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June 2024

Int GCSE Chemistry 4CH1 2C

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Introduction

This paper is slightly different this year, with a graph question that was not often tested and two curves plotted rather than just one. However many candidates did surprisingly well in this question with quite a few gaining all ten marks. Some of the three mark questions, which were explanations, were not so well done and only the best candidates gained three marks. The four mark question 7(b) was a question which had not been tested before. Only the very best candidates gained all four marks, with the majority just gaining one or two marks. Observations involving practical work were not particularly well done and many candidates found the equations difficult. Many candidates lost marks drawing the energy diagram as they did not use a ruler and the arrows were too short to be acceptable.

Question 1 (a)(i)

A large majority of candidates gave sulfur as the answer. Oxygen was seen occasionally as they were using the mass number rather than the atomic number.

Question 1 (a)(ii)

A large majority of candidates gave beryllium as the answer. A few gave the atomic number instead of the mass number and answered fluorine.

Question 1 (a)(iii)

Most candidates gave boron, but aluminium was seen occasionally. Boron is in Period 2 and aluminium is in Period 3.

Question 1 (a)(iv)

A large majority of candidates gave the correct electronic configuration. A small number used the mass number rather than the atomic number, so gave the incorrect electronic configuration.

Question 1 (b)

Many candidates gained three marks, but some answers lost marks by not mentioning the outer shell, or that the electron was more easily lost, when mentioning sodium.

(b) **Explain, in terms of electron configuration, why sodium is more reactive than lithium.**

(3)

Sodium has more electron shells than lithium as lithiums electronic configuration is 2,1 and sodiums electronic configuration is 2,8,1 As Sodium has more electron shells it is more reactive as it is further away from the nucleus which means that electrons can be lost more easily.

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Examiner Comments

Sodium has more electron shells than lithium is enough for one mark, but there is no mention of the weaker attraction between the outer electron and the nucleus. As there is only one electron easily lost, we do not allow electrons can be lost more easily.

ResultsPlus
Examiner Tip

Make sure you only refer to losing the single electron more easily, to gain the third mark.

(b) Explain, in terms of electron configuration, why sodium is more reactive than lithium.

(3)

Sodium is more reactive than lithium as it has an extra shell meaning the outer shell is further away from the nucleus, hence meaning that force of attraction it has to the nucleus is weaker, meaning it gives away the outer shell electron more easily, making it more reactive.

ResultsPlus
Examiner Comments

Sodium has an extra shell gains the first marking point. The force of attraction is weaker between the outer shell and the nucleus gains the second marking point and the outer electron is more easily given away is the third marking point.

A clear answer that gains all 3 points.

Question 2 (a)(i)

The majority of candidates stated oxygen and water and gained both marks. Occasionally hydrogen or carbon dioxide were seen which are not creditworthy.

Question 2 (a)(ii)

Most candidates mentioned a barrier method. The most common answer was either painting or galvanising. A few candidates mentioned sacrificial protection, which was not a barrier method so was not creditworthy. Some candidates just mentioned coating which was insufficient for the mark.

Question 2 (b)

This is a sacrificial method not a barrier method. Some candidates lost the mark by not connecting the more reactive metal to the iron.

(b) Explain how sacrificial protection prevents the rusting of iron.

(2)

- It creates a barrier between the oxygen in the air and iron
- It is a form of oiling

ResultsPlus
Examiner Comments

This is a barrier method, not sacrificial protection. No more reactive metal is mentioned and so no marks can be awarded.

ResultsPlus
Examiner Tip

As the previous question was a barrier method, it is not sensible to suggest using a barrier method again, rather than explaining sacrificial protection.

(b) Explain how sacrificial protection prevents the rusting of iron.

- get a more reactive metal than iron (2)

- Zinc is more reactive than iron, so it gets oxidised instead of iron, and donates its electrons to keep iron in its reduced state.

ResultsPlus
Examiner Comments

It is true that zinc is more reactive than iron, but there is no coating or connecting the zinc to the iron. The second marking point can be awarded for stating that zinc is oxidised instead of iron.

ResultsPlus
Examiner Tip

In order to gain the first mark you have to state how the metal is applied to the iron.

(b) Explain how sacrificial protection prevents the rusting of iron.

(2)

- a layer of zinc coating can be placed on top of the iron
- zinc is more reactive than iron, so water and oxygen will react with zinc instead of iron

ResultsPlus
Examiner Comments

A layer of zinc coating can be placed on top of the iron for the first mark and as water and oxygen will react with zinc instead of iron explains the second mark.

ResultsPlus
Examiner Tip

An explanation is required to gain the two marks.

Question 3 (a)

The majority of candidates knew that bitumen was formed at the bottom of the fractionating column, but sometimes with an unusual spelling, which was accepted if it was recognisable. A fair number of candidates also mentioned refinery gases but note that just stating gases or refinery oil is not enough to gain the first mark. Tar was sometimes mentioned but was ignored.

Question 3 (b)(i)

Aircraft fuel, plane fuel or jet fuel were all acceptable answers. Note that just mentioning aircraft without mentioning fuel is not enough for the mark. Paraffin lamps or heaters were ignored as kerosene is not used for safety reasons. Some candidates mentioned ship fuel, which was incorrect and lost the mark as it was a list principle. Note, if there is one correct answer and one incorrect answer no mark is awarded.

Question 3 (b)(ii)

Many candidates knew that the crude oil is heated and passes into the fractionating column. Fewer described how the kerosene condenses and removed from the column. Some candidates lost marks for stating that the crude oil was heated **in** the fractionating column.

(ii) Describe how kerosene can be obtained from crude oil.

(3)

Crude oil is vaporised and fed into the bottom of the fractionating column. The fractionating column is hotter at the bottom and cooler at the top. The crude oil rises, when it reaches the boiling point of kerosene it condenses. and can be collected as a liquid.

ResultsPlus
Examiner Comments

The crude oil is vaporised and fed into the fractionating column is enough for two marks. It also states how kerosene condenses and is collected, which is enough for the third mark.

ResultsPlus
Examiner Tip

Just stating that kerosene is obtained is not creditworthy as this is in the stem of the question.

(ii) Describe how kerosene can be obtained from crude oil.

(3)

Fursty heat up the ~~hydrocarbon~~ crude oil and vaporise it. The fractional column is hot at the bottom and cooler at the top. The kerosene will condense at its boiling point.

ResultsPlus
Examiner Comments

Heat up the crude oil and vaporise it is enough for the first mark, but there is no mention of it entering the column or how kerosene is removed or collected so no more marks awarded.

ResultsPlus
Examiner Tip

Make sure you describe the three stages, heating the crude oil, entering the vapour in the column and kerosene condenses and is collected or removed.

Question 3 (c)(i)

Silica or alumina were often referred to as the catalyst. A few candidates mentioned silicon, which was not creditworthy and iron or phosphoric acid was seen occasionally. Temperatures are less well known and candidates often referred to lower temperatures such as 300^{o}C or 350^{o}C rather than between 600^{o}C and 700^{o}C.

Question 3 (c)(ii)

Candidates need to explain why catalytic cracking is useful, so some products need to be mentioned to gain the marks. Many candidates just mentioned the supply and demand but did not mention any of the products so this meant they only gained one mark. Just stating short chain alkanes are more useful is not creditworthy as this is mentioned in the stem.

(ii) Explain why catalytic cracking is useful. (3)

There is a higher demand for short chain hydrocarbons than long chain hydrocarbons. This is because cracking produces short chain alkanes that can be used for fuel in cars, e.g. petrol, and it ~~(illegible)~~ produces alkenes, which can be used to make polymers. long chain hydrocarbons are less useful than short chain hydrocarbons

ResultsPlus Examiner Comments

This is a good answer as the candidate stated that there is a higher demand for short chain hydrocarbons. They also stated that short chain alkanes are used for petrol and that alkenes produced polymers, so all three marks can be awarded.

ResultsPlus Examiner Tip

Make sure you explain why cracking produces the products and give suitable examples.

(ii) Explain why catalytic cracking is useful.

(3)

catalytic cracking breaks down long chain hydrocarbons to create a small chain hydrocarbon and an alkene. This is useful because small chain hydrocarbons have a higher demand than long chain hydrocarbons. The alkenes produced can be used to make polymers.

ResultsPlus
Examiner Comments

Small chain hydrocarbons have a higher demand gains the first mark and alkenes produces polymers is the third marking point, but there is no mention of alkanes producing petrol or gasoline, so just two marks awarded.

ResultsPlus
Examiner Tip

You need to mention both the products of the alkenes and alkanes to obtain all three marks.

(ii) Explain why catalytic cracking is useful.

(3)

Catalytic cracking is useful since there is a high demand of short-chain Alkane and a low demand of long chain Alkane the way to break / get the short chain Alkane is by catalytic cracking which is why it is useful since there is a high demand of short-chain Alkane

ResultsPlus
Examiner Comments

High demand of short chain alkane and low demand of long chain alkane is the first marking point. There is no mention of the products produced so no other marks can be awarded.

ResultsPlus
Examiner Tip

Make sure you mention the products to gain all three marks.

Question 4

Many candidates did well in this question and some scored all 10 marks. A common answer was 75, rather than when the lines met. Always show your working on the graph as was instructed in Q04(d), otherwise some candidates lost at least two marks.

4 The table shows the maximum mass of potassium nitrate (KNO_3) and the maximum mass of sodium nitrate ($NaNO_3$) that dissolves in 25 cm^3 of water at different temperatures.

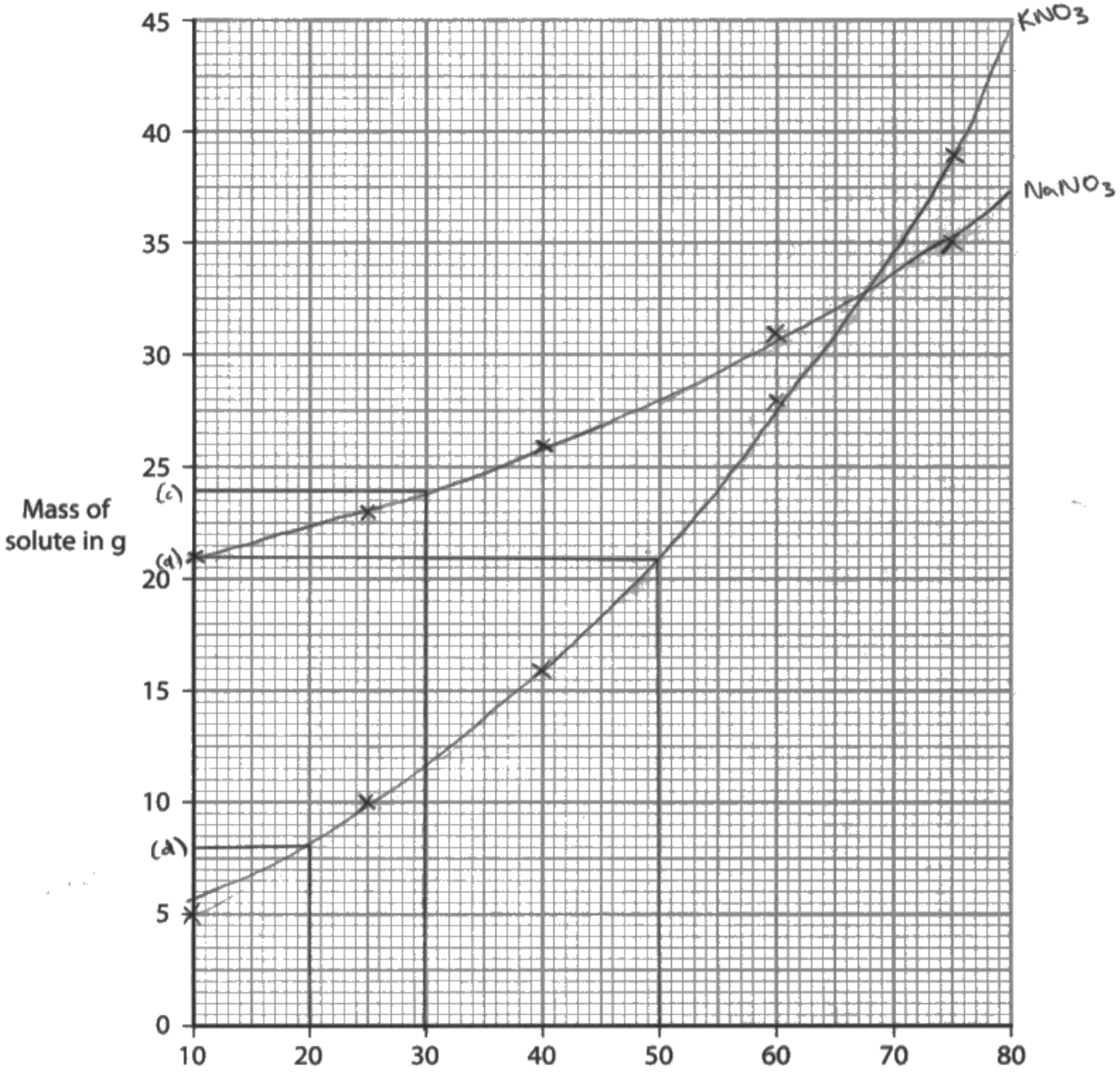
Temperature in °C	10	25	40	60	75
Mass of potassium nitrate in g	5	10	16	28	39
Mass of sodium nitrate in g	21	23	26	31	35

(a) (i) Plot the data for potassium nitrate and for sodium nitrate on the grid.

(2)

(ii) Draw and label a curve of best fit for KNO_3 and for $NaNO_3$

(2)



(b) The graph shows the temperature at which the maximum mass dissolved is the same for each solute.

Determine this temperature.

(1)

temperature = 67 °C

(c) Use your graph to calculate the solubility, in g per 100 g of water, of sodium nitrate at 30 °C.

[1.0 cm^3 of water has a mass of 1.0 g]

(2)

24g in ~~25~~ 25cm^3 = 25g

24 x 4 = 96g

solubility of sodium nitrate in g per 100 g of water = 96

(d) 25 cm^3 of a saturated solution of potassium nitrate is cooled from 50 °C to 20 °C.

Use your graph to determine the mass, in grams, of potassium nitrate that crystallises.

Show your working on the graph.

(3)

50° = 21g

20° = 8g

21 - 8 = 13g

mass = 13 g

ResultsPlus
Examiner Comments

This was a good answer. Crosses showed the plots clearly and they were correct. Smooth curves were drawn through the points and the curves were labelled correctly. Working was often shown in parts (b) and (c), but was not necessary to gain the mark. 67 was correct and 24 x 4 gave a correct answer of 96g. Working was clearly shown on the graph in part (d) which was necessary to gain the first two marks and the third mark was correct for the subtraction.

ResultsPlus
Examiner Tip

Make sure you plot the points clearly and draw smooth curves through the points. It is not always necessary to go through every point as long as they were close to the curve.

4 The table shows the maximum mass of potassium nitrate (KNO_3) and the maximum mass of sodium nitrate ($NaNO_3$) that dissolves in 25 cm^3 of water at different temperatures.

Temperature in °C	10	25	40	60	75
Mass of potassium nitrate in g	5	10	16	28	39
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(a) (i) Plot the data for potassium nitrate and for sodium nitrate on the grid.

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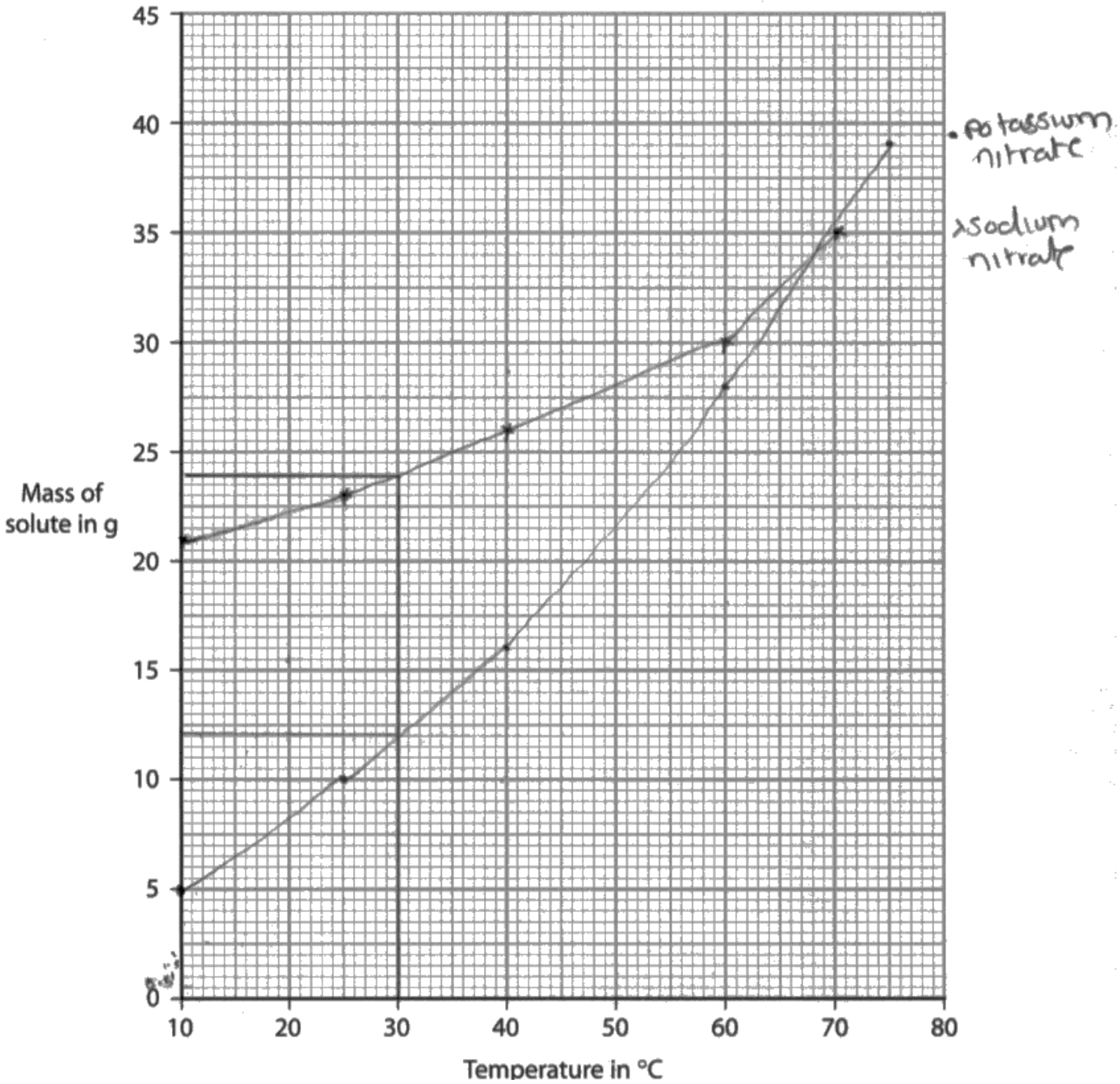
(ii) Draw and label a curve of best fit for KNO_3 and for $NaNO_3$

(2)



(b) The graph shows the temperature at which the maximum mass dissolved is the same for each solute.

Determine this temperature.

(1)

temperature = 75 °C

(c) Use your graph to calculate the solubility, in g per 100 g of water, of sodium nitrate at 30 °C.

[1.0 cm^3 of water has a mass of 1.0 g]

(2)

24g → 30C
100 → x

$\frac{30 \times 100}{24}$

solubility of sodium nitrate in g per 100 g of water = 125

(d) 25 cm^3 of a saturated solution of potassium nitrate is cooled from 50 °C to 20 °C.

Use your graph to determine the mass, in grams, of potassium nitrate that crystallises.

Show your working on the graph.

(3)

12g → 80C

30°C → 25 cm^3

mass = 12g g

ResultsPlus
Examiner Comments

Points are correct on the potassium nitrate curve and this is an acceptable curve and they are labelled correctly with the key for the dots and crosses, so one mark for part (a)(i) and one mark for part (a)(ii). However the points at 60 and 70 are incorrect and this is not a smooth curve as they are straight lines and dot to dot on the sodium nitrate lines, so no more marks here. 75 is not the point where they cross so no marks for part (b). One mark for 24g seen in part (c) but the second marking point is not the correct answer of 96g. No more marks for part (d) as the answer of 12g was at 30 rather than 20 and nothing else was creditworthy.

ResultsPlus
Examiner Tip

Make sure the points are shown clearly and are correct and they should be curves of best fit, not straight lines.

Question 5 (a)

Many candidates scored well. Common answers often included same general formula or same functional group. Many candidates also stated similar chemical properties or trends in physical properties. Some candidates lost a mark for stating 'same chemical properties' which was not creditworthy.

5 Methanol, CH_3OH, is the first member of the homologous series of alcohols.

(a) Give two characteristics of a homologous series.

1 same functional group

2 similar chemical properties

ResultsPlus
Examiner Comments

A good answer. Same functional group and similar chemical properties.

ResultsPlus
Examiner Tip

Learn the characteristics of the homologous series as it is often tested.

5 Methanol, CH_3OH, is the first member of the homologous series of alcohols.

(a) Give two characteristics of a homologous series.

1 Same boiling and melting point

2 Same ~~empirical~~ molecular formula

ResultsPlus
Examiner Comments

It should be the same general formula as the molecular formula is not the same. Also boiling and melting point would be a trend in the physical properties, as the boiling point and melting point are not the same.

ResultsPlus
Examiner Tip

If you want to refer to the physical properties make sure you state that there is a trend in physical properties.

Question 5 (b)(i)

Many candidates knew it was H_2SO_4, but a significant number gave the name of sulfuric acid and not the formula. The question asked for the formula so the name was not acceptable. A few candidates thought the catalyst was water, oxygen, HCl or phosphoric acid.

Question 5 (b)(ii)

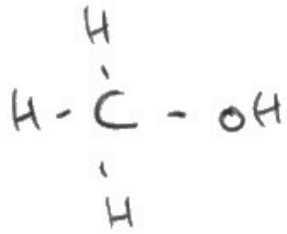
A wide range of colours were seen. Quite a few candidates knew the correct colours and scored two marks. One or two candidates unfortunately lost the marks for doing them the wrong way round. Brown or pink to colourless was sometimes seen, perhaps confusing bromine water and indicators in titrations.

Question 5 (b)(iii)

Many correct answers, but some candidates lost a mark by not showing all the bonds in the displayed formulae.

(iii) Draw the displayed formula for methanol and for methanoic acid in the boxes.

(2)

methanol	methanoic acid
	

ResultsPlus
Examiner Comments

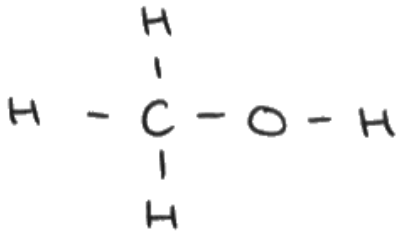
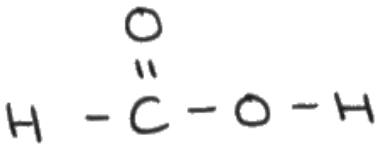
Unfortunately a mark was lost as there is no bond between the O and the H.

ResultsPlus
Examiner Tip

Make sure all bonds are shown in a displayed formula.

(iii) Draw the displayed formula for methanol and for methanoic acid in the boxes.

(2)

methanol	methanoic acid
	

ResultsPlus
Examiner Comments

This is a clear answer showing all the bonds correctly.

ResultsPlus
Examiner Tip

The structural formulae are given in the question, so use this information to show the displayed formulae. Check that there are 4 bonds to each carbon and 2 bonds to each oxygen and 1 bond to each hydrogen. Remember the C=O double bond in methanoic acid.

Question 5 (c)

The majority of candidates found this equation difficult. Many used the molecular formula or ethanoic acid instead of methyl methanoate formula. Most candidates knew water was the other product.

(c) Methanol reacts with methanoic acid to form an ester.

Complete the equation for this reaction.

(1)

$CH_3OH + HCOOH \rightarrow$ $HCOOCH_3$ + H_2O

ResultsPlus Examiner Comments

A correct equation.

ResultsPlus Examiner Tip

Make sure the equation is balanced with 6H, 2C and 3O.

(c) Methanol reacts with methanoic acid to form an ester.

Complete the equation for this reaction.

$CH_3OH + HCOOH \rightarrow$ $C_2H_4O_2$ + H_2O

ResultsPlus Examiner Comments

Although this is a correct molecular formula, you do not know whether this is ethanoic acid or methyl methanoate, so no mark can be awarded.

ResultsPlus Examiner Tip

As the equation shows it is a structural formula, a molecular formula is not sufficient to gain the mark.

(c) Methanol reacts with methanoic acid to form an ester.

Complete the equation for this reaction.

$CH_3OH + HCOOH \rightarrow$ CH_3COOH + H_2O

ResultsPlus
Examiner Comments

Unfortunately this is ethanoic acid not an ester so no mark can be awarded.

ResultsPlus
Examiner Tip

The question states that this is an ester, so there must be the structural formula of the ester, not the acid.

Question 5 (d)(ii)

Many candidates gave the correct molecular formula. A common mistake was to give the formula $C_5H_{12}O_2$ instead of $C_6H_{12}O_2$. Another common error was to give a part of a structural formula rather than a molecular formula which implied a lack of understanding. A few candidates gave the empirical formula rather than the molecular formula.

Question 6 (a)

Candidates that read the question realised that lead(II) bromide was an insoluble solid and often gained all three marks. Occasionally they lost the second marking point for not washing the residue. A significant number of candidates thought that they needed to heat the mixture to evaporate some of the liquid and thought that on cooling crystals will form. This limited them to a maximum of one mark.

6 A scientist reacts lead(II) nitrate solution with sodium bromide solution.

This is the equation for the reaction.

$$Pb(NO_3)_2(aq) + 2NaBr(aq) \rightarrow PbBr_2(s) + 2NaNO_3(aq)$$

(a) Describe how the scientist could obtain a pure dry sample of lead(II) bromide ($PbBr_2$) from the reaction mixture.

(3)

To obtain a pure dry sample, first filter the lead(II) bromide, and then wash it to remove impurities. Then, pat the sample dry with a filter paper.

ResultsPlus
Examiner Comments

This was a good answer gaining all three marks. They filtered the mixture, washed the lead(II) bromide to remove impurities and pat the sample dry with filter paper.

ResultsPlus
Examiner Tip

Make sure you note that the lead(II) bromide is a solid and is filtered, washed and dried. Also make sure you mention a suitable drying method to use, rather than just dry with no other description.

6 A scientist reacts lead(II) nitrate solution with sodium bromide solution.

This is the equation for the reaction.

$$Pb(NO_3)_2(aq) + 2NaBr(aq) \rightarrow PbBr_2(s) + 2NaNO_3(aq)$$

(a) Describe how the scientist could obtain a pure dry sample of lead(II) bromide ($PbBr_2$) from the reaction mixture.

(3)

Filter the ~~to~~ lead bromide ~~solide~~ solid from the Sodium Nitrate solution.

Evaporate excess solution in an evaporating ~~basin~~ basin

leave to crystalise and cool

filter crystals from remaining solution

~~to~~ gently dry in a warm oven.

ResultsPlus
Examiner Comments

The candidate gained one mark for filtering the mixture. However they went on to evaporate the solution and allow the crystals to cool. In this case they are now forming the sodium nitrate crystals which is not what is asked for, so we cannot allow the drying method.

ResultsPlus
Examiner Tip

Make sure you are obtaining the pure dry sample of lead(II) bromide, not forming crystals from the filtrate.

Question 6 (b)

Most candidates performed well in this question gaining all three marks. As this is a "show that" question it is necessary to show all the working. Candidates who did not show all the working lost marks.

(b) The scientist reacts an excess of lead(II) nitrate solution with 25 cm^3 of sodium bromide solution of concentration 2.0 mol/dm^3. 0.025 ✓ 2 ✓

(i) Show that the amount of sodium bromide used is 0.050 mol.

(1)

mol = vol | Conc.

$0.025 \times 2 = 0.050 mol$

(ii) Show that the maximum theoretical mass of lead(II) bromide is approximately 9 g.

[for $PbBr_2$ $M_r = 367$]

$\frac{0.05}{2} = 0.025 mol$

(2)

actual = theoretical

$367 \times 0.025 = 9.175 g$

mass = M_r | mol

ResultsPlus Examiner Comments

This question gained all three marks as the candidate clearly showed all the working and the answers in both parts.

ResultsPlus Examiner Tip

Working must be shown to gain all three marks.

(b) The scientist reacts an excess of lead(II) nitrate solution with 25 cm^3 of sodium bromide solution of concentration 2.0 mol/dm^3.

$C = \frac{M}{V}$

(i) Show that the amount of sodium bromide used is 0.050 mol.

(1)

$M = C \times V$

$25\ cm^3 = 0.025\ dm^3$

$2 \times 0.025 = 0.050$ mol

(ii) Show that the maximum theoretical mass of lead(II) bromide is approximately 9 g.

[for $PbBr_2$ $M_r = 367$]

(2)

mol = 0.025

$M_r = 367$

$mol = \frac{M}{M_r}$

$M = Mol \times M_r$

$0.025 \times 367 = 9.175$

$9.175 \approx 9_g$

ResultsPlus
Examiner Comments

This candidate gained two marks. Part 6(b)(i) showed the working and gained the mark. In part (b)(ii) there was no working showing either 0.05 divided by 2 to give 0.025 or the ratio 2:1 = 0.05:0.025 so the first marking point cannot be awarded. However the second marking point is awarded as 0.025 x 367 = 9.175g is clearly shown.

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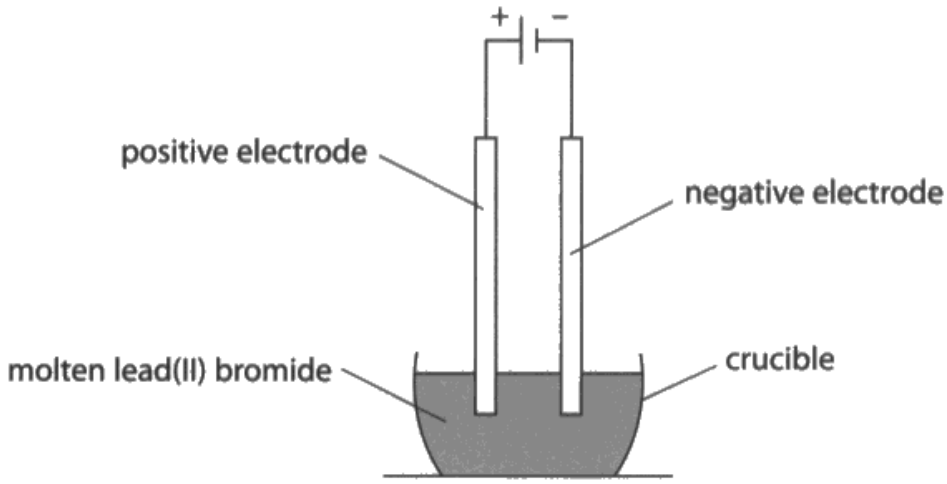
Examiner Tip

Note that the answer should be approximately 9g and if it is not you have made a mistake and should try again to find a value of approximately 9g.

Question 6 (c)(i)

The main focus of this question is to explain why solid lead(II) bromide does not conduct electricity but does conduct when it is molten. Only the stronger candidates score all three marks. Many lost the first marking point as there is no mention of the ions in fixed positions or in a lattice. More candidates gained the second marking point for stating that ions, electrons or charged particles are not free to move. Many candidates also lost the third marking point as they knew that the ions are free to move when molten but they failed to mention conducting electricity or carrying a current. A fair number of candidates stated that ions carry charge which is ignored. A fair number of candidates also stated that the electrons move when molten, which is incorrect so that is rejected and loses the third marking point.

(c) The scientist electrolyses molten lead(II) bromide using this apparatus.



(i) Explain why lead(II) bromide needs to be molten rather than solid for electrolysis to occur.

(3)

This is because it is an ionic compond so the ions can only move in a molten state so if it was solid ions wouldn't be able to move to each electrode.

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Examiner Comments

This response states that ions can move in a molten state, which is correct, but unfortunately there is no mention of conducting electricity or carrying a current, so the third marking point cannot be awarded. There is no mention of the ions either being in a fixed position or in a lattice so the first marking point cannot be awarded. They do state that in a solid the ions wouldn't be able to move so the second marking point can be awarded.

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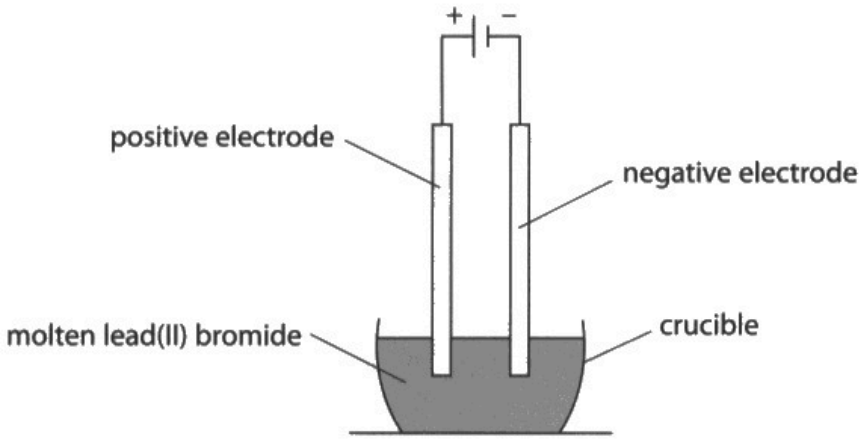
Examiner Tip

In order to gain the marks you need to explain why the ions are in fixed position and therefore that the ions cannot move. Also for electrolysis to occur you need to state why the ions are free to move when molten and that is why it can conduct electricity or the current can flow.

(c) The scientist electrolyses molten lead(II) bromide using this apparatus.



(i) Explain why lead(II) bromide needs to be molten rather than solid for electrolysis to occur.

(3)

lead (II) bromide is an ionic compound, when solid there are no mobile ions to conduct electricity, ~~when molten there~~ and ions are fixed in position. When molten, ions can move freely to conduct electricity, ~~it~~ electricity is need ~~to~~ for electrolysis to occur, hence lead (II) bromide has

ResultsPlus
Examiner Comments

This is a good answer which gains all three marks. Ions are in a fixed position and there are no mobile ions to conduct electricity. This scores the first two marking points. When molten ions can move freely to conduct electricity is the third marking point.

ResultsPlus
Examiner Tip

Explain why the ions are fixed and cannot move but when molten they are free to move and conduct electricity. Do not mention a solution or mobile electrons as marks will be lost.

Question 6 (c)(ii)

Many candidates gained two marks as they knew that graphite are suitable electrodes and stated either its ability to conduct electricity or to have a high melting point or sometimes stating that it is inert. Platinum is also an acceptable answer and was seen occasionally. Many candidates mentioned a transition metal such as copper, iron or zinc, which loses the first marking point but often stated that it has a high melting point or conducts electricity which is acceptable for the second marking point. No marks are allowed if there is an unsuitable metal as metals in group 1, 2 and 3 are too reactive.

(ii) The electrolyte is at a temperature of 400 °C.

Explain a suitable material for the electrodes.

(2)

Graphite because it conducts electricity due to its delocalised electrons and has a higher melting point than 400°c. Also graphite will not react with the electrolyte or the air

ResultsPlus
Examiner Comments

Graphite because it conducts electricity is enough for both marks. They have also gone on to say it has a higher melting point than 400^{o}C and it does not react with the electrolyte or the air. These comments are also true so there is no contradiction so no marks are lost.

ResultsPlus
Examiner Tip

Carbon is sometimes seen rather than graphite. This will lose the first marking point as carbon could be diamond or charcoal so this is ambiguous as they would not be suitable electrodes.

(ii) The electrolyte is at a temperature of 400 °C.

Explain a suitable material for the electrodes.

(2)

Copper - can conduct high level of electricity and has a high melting point

ResultsPlus
Examiner Comments

Copper is not a suitable electrode so loses the first marking point. However, as it is a transition metal the second marking point can be awarded for conducting a high level of electricity and has a high melting point.

ResultsPlus
Examiner Tip

Copper is sometimes used but it is not inert as the copper anode can dissolve in the electrolyte and produce Cu^{2+} ions, so they are not suitable electrodes when molten lead(II) bromide is used.

(ii) The electrolyte is at a temperature of 400 °C.

Explain a suitable material for the electrodes.

(2)

A metal because metals conduct electricity and also have very high melting points and could withstand 400° as a solid.

ResultsPlus
Examiner Comments

Just stating that a metal is used is too vague, as this could be an unsuitable metal so no marks can be awarded, as we do not know if it has a melting point higher than 400°C.

ResultsPlus
Examiner Tip

When asking for a suitable material, just stating a metal or a substance is too vague and no marks are awarded.

Question 6 (c)(iii)

Only the stronger candidates gave the correct equation. Common errors seen were having the incorrect charges or balancing incorrectly, adding 2Pb, which is incorrect.

(iii) Give the half-equation that occurs at the negative electrode.

cathode

$Pb^{2+}_{(l)} + 2e^- \longrightarrow Pb_{(s)}$

ResultsPlus Examiner Comments

The equation is correct. State symbols are not necessary but will not be penalised even if they are incorrect.

ResultsPlus Examiner Tip

Make sure the charges and the ions and atoms balance.

(iii) Give the half-equation that occurs at the negative electrode.

$Pb^{4+} + 4e^- \longrightarrow Pb$

ResultsPlus Examiner Comments

Even though the charges, atoms and ions balance, this is incorrect as the ion Pb^{4+} does not exist.

ResultsPlus Examiner Tip

The clue is in the question, as lead(II) bromide shows us that the charge on the lead ion is Pb^{2+} not Pb^{4+}.

Question 6 (d)(i)

Only the stronger candidates mentioned the brown gas or brown vapour. Common errors included brown liquid or brown solid. It must be a gas as the molten lead(II) bromide is heated to 400^{O}C. Some candidates did not mention the colour at all or gave the wrong colour. Orange or orange-brown was not accepted as this is just the bromine gas, not bromine water, which would have been orange.

Question 6 (d)(ii)

A common error was to state that bromine lost electrons, which was not accepted. However many candidates either just stated that electrons were lost or that bromide ions lost electrons. Both of these statements would gain the mark. A few candidates thought that electrons were gained.

(ii) State why the half-equation represents an oxidation reaction.

(1)

Because oxidation is the loss of electrons.

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Examiner Comments

This is sufficient to gain the mark.

ResultsPlus
Examiner Tip

Electrons are lost is all that is needed to gain the mark.

(ii) State why the half-equation represents an oxidation reaction.

(1

the bromine loses electrons

ResultsPlus
Examiner Comments

Bromine does not lose electrons so it does not gain the mark. If they had stated bromide ion loses electrons the mark would score.

ResultsPlus
Examiner Tip

The half-equation is shown in the question to help you answer the question correctly.

Question 7 (a)

Many candidates knew the definition and gained both marks. Some candidates lost a mark by not mentioning a pair of electrons and a few lost a mark for nucleus rather than nuclei. A few candidates did not score as they stated that electrons were shared between atoms, which was too vague. A few candidates mentioned ions which lost both marks or mentioned intermolecular forces which lost at least one mark.

7 This question is about hydrogen chloride (HCl).

Hydrogen chloride is a covalent compound.

(a) State, in terms of electrostatic attraction, what is meant by a covalent bond.

(2)

The strong electrostatic sorces of attraction between nudei and a shared pair of electrons.

ResultsPlus
Examiner Comments

This is a good answer and the correct definition.

ResultsPlus
Examiner Tip

Learn this definition as it is often asked.

7 This question is about hydrogen chloride (HCl).

Hydrogen chloride is a covalent compound.

(a) State, in terms of electrostatic attraction, what is meant by a covalent bond.

(2)

there are strong
When electrostatic forces between the shared electrons
and the nuclei of the two atoms involved

ResultsPlus
Examiner Comments

Unfortunately the candidate lost one mark for not mentioning a shared pair of electrons, but the nuclei of the two atoms involved was correct so scored one mark.

ResultsPlus
Examiner Tip

Always mention a shared pair of electrons and nuclei not nucleus.

7 This question is about hydrogen chloride (HCl).

Hydrogen chloride is a covalent compound.

(a) State, in terms of electrostatic attraction, what is meant by a covalent bond.

(2)

A covalent bond is when two non metals share electrons so that they both end up with a full outer shells.

Just sharing electrons between two non-metals is too vague and does not score.

When the question states in terms of electrostatic attraction you need to give the definition between the pair of electrons and the nuclei.

Question 7 (b)

A poorly answered question on the whole. There was a lot of confusion with candidates thinking that chlorine caused bleaching. Some candidates thought in the organic solvent it turned red, turned green or was bleached. Only the minority of candidates stated that the litmus paper stayed blue. Some candidates thought it was alkaline. Many candidates stated that the solution in water turned red but many then negated the mark by saying that it was bleached white.

(b) When hydrogen chloride gas is dissolved in an organic solvent, the hydrogen chloride remains a covalent molecule.

When hydrogen chloride gas is dissolved in water, ions are formed.

Explain what happens when dry blue litmus paper is dipped into separate samples of each solution.

When the HCl gas is in an organic solvent it bleaches the blue litmus to white. *
When the HCl gas ~~it~~ is in water the solution is acidic and so the blue litmus goes red

* as it stays in covalent form

ResultsPlus
Examiner Comments

The candidate stated that in the organic solvent bleaching occurred. HCl gas does not contain chlorine and stays as a covalent molecule so litmus paper stays blue. The candidate stated that in water the HCl turned acidic and the litmus goes red. This was enough for the third marking point, but just stating that it is acidic was not enough for the fourth marking point. Either H^+ ions or hydrochloric acid were needed for the mark.

ResultsPlus
Examiner Tip

Note that in order to bleach chlorine it must be a damp litmus paper and a chlorine molecule, not hydrogen chloride.

(b) When hydrogen chloride gas is dissolved in an organic solvent, the hydrogen chloride remains a covalent molecule.

When hydrogen chloride gas is dissolved in water, ions are formed.

Explain what happens when dry blue litmus paper is dipped into separate samples of each solution.

(4)

When dry blue litmus paper is placed in the an organic solvent, nothing will happen to it because there are no ions to react with the litmus paper. However, when it's placed in water, the litmus paper will become damp and since chloride ions are present, it will turn from blue to red and then bleach white.

ResultsPlus
Examiner Comments

The candidate gained the first two marks by stating that nothing will happen to the litmus paper as there are no ions present. Unfortunately the candidate thought that the chloride ions in water went red and was then bleached white. This negated the next two marks.

ResultsPlus
Examiner Tip

Note that chloride ions are not the same as chlorine and chloride ions do not bleach damp litmus paper.

(b) When hydrogen chloride gas is dissolved in an organic solvent, the hydrogen chloride remains a covalent molecule.

When hydrogen chloride gas is dissolved in water, ions are formed.

Explain what happens when dry blue litmus paper is dipped into separate samples of each solution.

(4)

when dry blue litmus is dipped into the organic solvent and hydrogen chloride there is no colour change. this is because the solution is not acidic, as the hydrogen chloride remains as a covalent molecule.

when dry blue litmus is dipped into the water with hydrogen chloride gas dissolved, it turns red. this is because the pH of the second solution is acidic. this is because dissolved in water, the HCl forms ions - one of which being H^+ ions. H^+ ions in a solution means it is acidic, and hydrochloric acid forms.

ResultsPlus
Examiner Comments

This is a good answer that gained all four marks. The candidate stated that in the organic solvent there was no colour change as the solution is not acidic. They went on to say that when the litmus dipped in the water containing hydrogen chloride it turned red as H^+ ions are present and hydrochloric acid forms.

ResultsPlus
Examiner Tip

The clue is in the question, so read it carefully. In the organic solvent hydrogen chloride remains a covalent molecule, but hydrogen chloride in water ions are formed.

Question 7 (c)

Many candidates gained all three marks in Q07(c)(i). A common error was to give +184 rather than –184, which gained two marks and if it was positive the energy diagram should then be endothermic. Some candidates also either multiplied the first two bond energies twice or forgot to multiply the H-Cl bond energy by two. Common errors in Q07(c)(ii) included, not giving the formulae of reactants and products, forgetting to put 2 in front of HCl or the arrows were sometimes too long or too short to score. A few candidates missed out the hump, which limited them to a maximum of two marks.

(c) In the presence of ultraviolet radiation, hydrogen reacts with chlorine to form hydrogen chloride.

This is the equation for the reaction.

H-H Cl-Cl 2x H-Cl

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$$

The table shows the bond energies.

Bond	H—H	Cl—Cl	H—Cl
Bond energy in kJ/mol	436	242	431

(i) Calculate the enthalpy change (ΔH), in kJ/mol, for the reaction.

Include a sign in your answer.

BB-BM:

(3)

BB: 436+242=678

BM: 431x2 = 862

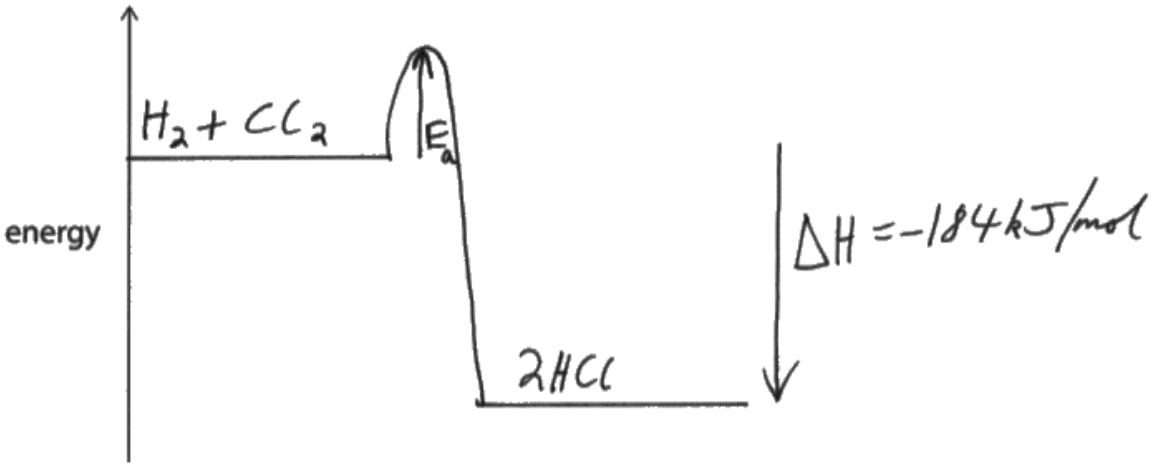
678-862 = -184

ΔH = −184 kJ/mol

(ii) Draw a reaction profile for the reaction.

Label the reactants, the products, ΔH and the activation energy (E_a).

(4)



ResultsPlus
Examiner Comments

This was a good answer which gained all seven marks. Working was clearly shown and gave the correct answer of –184. The diagram was exothermic and correct, with correct reactants and products and acceptable arrows showing Ea and deltaH.

ResultsPlus
Examiner Tip

When drawing the diagram use a ruler and make sure the arrows are the correct length and point them in the correct direction.

(c) In the presence of ultraviolet radiation, hydrogen reacts with chlorine to form hydrogen chloride.

This is the equation for the reaction.

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$$

H - H Cl - Cl → 2(H - Cl)

The table shows the bond energies.

Bond	H—H	Cl—Cl	H—Cl
Bond energy in kJ/mol	436	242	431

(i) Calculate the enthalpy change (ΔH), in kJ/mol, for the reaction.

Include a sign in your answer.

(3)

436 + 242 → 2(431)

678 → 862

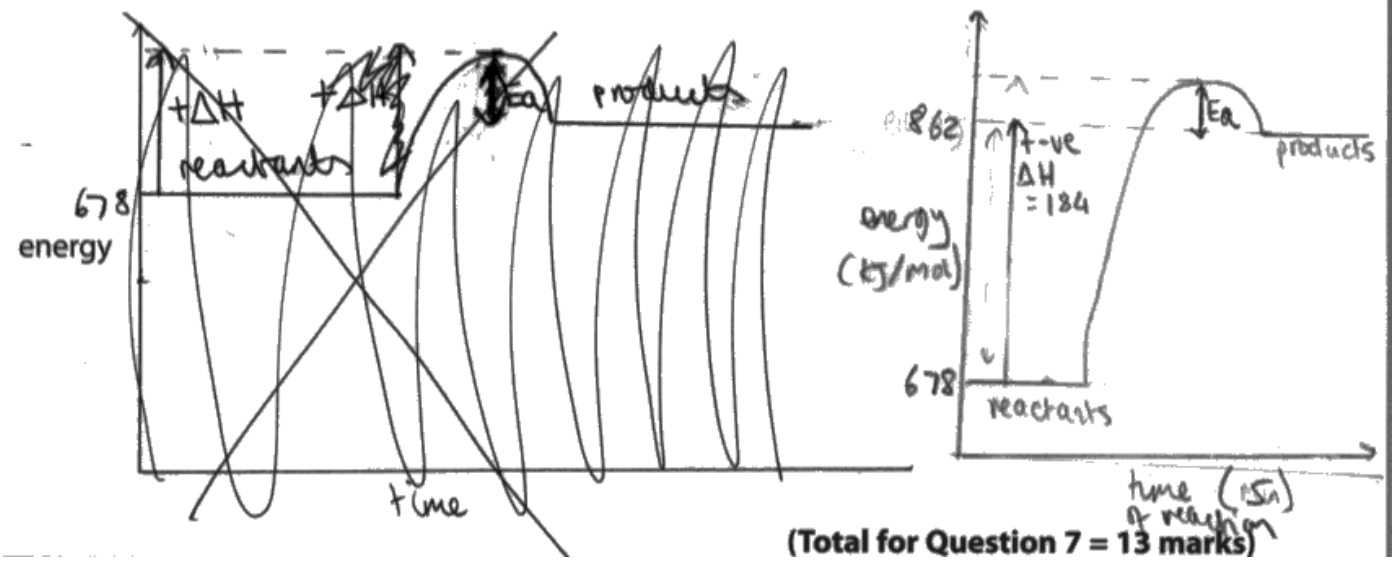
862 − 678 = 184

ΔH = 184 kJ/mol

(ii) Draw a reaction profile for the reaction.

Label the reactants, the products, ΔH and the activation energy (E_a).

(4)



(Total for Question 7 = 13 marks)

ResultsPlus
Examiner Comments

This candidate gained two marks in Q07(c)(i) as the bond energies were correct but the subtraction was the wrong way round, so the sign would be +184 and endothermic. The shape of the curve was correct as it is endothermic, so error carried forward. The arrow showing deltaH was correct and as it was endothermic the arrow pointing upwards was correct. No marks for the formulae of reactants and products and Ea is incorrect as it should go from the reactants to the top of the hump, not from the products.

ResultsPlus
Examiner Tip

Make sure you give the correct formulae as shown in the equation. Ea must start from the reactants up to the hump, which was a common error for an endothermic reaction.

(c) In the presence of ultraviolet radiation, hydrogen reacts with chlorine to form hydrogen chloride.

This is the equation for the reaction.

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$$

The table shows the bond energies.

Bond	H—H	Cl—Cl	H—Cl
Bond energy in kJ/mol	436	242	431

(i) Calculate the enthalpy change (ΔH), in kJ/mol, for the reaction.

Include a sign in your answer.

(3)

$Q = m \times c \times \Delta T$

$(436 \times 2) + (242 \times 2) = 1356$

$(2 \times 431) = 862$

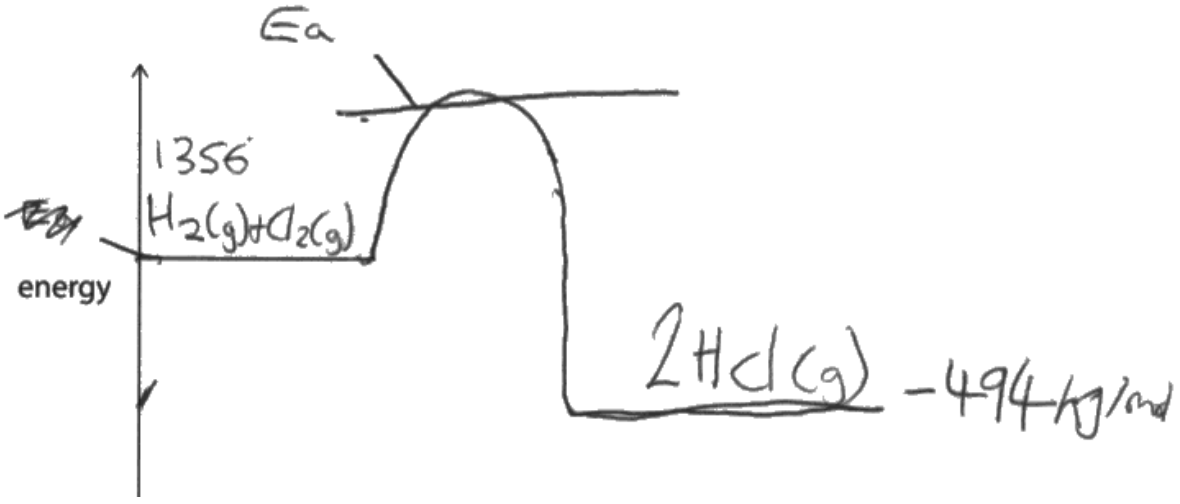
$1356 - 862 =$

$\Delta H =$ - 494 kJ/mol

(ii) Draw a reaction profile for the reaction.

Label the reactants, the products, ΔH and the activation energy (E_a).

(4)



ResultsPlus
Examiner Comments

1356 is incorrect as they should not have multiplied each bond by two. 1356 –862 should be +494, but on the answer line it is –494 which is incorrect, so just one mark for 862. As the answer line is negative the energy diagram is exothermic, which is fine for the first marking point and the reactants and products are correct for the second marking point. However no more marks can be awarded as the lines or arrows are not shown for deltaH and Ea.

ResultsPlus
Examiner Tip

Make sure you draw the lines or arrows for deltaH and Ea and clearly label them.

Paper Summary

Based on their performance on this paper, candidates should:

- Make sure you read the questions carefully as there were clues in the question.
- Learn the standard definitions as they are tested often.
- Not waste time repeating the stem of the question as this is not creditworthy.
- Make sure when plotting a graph that the points are clear and there are smooth curves through the points and not dot to dot.
- Show working on the graph as marks will be lost if no working is shown.
- Make sure you show **all** the working in a 'show that' question or marks will be lost.

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