Qualification Accredited

Oxford Cambridge and RSA

GCSE (9-1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE COMBINED SCIENCE B

J260
For first teaching in 2016

J260/06 Summer 2019 series

Version 1

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates. The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report. A full copy of the question paper can be downloaded from OCR.

Paper 6 series overview

J260/06 is the higher tier paper for the chemistry component for the GCSE (9-1) Combined Science B (Twenty First Century Science). The paper covers all the chemistry content of the specification.

To do well on this paper candidates need to have a good factual knowledge and to be able to apply it. They need to have experienced a range of practical techniques and have an understanding of when such techniques are applied. They need to have a range of basic mathematical skills.

Candidate performance overview

Candidates who did well on this paper generally did the following.

- Performed calculations using the mole concept and use of standard form: 2a(iii), 8a(iii)
- Produced clear and concise responses for Level of Response Question: 6a
- Used the information in the question and their knowledge to explain concepts:1b(iv), 3b(iii), 7c(i), 7c(ii), 8b(ii), 9a, 10c

Candidates who did less well on this paper generally did the following.

- Found it difficult to recall factual information: 2a(i), 5c(i), 6b, 8b(ii), 9b
- Produced responses that lacked detail, sometimes simply repeating information provided: 1b(iii), 1b(iv), 4a, 5a, 7c(ii), 7c(iii)
- Showed little practical knowledge: 3a, 3b(i), 4b(i), 7b(i), 7b(ii)

Question 1 (a) (i) and (a) (ii)

1 Alkanes are a family of hydrocarbons in crude oil. They all have the same general formula, C_nH_{2n+2}.

Table 1.1 shows some information about alkanes.

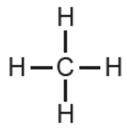
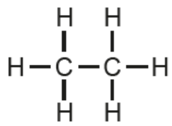
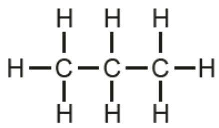
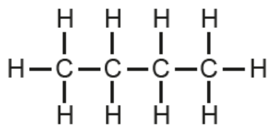
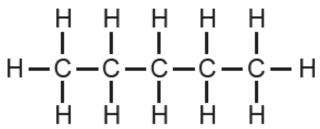
Alkane	**Number of carbons**	**Molecular formula**	**Empirical formula**	**Structural formula**	**Melting point (°C)**	**Boiling point (°C)**
Methane	1	CH_4	CH_4		–182	–161
Ethane	2	C_2H_6	CH_3		–183	–88
Propane	3	C_3H_8	....		–188	–42
Butane	4	C_4H_{10}	....			0
Pentane	5	C_5H_{12}	C_5H_{12}		–130	36
Hexane	6	....	C_3H_7	....	–95	

Table 1.1

(a) (i) Complete the blank spaces in **Table 1.1** to show the missing formulae. **[3]**

(ii) Which statements about a **structural formula** are **true** and which are **false**?

Tick (✓) **one** box in each row.

Statement	**True**	**False**
It shows the simplest ratio of atoms in a molecule.		
It shows how many atoms are in a molecule.		
It shows how the atoms in a molecule are arranged.		
It shows the molecule in 3D.		

[2]

Higher ability candidates showed a good understanding of the three different types of formula.

In (a)(i), some candidates did not know the difference between the molecular formula and the empirical formula. A few also gave C_3H_7 as the molecular formula for hexane. The structural formula for hexane was generally well drawn with all atoms shown. A few candidates omitted the bonds between the carbons.

Good understanding of structural formulae was shown in (a)(ii). Some thought structural formulae showed the simplest ratio of atoms in a molecule.

?	**Misconception**	The empirical formula for butane was C_4H_{10} the same as the molecular formula

Question 1 (b) (i) and (b) (ii)

(b) **(i)** Predict the **boiling point** of hexane.

Use the data in **Table 1.1** to help you.

Boiling point = ... °C **[1]**

(ii) Explain why it is difficult to use the data in **Table 1.1** to predict the **melting point** of butane.

....

....

.... **[1]**

Higher ability candidates used the trend in boiling points to predict the boiling point of hexane and understood that the absence of a regular trend in melting points made it difficult to predict the melting point of butane. Less able candidates thought that butane's boiling point of 0°C made it difficult to predict its melting point.

Question 1 (b) (iii)

(iii) What is the state of pentane at 25 °C?

Explain your answer.

State: ....

Explanation: ....

.... **[2]**

Most candidates identified that pentane would be a liquid at 25°C with many going on to explain that this was because the temperature was higher than the melting point and lower than the boiling point. Less able candidates quoted the melting point and/or the boiling point without explaining the significance.

Exemplar 1

State: Liquid

Explanation: The boiling point of pentone is 36°C while the melting point is -130°C **[2]**

This candidate correctly identifies that pentane will be a liquid. They go on to quote both the melting point and the boiling point but do not explain why this means that pentane will be a liquid at 25°C so does not gain the second mark.

Question 1 (b) (iv)

(iv) Explain the trend in boiling points in **Table 1.1**.

Use ideas about energy and intermolecular forces in your answer.

....

....

....

.... **[2]**

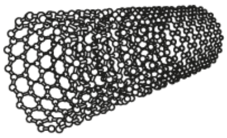
Higher ability candidates identified the link between boiling point and size of molecule and explained this in terms of intermolecular forces. Lower ability candidates described the trend as just down the table without the link to size of molecule. Many confused intermolecular forces with bonds between atoms or just referred to weaker bonds without specifying between molecules.

Question 2 (a) (i)

2 Carbon nanotubes were discovered in 1991.

Materials made from nanotubes can be used instead of steel because nanotubes are very strong. They are a few nanometres wide and up to 1 cm long.

The structure of a nanotube is shown below.



(a) (i) Nanotubes are nanoparticles.

Which statement explains why nanotubes are nanoparticles?

Tick (✓) **one** box.

They have covalent bonds.	☐
Their diameters are between 1 to 100 nm.	☐
They are made of carbon.	☐
They are hollow tubes.	☐

[1]

Most candidates correctly identified the size as the reason why nanotubes are nanoparticles. The presence of covalent bonds was the most common incorrect choice.

Question 2 (a) (ii)

(ii) Which two statements explain why nanotubes are very strong?

Tick (✓) **two** boxes.

Bonds between carbon atoms are strong.	☐
Lots of bonds must be broken to break the tube.	☐
The nanotubes have a hollow centre.	☐
They are very small.	☐
They have a large surface area.	☐

[2]

Higher ability candidates understood that it was the strength and number of bonds to be broken that determined the strength. Less able candidates chose the large surface area as one of the reasons.

Question 2 (a) (iii)

(iii) Nanotubes are a similar shape to a human hair but they are much smaller.

A human hair has a diameter of 0.001 mm.
A nanotube has a diameter of 2 nm and a length of 5 mm.

A scale model of a nanotube has the **same** diameter as a human hair.

What is the length of the scale model in mm?

$1\,\text{nm} = 1 \times 10^{-6}\,\text{mm}$

Length = ... mm **[3]**

The higher ability candidates were able to both convert units and use ratios to calculate the length of the scale model. Some candidates were able to convert between nm and mm but were then unable to calculate the length.

Question 2 (b)

(b) Short nanotubes can also be used to carry medicines into the body.

The medicine is put inside the tube and the tube is injected into the body.

Give **one** benefit and **one** risk of using nanotubes to carry medicines into the body.

Benefit

....

....

Risk

....

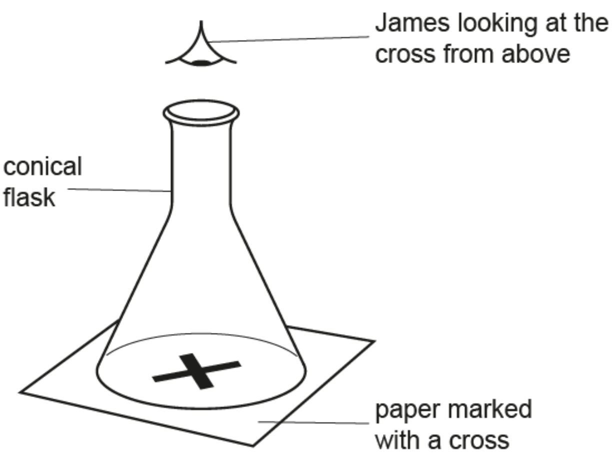
.... **[2]**

Higher ability candidates applied their knowledge of nanoparticles to identify a benefit and risk of using nanotubes to deliver medicines. Many chose benefits that would not be unique to using nanotubes rather than injecting the drug directly. Risks identified by lower ability candidates were often too vague such as may harm the body.

Question 3 (a)

3 James investigates the effect of concentration of acid on the rate of reaction, using dilute hydrochloric acid and sodium thiosulfate solution.

He stands a conical flask on a piece of paper marked with a cross.



He adds the reactants to the flask and immediately starts a stop watch.

He looks at the cross from above and stops timing when the cross becomes hidden by the contents of the flask.

This is the equation for the reaction.

$$2HCl(aq) + Na_2S_2O_3(aq) \longrightarrow S(s) + SO_2(g) + 2NaCl(aq) + H_2O(l)$$

(a) Explain why the cross becomes hidden by the contents of the flask.

....

....

.... **[2]**

Most candidates understood that the cross became hidden as the solution went cloudy. Higher ability candidates used the equation to identify the cloudiness as being caused by the formation of sulfur/solid. Lower ability candidates thought that the cloudiness was caused by gas bubbles or that the cross was hidden due to a colour change.

Question 3 (b) (i)

(b) James does four experiments. He uses the same volume of sodium thiosulfate solution each time ($10\,cm^3$).

He varies the concentration of dilute hydrochloric acid by adding different amounts of the acid and water together each time.

Here are James' results:

Experiment	Volume (cm^3)			Time taken (s)
	$Na_2S_2O_3$	HCl	H_2O	
1	10.0	10.0	30.0	74
2	10.0	20.0	20.0	42
3	10.0	30.0	10.0	32
4	10.0	40.0	0	25

(i) Suggest a piece of apparatus that James could use to accurately measure out the dilute acid, water and sodium thiosulfate.

.... **[1]**

Most candidates chose a piece of apparatus with suitable precision. Lower ability candidates suggested beakers, flasks, test tubes or measuring tubes.

Question 3 (b) (ii)

(ii) Explain why different volumes of water are used for each experiment.

....

....

.... **[2]**

Most candidates understood that the volume of water was varied in order to control the concentrations of the solutions. Many answers were too vague, just stating that it was to see the effect of water on the rate. Some understood that it affected the concentrations but did not make clear how it affected them, or which solution was affected. Higher ability candidates identified that it meant that the total volume of solution was kept the same so that the volume of acid added was proportional to the concentration.

Question 3 (b) (iii)

(iii) Describe and explain the effect of changing the concentration of hydrochloric acid on the rate of reaction.

Use ideas from the particle model in your answer.

....

....

....

....

....

.... **[3]**

Many candidates identified the link between the concentration of the acid and the rate of reaction. Some used the data in the table correctly, but linked volume of acid used with time taken for the reaction instead of concentration with rate. Higher ability candidates understood that the change in rate was due to a change in the frequency of collisions with a few going on to explain this by referring to the closeness of the particles. Lower ability candidates referred to energy changes of the particles.

Exemplar 2

At lower concentrations of hydrchloric acid, it takes longer for it to react with the sodium thiosulfate as there are many water ~~molecl~~ molecules in they way. ~~Hydroclorich~~ Hydrochloric acid does not react with water, so a hydrochloric acid molecule will bounce ~~off~~ off of the water molecule unti it would meet a sodium thiosulfate molecule to react with **[3]**

This response has linked concentration of the acid with the rate of reaction and has explained this by referring to the number of particles per cubic centimetre and the resultant change in the frequency of collisions. This is a 3-mark response.

Exemplar 3

~~liquids have intermolecular forces not as strong as solids, they (particles) (water molecules) hold them together however, they move randomly ... HCl~~

When there is more particles in a more contained area, there is more ~~contained area~~ successful collisions between the ~~acid~~ reactants to bond. this also happens in liquid state. The intermolecular forces between water molecules are ~~...~~ stronger compared to gas particles. Therefore, more HCl (hydrochloric acid), ~~more~~ faster reaction. ~~and successful collisions~~. **[3]**

This response gets 1 mark for the idea of more particles within a given volume. It refers to number of collisions rather than frequency and links rate with amount of acid rather than concentration of acid, so no further marks gained.

Question 4 (a)

4 Many countries with sunny climates get most of the salt they need from seawater.

The seawater is trapped in shallow pools and left in the sun. After some time, piles of solid salt can be collected.

(a) Why does this method work well in countries with warm climates?

....

.... **[2]**

Most candidates realised that the salt is obtained by evaporation of the water. Higher ability candidates understood that it would be speeded up by a warm climate. A few candidates talked about the water boiling or a lack of rainfall.

Question 4 (b) (i)

(b) Piles of solid salt contain insoluble impurities such as sand.

(i) Jack collects a sample of solid salt.

Describe an experiment that Jack could do to find out an accurate value for the mass of **pure salt** in his sample.

....

....

....

....

....

.... **[4]**

Higher ability candidates showed a good knowledge of this basic separation technique and gave a clear step by step description of the technique. Some did not mention weighing the salt after it had been collected. Many did not include the need to initially add water to the solid mixture and so struggled to produce a logical method. A few just suggested random techniques such as fractional distillation.

Question 4 (b) (ii)

(ii) Here are the results of one experiment.

Mass of salt mixed with sand = 5.42 g

Mass of pure salt obtained = 1.36 g

Calculate the **percentage** of pure salt in the sample.

Give your answer to **3** significant figures.

Percentage = ... % **[3]**

Most candidates correctly calculated this percentage and gave their answer to 3 significant figures. Some assumed that the given mass of mixture was for the sand only and so added the two figures together to find the mass of the mixture.

Question 5 (a)

5 Lithium is one of the elements in Group 1 of the Periodic Table. Lithium atoms have the electron arrangement 2.1.

(a) Give **one** similarity and **one** difference in the way that the electron arrangement of Lithium is the same as the electron arrangements of other atoms in Group 1 of the Periodic Table.

Similarity: ....

....

Difference: ....

.... **[2]**

Most candidates knew that all the elements in Group 1 have the same number of electrons in their outer shell. Many also knew that they had different numbers of electron shells. A few said they had the same number of outer shells. Lower ability candidates just said different numbers of electrons or described trends in reactivity.

Question 5 (b)

(b) Explain why elements on the left of the Periodic Table are metals.

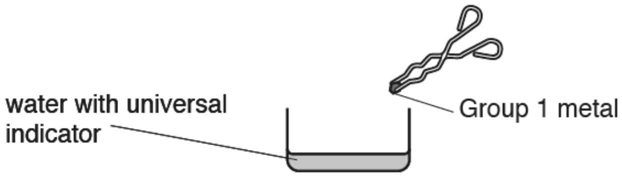
....

.... **[2]**

High ability candidates related the position in the Periodic Table to the number of electrons in the outer shell and linked this with loss of electrons to form cations, a characteristic of metals. Some just discussed the loss of electrons without relating it to the position in the Periodic Table. Many described physical properties of metals or compared reactivity of elements on either side of the Periodic Table.

Question 5 (c) (i)

(c) Beth is a chemistry teacher. She does experiments to show the reactivity of the Group 1 metals with water.



She places a small piece of lithium into the water with universal indicator and notes her observations.

(i) Name the **two** products of the reaction between lithium and water.

.... **and** ....
[2]

Most candidates knew at least one of the products of this reaction. Many gave products containing atoms of elements not present in the reactants. Common incorrect responses were lithium oxide, water, oxygen and carbon dioxide.

Question 5 (c) (ii)

(ii) What **two** changes will Beth **see** when these products form?

1. ....

....

2. ....

.... **[2]**

Most candidates gave a description of gas formation. A few also described the change in colour to blue due to the formation of an alkali. Many just said that there would be a colour change without specifying what it would be. Others said that the metal would change colour.

Question 5 (c) (iii)

(iii) Beth repeats her experiment with sodium and then potassium. She uses fresh water and indicator each time.

How will the observations from her experiments show the trend in reactivity of the Group 1 metals?

....

....

.... **[2]**

Most candidates knew that the Group 1 metals become more reactive down the group. More able candidates recalled the observations for sodium and potassium and used them to justify the trend.

Question 6 (a)

6 (a)* The table shows the emissions of nitrogen oxides and carbon monoxide from 1980 to 2015 for cars in the UK.

Catalytic converters have been fitted to all new cars since 1993.

Year	1980	1985	1990	1995	2000	2005	2010	2015
Nitrogen oxides emissions (kilotonnes)	532	631	853	654	400	271	165	148
Carbon monoxide emissions (kilotonnes)	3483	3943	4727	3933	2333	1566	720	331

Using the data in the table, discuss **how** and **why** the emissions from cars has changed from 1980 to 2015.

Your answer should include descriptions of the reactions that produce the emissions, including those that occur in the catalytic converter.

.... **[6]**

This level of response question was aimed up to grades 7-9. Most candidates were able to use the data to describe the changes in emissions over the time period. Some lacked detail, for example, just describing an overall decrease from start to finish without referring to the initial increase. Higher ability candidates included descriptions of the reactions which produced these emissions and the reactions that removed them in the catalytic converter. The chemistry of the formation and reduction of carbon monoxide was better understood than that of nitrogen monoxide. Some described how catalysts speed up a reaction without relating it to the reactions involved. Candidates were most successful when they used the question to structure their response.

Question 6 (b)

(b) Car emissions also contain small amounts of sulfur dioxide.

The amount of sulfur dioxide emitted by cars in 2019 is much less than it was 20 years ago.

Which two statements about sulfur dioxide emissions **from cars** are true?

Tick (✓) **two** boxes.

Modern cars have gas scrubbers fitted.	☐
Modern petrol contains less sulfur.	☐
Sulfur dioxide forms in cars when sulfur gas reacts with oxygen.	☐
Sulfur dioxide forms when sulfur compounds burn.	☐
Sulfur dioxide is formed in the catalytic converter.	☐
The catalytic converter absorbs solid sulfur.	☐

[2]

Higher ability candidates knew that sulfur dioxide is formed when sulfur compounds burn and that modern petrol contains less sulfur. Many candidates thought that sulfur dioxide is formed when sulfur gas reacts with oxygen or that modern cars have gas scrubbers fitted.

Question 7 (a)

7 Hydrogen peroxide (H_2O_2) is made in the body.

An enzyme breaks down the hydrogen peroxide into water and oxygen before it can damage cells in the body.

(a) Write a balanced symbol equation for the breakdown of hydrogen peroxide into water and oxygen.

.... **[2]**

Most candidates produced a correctly balanced equation.

?	**Misconception**	Hydrogen is produced instead of water.

Question 7 (b) (i) and (b) (ii)

(b) Ben investigates how this enzyme affects the rate of breakdown of hydrogen peroxide at different temperatures.

He uses a solid enzyme and a solution of hydrogen peroxide.

(i) Give **two** variables which Ben must keep constant at each temperature.

1 ....

2 ....
[2]

(ii) When Ben does a trial experiment he finds that the reaction is very slow.

What changes can he make for the reaction to be faster at each temperature?

....

.... **[2]**

Most candidates gave at least one suitable variable which must be kept constant for part (i). A few missed that it was comparing rates at different temperatures and chose temperature as a variable to keep constant. Higher ability candidates went on to suggest at least one change that would make the reaction faster for part (ii). Many gave suggestions not appropriate to this experiment such as increase the temperature or add a catalyst.

Question 7 (c) (i)

(c) Ben uses his results to plot a graph of the rate of reaction against temperature, as shown in **Fig. 7.1**.

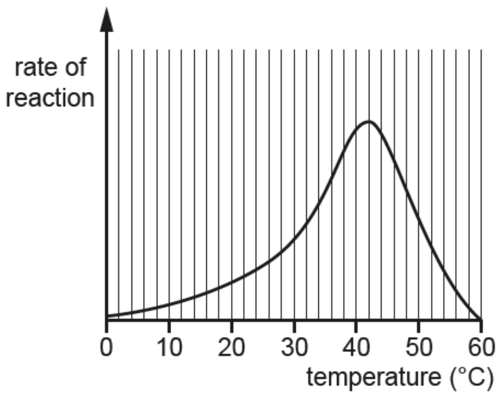


Fig. 7.1

(i) Explain why, initially, the rate of reaction increases as the temperature increases.

Use ideas from the particle model in your answer.

....

....

....

.... **[2]**

Higher ability candidates understood that increasing the temperature increased the energy of the particles. A few went on to explain that this led to an increase in the number of successful collisions. Many just referred to an increase in frequency or number of collisions. Lower ability candidates often discussed denaturing of enzymes instead of explaining the increase in rate of reaction as the temperature increases.

Question 7 (c) (ii)

(ii) Describe how the rate of reaction changes at temperatures above 30 °C.

Explain your answer.

....

....

.... **[3]**

Most candidates either described the increase in rate followed by a decrease or referred to denaturing of the enzyme. Many did both. A few high ability candidates went on to explain why the denaturing of the enzyme led to a decrease in rate, for example, using the idea that the active sites were no longer available and so the enzyme cannot function as a catalyst.

Question 7 (c) (iii)

(iii) What is the optimum temperature for the reaction shown in **Fig. 7.1**?

Optimum temperature = ... °C **[1]**

Most candidates successfully read the optimum temperature from the graph given.

Question 8 (a) (i)

8 Zinc metal is extracted from zinc blende (ZnS). The zinc blende is roasted in oxygen to form zinc oxide and sulfur dioxide.

zinc blende + oxygen ⟶ zinc oxide + sulfur dioxide

The zinc oxide is then heated with carbon at high temperature to form zinc and carbon dioxide. The zinc gas is cooled in an inert atmosphere to form solid zinc.

$$2ZnO(s) + C(s) \longrightarrow 2Zn(g) + CO_2(g)$$

(a) (i) Explain what has happened to the zinc oxide in this reaction.

.... **[1]**

Higher ability candidates identified that the zinc oxide is losing oxygen in this reaction or that the zinc is being displaced from the zinc oxide. Many just describe the reaction without focussing on the zinc oxide.

Question 8 (a) (ii)

(ii) Why is zinc gas cooled in an inert atmosphere rather than in air?

....

.... **[2]**

Those candidates who understood that an inert atmosphere is unreactive realised that the hot zinc would react in air. Higher ability candidates referred to a reaction with oxygen or the formation of zinc oxide. Many candidates thought that the zinc would not cool as quickly in air or that it would be dangerous or harmful to humans.

Question 8 (a) (iii)

(iii) What is the maximum mass of zinc that can be extracted from 10 tonnes of zinc oxide?

Mass of zinc = ... tonnes **[3]**

The higher ability candidates successfully used the equation to calculate the mass of zinc produced. Some calculated the relative formula mass of the zinc oxide correctly but were unable to relate this to the zinc. Others worked out the relative mass of two zinc oxides without realised that they would also have to double the zinc. A few thought that zinc oxide had two zinc atoms and one oxygen. Many either juggled with random numbers or omitted this question altogether.

Question 8 (b) (i)

(b) Carbon cannot be used to extract aluminium from aluminium oxide.

(i) What method is used to extract aluminium?

.... **[1]**

Most candidates knew that aluminium is extracted using electrolysis. Many candidates who did not know this suggested separation techniques such as distillation or filtration.

Question 8 (b) (ii)

(ii) Explain why carbon can be used to extract zinc but **not** aluminium.

....

....

.... **[2]**

Higher ability candidates clearly compared the reactivity of carbon with zinc and aluminium to explain why zinc can be extracted using carbon, but aluminium cannot. Some only gave an explanation for one of the metals. Others understood that it was to do with reactivity but could not relate it correctly to carbon.

Question 8 (c)

(c) There are piles of waste rock left near to old zinc mines. The rock contains lead impurities. Lead is toxic and may get into streams and rivers.

A new method called phytoextraction uses plants to remove the lead impurities from the piles of waste rock.

Describe how plants can be used to completely remove the lead impurities from the piles of waste rock near old zinc mines.

....

....

....

....

....

.... **[3]**

Most candidates had some ideas about how plants could be used to remove the lead. Higher ability candidates described planting the plants on the site, absorption of lead by the plants and removal of the lead containing plants from the site. Some confused the lead waste product with the zinc from the mines. A few candidates thought that the plants would use the lead as a nutrient or that photosynthesis would remove the lead, for example, by the oxygen produced turning the lead to lead oxide.

Question 9 (a)

9 Charcoal used on a barbecue is a form of carbon.

When charcoal burns in plenty of air it forms carbon dioxide. The reaction is **exothermic**.

$C(s) + O_2(g) \rightarrow CO_2(g)$

(a) David uses a burning firelighter to make some of the charcoal start to burn.

When the firelighter has been used up, the fire continues to spread until all the charcoal is burning.

Explain why the charcoal will not start to burn without using the firelighter **and** why the fire spreads after the firelighter is used up.

....

....

....

.... **[3]**

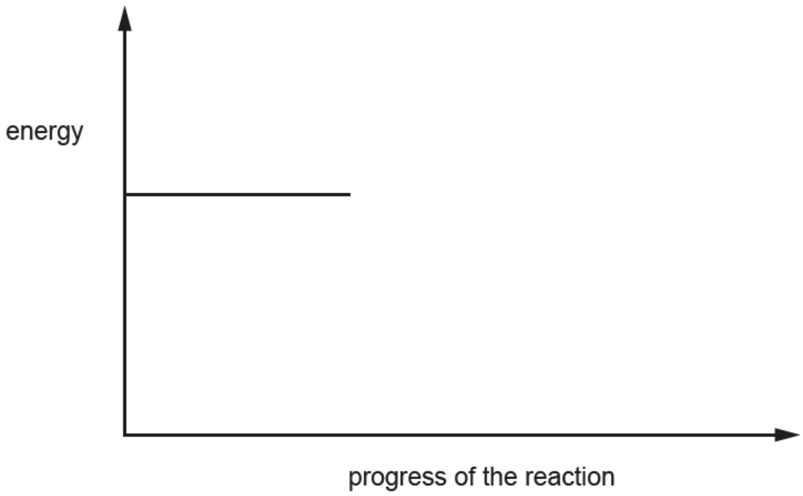
The higher ability candidates understood that activation energy was needed before the charcoal could react and that this was initially supplied by the firelighter and then by the heat produced by the reaction. The role of the firelighter in supplying energy was the most understood. Some realised that the information given that the reaction was exothermic was important but were not always able to explain its role in spreading the fire. Many candidates thought that the spread was connected to presence or lack of oxygen or that it was spread by carbon dioxide.

Question 9 (b)

(b) Complete the reaction profile diagram for the combustion of charcoal.

Include the following labels on your diagram:

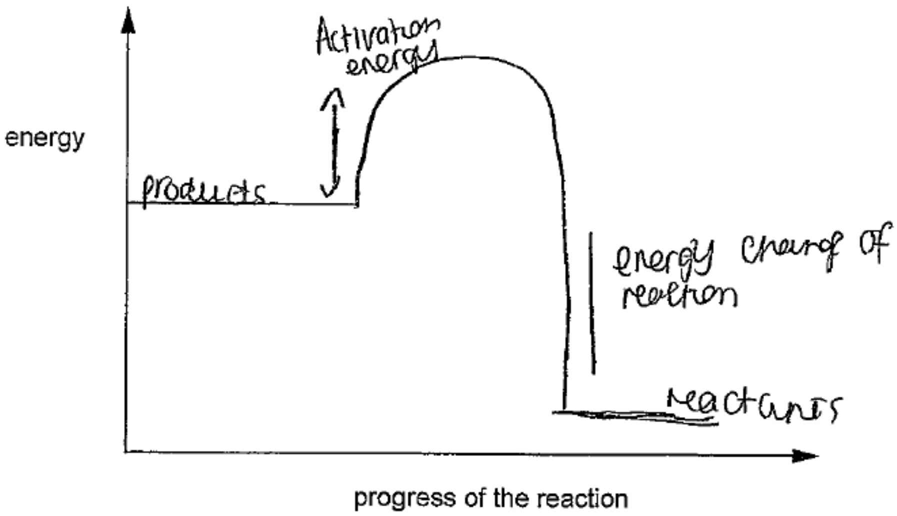
reactants **products** **activation energy** **energy change of reaction**



[4]

The relative energy levels of reactants and products and the overall shape of an energy profile were well understood. A few candidates showed the products at higher energy than the reactants or the products at the start of the reaction and the reactants at the end. Higher ability candidates also drew and labelled arrows to show the activation energy and energy of reaction. Some showed they had the right idea but drew arrows that did not clearly start or end at the appropriate energy level. Others did not show the energy change of reaction starting at the reactants and finishing at the products.

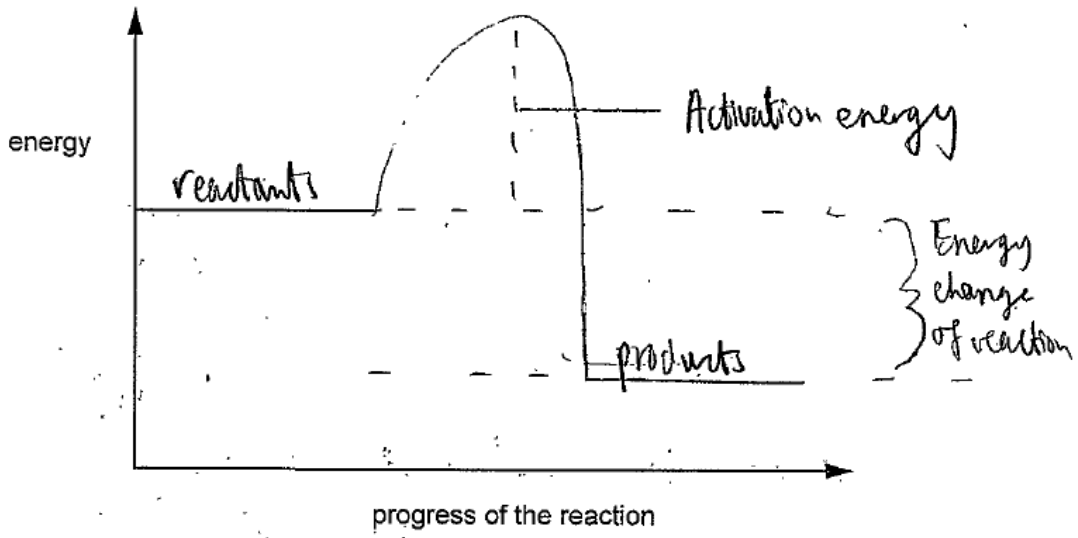
Exemplar 4



[4]

This candidate has the right idea and shows the shape of the profile clearly for 1 mark. They have shown the products at the start of the reaction and the reactants at the end, so this does not gain a mark. The activation energy and energy change of reaction are in the correct positions but are not clearly starting and ending at the correct levels.

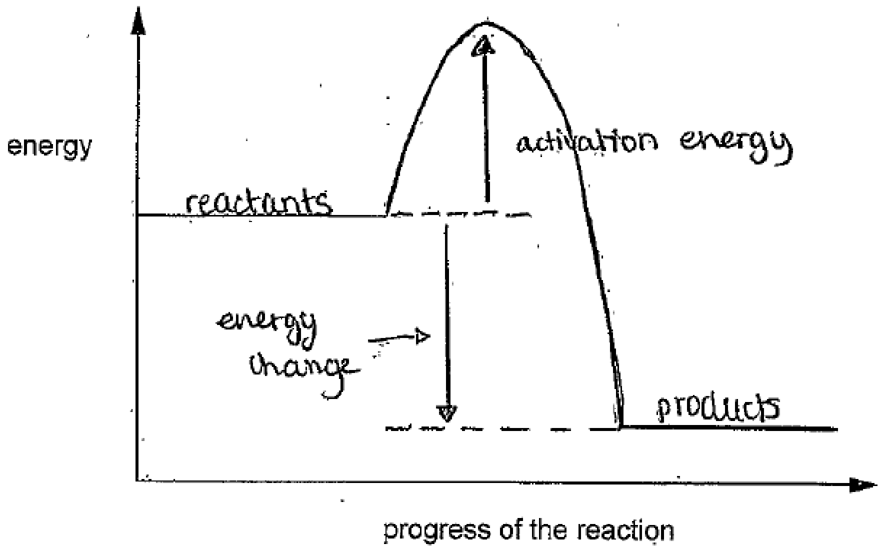
Exemplar 5



[4]

This response scores 3 marks for showing the correct shape and for correctly labelling the reactants, products and activation energy. The label for the energy change of reaction is in the correct position but is not shown going down from the reactants to the products.

Exemplar 6



[4]

This response shows a fully correct diagram. The arrows are not quite touching the correct levels but are near enough to show what the candidate intends.

Question 9 (c)

(c) When charcoal burns in insufficient air it forms carbon monoxide.

Carbon monoxide can also act as a fuel.

$2CO(g) + O_2(g) \rightarrow 2CO_2(g)$

Calculate the energy given out when **1 mole** of carbon monoxide burns in air.

Use the table of bond energies.

	Bond energy (kJ per mole)
bond between a carbon atom and an oxygen atom in CO molecule	1077
bond between oxygen atoms in O_2 molecule	495
bond between a carbon atom and an oxygen atom in CO_2 molecule	805

Give your answer to **3** significant figures.

Energy given out = ...kJ **[4]**

High ability candidates understood that the energy change can be calculated from the difference between the energy absorbed in bond breaking and the energy released in bond making. Some correctly worked out the total bonds broken and used this to find the energy absorbed and then went on to subtract the value they had calculated for energy released. Many candidates thought that there were only two C=O bonds formed in the production of two carbon dioxide molecules and so incorrectly calculated the amount of energy released. A few higher ability candidates understood that the value they had calculated was for two carbon dioxide molecules and so divided by two for their final answer.

Question 10 (a)

10 The table below gives the properties of four substances.

Substance	Melting point (°C)	Boiling point (°C)	Electrical conductivity
A	714	1418	Conducts when molten or in solution
B	650	1091	Conducts when solid or molten
C	1610	2230	Does not conduct
D	–102	–34	Does not conduct

(a) Which substance is a liquid over the biggest temperature range?

.... **[1]**

Most candidates successfully used the data to identify A as having the biggest difference between melting point and boiling point and so being a liquid over the biggest temperature range.

Question 10 (b)

(b) What type of bonding does each substance have?

Tick (✓) **one** box in each row.

	Covalent	Ionic	Metallic
A			
B			
C			
D			

[2]

Many candidates correctly identified the type of bonding in each substance and most knew at least two.

Question 10 (c)

(c) Metals and ionic compounds conduct electricity differently.

State **and** explain these differences.

....

....

....

....

....

.... **[3]**

High ability candidates structured their answers to fully compare the differences in electrical conduction in metals and ionic compounds. Some gave good descriptions of each type of conduction but did not explain why metals conduct as solids whereas ionic compounds do not. Lower ability candidates confused the two types and referred to electron movement in both or ion movement in both.

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