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Oxford Cambridge and RSA

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Tuesday 23 November 2021 – Morning

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

J260/07 Physics (Higher Tier)

Time allowed: 1 hour 45 minutes

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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

J260007

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 **20** pages.

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

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Answer **all** the questions.

1 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.

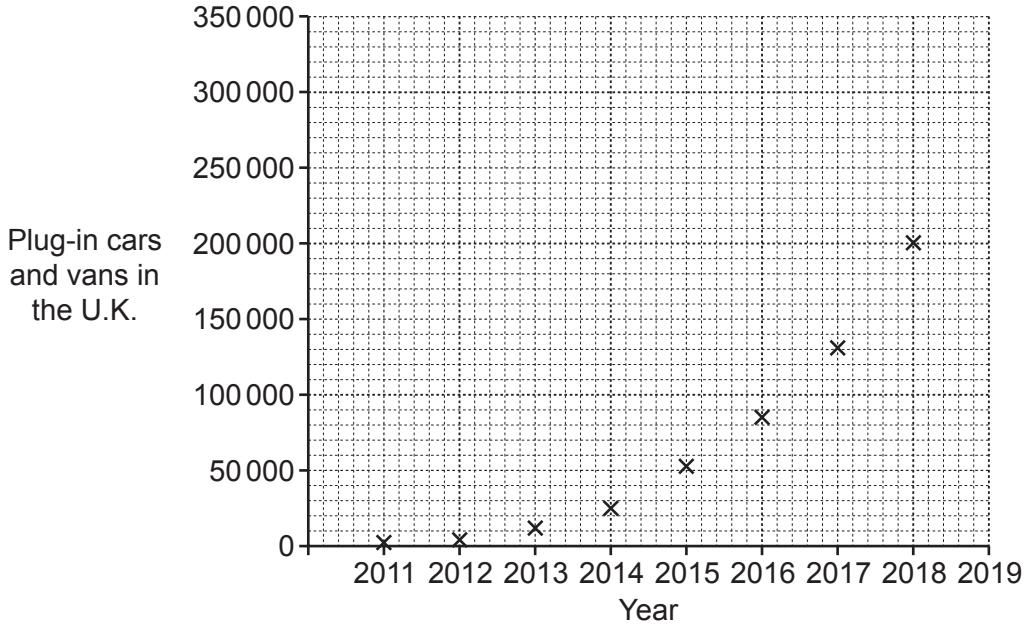
What is the difference between alternating voltage and direct voltage?

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

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(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.

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..... **[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 .....

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2 .....

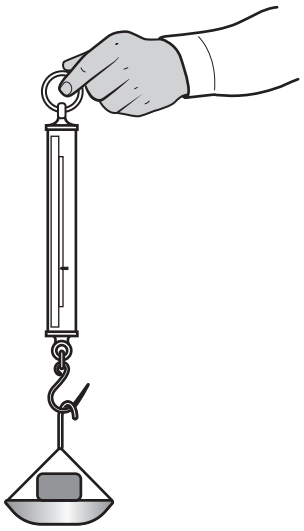
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[2]

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2 **(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 2.1 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 2.1

(i) On which of the planets in **Table 2.1** would the stone have the greatest weight?

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

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(ii) Explain what conclusions Amir can make from the data in **Table 2.1**.

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

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3 Beth has a scan to investigate the blood supply to her heart. Before the scan a radioactive tracer is injected into her blood. The radioactive tracer is a gamma emitter with a half-life of 6 hours.

(a) A method is shown for how a scan of Beth's heart is produced after the injection of the radioactive tracer.

It is **not** in the correct order.

Method
1. Gamma radiation is emitted from the heart.
2. Gamma radiation is detected by a gamma camera.
3. The radioactive tracer decays.
4. A computer forms an image on a screen.
5. Radioactive tracer concentrates in the heart.

Write the numbers in the correct order. The first one has been done for you.

5				

[3]

(b) Another radioactive isotope used in nuclear medicine is a beta emitter with a half-life of 8 days.

(i) Explain **one** reason why this isotope is not suitable to produce a scan of Beth's heart.

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

(ii) Suggest **one** medical use for this isotope.

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

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(c) Having an injection of a radioactive tracer into blood is an example of contamination with radioactive material.

(i) Compare the hazards of being contaminated by radioactive material with being irradiated by a radioactive material.

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

(ii) Both beta and gamma radiation are ionising.

Explain how ionising radiation is hazardous to the human body.

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

(iii) What fraction of the radioactive tracer remains radioactive 1 day after being injected into a person's blood?

Tracer half-life = 6 hours

Fraction = ... **[2]**

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4 Ben does an experiment to investigate the I-V characteristics of a thermistor.

(a) Draw a circuit diagram in the box that can be used for this experiment.

[4]

(b) Describe a method Ben can use to collect the data for his investigation.

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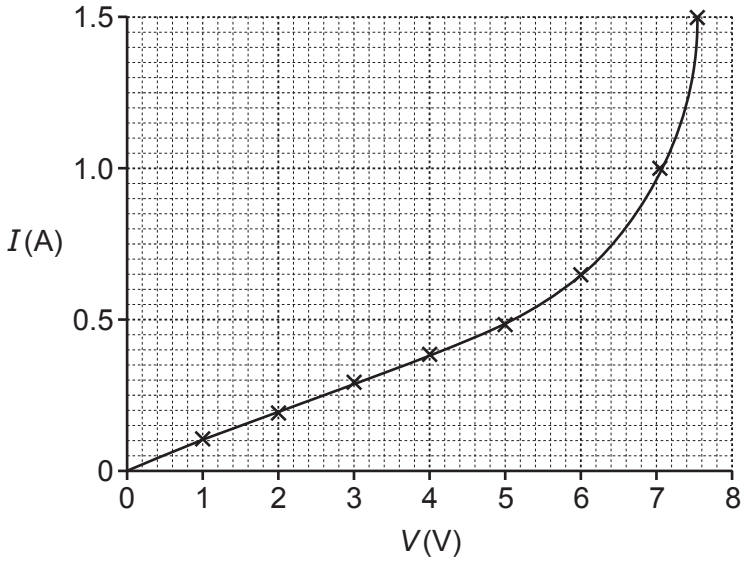
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(c) Ben plots a graph of his results, as shown.



Explain what the graph shows about the **resistance** of the thermistor as the potential difference changes.

You do **not** need to do any calculations.

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

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5 Two tug boats, tug **A** and tug **B**, are pulling a ship as shown in **Fig. 5.1**.

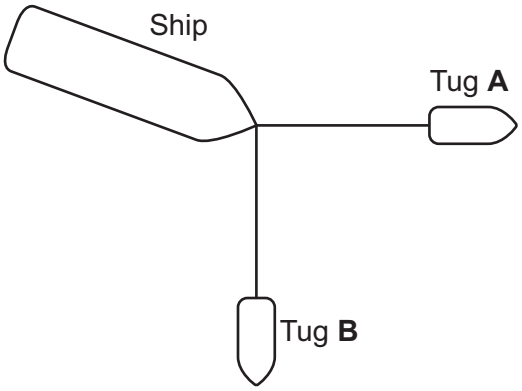


Fig. 5.1

The force of tug **A** on the ship is shown on the vector diagram in **Fig. 5.2**.

Scale: 1 cm = 100 kN.

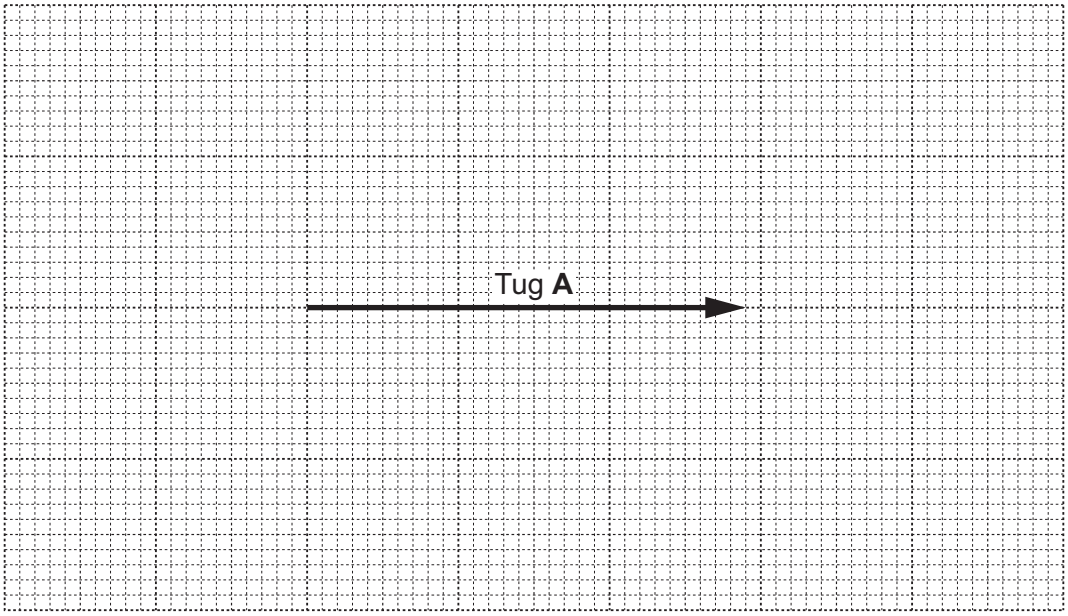


Fig. 5.2

(a) (i) Determine the magnitude of the force of tug **A** on the ship, using **Fig. 5.2**.

Force = ... kN **[1]**

(ii) The force of tug **B** on the ship is 240 kN.

Complete the vector diagram to show:

- the force of tug **B** on the ship
- the resultant force on the ship. **[2]**

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(iii) Determine the magnitude of the resultant force on the ship.

Resultant force = ... kN **[1]**

(b) The tugs start pulling the ship when the ship has an initial speed of 0.40 m/s. After the ship is pulled 65 m, it has a speed of 3.8 m/s.

The direction of the ship does not change.

Calculate the acceleration of the ship.
Give your answer to **2** significant figures.

Use the Data Sheet.

Acceleration = ... m/s^2 **[3]**

(c) The water waves in the sea are moving at 3.2 m/s and 10 waves pass a stationary boat in 16 s.

Calculate the wavelength of the water waves.

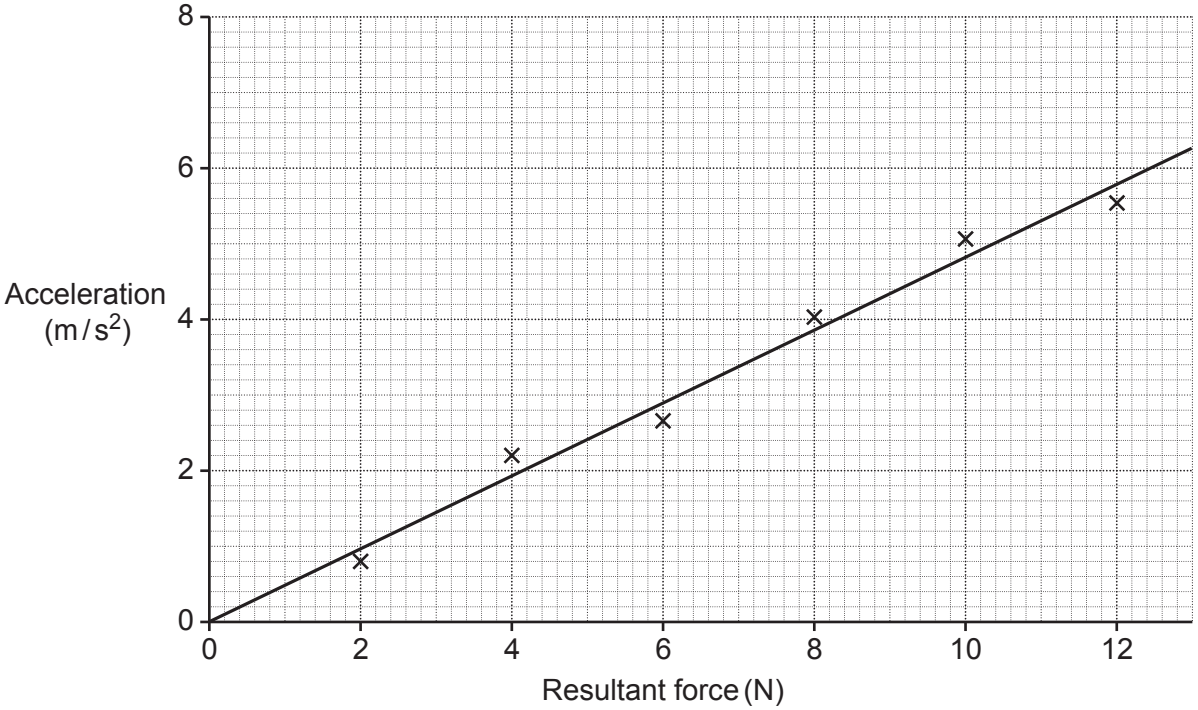
Use the equation: wave speed = frequency × wavelength

Wavelength = ... m **[3]**

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6 Sundip does an experiment to investigate how the acceleration of a trolley depends on the resultant force acting on it when the mass of the trolley is kept constant.

She plots a graph of acceleration against resultant force, as shown.



(a) (i) Sundip writes this conclusion:

My graph shows that acceleration ∝ resultant force.

Do you agree with Sundip's conclusion?

Yes ☐

No ☐

Explain your answer.

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

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(ii) Determine the mass of the trolley, using the graph.

Use the equation: force = mass × acceleration

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

Mass = ... kg **[3]**

(b)* Describe a method that Sundip could have used to accurately investigate how the acceleration of the trolley depends on the resultant force acting on it when the mass of the trolley is kept constant.

Include in your answer any safety considerations.

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

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7 Jamal is setting up the lights for a disco. He hangs a rotating mirror ball from the ceiling, as shown in **Fig. 7.1**.

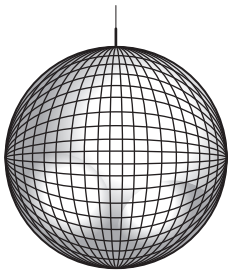


Fig. 7.1

(a) (i) The mirror ball reflects visible light. Visible light is a type of electromagnetic radiation with a small range of wavelengths.

Describe how the wavelength of **two** other types of electromagnetic radiation is different from the wavelength of visible light.

1. .....

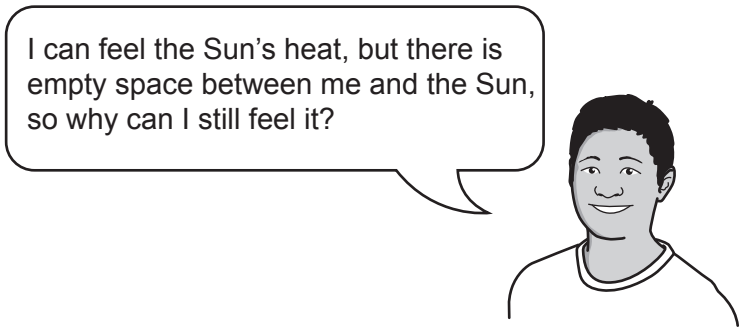
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2. .....

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[2]

Jamal closes the curtains in the room to keep out the sunlight.



(ii) Explain why Jamal feels the heat from the Sun.

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

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(b) A motor makes the mirror ball rotate. Motors use magnets and current-carrying conductors.

Fig. 7.2 shows a current-carrying conductor between the poles of a magnet.

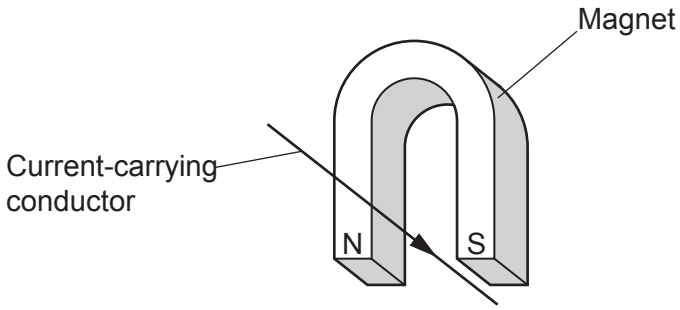


Fig. 7.2

(i) Add an arrow to **Fig. 7.2** showing the direction of the force on the current-carrying conductor. **[1]**

(ii) Describe how you worked out the direction. You may use a diagram.

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

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(c) **Fig. 7.3** shows part of an electric motor.

It has a rectangular coil of current-carrying wire between two magnetic poles.

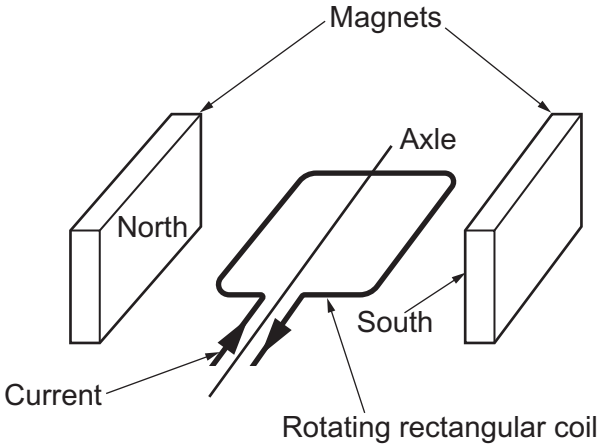


Fig. 7.3

Forces acting on the rectangular coil cause it to rotate around the axle.

Explain how the forces on the rectangular coil cause the coil to rotate until it is vertical.

You can add to the diagram.

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

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8 Energy is transmitted from power stations to homes by overhead power cables.

High voltages are used for transmitting electricity long distances because it is a more efficient way to transmit energy.

(a) Explain why it is more efficient to use a high voltage.

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

(b) This table gives information about the mains electricity.

Voltages used in National Grid distribution network	400 kV 132 kV 33 kV 11 kV
Voltage in homes	230 V
Frequency of supply	50 Hz

Which **one** statement is correct?

Tick (✓) **one** box.

At substations variable resistors are used to step down the voltage to 230 V. ☐

Overhead power cables only transmit energy from fossil fuel power stations. ☐

Radio waves with a frequency of 50 Hz are produced by the overhead power lines. ☐

The mains supply to homes is direct voltage. ☐

[1]

(c) The electricity generated from solar power in the U.K. has increased.

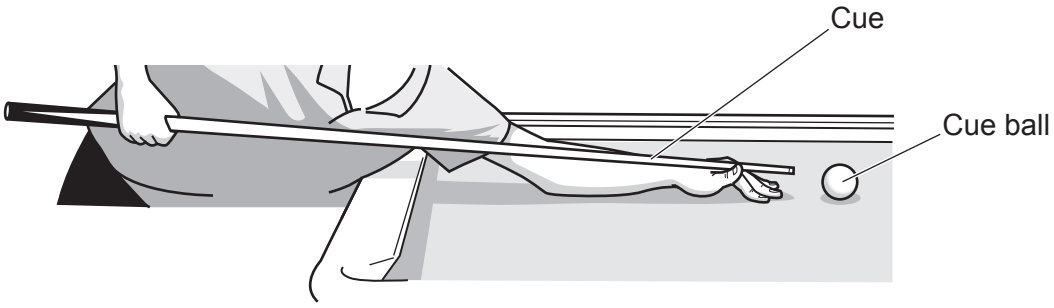
In 2010 it was 33 GW h. In 2017 it was 11 479 GW h.

Calculate how many orders of magnitude it increased in that time.

Orders of magnitude = ... **[2]**

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9 Kai is playing pool. The diagram shows the cue aimed at the cue ball.



(a) The cue hits the stationary cue ball with a force of 795 N.

The cue ball then starts to move with a momentum of 1.53 kg m/s.

(i) Calculate the time that the cue was in contact with the cue ball.

Give your answer to **3** significant figures.

Use the Data Sheet.

Time = ... s **[3]**

(ii) Calculate the speed of the cue ball.

Mass of the ball = 170 g

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

(b) The cue ball strikes another ball which is stationary.
The two balls then continue in a straight line.

Explain what happens to the momentum of the two balls in the collision.

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

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10 A sealed, insulated aluminium tank has a mass of 13 kg and contains 2.4 kg of air. Both the air and the aluminium tank have an initial temperature of 8.0 °C.

The tank of air is heated to 22.0 °C by a heater inside the tank.

(a) The heater transfers 189 000 J to heat the tank and the air.

Calculate the specific heat capacity of the air.

Specific heat capacity of aluminium = 900 J/kg °C

Use the equation:
change in internal energy = mass × specific heat capacity × change in temperature

Specific heat capacity of **air** = ... J/kg °C **[4]**

(b) **(i)** Explain how the motion of the air molecules in the tank changes as the temperature increases.

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

(ii) Explain how this change in motion affects the pressure of the gas.

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

END OF QUESTION PAPER

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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).

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