

Friday 7 June 2019 – Afternoon

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

J260/04 Combined Science (Foundation Tier)

Time allowed: 1 hour 45 minutes



You must have:

- the Data Sheet (for GCSE Combined Science 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

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Candidate number

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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, you should 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 **75**.
 - The marks for each question are shown in brackets [].
 - Quality of extended response will be assessed in the question marked with an asterisk (*).
 - This document consists of **24** pages.

Answer **all** the questions.

- 1 The element mercury is a metal. It is a liquid at room temperature and pressure.

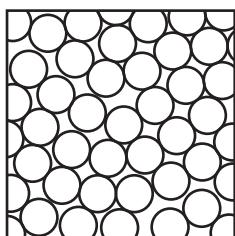
Fig. 1.1 shows a coin floating on mercury.

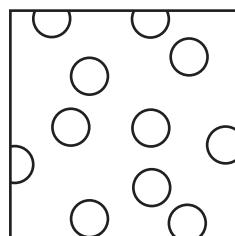


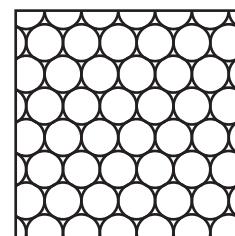
Fig. 1.1

- (a) (i) Which diagram shows the arrangement of particles in **liquid** mercury?

Tick (✓) **one** box.







[1]

- (ii) The coin floats because it is less dense than the mercury.

Which is the correct equation for calculating density?

Tick (✓) **one** box.

density = weight ÷ volume

density = volume × mass

density = mass ÷ volume

density = volume ÷ mass

[1]

- (b) Eureka cans are used to measure the volume of odd-shaped objects.

Fig. 1.2 shows the apparatus that can be used to find the volume of the coin in **Fig 1.1**.

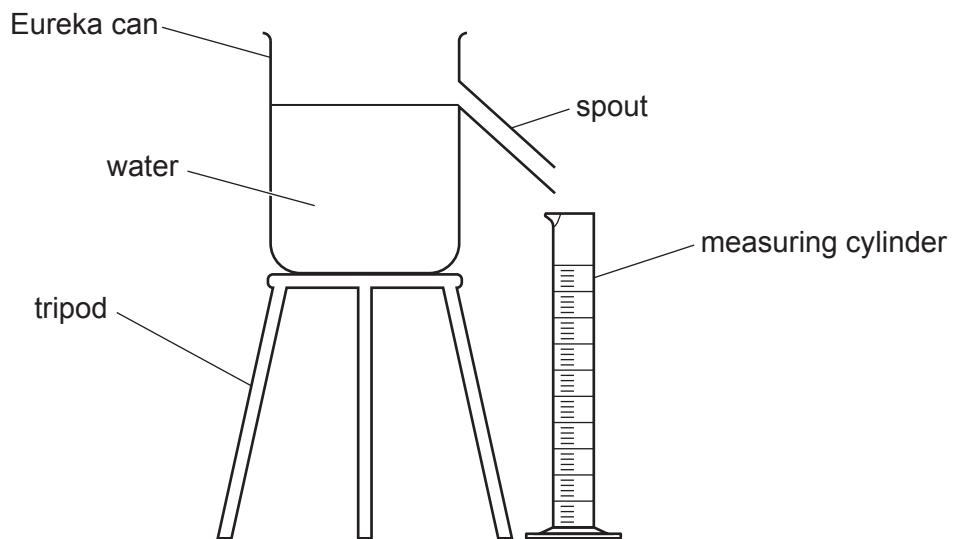


Fig. 1.2

Stages **A–E** of an experiment to find the volume of the coin are shown below but are **not** in the correct order.

- A** Put a measuring cylinder under the spout.
- B** Measure the volume of water in the measuring cylinder.
- C** Collect the water in the measuring cylinder.
- D** Fill the eureka can up to the spout with water.
- E** Gently place the coin in the eureka can.

Write the **letters** in the boxes to give the correct order of the stages.

The first one has been done for you.

D				
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[2]

- 2 One use of gene technology is genetic engineering.

Scientists have taken the gene for the blue pigment (pigments are coloured chemicals) in blackberries and transferred it into tomatoes. Tomatoes with this gene are blue in colour.

- (a) Genes are short sections of a long molecule.

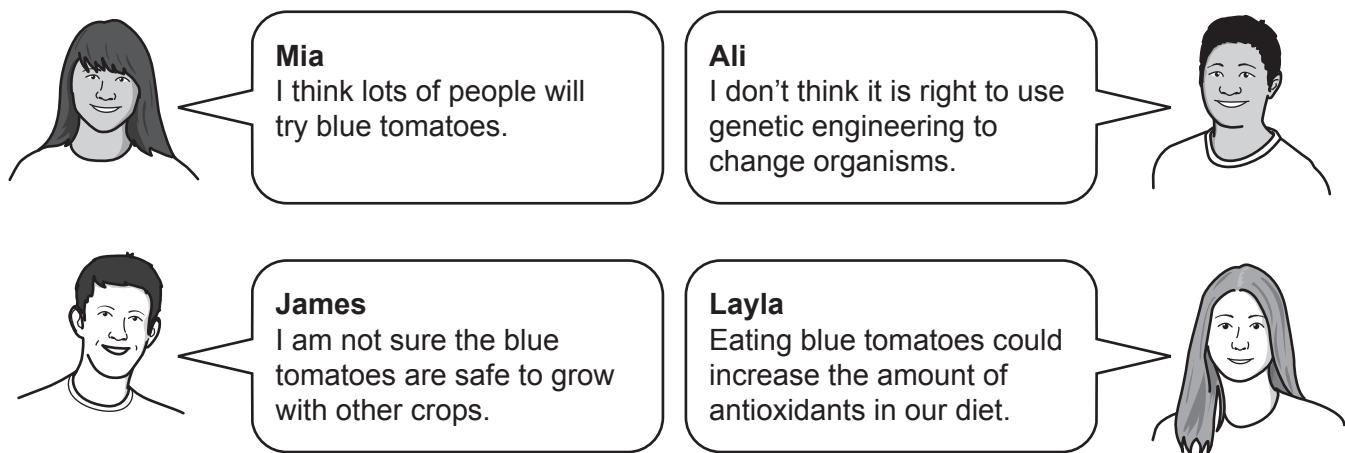
What is the name of this long molecule?

..... [1]

- (b) The blue pigment in the genetically modified tomatoes is an antioxidant.

Antioxidants prevent cell damage. This means eating blue tomatoes may be beneficial to our health. Blue tomatoes are still being tested and are not yet available for sale.

Some students are talking about blue tomatoes.



- (i) Which student talks about a **risk** of genetic engineering?

..... [1]

- (ii) Which student talks about an ethical **objection** to genetic engineering?

..... [1]

- (iii) Which student talks about a **benefit** of genetic engineering?

..... [1]

- (c) The pigments in red and blue tomatoes are water soluble.

The students use paper chromatography to investigate the pigments in red and blue tomatoes.

Complete the sentences below to describe and explain their method.

Use words from the list. You may use each word once, more than once or not at all.

solution	mobile phase	locating agent
solute	retention factor (Rf)	stationary phase

1. Crush the tomatoes to produce a coloured extract from each tomato.
2. Apply spots of each coloured extract to the pencil line drawn on the filter paper.
3. The filter paper is the
4. Place the paper into water, making sure the pencil line is above the level of the water.
5. The water is the
6. The water moves up the paper separating out the pigments.
7. As the compounds in the pigments are coloured there is no need to use a

[3]

- (d) Here is the chromatogram of their results.

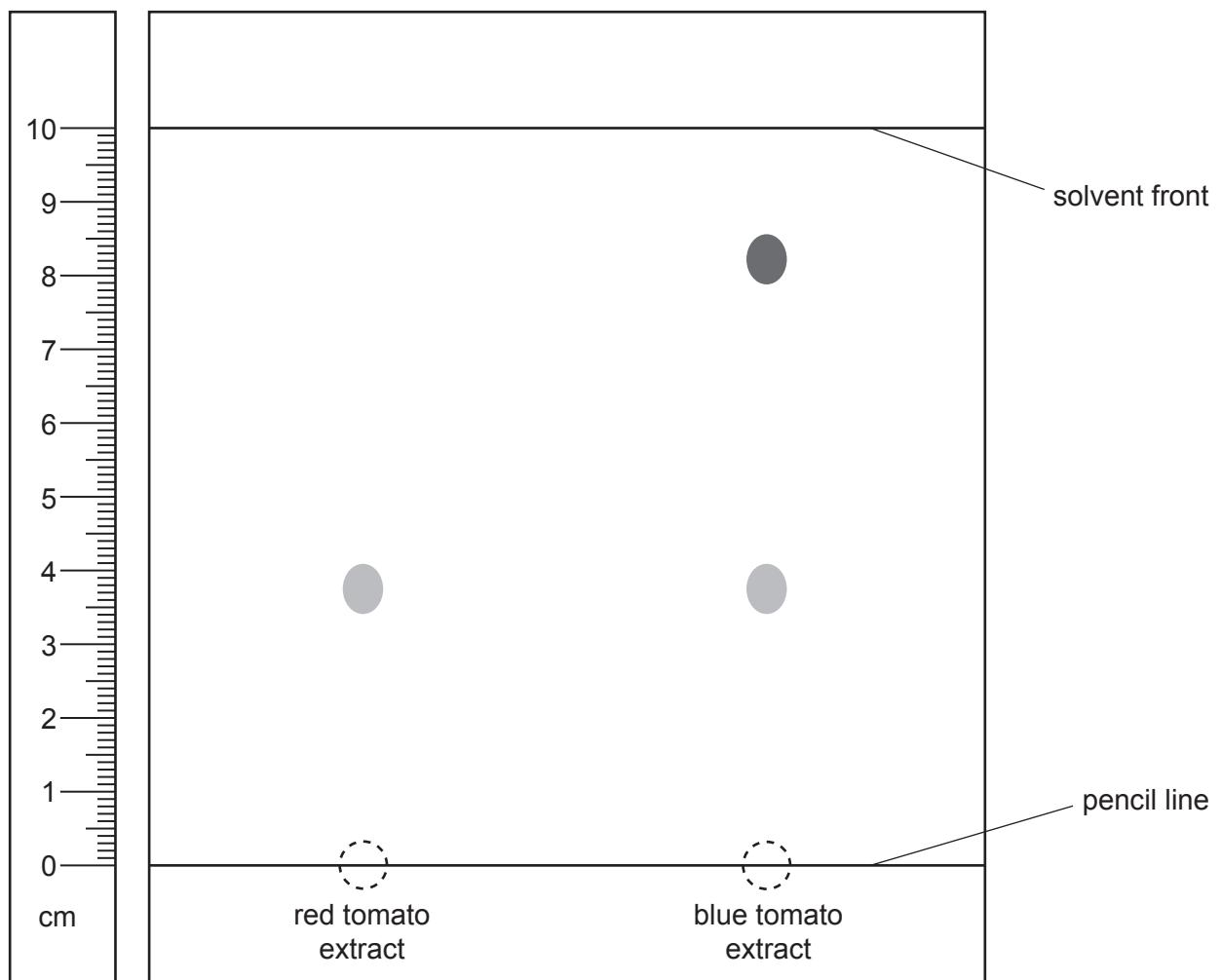


Fig. 2.1

- (i) Calculate the R_f value of the red pigment in the red tomato extract, using **Fig. 2.1**.

Use the formula: $R_f = \frac{\text{distance moved by red pigment in the red tomato extract}}{\text{distance moved by solvent}}$

$$R_f = \dots \quad [3]$$

- (ii) Explain why the line at the bottom of the chromatogram was drawn in pencil.

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.....

[2]

- (iii) Give **two** conclusions that the students can make from these results.

Conclusion 1

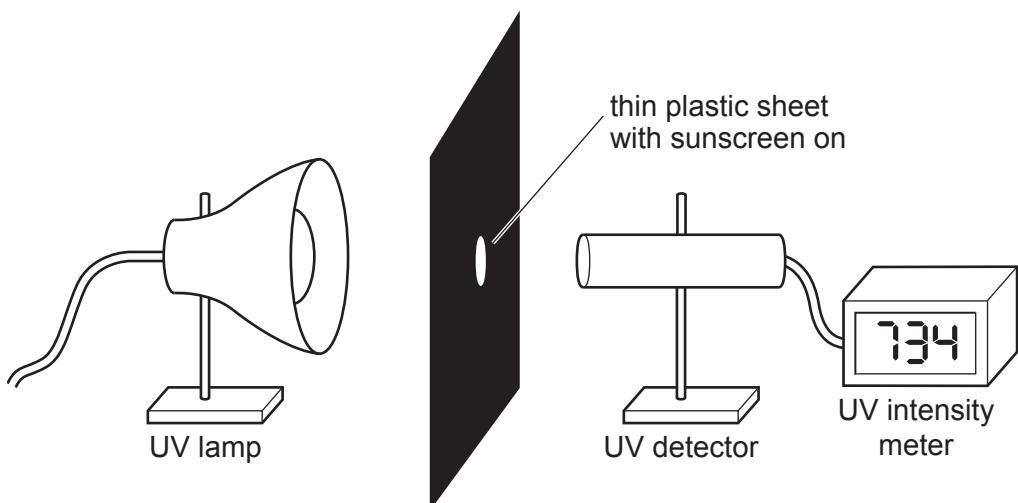
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Conclusion 2

.....
.....

[2]

- 3 Nina and Kareem are investigating the effectiveness of sunscreens (sun creams). They set up the apparatus shown below.



They plan to investigate five sunscreens with different sun protection factors (SPFs) to see how well they block UV radiation.

- (a) (i) There are a number of hazards in this experiment.

Draw lines to connect each **hazard** to the **safety procedure** that should be followed.

Hazard	Safety procedure
The hot lamp could cause burns	Wear long sleeves and gloves
UV damage to the skin	Keep hands dry at all times
Electric shock from equipment	Let the lamp cool before touching it
UV damage to the eyes	Wear sunglasses

[3]

- (ii) Which two statements are needed to collect valid results?

Tick (✓) **two** boxes.

Keep the lamp at the same UV intensity for each test.

Repeat the experiment five times.

Record the results to the same number of significant figures.

The same student should read the UV intensity meter.

The distance between lamp and plastic sheet should be kept the same.

[2]

- (b) Nina and Kareem collected data for five sunscreens (sun creams) with different SPFs.

They also recorded the UV intensity when **no sunscreen** was applied to the plastic sheet.

Explain why they recorded the UV intensity when no sunscreen was applied to the plastic sheet.

.....
.....
.....

[2]

- (c) **Table 3.1** shows the data that they collected for sunscreen with an SPF of 20.

	UV intensity (mW/cm ²)				
SPF 20 reading	28	30	28	32	31

Table 3.1

- (i) Calculate the mean UV intensity from the data in **Table 3.1**.

Give your answer to **2** significant figures.

$$\text{Mean UV intensity} = \dots \text{mW/cm}^2 \quad [2]$$

- (ii) Nina and Kareem wanted to check whether their measurements were accurate.

Which statement explains how they did this?

Tick (\checkmark) **one** box.

They recorded the intensity with a UV intensity meter.

They took five readings for each SPF.

They used the same UV lamp for all their readings.

[1]

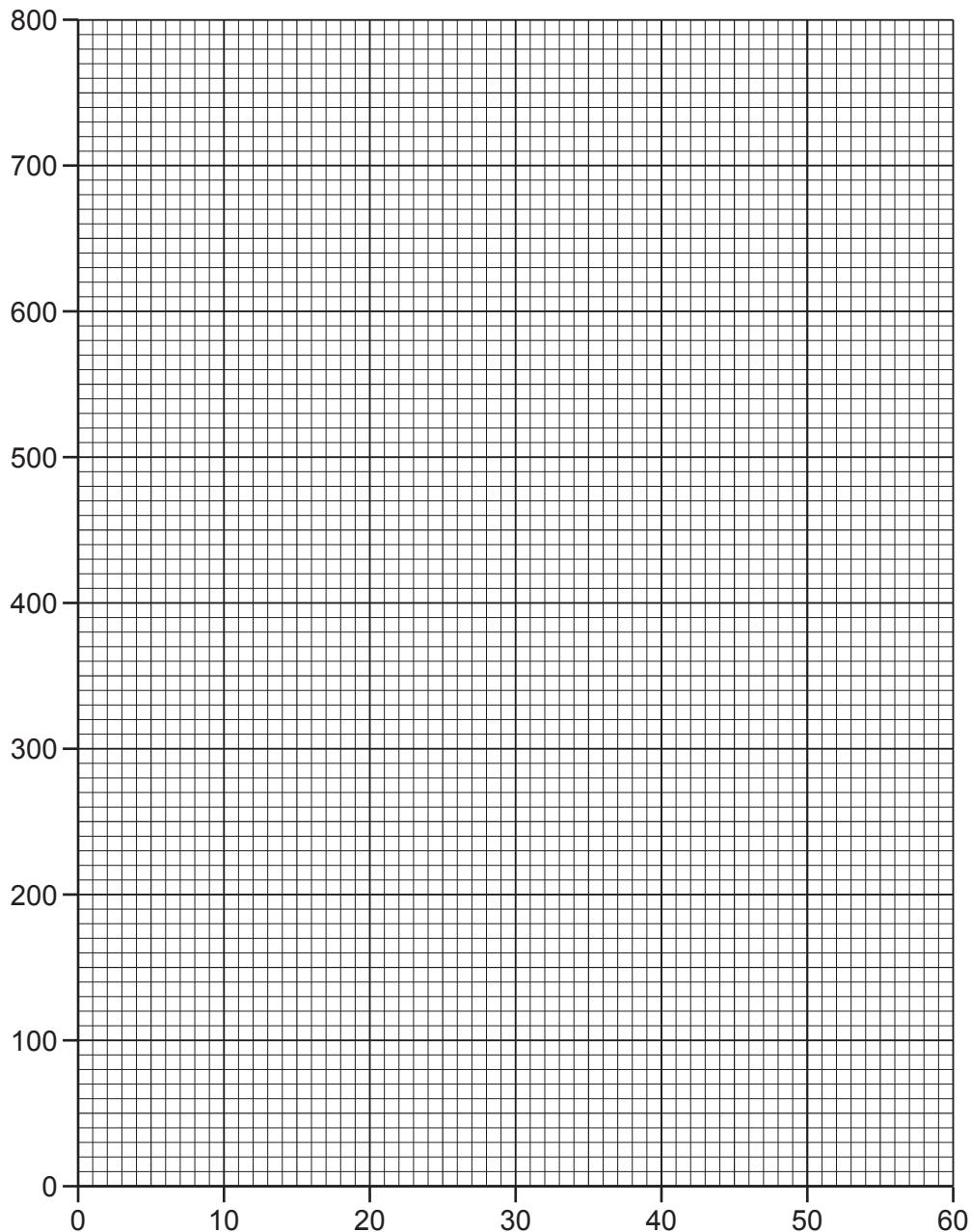
- (d) Table 3.2 shows the mean UV intensities of Nina and Kareem's other results.

Sun protection factor (SPF)	0	10	15	30	50
Mean UV intensity mW/cm²	748	76	37	23	14

Table 3.2

- (i) Complete the graph by plotting the results in **Table 3.2**, and drawing a line of best fit.

Add labels to the axes showing the units.



[3]

- (ii) Write down **two** conclusions Nina and Kareem can make from the graph.

1

.....

2

.....

.....

[2]

- (e) Explain why it is important to use sunscreen (sun cream) when your skin is exposed to UV radiation.

.....

.....

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[2]

- 4 Our core body temperature needs to be kept at about 37 °C.

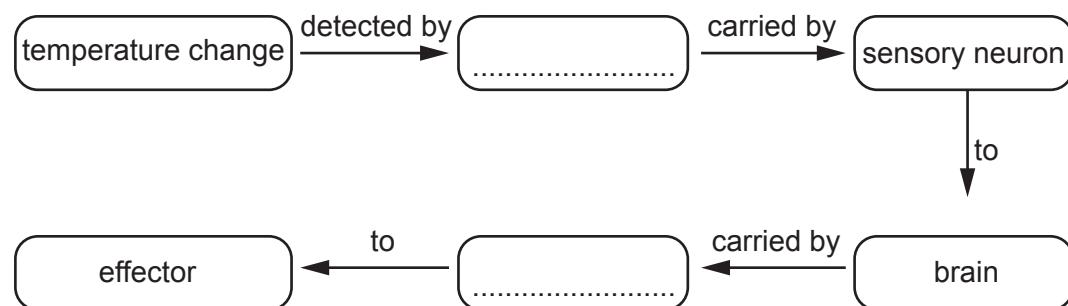
Maintaining body temperature relies on our nervous system.

- (a) (i) Complete the flow diagram, describing this process.

Use words from the list. You may use each word once, more than once or not at all.

muscle sensory receptor motor neuron

hormone sweat gland



[2]

- (ii) Explain why our body temperature needs to be maintained around 37 °C.

.....

[2]

- (iii) Low temperatures can be dangerous for humans.

Complete the sentences to describe why humans wear jackets in cold weather.

Use words from the list. You may use each word once, more than once or not at all.

conductors low reflected generators

insulators lost high conserved

Humans can survive in freezing temperatures with the correct clothing.

Jackets filled with feathers are good

This is because feathers have a thermal conductivity.

They reduce the amount of heat by the body.

[3]

- (iv) Temperature regulation is an example of homeostasis.

Which other processes in humans are maintained by homeostasis?

Tick (✓) **two** boxes.

Absorption of oxygen in the lungs

Blood sugar levels

Digesting food

Water balance

[2]

(b)* The table contains information about neurons in the human body.

Sensors were placed on different neurons.

The time taken for the impulse to pass from one sensor to the other was recorded.

Neuron type	Fatty sheath around neuron?	Distance between sensors (m)	Time for impulse to pass between sensors (s)	Speed of the neuron impulse (m/s)
Motor neuron	Yes	0.55	0.0047	117
Sensory neuron	Yes	0.27	0.0025	
Relay neuron	No	0.12	0.075	

Explain the differences in the speed of the impulses in the three neurons.

You should include calculations in your answer.

Use the equation: speed = distance ÷ time

[6]

[6]

- 5 HIV is an infection caused by a virus. People with this virus are HIV+. HIV weakens the immune system.

Tuberculosis (TB) is a disease caused by bacteria. It may be fatal in people with a weak immune system.

Fig. 5.1 shows the number of cases of TB and HIV per 100,000 people in the Central African Republic in one year.

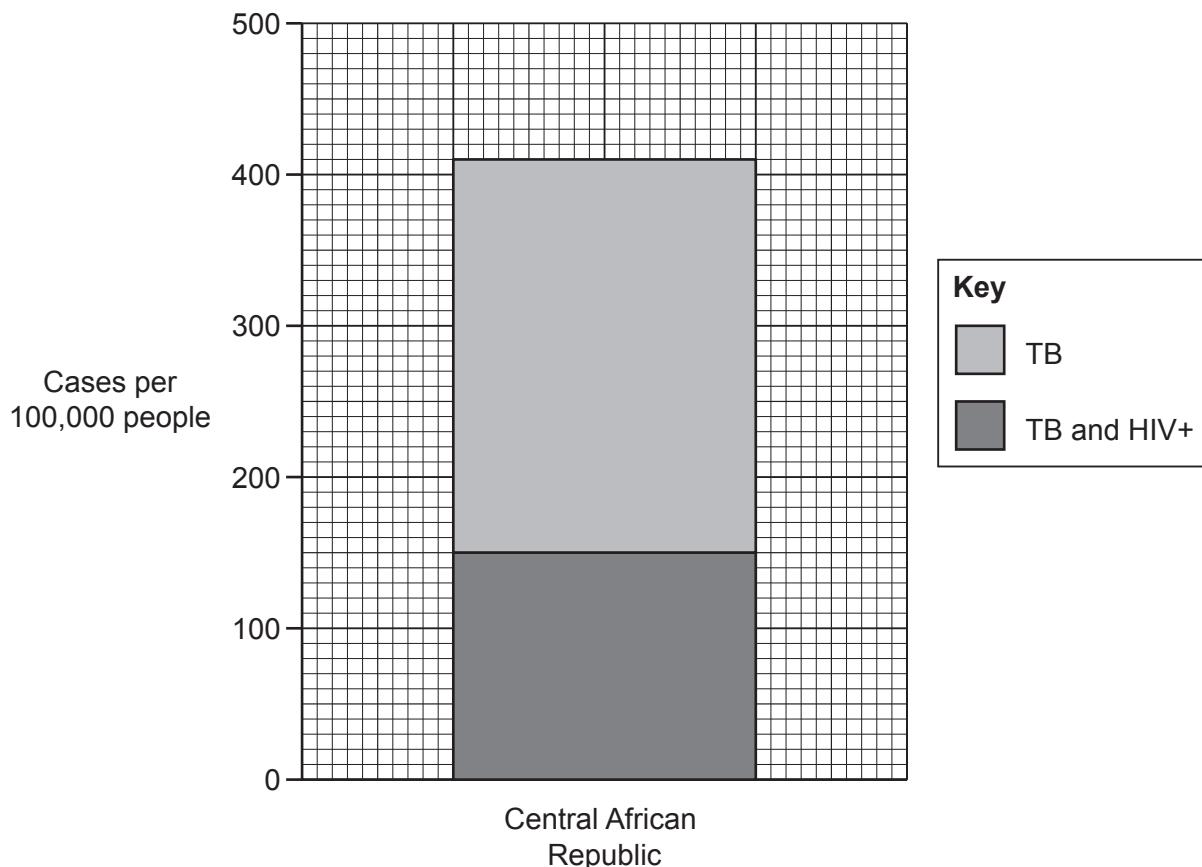


Fig. 5.1

- (a) Calculate the percentage of people in the Central African Republic who have tuberculosis **and** who are also HIV+.

Give your answer to **1** decimal place.

Percentage = % [4]

- (b) Six **other** African countries were investigated by scientists. The results are shown in **Fig. 5.2**.

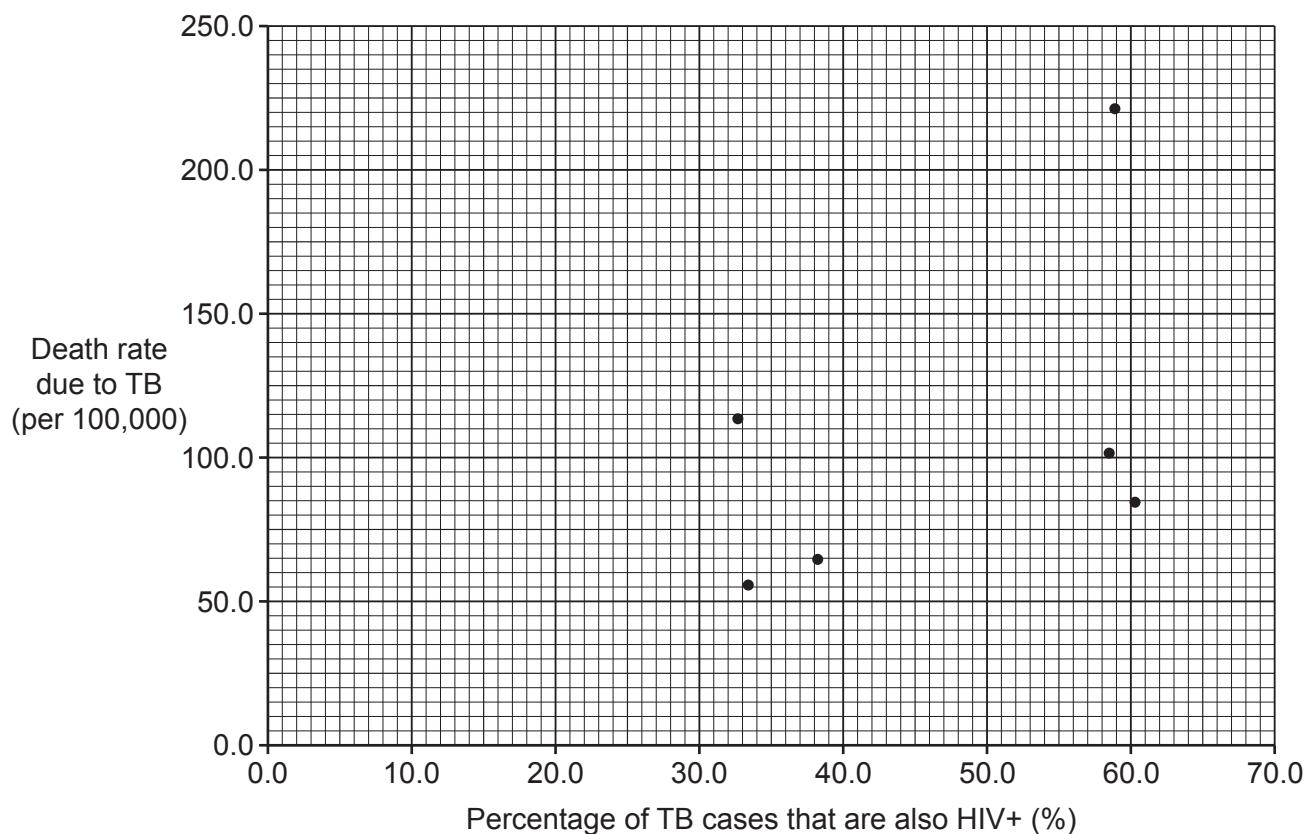


Fig. 5.2

- (i) Which statements about the graph are **true** and which are **false**?

Tick **one** box in each row.

Statement	True	False
There is a weak positive correlation between the percentage of TB cases that are also HIV+ and the death rate due to TB.		
There are three countries where the percentage of TB cases that are also HIV+ is above 55%.		
A line of best fit can be drawn on the graph.		

[3]

- (ii) What is the correct definition of a **positive correlation**?

Tick (✓) **one** box.

As the value of one variable increases, the value of the other tends to decrease.

As the value of one variable decreases, the value of the other tends to increase.

As the value of one variable increases, the value of the other tends to increase.

[1]

- (c) The scientists suggest some changes to their method to see if a stronger correlation exists.

Draw lines to connect each **change in method** with the **improvement** it should result in.

Change in method

Sample more countries

Improvement

Gives data that is more accurate

Record data over several years

Gives more points to plot on a graph

Use medical records rather than interviewing patients to determine cases of tuberculosis and HIV+

Allows the researchers to see any changes with time

[2]

- 6 Oil tankers transport crude oil. Crude oil is a mixture of hydrocarbons.

Occasionally they may be involved in an accident and catch fire as shown.



- (a) (i) Explain why the burning hydrocarbons in the oil produce thick black smoke.

.....
.....
.....

[2]

- (ii) The hydrocarbon fractions in crude oil are separated by fractional distillation.

Complete the sentences about fractional distillation.

Use words from the list. Each word can be used once, more than once, or not at all.

dissolved **cooled** **crystallise**
evaporate **heated** **melt**

During fractional distillation the mixture is heated and the fractions

at different temperatures.

The separated fractions are then so that they condense.

[2]

- (iii) The hydrocarbons in crude oil are mostly alkanes.

Octane is an alkane. Its molecular formula is C_8H_{18} .

Determine the empirical formula of octane.

Empirical formula = [3]

- (b) Some ships carry condensate oil, rather than crude oil.

Fig. 6.1 shows the composition of fractions in crude oil and condensate oil.

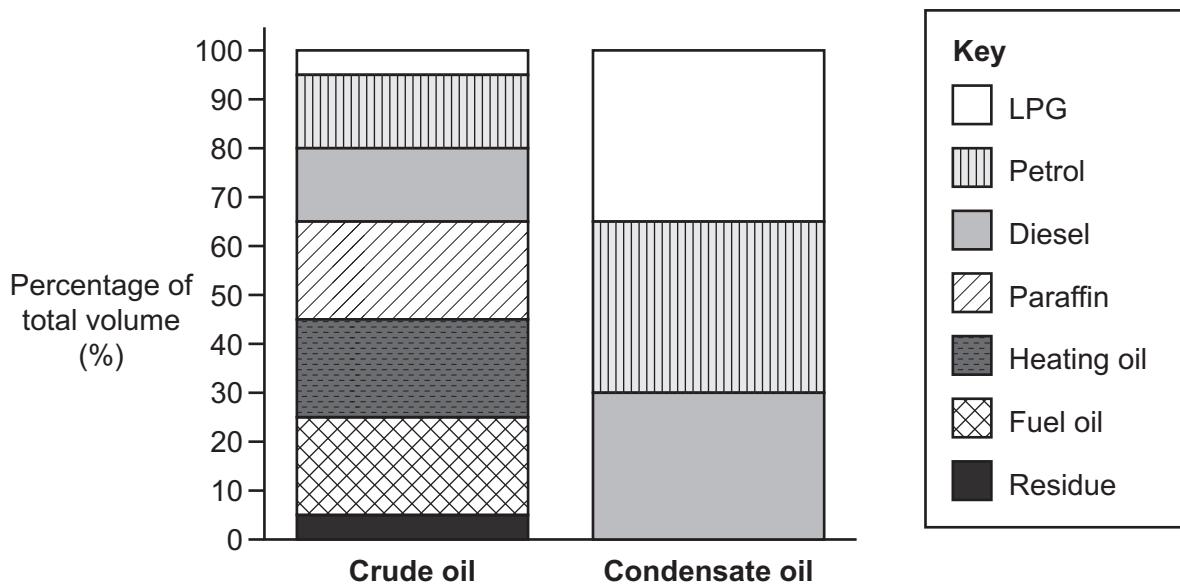


Fig. 6.1

Give **two** similarities and **two** differences between crude oil and condensate oil.

Use **Fig. 6.1** to support your answers.

Similarity 1

.....
.....

Similarity 2

.....
.....

Difference 1

.....
.....

Difference 2

.....
.....

[4]

- (c) The table shows some other differences between crude oil and condensate oil.

	Crude oil	Condensate oil
Colour	black	dark brown
Physical state at 25 °C	thick liquid	liquid
Boiling point range (°C)	–48 to 593	–29 to 427
Flash point (°C) (the lowest temperature the vapour will catch fire)	–6	–46
Density (g/cm³)	0.88	0.60

- (i) Which statement best explains why there is a **range** of temperatures for the boiling point of crude oil and condensate oil?

Tick (✓) **one** box.

Crude oil and condensate oil are hydrocarbons.

The oils contain different fractions.

The density of a liquid changes its boiling point.

The colour of the liquid causes the boiling point to change.

[1]

- (ii) Some people conclude that condensate oil is more dangerous to carry than crude oil.

Evaluate this conclusion.

Use the data in the table to support your answer.

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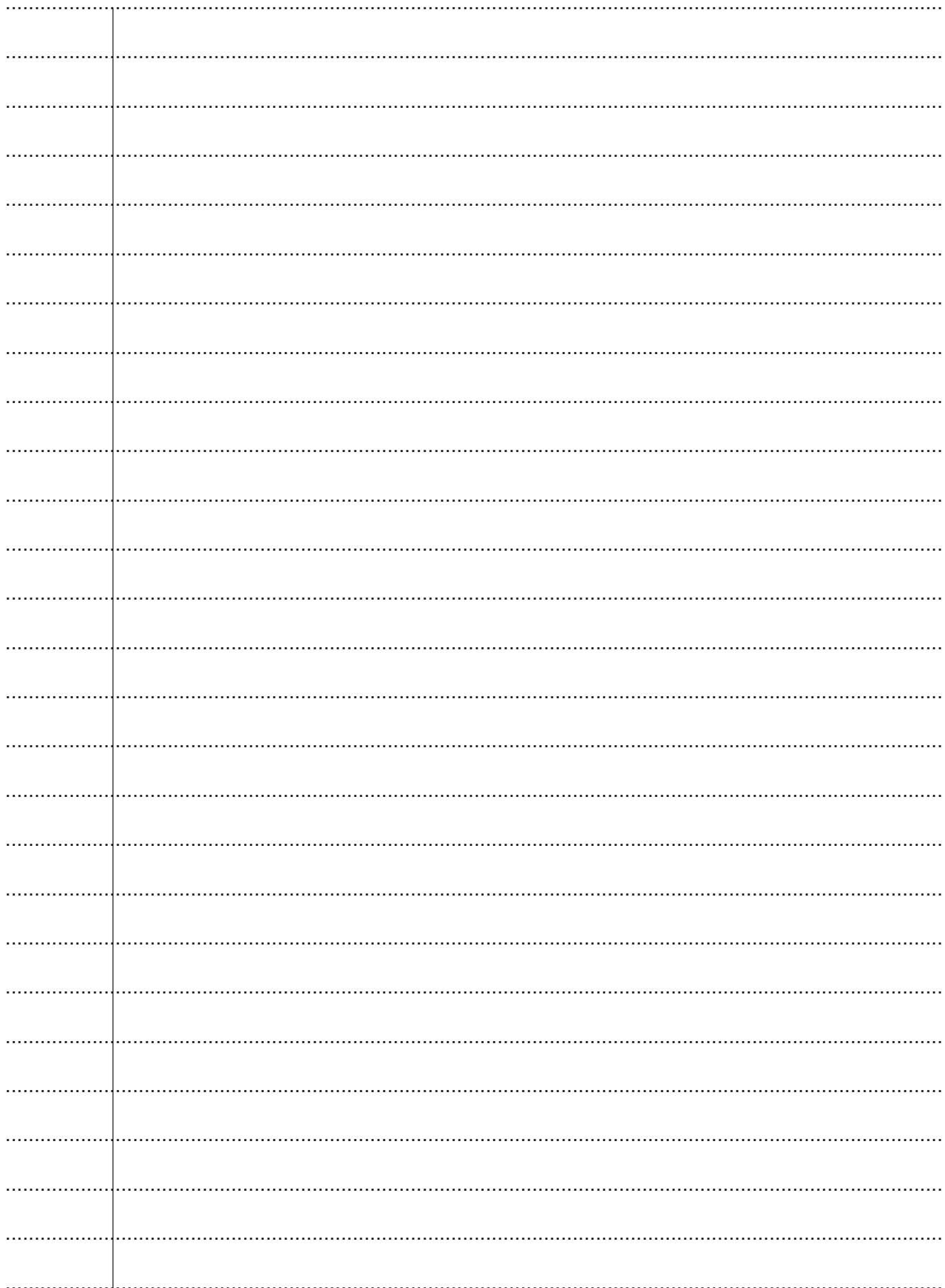
[3]

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).





The page features a vertical line on the left side and a series of horizontal dotted lines for handwriting practice. The vertical line is positioned at approximately [175, 100, 175, 900]. The horizontal dotted lines are evenly spaced from approximately [100, 100] to [900, 900]. There are 20 horizontal dotted lines in total.

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