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GCSE (9-1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE COMBINED SCIENCE B

J260

For first teaching in 2016

J260/03 Summer 2023 series

Version 1

ocr.org.uk/science

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. A selection of candidate answers is also provided. 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 and the mark scheme can be downloaded from OCR.

Paper 3 series overview

Paper 3 appeared to be accessible with most candidates attempting all questions. There is some improvement in candidates showing their working in calculations, this is important as candidates can score marks for correct methods even on simple calculations. In general, the calculations were dealt with well.

Candidates were not always familiar with the context of some experiments, although they should have at least seen the practical carried out. For example, the use of a ripple tank in Question 9 where a lack of familiarity was very obvious.

When using extra paper candidates did not always clearly label which question, they were continuing. Candidates often gave vague answers without using appropriate scientific vocabulary, which often lost marks.

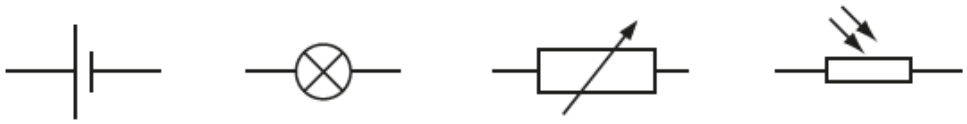
Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• showed working in calculations • showed familiarity with experiments • used appropriate scientific language.	• did not show working for calculations • lacked familiarity with experiments • did not use scientific vocabulary.

Question 1 (a)

1 Ling has a torch with a filament lamp.

(a) What is the correct circuit symbol for a filament lamp?

Put a (ring) around the correct option.

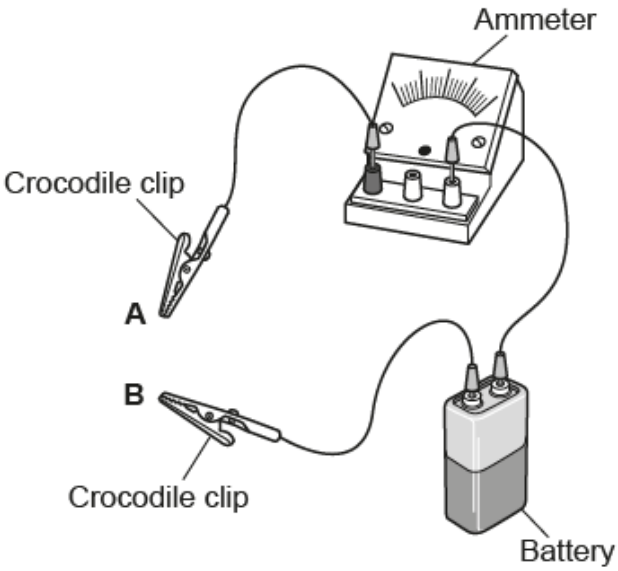


[1]

Most candidates correctly identified the symbol for filament lamp. The most common error was the symbol for an LDR.

Question 1 (b)

(b) The torch is not working. Ling makes this circuit to test components.



Complete the sentences to explain how the circuit works.

Put a (ring) around each correct option.

A component is connected to **A** and **B** using the **ammeter / battery / crocodile clips**.

If the ammeter measures a current it means that the circuit is **broken / complete / faulty**.

This shows that the component conducts **electricity / heat / light**.

[3]

This question was well answered by most candidates. Common errors included selecting ammeter from the first list and light from the third list.

Question 1 (c)

(c) Which equation shows how to calculate the energy transferred to the filament lamp?

Tick (✓) **one** box.

energy transferred = charge ÷ potential difference ☐

energy transferred = potential difference ÷ charge ☐

energy transferred = potential difference × charge ☐

[1]

Most candidates gave the correct response for this question.

Question 1 (d)

(d) The current through the filament lamp is 0.5A.

Calculate the charge that flows through the lamp in 30s.

Use the equation: charge = current × time

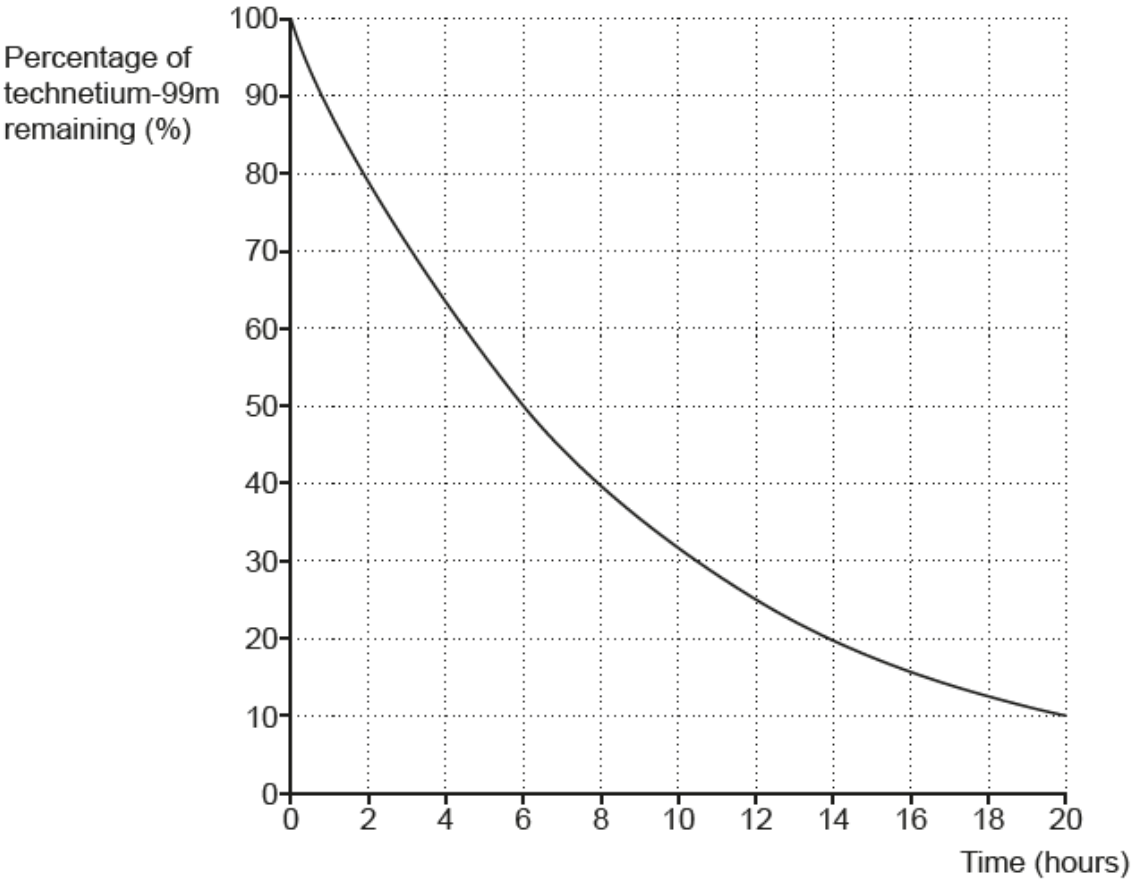
Charge = ...C **[2]**

Nearly all candidates could correctly calculate the charge.

Question 2 (a)

2 Jack has a kidney scan. A radioactive tracer called technetium-99m is used in the scan.

(a) This radioactive decay graph shows how the percentage of technetium-99m remaining in the tracer changes with time.



What is the half-life of technetium-99m?

Put a (ring) around the correct option.

6 hours **10 hours** **32%** **50%**

[1]

Common errors given in response to this question were 10 hours and 50%.

Question 2 (b)

(b) A gamma camera uses the radiation emitted by a radioactive tracer to form an image.

The statements describe how a kidney is scanned by a gamma camera.
They are **not** in the correct order.

A This causes gamma rays to be emitted from the kidney.

B There is radioactive decay of the tracer in the kidney.

C The radioactive tracer is injected into Jack's blood.

D The gamma rays are detected by the gamma camera.

E The tracer travels around the body and collects in the kidney.

Write the letters in the boxes to show the correct order of how a kidney is scanned.

The first one has been done for you.

C				

[2]

The most common error in the sequence was EBDA which gained 1 mark.

Question 2 (c) (i)

(c) Radioactive materials emit ionising radiation.

(i) Explain how ionising radiation can affect living things.

.....

..... **[1]**

Common errors given in response to this question were radiation poisoning, death and ionising radiation used to treat tumours.

Misconception

Many candidates were not clear that ionising radiation affects the **cells** of an organism.

Question 2 (c) (ii)

(ii) Using a radioactive source can result in contamination or irradiation.

Which statement is an example of contamination?

Tick (✓) **one** box.

A person wearing gloves picks up a radioactive rock. ☐

A radioactive isotope gets on the skin. ☐

The body is irradiated by a source of gamma radiation. ☐

[1]

Candidates were usually correct with their answer; the most common error was 'the body is irradiated by a source of gamma radiation'.

Question 3 (a)

3 Kai reads about an insect that has a large acceleration.

(a) The speed of the insect increases from 0 m/s to 0.9 m/s in a time of 0.006 s.

Calculate the acceleration of the insect.

Use the equation: $\text{acceleration} = \frac{\text{change in speed}}{\text{time taken}}$

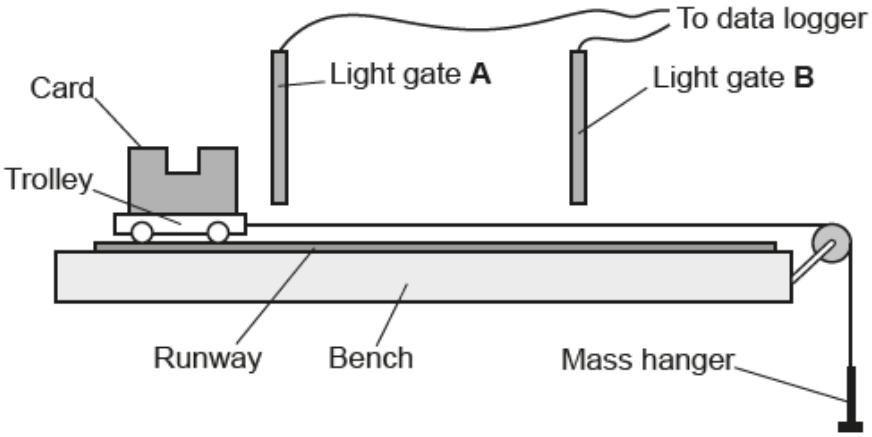
Acceleration = ... m/s^2 **[2]**

This question was usually calculated correctly.

Question 3 (b) (i)

(b) The insect has a very small mass.

Kai investigates how changing the force on an object affects the acceleration of the object.



(i) Complete the sentences to explain how Kai does the experiment.

Put a (ring) around each correct option.

Kai adds a 100 g mass to the **bench / mass hanger / trolley**.

He releases the trolley and it travels along the runway.

The light gates detect the **card / trolley / mass hanger**.

Kai repeats the experiment adding another **100 g mass / trolley / light gate** each time.

[3]

This question was well answered by most candidates. Occasionally marks were lost for choosing trolley in the first and second list.

Question 3 (b) (ii)

(ii) The data logger calculates the acceleration of the trolley.

What data does the data logger use to calculate the acceleration of the trolley?

Tick (✓) **three** boxes.

Data	Used to calculate acceleration
Distance between light gates **A** and **B**	
Length of the runway	
Mass of the mass hanger	
Speed of the trolley when it passes light gate **A**	
Speed of the trolley when it passes light gate **B**	
Time to travel from light gate **A** to light gate **B**	

[2]

This question proved challenging for many candidates with few getting more than 1 mark. The 'distance between light gates **A** and **B'** proved a strong distractor.

Question 3 (b) (iii)

(iii) The force accelerating the trolley is the weight of the mass hanger.

Calculate the weight of the mass hanger when its mass is 0.4 kg.

Use the equation: weight = mass × gravitational field strength

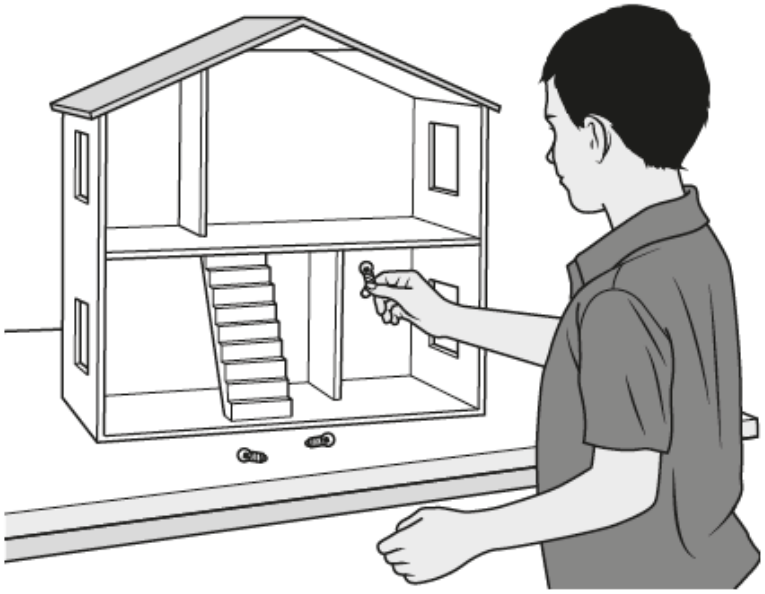
Gravitational field strength = 10 N/kg

Weight = ... N **[2]**

Most candidates completed the calculation for this question correctly.

Question 4 (a) (i)

4 Alex uses some filament lamps to light the rooms of a model house.



(a) Alex connects one filament lamp to a battery. The lamp has a resistance of 10 Ω and the current through it is 0.3 A.

(i) Calculate the potential difference across the lamp.

Use the equation: potential difference = current × resistance

Potential difference = ... V **[2]**

There were very few errors given in response to this question.

Question 4 (a) (ii)

(ii) Calculate the power transferred in the lamp.

Use the Equation Sheet.

Resistance of lamp = 10 Ω
Current through lamp = 0.3 A

Power transferred = ...W **[3]**

Most candidates were able to select the correct equation and make the substitution. The most common error was to select the wrong equation.

Question 4 (b) (i)

(b) Alex learns about connecting resistors in series and parallel.

(i) Alex builds a circuit with one fixed resistor, as shown in **Fig. 4.1**.

Alex then adds a second resistor in series as shown in **Fig. 4.2**.

Fig. 4.1

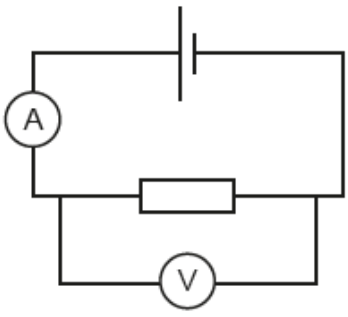
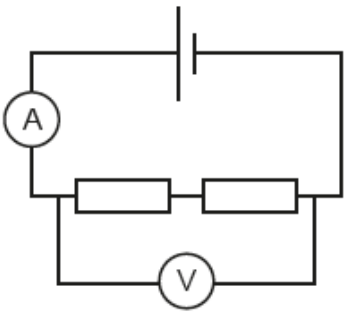


Fig. 4.2



Complete the sentences to explain the increase in total resistance of the circuit when a second resistor is added in series.

Put a (ring) around each correct option.

The reading of the current on the ammeter **increases / decreases** because it has to pass through both resistors.

The reading of the potential difference on the voltmeter **stays the same / increases**.

[1]

This question proved challenging with a choice of increase from the second list a very common error.

Question 4 (b) (ii)

(ii) Alex rebuilds his original circuit (**Fig. 4.1**).
Alex then adds a second resistor in **parallel** as shown in **Fig. 4.3**.

Fig. 4.1

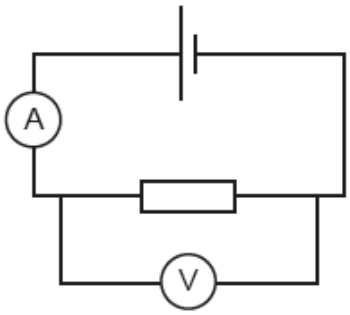
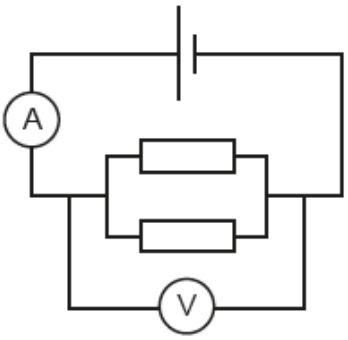


Fig. 4.3



Complete the sentences to explain the decrease in total resistance of the circuit when a second resistor is added in parallel.

Put a (ring) around each correct option.

The current passes through both branches of the circuit, so the reading on the ammeter
decreases / increases / stays the same.

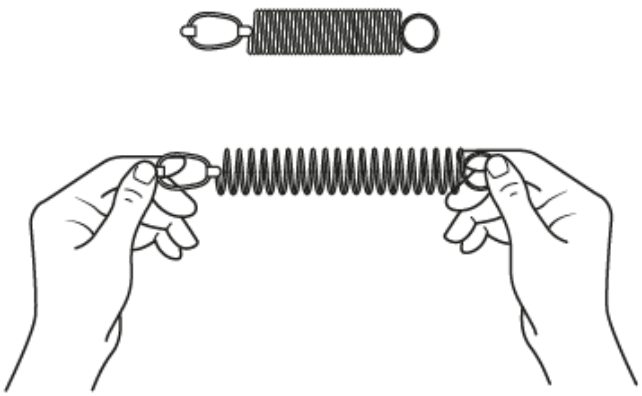
The potential difference reading on the voltmeter
decreases / increases / stays the same.

[2]

Commonly only 1 of these options was correctly chosen.

Question 5 (a)

5 The diagram shows a spring key ring which can be stretched.



(a) The stretching forces deform the spring. The deformation can be plastic or elastic.

Complete the sentences to describe the difference between plastic deformation and elastic deformation.

Plastic deformation:

When the force is removed .....

.....

Elastic deformation:

When the force is removed .....

.....

[2]

For this question there were plenty of correct answers. However some candidates assumed plastic and elastic referred to the materials rather than types of deformation.

Question 5 (b)

(b) A force of 9 N is used to stretch the spring.

Calculate the extension of the spring.

Use the equation: extension = $\frac{\text{force}}{\text{spring constant}}$

The spring constant = 2.5 N / cm

Extension = ...cm **[2]**

Nearly all candidates correctly calculated the extension.

Question 6 (a)

6 Beth investigates the change in stored energy when an electrical appliance is used.

Her results are shown in the table.

Electrical appliance	Power rating (W)	Time appliance is used for (h)	Change in stored energy (W h)
Fan heater	3000	2	6000
Television	150	2	300
Laptop computer	100	4	400
Refrigerator	100	24	2400

(a) Explain how the power rating, and the time the appliance is used for, affects the change in stored energy.

Use data from the table.

.....

.....

.....

.....

.....

..... **[4]**

Candidates did not perform well on this with almost none making comparison between fan/television and laptop/fridge as supporting evidence for their statements. Many candidates correctly identified the relationship Power x time = change in stored energy. In weaker responses, candidates talked about the power and time affecting the energy, but without saying how.

Question 6 (b)

(b) Beth wants her home to be warm.

How can Beth reduce the energy losses from her home?

.....

..... **[1]**

The common error for this question was to suggest using the appliances less, rather than providing insulation.

Question 7 (a)

7 Ben is heating some soup on a gas hob.

(a) The temperature of the soup increases.

Which diagram describes the transfer between energy stores when the soup is heated?

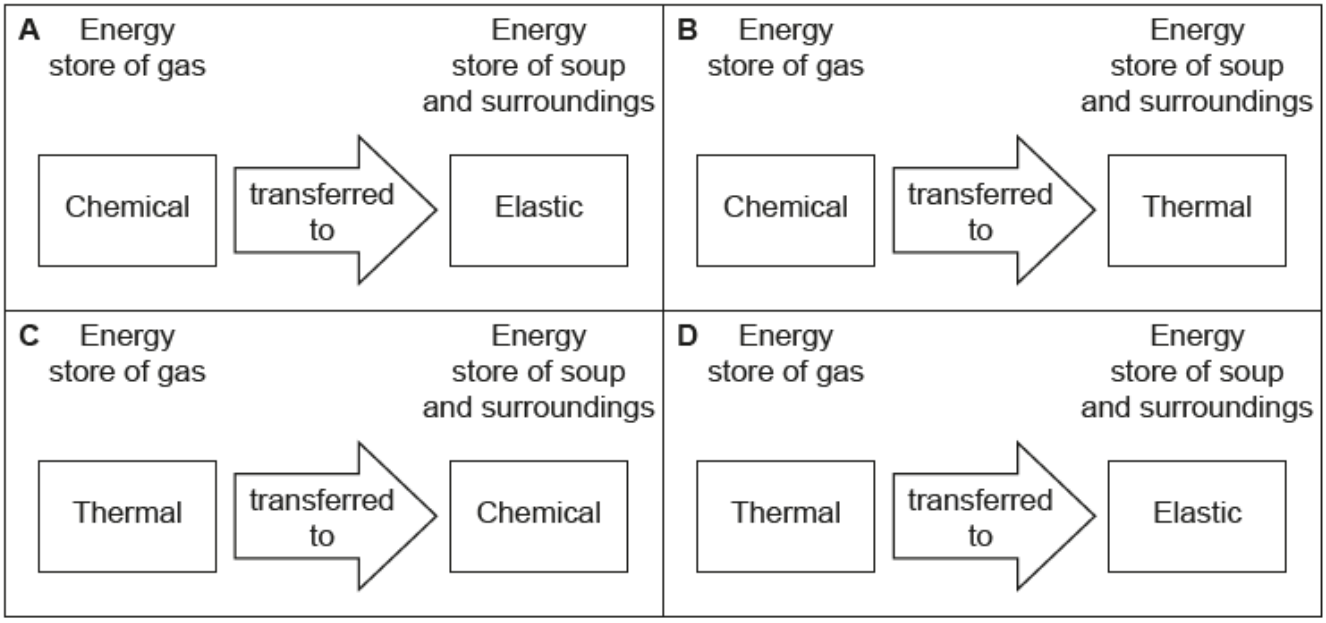


Diagram = ... **[1]**

This question was generally answered correctly. The most common error given was C.

Question 7 (b)

(b) Describe what happens to the liquid soup as its temperature increases.

Use ideas from the particle model.

.....

.....

.....

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

This was the least successfully answered question on the paper. Candidates appeared to miss the direction to use the particle model, with nearly all talking about what happens to the soup when it is heated up (as in cooking) and the change of state with no reference to particles. Chemical/thermal energy was often mentioned but not kinetic energy as was required.

Question 7 (c)

(c) When energy is transferred to the soup, the internal energy of the soup increases.

Calculate the energy transferred to the soup when the temperature is increased from 20 °C to 90 °C.

The mass of the soup is 400 g
The specific heat capacity of the soup is 4100 J/kg °C

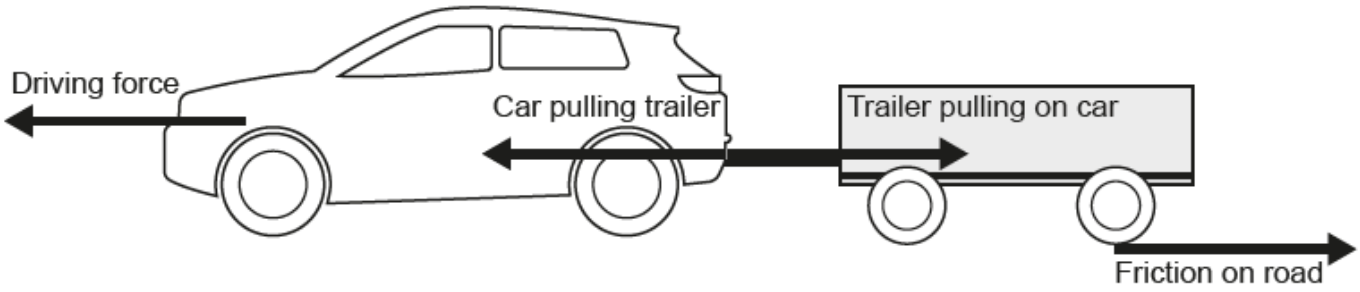
Use the Equation Sheet.

Energy transferred = ... J **[4]**

This question was generally well answered with by far the most common error being a failure to convert 400 g to kg giving an answer of 114 800 000 J. The most common mark scored was for calculating the temperature difference.

Question 8 (a)

8 A car is pulling a trailer. The diagram shows some of the forces on the car and the trailer.



(a) Newton's 3rd Law describes interaction pairs of forces.

(i) Which **two** forces in the diagram form an interaction pair?

Put (rings) around the **two** forces. **[1]**

(ii) State **two** reasons why these forces are an interaction pair.

1 .....

2 .....

[2]

The answers given showed little understanding of interaction pairs. Some candidates gained marks for opposite and/or equal, very few candidates referred to acting on different objects. The most common answer referred to the car pulling the trailer, friction and other forces shown on the diagram.

Question 8 (b)

(b) The car and trailer are travelling at a speed of 12 m/s.

Calculate the kinetic energy of the car and trailer.

The mass of the car is 1100 kg and the mass of the trailer is 300 kg.

Use the equation: kinetic energy = $\frac{1}{2}$ × mass × (speed)^2

Kinetic energy = ... J **[2]**

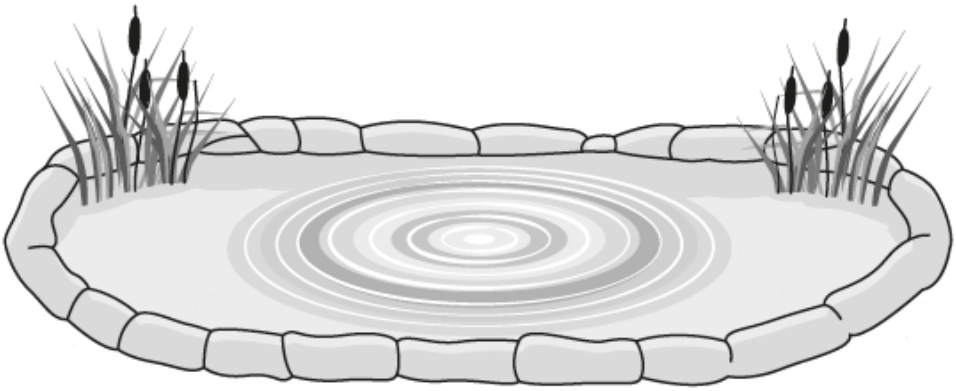
This question was generally answered correctly. The most common error was to not square the speed.

Question 9 (a) (i)

9 Eve drops a pebble into a pond.

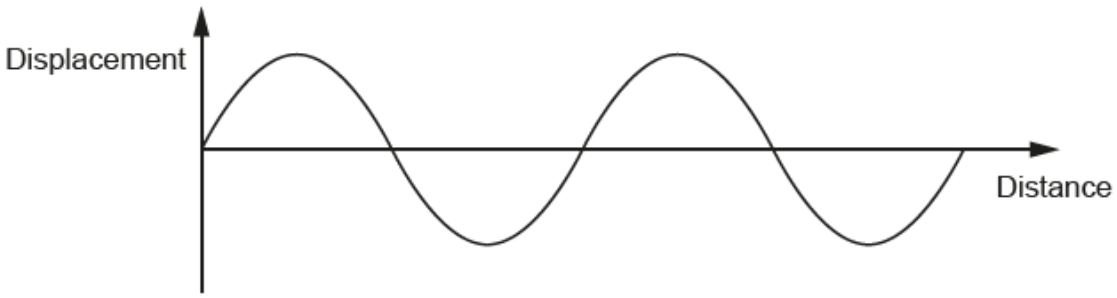
Fig. 9.1 shows how the water waves spread out.

Fig. 9.1



(a) (i) The graph shows a transverse wave.

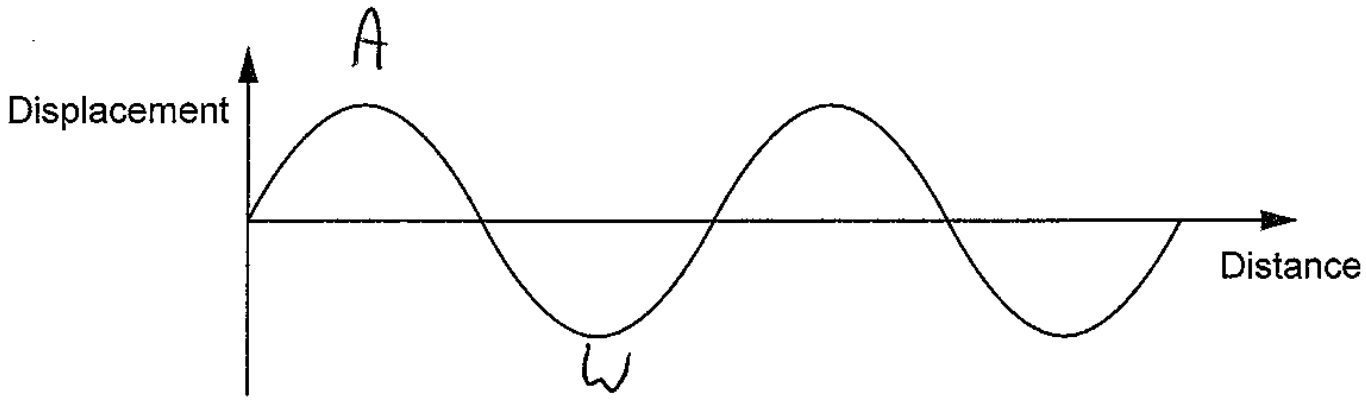
Label an amplitude with a letter **A**, and a wavelength with a letter **W** on the transverse wave.



[2]

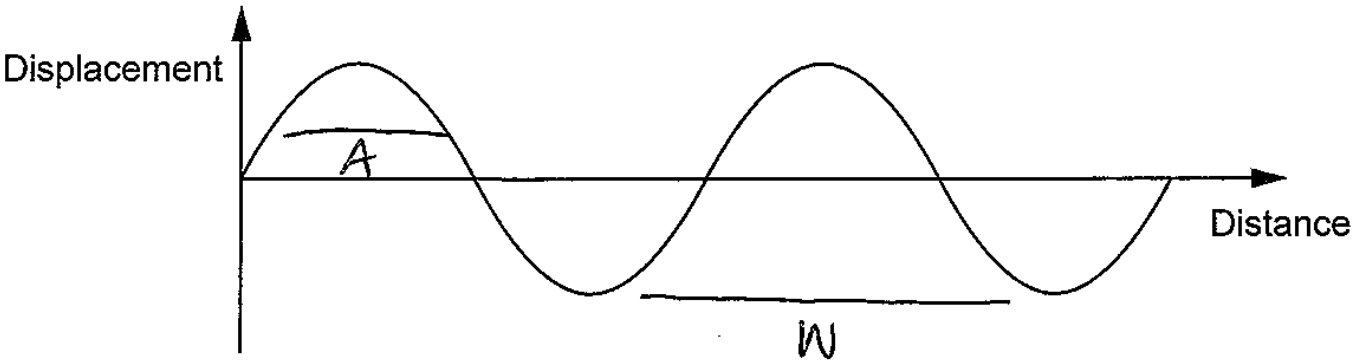
Not many responses given for this question scored marks. In many cases just letters were put on the diagram with no indication of amplitude/wavelength, see Exemplar 1. In other cases the indication was not accurate enough to gain marks, see Exemplar 2.

Exemplar 1



In this response we can see that the candidate has just written the letters **A** and **W** but with no indication of what they are referring to.

Exemplar 2



In this instance the candidate has given some indication of the measurements. **A** is clearly wrong and it is not clear that the **W** is intended to be a full wavelength.

Question 9 (a) (ii)

(ii) What is the **frequency** of the wave?

Tick (✓) **one** box.

The change in the wavelength of the waves in one second. ☐

The number of waves passing a point in one second. ☐

The time for the wavelength to change in seconds. ☐

[1]

Most candidates chose correctly for this question.

Question 9 (a) (iii)

(iii) A water wave has a wavelength of 0.3 cm and a frequency of 100 Hz.

Calculate the wave speed of the water wave.

Use the equation: wave speed = frequency × wavelength

Give your answer in **m/s**.

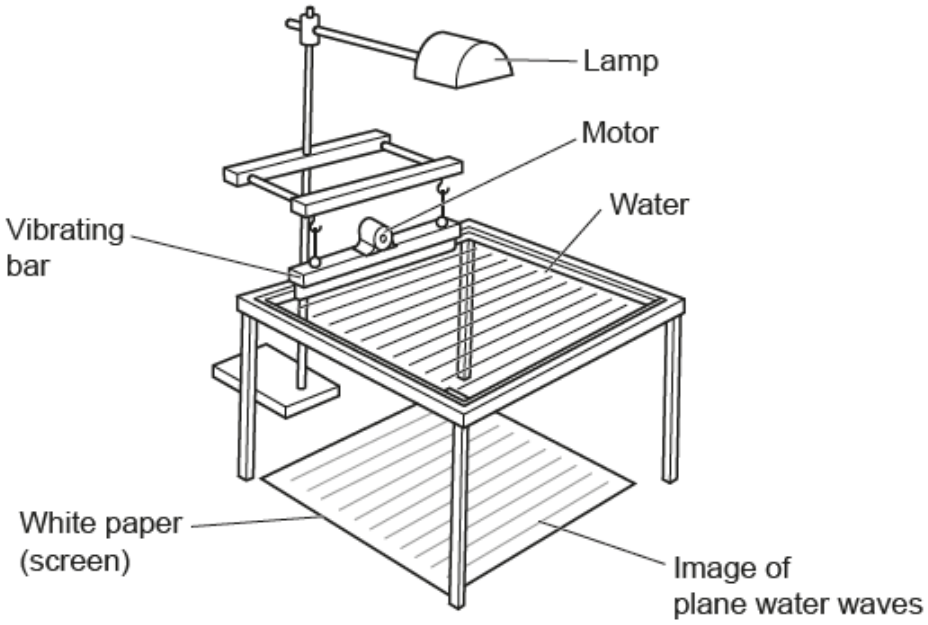
Wave speed = ...m/s **[3]**

By far the most common error here was to omit the unit conversion of 0.3 cm to metres.

Question 9 (b) (i)

(b) Eve investigates waves using a ripple tank, as shown in **Fig. 9.2**.

Fig. 9.2



(i) Complete the sentences to describe how Eve can use the ripple tank to measure the wavelength of a water wave.

Use words from the list.

distance	**mass**	**ruler**	**speed**	**stopwatch**	**time**

Make the waves low frequency waves by changing the ..... of the motor.

To measure the wavelength of the waves, place a ..... on the paper.

Measure the ..... between the waves to get the wavelength.

[3]

This question was generally answered well. The most common error was to choose time for the final sentence.

Question 9 (b) (ii)

(ii) How can Eve get a stationary image of the waves on the paper?

.....

..... **[1]**

Common errors were 'draw the wave' or 'stop the motor'. The most common correct answer was to take a photograph.

Question 9 (b) (iii)

(iii) The wavelength is very small.

How can Eve get a more accurate measurement of the wavelength?

.....

..... **[1]**

This question was very poorly answered by most candidates. Repeat the experiment was a common incorrect answer, other errors were 'make the waves bigger', 'stop the motor'.

Question 9 (b) (iv)

(iv) How can Eve reduce the uncertainty of her result?

Tick (✓) **one** box.

Increase the frequency of the vibrating bar.	☐
Repeat the experiment 3 times and use the mean value.	☐
Use a magnifying lens to see the waves.	☐

[1]

Most candidates correctly answered this question.

Question 9 (b) (v)

(v) Eve wants to investigate circular waves with the ripple tank. Dropping a pebble into the ripple tank does not continually produce circular waves.

Suggest how she can **continually** produce **circular** waves in the ripple tank.

.....

..... **[1]**

Most candidates appeared to be unfamiliar with this experiment and the simple solution of attaching a small ball to the vibrating bar. Many incorrect answers including 'Keep dropping pebbles/water, 'move vibrating bar to the centre' and 'use a round bowl'.

Question 10 (a)

10 When trains were invented, people were able to travel between places at 7 m/s. This is faster than the typical walking speed.

(a) What is a typical walking speed for an adult human?

Walking speed = ... m/s **[1]**

Only about a third of candidates got this correct. Most errors were on the high side, and candidates may have been confused between metres per second and miles per hour.

Question 10 (b)

(b) What is the difference between speed and velocity?

.....

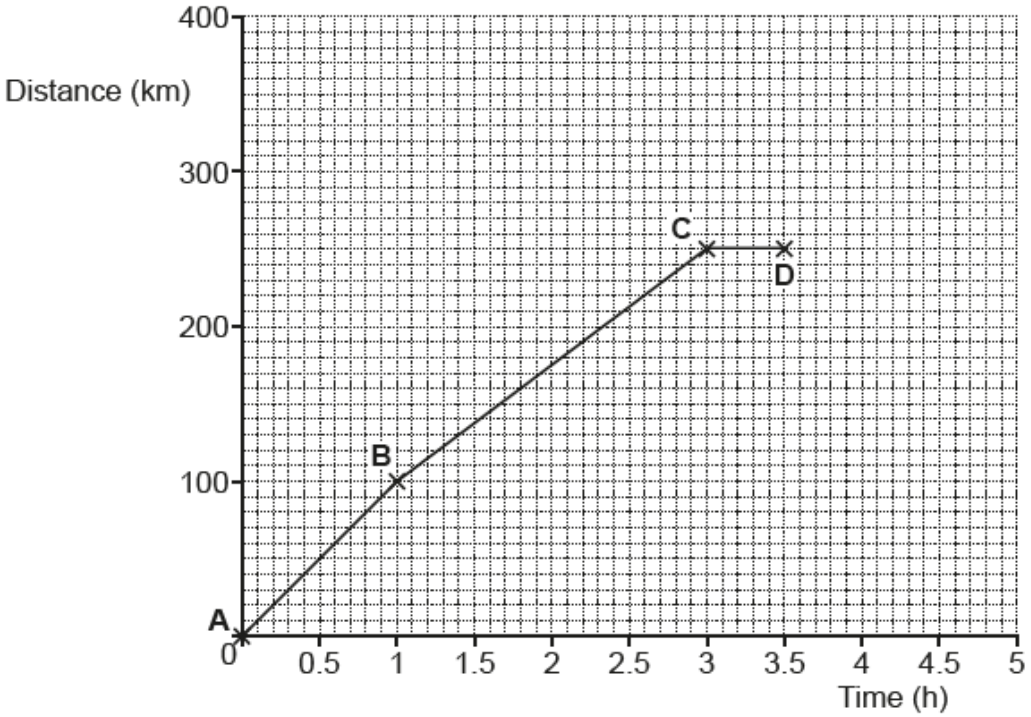
..... **[1]**

Very few candidates knew the difference between speed and velocity. Speed was usually described as how fast and velocity as distance or movement.

Question 10 (c) (i)

(c) The table and the graph show a train journey.

Point on journey	Distance (km)	Time (h)
A	0	0
B	100	1.0
C	250	3.0
D	250	3.5
E	300	4.0
F	350	5.0



(i) Plot the results for point **E** and point **F** on the graph. **[1]**

This question was generally well answered. Candidates using a pen often had difficulty amending any mistakes.

Question 10 (c) (ii)

(ii) Draw lines to complete the distance–time graph. **[1]**

Nearly all candidates correctly attempted dot-to-dot lines.

Question 10 (c) (iii)

(iii) Calculate the speed of the train between points **B** and **C**.

Use the equation: average speed = $\frac{\text{distance}}{\text{time}}$

Speed of train between points **B** and **C** = ... km/h **[2]**

Most errors here involved mis-reading data from the graph. A time of 3 hours was a common error.

Question 10 (c) (iv)

(iv) Describe how the speed of the train changes from point **A** to point **D**.

.....

.....

.....

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

Candidates often gained 1 mark for C-D stationary. However constant speed was missed, candidates usually said speed was increasing with no mention of higher constant speed for point A to point B. Possibly candidates confused the distance-time graph with a velocity-time graph. Many answers calculated the average speed from A to D, which was not given marks. Explanations were often unclear so marks were not given.

Question 10 (d)

(d) A stationary train accelerates steadily from an initial speed of 0 m/s to a final speed of 56 m/s.

Calculate the distance the train travels as it is accelerating.

The acceleration is 0.2 m/s^2.

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

Use the Equation Sheet.

Distance = ... m **[3]**

Candidates usually selected the correct equation, but often had problems rearranging it. The most commonly scored mark was for giving an answer to 2 significant figures.

Question 10 (e)

(e) In a collision a train comes to a stop quickly. This is a very large deceleration.

Explain why this is dangerous for the passengers.

In your answer, use the equation: force = mass × acceleration

.....

.....

.....

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

Candidates did not give clear answers here. Common problems were passengers being thrown forward but no consequence of this explained. The most common mark was for identifying that a large acceleration was linked to a large force.

Question 11 (a)

11 (a) Which **two** statements about electromagnetic radiation are true?

Tick (✓) **two** boxes.

All electromagnetic radiation is ionising. ☐

All electromagnetic radiation travels through space at the same speed. ☐

Only very hot bodies emit electromagnetic radiation. ☐

Our eyes can only detect a limited range of electromagnetic frequencies. ☐

Gamma rays are used for satellite communications. ☐

[2]

The most common correct answer was 'all electromagnetic radiation travels through space at the same speed'. The most common error was 'all electromagnetic radiation is ionising.

Question 11 (b) (i)

(b) (i) Complete the table by showing the main groups of the electromagnetic spectrum from long to short wavelengths.

Use words from the list.

Gamma rays	Microwave	Radio	Visible	X-rays	Ultraviolet

Electromagnetic radiation spectrum						
Long wavelength →						Short wavelength
		Infrared				

[3]

This was generally well answered with nearly all candidates scoring at least 1 mark. The most common errors involved microwaves and radio misplaced in the spectrum.

Question 11 (b) (ii)

(ii) Complete the sentence about electromagnetic radiation.

Put a (ring) around each correct option.

When the wavelength of electromagnetic radiation gets shorter

the frequency **increases / decreases / stays the same**

and the energy **increases / decreases / stays the same**.

[2]

Most candidates managed to score 1 mark here, with no noticeable pattern in the answers chosen.

Question 11 (c) (i)

(c) A new telescope in space called the JWST uses electromagnetic radiation to produce images of very distant galaxies.

(i) Suggest **one** benefit of seeing images of very distant galaxies.

.....

..... **[1]**

Many candidates did not grasp the idea of very distant galaxies, with answers about the solar system, planets, aliens. The most commonly correct answers were for improved understanding / increased knowledge.

Question 11 (c) (ii)

(ii) Suggest **one** reason why scientists looking at images from the JWST should tell everyone about their discoveries.

.....

..... **[1]**

Few candidates scored this mark for this question. Common errors were about making people aware and sharing ideas.

Question 12 (a)

12 The UK uses a number of different energy resources including wind and nuclear fuel to generate electricity.

(a) Give **one other** example of a renewable energy resource and a non-renewable energy resource.

Renewable: .....

Non-renewable: .....

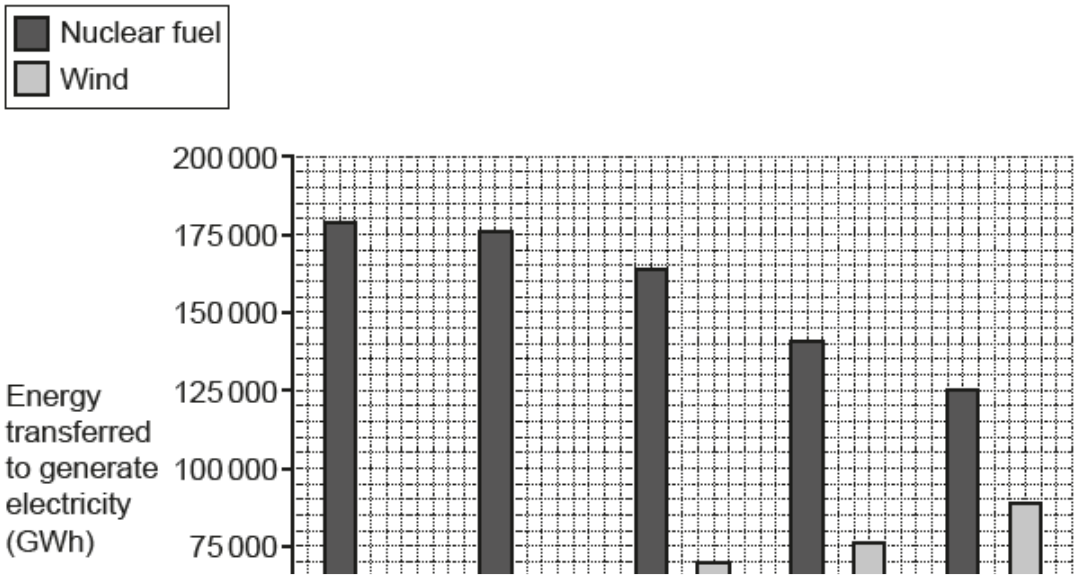
[2]

Most candidates had few problems with this. The most common error was to use wind power and nuclear power from the question stem.

Question 12 (b)*

(b)* Nuclear fuel and wind are used to generate electricity in the UK.

The graph shows the energy transferred to generate electricity from these resources between 2016 and 2020.



Describe how nuclear fuel and wind are used to generate electricity.

Include in your answer how the use of these energy resources has changed in the UK since 2016.

.....

.....

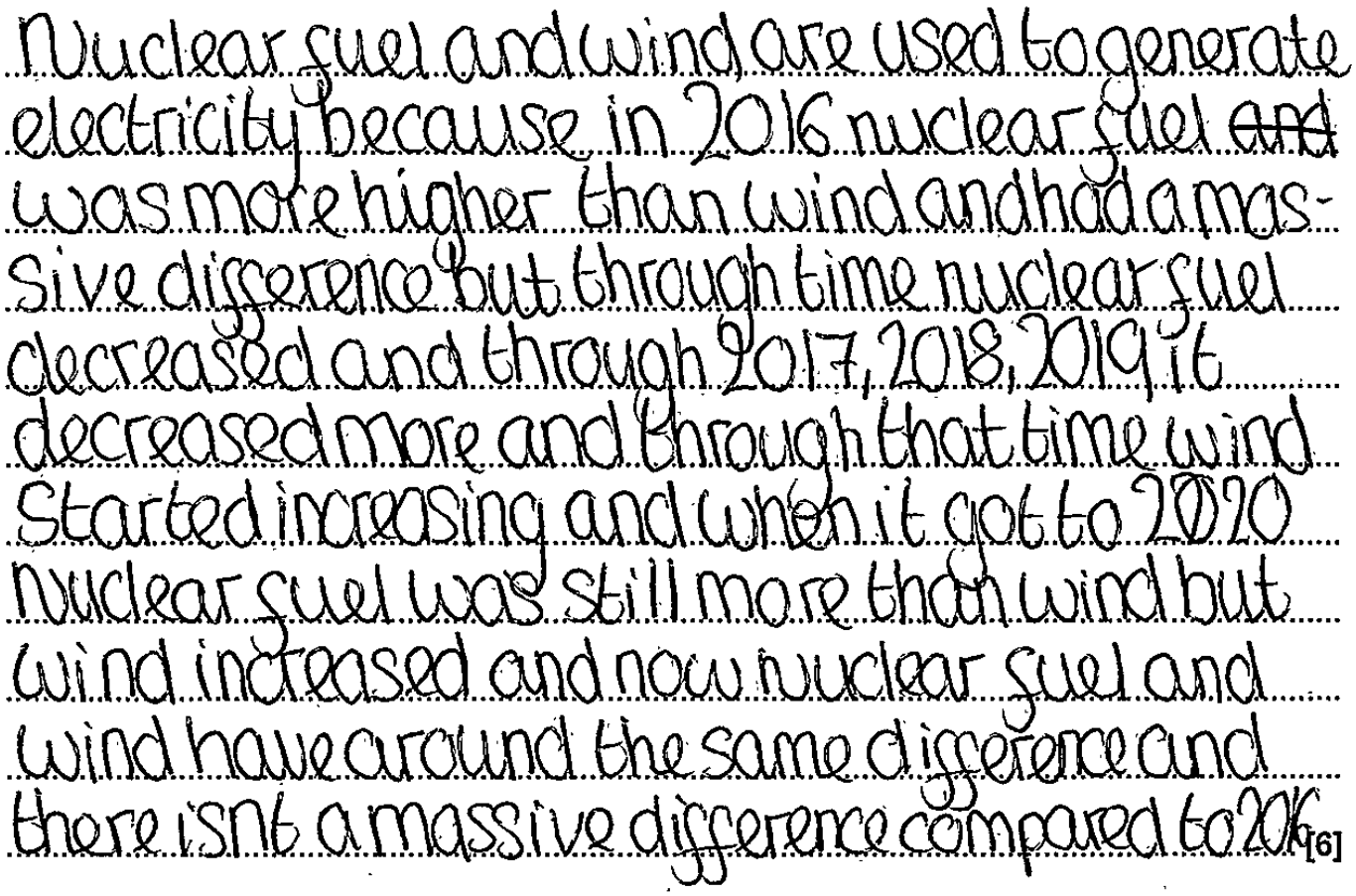
.....

.....

..... **[6]**

Many candidates limited the marks they could obtain by not answering the question. There were three parts to the question: how nuclear power produces electricity, how wind power produces electricity and what the graph tells us about wind and nuclear power production. Many candidates only described the graph and did not describe how nuclear power of wind produce electricity. This limited the marks to a maximum of Level 1 and 2 marks. See Exemplar 3. Very few candidates could describe how nuclear fuel could produce energy, with many confusing nuclear fuel with fossil fuels. The simpler process using wind turbines was more frequently mentioned.

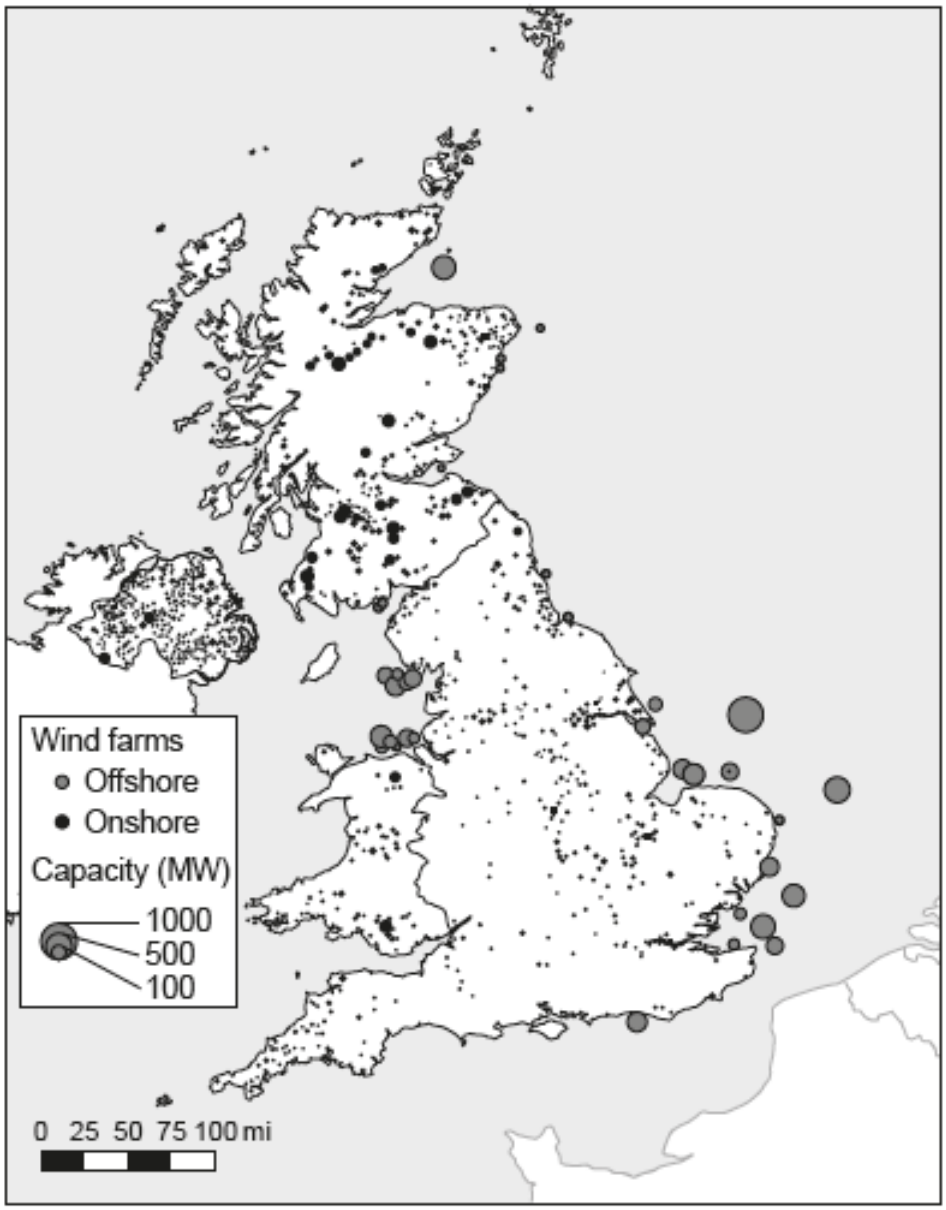
Exemplar 3



This response has given a fairly comprehensive description of the graph including some reference to the numerical data. However, it makes no attempt to explain how electricity is produced by nuclear or wind power. This limited the mark to Level 1.

Question 12 (c)

(c) This map shows wind farm sites in the UK in 2021.



Wind turbines can be built on land or in the sea.

Suggest **two** reasons why some land areas may **not** be suitable for wind turbines.

1 .....

.....

2 .....

.....

[2]

Most candidates scored at least 1 mark. The most common correct responses were unsuitable wind, close to population and unsightly. The most common error was insufficient space.

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