Oxford Cambridge and RSA

F

# Tuesday 23 November 2021 – Morning

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

### J260/03 Physics (Foundation Tier)

**Time allowed: 1 hour 45 minutes**

**You must have:**
- a ruler (cm/mm)
- the Data Sheet for GCSE (9–1) Combined Science (Physics) B (inside this document)

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

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

Centre number ☐☐☐☐☐ Candidate number ☐☐☐☐

First name(s) ____________________

Last name ____________________

**INSTRUCTIONS**
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

**INFORMATION**
- The total mark for this paper is **95**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **24** pages.

**ADVICE**
- Read each question carefully before you start your answer.

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Answer **all** the questions.

1 Jane wants to know if different types of radiation are absorbed, reflected or transmitted by different materials.

**(a)** Complete the sentences to describe if electromagnetic radiation is absorbed, reflected, or transmitted by the materials.

Put a (ring) around the correct answers.

Wood warms up when it **absorbs** / **reflects** / **transmits** infrared radiation.

Some metals are shiny because they **absorb** / **reflect** / **transmit** visible light.

Windows are made out of glass because glass **absorbs** / **reflects** / **transmits** visible light.

An X-ray scan can be hazardous because human bodily tissue **absorbs** / **reflects** / **transmits** X-rays.

**[4]**

**(b)** Complete the sentences about wavelength.

Use the words.

You can use each word once, more than once, or not at all.

**a shorter** **a longer** **the same**

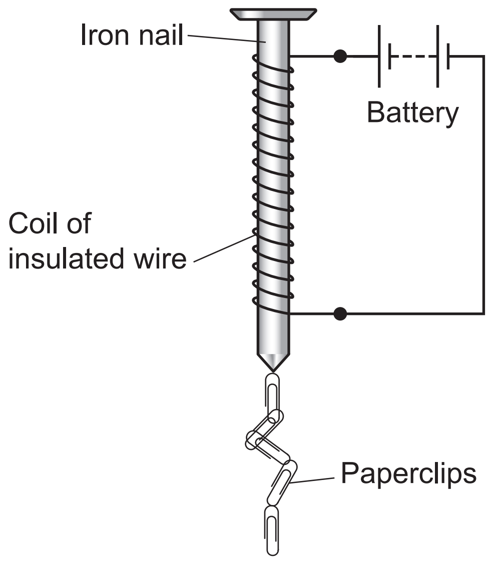
**(i)** X-rays have ...................................... wavelength compared to visible light. **[1]**

**(ii)** Infrared radiation has ...................................... wavelength compared to visible light. **[1]**

**(iii)** Radio waves have ...................................... wavelength compared to infrared radiation. **[1]**

**2** James makes an electromagnet.

The diagram shows the electromagnet picking up some paperclips.




**(a)** **(i)** Why has James used a nail that is made of **iron**?

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

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

**(ii)** How can James make the electromagnet stronger, so that it will pick up more paperclips?

Tick (✓) **two** boxes.

| | |
|---|---|
| Increase the current in the coil. | ☐ |
| Increase the number of turns of wire in the coil. | ☐ |
| Increase the resistance of the coil. | ☐ |
| Remove the iron nail. | ☐ |
| Use an aluminium nail. | ☐ |

**[2]**

**(b)** The current in the coil of insulated wire is 1.9 A and the potential difference across it is 0.95 V.

**(i)** Calculate the resistance of the coil of insulated wire.

Use the equation: resistance = potential difference ÷ current

Resistance = ...................................................... Ω **[2]**

**(ii)** The current passes through the coil for 30 s.

Calculate the charge that flows through the coil.

Use the equation: charge = current × time

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

**3** Mia stretches a spring using a forcemeter, as shown in **Fig. 3.1**.

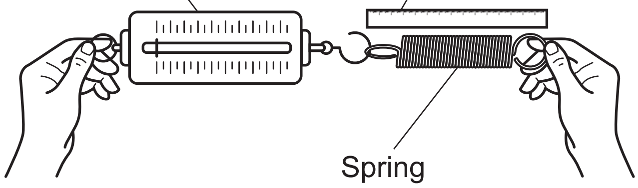



**Fig. 3.1**

**(a)** The spring stretches from 5.0 cm long to 8.5 cm long when a force of 7.7 N is used.

**(i)** Calculate the extension of the spring in **metres**.

Extension = ...................................................... m **[2]**

**(ii)** Calculate the spring constant of the spring.

Use the equation: spring constant = force ÷ extension

Spring constant = ................................................ N/m **[2]**

**(iii)** Calculate the energy stored in the spring.

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

Use the Data Sheet.

Energy stored = ...................................................... J **[3]**

**(b)** Mia investigates the work done when another spring is stretched.

She uses the equipment shown in **Fig. 3.2** and plots the graph shown in **Fig. 3.3**.

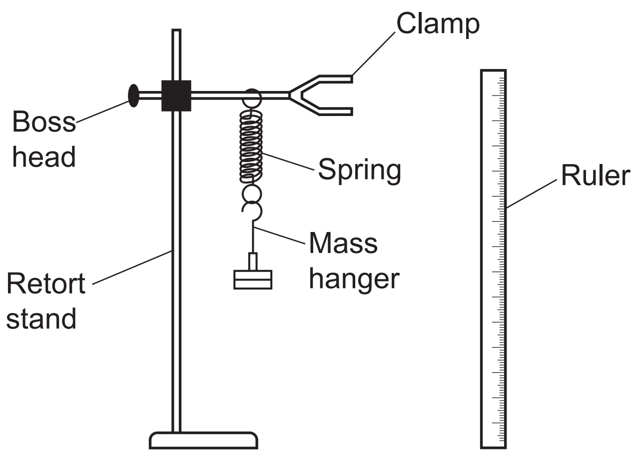



**Fig. 3.2**

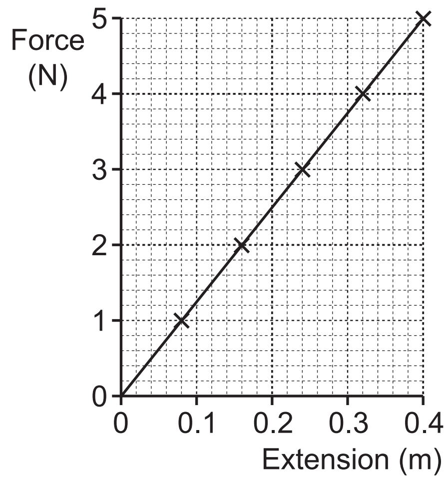



**Fig. 3.3**

**(i)** Suggest how Mia could make the experiment safer.

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

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

**(ii)** Complete the sentences to describe how Mia could collect the data she needs to plot the graph in **Fig. 3.3**.

Use the words.

You can use each word once, more than once, or not at all.

**energy** **extension** **final** **initial** **mass** **weight**

Measure the ..................................... length of the spring. Hang a mass on the spring.

Measure the new length of the spring. Subtract the measurements to calculate the

..................................... . Calculate the force by multiplying the .....................................

by the gravitational field strength. Repeat for five different masses.

**[3]**

**(iii)** Calculate the work done when the spring is stretched by a force of 5 N.

The area under the graph in **Fig. 3.3** is equal to the work done when the spring is stretched.

Work done = ..................................................... J **[3]**

**4** Amaya makes a bubble machine as shown in **Fig. 4.1**.

The fan blows air through the bubble wand.

A wand motor rotates the bubble wand between the bubble mixture and the moving air to make bubbles.

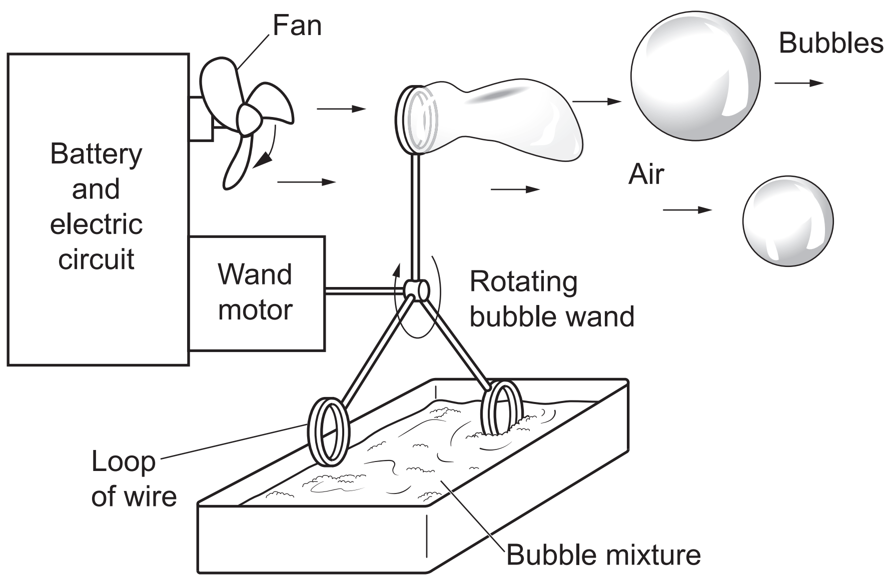



**Fig. 4.1**

**(a)** The bubble machine transfers energy to the bubble wand and bubbles.

Complete **Fig. 4.2** to show the energy transfer from the battery to the rotating bubble wand.

| **Energy store reduced in battery** | | **Energy is transferred by** | | **Energy store increased in rotating wand** |
|---|---|---|---|---|
| | → | | → | |

**Fig. 4.2** **[3]**

**(b)** **Fig. 4.3** shows an incomplete circuit diagram for the wand motor.

A variable resistor is needed to change the speed of the wand motor.

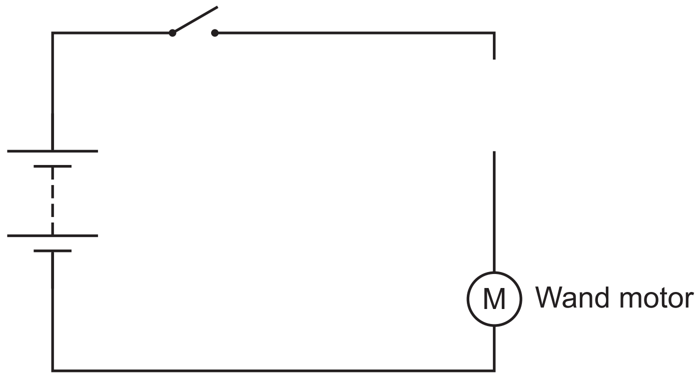



**Fig. 4.3**

**(i)** Complete the circuit diagram in **Fig. 4.3** by adding a **variable resistor**. **[1]**

**(ii)** The resistance of the variable resistor is set to 1.54 Ω and the resistance of the wand motor is 0.56 Ω.

Calculate the total resistance of the variable resistor and the wand motor.

Total resistance = ...................................................... Ω **[2]**

**(c)** Complete the statements to describe what happens to the current and potential difference when the resistance of the variable resistor is increased.

Use the words.

You can use each word once, more than once, or not at all.

**increases** **decreases** **stays the same**

**(i)** The current through the variable resistor ..................................... **[1]**

**(ii)** The potential difference across the wand motor ..................................... **[1]**

**(iii)** The total potential difference across the variable resistor and wand motor

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

**5** The different types of electromagnetic radiation are absorbed and emitted in different ways.

**(a)** Complete the table to show the type of electromagnetic radiation absorbed or emitted in each case.

Tick (✓) **one** box in each row.

| | **Type of electromagnetic radiation** | | |
|---|---|---|---|
| | **Gamma rays** | **Infrared** | **Ultraviolet** |
| **Absorbed and re-emitted by carbon dioxide** | | | |
| **Absorbed by oxygen to produce ozone** | | | |
| **Emitted from nuclei** | | | |

**[3]**

**(b)** Which **two** statements are correct?

Tick (✓) **two** boxes.

All electrons in an atom are at the same distance away from the nucleus. ☐

All electromagnetic radiation has the same frequency. ☐

All electromagnetic radiation is transmitted through space at the same speed. ☐

Atoms can become ions by losing their outer electrons. ☐

Visible light and gamma rays travel through space at different speeds. ☐

**[2]**

**(c)** This hazard sign is found on gamma ray sources, X-ray machines and some ultraviolet lamps.

Describe the risk of using equipment labelled with this hazard sign.

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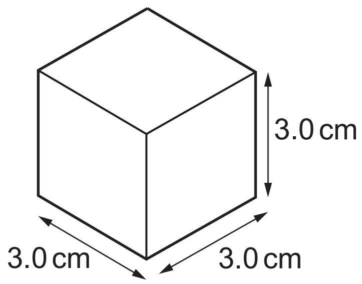
............................................................................................................................................ **[2]**

6 (a) Alex has a cube of tungsten metal.




(i) Calculate the volume of the cube.

Volume = ................................................ $cm^3$ **[1]**

(ii) The mass of the cube is 513 g.

Calculate the density of the cube.

Use the equation: density = mass ÷ volume

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

(b) This table shows the density of some solids, liquids and gases.

| | **State** | **Density ($kg/m^3$)** |
|---|---|---|
| **Methane** | Gas | 0.67 |
| **Air** | Gas | 1.2 |
| **Ethanol** | Liquid | 790 |
| **Water** | Liquid | 1000 |
| **Limestone** | Solid | 2700 |
| **Iron** | Solid | 7900 |

(i) What does the table show about the relationship between state and density?

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

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

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

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

**(ii)*** Explain the difference in density between air, water and iron.

Use data from the table to support your answer.

Include diagrams in your answer.

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

7 **(a)** Li is driving his car. The car travels at a constant speed.

Complete the sentence to describe the driving force on the car.

Put a (ring) around the correct answer.

The driving force on the car is **equal to** / **greater than** / **smaller than** the friction forces on the car. **[1]**

**(b)** Li brakes to a stop. The car decelerates at $5\,m/s^2$.

**(i)** Calculate the braking force.

The mass of the car is 1200 kg.

Use the equation: force = mass × acceleration

Braking force = ...................................................... N **[2]**

**(ii)** The car travels 55 m while braking.

Calculate the work done by the braking force.

Use the equation: work done = force × distance

Work done = ...................................................... J **[2]**

**(c)** Li wants to estimate the acceleration of the car on a racetrack. He uses two posts, post 1, and post 2.


Li starts the car from point **X** and accelerates steadily.

**(i)** Calculate the average speed of the car between the posts.

Distance between posts = 12 m

Time to travel between posts = 0.4 s

Use the equation: average speed = distance ÷ time

Average speed = .................................................. m/s **[2]**

**(ii)** It takes Li 10 seconds to travel from point **X** to the posts.

Calculate the average acceleration of the car from point **X** to the posts.

Use your answer from **(c)(i)**.

Average acceleration = ................................................ $m/s^2$ **[3]**

**(d)** Li drives the car home at 54 km/h.

Calculate this speed in **m/s**.

Speed = .................................................. m/s **[3]**

8 In 2011 an earthquake and tsunami damaged a nuclear power station in Japan. Radioactive isotopes were released and contaminated the area around the power station.

**(a)** Draw lines to connect each **description** with the correct **particle**.

| **Description** | **Particle** |
|---|---|
| | electrons |
| Isotopes of an element have the same number of | |
| | neutrons |
| Isotopes of an element have a different number of | |
| | protons |

**[2]**

**(b)** This table shows the half-lives of four of the isotopes released from the power station.

| **Isotope** | **Half-life** |
|---|---|
| Tellurium-129 | 70 minutes |
| Caesium-137 | 30 years |
| Plutonium-239 | 24 000 years |
| Selenium-79 | 327 000 years |

**(i)** If half-life was the only factor affecting how hazardous the isotope was, which isotope would be the most hazardous?

Put a (ring) around the correct answer.

**Caesium-137** **Plutonium-239** **Selenium-79** **Tellurium-129**

**[1]**

**(ii)** Explain why your answer to **(b)(i)** is the most hazardous isotope.

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

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

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

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

**(c)** Some of the radioactive isotopes from the power station were alpha emitters, some were beta emitters and some were gamma emitters.

**(i)** Explain why it is more hazardous to **breathe** in alpha emitters than to breathe in gamma emitters.

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

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

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

**(ii)** Explain why it is more hazardous to be irradiated from **outside** the body by gamma emitters than by beta emitters.

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

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

**9** Nina has an electric car. It has a rechargeable battery. She plugs it into a charger at home to recharge it overnight.

**(a)** The charger has a power rating of 7 kW.

**(i)** Calculate the total energy transferred when Nina charges the battery for 7.5 hours.

Give your answer in **kW h**.

Total energy transferred = ................................................ kW h **[3]**

**(ii)** The charging increases the energy stored in the battery by 48.3 kW h.

Calculate the efficiency of the charger.

Give your answer as a percentage.

Efficiency = .................................................... % **[3]**

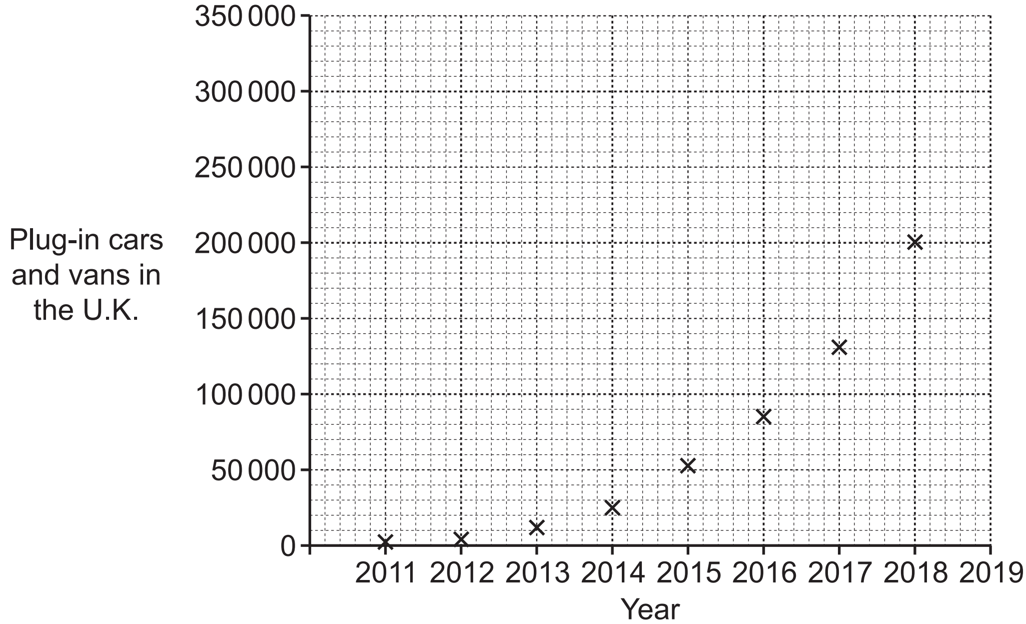
**(iii)** The domestic electricity supply voltage is alternating voltage, but the battery voltage is direct voltage.

What is the difference between alternating voltage and direct voltage?

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

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

**(b)** The graph shows the number of cars and vans in the U.K. that could be plugged in and charged, from 2011 to 2018.




**(i)** Complete the graph by drawing a curve of best fit. **[1]**

**(ii)** Use the graph to estimate the number of plug-in cars and vans in the U.K. in 2019.

Estimated number of plug-in cars and vans = ........................................................ **[1]**

**(c) (i)** Suggest **one** reason why the number of plug-in cars and vans in the U.K. is increasing.

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

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

**(ii)** Suggest **two** problems for the electricity supply industry if all petrol cars in the U.K. are replaced by electric cars that are plugged in overnight.

1 ...............................................................................................................................

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

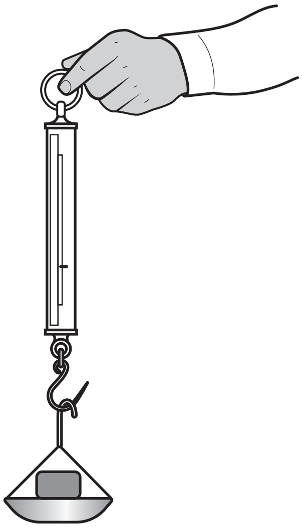
2 ...............................................................................................................................

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

**[2]**

**10** **(a)** Amir wants to know the weight of a stone.

He puts the stone in a pan and hangs the pan from a forcemeter as shown in the diagram. He then records the measurement shown on the forcemeter.



Amir's measurement is not accurate.

How can the experiment be improved to get a more accurate value for the stone's weight?

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

**(b)** Amir researches four different planets.

**Table 10.1** shows some of the data he finds.

| **Planet** | **Gravitational field strength of planet (N/kg)** | **Average density of planet ($\times 10^3$ kg/m$^3$)** | **Mass of planet ($\times 10^{24}$ kg)** |
|---|---|---|---|
| **Mars** | 4 | 3.9 | 0.64 |
| **Venus** | 9 | 5.2 | 4.9 |
| **Earth** | 10 | 5.5 | 6.0 |
| **Jupiter** | 23 | 1.3 | 1900 |

**Table 10.1**

**(i)** On which of the planets in **Table 10.1** would the stone have the greatest weight?

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

**(ii)** Explain what conclusions Amir can make from the data in **Table 10.1**.

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

**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).