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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 2024 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, in the insulation setup in Question 5 a lack of familiarity was often 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, often just writing an answer • demonstrated a lack of knowledge of experimental detail • tended to use everyday language which often lacked the precision of scientific vocabulary • showed a lack of familiarity with interpreting graphs.

Question 1 (a)

1 The table shows some of the main groupings of the electromagnetic spectrum.

(a) Complete the table.

Low frequency → High frequency Long wavelength → Short wavelength						
Radio wave	Microwave	Infrared	Visible light	Ultraviolet	X-rays	....

[1]

Nearly every candidate achieved the marks for this question. Although some left it blank, not familiar with the electromagnetic spectrum.

Question 1 (b)

(b) Which statement correctly compares a radio wave and an X-ray?

Tick (✓) **one** box.

A radio wave has a **longer** wavelength than an X-ray. ☐

A radio wave has a **shorter** wavelength than an X-ray. ☐

A radio wave has **the same** wavelength as an X-ray. ☐

[1]

This question was mostly answered correctly.

Question 1 (c)

(c) X-rays can remove electrons from atoms.

What is the removal of an outer electron from an atom called?

Tick (✓) **one** box.

Absorption ☐

Conduction ☐

Ionisation ☐

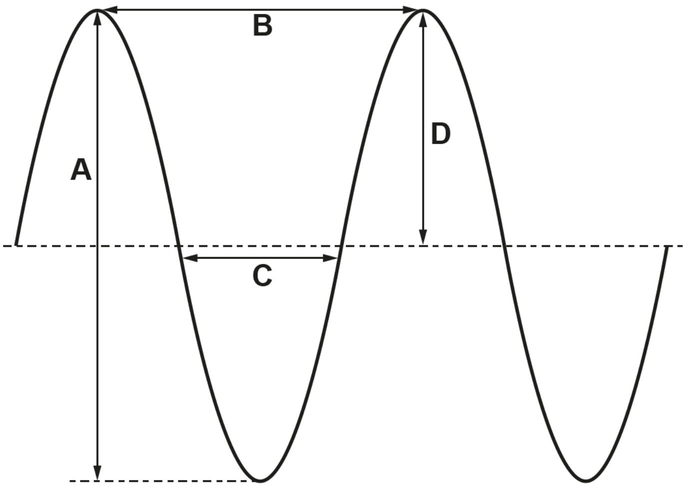
[1]

This question was mostly answered correctly.

Question 2 (a) (i)

2

(a) The diagram shows some ocean waves.



Choose from **A**, **B**, **C**, or **D**.

(i) Which distance is the wavelength of the wave? ☐

[1]

This question often caused confusion with the most common error being D.

Question 2 (a) (ii)

(ii) Which distance is the amplitude of the wave? ☐

[1]

Similar problems were encountered to Question 2 (a) (i) with the most common error being A.

Question 2 (b)

(b) The speed of some water waves on the ocean is 2.8 m/s.
The frequency of the waves is 0.35 Hz.

Calculate the wavelength of the waves.

Use the equation: $\text{wavelength} = \dfrac{\text{wave speed}}{\text{frequency}}$

Wavelength = ... m **[2]**

This question was well answered by most candidates.

Question 3 (a)

3 A student wants to know how different energy resources are used to generate electricity.

(a) Complete the table about the generation of electricity.

Use words from the list:

Coal	**Solar radiation**	**Wind**

Energy resource	**How the energy resource generates electricity.**
	Steam is produced. The steam drives a turbine, which is connected to a generator.
	The energy resource turns the turbine directly. The turbine is connected to a generator.
	Panels are used which generate electricity directly.

[2]

Most candidates correctly identified the different energy resources in this question.

Question 3 (b)

(b) Wind and solar radiation are examples of renewable energy resources. Coal is a non-renewable energy resource.

State **one other** renewable energy resource **and** one other non-renewable energy resource.

Renewable energy resource: ....

Non-renewable energy resource: ....

[2]

A common error was to repeat the stem of the question choosing solar and wind and coal for the renewable and non-renewable resources. There were also some answers that were not energy resources at all like food items, cars, roads. There were also some who mixed up the renewable and non-renewable resources.

Question 3 (c)

(c) Complete the sentences about global warming.

Put a (ring) around each correct option.

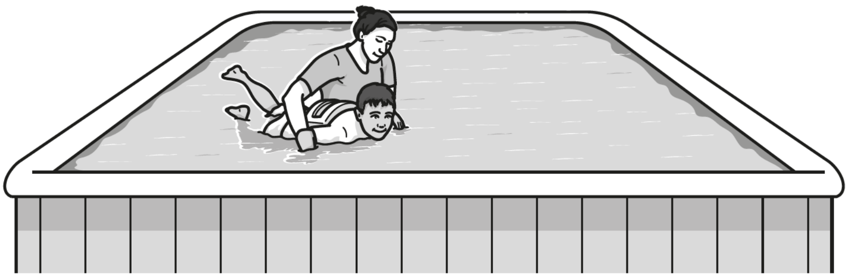
One of the main greenhouse gases in the Earth's atmosphere is **carbon dioxide / nitrogen / oxygen**.

The amounts of greenhouse gases in the atmosphere have been increasing over the past two hundred years mostly because of the increasing use of **biofuels / fossil fuels / nuclear fuels**.
[2]

This question was generally well answered. The most common error was oxygen for carbon dioxide.

Question 4 (a)

4 A hydrotherapy pool contains hot water. It is used to help people with some medical conditions.



(a) A water heater in a pool has a power of 2300 W. It is switched on for 6 hours.

Calculate the total energy transferred to the pool in 6 hours.

Give your answer in kWh.

Use the Equation Sheet.

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

The biggest problem seen on this question was the conversion of watts to kilowatts and the fact that candidates decided that they needed to turn the hours into minutes or seconds when in fact the answer was required in kWh.

Exemplar 1

Use the Equation Sheet.

energy transfered = power x time

2300 x 6 = 13800

Energy transferred = 13800 kWh **[4]**

This candidate has made a good attempt at the question but did not convert the 2300 W into kW. They have laid out the calculation very clearly, so gain 3 marks out of 4.

Question 4 (b)

(b) Suggest **one** reason for using the kilowatt-hour rather than the joule on electricity bills.

....

.... **[1]**

This question was poorly answered with many incorrectly suggesting it would be cheaper / more expensive.

Question 4 (c) (i)

(c) The pool contains 1250 kg of water. A water heater inside the pool heats up the water.
Over 6 hours the temperature of the water rises from 32 °C to 36 °C.

(i) Calculate the increase in the internal energy store of the water over 6 hours.

Use the Equation Sheet.

Specific heat capacity of water = 4200 J / kg / °C

Increase in internal energy = ... J **[3]**

Generally those candidates who did not write an equation seemed not to understand what to do, instead opting to multiply or divide a combination of numbers. For those who did use the correct equation, if they got the answer wrong it was because they didn't use the temperature change, but instead used one of the temperatures mentioned in the question.

Question 4 (c) (ii)

(ii) On another day, the total energy transferred by the water heater is 15 kWh and the increase in internal energy of the water is 10.8 kWh.

Calculate the efficiency of the water heater.

Use the equation:

$$\text{efficiency} = \frac{\text{useful energy transferred}}{\text{total energy transferred}}$$

Efficiency = ... **[2]**

This question was generally well answered. The most common error was to invert the two 'energy transferred' values.

Question 4 (d)

(d) When the pool is not being used the water cools down.

Suggest how the cooling effect can be reduced.

....

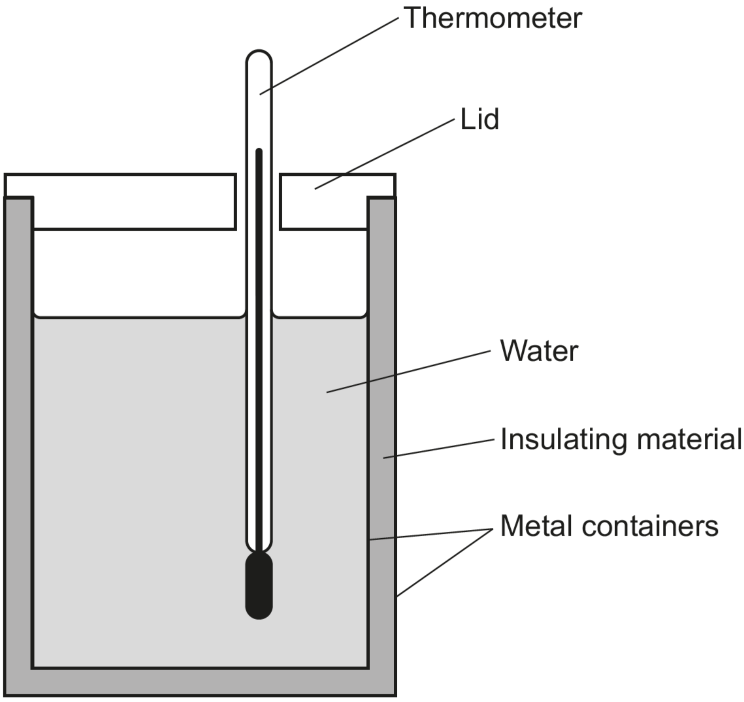
.... **[1]**

Many candidates mentioned covering the pool but there were also a lot suggesting leaving or putting the heater on.

Question 5 (a)

5 A student does an experiment to compare three materials as thermal insulators.

The diagram shows the equipment used.



(a) This is the method:

- Fill the space between the metal containers with the insulating material.
- Pour 100 cm^3 boiling water into the inner container and place a lid on the container.
- Place a thermometer in the water.
- Start a stopwatch when the temperature drops to 80 °C.
- After **5 minutes** measure the final temperature of the water.
- Repeat the experiment with different insulating materials.

List **three** factors that need to be controlled in this experiment.

1 ....

2 ....

3 ....

[3]

The majority of candidates got 2 marks here, but there was a lack of detail e.g. temperature was too vague, (start temperature and room temperature were good meaningful responses); material might have referred to the insulating material, which was the independent variable, or to the type of metal of the container (which does need to be controlled).

Question 5 (b) (i)

(b) The table shows the results of the experiment.

Insulating material	**Initial temperature (°C) at time = 0 minutes**	**Final temperature (°C) at time = 5 minutes**
Straw	80	69
Shredded paper	80	71
Sawdust	80	67

(i) Which material is the best thermal insulator?

....

Explain your answer.

....

....

....

....

.... **[3]**

This question was answered well with most candidates identifying that the shredded paper was the best insulator and then going on to mention the temperature was the highest at the end. However few answers referred to energy flow.

Question 5 (b) (ii)

(ii) Calculate the rate of change of temperature for **straw**, in degrees celsius per **second**.

Use the data from the table and the equation:

$$\text{Rate of change of temperature} = \frac{\text{change in temperature}}{\text{time taken}}$$

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

Rate of change of temperature for straw = ... °C / s **[4]**

There were a lot of rounding errors in this question and a lot did not take note of the 2 significant figures which were asked for. A lot of candidates did not convert the 5 minutes into seconds.

Question 6 (a)

6

(a) A physical quantity is something that can be measured and given a value.

Complete the table by writing in the unit for each physical quantity.

Quantity	Unit
Electric charge	
Specific latent heat	
Work done	

[3]

This question was one of the most challenging in this paper, with few candidates getting any marks at all and very few achieving all marks.

OCR support

To gain confidence with the quantities, symbols, units and unit abbreviations relevant to this specification candidates may find this table useful.

Question 6 (b)

(b) A physical quantity can be a vector quantity or a scalar quantity.

Complete the table.

Tick (✓) **one** box in each row.

Quantity	Scalar	Vector
Displacement		
Force		
Speed		

[2]

Most candidates got 1 mark on this question, but very few got all of the marks, with the most common mistake being displacement being put down as a scalar.

Question 6 (c)

(c) A car travels at a constant speed of 13.4 m / s.

Calculate the distance travelled by the car in 15 seconds.

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

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

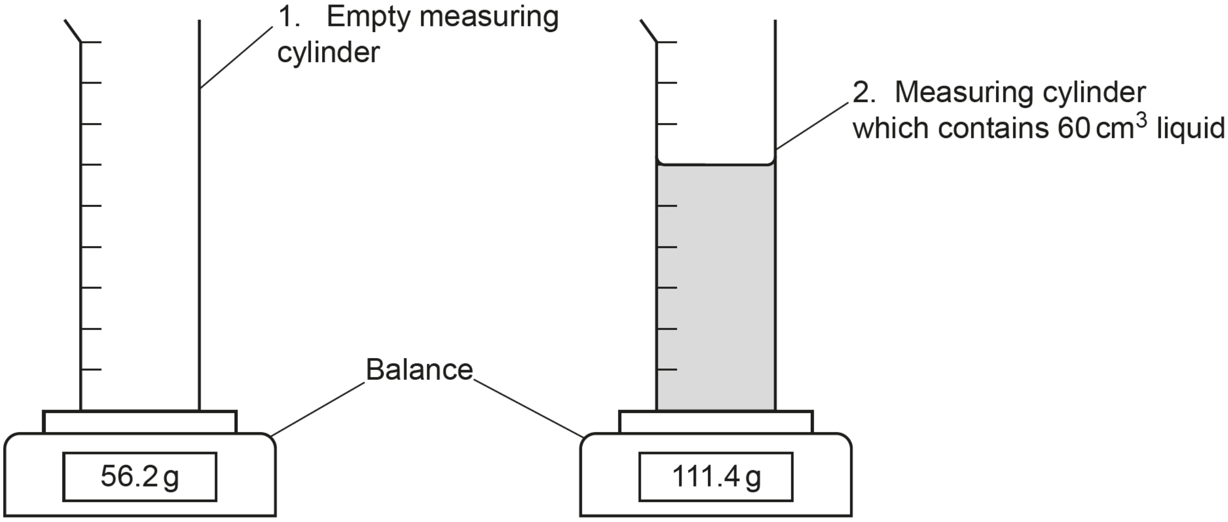
Most candidates had a good go at this question, with roughly half of them being able to rearrange the equation correctly.

Question 7 (a) (i)

7

(a) **Fig. 7.1** shows some equipment used to find the density of a liquid.

Fig. 7.1



(i) Calculate the mass of the 60 cm^3 of liquid.

Use **Fig. 7.1**.

Mass = ... g **[1]**

There were a lot of candidates who did not get this question correct, with a distinct misunderstanding of how to get the mass of the contents of the measuring cylinder, many candidates forgetting to subtract the mass of the empty measuring cylinder from the mass of the filled one.

Question 7 (a) (ii)

(ii) Calculate the density of the liquid.

Use the equation: density = $\frac{\text{mass}}{\text{volume}}$

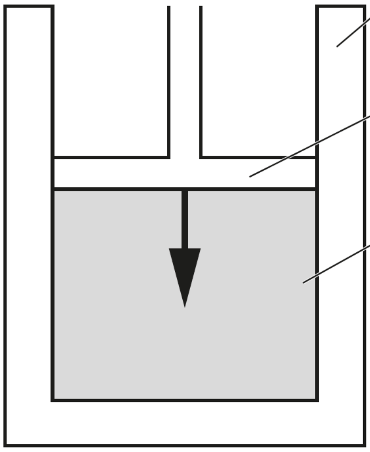
Density = ... g / cm^3 **[2]**

This question was answered well, with most candidates achieving these marks with the error carried forward.

Question 7 (b) (i)

(b) **Fig. 7.2** shows a fixed mass of gas trapped in a cylinder by a piston.
The piston can be moved up and down.

Fig. 7.2



(i) Complete the sentence to explain what happens to the density of the trapped gas when the piston is moved downwards.

Put a (ring) around the correct option to help you complete the sentence.

The density of the gas **decreases / increases / stays the same**

because ....

....

....

....

.... **[3]**

A common misunderstanding involved the closed nature of the system. There were some candidates who did not understand that it was a sealed container and spoke about particles escaping. For those candidates who realised that the gas was trapped, they struggled to realise that the particles being closer together increased the density, thus demonstrating a limited understanding of density.

Question 7 (b) (ii)

(ii) The piston is then fixed in place so that it cannot move.

The trapped gas is heated. This causes the pressure inside the cylinder to increase.

Explain why the gas molecules apply a larger pressure on the cylinder when the trapped gas is heated.

....

....

....

....

....

.... **[3]**

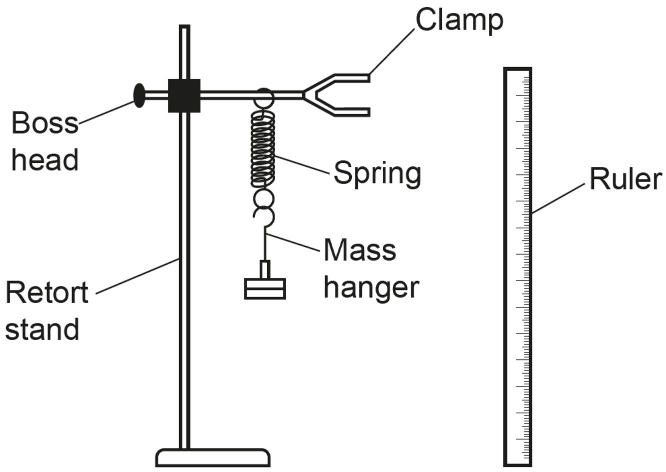
Very few candidates mentioned the gain in energy but opted to talk about the particles moving faster when heated, but they provided no more detail, so only achieved 1 mark. When collisions were mentioned, the response was often confused and did not mention the increased frequency of collisions.

Question 8 (a) (i)

8 A student investigates how the length of a spring changes when masses are added to it, using the equipment in **Fig. 8.1**.

The results are shown in **the table**.

Fig. 8.1



Mass (g)	Weight (N)	Length (cm)	Extension (cm)
0	0	4.0	0
100	1.0	6.4	2.4
200	2.0	8.8	4.8
300	3.0	11.2	7.2
400	4.0	13.6	....
500	5.0	16.0	12.0
600	6.0	18.4	14.4

(a)
(i) Calculate the extension of the spring when the mass is 400 g.

Write your answer in the table. **[1]**

The majority of candidates correctly answered this question.

Question 8 (a) (ii)

(ii) Calculate the spring constant when the mass is **300 g**.

Use the table and the equation: weight = spring constant × extension

Give your answer to **2** decimal places.

Spring constant = ... N / cm **[4]**

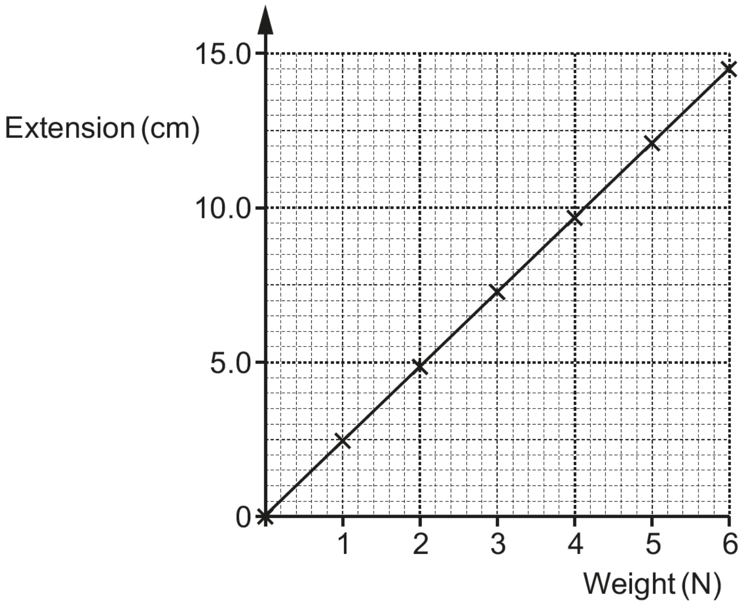
Rearranging was a problem here. Candidates often find it easier to substitute into the formula before rearranging, and this can still result in full marks. Candidates also had problems rounding the answer to 2 decimal places.

Misconception

Many candidates appeared to be unclear about the difference between decimal places and significant figures.

Question 8 (b)

(b) The graph shows the results of the experiment.



Describe the relationship between the weight and the extension of the spring.

Use data from the graph or the table to support your answer.

....

....

....

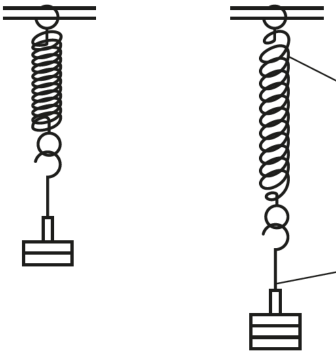
.... **[2]**

Most candidates could describe how the extension increased and the weight increased, but only one or two used the data as asked. Candidates need to read the questions more carefully and follow the instructions provided.

Question 8 (c)

(c) When a mass is added to the spring, the spring stretches and the masses move down and stop at a lower position, as shown in **Fig. 8.2**.

Fig. 8.2



Energy is transferred.

Explain how energy has been conserved even though the spring has stretched and the masses are in a different position.

Use ideas about gravitational potential and elastic potential energy stores.

....

....

....

....

....

.... **[3]**

Candidates got stuck in the language of this question, with many using the word conserved inappropriately. This led their answer down the wrong line of thinking. They did not understand that it was all about the decrease of one store of energy and the increase in another. A common error was suggesting that as more mass is added there is more gravitational potential energy.

Question 8 (d) (i)

(d) The energy stored in a stretched spring is given by the equation:

Energy stored in a stretched spring = $\frac{1}{2}$ × spring constant × (extension)^2

(i) What happens to the energy stored in a stretched spring when the extension is doubled?

Put a (ring) around the correct option.

The energy stored increases by:

less than two times / two times / more than two times.

[1]

The most common error in this answer to this question was to say 'two times'.

Question 8 (d) (ii)

(ii) Explain your answer to **(d)(i)**.

....

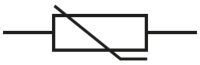
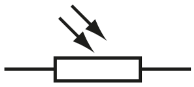
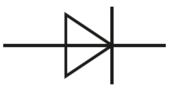
.... **[1]**

A common mistake was to think that squared meant 2 times.

Question 9 (a)

9
(a) Electric circuits are represented by symbols.

Draw lines to connect each **symbol** to its **name** and its **use**.

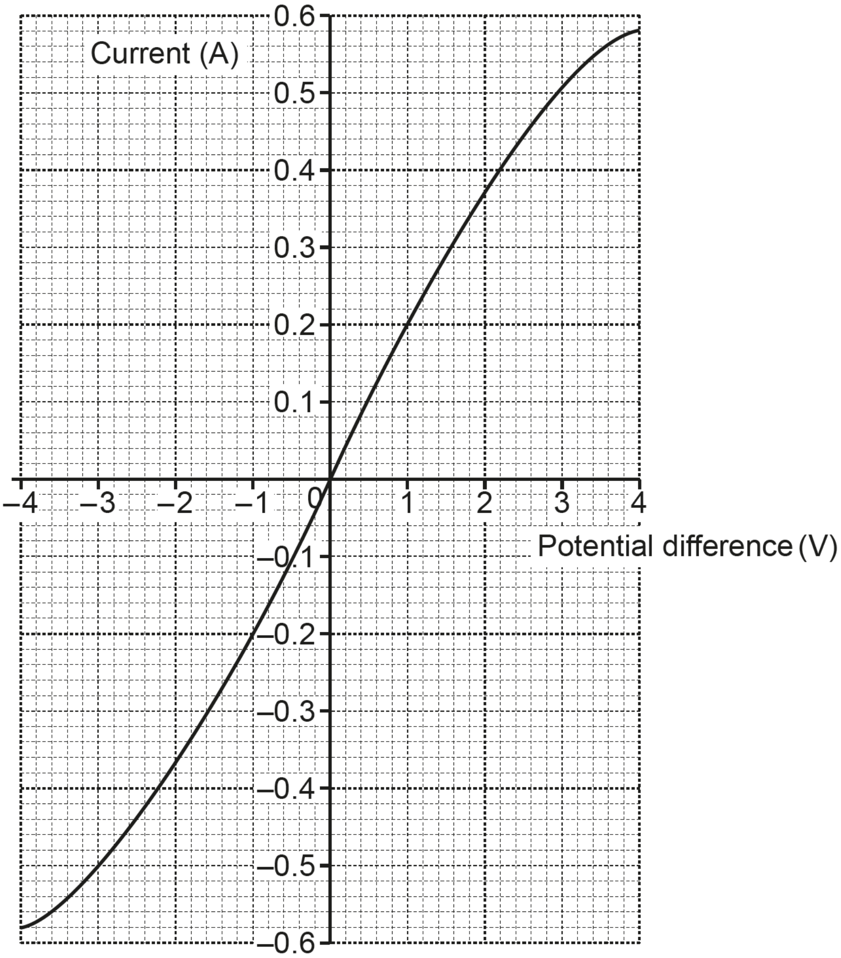
Symbol	Name	Use
	Diode	Allows current to flow in one direction only
	Thermistor	Detects changes in light intensity
	Light-dependent resistor	Detects changes in temperature

[4]

This question was generally answered well, with the right hand side usually correct and one correct on the left hand side.

Question 9 (b) (i)

(b) The graph shows how the current through a filament lamp varies with the potential difference across it.



(i) Describe how the current in the filament lamp changes as the potential difference across it increases from 0 V to 4 V.

....

....

....

.... **[2]**

This question posed a problem for a lot of candidates who either got no marks or just got the first mark.

Question 9 (b) (ii)

(ii) Calculate the resistance of the filament lamp when the potential difference across it is 2.2 V.

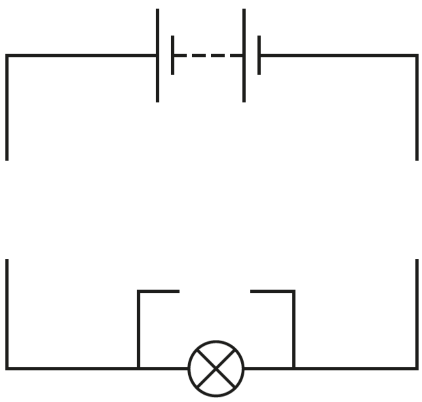
Use the graph and the Equation Sheet.

Resistance = ... Ω **[4]**

Very few candidates achieved all the marks for this question. Some put the line on the graph but did not read off the current and then used the wrong number in the equation. Candidates need to understand that it is important to write down the value they read off so that examiners can give an error carried forward mark where appropriate.

Question 9 (b) (iii)

(iii) The diagram shows part of the circuit that a student uses to obtain these results.



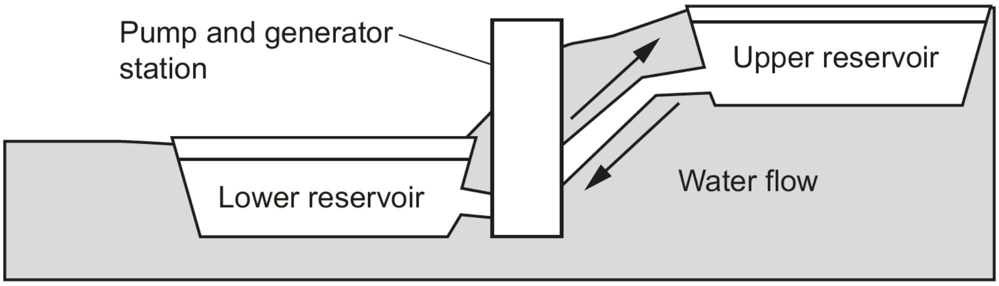
Complete the circuit diagram by adding a variable resistor, voltmeter and an ammeter to the circuit.

[3]

The ammeter was well answered. But there were a large number of voltmeters placed in series, rather than in parallel, and many variable resistors where just drawn as a resistor box or a resistor box with a diagonal line through the box.

Question 10*

10* The diagram shows a pumped storage system.



Electricity is used to pump water from the lower reservoir to the upper reservoir. When the water flows back down, its kinetic energy store is used to generate electricity.

Describe the benefits and risks of replacing fossil fuel power stations with wind farms and solar panels **and** explain how pumped storage systems can help to reduce the risks.

....

....

....

....

....

.... **[6]**

This question was generally well done, with the majority of candidates achieving at least a Level 2. Most candidates had a good go at this and kept their answer in the correct context. There was an excellent understanding of the risks and benefits of replacing fossil fuels with solar and wind, but less idea when it came to linking in why the pumped storage system was going to help alleviate the risks.

Question 11 (a)

11

(a) A student is investigating the motion of a trolley travelling down a ramp, using the equipment shown in **Fig. 11.1**.

Fig. 11.1

Describe how the student can use a metre ruler and a stopwatch to find out the average speed of the trolley down the ramp.

Use the idea that average speed = $\frac{\text{distance}}{\text{time}}$

....

....

....

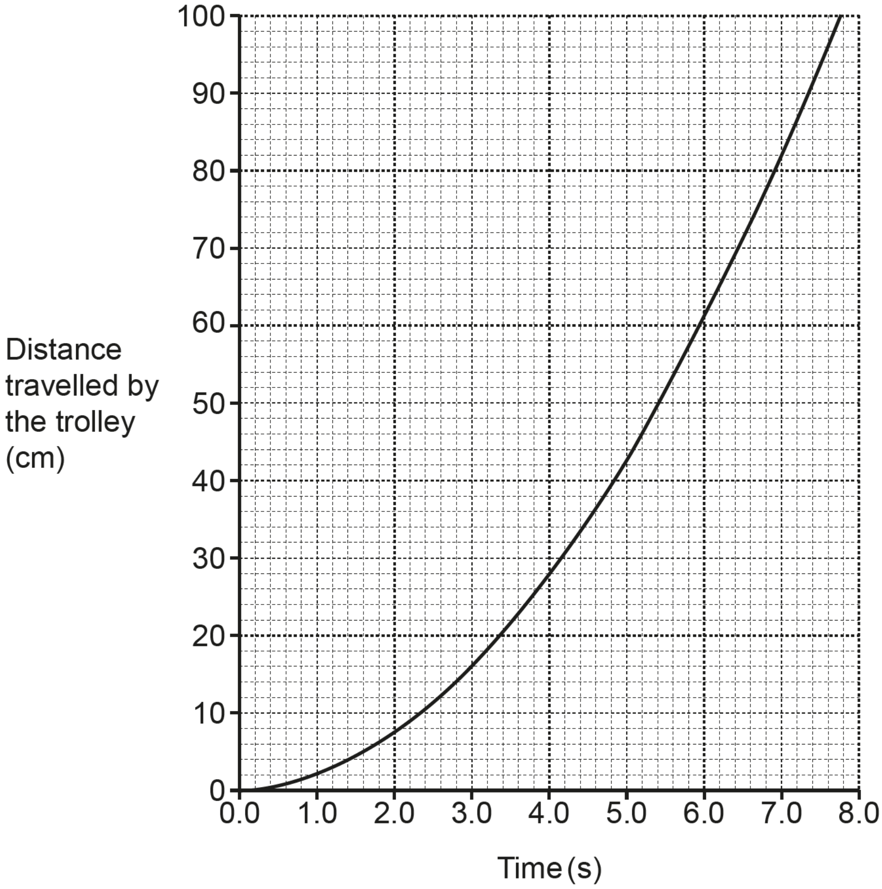
.... **[2]**

This question was answered well by the majority of candidates, although there were quite a few candidates who thought that they could use the ruler as a ramp. Many candidates were vague about what they were measuring.

Question 11 (b) (i)

(b) **Fig. 11.2** shows how far the trolley travels down the ramp in a given time.

Fig. 11.2



(i) Explain how **Fig. 11.2** shows that the trolley accelerates down the slope.

Use the idea that acceleration = $\frac{\text{change in speed}}{\text{time taken}}$

....

....

....

.... **[2]**

Very few candidates mentioned that the gradient of the distance time graph gave you the speed, and in fact a good proportion of the candidates did not mention the graph at all, even though the question asked them to comment on how the graph showed the trolley was accelerating.

Question 11 (b) (ii)

(ii) **Draw** a tangent on **Fig. 11.2** at Time = 5.0 s and use it to **calculate** the gradient at this time.

Gradient = ... cm/s **[4]**

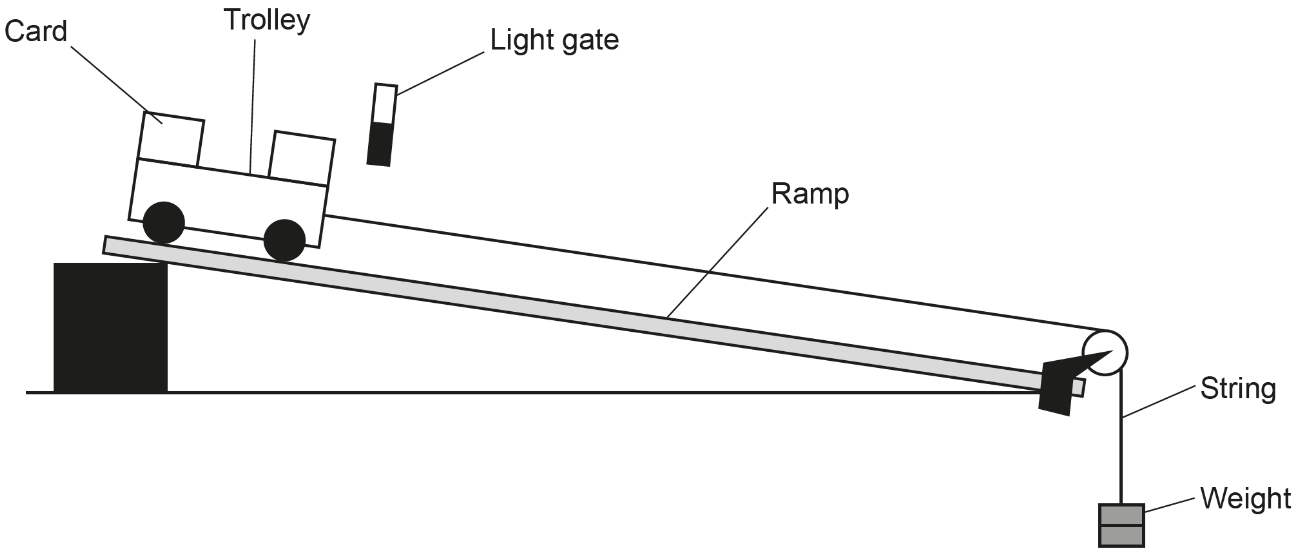
This proved to be a very challenging question. Few candidates appeared to understand clearly what a tangent is. Where candidates did draw a line, it was often in the wrong place and they did not seem to know how to find the gradient of the line they drew.

Question 11 (c) (i)

(c) The student then investigates how the size of a pulling force affects the motion of the trolley down the ramp.

Fig. 11.3 shows the equipment used.

Fig. 11.3

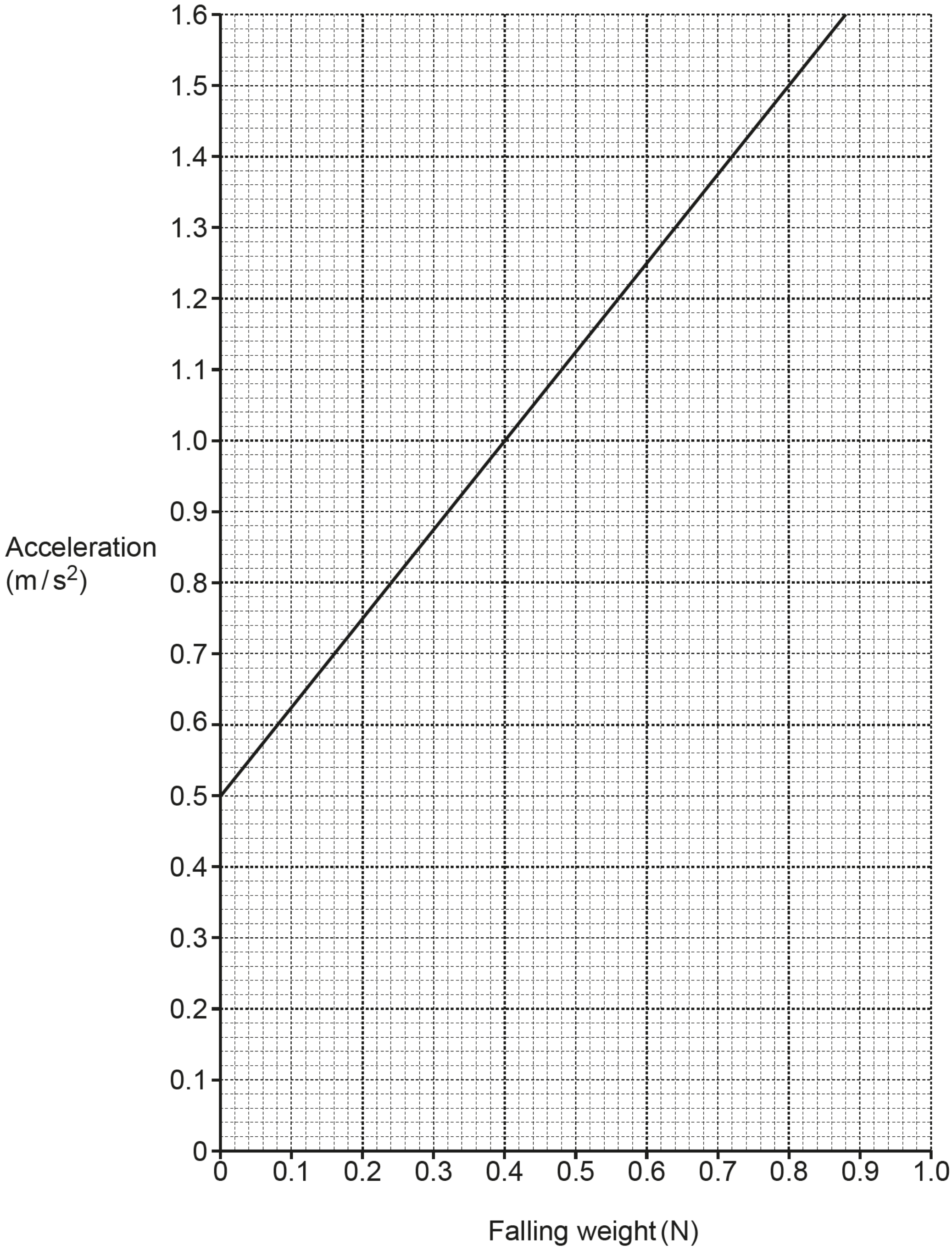


The pulling force on the trolley is provided by a falling weight attached to the trolley by a string.

The student measures the acceleration of the trolley when different weights are used.

Fig. 11.4 shows the student's results.

Fig. 11.4



(i) Calculate the resultant force acting on the trolley when the falling weight is 0.50 N.

The mass of the trolley is 0.80 kg.

Use **Fig. 11.4** and the Equation Sheet.

Resultant force = ... N **[4]**

This was a fairly straightforward question, but candidates drew the line on the graph to get the read off for acceleration and read the scale wrong or they did not use the correct equation from the sheet. Many candidates opted not to write the equation down, so the first mark could not be given if they had made a mistake. Candidates need to make sure they write their read off down somewhere.

Question 11 (c) (ii)

(ii) A student writes an equation for the graph in **Fig. 11.4**

Underneath the student writes the general equation for a straight line.

The student's equation: **acceleration = m × falling weight + c**

A straight line: **y = m × x + c**

What does **c** represent on the graph in **Fig. 11.4**?

Tick (✓) **one** box.

The acceleration caused by the slope of the ramp	
The initial speed of the trolley	
The mass of the trolley	
The resultant force on the trolley	

[1]

This question resulted in a real mix of answers with the majority of candidates opting for a wrong answer. There was no one answer that attracted most responses.

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