Question 1

(a)

 $Na_2CO_3 + 2HCl \longrightarrow 2NaCl + CO_2 + H_2O$

(b)

No. of moles of HCl = $(20/1000) \times 0.2 = 0.004$ Thus, No. of moles of Na₂CO₃= 0.004 / 2 = 0.002 Therefore, Concentration of Na₂CO₃ in moldm⁻³ = 0.002 x (1000/25) = 0.08 moldm⁻³ Concentration of Na₂CO₃ in gdm⁻³ = 0.08 x 106 = 8.48gdm⁻³

(c)

Concentration of hydrated sodium carbonate in gdm⁻³ = 5 x (1000/25) = 20gdm⁻³

Thus,

Mass of water of crystallization present in 1dm^3 of the hydrated sodium carbonate solution = 20 - 8.48 = 11.52g No of moles of water = 11.52 / 18 = 0.64Therefore, x = 0.64 / 0.08 = 8

Question 2

(a) (i) C1: sp^2 C2: sp^3

(ii)	Carbon	Shape	Bond angle
	C1	Trigonal planar	120°
	C2	tetrahedral	109°

Question 3

(a) (i) In water, ethanoic acid molecules form intermolecular hydrogen bonds with water molecules and exist as CH₃CO₂H. Hence its M_r is 60.

In a non-aqueous solvent, hexane, the id-id interactions between ethanoic acid and hexane is weaker so ethanoic acid molecules dimerise by forming stronger intermolecular hydrogen bonds with ethanoic acid molecules. Hence its M_r is twice that of CH_3CO_2H and becomes 120.



(b)

- 12 electrons around lodine
- n = 1
- Oxidation no. of lodine = +3

Question 4

(iii)



 $\Delta H_{reaction} = -395.4 - (-109 - 283)$ $= -3.4 \text{ kJ mol}^{-1}$

C(diamond)

- (b) The structure of graphite has more disorderliness due to the presence of delocalized electrons between the planes. Diamond has a giant covalent structure where the carbon atoms are bonded to each other in the lattice.
- (C) **Since** $\Delta S > 0$, hence $T\Delta S$ is always positive.

 $\Delta G = \Delta H$ - T ΔS will always be negative.

Hence, since $\Delta G < 0$ at all temperatures, the conversion is spontaneous -395.4 kJ mat all temperatures.

Energy (d)



Progress of reaction

- Label energy terms (both E_a and ΔH) √
- \checkmark Label diamond and graphite on the curve.

Question 5

(a) (i) Electrode A: $Pb(s) \rightarrow Pb^{2+}(aq) + 2e$

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Electrode B: Pb^{2+}(aq) + 2e \rightarrow Pb(s)
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Electrode C: 2Br(aq) \rightarrow Br_2(aq) + 2e
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- Electrode **D**: $2H_2O(I) + 2e \rightarrow H_2(g) + 2OH^{-}(aq)$ or $2H^{+}(aq) + 2e \rightarrow H_2(g)$
- (ii) No of moles of X = $1/119 = 8.40 \times 10^{-3}$ mol 3240 C gives 8.40×10^{-3} mol of X 3240/8.40 x $10^{-3} = 385560$ C of electricity gives 1 mol of X 385560/96500 = 4 F gives 1 mol of X n = 4

Question 6

Ca(OH)₂ (s) -s Ca²⁺ (aq) + 2OH⁻ (aq) + s + 2s

- (a) Ksp = $s(2s)^2 = 4s^3 = 1.0 \times 10^{-12}$ s= 6.30 x 10⁻⁵, solubility in water is 6.30 x 10⁻⁵ mol dm⁻³.
- (b) $[Ca^{2+}] = (0.10 + s)$ [OH] = 2s $Ksp = (0.10 + s)(2s)^2$ $1.1 \times 10^{-12} = (0.10 + s)(2s)^2$ $s = 1.58 \times 10^{-6} \text{ mol dm}^{-3}$
- (c) $[Ca^{2+}] = 1x10^{-3}/2 = 0.5 \times 10^{-3} \text{ mol dm}^{-3}$ $[OH^{-}] = 2 \times 2 \times 10^{-3} / 2 = 2 \times 10^{-3} \text{ mol dm}^{-3}$ Ionic product = $0.5 \times 10^{-3} \times (2 \times 10^{-3})^2 = 2 \times 10^{-9} \text{ mol}^3 \text{ dm}^{-9} > \text{Ksp}$ Hence, precipitation takes place.

Question 7

(a) From data booklet, atomic size: F 0.072 nm ;

Cl: 0.099 nm ; Br : 0.114 nm ; l : 0.133 nm

As size of halogen atom increases down the group, the bond length of H - X

increases/effectiveness of overlap of orbitals decreases. Bond energy of $\rm H-X$ decreases and ease of decomposition of

HX increases.

Or

From data booklet: Bond energy values: H – F : 562

kJ mol⁻¹; H – Cl : 431 kJ mol⁻¹ ; Br : 366 kJ mol⁻¹ and H – I : 299 kJ mol⁻¹

As the bond energy of H - X decreases down the group, the ease of decomposition of

HX increases. The bond energy decreases down the group as the atomic size of halogen atoms increases and H - X bond length increases.

- (b) (i) $2 \text{HBr} + \text{H}_2\text{SO}_4 \rightarrow \text{SO}_2 + \text{Br}_2 + 2\text{H}_2\text{O}$
 - (ii) HI is a stronger reducing agent than HBr
 It is able to reduce S from oxidation state +6 (in H₂SO₄) to -2 (in H₂S).
 HBr is only able to reduce S to +4 oxidation state (in SO₂)

Question 8





(b) (ii) Stage I:

Reagent and Condition: NH(CH₂CH₃)₂, heat

(c) (i) Reagent and condition: any acid except HNO₃ OR hot acidified KMnO₄ OR Br₂ with halogen carrier, heat Observation: miscible layer OR purple KMnO₄ decolourise OR brown Br₂ decolourise (ii) Reagent and condition: aqueous bromine, room temperature/heat OR acid chloride Observation: Procaine decolourises brown bromine with formation of white ppt. OR white fumes



[3] [Total: 13]

Question 9

- (a) VAL-CYS-ASP-LYS-GLY-CYS-LYS-VAL-ARG
- (b) The cool environment prevent the denaturation of protein insulin by heat which will disrupt side chain interactions in the tertiary structure of protein causing the protein to lose its native conformation/3D structure/coagulation.

(c)





[Total: 7]