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Wednesday 22 May 2019 – Afternoon

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

J259/01 Breadth in physics (Foundation Tier)

Time allowed: 1 hour 45 minutes

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

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

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

Centre number						Candidate number				

First name(s) ______________________

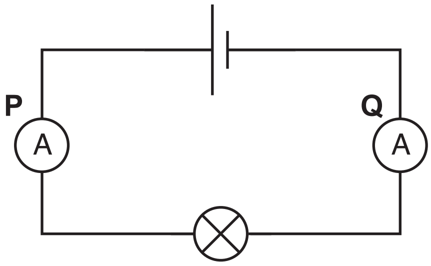
Last name ______________________

INSTRUCTIONS
- The Data Sheet will be found inside this document.
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Answer **all** the questions.
- Where appropriate, your answers should be supported with working. Marks may be given for a correct method even if the answer is incorrect.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.

INFORMATION
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- This document consists of **28** pages.

Answer **all** the questions.

1 Amaya and Li each build the circuit shown in the diagram.



(a) Which **two** parts of the circuit **must** be present for a current to flow?

Tick (✓) **two** boxes.

The ammeters, to measure the current ☐

The cell, to provide a potential difference ☐

The lamp, to provide resistance ☐

The wires, to make a complete circuit ☐

[1]

(b) Amaya measured the current in the lamp as 1.5 A.

The potential difference across the lamp is 3.3 V.

Calculate the resistance of the lamp.

Use the equation: resistance = potential difference ÷ current

Resistance = ...Ω **[2]**

(c) Amaya and Li compare their results.

The table shows the readings on the ammeters **P** and **Q**.

	Reading on ammeter P (A)	**Reading on ammeter Q (A)**
Amaya	1.5	1.5
Li	1.4	1.5

(i) Who got the expected results?

Amaya ☐

Li ☐

Explain your answer.

....

....

.... **[2]**

(ii) Amaya thinks her results are different to Li's because something is wrong with the ammeters.

Suggest how Amaya could check if there is something wrong with the ammeters.

....

....

.... **[1]**

2 A solar flare is an explosion on the surface of the Sun.

(a) Solar flares release huge amounts of radiation, including visible light and X-rays.

(i) Which statement is true?

Tick (✓) **one** box.

Visible light is ionising radiation. ☐

Visible light has a higher frequency than X-rays. ☐

X-rays have a shorter wavelength than visible light. ☐

X-rays are longitudinal waves. ☐

[1]

(ii) Why can humans see visible light but not X-rays?

Tick (✓) **one** box.

Our eyes can detect only a small range of frequencies. ☐

X-rays cannot travel through space towards the Earth. ☐

Our eyes cannot detect electromagnetic waves. ☐

X-rays are absorbed by the atmosphere of the Sun. ☐

[1]

(b) The speed of visible light in empty space is 300 000 km/s.

The distance from the Sun to the Earth is 150 000 000 km.

Speed can be calculated using the equation: speed = distance ÷ time

(i) Which is the correct way to calculate the **time** for visible light from a solar flare to reach the Earth?

Put a (ring) around the correct calculation.

$\mathbf{\dfrac{150\,000\,000}{300\,000}}$ $\mathbf{\dfrac{300\,000}{150\,000\,000}}$ **300 000 × 150 000 000**

[1]

(ii) When do the X-rays from the solar flare reach the Earth?

Tick (✓) **one** box.

After the visible light. ☐

At the same time as the solar flare happens. ☐

At the same time as the visible light. ☐

Before the visible light. ☐

[1]

(iii) Explain your answer to **(b)(ii)**.

....

....

.... **[1]**

3 Mia researches different models of the atom.

(a) What is the typical size of an atom?

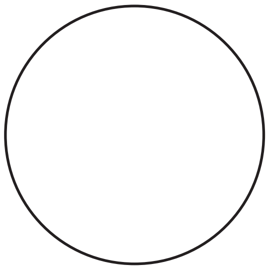
Put a (ring) around the correct answer.

10^{-3} m **10^{-6} m** **10^{-10} m** **10^{-20} m**

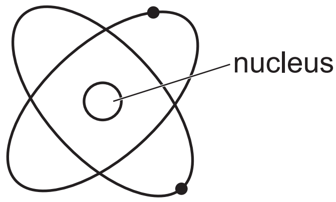
[1]

(b) Mia finds out about the models of atoms suggested by Dalton and Rutherford.

She draws these diagrams.



Dalton model



Rutherford model

Describe some of the **evidence** that led scientists to believe the Rutherford model instead of the Dalton model.

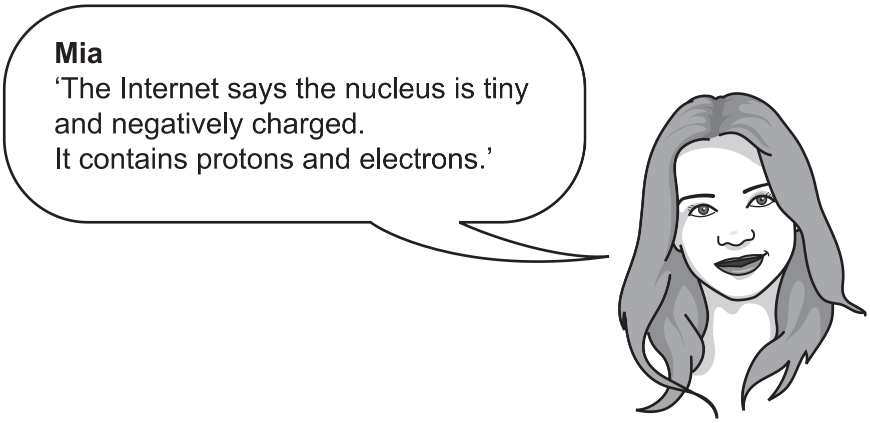
....

....

....

.... **[2]**

(c) Mia finds out more information about the nucleus of the atom on the Internet.



There are some mistakes in this information.

Write down **two incorrect** parts of the information.

1 ....

....

2 ....

.... **[2]**

(d) The nuclei of two atoms, carbon and neon, are represented below.

$^{12}_{6}\mathrm{C}$ $\quad$ $^{20}_{10}\mathrm{Ne}$

(i) What is the total **mass** of these two nuclei?

Put a (ring) around the correct answer.

12 – 6 **10 + 6** **20 + 10** **20 + 12**

[1]

(ii) What is the difference between the **charges** of these two nuclei?

Put a (ring) around the correct answer.

10 – 6 **12 – 6** **20 – 12** **20 – 10**

[1]

4 James investigates the magnetic field around a wire. He uses a vertical wire passing through a sheet of card, as shown in **Fig. 4.1**.

He maps the magnetic field using a compass.

The current in the wire is travelling upwards.

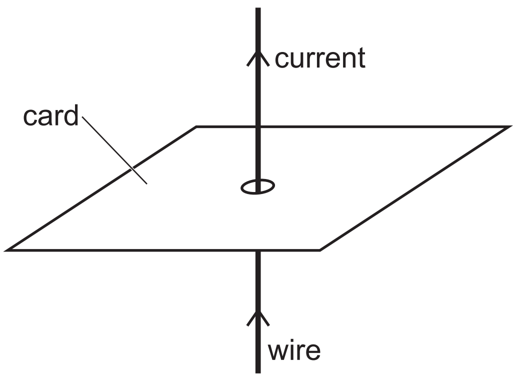


Fig. 4.1

(a) On the diagram in **Fig. 4.2**, draw the pattern of magnetic field lines that James should expect to find.

Draw at least **three** magnetic field lines and include **arrows** to show the direction of the magnetic field.

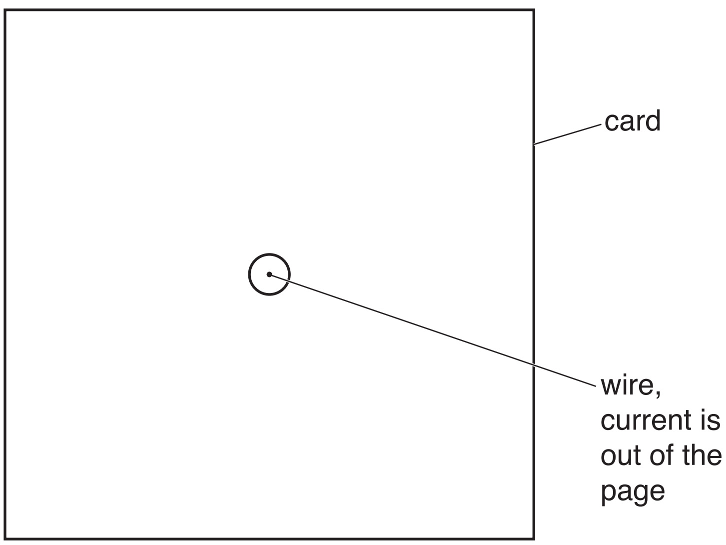


Fig. 4.2

[3]

(b) At the edge of the card, James cannot detect a magnetic field caused by the wire. He thinks this is because the magnetic field is very weak at the edge of the card.

(i) Explain why the magnetic field is weak at the edge of the card.

....

....

.... **[1]**

(ii) Describe **one** change that James could make to increase the strength of the magnetic field at the edge of the card.

....

....

.... **[1]**

(c) When the current in the wire is switched off, the compass points north.

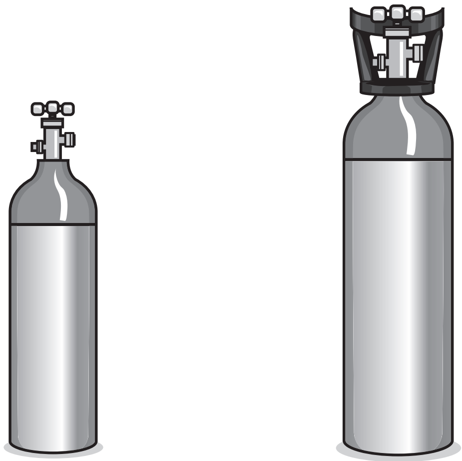
Explain why the compass points north.

....

.... **[1]**

5 Hospitals store oxygen at high pressure in metal cylinders.

The pictures show two cylinders, **A** and **B**. Both cylinders contain the same mass of gas and have the same temperature.



Cylinder **A** Cylinder **B**

(a) Cylinder **A** contains oxygen at a pressure of 23 000 kPa.

The area of the base of cylinder **A** is 0.030 m^2.

Calculate the force exerted by the gas on the base of cylinder **A**.

Use the equation: force normal to a surface = pressure × area of that surface

Force = ...N **[3]**

(b) Cylinder **B** has a larger volume than cylinder **A**.

The pressure in cylinder **B** is smaller than the pressure in cylinder **A**.

(i) Explain, using ideas about **particles**, why storing the same mass of gas in a larger volume produces a smaller pressure.

....

....

....

.... **[2]**

(ii) Both cylinders contain the same mass of gas and are at the same temperature.

	Pressure (kPa)	**Volume (dm^3)**
Cylinder A	23000	15
Cylinder B	10000	

Calculate the volume of gas in cylinder **B**.

Use the equation: pressure × volume = constant

Volume of gas = ... dm^3 **[2]**

6 Alex plays the violin. The violin has four strings. The strings are 32.5 cm in length, as shown in **Fig. 6.1**.

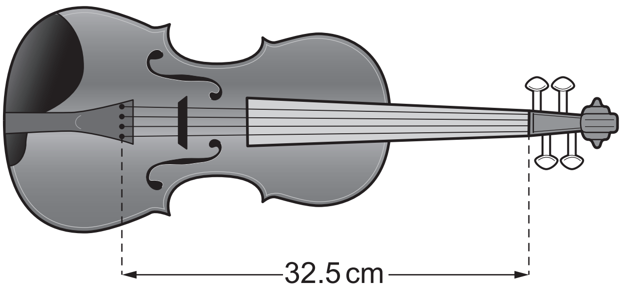


Fig. 6.1

When Alex plays the violin, waves pass along the strings. **Fig. 6.2** shows a wave on one of the strings.

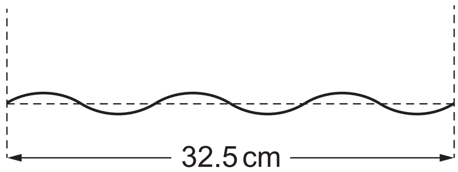


Fig. 6.2

(a) Calculate the wavelength of the wave shown in **Fig 6.2**.

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

Wavelength = ...cm **[2]**

(b) **(i)** Explain how **Fig. 6.2** shows that the wave is a transverse wave.

....

....

....

.... **[2]**

(ii) Explain how the sound waves produced by the violin are different to the waves on the string.

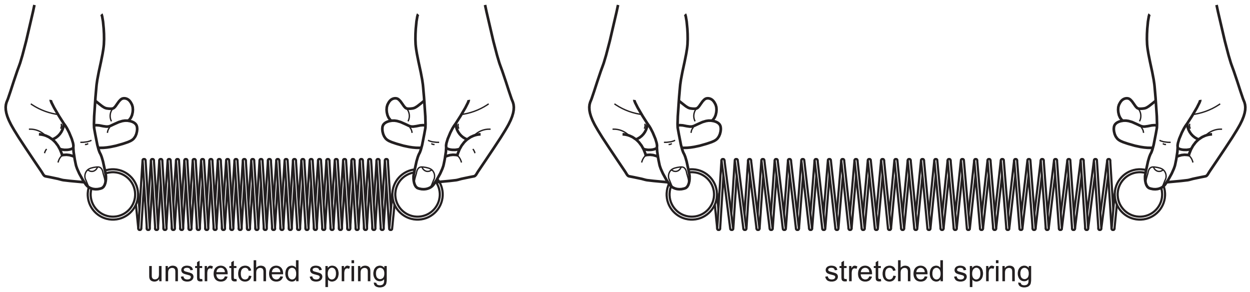
....

....

....

.... **[2]**

7 Sundip wants to use a spring to make a device to measure forces. She picks up a spring and stretches it.



(a) Explain why Sundip is wrong.

....

....

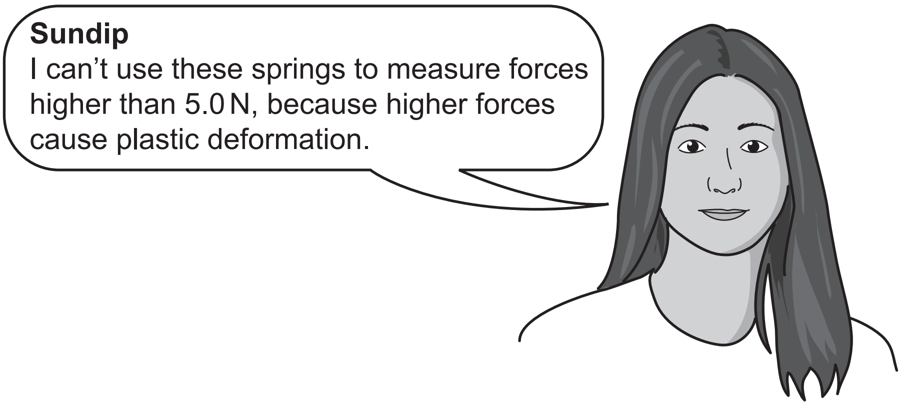
.... **[2]**

(b) Sundip investigates the extension of identical springs when different forces are applied.

The table shows her results.

Force (N)	Extension (cm)	Type of deformation
1.0	2.5	elastic
2.0	5.0	elastic
3.0	7.5	elastic
4.0	10.5	elastic
5.0	14.0	elastic
6.0	18.0	plastic
7.0	25.0	plastic

Sundip comments on her data in the table.



(i) Describe what is meant by plastic deformation.

....

.... **[1]**

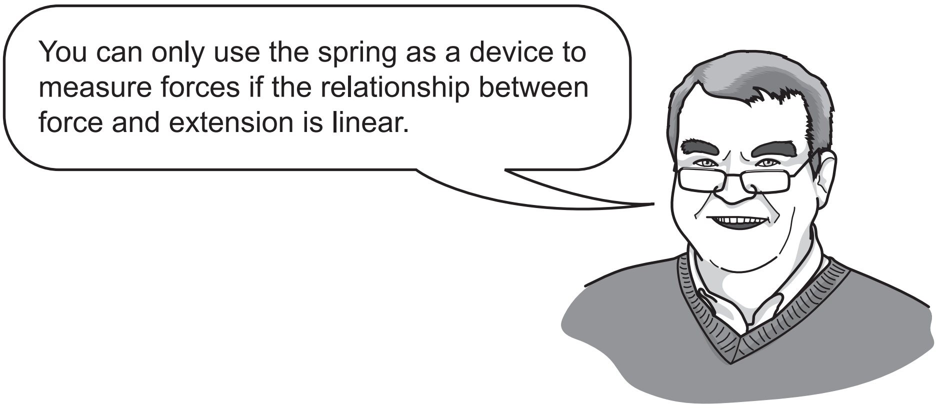
(ii) Explain why Sundip is correct.

....

....

.... **[1]**

(c) Sundip's teacher looks at her data in the table.



(i) Describe what is meant by a **linear relationship**.

....

.... **[1]**

(ii) Identify the maximum force for which the spring shows a linear force-extension relationship.

Use the data in the table to explain your answer.

Maximum force = ... N

Explanation ....

....

.... **[2]**

8 Layla charges the battery in her phone every evening.

The energy used to charge the battery is transferred from an energy resource at a power station.

(a) Two examples of energy resources are **fossil fuels** and **wind power**.

(i) Give one **similarity** and one **difference** in the ways these energy resources are used to generate electricity.

Similarity ....

....

Difference ....

.... **[2]**

(ii) Another energy resource is the Sun.

Energy is transferred from the energy store in the Sun as radiation.

Explain how the energy is stored in the Sun and how it is converted to radiation.

....

....

....

.... **[2]**

(b) Layla notices that her phone charger gets very hot. She thinks this might be dangerous. Her phone also takes a very long time to fully charge.

She decides to buy a new charger.

The table shows information about two phone chargers, **A** and **B**.

Charger	**Total energy transferred in 1 second (mJ)**	**Energy stored usefully in battery in 1 second (mJ)**	**Efficiency (%)**	**Cost to buy (£)**
A	195	112	57	12.00
B	240	150		12.00

(i) Calculate the efficiency of charger **B**.

Give your answer as a percentage.

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

(ii) Suggest which charger Layla should buy.

Justify your answer using the data from the table.

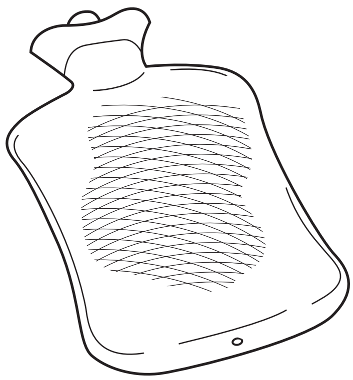
....

....

....

.... **[2]**

9 Ali uses a hot water bottle to keep warm.



(a) He uses a kettle to heat 1.1 kg of water from 20 °C to 90 °C. Ali then pours the hot water into the hot water bottle.

The specific heat capacity of water is 4200 J / kg / °C.

Calculate the change in internal energy in heating the water.

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

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

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

(b) The kettle transfers energy electrically.

The resistance of the kettle is 20 Ω.

The electric current in the kettle is 11 A.

Calculate the power of the kettle.

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

(c) Ali decides to use a heat pack instead of a hot water bottle.

A heat pack is a bag containing seeds, such as rice or wheat. It is heated in a microwave oven.

heat pack

Ali has two heat packs, one containing rice, and one containing wheat. He wants to investigate which heat pack will stay warm for longer.

(i) Suggest **two** pieces of measuring apparatus he will need to use in his investigation.

1 ....

2 ....
[2]

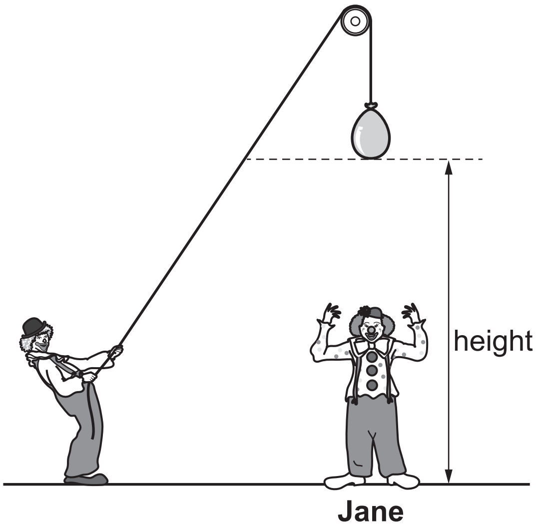
(ii) Suggest **one** control variable for Ali's investigation.

....

.... **[1]**

10 Jane is a clown in a circus. She is preparing a new show.

(a) In the show, water balloons will be dropped on her head from different heights.



(i) She needs the first water balloon to hit her at a speed of 10 m / s.

The first water balloon has a mass of 1.6 kg.

Calculate the kinetic energy of this water balloon moving at 10 m / s.

Kinetic energy = ...J **[3]**

(ii) The second water balloon has a mass of 2.4 kg. When it is released, it has gravitational potential energy of 120 J.

Calculate the height from which it is released.

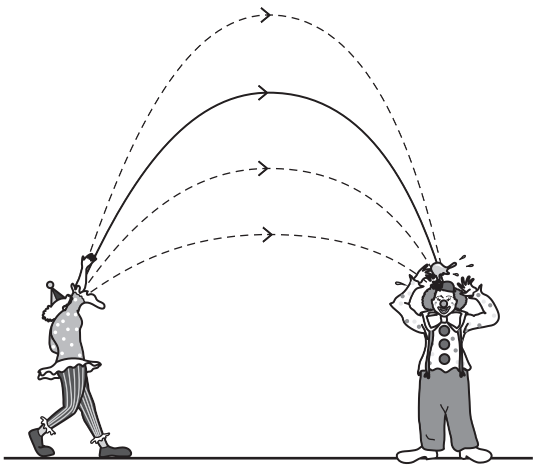
Use the equation:
gravitational potential energy = mass × gravitational field strength × height

Gravitational field strength = 10 N / kg

Height = ... m **[3]**

(b) In the next part of the show, a second clown throws water balloons at Jane.

The clown throws each water balloon at Jane to a different height.



(i) What is the name of the energy store before the water balloon is thrown?

Tick (✓) **one** box.

Chemical store ☐

Elastic store ☐

Kinetic store ☐

Nuclear store ☐

[1]

(ii) Name the energy store while the water balloon is in the air.

Tick (✓) **one** box.

Chemical store ☐

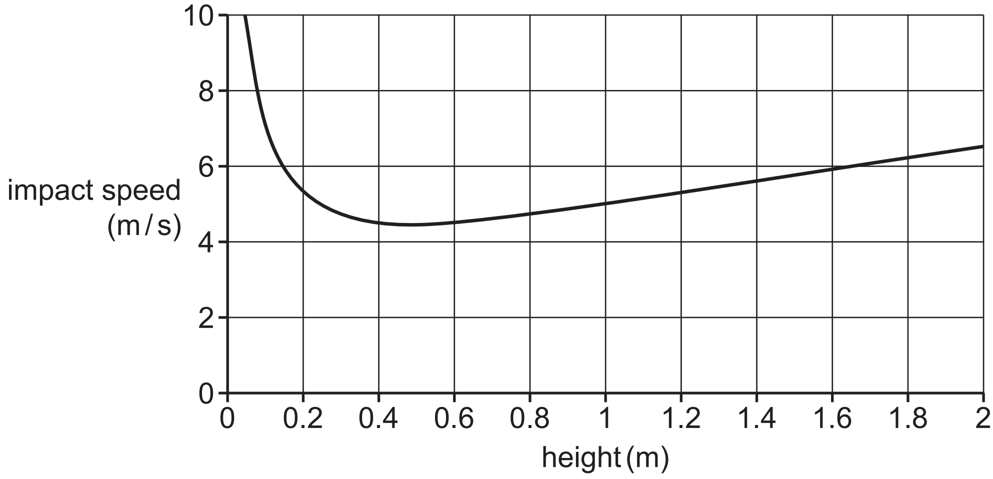
Elastic store ☐

Kinetic store ☐

Nuclear store ☐

[1]

(iii) The graph shows how the impact speed of the balloon depends on the height of the throw.



Describe the relationship between impact speed and height.

Use data from the graph in your answer.

....

....

....

.... **[2]**

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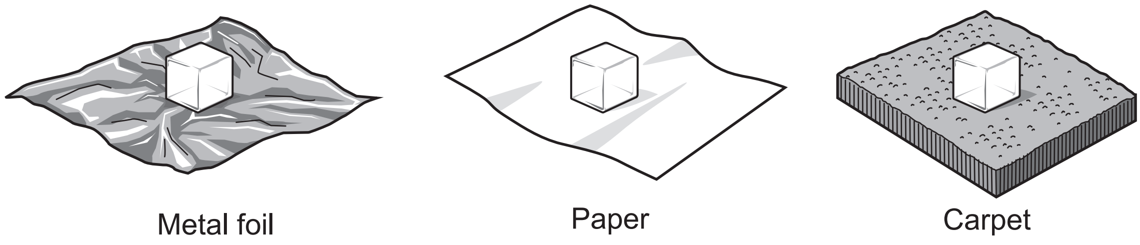
11 Amir investigates melting ice.

He puts ice cubes on different materials. He then measures the time taken for each ice cube to completely melt.



Amir's results are shown in the table.

Material	Time (min)
Metal foil	86
Paper	105
Carpet	162

(a) Calculate the thermal energy needed to melt 20 g of ice.

The specific latent heat of melting for ice is 334 000 J / kg.

Thermal energy = ...J **[3]**

(b) Explain why the ice cubes take different times to melt on different materials.

....

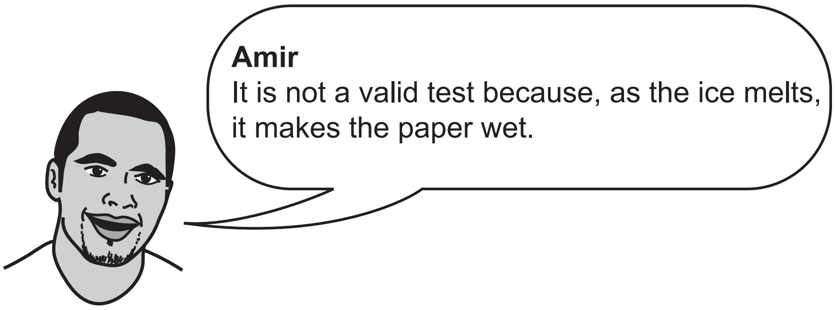
....

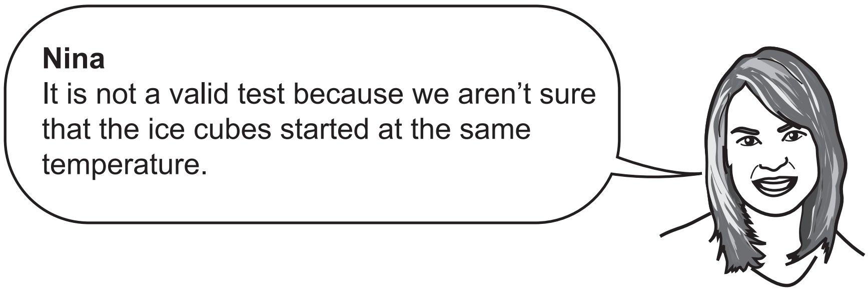
....

....

.... **[2]**

(c) Amir discusses the experiment with Nina, another student.





(i) Suggest improvements to the experiment to solve each of these problems.

Amir's problem ....

....

....

Nina's problem ....

....

.... **[2]**

(ii) Amir wants to speed up the experiment so it can be repeated more quickly.

Suggest **one** way he can change the experiment so that the ice melts more quickly, without making the experiment invalid.

....

.... **[1]**

12 Jamal is on a water slide.

(a) **Fig. 12.1** shows the force of gravity (weight) acting on Jamal.

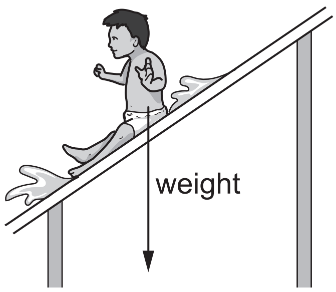


Fig. 12.1

(i) **Add an arrow** to **Fig. 12.1** to show the normal contact force between Jamal and the slide. Label this arrow **N**. **[1]**

(ii) **Add an arrow** to **Fig. 12.1** to show the force of friction between Jamal and the slide. Label this arrow **F**. **[1]**

(b) **(i)** State Newton's third law.

....

....

.... **[2]**

(ii) Explain how Newton's third law applies to the force of gravity (weight) acting on Jamal.

....

.... **[1]**

13 Beth works at a nuclear power station.

She is asked to investigate the risk caused by radioactive isotopes accidentally coming into contact with food.

(a) Would swallowing this food be a contamination effect or an irradiation effect?

Contamination effect ☐

Irradiation effect ☐

Explain your answer.

....

.... **[2]**

(b) Explain why it is hazardous if radioactive isotopes enter the body.

....

....

.... **[1]**

(c) Information about three isotopes is shown in the table.

Isotope	Type of decay	Half-life	Biological effects
Plutonium-241	beta	14 years	absorbed by the bones
Radium-226	alpha	1600 years	absorbed by the bones
Technetium-99m	gamma	6 hours	excreted after a few days

Which isotope is most hazardous when inside the body?

Explain your answer.

....

....

....

....

....

.... **[2]**

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).

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