Qualification Accredited

Oxford Cambridge and RSA

GCSE (9–1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE PHYSICS B

J259

For first teaching in 2016

J259/01 Summer 2023 series

Version 1

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 1 series overview

J259/01 is the Breadth in Physics paper at Foundation tier. It covers topics across the whole specification with short answer questions. This includes structured questions, calculations and questions based on practical skills. It counts for 50% of the marks for Foundation tier GCSE qualification in Physics (Twenty First Century Science). The other 50% is covered by J259/03 Depth in Physics.

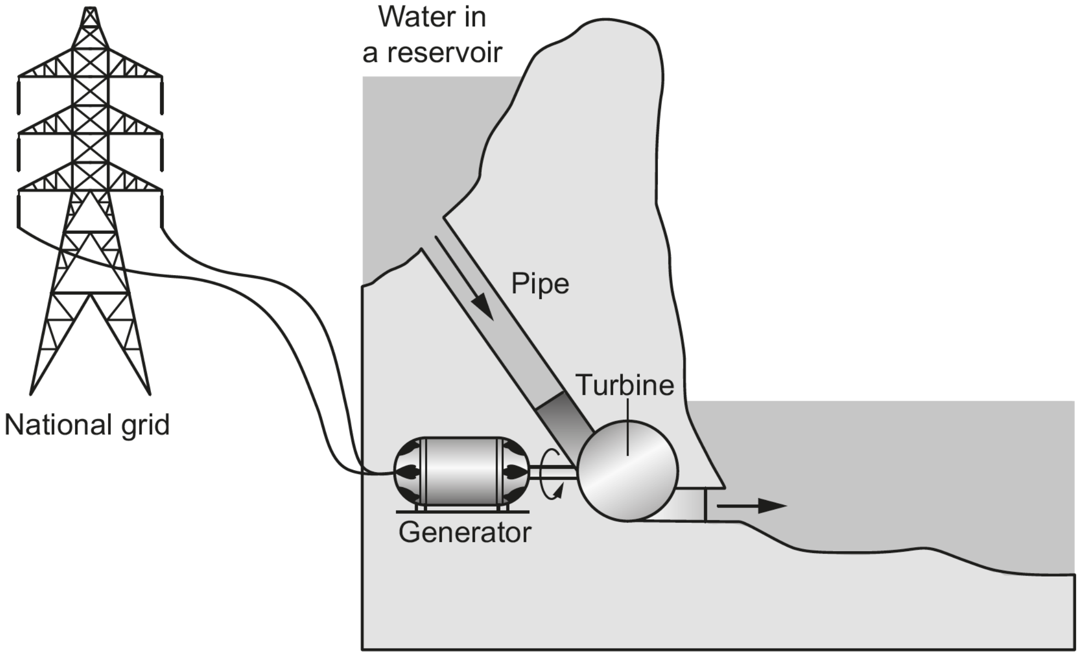
This paper included several questions about practical skills and interpretation of data, which some candidates found difficult. Some of the recall questions were well answered, but many candidates found it more difficult to apply their knowledge to the contexts provided in the questions.

There were also a number of questions on more challenging topics within the specification, namely energy transfers, electric fields, air pressure and the Big Bang.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• explained procedures and concepts using correct scientific terminology • laid out their numerical answers clearly to avoid making errors • were able to relate the science learnt in the classroom to the contexts provided in the questions.	• wrote unclear explanations, often copying down part of the questions. • were unable to rearrange equations or convert units correctly • struggled to apply scientific knowledge to the contexts presented in the questions.

Question 1 (a)

1 The diagram shows a hydroelectric power station.



(a) What is the useful energy store of the water in the reservoir?

Tick (✓) **one** box.

Chemical ☐

Electrical ☐

Gravitational Potential ☐

Thermal ☐

[1]

Most candidates gave the incorrect response 'Electrical' for this question. In generating electricity, it is the gravitational potential store that decreases. Electrical stores are not covered at GCSE (although electrical working is).

Question 1 (b)

(b) Many of the main energy resources use a turbine attached to a generator.

Complete the table to state what drives the turbine for each energy resource.

Tick (✓) **one** box in each row.

	What drives the turbine		
	Water	Wind	Steam
Energy resource			
Gas power			
Nuclear power			
Tidal power			

[3]

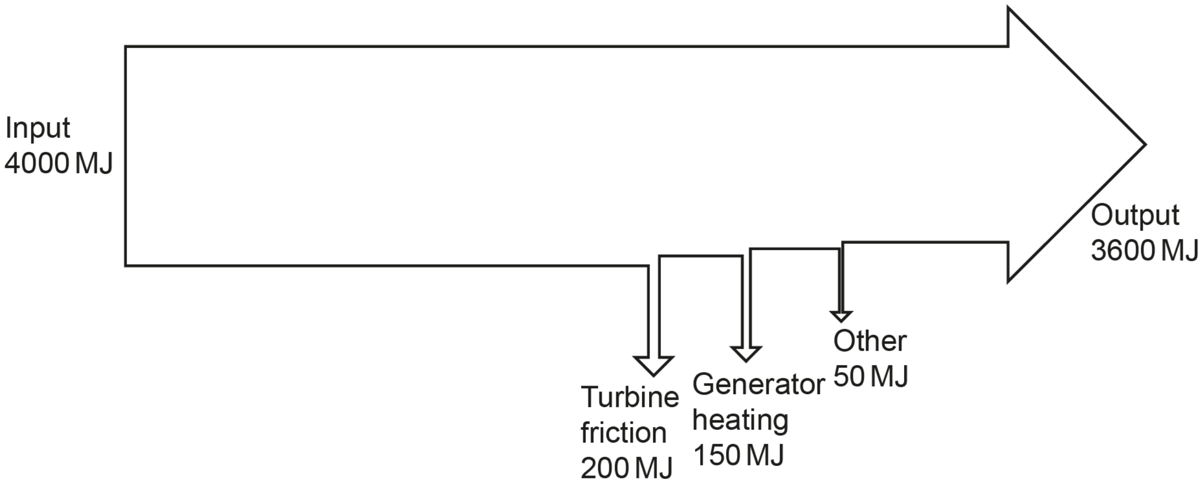
Most candidates gave the correct answer for tidal power, but many gave 'Wind' as their answer to either gas or nuclear power.

Misconception

In questions where candidates had to choose from a list or a table of options, some seemed reluctant to choose the same option more than once. Usually the options can be used once, more than once, or not at all.

Question 1 (c) (i) and (ii)

(c) A Sankey diagram of the energy transferred in the hydroelectric power station during one hour is shown.



(i) Calculate the total energy wasted every hour.

Wasted energy = ... MJ **[1]**

(ii) Suggest how to reduce the unwanted energy transfer due to friction as the turbine rotates.

....

.... **[1]**

Many candidates correctly interpreted the Sankey diagram to give the correct response to part (i). Some candidates gave an answer of one of the quantities of wasted energy, for example 50 MJ. Some candidates attempted to give a more developed answer and tried to work out the efficiency.

In part (ii) many candidates suggested that the speed of the turbine should be changed to reduce the unwanted energy transfer due to friction, but some did correctly suggest using a lubricant.

Question 1 (d)

(d) Calculate the power output of the hydroelectric power station.

Use:

- the equation: power = $\frac{\text{energy transferred}}{\text{time}}$
- the data in the Sankey diagram
- the information: 1 hour = 3600 seconds.

Power output = ... MW **[2]**

Many candidates used the value of energy input instead of energy output to calculate the power output.

Question 2 (a)

2 This question is about electromagnetic radiation.

(a) Complete the sentence about the human eye.

Put a ring around the correct option.

The human eye can detect a **wide** / **varied** / **narrow** range of frequencies of electromagnetic radiation.

[1]

Most candidates chose the correct option here.

Question 2 (b)

(b) Complete the description of light. Use words from the list.

charge	**detector**	**energy**	**source**

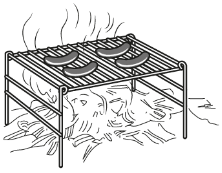
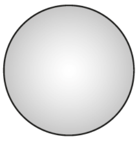
When light is emitted by a ...., it transfers .... and the eye absorbs it.

[1]

Many candidates correctly completed this description of light.

Question 2 (c) (i) and (ii)

(c) Every object emits electromagnetic radiation with different frequencies. Some examples are given in the table.

Object	**Typical frequency of radiation emitted (THz)**
Red hot barbecue 	461
The Earth 	29
The Sun 	600

(i) Put the frequencies in order of **energy**, from lowest to highest.

Lowest energy ....

....

Highest energy ....

[1]

(ii) What happens to the wavelength emitted from an object as its temperature increases?

Tick (✓) **one** box.

The wavelength decreases. ☐

The wavelength increases. ☐

The wavelength stays the same. ☐

[1]

Most candidates put the frequencies in the correct order for increasing energy in part (i). There was a fairly even split of responses to part (ii).

Question 2 (d) (i) and (ii)

(d) Earth emits infrared radiation with a typical wavelength of 10 μm (10 micrometers).

(i) State the number of micrometres in 1 metre.

1 m = ... μm **[1]**

(ii) How many times larger is 1 mm than 10 μm?

Tick (✓) **one** box.

10 ☐

100 ☐

1000 ☐

1 000 000 ☐

[1]

Some candidates correctly stated that there were a million μm in a metre in part (i), but there were many other incorrect numbers in this question. Most were factors of 10. Some candidates did get part (ii) correct but there were a number of candidates putting 1000 as a millimetre is 1000 times larger than 1 micrometre. Candidates needed to read the question carefully here.

Question 3 (a)

3 A student wants to construct a circuit that turns a lamp on when it gets dark.

A circuit can be a series or a parallel circuit.

(a) Which statement is correct?

Tick (✓) **one** box.

Current splits at branches in a parallel circuit. ☐

Potential difference across each component in a branch is the same. ☐

Potential difference is shared between all the branches of a parallel circuit. ☐

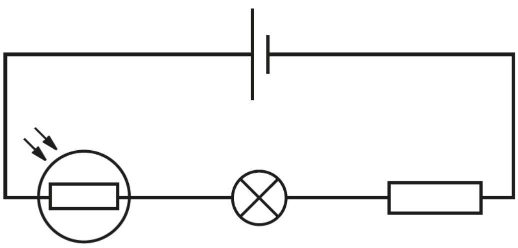
[1]

Type your commentary Although some candidates got the correct first statement, many incorrectly chose the third statement. Each branch of a parallel circuit will have the same potential difference, but the potential difference will be shared between all components connected in series in each branch of a circuit.

Question 3 (b) (i) and (ii)

(b) The student builds the circuit in **Fig. 3.1** using a cell, a lamp, a fixed resistor and an LDR.

Fig. 3.1



(i) Which circuit symbol in **Fig. 3.1** represents the fixed resistor?

Put a ring around the correct option in **Fig. 3.1**. **[1]**

(ii) The resistance of the LDR increases in the dark.

What happens to the current in this circuit in the dark?

Tick (✓) **one** box.

The current decreases ☐

The current increases ☐

The current stays the same ☐

[1]

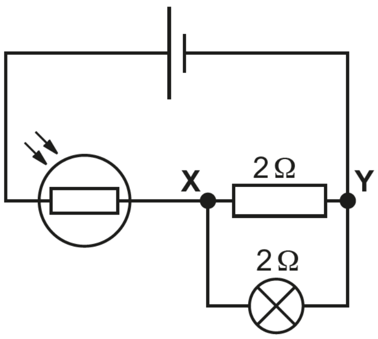
Most candidates who answered part (i) correctly identified the fixed resistor. The most common incorrect response was to circle the LDR. Several candidates omitted part (i).

In part (ii), most candidates incorrectly said that the current increased when the LDR was in the dark. The question states that the resistance of the LDR increases in the dark, and higher resistance means that less current can flow.

Question 3 (c)

(c) The student builds a second circuit as shown in **Fig. 3.2**.

Fig. 3.2



Which **two** statements together explain why the overall resistance between points **X** and **Y** is less than 2 Ω?

Tick (✓) **two** boxes.

More charge can pass than for either component alone. ☐

The lamp only allows current to flow in one direction. ☐

The potential difference across the lamp decreases. ☐

There are two paths for the current to flow. ☐

[2]

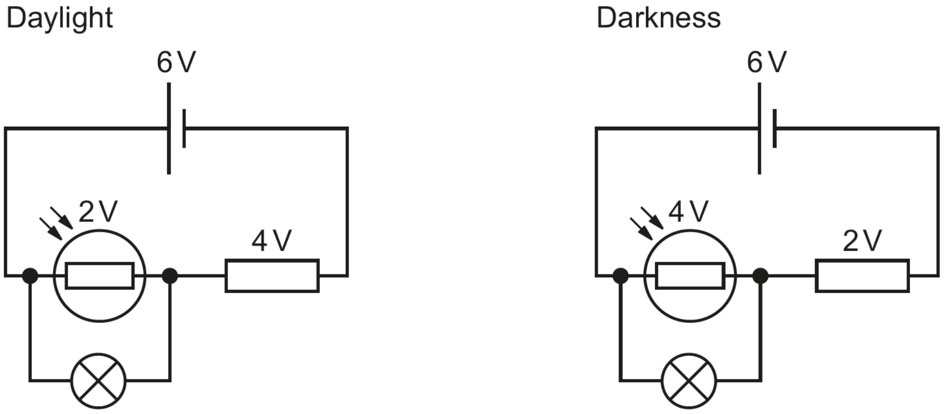
Most candidates chose one or other of the two correct responses in this question.

Question 3 (d)

(d) Finally, the student builds the circuit shown in **Fig. 3.3**.

The lamp lights up in darkness and does not shine in daylight.

Fig. 3.3



Complete the sentences to explain why the lamp lights in darkness.

Use words from the list.

current	**potential difference**	**power**	**resistance**

In darkness, the resistance of the LDR increases, and this means that the

.... across the LDR also increases.

The lamp has the same .... as the LDR, so the lamp is able to light. **[2]**

Some candidates correctly used potential difference for one or other of the spaces, but put a different quantity in the other space. The data on the diagram shows that the potential difference (measured in volts) across the LDR is larger in the circuit in the dark. The potential difference is the same for components in parallel.

Question 3 (e)

(e) The energy transferred by the lamp is 3.2 J when the potential difference is 4.0 V.

Calculate the charge flowing through the lamp.

Use the equation: $\text{charge} = \dfrac{\text{energy transferred}}{\text{potential difference}}$

State the **unit**.

Charge = ... Unit = ... **[3]**

Most candidates were able to correctly substitute the values into the given equation and calculate the correct numerical value of 0.8, but only a small number of candidates gave the correct unit for charge. There were many who gave J (joule), W (watt), A (amp) or Ω (ohm), which are all units used for electrical quantities. Candidates may be less familiar with the unit for charge, coulomb (C). Some candidates did put Q as the unit, and this is often used as a symbol for charge.

OCR support

Appendix 5d includes a table of quantities, common symbols, their SI units and their abbreviations. A student friendly printable version is available.

A candidate friendly printable version is available on Teach Cambridge.

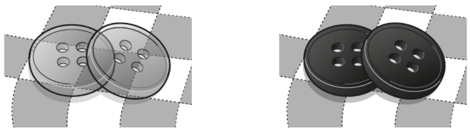
OCR's Alphabet of physics includes a table that highlights where confusion might otherwise occur. It includes practice questions.

Alphabet of Physics on Teach Cambridge

Question 4 (a) (i) and (ii)

4 Light interacts with different materials.

(a) The images show clear plastic and black plastic shirt buttons.



(i) Why do the clear buttons look clear when light is shone at them?

....

.... **[1]**

(ii) Why do the black buttons look black when light is shone at them?

....

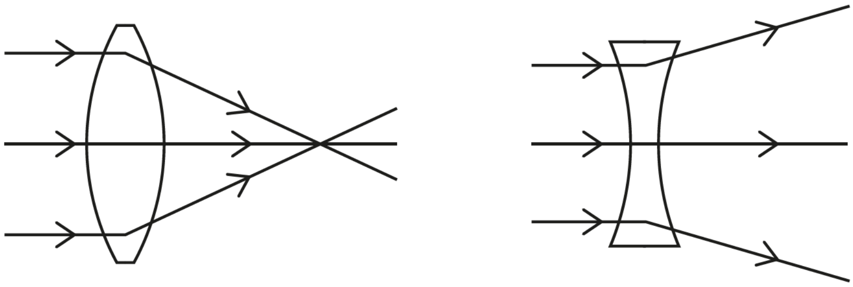
.... **[1]**

Many candidates correctly stated that the clear buttons were transparent and the black buttons were opaque, or described that light could pass through the clear buttons but was absorbed by the black buttons.

Question 4 (b)

(b) **Fig. 4.1** shows the path of some rays of light passing through two different types of glass lens.

Fig. 4.1



State **one** similarity and **one** difference between these two glass lenses.

Similarity ....

....

Difference ....

....

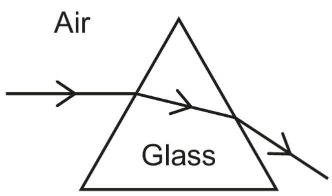
[2]

Many candidates found it difficult to describe any differences and similarities between the way the light behaves with the two different lenses using correct scientific terminology. Candidates should have described how the rays of light behaved after passing through the lenses. For example, one lens refracts or bends the rays away from each other and the other refracts the rays towards each other. Many just told us that the light goes in different directions.

Question 4 (c)

(c) White light is shone at a glass prism, as shown in **Fig. 4.2**.

Fig. 4.2



Describe what happens to the light as it travels from the air, through the glass prism and back into the air.

....

....

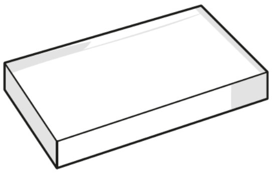
....

.... **[2]**

Most candidates were able to state that the light ray was refracted, or bent, as it passed through the glass prism, but needed to give more detail to gain full marks for this question. Some candidates correctly described that the white light would become a spectrum or that the light slowed down as it passed through the glass.

Question 4 (d)

(d) A student investigates the relationship between the angle of incidence and angle of refraction for a ray of light passing through a glass block.



This is the student's method:

- Put a glass block on some paper.
- Shine the light from a raybox into the glass block.
- Mark the path of the rays on the paper with a pen.
- Remove the glass block and the raybox.
- Sketch a line to show the path of the ray inside the glass block.
- Estimate the angle of incidence and angle of refraction.
- Repeat the experiment for one other angle of incidence.

Suggest how the student can improve their method to increase the quality of the data collected.

....

....

....

....

....

.... **[3]**

Some candidates were able to suggest improvements to this method; common correct examples included using a ruler to draw straight lines and using a protractor to measure the angles rather than just estimate them. Some candidates did give some impractical suggestions such as drawing the line showing the path of the ray of light in the block before removing the block.

Question 5 (a)

5 Sound travels through metal and air.

Passengers at a train station notice that they can hear a rumble in the metal rails for nearly a minute before they hear the sound of the train coming.

(a) The speed of the sound wave in the metal rails is 3300 m/s.

Write down the distance the sound wave travels through the metal rails in 1 second.

Distance = ... m **[1]**

Many candidates correctly stated that the sound wave travels 3300 metres in one second. Some candidates attempted to calculate some other value.

Question 5 (b)

(b) The frequency of the sound wave in the metal rails is 110 Hz.

Calculate the wavelength of the sound wave in the metal rails.

Use the equation: wave speed = frequency × wavelength

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

Many candidates were able to rearrange the given equation to find wavelength correctly. Some candidates who do not rearrange just multiplied the given numbers together.

Question 5 (c) (i)

(c) The sound wave in the metal rails causes a sound wave in the air.

The speed of the sound wave in air is 10 times less than the speed of the sound wave in the metal rails. The frequency of the sound wave stays the same.

(i) Calculate the speed of the sound wave in the air.

Speed = ... m/s **[1]**

Some candidates correctly interpreted the question to divide the speed of the sound wave in metal by 10. Some candidates subtracted 10, or used the calculated value for wavelength in part (b) (ii) instead of the speed of sound.

Question 5 (c) (ii)

(ii) Complete the sentence about the wavelength of the sound wave in the air.

Put a ring around the correct option.

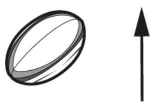
The sound wave in the air has **a longer** / **a shorter** / **the same** wavelength compared to the sound wave in the metal rails.

[1]

Many candidates did correctly indicate that the wavelength of the sound would be shorter if the wave was travelling slower. The more common incorrect response was to say that the wavelength remained the same.

Question 6 (a) (i)

6 A rugby ball is kicked with an upwards velocity of 20 m/s. The ball has a mass of 0.6 kg.



(a) **(i)** Calculate the kinetic energy of the ball just after it has been kicked.

Use the Equation Sheet.

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

Many candidates chose the correct equation to calculate kinetic energy and were able to calculate the correct value. Some candidates wrote the equation down and substituted the values in correctly but then omitted to square the velocity and were able to gain some marks because they had shown some working.

Assessment for learning

Candidates who show their working in calculation questions are likely to gain marks even if the final value is incorrect. Encourage candidates to write out the equation and then substitute in the values on the next line down directly underneath the symbols, so that the working is clear to both the examiner and themselves. They are then less likely to make a mistake when using their calculator.

Question 6 (a) (ii)

(ii) Convert 20 m/s into km/h.

1 km = 1000 m
1 hour = 3600 seconds

20 m/s = ... km/h **[2]**

Many candidates found this question difficult, and there were many different types of errors, but again those candidates who showed some working were able to gain one mark even if they did not get the final correct answer.

Assessment for learning

When converting units, it is helpful to think about the relative size of each unit.

To convert 20 m into km, first remember that a metre is smaller than a kilometre so the number of kilometres will be **smaller** than the number of metres – so **divide** by the conversion factor: 20 m = 20 ÷ 1000 = 0.02 km.

To convert the speed from 'per hour' to 'per second'. If something is moving 20 m in one second, it will travel a much longer distance in an hour, so we need to multiply by the factor to get a bigger number: 0.02 km/s × 3600 = 72 km/h.

Question 6 (b) (i) and (ii)

(b) (i) As the ball moves upwards through the air, some work is done to increase the thermal store of the surroundings.

State the name of the force doing this work.

.... **[1]**

(ii) State **one other** energy transfer as the ball moves upwards through the air.

....

.... **[1]**

Candidates found both these questions difficult; there was confusion between forces and energy stores. Many candidates wrote a type of energy store as the answer to part (i), where the answer should have been a force. A few candidates correctly gave the answer as air resistance or friction with the air.

In part (ii), candidates were asked to state an energy transfer, not just a type of energy store. Energy can be transferred from one energy store to another or from one object to another. An answer of 'kinetic energy' is not an energy transfer. Candidates needed to say what was happening to the kinetic energy of the ball, for example the kinetic energy is reducing and the gravitational energy is increasing as the ball goes upwards.

Question 6 (b) (iii)

(iii) Calculate the work done by a force of 3.5 N when the ball moves a distance of 5.2 m through the air in the direction of the force.

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

Use the equation: work done = force × distance

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

Most candidates were able to calculate the work done correctly, by substituting the values into the given equation and multiplying them together. Most candidates gave the answer as it was displayed on a calculator and did not round the answer to 2 significant figures.

Question 6 (c)

(c) The ball's velocity decreases as it goes upwards. It reaches a maximum height and then its velocity increases as it falls downwards.

State the velocity of the ball at the moment it reaches its maximum height.

Velocity = ... m/s **[1]**

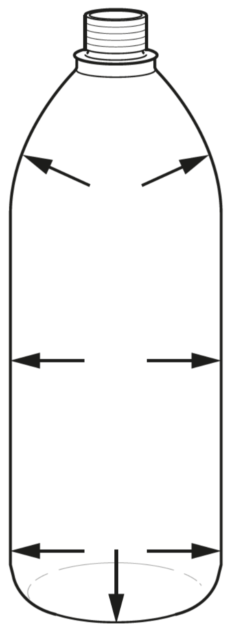
Only a few candidates correctly stated that the velocity would be zero at the maximum height. There was a wide variety of incorrect answers given. In the question, candidates are told that the velocity decreases until it reaches the maximum height and then it will speed up in the opposite direction, so in between these two the ball is stationary for an instant.

Question 7 (a)

7 (a) A mountaineer has an empty plastic bottle at the top of a mountain. The lid is off.
The arrows on **Fig. 7.1** show the air pressure acting on the inside of the bottle.

Draw **three** arrows on **Fig. 7.1** to show the air pressure acting on the outside of the bottle.

Fig. 7.1



[2]

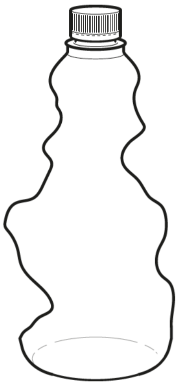
Candidates here were expected to draw arrows equal and opposite to the printed arrows on the diagram, but most of them did not do that. Many candidates did not appreciate that the lid was not on the bottle and put an arrow pointing towards the open top of the bottle (which therefore is not on the outside surface of the bottle). On the whole most candidates did draw arrows pointing towards the outside surface of the bottle, but not usually all at right angles. There was a tendency to put the arrows pointing diagonally downwards, perhaps implying that they thought that air pressure acted downwards.

Question 7 (b) (i) and (ii)

(b) The mountaineer puts the lid on the bottle and climbs down the mountain.

At the bottom of the mountain, the bottle has a crushed shape, as shown in **Fig. 7.2**.

Fig. 7.2



(i) Suggest why the bottle has a crushed shape at the bottom of the mountain.

....

....

....

.... **[2]**

(ii) Explain why air pressure varies with height above the surface of the Earth.

....

....

....

.... **[2]**

Candidates found it very difficult to explain air pressure at different altitudes. Most candidates said that the pressure at the top of the mountain was higher than the pressure at the bottom, so they were unable to explain correctly why the bottle became crushed on the way down the mountain. There was a lot of confusion about oxygen levels and gravity changing with height about the Earth.

Assessment for learning

Candidates should be able to describe a simple model of the Earth's atmosphere and of atmospheric pressure, and explain why atmospheric pressure varies with height above the surface.

Atmospheric pressure could be explained in terms of the pressure exerted by a column of fluid above the surface of the Earth. The pressure is caused by the gravitational force acting on the mass of that column of air above you. So the higher you are, the shorter the column of air, the lower the mass, and therefore the lower the pressure.

Exemplar 1

(i) Suggest why the bottle has a crushed shape at the bottom of the mountain.

~~It's because the mountanier is using his weight tho to squash the bottle since there is no more air inside of it there's no pressure acting on the inside of the bottle~~ **[2]**

~~the~~ He is climbing down there's no air pressure when going down.

(ii) Explain why air pressure varies with height above the surface of the Earth.

The pressure in the atmosphere decreases, this is because the altitude increases, the number of air molecules decrease so the weight of the air decreases **[2]**

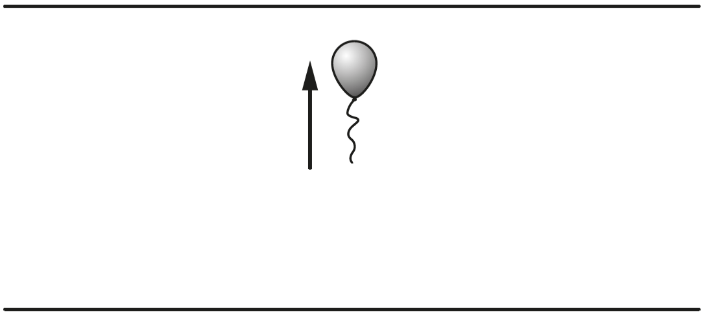
The pressure is higher at the bottom of the mountain than at the top. So when he sealed the bottle at the top and brought it down, there was more pressure outside than in. More force pushing in on the sides than pushing out

This candidate has correctly stated, at the beginning of part (i), that the pressure is higher at the bottom of the mountain and has said that the bottle was sealed at the top implying that there is lower pressure air trapped inside. Then it says that there is more pressure acting on the outside of the bottle than on the inside so the bottle gets crushed.

Then in part (ii), the candidate tries to explain that at higher altitudes there are fewer air molecules so the weight of the air is less. In order to gain more marks the candidate could have stated that air pressure is caused by the weight of the air above.

Question 7 (c) (i) and (ii)

(c) A helium balloon is released and rises to the ceiling.



The balloon has a final speed of 2 m/s just before it reaches the ceiling.
Initial speed = 0 m/s
Acceleration = 0.5 m/s^2

(i) Select **one** equation from the Equation Sheet which can be used to find the distance the balloon travels, using the variables given.

....

.... **[1]**

(ii) How can you calculate the distance the balloon travels?

Put a ring around the correct calculation.

distance = $2^2 - 0^2 - (2 \times 0.5)$

distance = $\dfrac{(2 \times 0.5)}{(2 - 0)}$

distance = $\dfrac{2^2 - 0^2}{(2 \times 0.5)}$

distance = $\dfrac{(2 \times 0.5)}{2^2 - 0^2}$

[1]

Many candidates selected the correct equation from the equation sheet, and many of them were also able to select the correct rearrangement in part (ii)

Question 8 (a)

8 **(a)** Complete the sentences about radioactive substances.

Put a ring around each correct option.

Atoms in radioactive substances have **balanced** / **stable** / **unstable** nuclei. This means that they will **absorb** / **emit** / **reflect** particles or electromagnetic radiation. **[2]**

Many candidates correctly stated that radioactive substances have unstable nuclei and they emit particles or electromagnetic radiation. More candidates got the second part of this question correct than the first.

Question 8 (b)

(b) The nuclear equation shows the radioactive decay of a sulfur nucleus to a chlorine nucleus.

$$^{35}_{16}S \rightarrow \, ^{35}_{17}Cl + \, ^{0}_{-1}e^{-}$$

Identify the radioactive decay in the nuclear equation.

Tick (✓) **one** box.

Alpha decay ☐

Beta decay ☐

Gamma decay ☐

[1]

There were a variety of responses here, but many candidates did correctly choose beta decay.

Question 8 (c)

(c) Which statement explains why sulfur and chlorine are different elements?

Tick (✓) **one** box.

They have different numbers of electrons. ☐

They have different numbers of neutrons. ☐

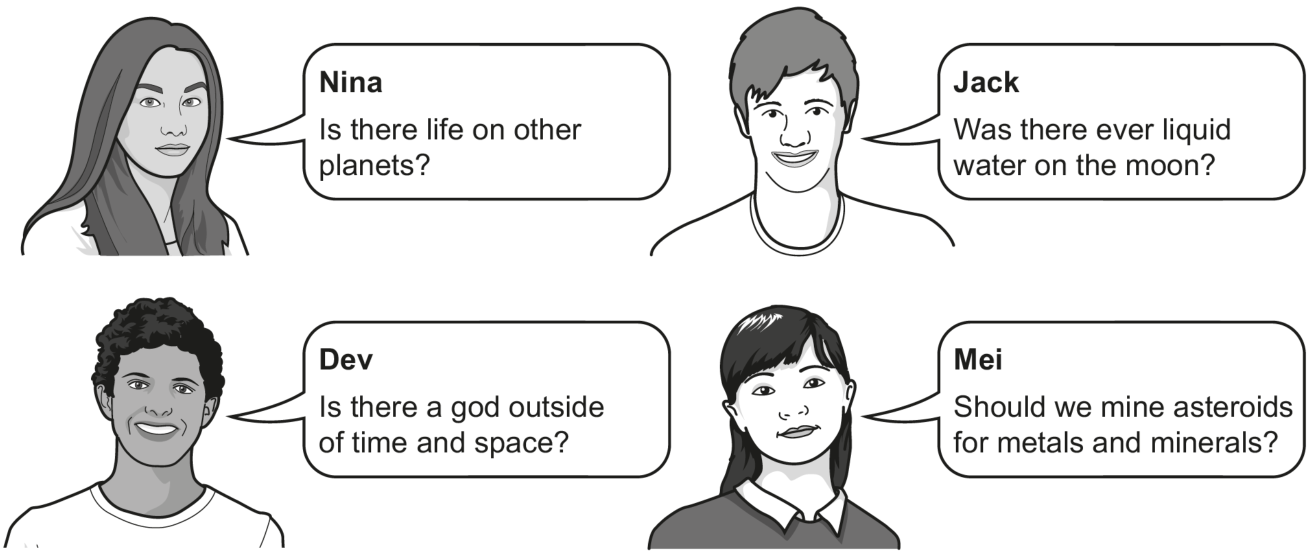
They have different numbers of protons. ☐

[1]

Many candidates incorrectly chose the different numbers of electrons, not appreciating that nuclei do not contain electrons, only neutrons and protons.

Question 9 (a) (i) and (ii)

9 (a) A group of students were asked to suggest questions that science cannot answer.



(i) Which **two** students are asking questions that scientific evidence can answer?

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

(ii) Which student is asking an ethical question? .... **[1]**

In part (i), most candidates got at least one of the correct names – either Nina or Jack, but many included Mei, which was the answer to part (ii).

Nina and Jack are asking factual questions which could be answered by collecting data from space probes, so they are the two question which can be answered using scientific evidence.

Mei is asking a question starting with 'should', so this means that there is some judgment to be made and some people may have different ideas about it, so this is the ethical question.

Question 9 (b)

(b) Evidence for the Big Bang is a topic that sparks religious and philosophical debate as well as scientific discussion.

One source of evidence for the Big Bang comes from the red shift of light from galaxies.

What causes red shift?

Tick (✓) **one** box.

The temperature of the stars in the galaxy ☐

The direction and speed a galaxy is moving as it emits light ☐

How massive the stars in a galaxy are ☐

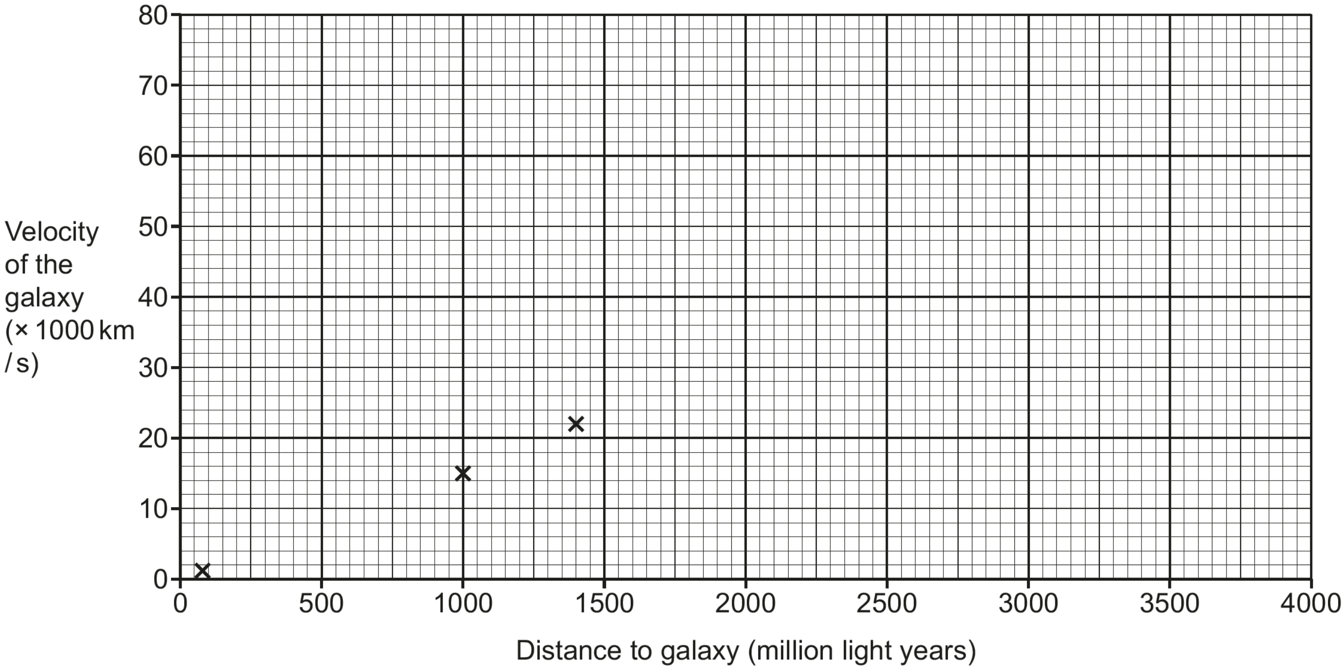
[1]

Many candidates got this question correct, with the most common incorrect response being the temperature of the stars in the galaxy.

Question 9 (c) (i)

(c) The table and the graph show some of the data that first supported the 'Big Bang' theory.

Distance to the galaxy (million light years)	Velocity of the galaxy (× 1000 km/s)
78	1.2
1000	15
1400	22
2500	**39**
3950	**61**



(i) Plot the results from the table on the graph. 3 points have already been plotted.

Include on your graph a line of best fit. **[2]**

Many candidates were able to correctly plot the points on the graph and draw an acceptable straight line. Some candidates mis-read the x-scale and plotted (3950, 61) one square to the left of the correct position.

Question 9 (c) (ii) and (iii)

(ii) What is the relationship between distance and velocity shown by the graph?

Tick (✓) **one** box.

Directly proportional ☐

Inversely proportional ☐

No correlation ☐

Non-linear ☐

[1]

(iii) Identify **two** features of the graph that show this relationship.

1. ....

2. ....

[2]

Although many candidates correctly stated that the graph showed that the relationship between the two variable was direct proportion, they were unable to identify the features of the graph which showed that this was the case. Many misinterpreted the question and just tried to describe the relationship, for example, as the distance increases the velocity increases. A few candidates did correctly state that direct proportion means that there was a straight line, but hardly any candidates said that it should go through the origin or (0,0).

Question 9 (c) (iv)

(iv) Describe the 'Big Bang' model.

....

....

....

.... **[2]**

Most candidates tried to explain the birth of the Solar System rather than the Big Bang in this question. The previous parts to the question were intended to guide candidates towards the idea of the expanding universe and that more distant galaxies are travelling away from each other with increasing speed. A few candidates did correctly explain this, and some did state that the Universe began at a single point.

Exemplar 2

it's the evolution of the universe from the earliest known periods. The universe began as just a single point a~~nd~~ then expanded and streched to grow as large as it is **[2]**
forming planets(Solar system)

This is a good response as the candidate has correctly said that the Universe began as a single point, as well as saying that the Universe then expanded. There is some mention about the Solar System, but the creation of the Solar System is a completely different process. This final statement does not contradict the correct statements about the Universe.

Question 10 (a)

10 The picture shows a child on a slide. The child's hair is standing on end due to static electricity.

(a) Suggest what has happened to cause the child's hair to stand on end.

....

....

....

.... **[2]**

Although many candidates did correctly state that friction was involved here, many of them indicated that the boy must have laid down whilst coming down the slide, so that his hair was in direct contact with the slide, and some candidates suggested that he had rubbed his hair on a balloon, and the static electricity was unrelated to the action on the slide. Some candidates did state that there was a transfer of charge, but very few explained that all the hairs would have the same charge and be repelling one another. Candidates often failed to use the correct terminology and talked about static energy.

Question 10 (b)

(b) Complete the sentence to explain static electricity.

Put a ring around the correct option.

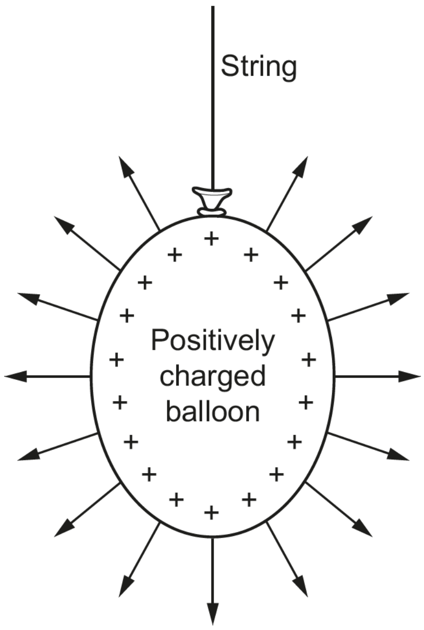
Static electricity is the **sharing** / **storing** / **transfer** of electrons between insulators. **[1]**

Many candidates correctly chose 'transfer' here. Similar numbers of candidates picked either of the other two responses.

Question 10 (c) (i) and (ii)

(c) The diagram shows a positively charged balloon, hanging freely from a string.

There is an electric field around the balloon, as shown by the arrows.



(i) Explain what the direction and spacing of the arrows mean about the electric field.

Direction of arrows ....

....

Spacing of arrows ....

....
[2]

(ii) A second balloon is brought close to this balloon and the two balloons repel one another.

State the type of charge on the second balloon.

.... **[1]**

Most candidates were unable to explain how the electric field around the balloon was represented in the diagram. Most responses were just a description of the diagram.

However, most candidates correctly stated that the charge on the second balloon was positive, because it was being repelled.

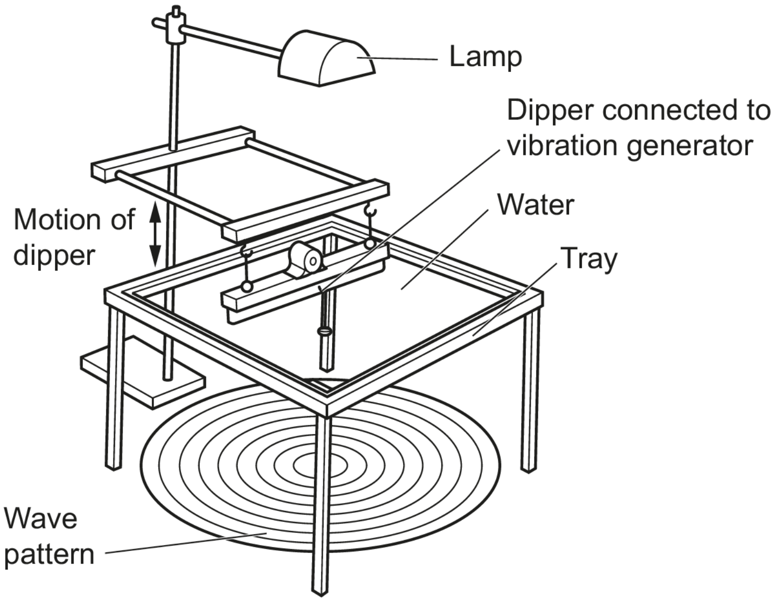
Assessment for learning

Candidates should learn how to explain the concept of an electric field, and how it helps to explain the phenomenon of static electricity.

Electric fields are regions of space surrounding any charged object. They are represented by 'field lines' which show the direction (with an arrow) of an electrostatic force on another positive charge. The spacing of the lines is used to represent the strength of the force acting – the closer together the lines, the larger the force.

Question 11 (a)

11 A student sets up a ripple tank, as shown in the diagram. The dipper dips up and down and sends circular water waves outwards.



(a) Which row gives the correct definitions of wavelength and frequency?

Tick (✓) **one** box.

Wavelength	**Frequency**	
The distance a wave travels in 1 second.	The number of waves in 1 second.	
The distance a wave travels in 1 second.	The time it takes for 1 wave to pass.	
The distance from peak to peak.	The number of waves in 1 second.	
The distance from peak to peak.	The time it takes for 1 wave to pass.	

[1]

There was a wide range of responses this question.

Question 11 (b) (i), (ii) and (iii)

(b) **(i)** The student takes a photograph of the wave pattern.

State **one** piece of equipment which needs to be included in the photograph to find the wavelength of the water waves.

.... **[1]**

(ii) The student then uses a smart phone to record a video of the movement of the water waves for a few seconds.

Describe how the student could use a video to find the frequency of the water waves.

....

....

....

.... **[2]**

(iii) How can the student now calculate the speed of the water waves?

....

.... **[1]**

These questions were structured to try to help the candidates explain how to use the apparatus to find the speed of the waves in the ripple tank, but many candidates did not follow the structure.

In part (i), there were a good number of correct responses of ruler or measuring tape, but many candidates just wrote down one of the labels from the diagram. For example, 'dipper connected to vibration generator' was a popular answer, showing that the candidates didn't really understand the question.

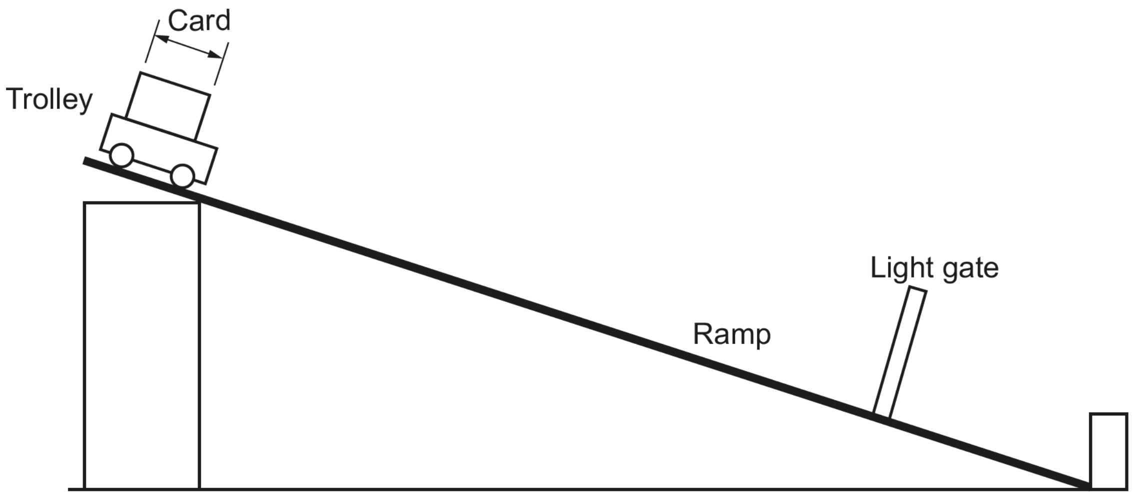
In part (ii), candidates were not precise enough, and often just referred to counting the waves without mentioning that they needed to find out the number of waves in a certain time period, nor that they could use the time on the phone or put a stopwatch into the video view. Some candidates completely misinterpreted this question and suggested that they should find the wave speed and then divide by the wavelength.

In part (iii), many candidates did suggest using the equation 'wave speed = wavelength × frequency', but some used 'speed = distance ÷ time', which is not appropriate here unless the distance is defined as the wavelength and the time as being the time period of the wave. Some candidates tried to describe the method for finding the frequency again here.

Question 12 (a)

12 **Fig. 12.1** shows a trolley at the top of a ramp.

Fig. 12.1



(a) The trolley is released and accelerates down the ramp. When the trolley passes through the light gate, the instantaneous speed of the trolley is displayed.

Describe how the acceleration of the trolley down the ramp can be calculated using one light gate and a stopclock.

$$\text{Acceleration} = \frac{\text{change in speed}}{\text{time taken}}$$

....

....

....

.... **[2]**

The subtlety of this question was lost on most candidates, who mostly just re-wrote the equation in their own words. What was needed here was a practical method for finding the two variables in the given equation. Some candidates just referred to using the stop watch to find the 'time taken' without specifying that the stopwatch should be started as the trolley set off, and that it should be stopped when it reached the light-gate. It was pleasing to see that some candidates did appreciate that as the trolley started with zero speed then the speed displayed by the light gate would be the 'change in speed'.

Exemplar 3

The trolley will accelerate from the top of the ramp and will pick up speed, tho it 'passes the light gate its change in speed will be shown out when the trolley finishes it can be divided by time taken. **[2]**

This candidate has clearly indicated that the speed shown on the light gate will actually be the 'change-in-speed' of the trolley. The candidate then suggests that this value is then divided by the 'time taken', but has not specified that the time for the trolley to travel from the top of the ramp to the light gate should be recorded using the stop clock.

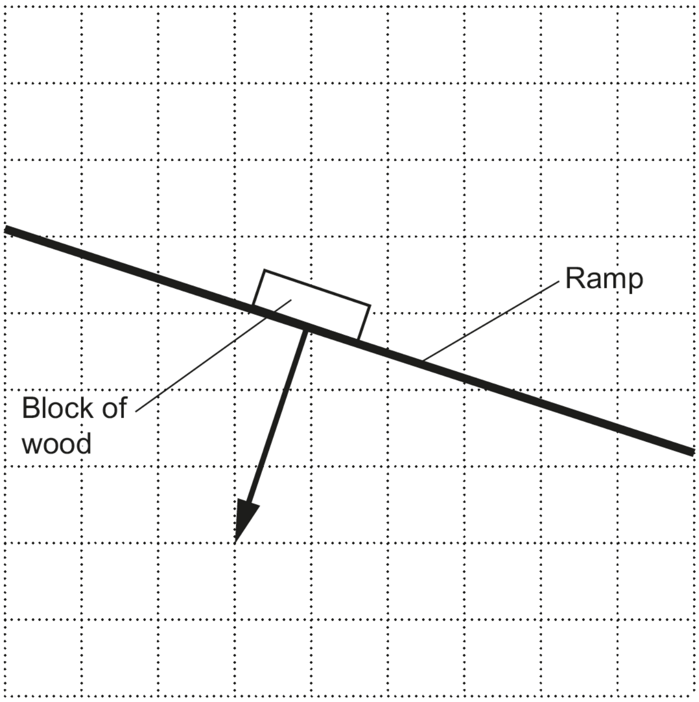
Question 12 (b)

(b) A block of wood is placed on the ramp. It exerts a force of 3.2 N on the ramp, perpendicular to the surface of the ramp. This is shown as a vector on **Fig. 12.2**.

Draw **one** vector on **Fig. 12.2** to show the force the ramp exerts on the block of wood, to complete the interaction pair.

Use a ruler.

Fig. 12.2

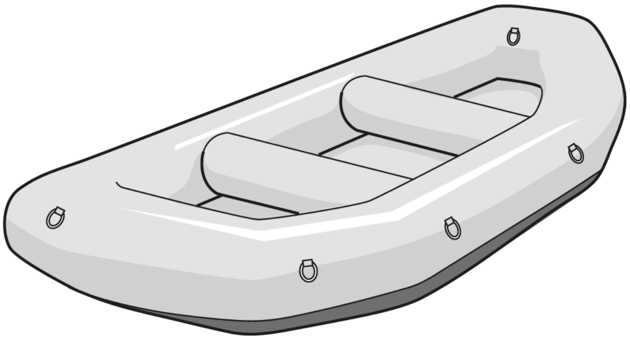


[1]

Most candidates were unable to answer this question. The force diagram was printed on squared paper to help candidates to be able to draw an arrow of equal length and in the opposite direction to the one printed. Some candidates did draw an arrow in the right direction, but it was not of the correct length. There were many responses with arrows or lines drawn in all sorts of directions.

Question 13 (a)

13 This question is about an inflatable boat.



(a) Boats float because they are less dense than water.

Define density.

....

.... **[1]**

There were several vague statements here about density being a measure of how compact molecules are together, or just saying that density was like weight. The equation to calculate density is given in the equation sheet, so some candidates may have found it there to help them answer this question correctly.

Question 13 (b)

(b) The boat is inflated in the morning and then left out in the sun. The temperature of the air inside the boat rises to 50 °C.

- The volume and mass of the air inside the inflated boat are constant.
- The table contains data about the average speed of air molecules at different temperatures and pressures.

Temperature (°C)	Average speed of air molecules (m/s)	Pressure (Pa)
20	508	115 000
40	525	122 000
60	542	129 000

Explain why the boat feels firmer after being left out in the Sun.

Use the data in the table. You do not need to do any calculations.

....

....

....

....

....

.... **[3]**

Many candidates correctly described that as the temperature of the boat increased whilst it was out in the sun, the speed of the molecules increased, and this lead to the pressure increasing. Some candidates did refer to the molecules colliding with the surface to create pressure, but did not go as far as saying that the molecules would collide more often, as they were moving faster.

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