OXFORD
INTERNATIONAL
AQA EXAMINATIONS

INTERNATIONAL AS LEVEL CHEMISTRY

(CH01)

Unit 1: Inorganic 1 and Physical 1

Example responses with commentary

For teaching from September 2016 onwards
For AS exams in May/June 2018 onwards

This guide includes some examples of student responses to a selection of questions from the summer 2018 CH01 unit.

The question parts are reproduced, along with the final mark scheme, student responses and a commentary from the Lead Examiner on each of the students' answers.

Both teachers and students are encouraged to look at the published mark schemes and examiners reports after each examination series.

'Command' words (eg calculate, state, describe, identify) appear at the start of a sentence so students are in no doubt what is required in answering each question. To help students the answer space is often structured to help them e.g. if they are asked to 'identify a reagent...' and 'state what you observe...', then there will be one answer line for them to write their reagent and then one line for each observation.

Students should be aware that the number of marks awarded indicates the number of points required in their response. If there are several marks available then the first marking point in the mark scheme is M1. Any ideas 'underlined' in the mark scheme are essential to gain credit (although on occasions students can express these ideas in 'their own words').

Students should be aware that any contradiction in their answer is treated using a '**list'** principle (refer to published mark scheme, page 3, section 3.1 Marking of lists). For example, if the student had stated that the effect is 'decrease' and had also written that the amount increases, then the examiner is likely to view this as one correct point and one incorrect, and is unable to award any marks.

Students should note that provided their answers are legible, they are awarded credit for correct chemistry. If a student wishes to change their first answer then this should be clearly crossed out. If they do not and write a different answer then the 'list principle' will be applied and zero marks will be scored. Do ensure that any working or alternative answers are clearly crossed out!

In calculations students should show what they are calculating in each step. Students should know how many significant figures they should use in their answer; 3 sig. fig. is standard practice. However, there are occasions when some other precision is required eg A_r and M_r must be stated to one decimal place, pH readings to two decimal places or when students are asked otherwise eg 'Give' your answer to the nearest whole number.

Oxford AQA produced a webinar on 'Improving exam performance for AO1 and AO2' in science. During the presentation an emphasis was placed upon the large amount of content that students must learn. These are available for viewing on the Oxford International AQA Examinations website.

Chemistry is a practically based subject and as a minimum students should carry out the 10 required practicals (summarised on p.49 of the specification). Wherever possible students should be provided with practical opportunities to reinforce their learning e.g. reacting Mg with steam, relative solubility of Group 2 hydroxides and sulfates, etc.

When drawing covalent bonds in organic molecules care must be taken eg in alcohols students must show the bond from C to O of the –OH alcohol group (refer to mark scheme pages 7-9, section 3.12 Organic structures for further examples). Another frequent mistake made is that the bond between O-H is not shown when students are asked to draw a displayed formula.

QUESTION

03.1

0 3 . 1 Identify a reagent that could be used in a simple test tube reaction to distinguish between aqueous magnesium chloride and aqueous barium chloride.

State what you would observe.

[3 marks]

Reagent _____

Observation with aqueous magnesium chloride _____

_____

_____

Observation with aqueous barium chloride _____

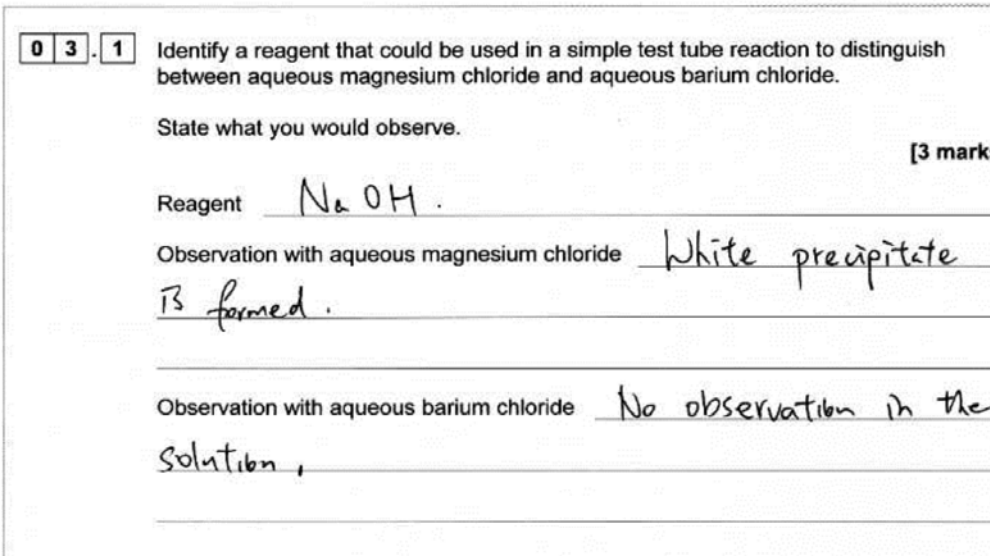
_____

_____

MARK SCHEME

Question	Marking guidance	Mark	Comments
03.1	any soluble sulfate including (dilute) sulfuric acid	1	
	colourless solution or no visible change	1	
	white precipitate	1	
	OR		
	NaOH or any soluble hydroxide or ammonia		
	white precipitate		
	colourless solution or no visible change		

STUDENT A



0 3 . 1 Identify a reagent that could be used in a simple test tube reaction to distinguish between aqueous magnesium chloride and aqueous barium chloride.

State what you would observe.

[3 mark

Reagent NaOH.

Observation with aqueous magnesium chloride White precipitate is formed.

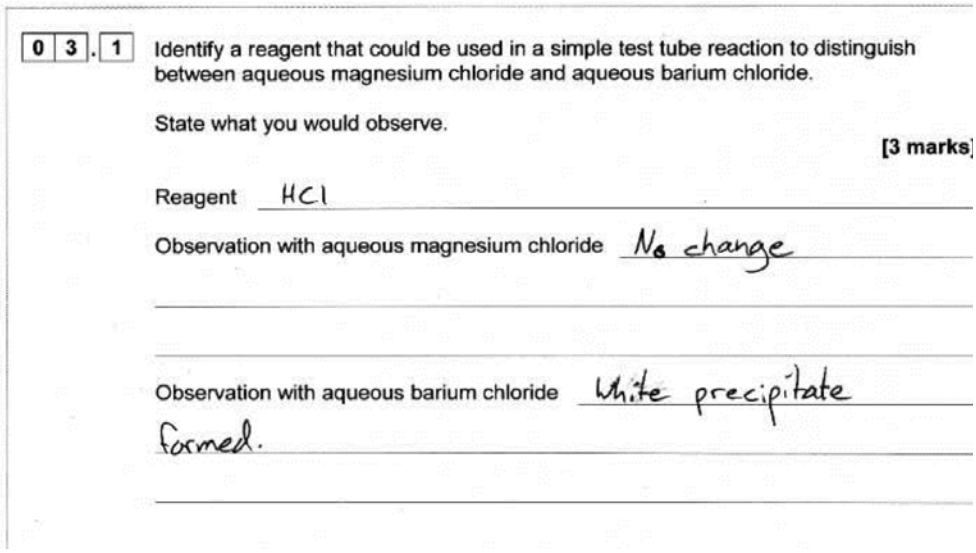
Observation with aqueous barium chloride No observation in the solution.

EXAMINER COMMENTARY

This student has selected a correct reagent (NaOH) to carry out the test (others are suitable e.g. Na_2SO_4) and has given the correct observation with magnesium chloride. There is 'no visible change' when sodium hydroxide is added to barium chloride; unfortunately the student has not clearly stated this; it was common for no visible change for one substance not be clearly stated.

2 marks awarded.

STUDENT B



0 3 . 1 Identify a reagent that could be used in a simple test tube reaction to distinguish between aqueous magnesium chloride and aqueous barium chloride.

State what you would observe.

[3 marks]

Reagent HCl

Observation with aqueous magnesium chloride No change

Observation with aqueous barium chloride White precipitate formed.

EXAMINER COMMENTARY

It is acceptable to use **correct** chemical formula when answering a question.
Students who could not state a reagent could not then gain observation marks. In this question this is considered to be a 'chemical error' (in mark schemes this will be written as CE 0/3 in the right hand column). Often reagents and/or observations were incomplete in these responses.

0 marks awarded.

QUESTION

04.4

0 4 . 4 The pressure on the equilibrium mixture is increased.

Predict the effect of the increase in pressure on the amount of oxygen in the equilibrium mixture.

Explain your answer with reference to Le Chatelier's principle.

[3 marks]

Effect _____

Explanation _____

_____

_____

_____

_____

MARK SCHEME

Question	Marking guidance	Mark	Comments
04.4	decreases more moles on right side or 2 → 3 moles or moves to left side that has least moles equilibrium moves to oppose increase in pressure or equilibrium moves to decrease pressure	1 1 1	If M1 incorrect CE 0/3. If blank mark on

STUDENT A

0 4 . 4 The pressure on the equilibrium mixture is increased.

Predict the effect of the increase in pressure on the amount of oxygen in the equilibrium mixture.

Explain your answer with reference to Le Chatelier's principle.

[3 marks

Effect decreases

Explanation the left side has 2 moles of gas, which is less than the 3 moles on the right. The equilibrium will shift to the left to oppose the change and try to lower the pressure by favouring the side with fewer molecules. Less product (O_2) will form

EXAMINER COMMENTARY

The student has described the correct effect (note a chemical error would have applied if M1 was incorrect ie CE 0/3).
M3 is for **equilibrium moves** to **oppose increase in pressure** or **equilibrium moves** to **decrease pressure.**
The 'idea' underlined in the mark scheme is essential to gain credit (although here students can express these ideas in 'their own words').
This student has stated that equilibrium shifts (acceptable for 'moves'). On its own to 'oppose the change' is generic and not credit worthy. However, this student has added 'to lower the pressure' (acceptable as decrease pressure).
Less product (O_2) will form is ignored; it is correct and has already been credited in M1 (ie effect = decreases).

3 marks awarded.

STUDENT B

0 4 . 4 The pressure on the equilibrium mixture is increased.

Predict the effect of the increase in pressure on the amount of oxygen in the equilibrium mixture.

Explain your answer with reference to Le Chatelier's principle.

[3 mar

Effect reduces amount of oxygen

Explanation There is a 2:3 ratio with fewer molecules on the left-hand side of the equilibrium. Le Chatelier's principle states an increase in pressure favours the side with fewer molecules. As a result, the equilibrium will shift to the left so more NO_2 produced and less O_2 produced.

EXAMINER COMMENTARY

Many students did not score all the marks in this question as the explanations were incomplete. This student has gained the first two marking points. For M3 they have not added that the equilibrium moves to 'decrease the pressure' or 'oppose the increase in pressure'.

2 marks awarded.

QUESTION

05.1

0 5 This question is about bonding and structure.

0 5 . 1 Draw the shape of the PCl_3 molecule and the shape of the SF_3^- ion.
Include any lone pairs of electrons that influence the shape.

Name the shape of the PCl_3 molecule.

Suggest the bond angle in the PCl_3 molecule.

[4 marks]

	PCl_3 molecule	SF_3^- ion
Shape		
Name of shape		
Bond angle		

MARK SCHEME

Question	Marking guidance	Mark	Comments
05.1	PCl_3		
	pyramidal / tetrahedral shape with 1 lone pair	1	
	(triangular) pyramidal / tetrahedral shape	1	(allow 100° for correct angle PCl_3)
	106.5° – 107.5°	1	
	SF_3^- ion		
	structure with 3 bond pairs and 2 lone pairs	1	

STUDENT A

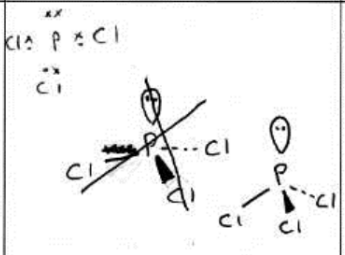
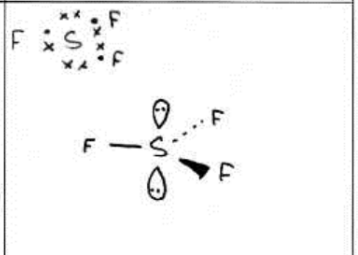
0 5 This question is about bonding and structure.

0 5 . 1 Draw the shape of the PCl_3 molecule and the shape of the SF_3^- ion.
Include any lone pairs of electrons that influence the shape.

Name the shape of the PCl_3 molecule.

Suggest the bond angle in the PCl_3 molecule.

[4 marks]

	PCl_3 molecule	SF_3^- ion
Shape		
Name of shape	Trigonal Pyramidal	
Bond angle	107°	

EXAMINER COMMENTARY

This question discriminated well; only the best students could score all the marks.
This student has clearly crossed out an attempt of their answer that they do not want to be marked.

4 marks awarded.

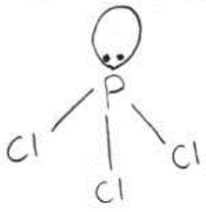
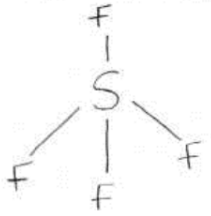
STUDENT B

0 5 . 1 Draw the shape of the PCl_3 molecule and the shape of the SF_3^- ion.
Include any lone pairs of electrons that influence the shape.

Name the shape of the PCl_3 molecule.

Suggest the bond angle in the PCl_3 molecule.

[4 marks]

	PCl_3 molecule	SF_3^- ion
Shape		
Name of shape	trigonal planar	
Bond angle	120°	

EXAMINER COMMENTARY

The student has correctly deduced and drawn the shape of the PCl_3 molecule. Unfortunately they have confused the 3 bonded trigonal planer shape with this one, based upon a tetrahedral.
The shape of the SF_3^- ion is based upon a S atom having 6 outer level electrons, to which is added one electron for the charge and one electron per fluorine atom (due to the sharing of an electron pair to make a covalent bond).
Thus, 10 electrons in S's outer level are divided into 5 pairs and the shape is based upon the trigonal bipyramidal structure; the two lone pairs sit opposite each other to minimise their repulsion (although M4 was for any structure with 3 bond pairs and 2 lone pairs).

1 mark awarded.

QUESTION

06.1

0 6 . 1 A 2.49 g sample of gaseous **Y** occupies a volume of 1.35×10^{-3} m^3 at a temperature of 252 °C and a pressure of 101 kPa

Calculate the relative molecular mass of **Y**.

Give your answer to the nearest whole number.

The gas constant R = 8.31 J K^{-1} mol^{-1}

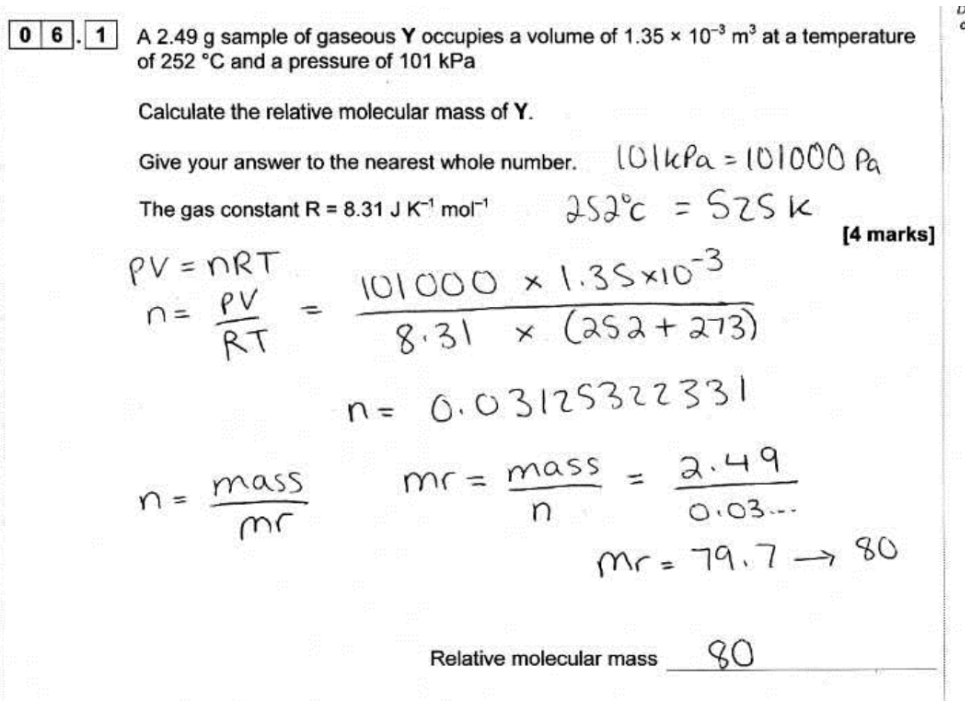
[4 marks]

Relative molecular mass _____

MARK SCHEME

Question	Marking guidance	Mark	Comments
06.1	n = PV/RT or Mr = m RT/PV	1	
	P = 101000 Pa and T = 525 K	1	
	n = 101000 × 1.35 x 10^{-3} / 8.31 × 525 = 0.03125 mol		
	and M_r = 2.49/0.03125 (= 79.68)	1	Allow 79.6-80.3
	OR		
	M_r = 2.49 × 8.31 × 525 / 101000 × 1.35 x 10^{-3} (= 79.68)		
	M_r = 80	1	

STUDENT A



0 6 . 1 A 2.49 g sample of gaseous **Y** occupies a volume of 1.35×10^{-3} m^3 at a temperature of 252 °C and a pressure of 101 kPa

Calculate the relative molecular mass of **Y**.

Give your answer to the nearest whole number. 101kPa = 101000 Pa

The gas constant R = 8.31 J K^{-1} mol^{-1} 252°C = 525 K

[4 marks]

$PV = nRT$

$n = \frac{PV}{RT} = \frac{101000 \times 1.35 \times 10^{-3}}{8.31 \times (252 + 273)}$

$n = 0.031253222331$

$n = \frac{mass}{mr}$ $mr = \frac{mass}{n} = \frac{2.49}{0.03...}$

$mr = 79.7 \rightarrow 80$

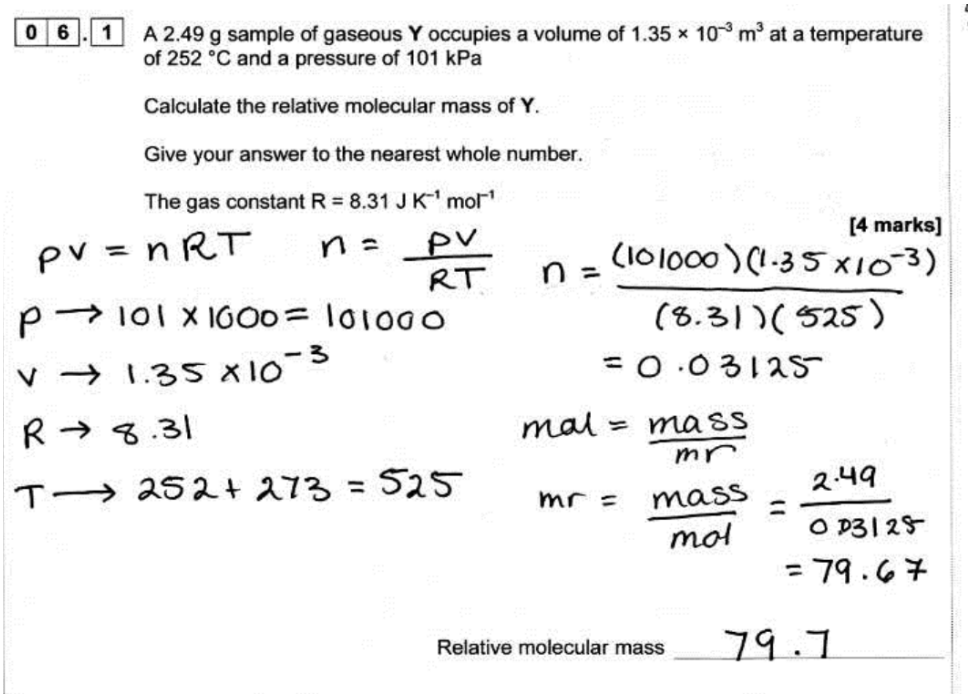
Relative molecular mass 80

EXAMINER COMMENTARY

This student has started by converting the given pressure and temperature into the correct units (M2).
In each step the student has clearly shown what they are calculating.

4 marks awarded.

STUDENT B



0 6 . 1 A 2.49 g sample of gaseous **Y** occupies a volume of 1.35×10^{-3} m^3 at a temperature of 252 °C and a pressure of 101 kPa

Calculate the relative molecular mass of **Y**.

Give your answer to the nearest whole number.

The gas constant R = 8.31 $J\ K^{-1}\ mol^{-1}$

[4 marks]

$pV = nRT$ $\quad n = \frac{pV}{RT}$ $\quad n = \frac{(101000)(1.35 \times 10^{-3})}{(8.31)(525)}$

$= 0.03125$

$p \rightarrow 101 \times 1000 = 101000$

$V \rightarrow 1.35 \times 10^{-3}$

$R \rightarrow 8.31$

$T \rightarrow 252 + 273 = 525$

$mol = \frac{mass}{mr}$

$mr = \frac{mass}{mol} = \frac{2.49}{0.03125}$

$= 79.67$

Relative molecular mass 79.7

EXAMINER COMMENTARY

This student has clearly shown what they are calculating in each step (which is good practice).
In this instance the student has probably not read the question (RTQ) carefully enough and has unnecessarily lost a mark.

3 marks awarded.

QUESTION

07.1

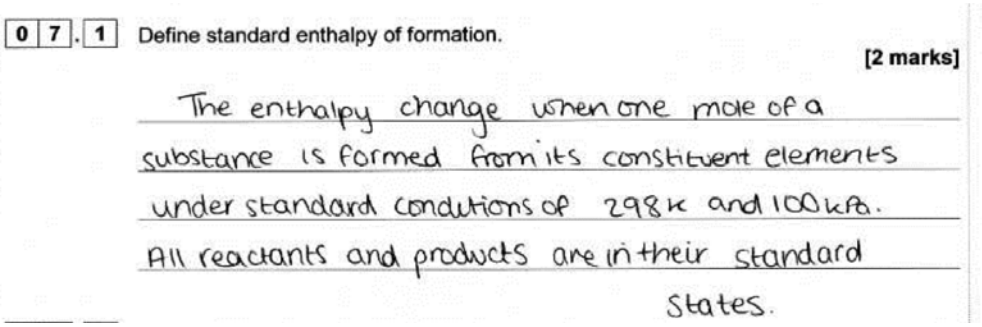
0 7 . 1 Define standard enthalpy of formation.

[2 marks]

MARK SCHEME

Question	Marking guidance	Mark	Comments
07.1	enthalpy (or heat energy) change when 1 mol of a substance	1	
	is formed from its elements when all substances in their standard states	1	Allow normal states at 298 K and 100 kPa or standard conditions

STUDENT A



0 7 . 1 Define standard enthalpy of formation.

[2 marks]

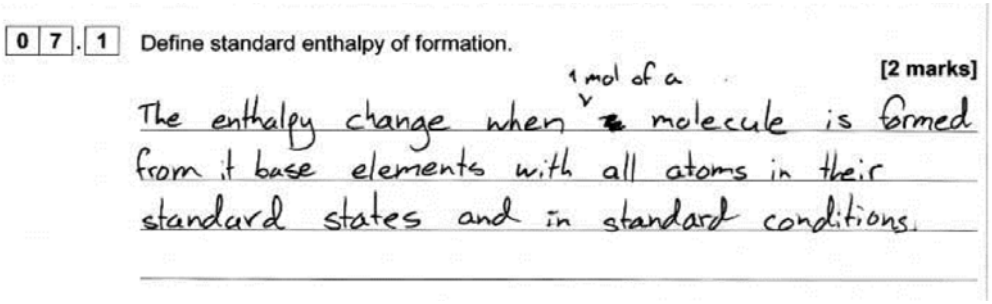
The enthalpy change when one mole of a substance is formed from its constituent elements under standard condutions of 298K and 100kPa. All reactants and products are in their standard states.

EXAMINER COMMENTARY

The definition was generally not well known.

2 marks awarded.

STUDENT B



0 7 . 1 Define standard enthalpy of formation. [2 marks]

The enthalpy change when 1 mol of a molecule is formed from it base elements with all atoms in their standard states and in standard conditions.

EXAMINER COMMENTARY

The student has unfortunately failed to learn the complete definition; substances should have been used instead of atoms.

1 mark awarded.

QUESTION

07.2

0 7 . 2 State Hess's Law.

Use the data in **Table 1** to calculate the standard enthalpy change, in kJ mol^{-1}, for the following reaction.

$$CaO(s) + 2HCl(g) \rightarrow CaCl_2(s) + H_2O(l)$$

Table 1

	CaO(s)	HCl(g)	$CaCl_2$(s)	H_2O(l)
$\Delta_f H^\ominus$ / kJ mol^{-1}	–635	–92	–795	–286

[4 marks]

Hess's Law _____

_____

Enthalpy change kJ mol^{-1}

MARK SCHEME

Question	Marking guidance	Mark	Comments
07.2	enthalpy change (or enthalpy of reaction) is independent of route	1	
	$\Delta H = \Sigma \Delta_f H^{\ominus}$ prods – $\Sigma \Delta_f H^{\ominus}$ reactants (or cycle)	1	
	$\Delta H = -795 - 286 - (-635 + 2 \times -92)$	1	
	$= -262$ (kJ mol^{-1})	1	+262 scores 1 mark out of the last three

STUDENT A

0 7 . 2 State Hess's Law.

Use the data in **Table 1** to calculate the standard enthalpy change, in kJ mol^{-1}, for the following reaction.

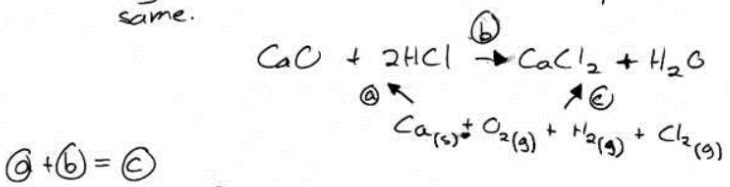
$$CaO(s) + 2HCl(g) \rightarrow CaCl_2(s) + H_2O(l)$$

Table 1

	CaO(s)	HCl(g)	$CaCl_2$(s)	H_2O(l)
$\Delta_f H^\ominus$ / kJ mol^{-1}	–635	–92	–795	–286

[4 marks]

Hess's Law A chemical has the same enthalpy change regardless of the path taken as long as the start and finish points are the same.



a + b = c

b = c − a

a = −635 + 2 × −92 = −819

c = −795 + −286 = −1081

b = −1081 − −819 = 1081 + 819 = −262

Enthalpy change −262 kJ mol^{-1}

EXAMINER COMMENTARY

Answers were variable with only the best students being able to give the definition and calculate the correct answer.

4 marks awarded.

STUDENT B

0 7 . 2 State Hess's Law.

Use the data in **Table 1** to calculate the standard enthalpy change, in kJ mol^{-1}, for the following reaction.

$$CaO(s) + 2HCl(g) \rightarrow CaCl_2(s) + H_2O(l)$$

Table 1

	CaO(s)	HCl(g)	$CaCl_2$(s)	H_2O(l)
$\Delta_f H^\ominus$ / kJ mol^{-1}	–635	–92	–795	–286

[4 marks]

Hess's Law Where any route to be taken to

Σ reactants − Σ Products

(~~–635 –92~~) =

(– 635 – 2(92)) – (–795 – 286)

$\Delta_f H^\circ$ = 262

Enthalpy change 262 kJ mol^{-1}

EXAMINER COMMENTARY

This student has not learnt Hess's Law (AO1 skill).
Students are encouraged to use an acronym to help then answer questions with either enthalpy (formation) or enthalpy (combustion) data.

1 mark awarded.

QUESTION

07.3

0 7 . 3 100 cm^3 of distilled water was measured out using a measuring cylinder and transferred to a polystyrene cup.
The temperature of the water was 25.0 °C
A 2.10 g sample of anhydrous calcium chloride was added to the water and the mixture was stirred.
The temperature of the mixture increased to 28.4 °C

Calculate the enthalpy of solution, in kJ mol^{-1}, for calcium chloride.

The specific heat capacity of the solution = 4.18 J K^{-1} g^{-1}

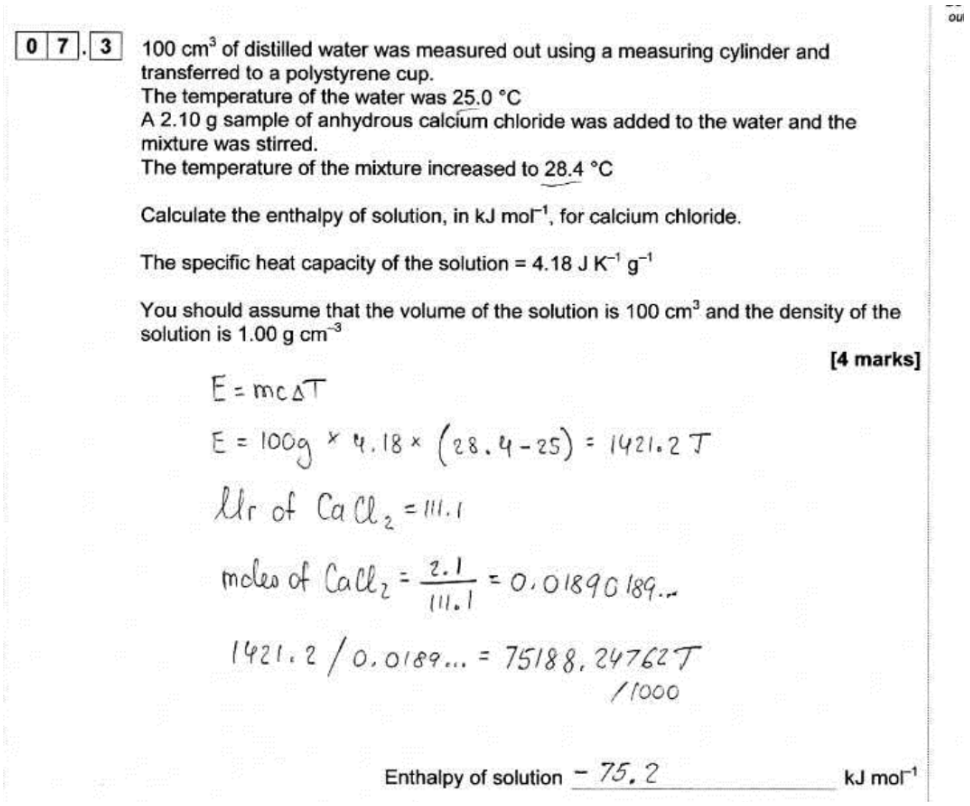
You should assume that the volume of the solution is 100 cm^3 and the density of the solution is 1.00 g cm^{-3}

[4 marks]

MARK SCHEME

Question	Marking guidance	Mark	Comments
07.3	Q = mcΔT	1	
	(= 100 × 4.18 × 3.4) = 1421 J	1	Allow m = 102(.1)
	moles of $CaCl_2$ = (2.10/111.0 =) 0.0189	1	
	enthalpy of solution = (1421 × 10^{-3} / 0.0189 =) –75.2 (kJ mol^{-1})	1	must have minus sign for M4

STUDENT A



0 7 . 3 100 cm^3 of distilled water was measured out using a measuring cylinder and transferred to a polystyrene cup.
The temperature of the water was 25.0 °C
A 2.10 g sample of anhydrous calcium chloride was added to the water and the mixture was stirred.
The temperature of the mixture increased to 28.4 °C

Calculate the enthalpy of solution, in kJ mol^{-1}, for calcium chloride.

The specific heat capacity of the solution = 4.18 J K^{-1} g^{-1}

You should assume that the volume of the solution is 100 cm^3 and the density of the solution is 1.00 g cm^{-3}

[4 marks]

$E = mc\Delta T$

$E = 100g \times 4.18 \times (28.4 - 25) = 1421.2\ J$

Mr of $CaCl_2 = 111.1$

moles of $CaCl_2 = \frac{2.1}{111.1} = 0.01890189...$

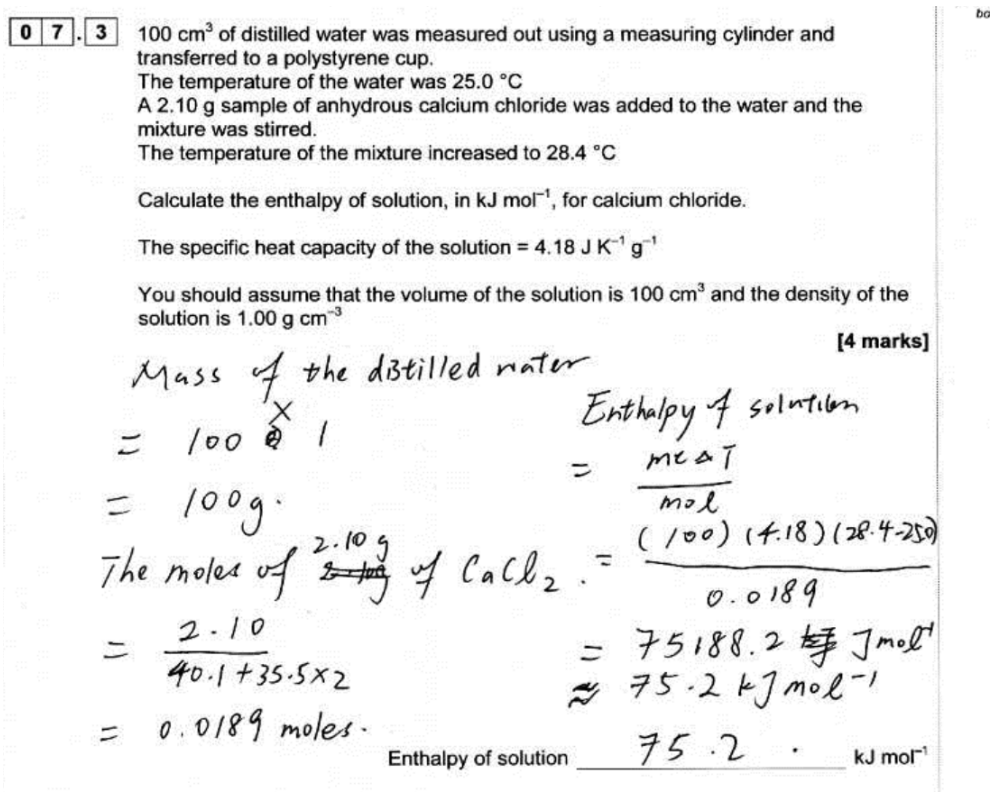
$1421.2 / 0.0189... = 75188.24762\ J$
$/1000$

Enthalpy of solution -75.2 kJ mol^{-1}

EXAMINER COMMENTARY

4 marks awarded.

STUDENT B



0 7 . 3 100 cm^3 of distilled water was measured out using a measuring cylinder and transferred to a polystyrene cup.
The temperature of the water was 25.0 °C
A 2.10 g sample of anhydrous calcium chloride was added to the water and the mixture was stirred.
The temperature of the mixture increased to 28.4 °C

Calculate the enthalpy of solution, in kJ mol^{-1}, for calcium chloride.

The specific heat capacity of the solution = 4.18 J K^{-1} g^{-1}

You should assume that the volume of the solution is 100 cm^3 and the density of the solution is 1.00 g cm^{-3}

[4 marks]

Mass of the distilled water
= 100 × 1
= 100g.

The moles of 2.10g of $CaCl_2$.
= 2.10 / (40.1 + 35.5 × 2)
= 0.0189 moles.

Enthalpy of solution
= mcΔT / mol
= (100)(4.18)(28.4-25.0) / 0.0189
= 75188.2 J mol^{-1}
≈ 75.2 kJ mol^{-1}

Enthalpy of solution 75.2 kJ mol^{-1}

EXAMINER COMMENTARY

In this question few students scored all the marks although many did manage to score partial marks. A common error was to miss a negative sign in their final answer, for the exothermic reaction.

3 marks awarded.

QUESTION

08.5

0 8 . 5 State two observations made when magnesium reacts with steam.

Write an equation for the reaction.

[3 marks]

Observation 1 _____

_____

Observation 2 _____

_____

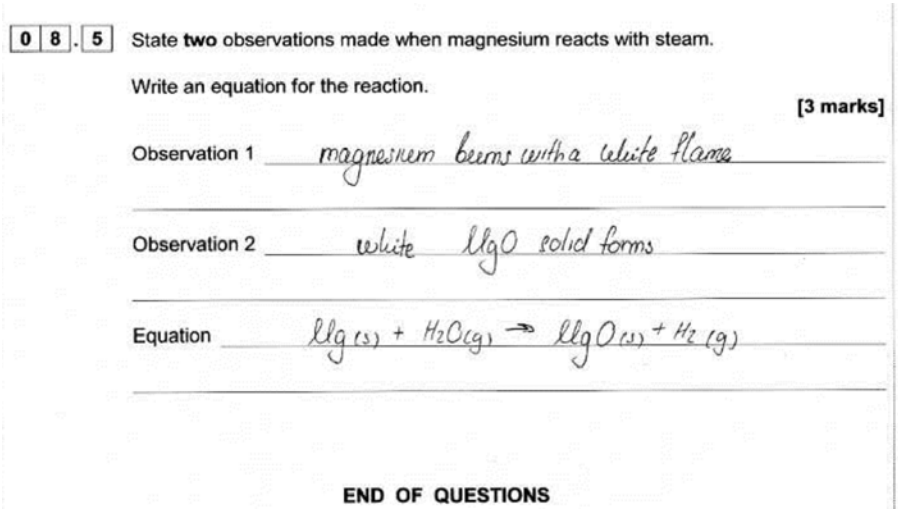
Equation _____

_____

MARK SCHEME

Question	Marking guidance	Mark	Comments
08.5	white powder/ash/ solid	1	ignore black solid
	(bright) white light	1	
	$Mg + H_2O \rightarrow MgO + H_2$	1	ignore state symbols; allow multiples

STUDENT A



0 8 . 5 State **two** observations made when magnesium reacts with steam.

Write an equation for the reaction.

[3 marks]

Observation 1 magnesium burns with a white flame

Observation 2 white MgO solid forms

Equation $Mg_{(s)} + H_2O_{(g)} \rightarrow MgO_{(s)} + H_{2(g)}$

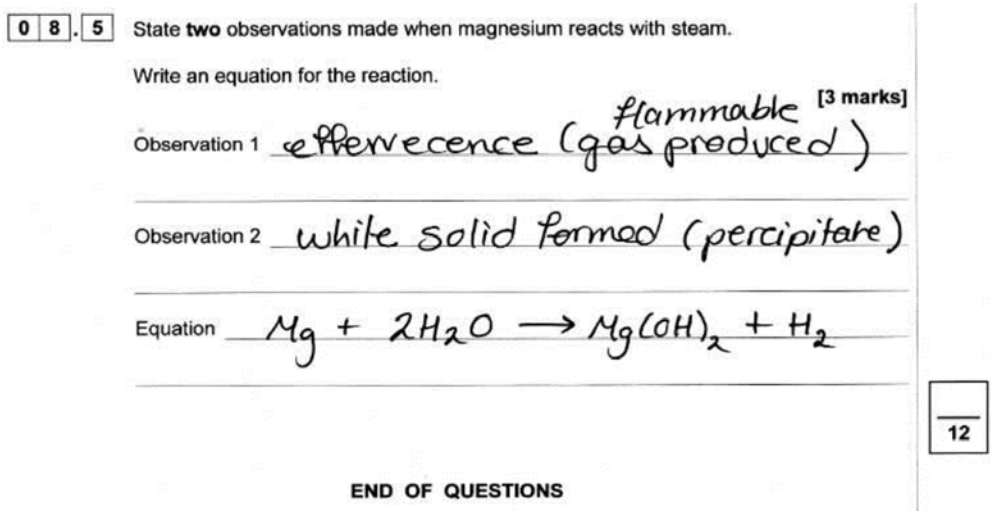
END OF QUESTIONS

EXAMINER COMMENTARY

Very few students could give correct observations and a correct equation.

3 marks out of a possible 3 awarded.

STUDENT B



0 8 . 5 State **two** observations made when magnesium reacts with steam.

Write an equation for the reaction.

[3 marks]

Observation 1 effervecence (flammable gas produced)

Observation 2 white solid formed (percipitate)

Equation $Mg + 2H_2O \rightarrow Mg(OH)_2 + H_2$

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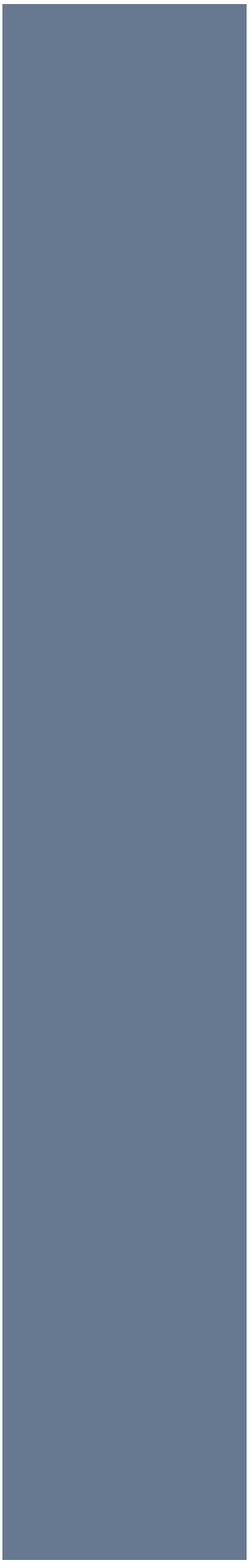
END OF QUESTIONS

EXAMINER COMMENTARY

Many students (such as this) were confused with the reaction of magnesium with water, rather than with steam: Mg + H_2O (g) → MgO + H_2

1 mark awarded.



FURTHER GUIDANCE AND CONTACTS

You can contact the subject team directly at **english@oxfordaqaexams.org.uk**

Please note: We aim to respond to all email enquiries within two working days.

Our UK office hours are Monday to Friday, 8am – 5pm local time.

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