

Name of the Student: _____

Max. Marks : 26 Marks

Time : 26 Minutes

Mark Schemes

Q1.

- (a) Enthalpy change /
- ΔH
- when 1 mol of a gaseous ion

Enthalpy change for $X^{+/-}(g) \rightarrow X^{+/-}(aq)$ scores M1 and M2

1

forms aqueous ions

*Allow heat energy change instead of enthalpy change**Allow 1 mol applied to aqueous or gaseous ions**If substance / atoms in M1 CE = 0**If wrong process (eg boiling) CE = 0*

1

- (b)
- $\Delta H(\text{solution}) = \Delta H(\text{lattice}) + \sum(\Delta H_{\text{hydration}})$

OR $+77 = +905 - 464 + \Delta H(\text{hydration, Cl}^-)$ OR $\Delta H(\text{hydration, Cl}^-) = +77 - 905 + 464$ *Allow any one of these three for M1 even if one is incorrect*

1

 $= -364 \text{ (kJ mol}^{-1}\text{)}$ *Allow no units, penalise incorrect units, allow kJ mol⁻¹**Allow lower case j for J (Joules)**+364 does not score M2 but look back for correct M1*

1

- (c) Water is polar / water has
- $\text{H}\delta^+$

1

(Chloride ion) attracts (the H in) water molecules

(note chloride ion can be implied from the question stem)

*Idea that there is a force of attraction between the chloride ion and water**Do not allow H bonds / dipole–dipole / vdW / intermolecular but ignore loose mention of bonding**Do not allow just chlorine or chlorine atoms / ion**Mark independently*

1

- (d)
- $\Delta G = \Delta H - T\Delta S$

Look for this equation in part (d) and / or (e); equation can be stated or implied by correct use. Record the mark in part (d)

$$(\Delta G = 0 \text{ so}) T = \Delta H / \Delta S$$

1

$$T = 77 \times 1000 / 33 = 2333 \text{ K (allow range 2300 to 2333.3)}$$

Units essential, allow lower case k for K (Kelvin)

Correct answer with units scores M1, M2 and M3

2.3 (K) scores M1 and M2 but not M3

1

Above the boiling point of water (therefore too high to be sensible) / water would evaporate

Can only score this mark if M3 > 373 K

1

1

(e) $\Delta S = (\Delta H - \Delta G) / T$ OR $\Delta S = (\Delta G - \Delta H) / -T$

1

$$= ((-15 + 9) \times 1000) / 298 \text{ OR } (-15 + 9) / 298$$

1

$$= -20 \text{ J K}^{-1} \text{ mol}^{-1} \quad \text{OR} \quad -0.020 \text{ kJ K}^{-1} \text{ mol}^{-1}$$

(allow -20 to -20.2) (allow -0.020 to -0.0202)

Answer with units must be linked to correct M2

For M3, units must be correct

Correct answer with appropriate units scores M1, M2 and M3 and possibly M1 in part (d) if not already given

Correct answer without units scores M1 and M2 and possibly M1 in part (d) if not already given

Answer of -240 / -0.24 means temperature of 25 used instead of 298 so scores M1 only

If ans = +20 / +0.020 assume AE and look back to see if M1 and possibly M2 are scored

1

[13]

Q2.

- (a) Chloride (ions) are smaller (than bromide ions)

Must state or imply ions.

Allow chloride has greater charge density (than bromide).

Penalise chlorine ions once only (max 2 / 3).

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So the force of attraction between chloride ions and water is stronger

This can be implied from M1 and M3 but do not allow intermolecular forces.

1

Chloride ions attract the $\delta+$ on H of water / electron deficient H on water

Allow attraction between ions and polar / dipole water.

*Penalise H^+ (ions) and mention of hydrogen bonding for **M3***

Ignore any reference to electronegativity.

Note: If water not mentioned can score M1 only.

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- (b) $\Delta H_{\text{solution}} = \Delta H_L + \Delta H_{\text{hyd}} K^+ \text{ ions} + \Delta H_{\text{hyd}} Br^- \text{ ions} / = 670 - 322 - 335$

Allow $\Delta H_{\text{solution}} = \Delta H_L + \Sigma \Delta H_{\text{hyd}}$

1

$= (+)13 \text{ (kJ mol}^{-1}\text{)}$

Ignore units even if incorrect.

+13 scores M1 and M2

-13 scores 0

-16 scores M2 only (transcription error).

1

- (c) (i) The entropy change is positive / entropy increases

ΔS is negative loses M1 and M3

1

Because 1 mol (solid) $\rightarrow$ 2 mol (aqueous ions) / no of particles increases

Allow the aqueous ions are more disordered (than the solid).

Mention of atoms / molecules loses M2

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Therefore $T\Delta S > \Delta H$

1

- (ii) Amount of KCl = $5/M_r = 5/74.6 = 0.067(0) \text{ mol}$

If moles of KCl not worked out can score M3, M4 only (answer to M4 likely to be 205.7 K)

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Heat absorbed = $17.2 \times 0.0670 = 1.153 \text{ kJ}$

Process mark for M1 $\times 17.2$

1

Heat absorbed = $\text{mass} \times \text{sp ht} \times \Delta T$

$(1.153 \times 1000) = 20 \times 4.18 \times \Delta T$

If calculation uses 25 g not 20, lose M3 only (M4 = 11.04, M5 = 287)

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$$\Delta T = 1.153 \times 1000 / (20 \times 4.18) = 13.8 \text{ K}$$

If 1000 not used, can only score M1, M2, M3

M4 is for a correct ΔT

Note that 311.8 K scores 4 (M1, M2, M3, M4).

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$$T = 298 - 13.8 = 284(.2) \text{ K}$$

If final temperature is negative, M5 = 0

Allow no units for final temp, penalise wrong units.

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