OCR
Oxford Cambridge and RSA

**F**

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

**J259/02** Depth in physics (Foundation Tier)

## Friday 15 June 2018 – Morning

### Time allowed: 1 hour 45 minutes

**You must have:**
- the Data Sheet (for GCSE Physics B (inserted))
- a ruler (cm/mm)

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

| | |
|---|---|
| First name | |
| Last name | |
| Centre number | |
| Candidate number | |

**INSTRUCTIONS**
- The Data Sheet will be found inside this document.
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided. Additional paper may be used if required but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the barcodes.

**INFORMATION**
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in questions marked with an asterisk (*).
- This document consists of **24** pages.

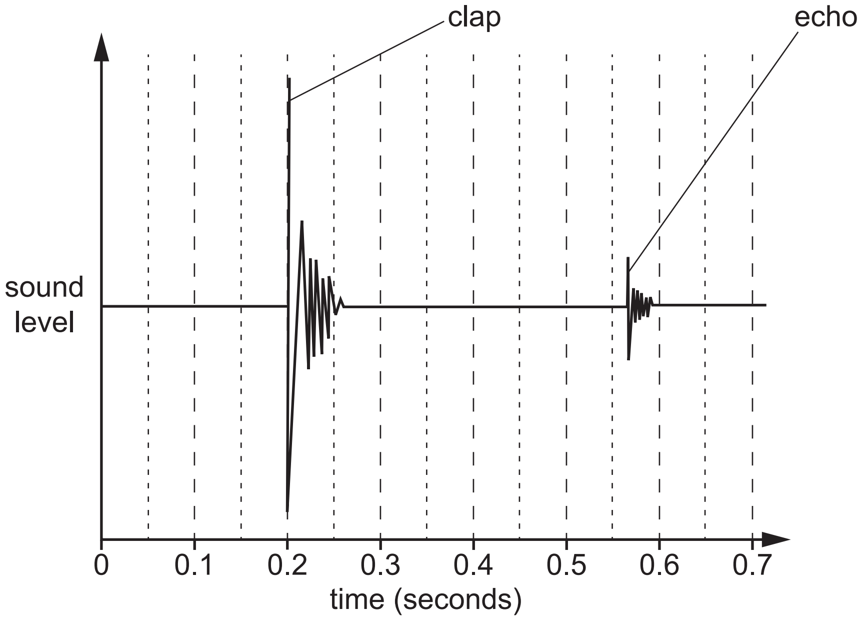
Answer **all** the questions.

**1** Over 300 years ago, Isaac Newton measured the speed of sound in air in a long outdoor corridor.

Eve and Ali repeated this experiment by measuring the time between a clap and its echo.

**(a)** Eve clapped her hands, and Ali timed with a tablet computer.

The computer recorded the sound of the clap and its echo and produced the graph below.




**(i)** What time was the sound of the **clap** recorded?

Time = ............................................. seconds **[1]**

**(ii)** What time was the sound of the **echo** recorded?

Time = .............................................. seconds **[1]**

**(iii)** Calculate the time of travel for the sound wave to go from Eve to the wall and to return to the computer.

Time of travel = .............................................. seconds **[1]**

**(b)** The distance from Eve to the reflecting wall is 64 m.

Explain how you can use the distance, together with a time from part **(a)**, to calculate the speed of sound.
**You do not have to include the calculation.**

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**(c)** Isaac Newton's value for the speed of sound was less accurate than the one given by this method.

Suggest and explain why Newton could not get an accurate answer.

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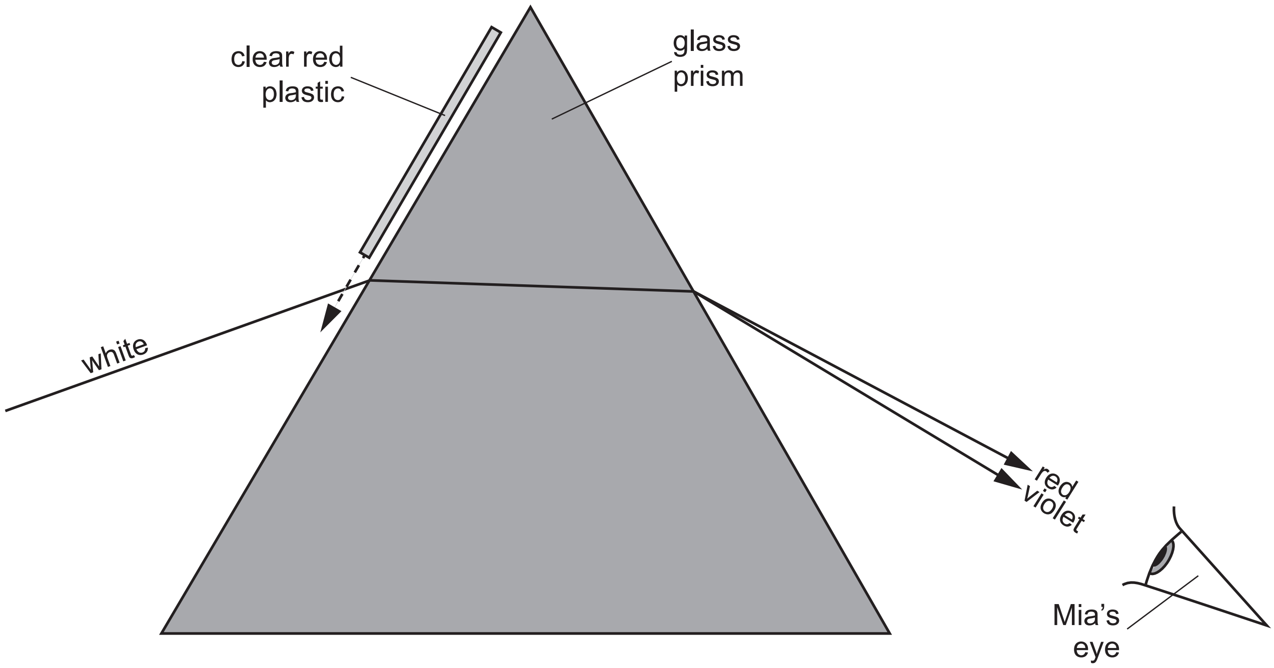
............................................................................................................................................. **[2]**

**2** This question is about light moving from one medium to another.

Mia uses a ray-box to send a ray of white light into a triangular glass prism. She sees a spectrum of colours coming out.

She slides a sheet of clear red plastic into the path of the light as shown in the diagram.

When the red plastic is in place, she sees that most of the colours in the spectrum have vanished.




**(a)** Complete the following sentences using the words below.

**absorption** **frequency** **reflection** **refraction** **speed** **transmission**

When light goes from air into glass, it changes direction.

This change of direction is called .................................... .

This happens because the light changes its .................................... when it enters the glass.

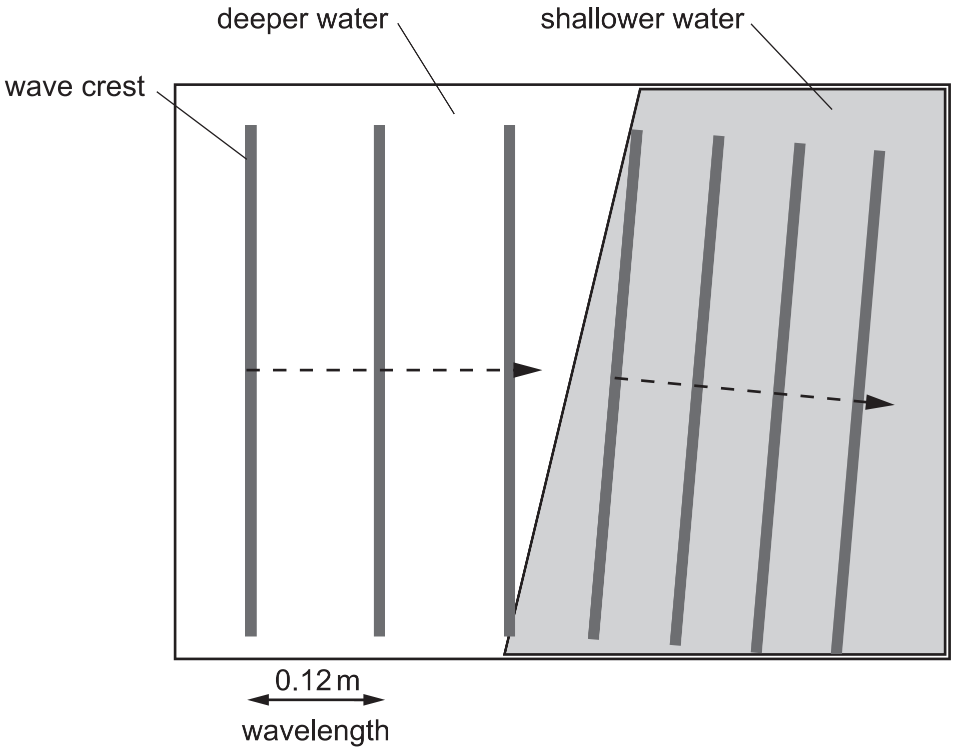
The red plastic removes all colours except red. This is called .................................... .

**[3]**

**(b)** This behaviour can be modelled with water waves in a ripple tank.

The diagram shows water waves moving from deeper water into shallower water.

It is viewed from above the ripple tank, with the wave crests shown as thick grey stripes.




**(i)** The waves were produced at a frequency of 2.5 hertz (Hz).

Calculate the speed of the waves in the deeper water.

Use the equation: wave speed = frequency × wavelength.

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

**(ii)** Explain how the ripple tank diagram helps to explain the behaviour of light shown in part **(a)**.

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

**3** The generator in a power station is connected to the National Grid through a transformer.

Near a town, other transformers are used to transfer power into homes.

**Fig. 3.1** is a simplified diagram showing just one transformer near the homes.

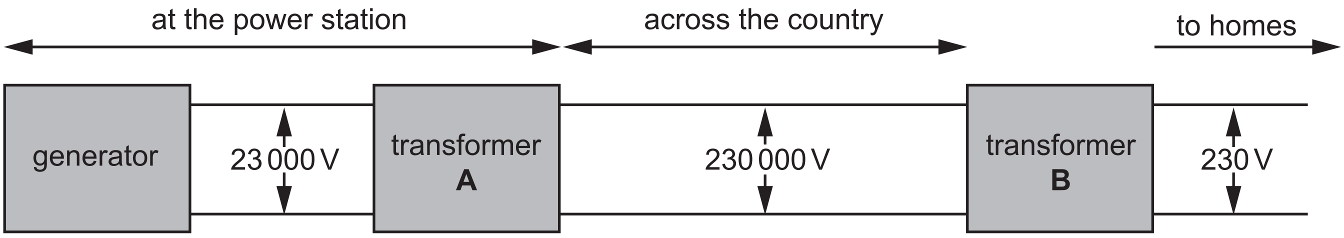


**Fig. 3.1**

**(a)** The generator produces an alternating voltage, not a direct voltage.

Explain the difference between these two types of voltage.

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

**(b)** **(i)** Using **Table 3.1** calculate the output current for transformer **B**.

Use the equation:
Input potential difference × Input current = Output potential difference × Output current

Transformer **A** has already been completed.

| **Transformer** | **Input potential difference (V)** | **Input current (A)** | **Output potential difference (V)** | **Output current (A)** |
|---|---|---|---|---|
| **A** | 23 000 | 3000 | 230 000 | 300 |
| **B** | 230 000 | 300 | 230 | |

**Table 3.1**

**[3]**

**(ii)** Use the input data for transformer **A** to show that the output power of the generator is more than 60 megawatts (MW).

1 MW = 1 000 000 W

Output power = ............................................... MW **[3]**

**(iii)** A typical home needs a power of 10 kilowatts (kW).

1 kW = 1000 W.

Calculate the number of homes that this power station could supply.
Use your answer to **(b)(ii)**.

Number of homes = ............................................... **[2]**

**(c)** All power stations use step-up transformers like transformer **A** between the generator and the National Grid power cables.

Explain how using 230 000 V instead of 23 000 V for the cables across the country makes energy transfer more efficient.

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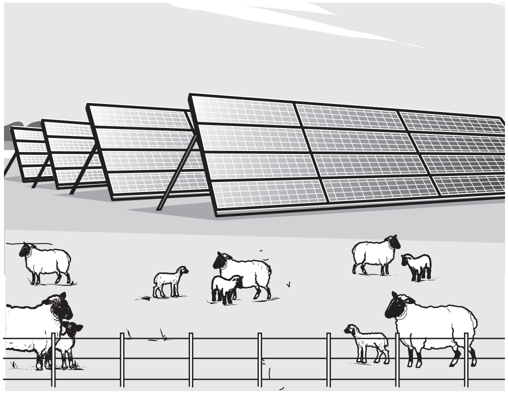
........................................................................................................................................ **[2]**

**4** Solar farms are large power stations made up from many photovoltaic (PV) panels. Even though they are now very common, most of Britain's electricity is generated by burning gas.



A solar farm

A gas-burning power station

**(a)** Here are some data about these two types of power station.

| **Type of power station** | **Solar farm** | **Gas-burning** |
|---|---|---|
| **Power output (MW)** | 35 | 1400 |

**(i)** Calculate the number of solar farms that would be needed to give the output power of this gas-burning power station.

Number of solar farms = ................................................ **[2]**

**(ii)** In the table, the 35 MW power of the solar farm is the **maximum** power it can produce.

Give **two** reasons why the output power is often less than 35 MW.

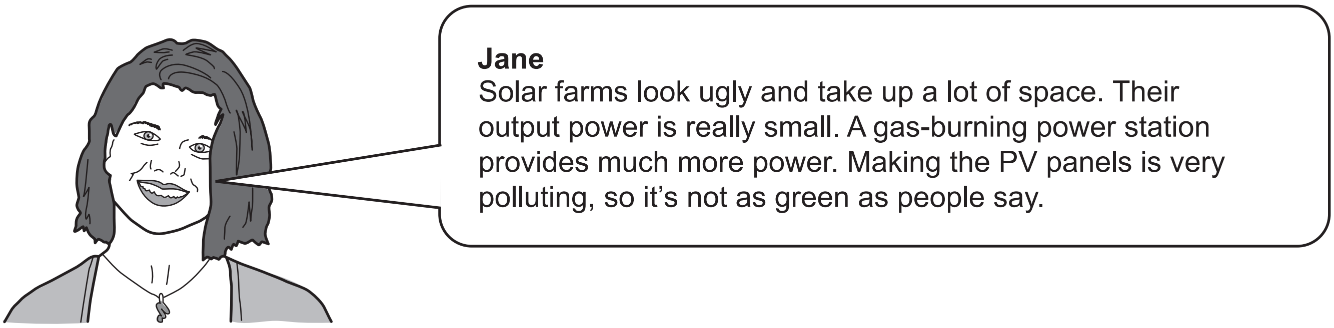
1 ..........................................................................................................................

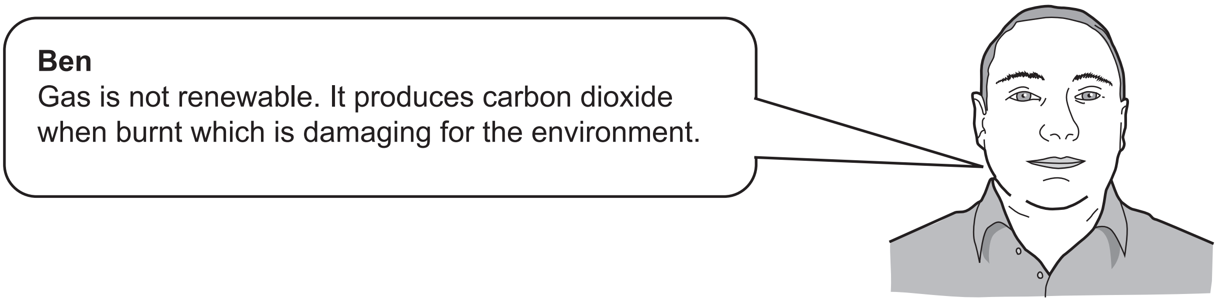
..........................................................................................................................

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

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

**(b)*** Jane and Ben have different views about these power stations.




Describe the **advantages** and **disadvantages** of both power stations using Jane and Ben's views.

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

5 There is a film about an astronaut named Mark Watney. He is left alone on the planet Mars. He has to use science to stay alive until he can be rescued.

(a) Mars is a cold planet. Watney uses a radioactive thermal generator to heat himself. The generator contains radioactive plutonium-238 which emits alpha-particles (α).

(i) Complete the radioactive decay equation for plutonium-238.

$$^{238}_{94}\mathrm{Pu} \longrightarrow \,^{\ldots\ldots\ldots}_{\ldots\ldots\ldots}\mathrm{U} + \,^{4}_{2}\alpha$$

**[2]**

(ii) The radioactive plutonium-238 is sealed inside a case with thin walls made of aluminium. The plutonium-238 emits a large number of high energy alpha-particles each second.

**Two** of the following statements, taken together, explain why Watney is not at any risk from irradiation.

Tick (✓) **two** boxes.

| | |
|---|---|
| Alpha particles cannot penetrate a thin sheet of paper. | ☐ |
| Alpha radiation is never dangerous. | ☐ |
| Alpha radiation is not part of the electromagnetic spectrum. | ☐ |
| The aluminium in the case is thicker and denser than thin paper. | ☐ |
| He always wears safety glasses when he handles the plutonium-238. | ☐ |

**[2]**

**(b)** To be rescued, Watney needs to travel 3200 km across Mars to a rocket.

He drives there using a battery-powered vehicle. The battery is recharged using solar panels.

The Sankey diagram in **Fig. 5.1** shows the energy transferred in one hour by the solar panels.

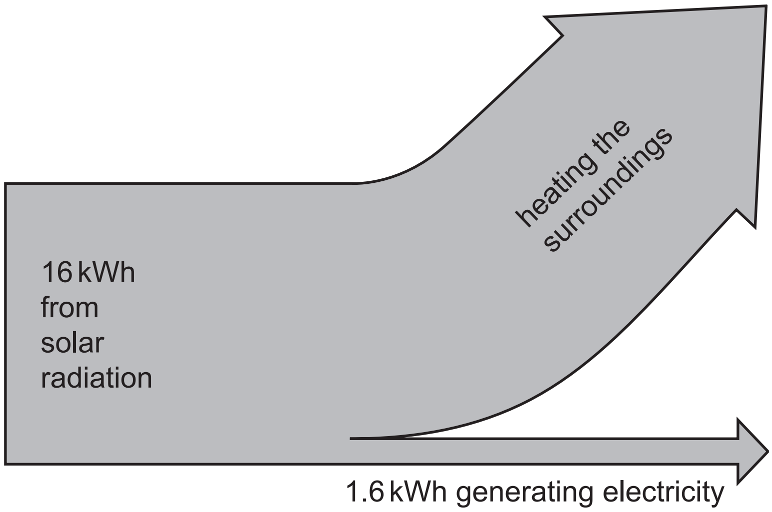



**Fig. 5.1**

**(i)** Calculate, as a percentage, the efficiency of the solar panels.

Use the equation: efficiency = (useful energy transferred ÷ total energy transferred) × 100

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

**(ii)** The rechargeable battery stores 18 kWh of energy.

Use data from **Fig. 5.1** to show that the solar panels need more than 10 hours to recharge the battery.

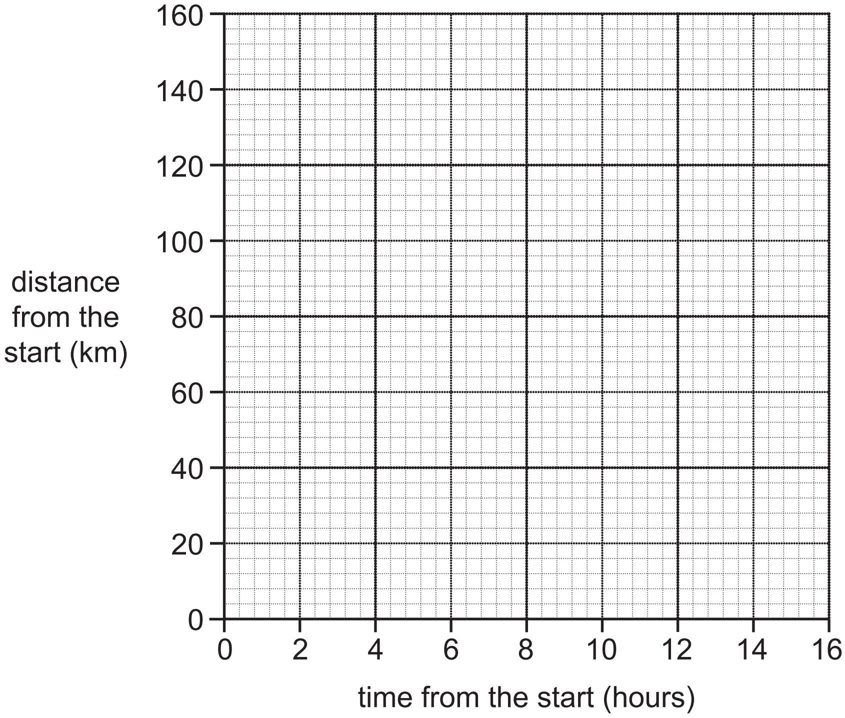
**[2]**

**(c)** Watney sets off on his journey to the rocket.

He drives for 4 hours at a steady speed of 25 km/hour.

He then stops to let the battery re-charge for 10 hours.

Complete this distance-time graph.




**[4]**

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**6** Alex is investigating the forces acting on a trolley to slow it down on different surfaces.

**Fig. 6.1** shows his apparatus. Each time, he starts the trolley at the same marked point and measures how far it goes along the test surface before it stops. The centre of the trolley is marked with a dot.

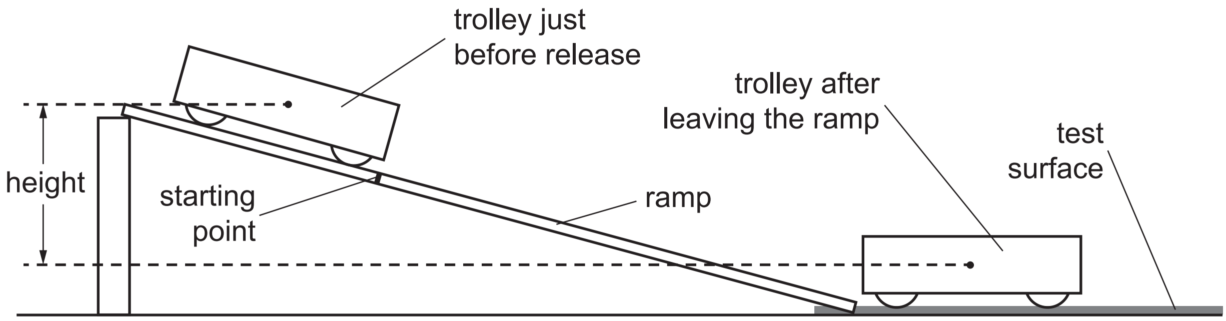


**Fig. 6.1**

**(a) (i)** Here are measurements that Alex takes.
Mass of trolley = 0.80 kg
Height = 0.20 m

Assume gravitational field strength = 10 N/kg

Calculate the gravitational potential energy transferred when the trolley leaves the ramp.

Gravitational potential energy transferred = .............................................. J **[3]**

**(ii)** Alex says that the kinetic energy of the trolley when it leaves the ramp is the same as the gravitational potential energy transferred.

Which of the following statements must be true if Alex is to assume this?

Tick (✓) **two** boxes.

| | |
|---|---|
| Air resistance is very small. | ☐ |
| Gravity acts downwards on the trolley. | ☐ |
| The ramp is very flat. | ☐ |
| The trolley is very light. | ☐ |
| There is not much friction acting on the trolley. | ☐ |

**[2]**

**(iii)** Alex repeats the experiment five times. He measures the distance the trolley travels along the test surface each time.

**Table 6.1** shows his results.

| **Reading** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|
| **Distance travelled (m)** | 1.2 | 1.4 | 1.2 | 0.6 | 1.4 |

**Table 6.1**

Calculate the mean distance the trolley travelled along the test surface.

Tick (✓) **one** box.

1.1 m ☐

1.2 m ☐

1.3 m ☐

1.4 m ☐

**[1]**

**(b)** Alex carries out this experiment for a range of kinetic energy values.

**Table 6.2** shows his results.

| **Initial kinetic energy (J)** | 0.8 | 1.6 | 2.4 | 3.2 | 3.9 | 4.8 |
|---|---|---|---|---|---|---|
| **Mean distance travelled (m)** | 0.80 | 1.35 | 1.60 | 1.85 | 1.90 | 1.95 |

**Table 6.2**

These data are plotted on the graph in **Fig. 6.2**. Three points have been left off.

**(i)** State the reason why Alex was right to plot a point at the origin, (0,0).

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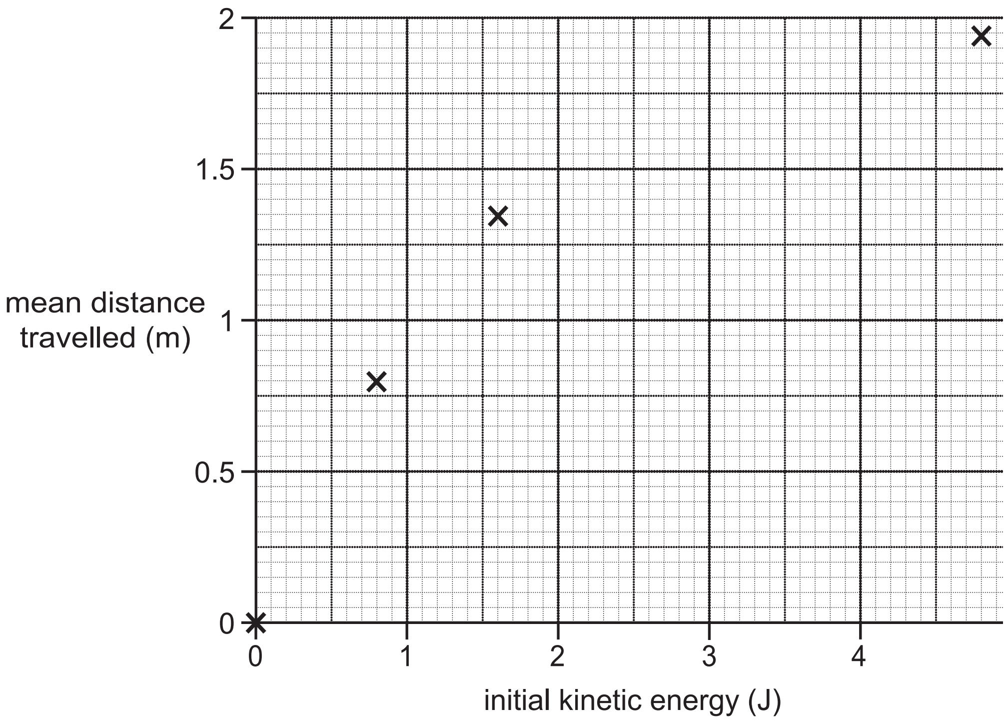
.............................................................................................................................. **[1]**

**(ii)** Plot the three remaining points on the graph in **Fig. 6.2** and draw an appropriate best fit curve.




**[2]**

**Fig. 6.2**

**(c)** Describe the pattern shown by these results.

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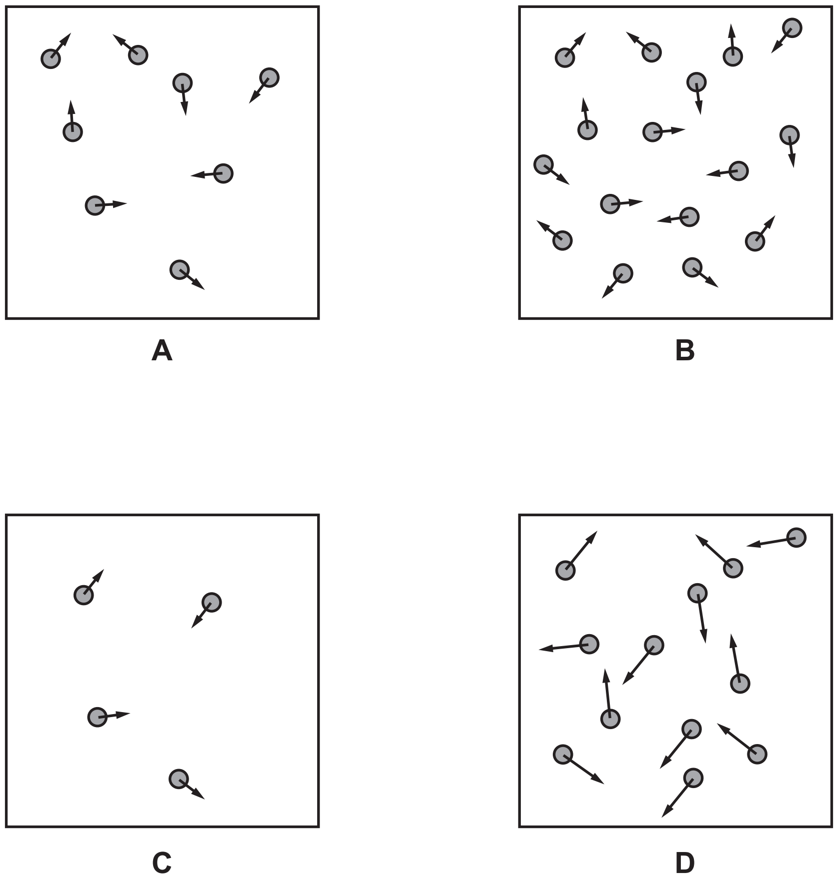
.............................................................................................................................. **[2]**

7 This question is about the particles in a gas and the pressure they exert on a container.

**(a)** The diagram below shows four samples of the same gas in containers of the same size.

Each particle is shown as a circle.

The arrow on each particle shows its velocity.




Answer each question with one of the letters **A**, **B**, **C** or **D**.

**(i)** Which sample has the **fastest** particles?

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

**(ii)** Which sample has the **greatest** density?

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

**(iii)** Which sample is at the **highest** temperature?

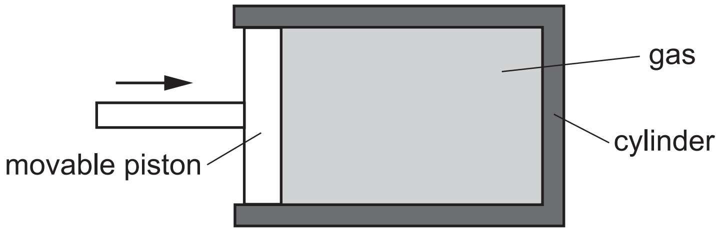
....................... **[1]**

**(iv)** Which sample has the **smallest** pressure?

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

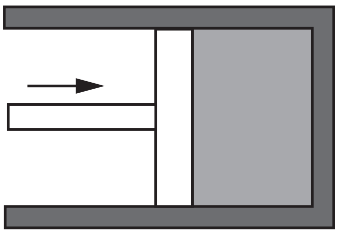
**(b)** A tight-fitting moveable piston traps gas in a cylinder as shown in the diagram.

The gas has volume 300 $cm^3$ and pressure of 100 kilopascals (kPa).




The piston is now pushed in and changes the volume of the gas to 150 $cm^3$.

The temperature of the gas has not changed.



Calculate the new pressure of the gas.

Use the equation: old pressure × old volume = new pressure × new volume

New pressure = ............................................... kPa **[2]**

**(c)** The piston is moved to a new position.

The force with which the gas pushes out on the piston is now 300 N.

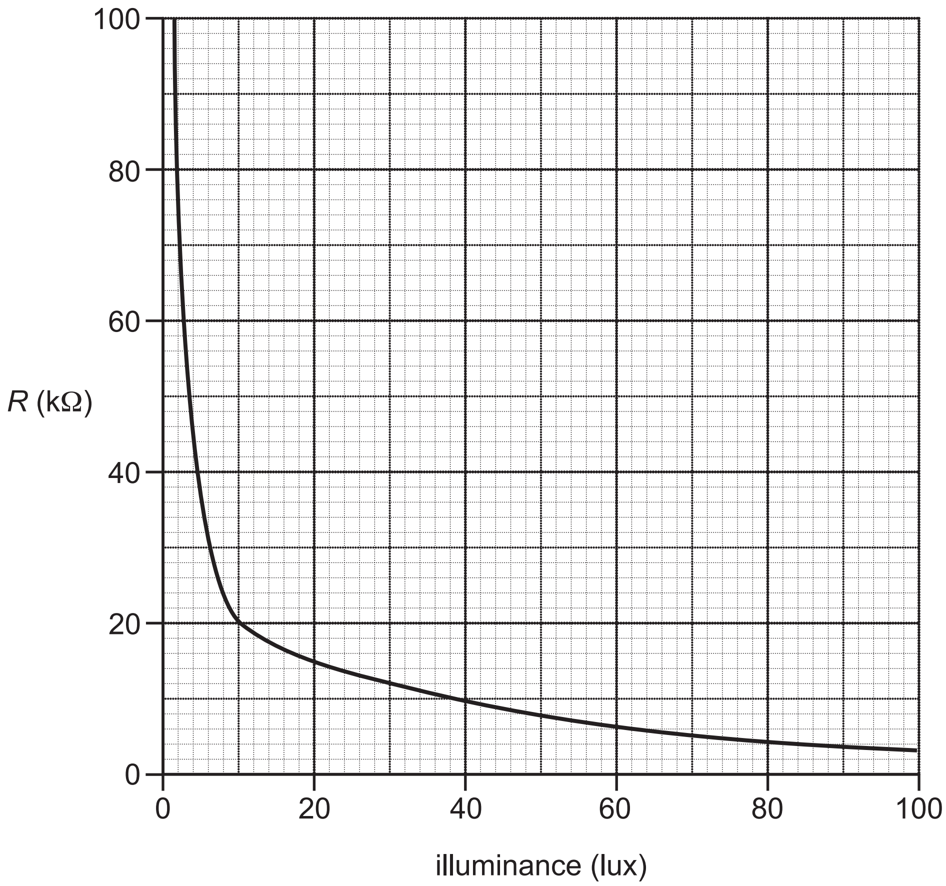
The area of the piston is 0.002 $m^2$.

Calculate the pressure of the gas in pascals (Pa).

Pressure = ............................................... Pa **[3]**

**8** This question is about using an LDR (light-dependent resistor) to measure light intensity.

**(a)** The resistance *R* of an LDR varies with illuminance (the amount of light energy per unit area hitting a surface) as shown in the graph.




**(i)** Which of the following statements correctly describes this variation?

Tick (✓) **one** box.

The resistance is directly proportional to the illuminance. ☐

The resistance and the illuminance have a positive correlation. ☐

As the illuminance increases, the change in resistance becomes less and less. ☐

The resistance is greater at 80 lux than at 20 lux. ☐

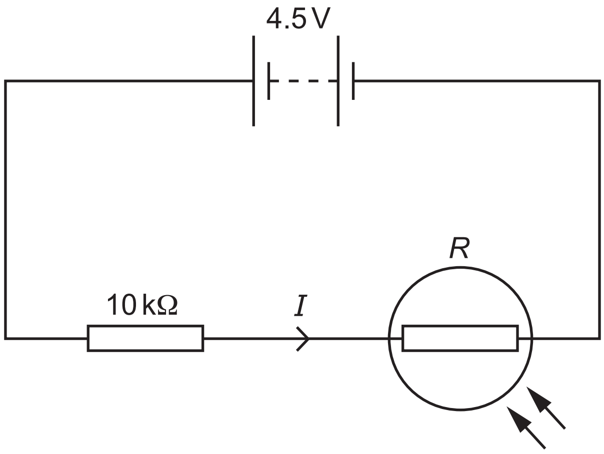
**[1]**

**(ii)** Use the graph to estimate the change in resistance of the LDR when the illuminance increases from 10 lux to 70 lux.

Change in resistance = ............................................... kΩ **[2]**

**(b)** The LDR is connected in series with a fixed resistor of resistance 10 kΩ and a 4.5 V battery.

The **total** resistance at 30 lux is 22 000 Ω.




**(i)** Calculate the current in the circuit.

Current = ............................................... A **[3]**

**(ii)** Calculate the potential difference across the fixed 10 kΩ resistor when the illuminance is 30 lux.

Potential difference = ............................................... V **[3]**

**(iii)** Describe, without any calculations, how the potential difference across the fixed resistor will change when the illuminance increases from 30 lux to 100 lux.

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

**9** Sarah carries out an experiment to measure the specific latent heat of vaporisation of water. She does this by finding the energy needed to evaporate a known mass of water.

The apparatus she uses is shown in **Fig. 9.1**.

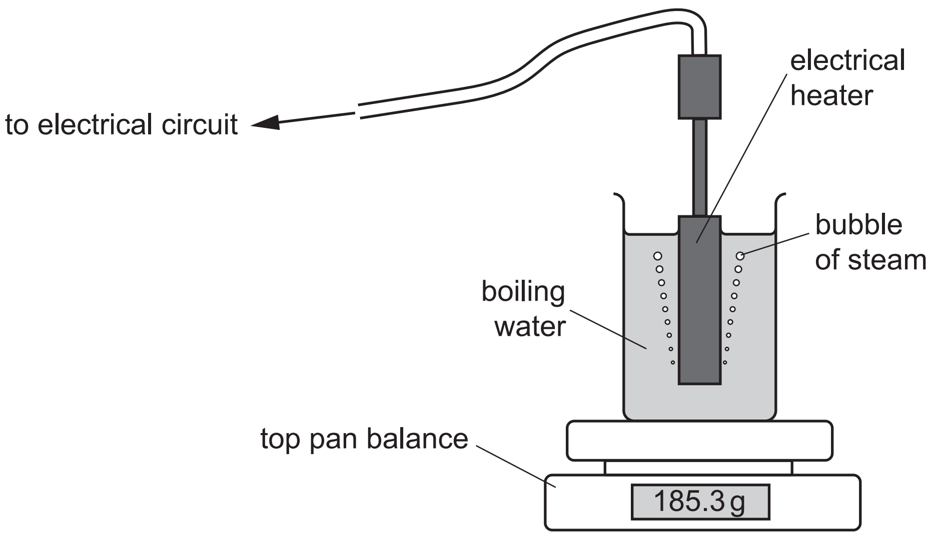



**Fig. 9.1**

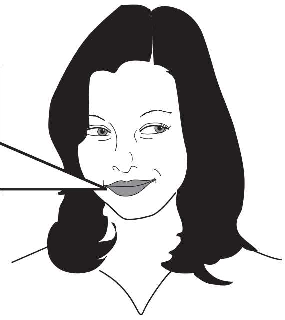
Using this apparatus, Sarah takes these readings.

| | **Measured value** |
|---|---|
| current | 3.0 A |
| potential difference | 12 V |
| time | 150 s |
| balance reading at start | 185.3 g |
| balance reading at the end | 184.3 g |

**Table 9.1**

**(a)*** Sarah is not happy with her results.

**Sarah**
The book says the specific latent heat of vaporisation of water should be 2300 J for every gram evaporated. The readings in **Table 9.1** give an answer that's far too big.



Is Sarah right?

What could Sarah do to get an accurate value of the specific latent heat of vaporisation of water from her experiment?

**[6]**

**(b)** Sarah's book has this information about vaporisation of two liquids.

| Liquid | Specific latent heat of vaporisation (J per gram) |
|---|---|
| water | 2300 |
| alcohol | 950 |

Suggest why it takes more energy to evaporate 1 gram of water than it does to evaporate 1 gram of alcohol.

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

**END OF QUESTION PAPER**