrolysis gives dextrorotatory glucose and levorotatory fructose. Since the levorotation of fructose ( $-92.4^\circ$ ) is more than dextrorotation of glucose ( $+52.5^\circ$ ), the mixture is levorotatory. (1)
- (b) Invert sugar, The hydrolysis of sucrose brings about a change in the sign of rotation, from dextro (+) to laevo (-) and the product is named as invert sugar. (1)
- (c) Glucose (1)



Mechanism:



28.

$$\log\left(\frac{k_2}{k_1}\right) = \frac{E_a}{2.303R} \left[ \frac{1}{T_1} - \frac{1}{T_2} \right]$$

$$\log\frac{0.20}{0.05} = \frac{E_a}{2.303R} \left[ \frac{1}{200} - \frac{1}{500} \right]$$

$$\log 10 = \frac{E_a}{19.15} \left( \frac{300}{200 \times 500} \right)$$

$$E_a = \frac{19.15 \times 200 \times 500}{300}$$

$$E_a = 6383 \text{ J / mol} \quad (1+1+1)$$

#### SECTION D

29. (a) D. Energy is directly proportional to the wave number. Maximum energy of light is required for an electron to jump from  $t_{2g}$  to  $e_g$  in case of  $[\text{CrD}_6]^{3-}$  (1/2+1/2)

OR

(a) A, The splitting caused in least in this case as the energy required for electron to jump from  $t_{2g}$  to  $e_g$ , is minimum. (1/2 +1/2)

(b)  $[\text{CrB}_6]^{3+}$ , wavelength of light absorbed is  $1/17830 = 560\text{nm}$  for the complex while  $1/13640 = 733\text{nm}$  for  $[\text{CrA}_6]^{3-}$  complex. (1/2+1/2)

(c) (i)  $[\text{CrCl}_6]^{3-}$ , Hexachloridochromate(III) ion (1 each)

(ii)  $[\text{Cr}(\text{NH}_3)_6]^{3+}$ , Hexaamminechromium(III) ion

A =  $\text{Cl}^-$ , B =  $\text{H}_2\text{O}$ , C =  $\text{NH}_3$ , D =  $\text{CN}^-$

30. (a) 2mol  $e^-$  (or 2F) have been transferred from anode to cathode to consume 2 mol of  $\text{H}_2\text{SO}_4$

therefore, one mole  $\text{H}_2\text{SO}_4$  requires one faraday of electricity or 96500 coulombs. (1)

(b)  $w_{\text{max}} = -nFE^\circ = -2 \times 96500 \times 2.0 = 386000 \text{ J}$  of work can be extracted using lead storage cell when the cell is in use. (1)

(c) **Both yes and no should be accepted as correct answers depending upon what explanation is provided.**

**Yes**, Hydrogen is a fuel that on combustion gives water as a byproduct. There are no carbon emissions and no pollutions caused.

However, at present the means to obtain hydrogen are electrolysis of water which use electricity obtained from fossil fuels and increase carbon emissions.

In spite of the problems faced today in the extraction of hydrogen, we cannot disagree on the fact that hydrogen is a clean source of energy. Further research can help in finding solutions and greener ways like using solar energy for extraction of hydrogen. (2)

**No**. It is true that Hydrogen is a fuel that on combustion gives water as a byproduct. There are no carbon emissions and no pollutions caused.

However, at present the means to obtain hydrogen are electrolysis of water which use electricity obtained from fossil fuels and increase carbon emissions.

Hydrogen is no doubt a green fuel, but the process of extraction is not green as of today. At present, looking at the process of extraction, hydrogen is not a green fuel. (2)

OR

**Both answers will be treated as correct**

(i) Lead batteries are currently the most important and widely used batteries. These are rechargeable. The problem is waste management which needs research and awareness. Currently, these are being thrown into landfills and there is no safe method of disposal or recycling. Research into safer method of disposal will reduce the pollution and health hazards caused to a great extent.

(1 mark for importance, 1 for need for the research)

(ii) Fuel cell is a clean source of energy. Hydrogen undergoes combustion to produce water. The need of the hour is green fuel and hydrogen is a clean fuel. The current problem is obtaining hydrogen. Research that goes into this area will help solve the problem of pollution and will be a sustainable solution.

(1 mark for importance, 1 for need for the research)

### SECTION E

31. (a) Both  $\text{Ti}^{3+}$  and  $\text{Cu}^{2+}$  have 1 unpaired electron, so the magnetic moment for both will be 1.73 BM
- (b) Zn, it has a more negative electrode potential so will corrode itself in place of iron.
- (c)  $\text{Mn}^{2+}$  has  $3d^5 4s^1$  configuration and configuration of  $\text{Cr}^{3+}$  is  $3d^5$ , therefore, ionisation enthalpy of  $\text{Mn}^{2+}$  is lower than  $\text{Cr}^{3+}$ .
- (d) Sc and Zn both form colourless compound and are diamagnetic.
- (e) The decrease in the atomic and ionic radii with increase in atomic number of actinoids due to poor shielding effect of 5f electron.
- (f) In both chromate and dichromate ion the oxidation state of Cr is +6

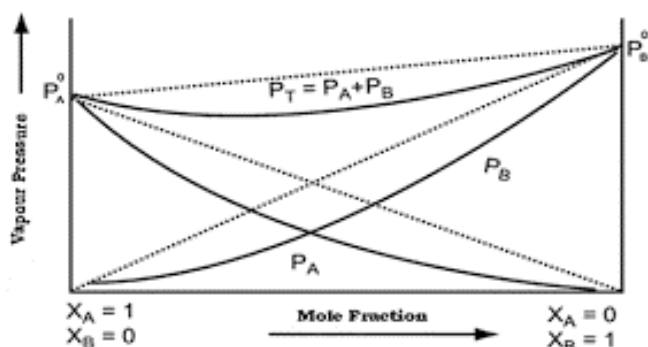
(g)  $10\text{I}^- + 2\text{MnO}_4^- + 16\text{H}^+ \rightarrow 2\text{Mn}^{2+} + 8\text{H}_2\text{O} + 5\text{I}_2$

(1 each, any 5)

32. (a) Addition of glucose to water is an endothermic reaction. According to Le Chatelier's principle, on increase in temperature, solubility will increase. (1)
- (b) Q is ocean water, due to the presence of salts it freezes at lower temperature (depression in freezing point) (1)
- (c)  $K_3[Fe(CN)_6]$  gives 4 ions in aqueous solution (1/2)
- $$i = 1 + (n-1)\alpha \quad (1/2)$$
- $$i = 1 + (4-1) \times 0.0.852$$
- $$i = 3.556 \quad (1/2)$$
- $$\Delta T_b = iK_b m = 3.556 \times 0.52 \times 1 = 1.85 \quad (1)$$
- $$T_b = 101.85^\circ C \quad (1/2)$$

OR

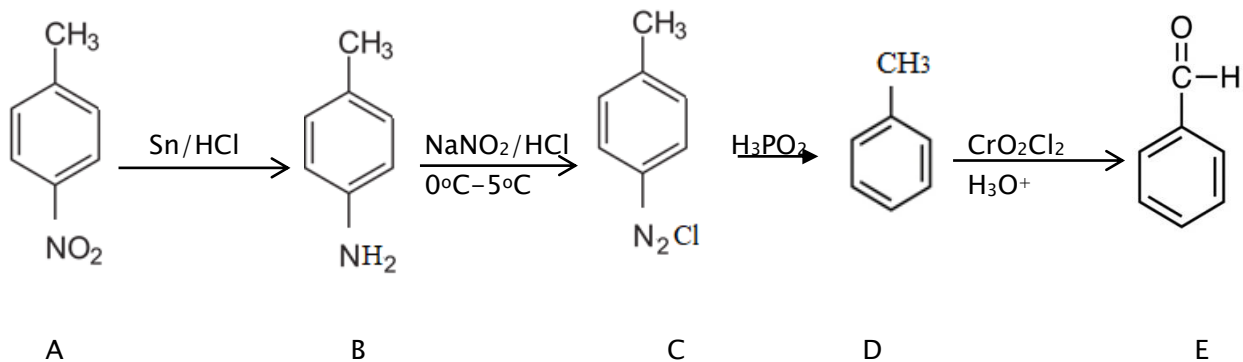
- (a) Negative Deviation is expected when phenol and aniline are mixed with each other. The net volume of the mixture will decrease,  $\Delta V < 0$  due to stronger intermolecular interactions. (1)



P-X Diagram for Solutions Showing Negative Deviation from Raoult's Law

- (1)
- (b) Relative lowering of vapour pressure =  $(P^\circ - P) / P^\circ = x_2$  (1/2)
- $$x_2 = n_2 / n_1$$
- $$n_2 = 0.1$$
- $$n_1 = 100/18$$
- $$x_2 = 0.1 / 5.55 + 0.1 = 0.1 / 5.65 = 0.018 \quad (1/2)$$
- $$P^\circ = 23.8 \text{ mm Hg}$$
- $$\text{Relative lowering of vapour pressure} = (23.80 - P) / 23.80 = 0.018 \quad (1/2)$$
- $$23.80 - P = 0.428 \quad (1/2)$$
- $$P = 23.80 - 0.428 = 23.37 \text{ mm Hg} \quad (1)$$

33. Compound "A" is p-methylnitrobenzene      Compound "B" is p-methylbenzenamine  
 Compound C is p-methylbenzenediazoniiumchloride      Compound D - Toluene  
 Compound E - Benzaldehyde  
 The chemical reactions involved are



( 1 mark for correct identification of A, 1 each for identification and reaction of formation of B,C,D and E from A)

OR

(a) (i) The hydrogen attached to N-Ethylbenzene sulphonamide is acidic in nature. This is due to the presence of strong electron withdrawing sulphonyl group. Hence, it is soluble in alkali. (1)

(ii) Reduction with iron scrap and hydrochloric acid is preferred because  $\text{FeCl}_2$  formed gets hydrolysed to release hydrochloric acid during the reaction. Thus, only a small amount of hydrochloric acid is required to initiate the reaction. (1)

(b) (i)  $\text{C}_6\text{H}_5\text{NH}_2 > \text{C}_6\text{H}_5\text{NHCH}_3 > \text{NH}_3 > \text{C}_6\text{H}_5\text{CH}_2\text{NH}_2 > \text{CH}_3\text{NH}_2$  (1)

(ii)  $\text{C}_2\text{H}_5\text{Cl} < \text{C}_2\text{H}_5\text{NH}_2 < \text{C}_2\text{H}_5\text{OH}$  (1)

(iii)  $\text{CH}_3\text{COOH} > \text{C}_2\text{H}_5\text{OH} > \text{CH}_3\text{NH}_2 > \text{CH}_3\text{OCH}_3$  (1)





