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GCSE (9-1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE COMBINED SCIENCE B

J260
For first teaching in 2016

J260/04 Summer 2019 series

Version 1

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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 4 series overview

Combined Science B (Twenty First Century Science) – candidates study biology, chemistry and physics using a context-based approach. Ideas are introduced within relevant and interesting settings which help candidates to anchor their conceptual knowledge of the range of scientific topics required at GCSE Level. Practical skills are embedded within the specification and candidates are expected to carry out practical work in preparation for a written examination that will specifically test these skills.

Paper J260/04 is a Foundation Level paper and tests grades 1-5. It is worth a total of 75 marks and lasts 1 hour 45 minutes. The paper carries a weighting of 20.8% of the marks for the GCSE and tests content from all areas of the specification.

To do well on this paper, candidates need a broad understanding of all areas of the specification and should be able to process data as well as recall their knowledge and apply it to unfamiliar contexts.

Most successful questions	*Least successful questions*
• 1ai – Candidates had a good knowledge of particle arrangements • 3e – Candidates showed good knowledge of the dangers of UV waves • 6b – Candidates were good at analysing the data and forming conclusions	• 2c – Candidates appeared to be unfamiliar with the terminology surrounding chromatography • 3b – Candidates did not appear to know the word 'control' • 4aii – Candidates appeared confused by thermal conductivity and the idea of conserving heat • 5a – Candidates had difficulty reading the scale of the bar chart • 6ai – Candidates did not seem to know about incomplete combustion • 6aiii – Candidates did not appear to know about empirical formulae • 6cii – Candidates could not compare the data in the table and instead quoted it rather than processing it
Candidates who did well in the examination	***Candidates who did not do so well in the examination***
• Applied their knowledge and understanding to new situations • Showed clear working out in numerical questions • Made clear, concise and unambiguous statements in the Level of Response question (4b) • Used the maximum number of marks available for each question and wrote the same number of correct statements to ensure they scored the full mark for the question • Were able to correctly draw a curved line of best fit • Correctly used a range of scientific terms in their answers • Were able to read numbers from bar charts and use this information to calculate percentages	• Found it difficult to apply their knowledge and understanding to new situations • Only gave their incorrect final answer in numerical questions, therefore missing out on marks for working out • Repeated information given in the question without applying or processing it • Gave answers that did not address what the question was asking or did not give enough specific detail • Confused speed and time when answering the Level of Response question (4b) • Did not tick the correct number of boxes in multiple choice questions • Had difficulty plotting points on the graph axes and drawing a suitable curve of best fit • Had difficulty correctly reading numbers from the scale on charts. E.g. Confusing 410 and 401

Question 1 (a) (i)

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.

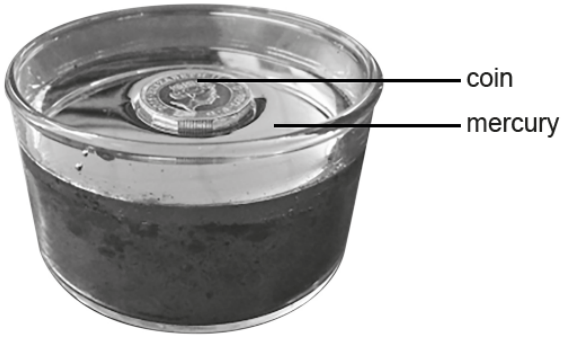
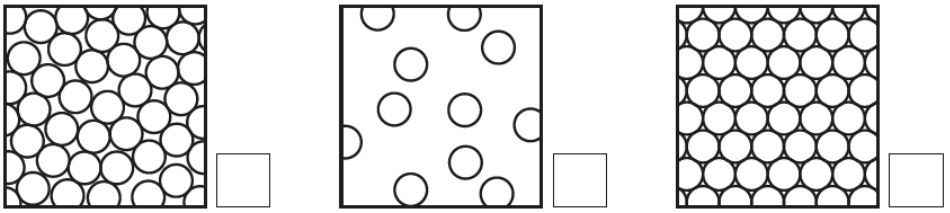


Fig. 1.1

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

Tick (✓) **one** box.



[1]

Most candidates were able to correctly identify the arrangement of particles in a liquid.

Question 1 (a) (ii)

(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]

About half of candidates chose the correct equation. It would benefit candidates to learn the equations in the specification.

Question 1 (b)

(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**.

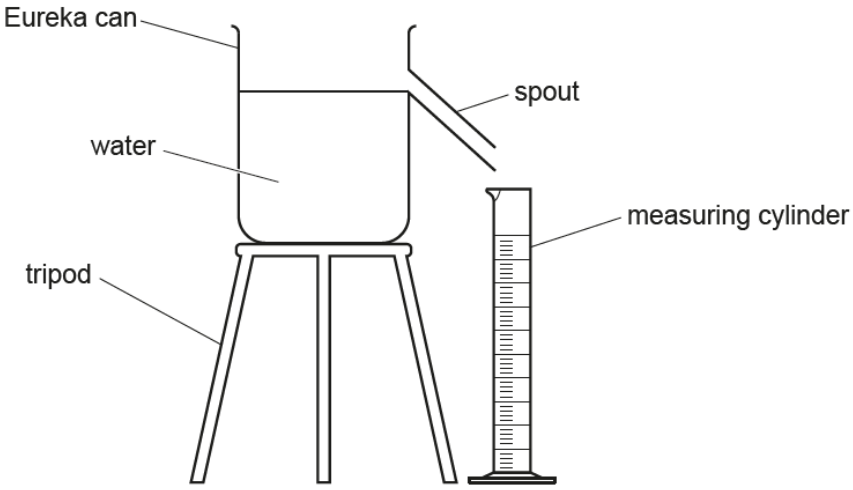


Fig. 1.2

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				

[2]

Just over half of candidates were credited both marks for this question with just over a fifth gaining no marks. The most common mistake was putting E and A the wrong way around.

Question 2 (a)

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]**

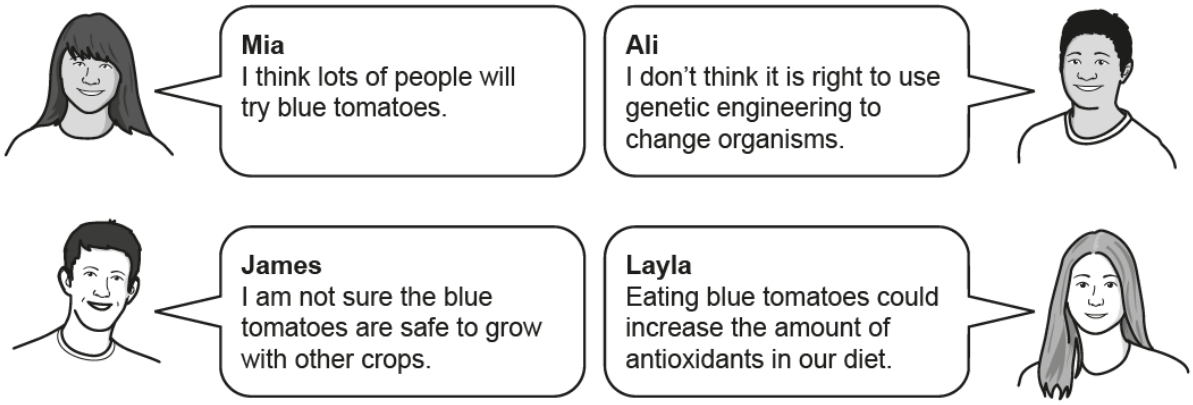
About half of the candidates correctly answered this question. The most common wrong answers were chromosomes, gametes, bases and alleles.

Question 2 (b) (i), (ii) and (iii)

(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]**

Questions 2(b) (ii) and (iii) were answered well with most candidates identifying the correct student. The candidates found part (i) the most challenging with only about half of candidates choosing James.

Question 2 (c)

(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]

Candidates found this question challenging and few candidates gained all three marks. The most common credited mark was one mark for stating 'locating agent' for the final gap. Candidates were confused by the two different phases and many opted for the words 'solute' and 'solution'.

Question 2 (d) (i)

(d) Here is the chromatogram of their results.

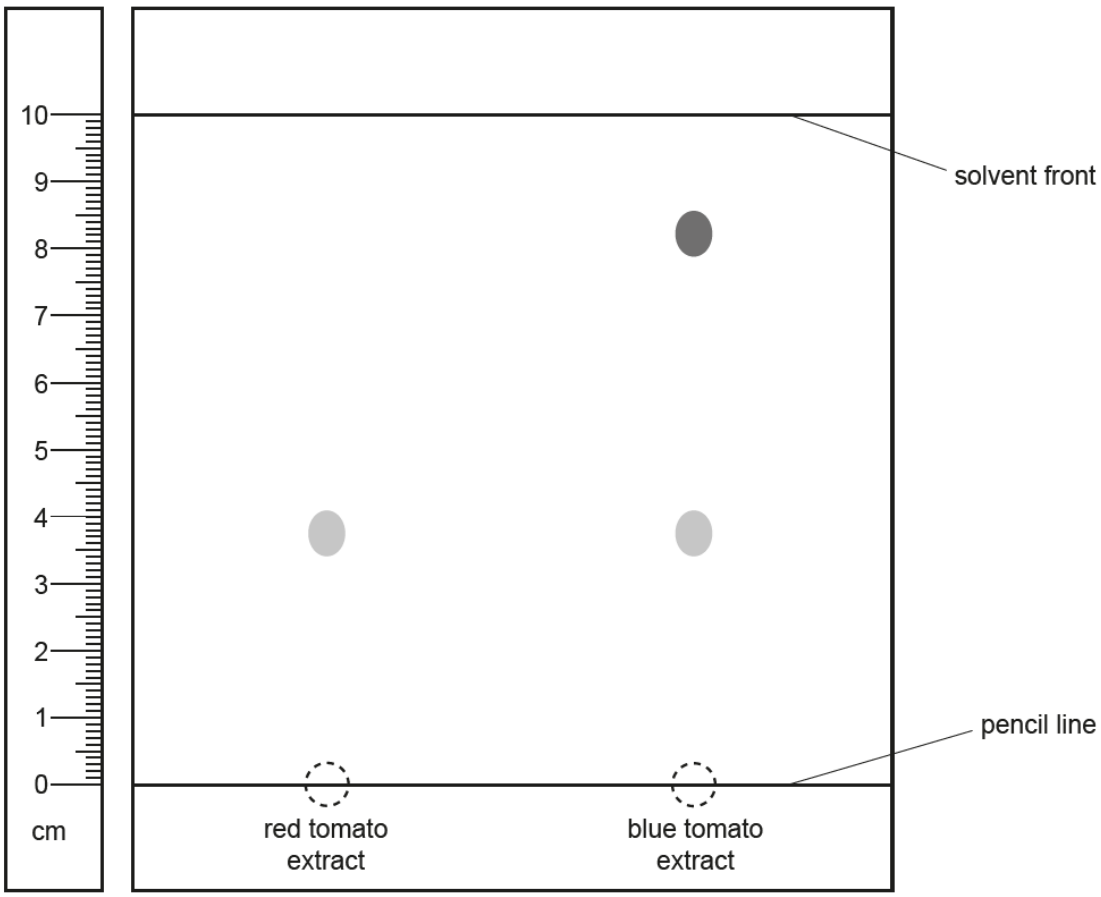


Fig. 2.1

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

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

Rf = ... **[3]**

Candidates found this question challenging with few candidates gaining all three marks. Candidates should measure from the centre of the blobs, but many tried to measure from the very top or bottom edges. We gave some leeway on this but discounted answers that were at the edge. Many candidates gained the first marking point but then proceeded to divide this by the height of the blue spot rather than the height of the solvent front. We did not allow error carried forward for identifying incorrect numbers.

Question 2 (d) (ii)

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

.....

.....

.....

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

Most candidates gained only one mark, but a few candidates gained both marks. The most common answer related to the idea of smudging the ink/not smudging pencil. Very few candidates scored the mark relating to solubility. Many candidates answered in terms of rubbing out the pencil if a mistake was made, missing the idea that pencil marks do not run up the paper.

Question 2 (d) (iii)

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

Conclusion 1

.....

.....

Conclusion 2

.....

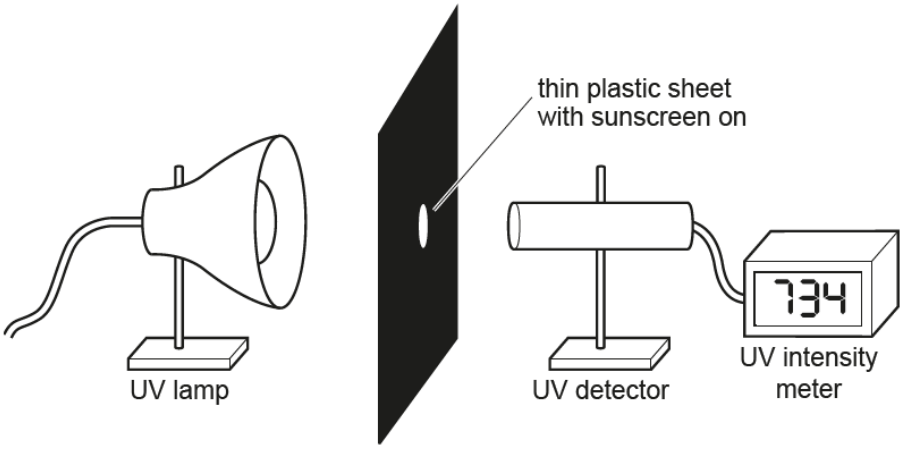
.....

[2]

Very few candidates gained any marks for this question. Lots of candidates gave answers along the lines of 'blue tomatoes contain more pigment', which could be taken to mean they had a darker colour – which we did not allow. We needed the plural 'pigments' if they were going to answer comparative terms rather than giving numbers. Most of the correct answers were about red having one pigment and blue having two. We were generous on use of language, allowing words such as colour/dyes/inks/dots for pigment. We ignored anything about RF values or distances.

Question 3 (a) (i)

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]

This question was well answered with most candidate gaining all three marks.

Question 3 (a) (ii)

(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]

Most candidates gained one or two marks for this question. Ticking the second box was the most common incorrect answer and many candidates only ticked one box despite being told to tick two.

Question 3 (b)

(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]**

Candidates found this question challenging with very few candidates gaining both marks. Examiners were mindful of the experimental situation (sunscreen on plastic, not skin) so references to burning/people/skin/damage/you etc were not allowed. The most common correct answer related to comparisons. The word 'control' appeared in very few responses.

Question 3 (c) (i)

(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.

Mean UV intensity = ...mW/cm^2 **[2]**

Most candidates gain at least one mark for this question. Of those who gained one mark, many left their answer as 29.8 and did not round to 2 significant figures. Some candidates tried to round their answer but ended up with 29 rather than 30. A significant minority of candidates did not show their working and gave the wrong final answer and would probably have gained one mark had they shown how they arrived at this.

Question 3 (c) (ii)

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

Which statement explains how they did this?

Tick (✓) **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]

Few candidates gained the mark for this question, showing confusion between accuracy (1st box), precision (2nd box) and a control (3rd box).

Question 3 (d) (i)

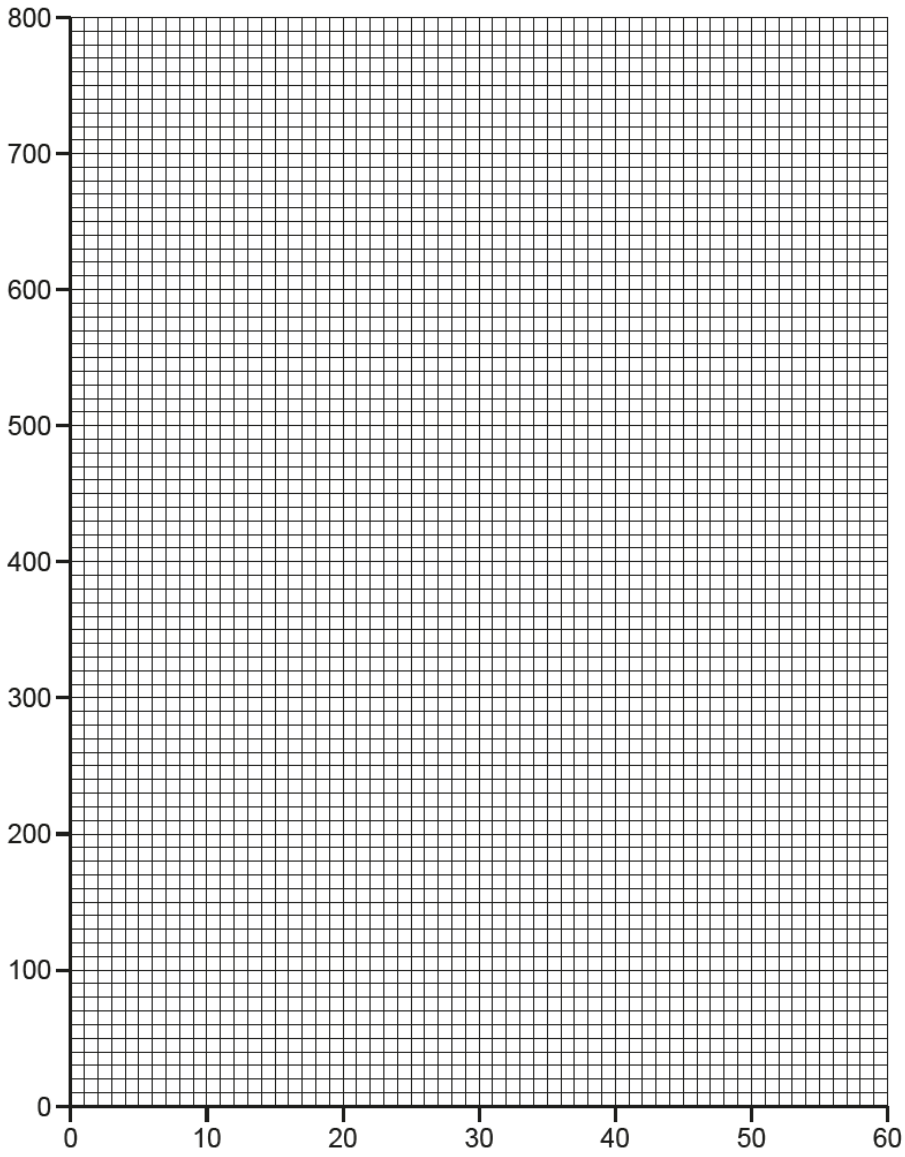
(d) **Table 3.2** shows the mean UV intensities of Nina and Kareem's other results.

Sun protection factor (SPF)	0	10	15	30	50
Mean UV intensity mW/cm^2	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]

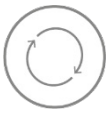
Most candidates gain at least one or two marks on this graph with only a few gaining all three marks.

Taking the three marking points in turn:

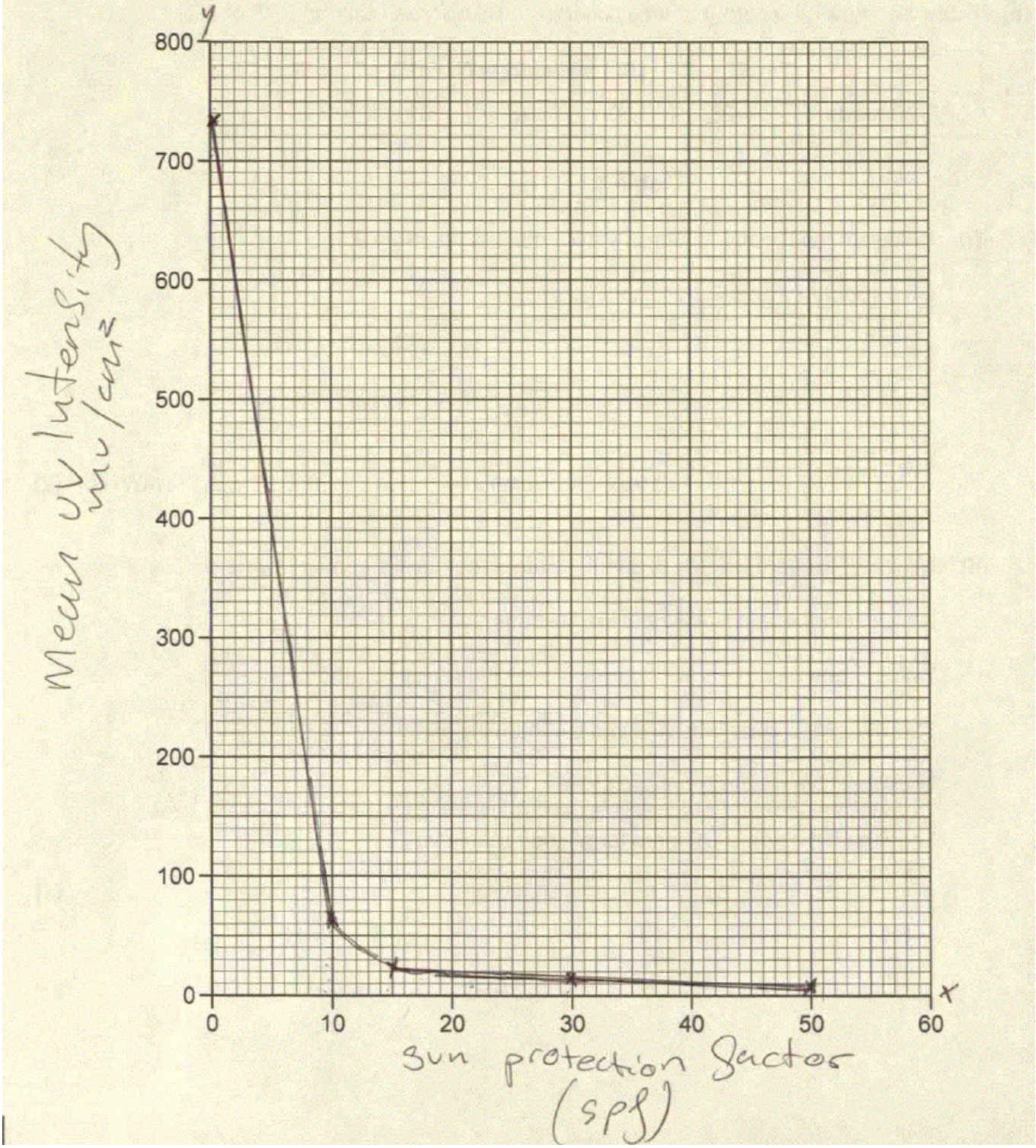
The axes needed to have the units present and not just the quantity that was measured.

Candidates should take considerable care when plotting the points. It was common to see very large crosses or blobs rather than small, precise markings. The plot at 748 was mis-plotted in a significant number of cases.

We tried to be generous with the lines of best fit as this was a tricky line to draw freehand. It was common to see some very good smooth, continuous curves, but we often saw dot to dot lines with sharp angles, very thick lines and many cases where candidates drew double or triple lines of best fit leading examiners to question which one to mark. Exemplar 1 shows an example of this and the candidate was given 1 mark. Many candidates thought the point at 748 was an outlier and drew a perfect straight line through the other points but did not indicate they thought the point was an outlier and so did not gain the mark.

	**AfL**	It may be worthwhile for teachers to get candidates to practise the drawing of awkward lines of best fit.

Exemplar 1



Question 3 (d) (ii)

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

1 .....

.....

.....

2 .....

.....

.....

[2]

Very few candidates gained both marks for this question. We were interested, here, in trends and patterns and not individual points. The most common correct response was about the link between higher SPF and lower UV. Many candidates who gained no marks gave answers that related to a single point on the graph, for example, 'with zero SPF the intensity was highest' and missed the idea of the link between the variables. Others gave answers that were about sunburn and cancer and not the data in the graph.

Question 3 (e)

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

.....

.....

.....

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

This question was well-answered with most candidates gaining at least one mark. The mention of cancer was the most common mark given, followed by the idea of (sun) burn.

Question 4 (a) (i)

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

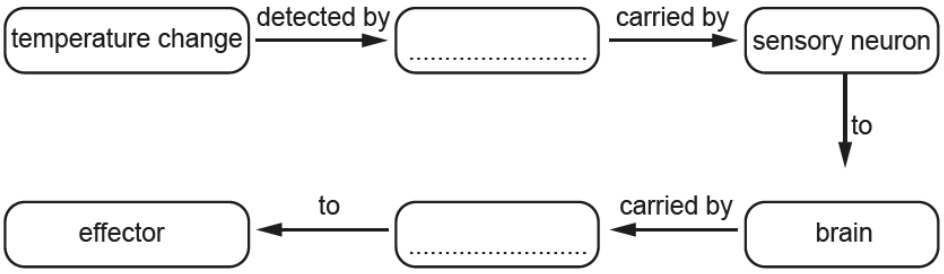
Maintaining body temperature relies on our nervous system.

(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]

This question discriminated well. A third of candidates gained 2 marks, a third gained one mark and the other third gained no marks.

Question 4 (a) (ii)

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

.....

.....

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

Candidates found this question challenging with only the high ability candidates gaining some marks. Examiners saw lots of answers about us being ill or unwell if body temperature went too far from 37°C, getting too hot/overheating/sweating or being too cold/hypothermia and even dying. Other answers that were closer to what we wanted were a little vague saying 37°C was 'the right' temperature. Very few candidates gained the first marking point about enzymes but those who did usually mentioned them denaturing, thereby being credited two marks.

Question 4 (a) (iii)

(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]

Again, candidates found this question challenging. Most candidates gained the first marking point. The most common wrong answer was the second, to say that feathers had a 'high' conductivity. This was closely followed by the last answer with the most popular choice being 'conserved'.

Question 4 (iv)

(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]

Over half the candidates gained one mark with the higher ability candidates gaining both marks. A large minority only ticked one box.

Question 4 (b)

(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]**

This level of response question discriminated between candidates very effectively. Candidates who did not gain any credit usually had not calculated the missing speeds or had made mistakes. We did not allow the relay neuron's speed of 1.6 m/s to be rounded up to 2 m/s – as seen in Exemplar 3. The candidate still scored 2 marks because the 108 was correct and they then made a good comment about the speed of the motor neuron.

.To score all 6 marks we wanted candidates to correctly calculate both missing speeds, to then make a comment about the relative speeds of the different neurons and to then explain this difference with reference to the fatty sheath. Exemplar 2 shows a good example of a 6-mark answer.

A large number of candidates made the mistake of stating that the relay neuron was fastest – hinting that they saw it had the lowest time, but not realising the distance was significantly lower thereby making the speed lowest. Even candidates who correctly calculated both speeds made this mistake. Most candidates who calculated the speeds then made a good comparison of them.

Exemplar 2

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	108
Relay neuron	No	0.12	0.075	1.6

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

The Relay neuron has the slowest nerve impulse speed at only 1.6 m/s this most likly due to the fact that it has no fatty sheath surrounding it slowing nerve impulse down on the other hand, Motor and Sensory neurons both have fatty sheaths to speeding nerve impulses up they have keys to distals between leaves than the relay neuron.

Exemplar 3

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	108
Relay neuron	No	0.12	0.075	2

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

Your motor neurons impulses are faster compared to the sensory and relay neurons. After using the equation speed = distance ÷ time it is clear to see that the slowest neuron type is the relay neuron, ~~[illegible]~~ the speed is 2m/s.

Question 5 (a)

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.

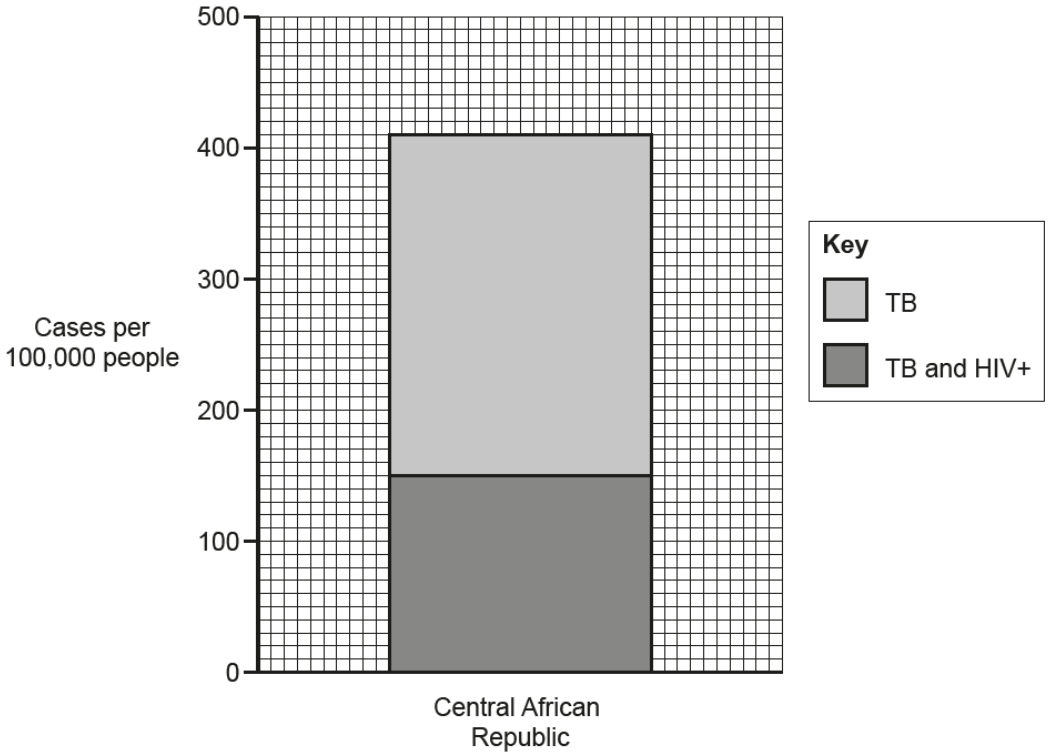


Fig. 5.1

(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]**

This question involved reading two numbers from the chart and then processing them to calculate the percentage. Half of candidates were unable to gain any marks on this question. Some of these did not gain the first mark because they incorrectly read 410 as 401 from the chart. Others stated their final answer, but it was incorrectly rounded and because they had not shown any working at all, they too did not gain any marks. We did not allow error carried forward here as candidates only needed to read numbers from the chart.

Question 5 (b) (i)

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

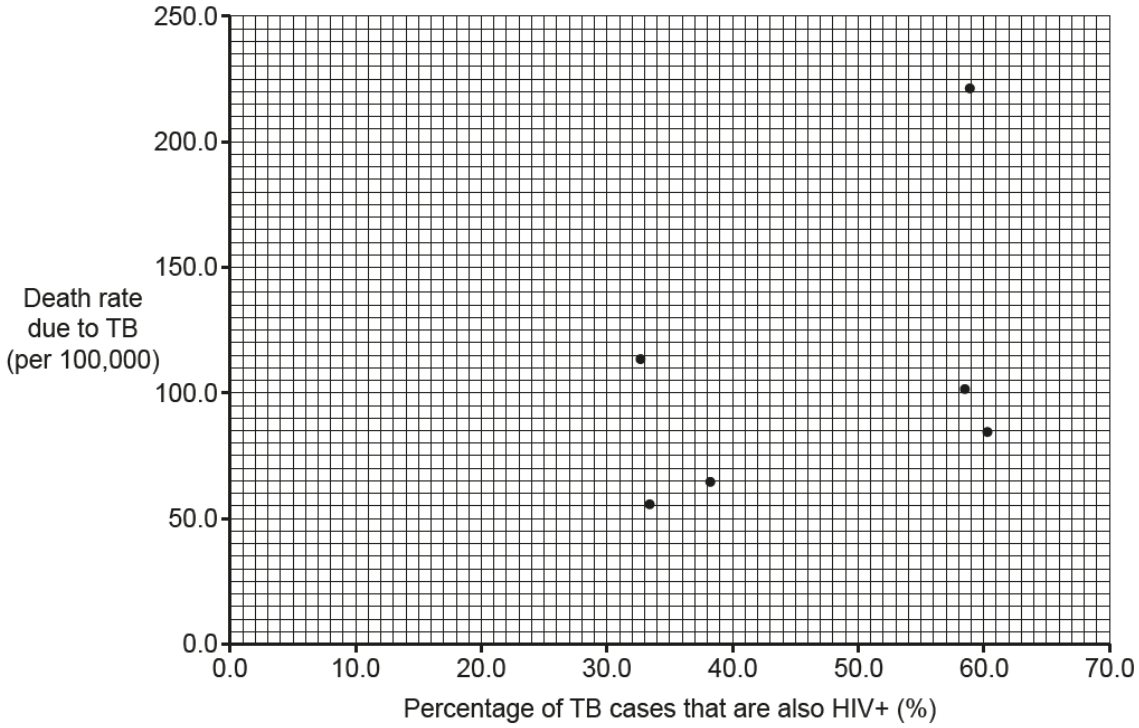


Fig. 5.2

(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]

This question scored well with most candidates gaining either 2 or 3 marks.

Question 5 (b) (ii)

(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]

Most candidates gained the mark here.

Question 5 (c)

(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	Improvement
Sample more countries	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

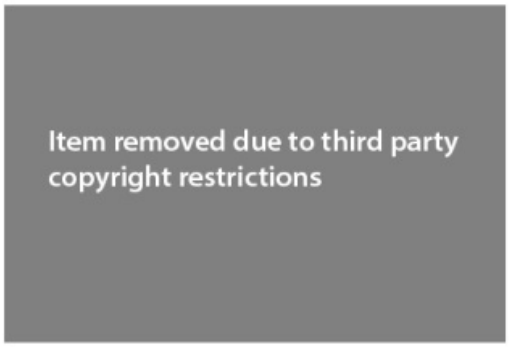
[2]

Most candidates gained at least one mark for this question with the higher ability candidates gaining both marks.

Question 6 (a) (i)

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]**

Question 6 was the one that was common to both the higher and foundation papers. In this particular part of the question, it was rare to see anything creditworthy. The most common correct answer was about carbon or soot. The idea of incomplete combustion or a lack of oxygen was rarely seen.

Question 6 (a) (ii)

(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]

Most candidates gained at least one mark for this question. Only the higher ability candidates gained both marks. Some candidates did not gain either mark.

Question 6 (a) (iii)

(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]**

Empirical formulae seems to be an area that candidates find difficult. Most candidates did not gain any marks for this question. The most common response was to draw the structure of the molecule and this was not worth any credit.

Question 6 (b)

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

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

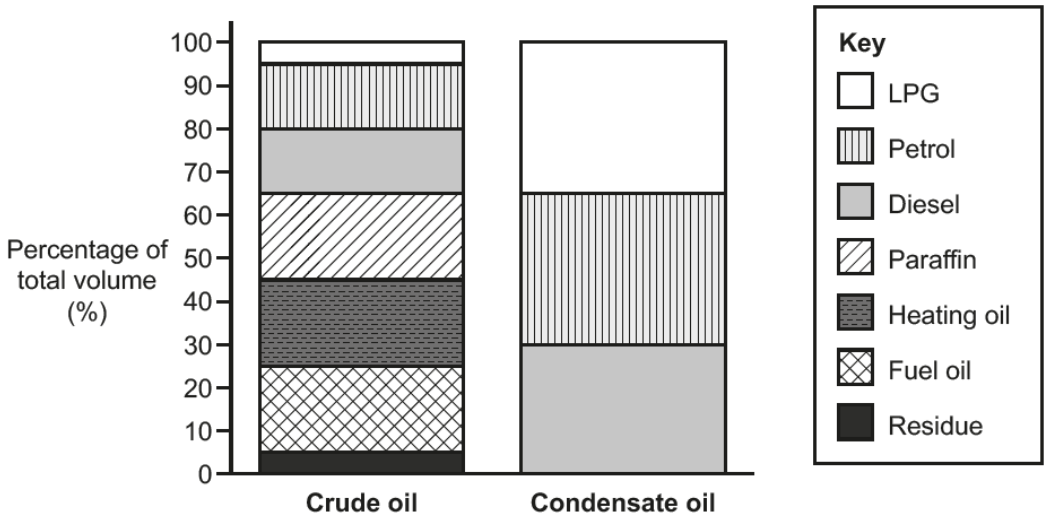


Fig. 6.1

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]

Most candidates gain some marks on this question with about half gaining all four marks. The obvious similarities and differences were the best ones to give and candidates who tried to look for something beyond the obvious tended not to gain marks here. If candidates are given a choice of the obvious answer or one that is borderline, they are well advised to give the obvious one. We were generous on language with oils/chemicals/products/ingredients being valid substitutions for the word 'fractions'. Some candidates tried to give differences but were not specific about which oil they meant. Responses like 'one has residue' would not have scored but 'crude has residue' would.

Question 6 (c) (i)

(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/cm^3)	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]

Under half of candidates correctly answered this question. The most common wrong answer was the one about density.

Question 6 (c) (ii)

(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.

.....

.....

.....

.....

.....

..... **[3]**

Over half of candidates did not gain any credit for this question, usually because they quoted things from the table without processing or adding to it. We were after comparatives, so things like 'crude is a thick liquid' were not enough but an answer along the lines of 'crude is less runny' was sufficient. There was a lot of confusion about boiling point and flash point and a large number of candidates thought the colour made the oil more or less dangerous.

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