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GCSE (9-1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE PHYSICS B

J259
For first teaching in 2016

J259/04 Summer 2019 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. 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 can be downloaded from OCR.

Paper 4 series overview

J259/04 Depth in Physics is one of the two examination components aimed at Higher Tier candidates studying GCSE (9-1) 21st Century Science Suite which assesses content across the teaching chapters P1 to P7 including assessment of P8 Practical Skills. Questions 1 to 3 are overlap questions with the Foundation paper. The examination assesses the three Assessment Objectives; AO1 demonstrating knowledge and understanding of scientific ideas, techniques and procedures, AO2 applying that knowledge to solve problems and AO3 analysing information, drawing conclusions and improving experimental procedures. The majority of the paper assesses candidate's demonstration and application of their knowledge with 20% of the paper assessing their ability to analyse, interpret and evaluate information. With all J259 examinations there is a requirement to assess mathematical skills which comprise of approximately 30% of the paper which include calculations and graphical interpretation. This paper includes two LOR Questions; 2 and 8 and a synoptic Question 5b where candidates are required to demonstrate and apply knowledge from the different teaching chapters in the specification.

Candidates who did well on this paper generally did the following:

- Recalled, rearranged and substituted numbers into equations with their working shown clearly.
- Recognised when units such as centimetres needed to be converted to metres for example.
- Made more than one point when following command words to describe and explain and when the number of marks indicate that a more developed answer is required.
- Described and evaluated information presented in charts and diagrams.
- Developed their reasoning or justifications with correct and suitable scientific terminology.

The most common misconception was the incorrect application of the relationship between pressure and volume.

There was no evidence that any candidates were disadvantaged by time constraints. Only a very small number of candidates achieved marks that indicated that the Foundation Tier examination would have been a more appropriate paper for them. By contrast, approximately 14% of the candidates scored 70 marks are more. Also, there was a broader spread of marks given which indicates the accessibility of the paper and also that candidates have been entered for the correct tier of entry.

Question 1 (a) (i)

1 This question is about gears and levers.

(a) A wristwatch with its back cover removed is shown in **Fig. 1.1**.

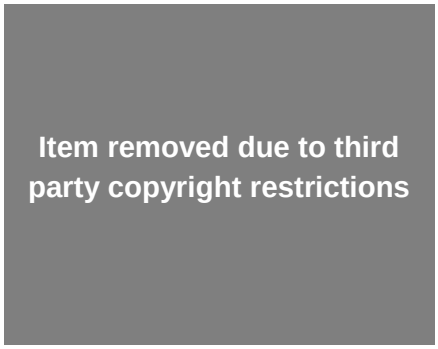


Fig. 1.1

You can see some of the gears inside the wristwatch.

Two gears **Q** and **R** are shown in **Fig. 1.2**.

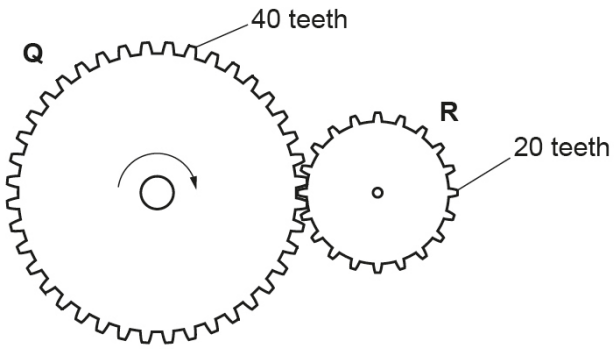


Fig. 1.2

The gear **Q** has 40 teeth and gear **R** has 20 teeth. Both gears have the same size teeth.

The gear **Q** moves in a clockwise direction.

Gear **Q** rotates at 6 revolutions per minute.

(i) On **Fig. 1.2**, show the direction of rotation of gear **R**. **[1]**

This question was answered well. About 10% of candidates made no response which might because candidates missed this part of the question as they needed to answer on the diagram above.

Question 1 (a) (ii)

(ii) How many revolutions are completed by gear **R** in one minute?

Number of revolutions = ... per minute **[2]**

This question was answered well with most candidates being given 1 mark for calculating the ratio of teeth (40/20) but some candidates were not given the second mark as they did not subsequently multiply the number of revolutions correctly.

Question 1 (b)

(b) The lid of a can of paint has a lip which makes it easier to open, using a lever.

The diagram below shows a screwdriver placed under the lip.

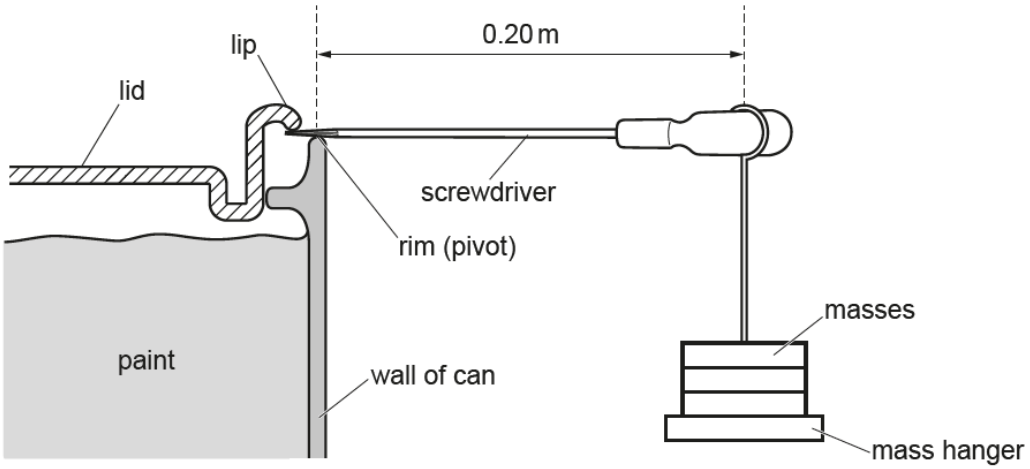


Fig. 1.3

In an experiment, masses are added to the mass hanger to open the lid.

The mass hanger hangs at a distance of 0.20 m from the rim (pivot) of the can.

A total weight of 32 N of the hanging masses opens the lid.

Calculate the moment of this force.

Moment = ... Nm **[3]**

This question was answered well with candidates correctly recalling and applying the moment of a force.

Question 2

2* Kai is doing experiments in the laboratory to determine the density of the two different liquids, **E** and **F**.

He uses a measuring cylinder placed on a balance.

He then pours different volumes of liquid **E** into the measuring cylinder, and records the balance reading, as shown in **Fig. 2.1**. The balance reading is equal to the total mass of the measuring cylinder and the liquid.

He then empties the measuring cylinder, and repeats the same procedure with liquid **F**.

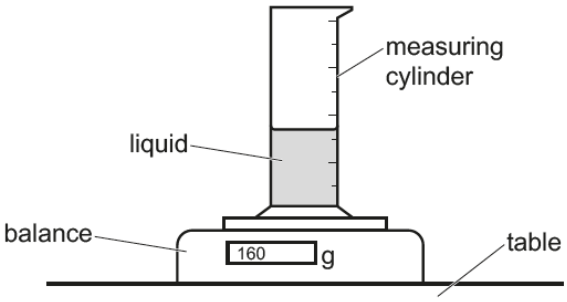


Fig. 2.1

Kai's results are shown in **Fig. 2.2**.

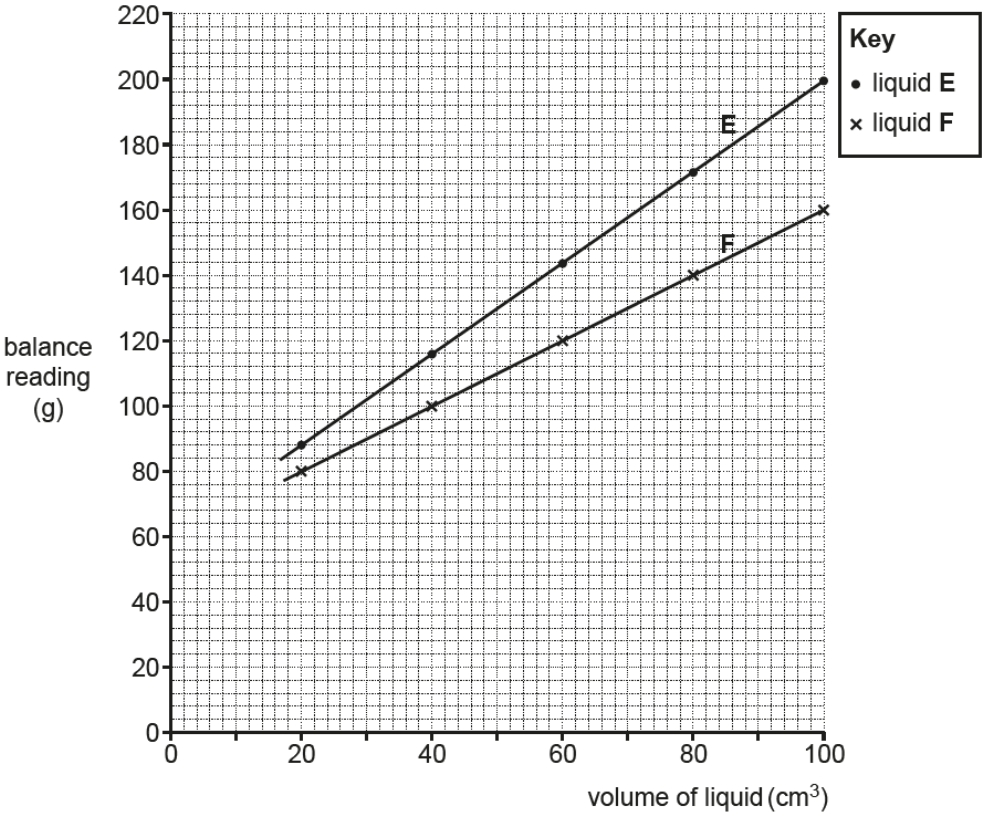


Fig. 2.2

Compare the density of the liquids **E** and **F**.

Your answer should include calculations and a detailed analysis of **Fig. 2.2**.

Use the equation: density = mass ÷ volume

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

Exemplar 1

In Fig 2.2, liquid E has a higher density because as the volume increases, it's mass is always larger that liquid F. As liquid E always has a higher mass (85-200) than liquid F. (80-160), the density must also be higher for liquid E compared to liquid F. For example, when both liquids E and F have a volume of 100 cm^3, E has a mass of 200g. This means it's density is 2 g/cm^3 whilst F's density is 1.6 **[6]** because it has a mass of 160g.

Exemplar 1 is an example of the most typical Level 2 response written by candidates where the density of both liquids is calculated using values from singular points on the graph. There is a comparison of the densities as they have interpreted that liquid E is denser than liquid F.

Exemplar 2

Use the equation: density = mass ÷ volume

density = mass / volume

Liquid E

200 − 60 = 140 g

x = 140 g / 100 cm³ = 1.4 g/cm³

Liquid F

160 − 60 = 100 g

x = 100 g / 100 cm³ = 1 g/cm³

Both the lines for liquid E and F meet at 60 g showing that the measuring cylinder has a mass of 60 g (subtract from readings to give mass of liquids as both weigh 60 g eventhough volume is 0 cm³)

Liquid E is denser than liquid F as it has a steeper gradient (grams per cm³ is density).

Liquid E has a density of 1.4 g/cm³ compared to 1 g/cm³ for liquid F.

Both lines show a positive correlation and show that volume is directly proportional to mass.

Density is the mass per unit volume so the gradient shows the density difference through the gradient of the lines and if more volume of liquid was added, it would increase at a constant rate. **[6]**

Exemplar 2 is an example of a Level 3 response from a higher ability candidate. The candidate has calculated the correct density for both liquids either from the gradient or subtracting the mass of the cylinder so has also interpreted and evaluated the graph.

Question 3 (a)

3 Lyla and Alex are investigating two identical light-dependent resistors (LDRs). A torch is used as a light source by Lyla, and Alex decides to use a table lamp.

Each light source is placed above the LDR.

The resistance of the LDR is determined for different numbers of identical sheets of tracing paper placed on the LDR, as shown in **Fig. 3.1**.

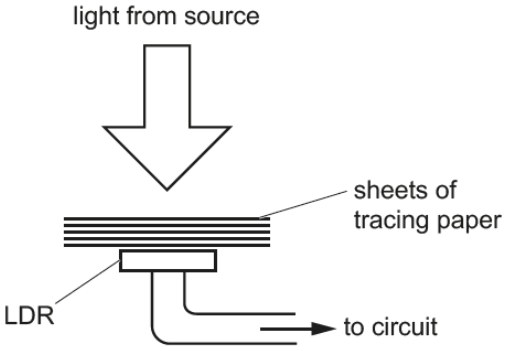


Fig. 3.1

Lyla's and Alex's results are shown in **Fig. 3.2**.

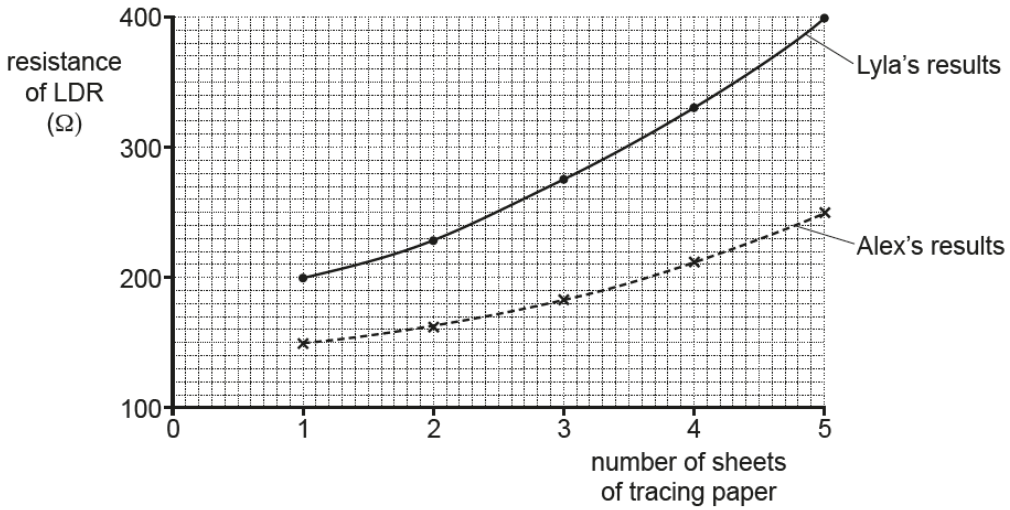


Fig. 3.2

(a) Use **Fig. 3.2** to explain how the **light intensity** affects the resistance of the LDR.

.....

.....

.....

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

The majority of candidates were given 1 mark for either an analysis or explanation of the graph i.e. more sheets of tracing paper increases the resistance of the LDR or as the light intensity increases the resistance decreases. There were a number of candidates that described the relationship as proportional i.e. as light intensity increased the resistance of the LDR increased. Also, some candidates compared the graph of Lyla's and Alex's results without linking to light intensity and/or resistance.

Question 3 (b)

(b) The LDR is connected to a cell, an **ammeter** and a **voltmeter**.

The meter readings from the ammeter and voltmeter are used to determine the resistance of the LDR.

Complete **Fig. 3.3** to show the likely circuit connected by Lyla and Alex.

[2]

Fig. 3.3

Approximately half of candidates were given 1 mark for correctly connecting the ammeter in the circuit diagram. Higher ability candidates were able to draw the voltmeter in parallel but a number of candidates were drawing the voltmeter in series. There were about 14% of candidates who made no response which may because they missed the stem of the question and continued to part (c).

	AfL **Answers on diagrams**	Candidates often miss parts of questions which require them to mark or annotate a diagram, rather than writing an answer in blank space. Encourage them to read the text for instructions rather than scanning for answer space to identify where there is a command word, such as complete or show, as in question 1(a)(i).

Question 3 (c) (ii)

(ii) Suggest **one** improvement that needs to be made to get identical results.

.....

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

Parts (c) i and ii were generally answered well with responses for both parts being identical i.e. light source or level of ambient light. Some candidates suggested that the equipment used to set up the circuit needed to be controlled to ensure identical results.

Question 4 (a) (i)

4 Marshmallows are spongy sweets that have tiny pockets of trapped air. Ling is using marshmallows to investigate the relationship between pressure and volume.

(a) Ling places a small marshmallow inside an air-filled plastic syringe. The open end of the syringe is blocked. The syringe has a millilitre (ml) scale.

The volume of the air inside the syringe is increased by moving the plunger to the left.

The temperature of the air inside the syringe remains constant.

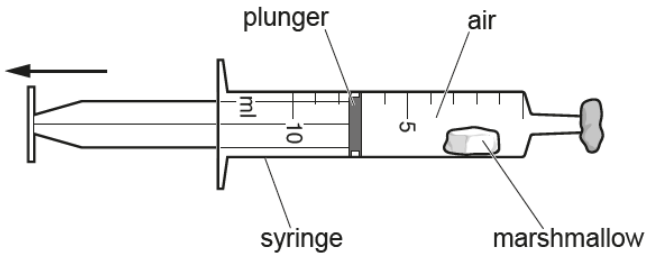


Fig. 4.1

(i) Explain why the marshmallow increases in size when the volume of air inside the syringe is increased.

.....

.....

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

Exemplar 3

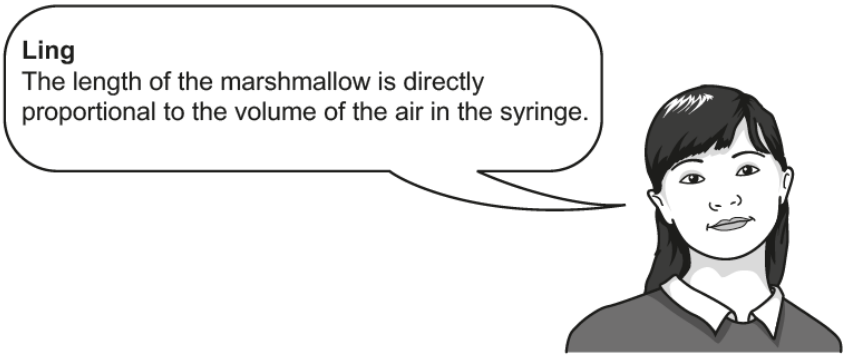
(i) Explain why the marshmallow increases in size when the volume of air inside the syringe is increased.

More air gets into the marshmallow so the volume increases. Therefore, size increases **[2]**

Exemplar 3 is a typical response from candidates as they explained the increase in size or expansion of the marshmallow due to air entering it from the syringe. As a result, some candidates concluded that the pressure was increasing and did not apply the relationship pressure x volume = constant. This question was not well answered as just under a third of candidates were given 1 mark for linking that the pressure was decreased due to increased volume of air in the syringe.

Question 4 (a) (ii)

(ii) Ling makes the following hypothesis.



Explain how Ling can take measurements, and analyse the data to check her hypothesis.

.....

.....

.....

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

Most candidates were given 1 mark usually for suggesting that repeat readings needed to be taken but this was not always well communicated. Also, candidates were not always clear on the measurements needed to be taken and would often confuse the volume of air with pressure. Very few candidates were given the third mark, even though they suggested plotting a graph they did not explain the graphical or proportional relationship between length and volume.

Question 4 (b)

(b) Ling has a large fish tank.

Bubbles of air rise through the water from the bottom of the tank, as shown in **Fig. 4.2**.

The volume of a bubble of air **increases** as it rises to the surface of the water.

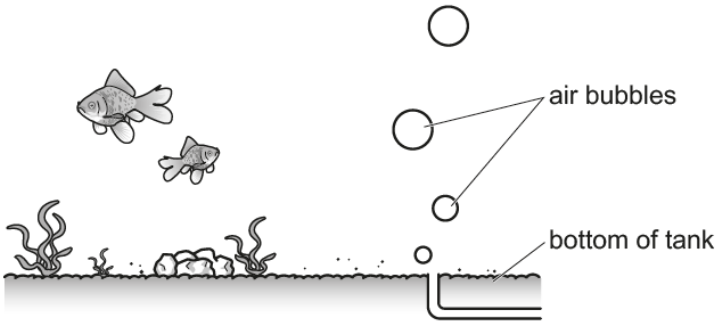


Fig. 4.2

Ling has the following information about an air bubble.

	Volume of air bubble (mm^3)	**Pressure of air inside air bubble (Pa)**
Air bubble at surface	8.8	100 000
Air bubble at bottom of tank		110 000

Calculate the volume, in mm^3, of the air bubble at the bottom of the tank.

Volume = ... mm^3 **[3]**

Higher ability candidates applied the relationship pressure x volume = constant to calculate the correct volume of air. A lot of candidates confused the relationship to calculate the volume of air as 9.68mm^3 by applying the ratio of pressure and volume incorrectly.

Question 5 (a)

5 Ultrasound is used in hospitals to image the inside of our bodies.

Fig. 5.1 shows an ultrasound wave travelling from air into the patient's skin.

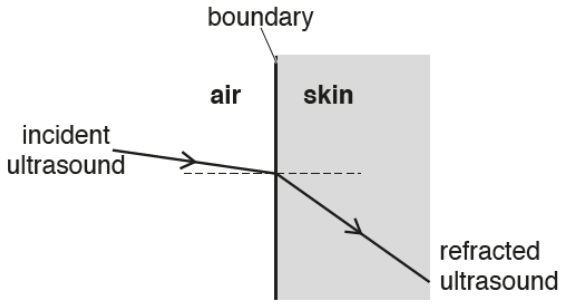


Fig. 5.1

The ultrasound wave is **refracted** at the air-skin boundary.

(a) Describe what happens to the **speed**, **frequency** and **wavelength** of the ultrasound wave as it travels from air to skin.

Speed: .....

Frequency: .....

Wavelength: .....

[3]

The question was generally not answered well as about half of candidates were given 1 mark. Many candidates applied their knowledge of light refracting in a denser medium rather than sound and as a result described the speed as decreasing. Also, many did not apply the wave speed equation and recognise that the frequency did not change.

Question 5 (b)

(b) **Fig. 5.2** is a diagram of a human eye. Ultrasound can be used to determine the length of an eyeball.

Pulses of ultrasound are sent into the eye.

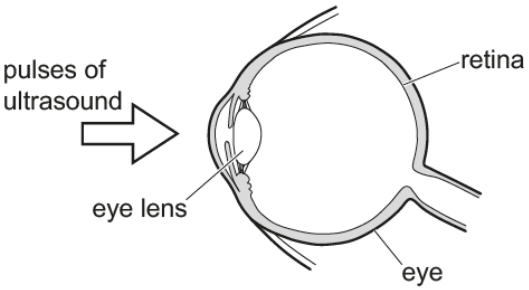


Fig. 5.2

The ultrasound pulse is **reflected** at the retina.

It takes 4.0×10^{-5} s for an ultrasound pulse to travel from the front of the eye, to the retina, and then back to the front of the eye.

The speed of the ultrasound pulse in the eye is 1100 m/s.

Calculate the length of the eyeball in metres.

Length of eyeball = ... m **[4]**

The majority of candidates were given 3 marks for a calculated length of 0.044m. Candidates were not given the 4th mark because they did not divide this value by 2 allowing for the journey to and from the retina in order to obtain the correct length of eyeball.

Question 5 (c)

(c) **Fig. 5.3** shows the ultrasound pulses that were sent into the eye, as described in part **(b)**.

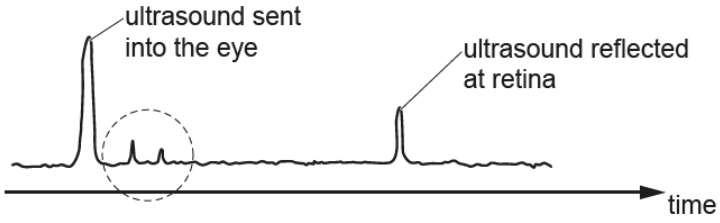


Fig. 5.3

Suggest an explanation for the other two pulses ringed in the diagram.

.....

.....

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

The majority of candidates were given 1 mark for suggesting that the ultrasound was passing through the eye lens but did not explain that the pulses were due to reflection. Some candidates suggested that the pulses were due to the ultrasound being refracted, suggesting that candidates were confusing the behaviour of light and sound passing through different media.

?	**Misconception** **Confusing sound and light**	The challenge here is to identify that light, as an electromagnetic radiation, has specific properties which are distinct from those of sound. Light travels at a lower speed in denser materials. In the context of medical ultrasound, the wave travels faster in the body than the air.

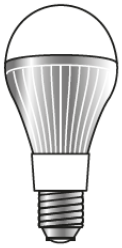
Question 6 (a)

6 Kareem is researching replacement bulbs for his grandad.

He finds three types of bulbs – incandescent, compact fluorescent light (CFL) and light-emitting diode (LED).

incandescent

CFL



LED

Table 6.1 shows some information on these bulbs.

	Incandescent	**CFL**	**LED**
Power (W)	60	12	8
Life span (hours)	2000	10 000	50 000
CO_2 emissions at power station in 50 000 hours (kg)	1600	330	220

Table 6.1

The three bulbs in **Table 6.1** have the **same** brightness.

(a) Kareem makes the following comment about the information in **Table 6.1** to his grandad.

Is Kareem correct?

Yes ☐

No ☐

Give **two** reasons for your answer.

1. .....

.....

2. .....

.....

[2]

Most candidates were given 1 mark for using information from the table to give an environmental reason for LED bulbs (amount of CO_2 emissions). Many candidates also tried to suggest the life span for either an environmental or efficiency reason but without detailing the reason i.e. environmental – changed less often/less waste or efficiency – more energy supplied over its lifetime. Some higher ability candidates attempted to apply E = P x t to calculate the total energy supplied for each bulb to make a comparison in supporting Kareem's statement for LED bulbs.

Question 6 (b)

(b) Calculate the number of **incandescent** bulbs that would be required to do the same job as a single LED bulb, in 50 000 hours.

Use information from **Table 6.1**.

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

This question was generally answered well with candidates correctly calculating the number of incandescent bulbs but some candidates applied different values taken from information in Table 6.1 and were not given any marks.

Question 6 (c)

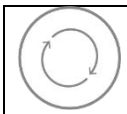
(c) Calculate the total cost, in pence, of using one **LED bulb** for its lifetime.

The cost of one kWh of energy is 13 p.

Use information from **Table 6.1**.

Total cost = ... pence **[4]**

The majority of candidates correctly calculated the total cost and those candidates given 3 marks were for an incorrect or no conversion of the power in W to kW. Some candidates who were given 1 or 2 marks for attempting a calculation for E = P x t or a cost calculation with an incorrect calculated energy in kWh. Some candidates converted the cost to £'s but did not give the correct unit.

	**AfL** **Show your working**	Here, as well as question 6(c) there were marks available for "wrong" answers where the correct working was shown for part of the question, or where incorrect data was used.

Question 7 (a) (i)

7 Eve is investigating the force on a current-carrying wire when it is placed in a magnetic field, as shown in **Fig. 7.1**.

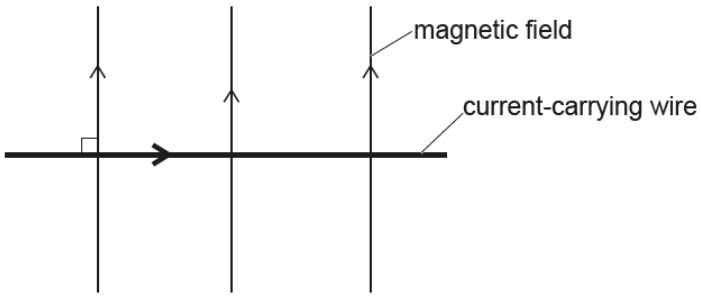


Fig. 7.1

The direction of the current in the wire is from left to right.

The magnetic field of the magnet is in the plane of the paper and perpendicular to the current-carrying wire.

The current-carrying wire moves.

(a) (i) Use Fleming's left-hand rule to predict the **direction** in which the **wire** moves.

Tick (✓) **one** box.

- Up along the plane of the paper. ☐
- Down along the plane of the paper. ☐
- Out of plane of paper. ☐
- Into the plane of paper. ☐

[1]

The majority of candidates identified the correct direction of movement.

Question 7 (a) (ii)

(ii) Describe how you used Fleming's left-hand rule to find the direction in which the wire moves.

.....

.....

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

The majority of candidates did not score well on this question as they would often confuse and attribute the incorrect finger to the direction of force, magnetic field and current.

Question 7 (b)

(b) Explain **why** the current-carrying wire moves.

Use ideas about magnetic fields in your answer.

.....

.....

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

This question was not well answered as the majority of candidates were not given a mark. Candidates would give some explanation that a force was acting on the wire but not as a result of the motor effect. Only a few candidates used ideas about magnetic fields around a current-carrying wire.

?	**Misconception**	Field theory has its own misconceptions, and the motor effect relies on the interaction of two fields. One common misconception in such questions is to introduce the notion of electric charge and to consider attraction and repulsion, rather than interaction of magnetic fields.

Question 7 (c)

(c) The current in the wire is 2.0 A. The magnetic flux density is 0.060 T.

Calculate the force acting on the 4.5 cm length of the wire.

Force = ... N **[4]**

This question was answered well with the majority of candidates being given 3 marks for a force of 0.54N due to not converting the length from cm to m.

Question 7 (d)

(d) Explain what happens to the size of the force in **(c)** when the current in the wire is doubled.

.....

.....

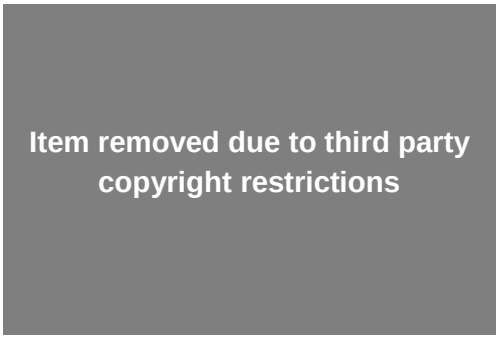
..... **[2]**

Most candidates were given 1 mark for describing that the force of the wire also doubled and some higher ability candidates were able to explain the relationship in terms of current and force being proportional.

Question 8

8* Electrical energy is transported across the country using the National Grid.

Transformers play a key role in this transportation.



Describe and explain the role of **transformers** in the transmission of electrical power from power stations to our homes.

You may include a labelled diagram of a transformer.

.....

.....

.....

.....

.....

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

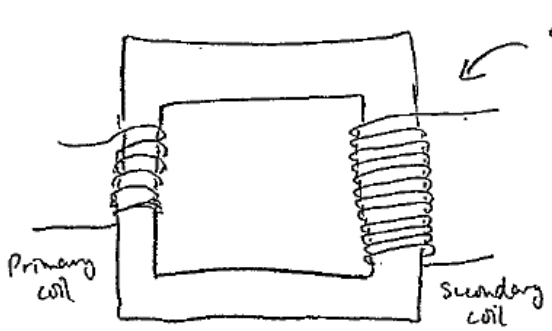
Exemplar 4

The National Grid is a web of wires and transformers that provide local areas with power. There are two types of transformers used; a step up and step down transformer. Step up transformers increase the voltage to reduce the current and the amount of energy lost to heat while travelling thrayn the wires. The step down transformer then reduces the voltage back down to a safe amount - 230V - and the electrical power is then ~~tran~~ transferred to our homes.

Exemplar 4 is an example of a typical response from candidates as most responses were given Level 1 or lower Level 2. In this typical response candidates describe the role of step-up and step-down transformer in efficient electrical power transmission in the National Grid. If the candidates had drawn a labelled diagram of a step-up and step-down transformer including the number of coils and iron core it would have support their written description. There were a lot of responses where candidates confused voltage, current, power and resistance as they would state that the power or resistance was increased or decreased. There were very few who realised that the power is the same by applying the relationship power = voltage x current.

Exemplar 5

You may include a labelled diagram of a transformer.



Step- up transformer (more turns in secondary coil than in primary coil) = increases voltage.

Electricity needs to travel long distances from the power stations to our homes and they carry a lot of electricity. Transformers help transmit electricity efficiently. ~~So~~ After the power station, there is a step- up transformer (more ~~coils~~ turns in secondary coil) which increases the voltage which leads to a decreased current (since power = voltage x current) but the power remains the same. This ~~decreases~~ decreases energy wasted as a high current leads to heating up the wires (so energy is dissipated as heat). The electricity is transmitted at an extremely high voltage (400,000V) until it comes near to homes where a step-down ~~tra~~ transformer decreases voltage and increases current (more turns in primary coil) to make it safe for us to use in our homes / electrical appliances. **[6]**

Exemplar 5 is an example of Level 3 response as all aspects of electrical energy transmission have been described and explained in terms of step and step-down transformers, power, voltage and current. Only about 10% of candidates were given Level 3 marks of 5 or 6. Some higher ability candidates also explained how transformers worked in terms of electromagnetic induction.

Question 9 (a)

9 Astronomers use telescopes in space to observe the Universe.

(a) The Kepler telescope has been used to detect planets around distant stars.

It orbits around the Sun in a circular orbit, as shown in **Fig. 9.1**.

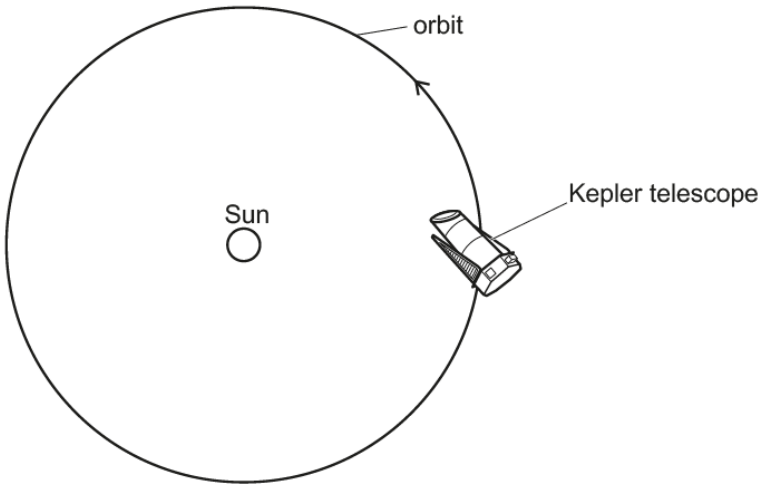
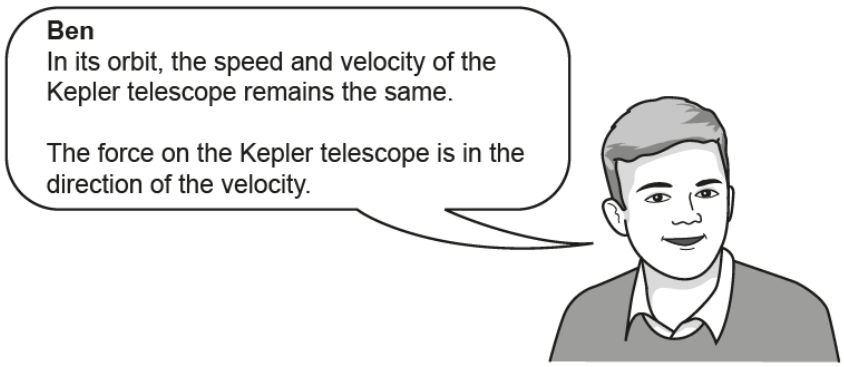


Fig. 9.1

Ben makes the following comment.



Is Ben correct?

Explain your answer.

.....

.....

.....

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

In general, this question was not answered well with approximately 40% of candidates being given 1 mark which was mostly for describing that the velocity was changing due to changing direction. Higher ability candidates were able to correctly discuss and explain the direction of the force for a circular orbit but the majority of candidates did not address this part of Ben's statement.

Question 9 (b) (i)

(b) The Hubble Space Telescope discovered the Baby Boom Galaxy, where one star is formed every two hours.

(i) Explain how a star is initially formed.

Use ideas from the particle model in your answer.

.....

.....

.....

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

Even though most of candidates' answers were well reasoned in describing matter coming together, they did not explain that matter was coming together due to gravitational forces. Also, some candidates would describe how pressure increased with more matter but did not link it to temperature and nuclear fusion to be given the second mark. Some candidates would describe the formation of stars as a chemical reaction and specifically as an explosion.

Question 9 (b) (ii)

(ii) Explain the evidence for the 'Big Bang' model of the Universe.

.....

.....

.....

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

Most candidates were given 1 mark with nearly 40% of candidates being given 2 marks. Most candidates were credited for interpreting the evidence of the 'Big Bang' model as the Universe expanding which was a more simplistic answer than describing the red shift of distant galaxies.

Question 9 (c)

(c) The Hubble Space Telescope was launched from the surface of the Earth using a reusable rocket (Space Shuttle).

Fig. 9.2 shows the typical forces acting on a rocket during lift-off.

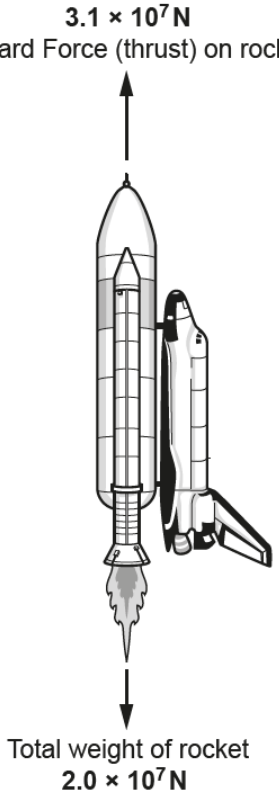


Fig. 9.2

The total mass of the rocket is 2.0×10^6 kg.

Calculate the acceleration of the rocket during lift-off.

Acceleration = ... m/s^2 **[4]**

Higher ability candidates performed well on this question as nearly 40% of candidates gained 4 marks for correctly calculating the resultant force acting on the rocket and then recalling and applying F=ma. Other candidates who recalled and rearranged the formula but did not calculate the resultant force were credited for a correct calculation of acceleration from an incorrect resultant force.

Question 10 (a) (i)

10 A delivery company uses GPS tracker devices to monitor the velocity of their vans.

(a) The velocity against time graph of one van is shown in **Fig. 10.1**.

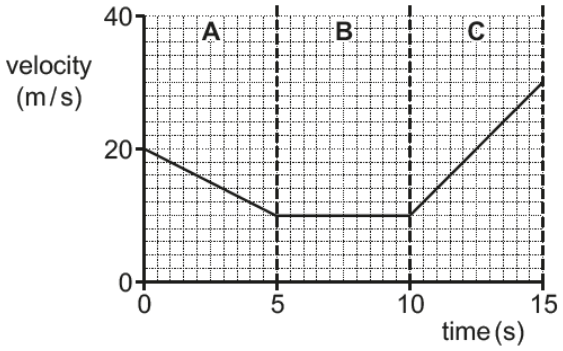


Fig. 10.1

Fig. 10.1 has been divided into three sections **A**, **B** and **C**.

(i) Describe the motion of the van in the three sections.

Section **A**: .....

Section **B**: .....

Section **C**: .....

[3]

This question was answered well as the majority of candidates described the motion of the three sections. Some candidates were not specific in their descriptions and for example described the motion of Section B as constant without referring to speed or velocity.

Question 10 (a) (ii)

(ii) Calculate the acceleration of the van in section **C**.

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

This question was answered well as the majority of candidates calculated the acceleration from gradient values taken from Section C.

Question 10 (b) (i)

(b) One of the vans collides with a **stationary** car.

(i) **Fig. 10.2** shows the momentum against time graph for the **van**.

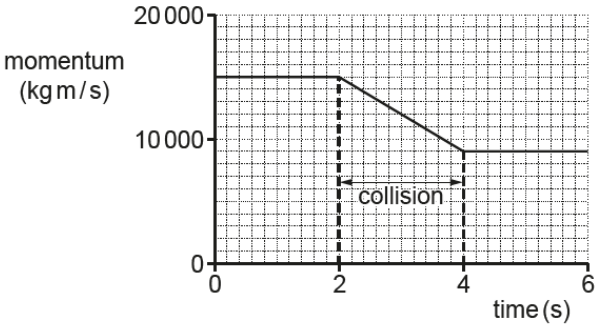


Fig. 10.2

Use **Fig. 10.2** to explain why the momentum of the **car** is **6000 kg m/s** immediately after the collision.

.....

.....

.....

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

This question was not well answered as about a half of candidates were not given a mark Most candidates did not use values from the graph to show that the momentum of the van was 6000 kg m/s (15000 – 9000) and that this was transferred to the car during the collision. There were a number of candidates who confused momentum and energy transfer.

Question 10 (b) (ii)

The mass of the van is 1500 kg and the mass of the car is 1000 kg.

(ii) Calculate the speed of the car immediately after the collision.

Use the information given in **(b)(i)** to help you answer the question.

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

Higher ability candidates performed well on this question as the recalled and rearranged the formula velocity = momentum / mass using the correct values from the graph.

Question 11 (a)

11 A patient has been diagnosed with a very small cancerous growth on her neck.

A doctor gives the patient a leaflet with information on two possible treatments for her cancer: X-ray radiotherapy and brachytherapy. The information is shown in the table.

	Radiotherapy	Brachytherapy
How are the cancerous cells killed off?	An external beam of X-rays (or gamma rays) is used.	Beta-radiation from material placed in the body is used.
How long does the treatment take?	1 to 2 weeks	6 weeks
Are living cells damaged?	Yes	Yes

(a) The patient and her doctor decide to treat the cancer with **radiotherapy**.

Why did they decide to treat the cancer with radiotherapy?

Use information from the table in your answer.

.....

.....

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

Most candidates were given 1 mark for discussing the benefits of the shorter treatment/exposure time with radiotherapy. The second mark was not well answered as even though candidates recognised the different methods of treatment, they did not explain in detail the effects of this in terms of irradiation and contamination.

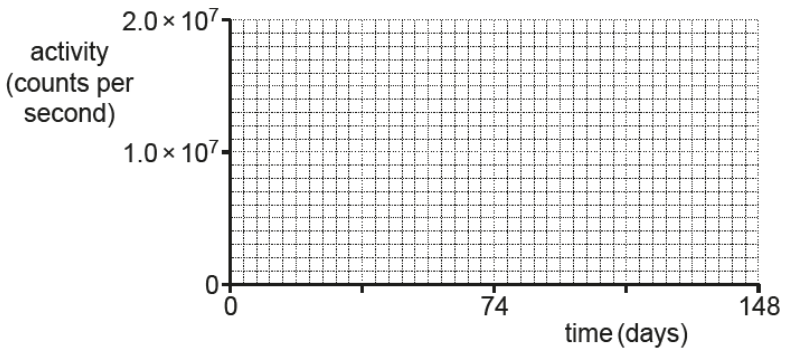
Question 11 (b) (i)

(b) Radioactive iridium-192 is used for the **brachytherapy** treatment.

The half-life of iridium-192 is 74 days.

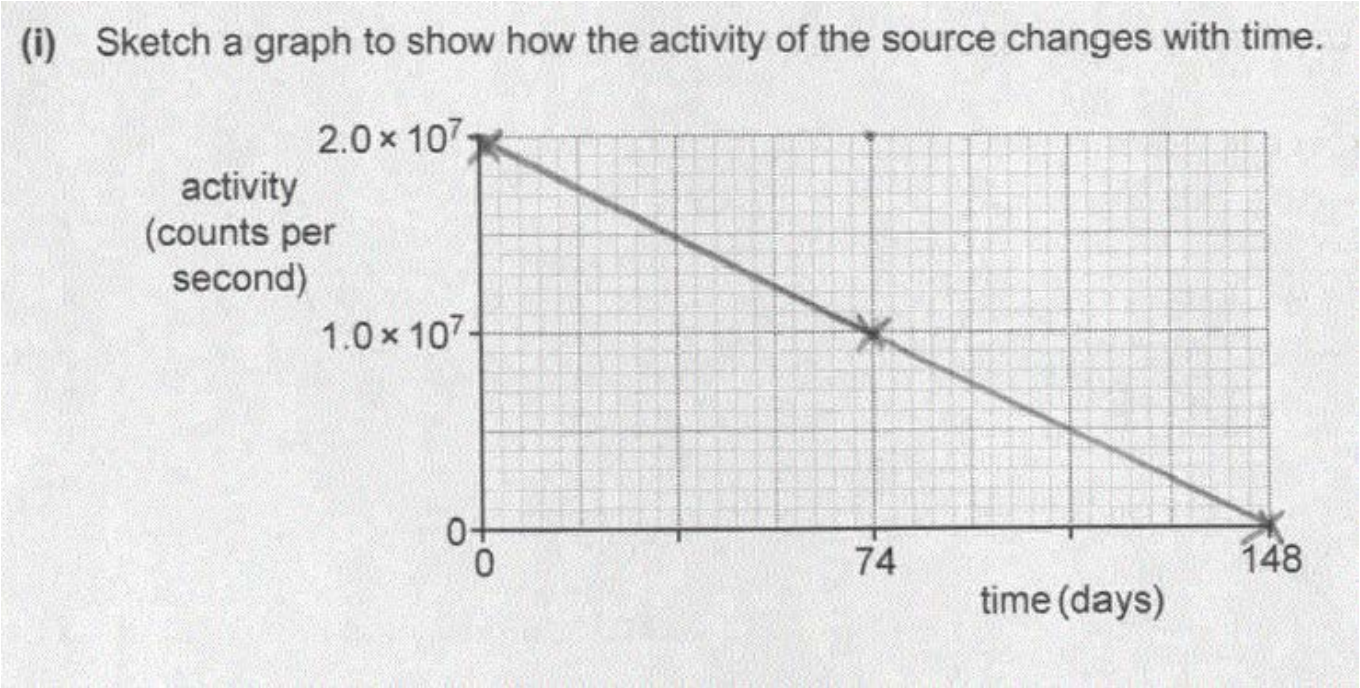
The initial activity of the iridium source is 2.0×10^7 counts per second.

(i) Sketch a graph to show how the activity of the source changes with time.



[3]

Exemplar 6



Exemplar 6 shows a typical response from candidates with most being given 1 mark for correctly plotting the activity at 0 days but drawing a straight line to 0 counts per second at 148 days. Approximately half of candidates correctly plotted the half-life of 0.5 x 10^{-7} (counts per second) at 148 days but did not draw a half-life curve and instead drew a straight line connecting the three plotted points.

Question 11 (b) (ii)

(ii) The initial activity of another iridium-192 source is **different** from **(b)(i)**.

What fraction of the iridium nuclei are left in the new source after **3** half-lives?

Fraction = ... **[3]**

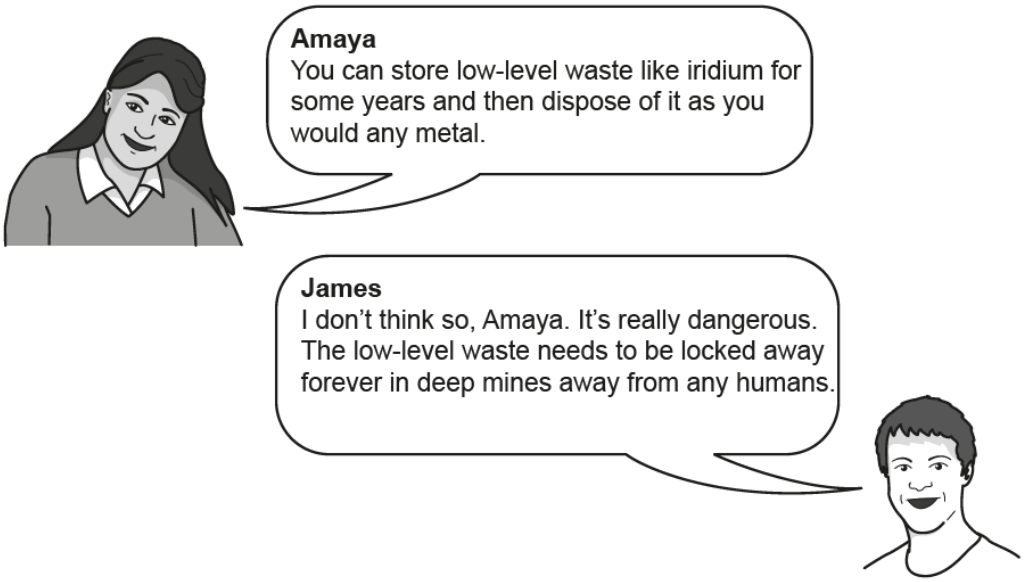
This question was generally answered well with most candidates expressing the bald fraction of nuclei left after 3 half-lives. Some candidates demonstrated that they understood the concept of half-life calculation but halved the number of days rather than the activity.

Question 11 (c)

(c) Iridium-192 is a low-level waste product of fission reactions in a nuclear power station.

Low-level wastes, such as Iridium-192, have short half-lives.

Amaya and James are discussing what should happen with low-level wastes like iridium.



Who do you agree with? Justify your answer.

.....

.....

.....

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

This question was not well answered as only approximately 50% of candidates were given a mark. The majority of candidates either recognised that a short half-life meant that Iridium-192 could be disposed of after a period of time but without referring to decreased activity or they agreed with James by arguing that all waste is dangerous so needs to be stored.

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