



Name \_\_\_\_\_ Class: \_\_\_\_\_

Start Time \_\_\_\_\_ End Time \_\_\_\_\_ Time Taken \_\_\_\_\_

**Time allowed: 62 minutes****INSTRUCTIONS TO CANDIDATES**

- This document is designed to be used as a practice test.
- Complete the test under exam conditions in one sitting.
- Optional: Before marking it, go through the paper with a set of notes and improve your answers.
- Mark the test using the mark scheme make corrections on the paper.
- Complete the table on the front page.
- Improve your notes so that they better reflect your weaknesses.
- Make a note of your strengths and weaknesses for future revision.

Success Criteria	Questions in Paper	Mark	Out of	%	Rank Order
Hess's law	1ai part 1		3		
Calorimetry	1ciii		5		
Bond enthalpy	1a-b		4		
Electron affinity	1c		1		
Born Haber Cycles – Drawing them	1di		3		
Born Haber Cycles – Calculations	1bii		2		
Perfect Ionic Model Vs Covalent Character	1e		6		
General Enthalpy Understanding	2a-b, 2d		4		
Enthalpy of Hydration – Theory	3a		3		
Enthalpy of Hydration – Calculations	3b		2		
Entropy Changes – Theory	3ci		3		
Entropy Calculations	4ai Part 2		3		
Gibbs Free Energy Calculations	2c, 4aii, 4b, 4c, 5a		13		
Gibbs Free Energy Graphs	5b, 5c, 5d		6		
General Chemistry	2e		2		
<b>Total</b>			60		



## Q1.

(a) 242

*Units not essential*

1

(b) Bond is shorter or bonding pair closer to nucleus

*Allow Cl is a smaller atom**Allow fewer electron shells**do not allow smaller molecules*

1

So attraction (between nucleus and) (to) bond pair is stronger

*Allow shared pair (or bonding electrons) held more tightly**Mention of Cl<sup>-</sup> loses M2*

1

(c) Net attraction between the chlorine nucleus and the extra electron

*Allow Cl<sup>-</sup> ion more stable than Cl*

1

(d) (i) step 1  $\text{Ag(s)} \rightarrow \text{Ag(g)}$  only change

1

step 2  $\text{Ag(s)} \rightarrow \text{Ag}^{\text{(g)}} + \text{e}^-$  only change

1

step 3  $\frac{1}{2}\text{Cl}_2\text{(g)} \rightarrow \text{Cl(g)}$  only change*This step can be first, second or third*

1

(ii)  $127 + 289 + 732 + 121 - 364$ 

1

 $= 905 \text{ kJ mol}^{-1}$ *-905 scores 1 mark only*

1

(e) (i) Ions can be regarded as point charges (or perfect spheres)

*Allow no polarisation***OR** *only bonding is ionic***OR** *no covalent character*

1

(ii) Greater

*Electronegativity argument or mention of intermolecular,**CE = 0*

1

Chloride ions are smaller than bromide*Mark independently but see above*

1

They are attracted more strongly to the silver ions

*Mark independently*



(iii) AgCl has covalent character

*Ignore reference to molecules*

Forces in the lattice are stronger than pure ionic attractions

*Allow stronger bonding OR additional/extra bonding*

1

1

1

[15]

## Q2.

(a) Standard pressure (100 kPa) (and a stated temperature)

*Allow standard conditions. Do not allow standard states*

*Allow any temperature*

*Allow 1 bar but not 1atm*

*Apply list principle if extra wrong conditions given*

*Penalise reference to concentrations*

1

(b) Hydrogen bonds between water molecules

1

Energy must be supplied in order to break (or loosen) them

*Allow M2 if intermolecular forces mentioned*

*Otherwise cannot score M2*

*CE = 0/2 if covalent or ionic bonds broken*

1

(c)  $T = \Delta H / \Delta S$

1

$$= (6.03 \times 1000) / 22.1$$

1

$$= 273 \text{ K}$$

*Allow 272 to 273; units K must be given*

*Allow 0°C if units given*

*0.273 (with or without units) scores 1/3 only*

*Must score M2 in order to score M3*

*Negative temperature can score M1 only*

1

(d) The heat given out escapes

1

(e) (Red end of white) light (in visible spectrum) absorbed by ice

*Allow complementary colour to blue absorbed*

1

Blue light / observed light is reflected / transmitted / left

*Penalise emission of blue light*

1



## Q3.

- (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).*

1

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.*

1

- (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 (kJ mol<sup>-1</sup>)

*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

*$\Delta S$  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*

1

Therefore  $T\Delta S > \Delta H$

1

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

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

1

Heat absorbed =  $17.2 \times 0.0670 = 1.153$  kJ



Process mark for M1 × 17.2

1

Heat absorbed = mass × sp ht × ΔT

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

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

1

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

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).

1

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

If final temperature is negative, M5 = 0

Allow no units for final temp, penalise wrong units.

1

[13]

#### Q4.

- (a) (i) **Standard enthalpy change:**  
 $\Delta H_R = \Sigma \Delta H_f(\text{products}) - \Sigma \Delta H_f(\text{reactants})$  (1)  
 or cycle

$$\Delta H_R = ([2 \times 0] + [3 \times -393.5]) - (-824.2 + [3 \times -110.5])$$
 (1)  
 $= -24.8 \text{ (kJ mol}^{-1}\text{)}$  (1)

Allow + 24.8 max one

**Standard entropy change:**  $\Delta S = \Sigma S(\text{products}) - \Sigma S(\text{reactants})$  (1)

$$\Delta S = ([2 \times 27.3] + [3 \times 213.6]) - (87.4 + [3 \times 197.6])$$
 (1)  
 $= (54.6 + 640.8) - (87.4 + 592.8)$  (1)  
 $= 15.2 \text{ (JK}^{-1}\text{mol}^{-1}\text{)}$  (1)

Allow -15.2 max one

- (ii)  $\Delta G = \Delta H - T\Delta S$  (1)  
 $\Delta H$  negative and  $-T\Delta S$  is negative (or  $\Delta S$  positive or  
 or correct calc) (1)  
 Hence  $\Delta G$  is always negative  
 (or feasible when  $\Delta G \leq 0$ ) (1)

9

- (b)  $\Delta G = 0 = \Delta H - T\Delta S$  Hence  $\Delta H = T\Delta S$  (1)  
 $T = \Delta H / \Delta S = 492.7 \times 1000 / 542.6$  (1)  
 $= 908 \text{ K}$  (1)  
 penalise missing 1000 by one mark

3

- (c)  $\Delta G(b) = \Delta G(a)$   
 $(492.7 \times 10^3 - T \times 542.6) = (-24.8 \times 10^3 - T \times 15.2)$  (1)



$$517.5 \times 10^3 = 527.4 T \text{ (1)}$$

$$T = 981.2 \text{ K(1)}$$

Allow 980 - 982

Penalise missing 1000 by one mark

3

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**Q5.**

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

Ignore e

1

(b) 0.098 or 98

Allow 0.097 to 0.099/97 to 99

Allow 0.1 only if 0.098 shown in working

1

$\text{kJ K}^{-1} \text{ mol}^{-1}$

$\text{J K}^{-1} \text{ mol}^{-1}$

Allow in any order

Unless slope is approx. 100(90-110) accept only  $\text{kJ K}^{-1} \text{ mol}^{-1}$ . If no slope value given, allow either units

1

$-\Delta S/\Delta S$

1

(c)  $\Delta G$  becomes negative

Mark independently unless  $\Delta G$  +ve then  $CE = 0$

1

So reaction becomes spontaneous/feasible

Or reaction can occur below this temperature

Or reaction is not feasible above this temperature

1

(d) Ammonia liquefies (so entropy data wrong/different)

Allow any mention of change in state or implied change in state even if incorrect

eg freezing/boiling

1

[7]