A Level OCR Chemistry
Chapter 17 – answers

Question	Answers	Extra information	Mark	AO Spec reference
1(a)	The energy/enthalpy change when **1 mole** **gaseous** atoms Gain **1 mole of electrons** Under standard conditions		1 1 1	5.2.1 AO1
1(b)	Born-Haber cycle. 2nd E_a O = 602 + 148 + 738 + 1450 + 249 – 141 – 3890 = + 844 kJ mol^{-1}	**1** mark for each correct step	6 1 1	5.2.1 AO2
1(c)	Electrons are attracted to nucleus Energy needs to be put in to overcome this attraction/force/bond		1 1	5.2.1 AO3
2(a)	The enthalpy/energy change when **1 mole** Of **gaseous atoms** Is formed under standard conditions		1 1 1	5.2.1 AO1
2(b)	ΔH = 164 + 549 + 1064 + (2 × 243) – (2 × 349) – 2150 = –585 kJmol^{-1}	Allow correct Born–Haber cycle	1 1	5.2.1 AO2
2(c)	Removing an electron from a positive ion More energy required to overcome attraction	Allow reference to smaller radius/ size	1 1	5.2.1 AO3
2(d)	Bond enthalpy results in 2 moles of Cl atoms being formed So double the atomisation by definition	Allow both correct definitions	1 1	5.2.1 AO3
3(a)	The enthalpy/energy change when one mole of **solid ionic** compound is **formed** From its constituent ions in the gas state. Under standard conditions		1 1 1	5.2.1 AO1

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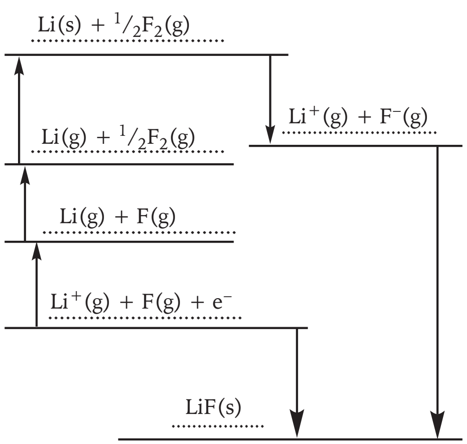
3(b)(i)		Must have state symbols Do not accept multiples	4	5.2.1 AO1
3(b)(ii)	−616 − 159 − 520 − 79 + 328 = −1046 −1046	 Must have − sign for second mark	1 1	5.2.1 AO2 MS2.4
4(a)	The enthalpy/energy change when <u>1 mole</u> of <u>gaseous ions</u> Are completed surrounded by water To create an infinitely dilute solution	 Allow reference to ions "no longer interacting/influencing each other" or WTTE	1 1 1	5.2.1 AO1
4(b)	Copper and sulphate don't exist in the gas state / impossible to measure Temperature change		1 1	5.2.1 AO3

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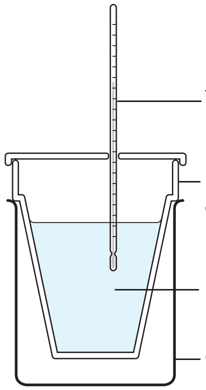
<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO
Spec reference</th></tr>
<tr><td>4(c)(i)</td><td>
</td><td></td><td>2</td><td>5.2.1
AO3</td></tr>
<tr><td>4(c)(ii)</td><td>This question is marked using Levels of Response.
Examiners should apply a ‘best-fit’ approach to the marking.

Level 3 5–6 marks: All stages are covered and the explanation of each stage is generally correct and virtually complete.
Answer is communicated coherently and shows a logical progression from stage 1 to stage 2, stage 3 and then stage 4.
Coherent communication where each stageeis explained

Level 2 3–4 marks: All stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies
OR two stages are covered and the explanations are generally correct and virtually complete.
Answer is mainly coherent and shows some progression from stage 1 to stage 2, stage 3 and then stage 4.</td><td>Partially complete means ¾ of stage met</td><td>6</td><td>5.2.1
AO3</td></tr>
</table>

Question	Answers	Extra information	Mark	AO Spec reference
	<table><tr><td>Level 1 1–2 marks</td><td>Two stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies OR only one stage is covered but the explanation is generally correct and virtually complete. Answer shows some progression between two stages</td></tr><tr><td>Level 0 0 marks</td><td>Insufficient correct chemistry to gain a mark.</td></tr></table>	**Indicative content** **Stage 1:** Measuring out the copper sulfate and water 1a: uses suitable equipment (scales balance) 1b: uses named suitable mass (between 2–8 g) of both salts 1c: evidence of weigh reweigh technique to determine mass of salt delivered 1d: Known volume of water measured using suitable equipment (measuring cylinder/ pippette) **Stage 2:** Determining both enthalpies 2a: simple calorimeter set up (polystyrene cupand lid) 2b: basic method of measuring starting temperature (with thermometer) over time (min 3 mins) then adding and recording the temperature for a time after (min 4 mins) 2c: acknowledgement that when salt is added temperature should not be recorded 2d: Graphical determination of instantaneous temperature rise by extrapolation		

Question	Answers	Extra information	Mark	AO Spec reference
		Stage 3: Calcualting ΔH 3a: use of $q = mc\theta$ or equivalent 3b: use of M_r to find moles and hence ΔH_1 and ΔH_2 3c: Use of hess cycle or $\Delta H_1 - \Delta H_2$		
4(d)	(−2099) + (−1080) −(−67) = −3112 kJ mol^{-1}	Allow correct cycle or diagram +3112 scores **1** mark	2	5.2.1 AO2 MS2.4
5(a)	The measure of disorder of a system	Reject 'chaos'	1	5.2.2 AO1
5(b)(i)	Enthalpy change = $\Sigma\Delta_f H$ products − $\Sigma\Delta_f H$ reactants = (−709 + −394 + −286) − (−483 + −951) = 45 kJmol^{-1} Entropy change = ΣSproducts − ΣSreactants = (175 + 214 + 70) – (158 + 102) = 199 J mol^{-1} $\Delta G = \Delta H - T\Delta S$ OR 0 = 45000 − 199T T > 45 000/199 = 226 K	**2** marks for ΔH **2** marks for ΔS **2** marks for use of Gibbs equation Allow correct cycle Answer of 225 °C scores only **5**	1 1 1 1 1 1	5.2.2 AO2 MS2.2,2.3,2.4
5(b)(ii)	Temperature way below freezing. Ethanoic acid will be solid / energy lower than activation energy	Ignore references to water being ice unless specifically referenced in terms of solution	1	5.2.2 AO3

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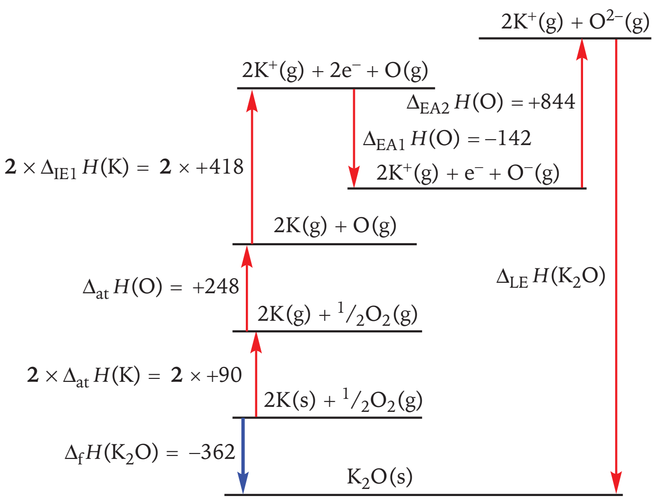
6(a)	 $\Delta_{LF}H = -362 + (2x - 90) + (2x - 418) + -248 - (-142) + -844$ $= -2328$ kJ mol^{-1}	**1** mark is for overall shape **2** mark is for correct equations **3** mark is for doubling K equations 23588 scores all **6** marks only if accompanied by a correct cycle. Without cycle max score is **3** Do not penalise scale of lines on Born-Haber cycle An answer of 1850 with cycle scores **3** marks	6	5.2.1 MS2.4 AO2
6(b)(i)	Oxygen is a gas so more disordered / gas more disordered than solid		1	5.2.2 AO3

Question	Answers	Extra information	Mark	AO Spec reference
6(b)(ii)	$\Delta G = \Delta H - T\Delta S$ ΔS = 94 – (2 × 67) – (205/2) = –142.5 J mol^{-1} T = 573 ΔG = –362 – (573 × –0.1425) OR –362×10^3 – 573 × –142.5 = –280 kJ mol^{-1} OR –280×10^3 J mol^{-1} Reaction is feasible/spontaneous as ΔG is less than 0		1 1 1 1 1 1	5.2.2 AO2 MS2.1,2.2,2.3,2.4
7(a)	Correct axis (T is x-axis Gibbs is y-axis) labelled Suitable scale (plotted points should take up over half the paper) Points plotted accurately Read off temperature from line Temperature = 1112 K	Allow 1 point plotted outside 1 mm Allow 1110–1120 K	1 1 1 1 1	5.2.2 MS3.3
7(b)	$PV = nRT$ $n = PV/RT$ $n = \frac{100000 \times 0.5}{8.31 \times 298}$ = 20.2 moles mass = 100.1 × 20.2 = 2021 g	Accept 2.022 kg	1 1 1 1	2.1.3 AO2 MS2.2,2.3,2.4
7(c)	$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(s)$		1	2.1.2 AO1
7(d)	M_r $Ca(OH)_2$ = 40.1 + (2 × 17) = 74.1 2.28/74.1 = 0.308 moles Moles H_2SO_4 = 0.308 as 1:1 Concentration = 0.0308/0.5 = 0.0616		1 1 1 1	2.1.3 AO1 MS0.2

OXFORD Revise

Question	Answers	Extra information	Mark	AO Spec reference
7(e)	pH = −log (0.0616 × 2) = 0.91	Must be 2 dp.	1	5.1.3 MS0.4,2.5 AO2
8(a)	Because it is an element		1	3.2.1 AO1
8(b)	$\Delta_r H = \Sigma\Delta_f H$ (products) – $\Sigma\Delta_f H$(reactants) ΔH = −111 – (−75 – 242) (+) 206 (kJ mol^{-1}) $\Delta S = \Sigma S$(products) – ΣS(reactants) ΔS = 3 × 131 + 198 – (186 + 189) (+) 216 J K^{-1} mol^{-1} ($\Delta G = \Delta H - T\Delta S$) = 206 – (973 × 0.216) OR 206×10^3 – (973 × 216) −4.168 kJ mol^{-1} OR −4168 J mol^{-1} Reaction is feasible as $\Delta G \leq 0$	**2** marks for ΔH **2** marks for ΔS **2** marks for Gibbs equation including unit conversions **1** mark for valid comment	2 2 2 1	5.2.2 AO2 MS3.3

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8(d)	Moles steam = 2.70 Moles CO = 1.30 Moles H_2 = 3.90 Mole fractions CH_4 = 0.7 / 8.6 = 0.0814 H_2O = 2.7 / 8.6 = 0.314 CO = 1.3 / 8.6 = 0.151 H_2 = 3.9 / 8.6 = 0.453 Partial pressures CH_4 = 0.0814 × 300 = 24.4 H_2O = 0.314 × 300 = 94.2 CO = 0.151 × 300 = 45.3 H_2 = 0.453 × 300 = 136 $K_p = \frac{p_{CO} \times p_{H_2}^3}{p_{CH_4} \times p_{H_2O}}$ $= \frac{45.3 \times 136^3}{24.4 \times 94.2}$ kPa^2		1 1 1 1 1 1 1 1	5.1.2 AO2 MS1.1,2.2,2.3

Skills box answers:

a) Units of k = $dm^3\ mol^{-1}\ s^{-1}$
b) Units of K_c = $mol\ dm^{-3}$
c) Units of K_p = Pa
d) Units of k = $dm^6\ mol^{-2}\ s^{-1}$
e) Units of K_c = $mol^3\ dm^{-9}$
f) Units of K_p = Pa^3