1.	В	6.	A	11.	D	16.	С	21.	D	26.	С
2.	С	7.	D	12.	A	17.	В	22.	В	27.	В
3.	В	8.	A	13.	D	18.	С	23.	С	28.	A
4.	С	9.	С	14.	D	19.	В	24.	С	29.	С
5.	С	10.	В	15.	В	20.	A	25.	D	30.	A

Answers to H1 Chemistry Prelims Paper 1

Suggested Answers to H1 Chemistry Prelims Paper 2

Section A

1. (a) Dot and cross diagram for hydrazine:



Shape of molecule: Trigonal pyramidal Bond angle of H–N–H: 107°

- (c) $NO_3^-(aq) + 4H^+(aq) + 3e^- \longrightarrow NO(g) + 2H_2O(l)$ $N_2H_4(l) \rightarrow N_2(g) + 4H^+(aq) + 4e^-$

Overall balanced equation: $4NO_3^{-}(aq) + 4H^+(aq) + 3N_2H_4(l) \longrightarrow 4NO(g) + 8H_2O(l) + 3N_2(g)$

- (d) Enthalpy change of reaction = [4(-394) + 12(-242)] - [5(-20) + 4(+53)]= $-4590 \text{ kJ mol}^{-1} (3 \text{ s.f.})$
- (e) Diphosphine molecules experience <u>permanent dipole-permanent dipole forces of</u> <u>interactions</u> whereas hydrazine molecules experience <u>intermolecular hydrogen</u> <u>bonding</u>. It requires more energy to overcome hydrogen bonding as compared to permanent dipole-permanent dipole forces of attraction.
- (f) Structure of carbonyl compound:



Type of reaction in Step I: condensation

 (a) (i) <u>Group I</u>. <u>Largest increase in energy to remove the second outermost electron</u>. <u>X could be potassium</u>.



- **3.** (a) *Standard enthalpy change of neutralisation* is the <u>heat change</u> when an amount of acid neutralises a base to <u>form 1 mole of water</u> (in dilute aqueous solution) at <u>298 K and 1 atmosphere pressure.</u>
 - (b) (i) Amount of $Ba(OH)_2$ added = $30.0 \times 10^{-3} \times 0.40$
 - = 0.012 mol
 - ... amount of OH⁻ added
 - = 2 x 0.012
 - = <u>0.024 mol</u>

Amount of H⁺ added

- = amount of HCl added
- $= 40.0 \times 10^{-3} \times 0.80$
- = <u>0.032 mol</u>
- \therefore HCl is in excess.

Amount of water formed from acid-base reaction = 0.024 mol

Heat evolved from reaction = $(30.0 + 40.0) \times 4.3 \times 4.0 = \underline{1204 \text{ J}}$ Enthalpy change of neutralisation

- $= -\frac{1204 \div 1000}{0.024} = -50.2 \text{ kJ mol}^{-1} \text{ (sign and correct units)}$
- (ii) <u>Heat energy was lost</u> during the experiment and hence, the experimental errors led to the difference in the calculated value from the theoretical value.
 - OR
 - The density of water is used as an approximate to the density of the solution.

• The specific heat capacity of the water is used as an approximate to the specific heat capacity of the solution.



- (ii) Enzymes are proteins which act as biological <u>catalysts</u> which speed up the reaction by <u>providing an alternative pathway that lowers the activation</u> <u>energy of the reaction</u> such that <u>more molecules now have energy</u> <u>greater than or equal to E_a ' (catalysed reaction).</u>
- **4.** (a) The C=C double bond <u>restricts free rotation about the double bond.</u> There are <u>2</u> <u>different adjacent groups attached to each of the doubly bonded carbon.</u>
 - (b) (i) Step I reduction





(iii) HCN is a weak acid which dissociates partially:

 $HCN(aq) \longrightarrow H^+(aq) + CN^-(aq)$

Adding a trace amount of base will remove H^+ and shifts the position of the equilibrium to the right to <u>increase the concentration of CN⁻</u>. The rate increases with increasing concentration of CN⁻.



(b)



Section B

6. (a) (i) Lattice energy of NaCl
=
$$\Delta H_1 - \Delta H_2 - \Delta H_3 - \Delta H_4 - \Delta H_5$$

= -776 - (109) - (244) - 494 - (-364)
= -1260 kJ mol⁻¹

(ii) ΔH_1 – Enthalpy change of formation of NaCl(s) ΔH_4 – First ionisation energy of Na(g)

(iii) Lattice energy $\propto \frac{q^+ \times q^-}{r_+ + r_-}$

The lattice energy of MgC l_2 will be <u>more exothermic</u> compared to that of NaCl. This is because the Mg²⁺ ion has a <u>higher charge and smaller ionic</u> <u>radius/ higher charge density</u> compared to Na⁺ ion.

(b) Empirical fomula of **P** is C_4H_9Br , since M_r is 136.9, the molecular fomula is C_4H_9Br .

Explanation:

- **P** reacts via <u>substitution</u> with aq. sodium hydroxide to give **Q**. **Q** is likely to be an <u>alcohol</u>.
- **Q** on oxidation gives **R**, which forms orange ppt with 2,4dinitrophenylhydrazine via <u>condensation</u>. **R** is a <u>carbonyl compound</u>.
- Positive iodoform test with Q and R. <u>Q has the structure –CH(OH)(CH₃)</u>



while R has the structure :

• P undergoes <u>elimination</u> with hot ethanolic NaOH to give V, W and X. V, W and X are likely to be <u>alkenes</u>.

Structure of **P**:

Structure of Q:

$$CH_3CH_2$$
 — CH — CH_3
|
OH

Structure of R:

$$CH_3CH_2 - C - CH_3$$

Structure of V, W and X:



(c) (i) <u>Test:</u> Add acidified KMnO₄ to both compounds and heat. Bubble any gas evolved into Ca(OH)₂(aq).
 Observations:



will produce CO_2 gas which gives a white ppt with $Ca(OH)_2(aq)$.

(ii) <u>Test:</u> Add aqueous alkaline iodine to both compounds and heat. <u>Observations:</u>



will give a yellow ppt with aqueous alkaline iodine.

7. (a) (i) Weak acids dissociate partially in water.

(ii)
$$K_a = \frac{[\text{HCO}_3^-(aq)][\text{H}^+(aq)]}{[\text{H}_2\text{CO}_3(aq)]}$$
; mol dm⁻³

(iii) Addition of
$$H^+$$
:
 $HCO_3^- + H^+ \longrightarrow H_2CO_3$

Addition of OH⁻: $H_2CO_3 + OH^- \longrightarrow HCO_3^- + H_2O$ With a large reservoir of H_2CO_3 and HCO_3^- present, since the amount of H^+ and OH^- added is small, there will be insignificant changes in $[H_2CO_3]$ and $[HCO_3^-]$.

Hence pH is maintained.

- (v) <u>Yes.</u> K_c changes with temperature and an increase in temperature will cause the <u>position of the equilibrium to shift</u>, therefore changing the concentrations of the ratio of hydrogen carbonate ion and carbonic acid in plasma.
- (b) (i) The melting points from Na to Al are <u>high due to their giant metallic</u> <u>structures and melting involves overcoming strong metallic bonds. The melting point increases from Na to Al</u> as the strength of the metallic bond increases from Na to Al due to <u>an increasing number of mobile valence electrons used in bonding.</u>

Si has the highest melting point due to its <u>giant molecular structure</u>. A large amount of energy is required to break the <u>strong covalent bonds [1]</u> in Si.

 P_4 , S_8 , Cl_2 and Ar have <u>lower melting points since they are simple</u> <u>molecules with weak van der Waals' forces</u> between molecules. The strength of the van der Waals' forces increases with the size of the <u>electron cloud in the order of Ar</u>, Cl_2 , P_4 , S_8 .

(ii) Ga_2O_3 has a giant ionic structure. Ga_2O_3 is amphoteric.

 $\begin{aligned} &\mathsf{Ga}_2\mathsf{O}_3(s) + 6\mathsf{HC}l(\mathsf{aq}) \to 2\mathsf{GaC}l_3(\mathsf{aq}) + 3\mathsf{H}_2\mathsf{O}(l) \\ &\mathsf{Ga}_2\mathsf{O}_3(s) + 2\mathsf{NaOH}(\mathsf{aq}) + 3\mathsf{H}_2\mathsf{O}(l) \to 2\mathsf{NaGa}(\mathsf{OH})_4(\mathsf{aq}) \end{aligned}$

(c) No. of mol of Cl atoms in MCl_3

= No. of mol of AgCl formed
=
$$\frac{33.00}{1000} \times 0.0500$$

= $\frac{1.65 \times 10^{-3} \text{ mol}}{\text{No. of mol of MC}l_3 \text{ used}}$
= $\frac{1}{3} \times \text{No. of mol of AgC}l$
= $\frac{1}{3} \times 1.65 \times 10^{-3}$

= 5.50×10^{-4} Molar mass of MC l_3 = 0.100/5.50 x 10⁻⁴ = 181.8 g mol⁻¹ A_r of M = 181.8 - 3(35.5) = 75.3 = 75 (to nearest whole number) M is As (arsenic)

(a) (i) Substitution

Reagents & conditions required: <u>aqueous</u> KOH, heating.

(ii)

$$CH_{3}CH_{2}Cl \xrightarrow{\text{Ethanolic KCN}} CH_{3}CH_{2}CN \xrightarrow{\text{Dil. } H_{2}SO_{4}} CH_{3}CH_{2}COOH$$

(iii) CH₃CH₂COOCH₂CH₃ Reagents and conditions required: Conc. H₂SO₄, heat.

(iv) $CH_3CH_2OH \Longrightarrow CH_3CH_2O^- + H^+$ $CH_3CH_2COOH \Longrightarrow CH_3CH_2COO^- + H^+$

> Propanoic acid dissociates in aqueous solution to form the <u>propanoate</u> ion, which is resonance stabilised, compared to the ethoxide ion formed from the dissociation of ethanol, <u>which has a negative charge localised</u> on the O⁻ ion.

Hence propanoic acid is more acidic than ethanol.

- (b) (i) Refrigerants / aerosol propellants / fire extinguisher
 - (ii) The C–F bond is stronger as the <u>fluorine orbital is smaller in size</u> than chlorine orbital, resulting in <u>a more effective overlap of orbitals.</u>
 - (iii) Chlorine atoms are <u>not used up</u> in these reactions (chlorine atoms do not appear in the net reaction / are <u>regenerated</u>).
 OR
 Chlorine radicals <u>react with ozone</u> to destroy the ozone layer.

8. (



First order with respect to benzenediazonium chloride.

- (ii) Water is present in <u>large excess</u> and will appear to be zero order with respect to the reaction.
- (iii) Amount of nitrogen evolved

 $=\frac{220}{24000}=\underline{9.167\times10^{-3}\text{ mol}}$

Mass of benzenediazonium chloride required = $9.167 \times 10^{-3} \times 141.5 = 1.30$ g