Oxford Cambridge and RSA

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Thursday 16 May 2019 – Morning

GCSE (9–1) Combined Science B (Twenty First Century Science)

J260/06 Chemistry (Higher Tier)

Time allowed: 1 hour 45 minutes

You must have:
- the Data Sheet (for GCSE Chemistry B (inserted))
- a ruler (cm/mm)

You may use:
- a scientific or graphical calculator
- an HB pencil

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number						Candidate number				

First name(s) ______________________________________

Last name ______________________________________

INSTRUCTIONS

- The Data Sheet will be found inside this document.
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Answer **all** the questions.
- Where appropriate, your answers should be supported with working. Marks may be given for a correct method even if the answer is incorrect.
- Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.

INFORMATION

- The total mark for this paper is **95**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in the question marked with an asterisk (*****).
- This document consists of **20** pages.

Answer **all** the questions.

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.

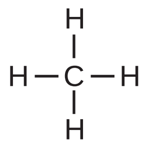
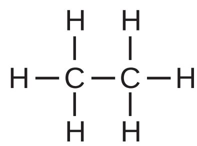
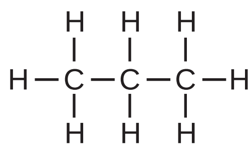
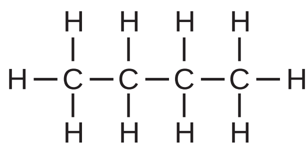
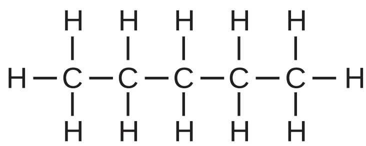
Alkane	Number of carbons	Molecular formula	Empirical formula	Structural formula	Melting point (°C)	Boiling point (°C)
Methane	1	CH_4	CH_4		–182	–161
Ethane	2	C_2H_6	CH_3		–183	–88
Propane	3	C_3H_8	....		–188	–42
Butane	4	C_4H_{10}	....			0
Pentane	5	C_5H_{12}	C_5H_{12}		–130	36
Hexane	6	....	C_3H_7	....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

(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]**

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

Explain your answer.

State: ....

Explanation: ....

.... **[2]**

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

Use ideas about energy and intermolecular forces in your answer.

....

....

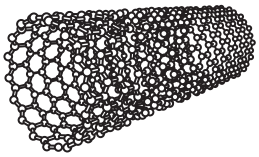
....

.... **[2]**

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]

(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]

(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]**

(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

....

....

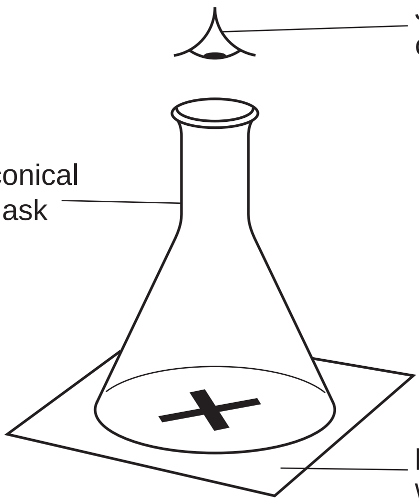
Risk

....

.... **[2]**

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.

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

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

....

....

.... **[2]**

(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]**

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

....

....

.... **[2]**

(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]**

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]**

(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.

....

....

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.... **[4]**

(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]**

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: ....

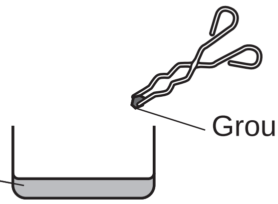
.... **[2]**

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

....

.... **[2]**

(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]

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

1. ....

....

2. ....

.... **[2]**

(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]**

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.

....

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.... **[6]**

(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]

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]**

(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]**

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

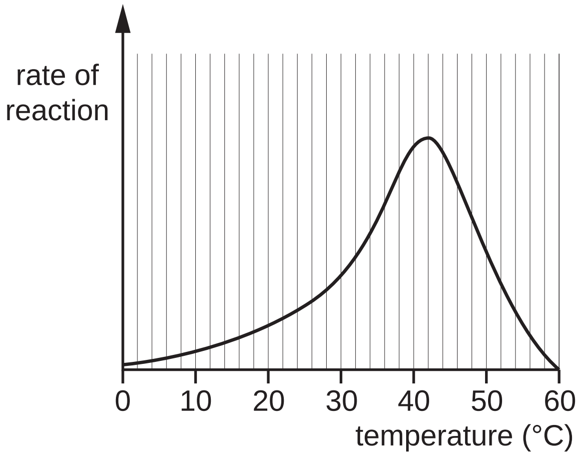

Fig. 7.1

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

Use ideas from the particle model in your answer.

....

....

....

.... **[2]**

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

Explain your answer.

....

....

.... **[3]**

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

Optimum temperature = ... °C **[1]**

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 $\longrightarrow$ 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]**

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

....

.... **[2]**

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

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

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

(i) What method is used to extract aluminium?

.... **[1]**

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

....

....

.... **[2]**

(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.

....

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....

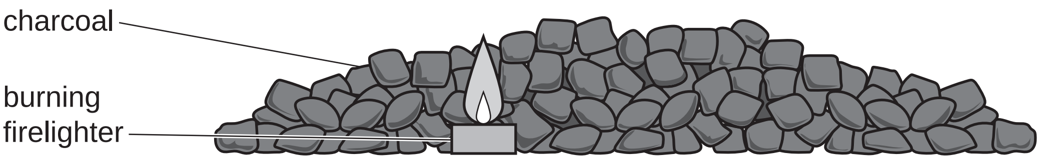
.... **[3]**

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**.

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

(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.

....

....

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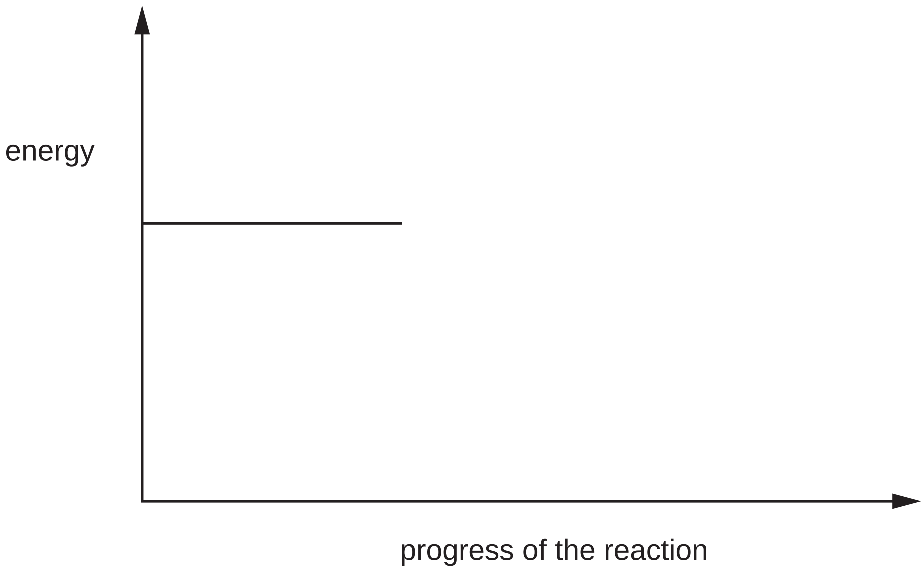
.... **[3]**

(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]

(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]**

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]**

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

Tick (✓) **one** box in each row.

	Covalent	**Ionic**	**Metallic**
A			
B			
C			
D			

[2]

(c) Metals and ionic compounds conduct electricity differently.

State **and** explain these differences.

....

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.... **[3]**

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).