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GCSE (9-1)

Examiners' report

GATEWAY SCIENCE COMBINED SCIENCE A

J250
For first teaching in 2016

J250/06 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 6 series overview

J250/06 is the second physics foundation tier paper in the Gateway GCSE Combined Science suite. It assesses content from specification topics P4-P6. It also assumes knowledge of the topics in B1-B3. To perform well on this paper, candidates need to have a sound knowledge of the theory covered in topics P4-P6 and be able to apply this to novel situations. They also need to apply the skills and understanding that they have developed in the practical activities covered in topic CS7. This paper also contains questions that have elements of synopticity, drawing on material covered by topics P1-P3. There are also questions that involve the examination of key mathematical requirements from Appendix 5f of the specification.

Candidate performance

Candidates who did well on this paper had a good background knowledge and generally did the following:

- Performed calculations involving substituting into equations including conversion of units: Q3, Q6, Q7, and Q15(b)
- Interpreted correctly: information from tables, graphs, Q12(c) and diagrams Q13(d)
- Demonstrated a good knowledge identifying types of radiation Q13(b)
- Applied their knowledge of physics concepts to novel situations: Q4, Q9 Q14(b)

Candidates who did less well generally lacked basic understanding of physics concepts. This led to many candidates giving a no response to questions that required this background knowledge (AO1 and AO3) whereas they made good attempts at manipulating given data (AO2).

They generally did the following

- Found multi-choice questions that depended on prior knowledge difficult, e.g. Q1, Q2, And Q4
- Did not know the method for comparing different types of radioactive sources Q13(b)(ii)
- Could not complete a decay equation Q13(b)(ii)
- Did not know the parts of spectrum Q11(a) and why sound isn't part of it Q11(b)
- Had little knowledge of electrical safety Q14(b)
- Showed little understanding of energy stores or energy dissipation Q12(d) and Q14 (a)(ii)

Section A overview

This section consisted of ten multiple choice questions. Virtually all candidates attempted these questions. Questions 3, 6 7, 8 and 10 were generally well answered and tended to be questions using mathematical skills. Questions 1, 2, 4 and 9 which required background knowledge (AO1) were not so well answered.

Question 1

1 Which statement describes what human eyes can detect?

A Limited range of electromagnetic waves.

B Limited range of sound waves.

C Wide range of electromagnetic waves.

D Wide range of sound waves.

Your answer ☐ **[1]**

Candidates had difficulty deciding between the correct response A, and C which was incorrect

Question 2

2 Which of the following factors affects thinking distance **and** braking distance for a car?

A Tiredness of the driver.

B Worn out brakes.

C Worn out tyres.

D The speed of the car.

Your answer ☐ **[1]**

Only a minority of candidates selected the correct response D, A was the most common distractor

Question 3

3 A student completes four calculations for work done.

Which row of the table is correct?

Use the equation: work done = force × distance

	Force (N)	Distance (m)	Work done (J)
A	100	2	200
B	100	3	33
C	200	2	100
D	200	3	467

Your answer ☐ **[1]**

Most candidates answered this question correctly.

Question 4

4 Which statement is correct?

A Changes in atoms and nuclei can generate radiations over a wide range of frequencies.

B Changes in atoms and nuclei can generate radiations over a narrow range of frequencies.

C Changes in atoms and nuclei do not generate radiations.

D Changes in atoms and nuclei always generate radio waves.

Your answer ☐ **[1]**

This question was not well answered with all distractors equally likely to be seen.

Question 5

5 What is the typical value for a human reaction time to a stimulus?

A 0.02 s

B 0.2 s

C 0.8 s

D 1.2 s

Your answer ☐ **[1]**

A reasonably well answered question, D was a common wrong answer.

Question 6

6 A 30 kW boiler is used for 4 hours.

Calculate the energy transferred.

Use the equation: energy transferred = power × time

A 7.5 kWh

B 120 kWh

C 7500 kWh

D 120 000 kWh

Your answer ☐ **[1]**

Candidates generally answered this question correctly

Question 7

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

Calculate the thermal energy needed to melt 2.0 kg of ice.

A 167 J

B 668 J

C 167 000 J

D 668 000 J

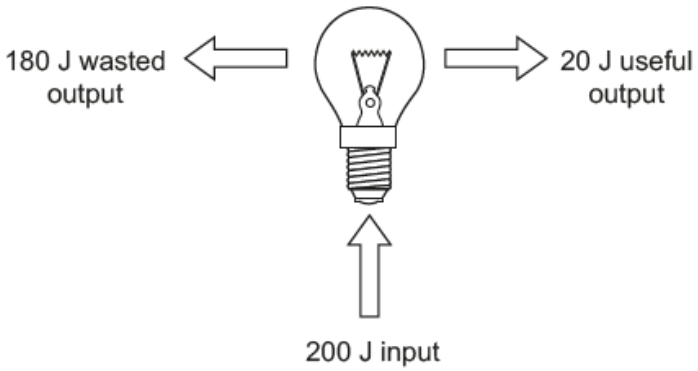
Your answer ☐ **[1]**

This question was generally answered correctly. C was the most common incorrect option.

Question 8

8 Calculate the efficiency of this light bulb.

Use the equation: efficiency = useful output energy transfer ÷ input energy transfer



A 0.1

B 0.8

C 0.9

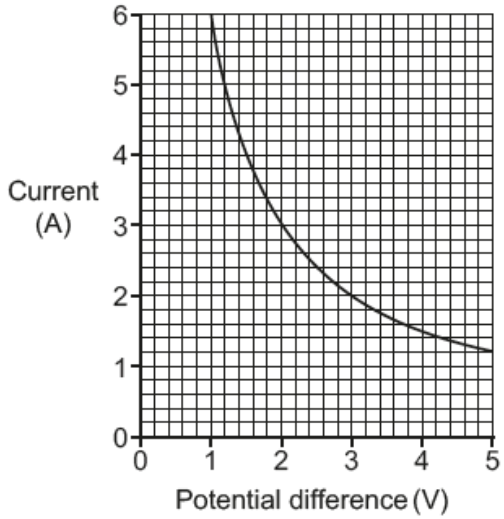
D 1.0

Your answer ☐ **[1]**

Most candidates correctly answered this question.

Question 9

9 This graph shows current and potential difference for the secondary coil of a transformer.



What happens to current as potential difference **doubles**?

A It doubles

B It halves

C It stays the same

D It triples

Your answer ☐ **[1]**

Candidates answered this question reasonably well. A and C were the most common incorrect responses

Question 10

10 An astronaut lifts a 0.25 kg hammer 1.0 m above the surface of the Moon.

The gravitational field strength on the Moon is 1.6 N/kg.

Calculate the potential energy stored.

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

A 0.16 J

B 0.40 J

C 6.40 J

D 400 J

Your answer ☐ **[1]**

The candidates mostly answered this question correctly

Section B overview

The questions in this section where mostly short structured questions or calculations. There was one 6-mark level of response question.

Question 11 (a)

11 Electromagnetic waves are usually divided into seven different groups.

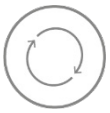
(a) This diagram of the electromagnetic spectrum is incomplete.

Complete the diagram by adding the missing parts of the electromagnetic spectrum.

	microwaves	infra-red	visible light		X-rays	gamma rays

[1]

This question had a surprising number of 'no responses' and many candidates leaving one blank cell also lost the mark. Incorrect answers commonly included sound/ultrasound or alpha/beta

	**AfL**	Candidates often miss parts of questions which require them to mark or annotate a diagram, rather than writing an answer in blank space. Encourage candidates 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.

Question 11 (b)

(b) Sound is **not** part of the electromagnetic spectrum.

Explain why.

.....

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

Very few candidates understood the difference between sound and waves in the electromagnetic spectrum. It was common for candidates to state the wording of the question 'Sound waves are not electromagnetic', or that 'sound cannot be seen'. The most frequent correct response seen was that sound is a longitudinal wave.

Question 11 (c) (i)

(c) All waves have a **frequency.**

(i) Which part of the electromagnetic spectrum has the **highest** frequency?

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

Candidates generally answered this question correct. A common error was to response 'the right side'

Question 11 (c) (ii)

(ii) What happens to the wavelength of an electromagnetic wave as the frequency increases?

Tick (✓) **one** box.

Decreases ☐

Increases ☐

Stays the same ☐

[1]

The majority of candidates answered this question correctly.

Question 11 (d)

(d) Describe how X-rays and gamma rays can damage humans.

.....

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

Candidates generally answered this question well and the majority understood the risks of these ionising radiations. Causing cancer was the most commonly seen marking point. Some candidates, like in **Exemplar 1**, had the correct general idea but did not use exact enough language to score the mark.

Exemplar 1

Because they can travel through the body and interfear with the cells

Question 12 (a)

12 A student investigates the stopping distance of a toy car.
He looks for a relationship between angle of slope and stopping distance as shown in **Fig. 12.1**.

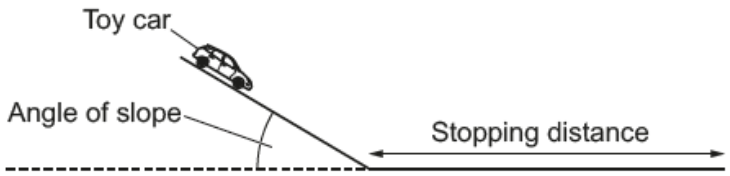


Fig. 12.1

(a) Complete **Table 12.1** to show the apparatus he needs.

Measurement	Apparatus needed
angle of slope	
stopping distance	

[2]

Table 12.1

Most candidates attempted this question. Protractor was the most commonly achieved marking point. Although there was a wide number of incorrect spellings seen. The main incorrect responses were, stopwatch or timer to measure stopping distance and metre stick instead of the correct metre rule(r).

Question 12 (b)

(b) Describe **two** things the student should do to get precise and repeatable results.

1 .....

.....

2 .....

.....

[2]

Most candidates gained one mark for idea of repeating readings using the same toy car or starting from same spot were the other common correct responses. It was common to see 'keep the angle the same' which was the independent variable in this experiment or 'keep the same distance' which was the dependent variable. It was also common to see 'keep everything the same' which was too vague to gain credit.

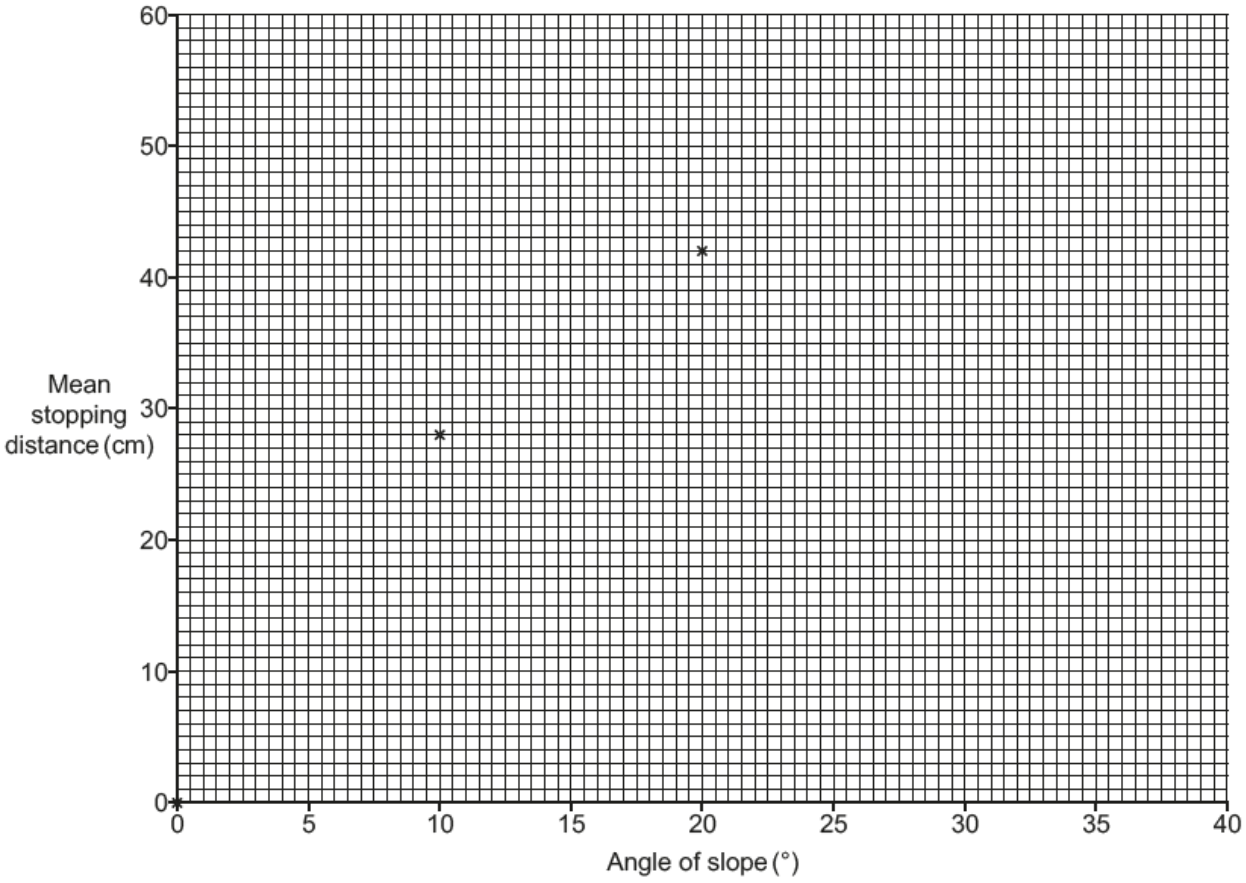
Question 12 (c) (i)

(c) **Table 12.2** shows the results from the experiment.

Angle of slope (°)	Stopping distance (cm)		
	Attempt 1	Attempt 2	Mean
0	0	0	0
10	28	27	28
20	42	44	43
30	50	55	53
40	56	57	57

Table 12.2

(i) Plot the results from **Table 12.2** on the axes below and draw a curve of best fit.
The first three points have already been plotted for you.



[2]

The points were generally plotted correctly. Although, it was a common error for candidates to plot numbers from the Attempt 1 column rather than the mean. Candidates commonly lost the line mark by joining the dots with a ruler or by having multiple or thick lines. Centres should continue to advise candidates to use a sharp pencil for graphs rather than pens.

Question 12 (c) (ii)

(ii) Describe the relationship shown by the graph.

.....

.....

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

Candidates generally obtained the first marking point but the second point where candidates needed to comment on the change of gradient, was seldom seen. Where candidates did not gain the first mark it was for ambiguous phrases such as 'the longer the car takes to stop' or for referring to stopping time rather than distance.

Question 12 (c) (iii)

(iii) Use the graph to estimate the mean stopping distance at an angle of 15°.

Mean stopping distance = ... cm **[1]**

This question was generally well answered. Responses that did not gain the mark were either under-reading by 5 or over reading by 10 so 32 and 47 were commonly seen.

Question 12 (c) (iv)

(iv) Explain why the result at 30° in **Table 12.2** is the **least** precise.

.....

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

Many candidates had the correct idea, that the precision was linked to the range, but did not gain the mark by not comparing to the ranges of the other angles in the table as shown in **Exemplar 2**.

Exemplar 2

Because between the two attempts theres a difference of 5 cm [1]

Question 12 (d)

(d) Energy is transferred as the toy car moves from point **X** to point **Y**, as shown in **Fig. 12.2**.

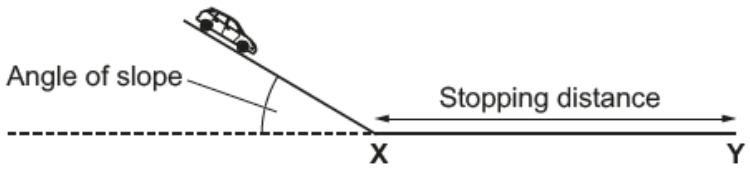


Fig. 12.2

Write down the energy store that increases and the energy store that decreases as the toy car in **Fig. 12.2** moves from point **X** to point **Y**.

Energy store that increases .....

Energy store that decreases .....

[2]

Candidates found this question challenging. A few responses were seen with the correct responses reversed, Gravitational Potential energy was often stated as the increasing store, but mostly mechanisms (such as friction/drag) were given rather than energy stores. Some candidates clearly missed the reference to 'from point **X** to point **Y'** and gave the changes while moving down the slope.

Question 13 (a)

13 This question is about radioactive atoms.

(a) Why are some atoms radioactive?

.....

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

Very few correct responses were seen. Lots of responses were about electron shells, or atoms containing radiation/alpha/beta/gamma

Question 13 (b) (i)

(b) Phosphorus-32 ($^{32}_{15}P$) gives out beta particles.

(i) Complete the equation for the beta decay.

$$^{32}_{15}P \longrightarrow \underset{\ldots\ldots}{^{32}S} + \underset{-1}{^{\ldots\ldots}\beta}$$

[2]

Quite a few no responses were seen from candidates. Some correct responses were given, the beta particle was correct more often, but a number of candidates still could not recall the mass number of a beta particle. In general, a wide range of numbers were included in the incorrect responses.

Question 13 (b) (ii)

(ii) Phosphorus-32 **only** gives out beta particles.

Describe a simple experiment to show how this can be demonstrated in a laboratory.

You may include a diagram in your answer.

.....

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

There were a lot of no responses here, with very few candidates actually being able to describe a practical. Those that did get the right idea often got 3 marks, for the materials, and the penetrating ability. Very few were able to obtain the Geiger counter mark for 4 marks. A wide range of experiments were suggested in the responses, many involving chemical reactions or a change of state, along with Rutherford gold leaf experiments.

Question 13 (c)

(c) Beta particles are one type of radioactive particle.

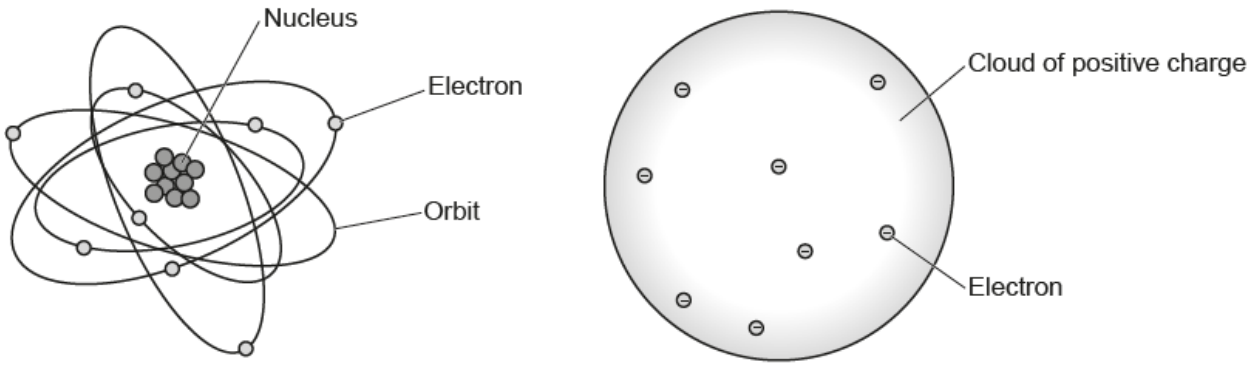
Name a **different** particle given out by radioactive atoms.

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

The majority of candidates answered this question correctly with alpha being the most common response. Gamma was the most common incorrect response

Question 13 (d) (i)

(d) Look at the diagram.
It compares the model of the atom today with a model of the atom in 1902.



Model of the atom today **Model of the atom in 1902**

(i) Describe **two** differences between the models in the diagram.

1 .....

.....

2 .....

.....

[2]

The question was mostly well answered by candidates. However, some marks were lost because responses weren't explicit about which model was being discussed, for example 'one has an orbit, one doesn't'.

Question 13 (d) (ii)

(ii) Explain why the model of the atom has changed over time.

.....

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

A generally well answered question. Improved technology was the most common correct response. Some candidates described the Rutherford gold leaf experiment as evidence of more research, others talked more generally about scientists carrying out experiments, sharing theories. Incorrect responses included atoms evolving or scientists are now more intelligent.

Question 14 (a) (i)

14 This question is about electrical devices.

(a) The diagram shows two different electrical devices.

Torch

Electric fan

(i) Write down the source of electrical energy for each device.

torch .....

electric fan ..... **[1]**

Most candidates had the battery correct, but did not obtain a mark by not linking the fan to a.c.mains or power generators. A lot of candidates just referred to the diagram to give plug or socket as the source of energy for the fan.

Question 14 (a) (ii)

(ii) Describe how energy is dissipated in the **electric fan**.

.....

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

Candidates found this question challenging with not much understanding of the term dissipated. There were quite a few no responses. Most responses talked about the 'useful' energy transfer to kinetic energy in the fan blades / air.

Exemplar 3

The fan goes round and round which causes more energy to be dissipated as they are working hard to get air out. **[1]**

In **Exemplar 3**, the candidate has realised that the movement is causing the dissipation of energy but has not gained the mark because they have not said this is causing a transfer of heat and sound (eventually increasing the thermal energy store of the surroundings).

?	**Misconception**	A few candidates thought that fans make cold air.

Question 14 (a) (iii)

(iii) The electric fan is rated 230 V, 0.3 A.

Calculate the power of the electric fan.

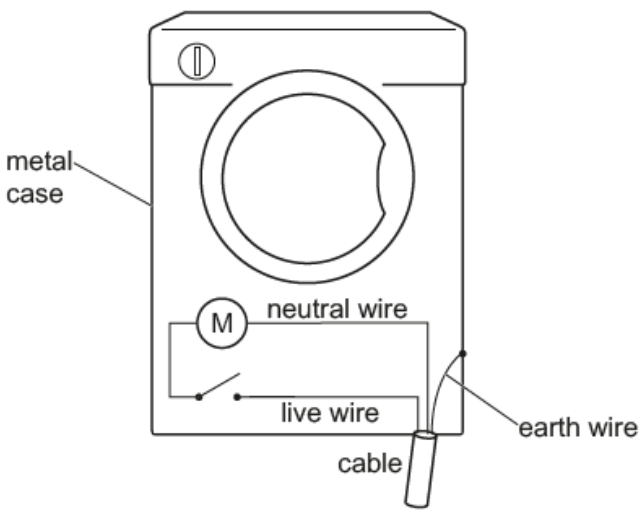
Use the equation: power = potential difference × current

Power = ... W **[2]**

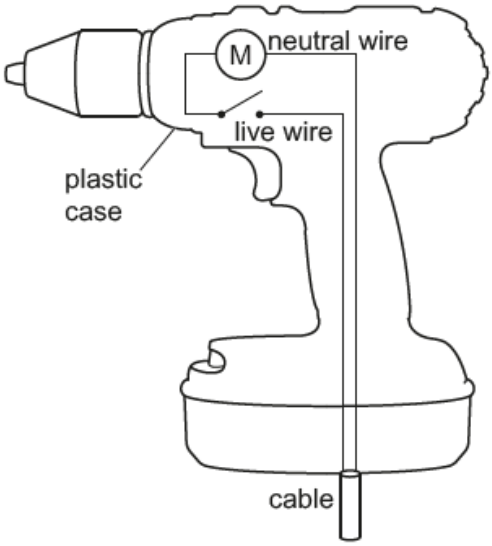
This substitution question was generally well answered by the majority of candidates.

Question 14 (b)

***(b)** Here is a diagram of a **tumble dryer** and an **electric drill**.
Each appliance is wired differently.



Tumble dryer



Electric drill

Explain whether the **tumble dryer** and **electric drill** are both safe to use.

Include the function of the earth, live and neutral wires in your answer.

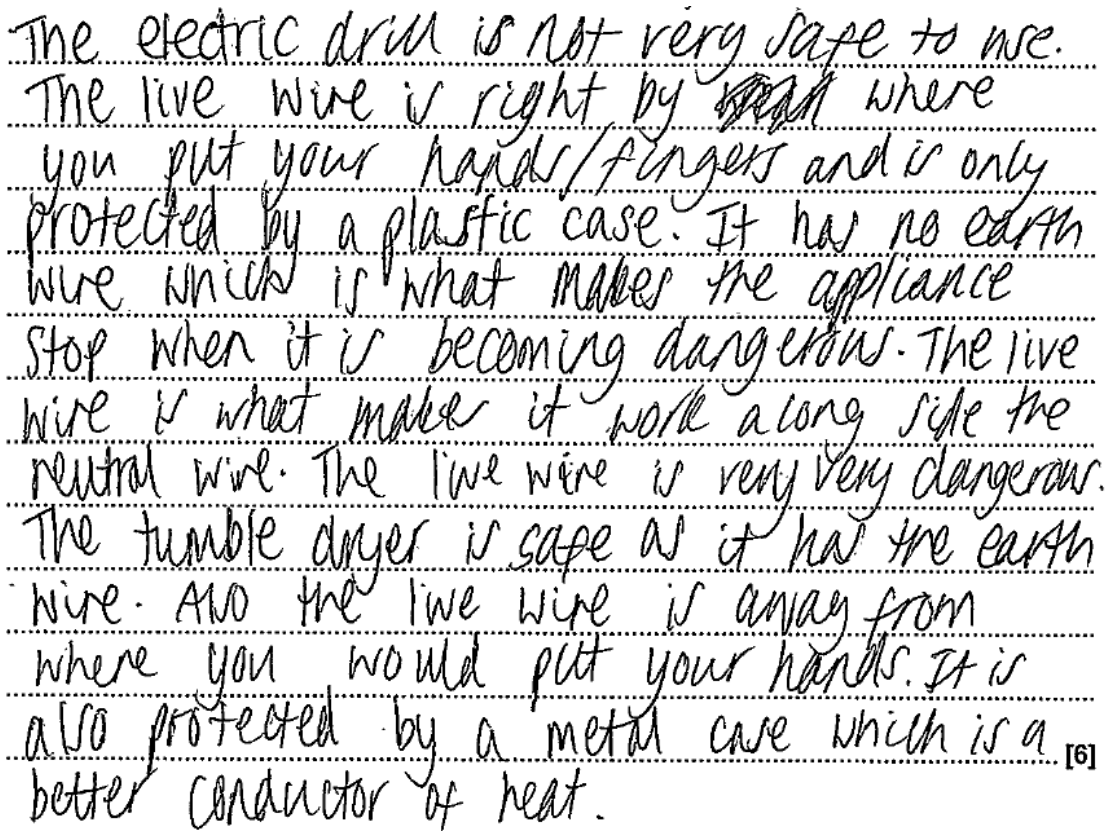
.....

.....

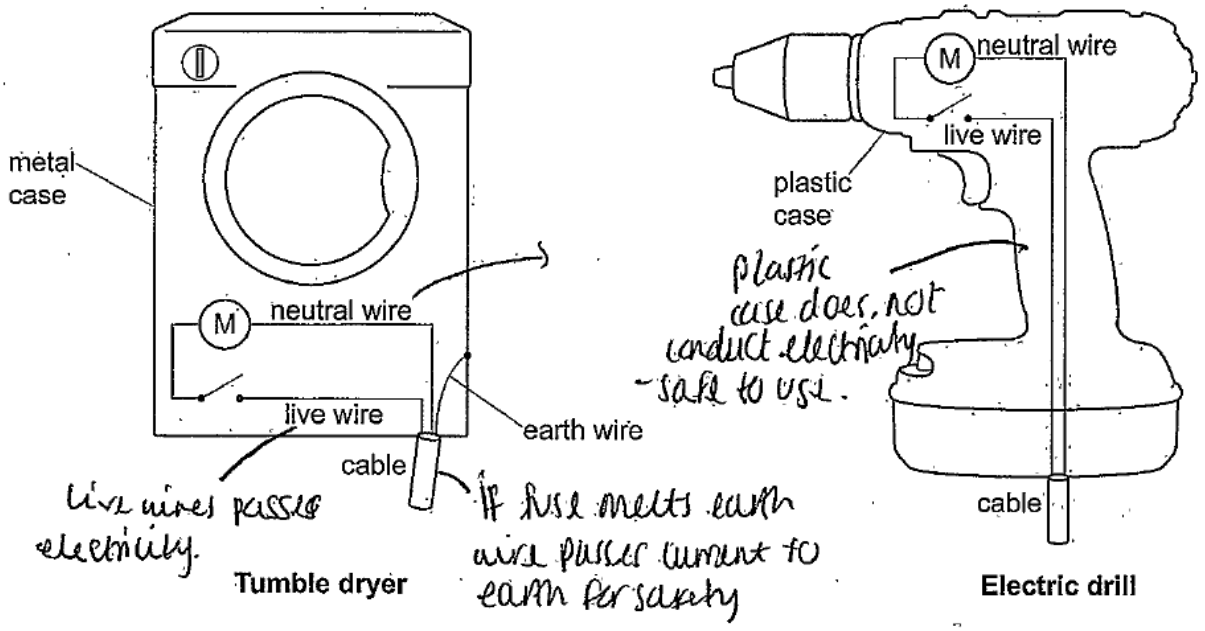
..... **[6]**

Candidates found this 6-mark level of response question challenging. The question was attempted by most candidates but the majority of those did not gain a mark and were mostly just referencing and describing the diagram, rather than using their own knowledge. As a result, a few candidates linked the earth wire to safety and achieved Level1 for a very simple explanation of the tumble dryer safety as shown in **Exemplar 4**. A lot of candidates focused on the casing, and the idea that metal is stronger than plastic, or on whether or not they were able to catch on fire. It was surprising how many could not link the idea of a plastic casing acting as an insulator. Credit worthy responses were likely to be at Level 1, since many candidates ignored the instruction to include the function of the three wires. While handwriting was occasionally very poor, the quality of written English was generally good. Responses often contained contradictory statements for example 'drill is safe because it had a plastic case, but not safe because it lacked an earth wire'. **Exemplar 5** shows a response that was given Level 3. This response includes explanations for both the tumble dry and drill. It also gives a description of the role of the three wires. It was given 5 rather than 6 because of the very limited description of the neutral wire.

Exemplar 4


The electric drill is not very safe to use. The live wire is right by ~~death~~ where you put your hands/fingers and is only protected by a plastic case. It has no earth wire which is what makes the appliance stop when it is becoming dangerous. The live wire is what make it work along side the neutral wire. The live wire is very very dangerous. The tumble dryer is safe as it has the earth wire. Also the live wire is away from where you would put your hands. It is also protected by a metal case which is a better conductor of heat. [6]

Exemplar 5



Explain whether the **tumble dryer** and **electric drill** are both safe to use.

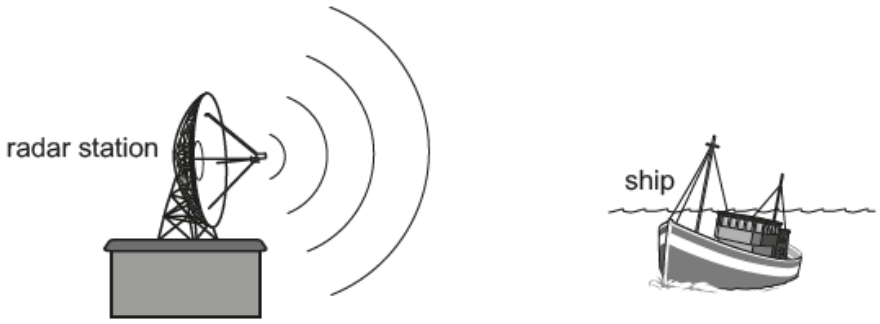
Include the function of the earth, live and neutral wires in your answer.

The tumble dryer is safe to use, this is because it has safety feature's in place such as the earth wire. The role of the earth wire is to ensure the dryer does not explode or cause an electric shock as there is a fuse in place, and when the fuse melt's due to too much electricity passing by, it then cause's the current to pass through the earth wire which take's the current to the earth, ~~and~~ which will not electrocute anyone. the role of the live wire is to pass electricity through the appliance so that it works, and the role of the neutral wire is to ~~pass~~ allow electricity to flow normally ~~and~~ . this wire is blue, the live wire is brown and the earth wire is green/yellow. The drill is similar to this but* [6]

14 (b)	as it has a live wire and a neutral wire, but it does not have an earth wire this is because the dryer has a metal casing, which is a conductor and if electricity passes through it can electrocute a person who touches the machine, this is not the case for the drill as the drill has a plastic casing, which is not a conductor, this means that a person cannot get electrocuted by this. The drill has a fuse which will melt if it detects an overide of power going through it, this will then stop the drill reducing the risk of it exploding or burning.

Question 15 (a) (i)

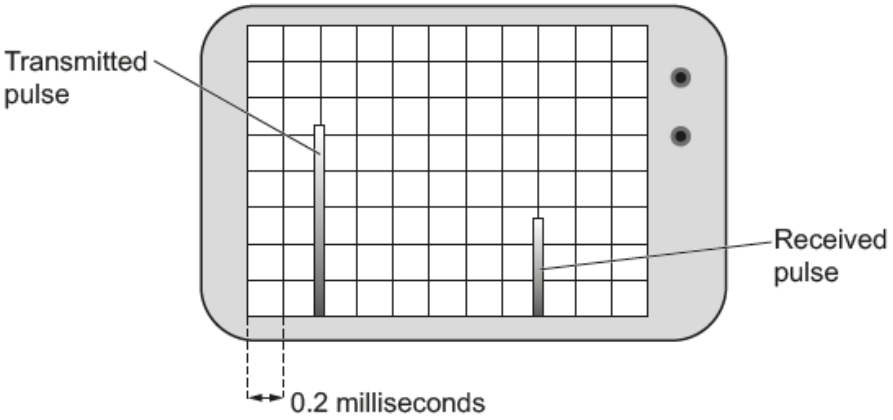
15 Radar stations can be used to find out where ships are.



At a radar station:

- a radar transmitter transmits pulses of microwaves
- the pulses are reflected by the ship
- a radar receiver detects the pulses.

(a) The diagram shows the radar signals on an oscilloscope screen:



(i) Calculate the time taken between the pulse being transmitted and received.

Time taken = ... ms **[1]**

Many candidates gained this mark. The common errors were 1.4, or counting the return as well, so having 2.4 as a response.

Question 15 (a) (ii)

(ii) A radar signal is sent from the radar station. The signal reflects off the ship and is detected 0.0006 s later.

The speed of the microwaves is 3.0×10^8 m/s.

Calculate the distance of the ship from the radar station.

Use the equation: distance travelled = speed × time

Distance = ... m **[2]**

Most candidates scored 1 mark for 180 000 but did not half this answer, as they did not understand that the time was for the signal to get there and return.

Question 15 (a) (iii)

(iii) The amplitude of the received pulse is lower than the transmitted pulse.

Suggest why.

.....

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

Very few candidates obtained this mark. Most did not link the amplitude to the amount of energy in the wave, and therefore were unable to obtain the answer.

Question 15 (b)

(b) Radar stations use microwaves with a frequency of 200 MHz.

The speed of the waves is 3.0×10^8 m/s.

Calculate the wavelength of these waves.

Wavelength = ... m **[4]**

Very few candidates obtained full 4 marks, but most did rearrange the equation correctly and substitute into it to obtain 3 marks. Very few converted 200Mhz correctly.

Question 16 (a)

16 This question is about radioactive decay.

A teacher models radioactive decay using 100 dice:

- she shakes a beaker containing 100 dice and empties the dice into a tray
- every time a number "6" lands face up, she removes that dice
- she places the remaining dice in the beaker and repeats the process.

Here are some of the results from this experiment.

Number of throws	Number of dice removed				Number of dice remaining
	Attempt 1	Attempt 2	Attempt 3	Mean	
1	16	18	17	17	83
2	15	14	14	14	69
3	10	12	11	11	58
4	10	9	10	10	48
5	8	9	7	8	40

(a) Describe the difference between **mean**, **mode** and **median**.

In your answer use data from the second throw in the table (shaded in grey).

..... [3]

This question was answered well by most candidates. Most were able to recall the definitions of each term. Candidates who did not gain any marks usually did not use the data as instructed in the question as shown by **Exemplar 6**. Only a relative few candidates had the terms the wrong way around.

Exemplar 6

The mean shows the average score so on throw it was 14. The median shows the midal number. ~~The mode will for so on throw two it was~~ The mode will show the attempt with the highest ~~time~~ number of dice removed so is [3]

Question 16 (b)

(b) Use the table to estimate the half-life of the dice.

Give your answer to the **nearest whole number**.

Half-life = ... throws **[1]**

Candidates found this question challenging. A wide range of incorrect responses were seen. For example, by halving numbers until the answer matched the number of throws or just by halving either one of the values on the table or the sum of the means.

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General qualifications

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