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OCR
Oxford Cambridge and RSA

GCSE (9-1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE COMBINED SCIENCE B

J260
For first teaching in 2016

J260/07 Summer 2018 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.

3-3 grade

Like all exam boards, we have awarded a 'safety net' grade of 3-3 for higher tier GCSE Combined Science candidates in 2018 where appropriate so that they are not disadvantaged by being the first to sit a new GCSE. To help teachers making difficult decisions about higher versus foundation tiers in 2019, OCR will be providing further guidance and extra webinars during the Autumn term.

Paper J260/07 series overview

J260/07 is one of the four examination components for the new higher tier GCSE (9-1) Twenty First Century Science Combined Science B. This component assesses the contents of the physics chapters P1 to P6 and the practical skills in chapter BCP8. The question styles used include objective, short answer and one extended Level of Response.

Candidate performance overview

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

- Produced clear and concise responses to the Level of Response question (Q2) covering all aspects of the question.
- Recalled equations and showed the stages of calculations in a logical sequence: Q3a, Q4a, Q5a, Q6a(ii), Q7b(ii), Q7b(iv), Q8a, Q9b.
- Used scientific terminology confidently when applying knowledge of ideas.
- Showed the ability to analyse information to make conclusions.
- Drew clear labelled diagrams: Q1a, Q5c, Q7a, Q7b(i).

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

- Found it difficult to apply scientific ideas, which they had learnt, to new situations.
- Were not able to recall equations correctly.
- Showed poor setting out of numerical questions and had difficulty rearranging equations.
- Did not always draw diagrams even where question indicated it would be helpful. Diagrams that were drawn were not labelled.
- Used everyday words and phrases rather than scientific terminology.

There was no evidence that any time constraints had led to a candidate underperforming and scripts where there was no response to the final question also had other questions in the examination which had not been attempted.

Most successful topics/questions	*Least successful topics/questions*
• Energy resources Q4 • Structure of the atom Q1a • Plotting points on graph Q5b(i) • Q3a and Q8a calculations • Interpreting half-life from graph Q9a	• Radioactivity Q9c • Resistance and current Q3c • Describing and applying models: Thomson atom Q1c(ii), matter under stress Q5b(i) and Q5b(ii), particles Q8b • Forces Q7a, Q7b(i) • Calculations Q5a, Q6a(ii), Q7b(ii), Q9b

Question 1 (a)

1 This question is about the structure of the atom.

(a) Describe the structure of the atom.
Include information about particles that make up the atom.
You may include a diagram.

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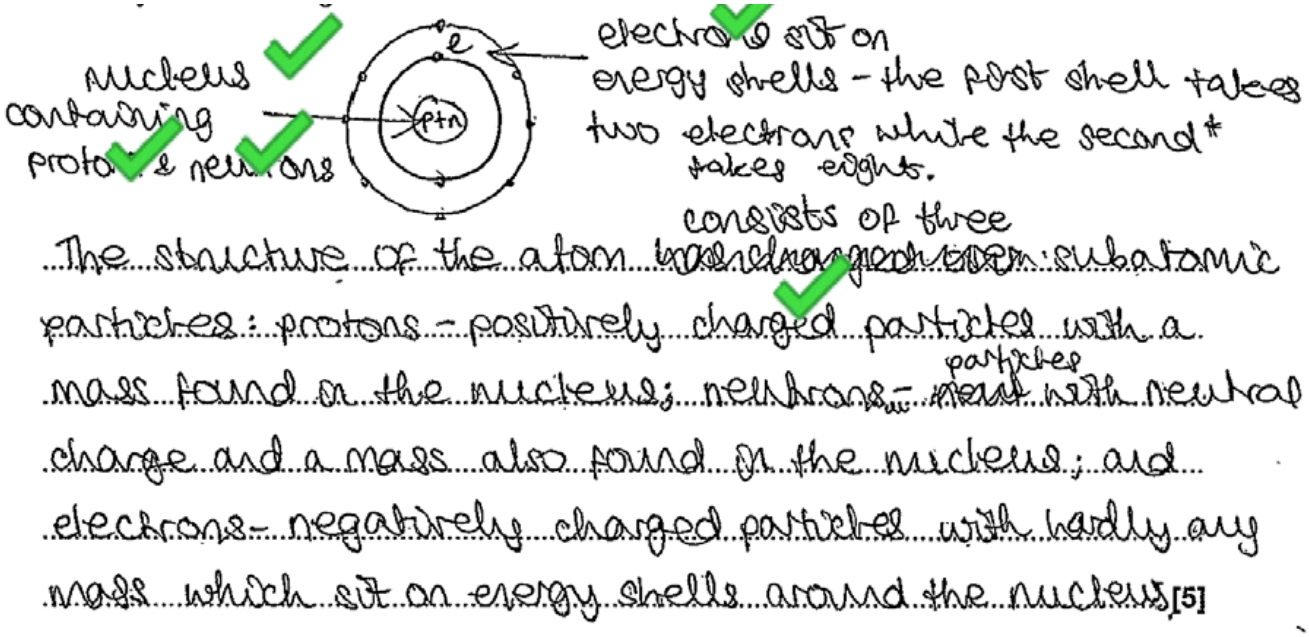
.....

.....

..... **[5]**

This question required candidates to demonstrate their knowledge about the structure of the atom (AO1). Many good answers were seen and labelled diagrams were able to be awarded full credit. Some candidates correctly identified particles in the atom but did not state where these are situated and therefore did not receive credit.

Exemplar 1



This response shows how candidates can answer a question with a well labelled diagram. Four of the five marks are credited from the information in the diagram. The written text gives more information from which the fifth mark is gained.

Question 1 (b) (i)

(b) (i) What is the size of a typical atom?

Draw a (ring) around the correct answer.

10^{-15} m 10^{-10} m 10^{-5} m 10^{-1} m 10^{5} m 10^{10} m

[1]

The majority of candidates across the full ability range knew the order of magnitude of a typical atom.

Question 1 (b) (ii)

(ii) How does the size of the nucleus compare to the size of an atom?

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

Most candidates knew that the nucleus is smaller than the atom. In order to achieve the mark smaller needed to be qualified e.g. much smaller.

Question 1 (c) (i)

(c) The development of our modern model of the atom started with the discoveries of J.J. Thomson in 1897.

(i) What did J.J. Thomson discover, that appeared to come from the atom?

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

Only a few candidates knew that J.J. Thomson discovered electrons or negative particles.

Question 1 (c) (ii)

(ii) The model changed because of J.J. Thomson's discovery. Describe the new model J.J. Thomson suggested.

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

Some candidates mentioned 'plum pudding' model but did not give any details, such as like a positively charged pudding with negatively charged plums in it. Candidates were expected to describe particles of matter with negative electrons spread throughout them. J.J. Thomson's model was confused, in many answers, with either Bohr's nuclear model or Rutherford's alpha particle scattering experiment.

Question 1 (d)

(d) The element carbon has two isotopes, carbon-12 and carbon-14.

What is the difference between these two isotopes?

.....

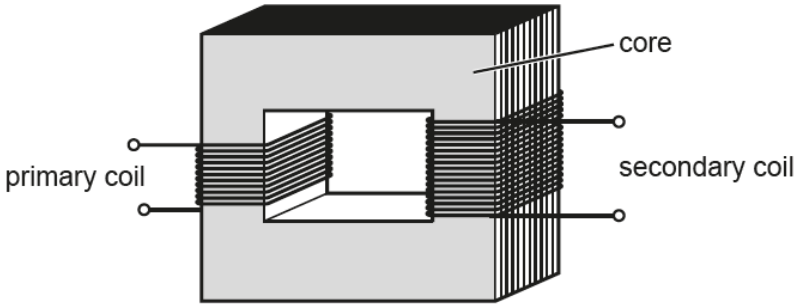
..... **[2]**

This question required candidates to apply their knowledge about isotopes (AO2). Only a small number of more able candidates stated that carbon-14 contains two more neutrons than carbon-12. The majority of candidates did not know that isotopes have different numbers of neutrons or different masses.

Question 2

2* Eve wants to connect an electric pump to the mains electricity supply.

She needs a transformer which can supply enough power for an **output** potential difference of **12 V** and an **output** current of **3 A**.

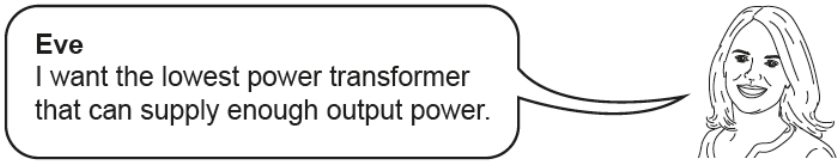


input power = potential difference across primary coil × current in primary coil

output power = potential difference across secondary coil × current in secondary coil

She has three transformers to choose from:

	Transformer A	Transformer B	Transformer C
Maximum input power (W)	30	60	60
Output potential difference (V)	12	12	15



Which transformer should Eve choose?
Justify your answer and use calculations to support your decision.

.....

.....

.....

.....

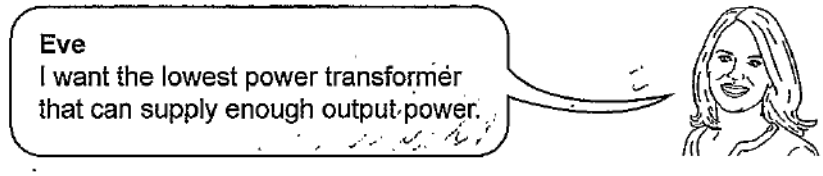
..... **[6]**

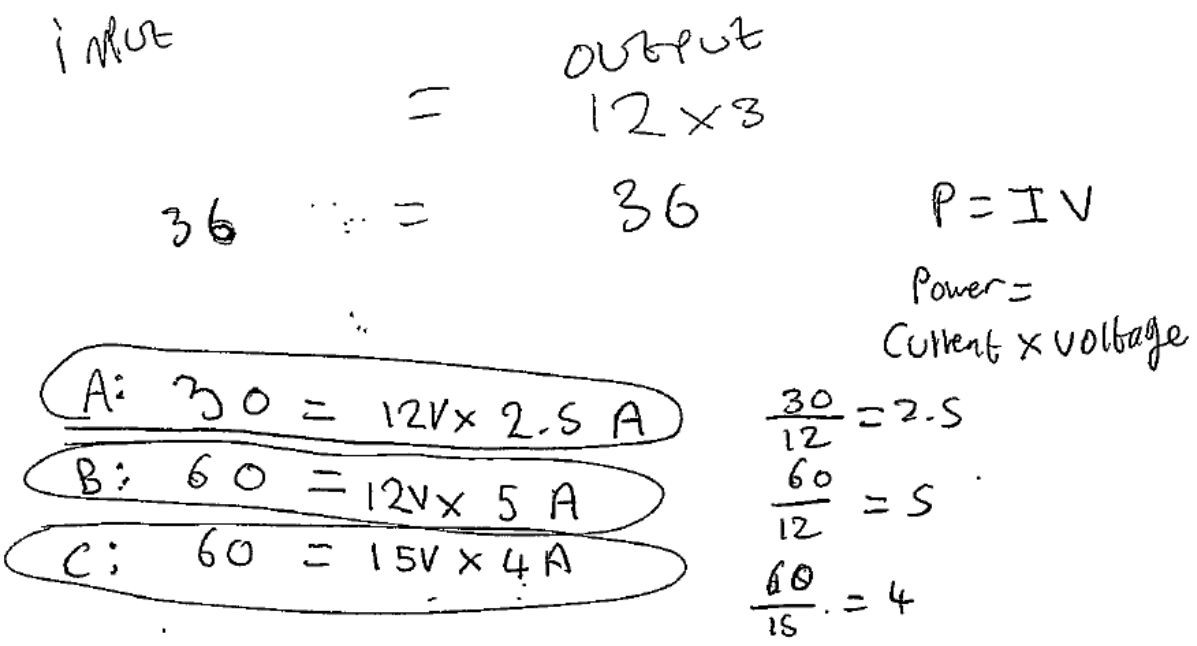
This extended Level of Response question gave candidates the opportunity to apply their knowledge and understanding (AO2) of the working of transformers by making relevant calculations. It also gave them the opportunity to show how they can analyse information and data to make judgements and evaluate which transformer was suitable (AO3).

In order to achieve levels 2 or 3 candidates needed to answer all three parts of the question: choose a transformer, justify their choice and make supporting calculations. The majority of candidates achieved level 1 as their answers stated their choice of transformer and gave a qualitative reason, but did not provide a supporting calculation. Many answers revealed misunderstandings about transformers and the data. The most common level 1 answer was transformer A, because it has the lowest maximum input power. Candidates did not appreciate that the output p.d. is fixed and that the input and output powers can vary according to the current in the secondary coil. Where calculations were made, some were not always relevant or used correctly.

Exemplar 2

	Transformer A	Transformer B	Transformer C
Maximum input power (W)	30	60	60
Output potential difference (V)	12 ✓	12	✓ 15





Eve should choose transformer B. This is because it is able to supply 12V and 5A, which is what is required. Also, it is a better choice than transformer A because, although it has the lowest input power, it can not supply enough Amps, only 2.5A. Transformer B is also better than transformer C because transformer C has an output of 15V, which is more than Eve wanted so it is not a suitable choice. Furthermore, transformer B is the best choice because it fulfils Eve's requirements and is the lowest power transformer. [6]

This exemplar shows one way of achieving level 3. The candidate has selected transformer B having first analysed the data table and give their calculations. I addition they have justified their choice by referring to A and C using the data and relevant calculations to show why transformer B is the best choice.

Question 3 (a)

3 A portable electric heater can be used with a 12V car battery to heat a car. **Fig. 3.1** shows the electric circuit for the heater.

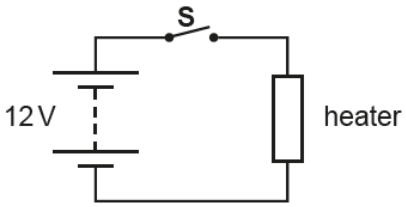


Fig. 3.1

(a) When the switch, **S**, is closed the current in the heating element is 14A.

Calculate the resistance of the heating element.

Give your answer to **2** decimal places.

Give the units in your answer.

Resistance = ... units ..... **[5]**

This calculation question required candidates to recall the equation for resistance and apply the data. Higher ability candidates performed very well on this question by stating the equation, correctly substituting the data and rounding their answer to 2 decimal places as well as giving the unit as Ω. Many lower ability candidates did not state the equation, divided 14 by 12 and gave a wrong unit.

Question 3 (b)

(b) The statements below about the circuit in **Fig. 3.1** are either **true** or **false**.

Put a tick (✓) in the correct box after each statement.

	True	False
If the current changes the resistance of the heating element remains constant.		
The size of the current depends on the potential difference across the heating element.		
The potential difference across the battery increases if the resistance of the heating element increases.		
The size of the current depends on the resistance of the heating element.		

[4]

The question required candidates to manipulate and apply their understanding of $V = IR$. All candidates attempted this question with over 80% achieving at least half marks. However, common misconceptions in understanding were present in candidates at all ability levels.

Question 3 (c)

(c) Some electric heaters have two identical heating elements. **Fig. 3.2** shows a heater circuit with two elements each of resistance *R*.

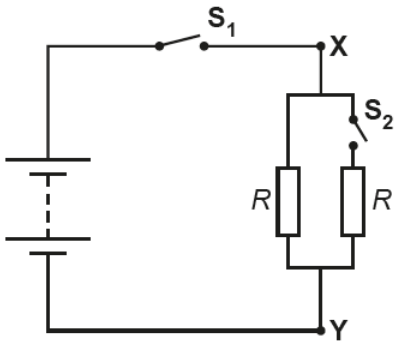


Fig. 3.2

With both switches open, an electrician uses a meter to measure the resistance between points **X** and **Y**. She then closes switch $\mathbf{S_2}$.

State and explain how the resistance between **X** and **Y** changes when switch $\mathbf{S_2}$ is closed.

.....

.....

.....

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

Most answers to this question showed misunderstandings about resistance and current. A common error was that the resistance doubles because there are now two resistors. In order to achieve the mark for the explanation candidates needed to say that the two paths are identical or the current is shared equally, not just that there are two paths or more current.

Question 4 (a)

4 In 2015 gas-fired power stations in the UK generated 99.8 TWh of electricity.

Renewable resources generated 83.3 TWh, which was 27% of the total electricity generated in the UK.

(a) What percentage of the total electricity generated in the UK was generated in gas-fired power stations?

Generated in gas-fired power stations = ...% **[3]**

Higher ability candidates demonstrated an understanding of percentages and gave logically displayed answers for this question. Lower ability candidates tended to use the data without showing any logical sequence.

Question 4 (b)

(b) Explain the difference between renewable resources and non-renewable resources.

.....

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

Most candidates showed some knowledge of these terms. The most common acceptable answers were that renewable will not run out or is replaced, or the reverse for non-renewable. Answers such as 'renewable can be reused or recycled' were not precise enough to gain credit.

Question 4 (c)

(c) There are plans to use more tidal lagoons to generate electricity in the future.

A tidal lagoon is a reservoir enclosed by a sea wall. The lagoon is filled by the tide through open gates where turbines are placed.

Electricity is generated at high tide when water flows through the turbines to fill the lagoon.

Electricity is also generated at low tide when the water flows out through the turbines, emptying the lagoon.

Give an **advantage** and a **disadvantage** of using a tidal lagoon and gas-fired power station to produce electricity.

Tidal lagoon

Advantage .....

.....

Disadvantage.....

.....

Gas-fired power station

Advantage .....

.....

Disadvantage.....

.....

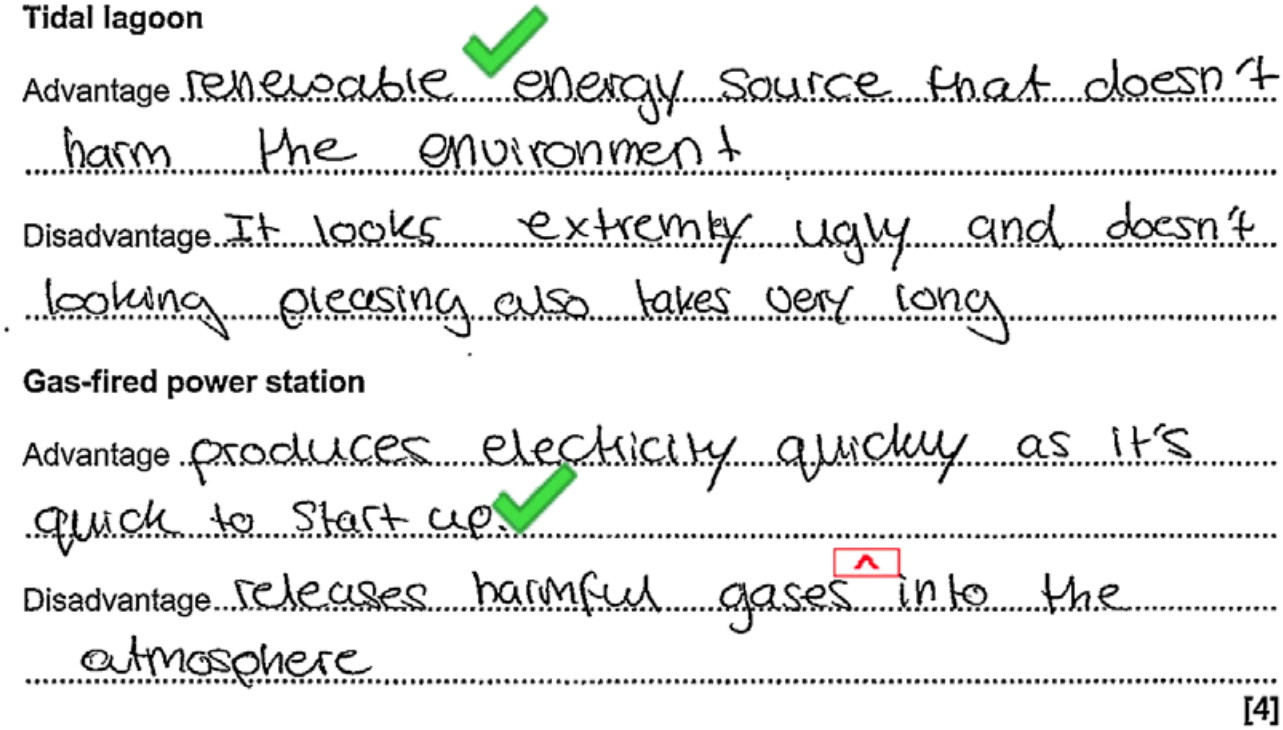
[4]

Most candidates gave two or more correct responses to show their understanding of scientific ideas (AO1). The most common of these were: tidal advantage – renewable or does not produce carbon dioxide; gas-fired disadvantage – non-renewable or fossil fuel or produces greenhouse gases.

The most common misconception was to state a reason that lacked sufficient detail to be understandable as an advantage/disadvantage. For example many candidates stated pollution or harming the environment, but with no mention of greenhouse gases, carbon dioxide or global warming. Other candidates wrote about the power (or energy per year) using vague terms such as amount of electricity.

The answer space provided is there to indicate to candidates the detail of the response expected. In this case two lines were given for each advantage/disadvantage.

Exemplar 3



Tidal lagoon

Advantage renewable energy source that doesn't harm the environment

Disadvantage It looks extremly ugly and doesn't looking pleasing also takes very long

Gas-fired power station

Advantage produces electricity quicky as it's quick to start up.

Disadvantage releases harmful gases into the atmosphere

[4]

This answer was credited with two marks.

The mark for tidal advantage is credited for 'renewable'. It would not have been given if it just said 'does not harm the environment' or 'does not pollute'.

The mark for gas-fired advantage is for 'quick to start up'. The disadvantage provided has not been credited as the harmful gases are not specified.

Question 5 (a)

5 Amir conducts an experiment to find out the energy stored when a spring is stretched.

He collects data for the force stretching the spring and its extension. He adds weights to the spring and measures the extension using a meter ruler.

A graph of Amir's results is shown in **Fig. 5.1**.

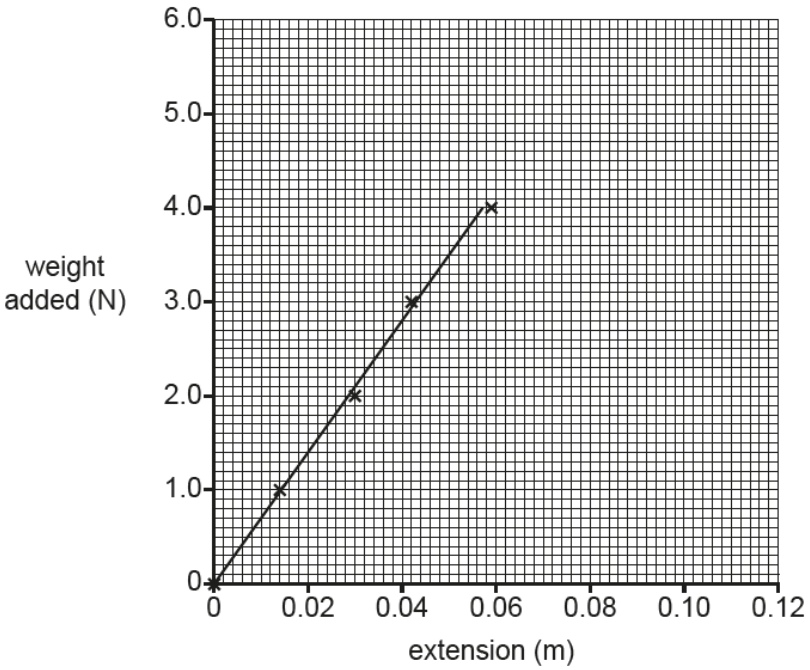


Fig. 5.1

(a) Use the graph in **Fig. 5.1** to calculate the energy stored in the spring when it is stretched by 5.0 cm.

Energy stored = ...J **[3]**

The equation for energy stored in a stretched spring from the data sheet was used incorrectly by most candidates. They used the graph to find the weight added at 5 cm and wrongly assumed that this value was the spring constant. Only a few higher ability candidates applied their knowledge and understanding of scientific techniques and procedures (AO2) to determine the appropriate area under the force-extension graph. Some of these candidates did not convert 5 cm to 0.05 m.

Question 5 (b) (iii)

(iii) Describe what has happened to the behaviour of the spring to cause the change described in **(b)(ii)**.

.....

.....

.....

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

Questions (b)(ii) and (b)(iii) tested the candidates' ability to interpret information given in graph form and draw conclusions (AO3).

The mathematical terms proportional and linear were rarely seen. Candidates tended to use correlation or state that as force increased so did extension, neither of which gained credit. Very few answers mentioned that a change took place at 4 N.

Answers to part (b)(iii) revealed that candidates did not know the correct scientific terminology to describe the behaviour of the spring.

Question 5 (c)

(c) Amir decides to repeat the experiment with an identical spring.

Describe how Amir can do this experiment with the spring using a safe and accurate method. Include detail about the measurements he should make and how he can find the force and the extension.

You may include a labelled diagram in your answer.

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.....

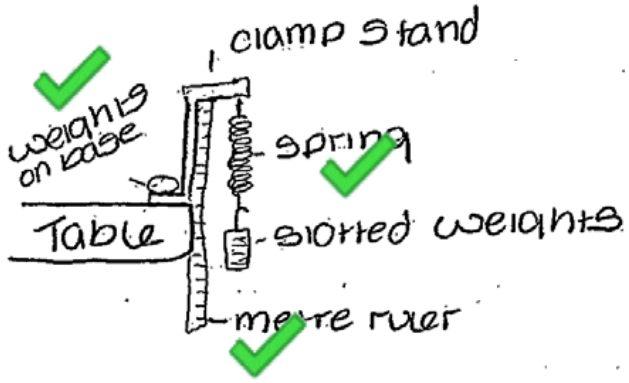
..... **[5]**

This question allowed candidates to organise scientific ideas to show that they knew about experimental procedures (AO3).

Most answers included details of an experimental set-up either by a labelled diagram or in the text. Candidates did not always describe how the experiment was made safe and accurate. Many answers did not give enough detail as to how the measurement of extension was made. Stating that 'extension is measured using a ruler' and ambiguous statements about using the ruler 'to measure the spring' were not sufficient to gain credit.

Exemplar 4

You may include a labelled diagram in your answer.



force = mass × acceleration

work done = force × dist moved.

Amir needs a clamp stand, ruler, slotted weights, a spring. He should set the experiment up as shown in the diagram and add the slotted weights individually recording the amount of weights on the spring and the extension. Amir can find the force by multiplying the amount of newtons by distance moved. [5]

Turn over

The labelled diagram in this exemplar gains three marks for: the set-up of a weight hanging from a spring, a ruler placed parallel and close to the spring; and for the weights on the base of the stand acting as a safety device. No more marks are credited for the description in the text as it neither details of how the extension will be measured accurately nor discusses safety issues.

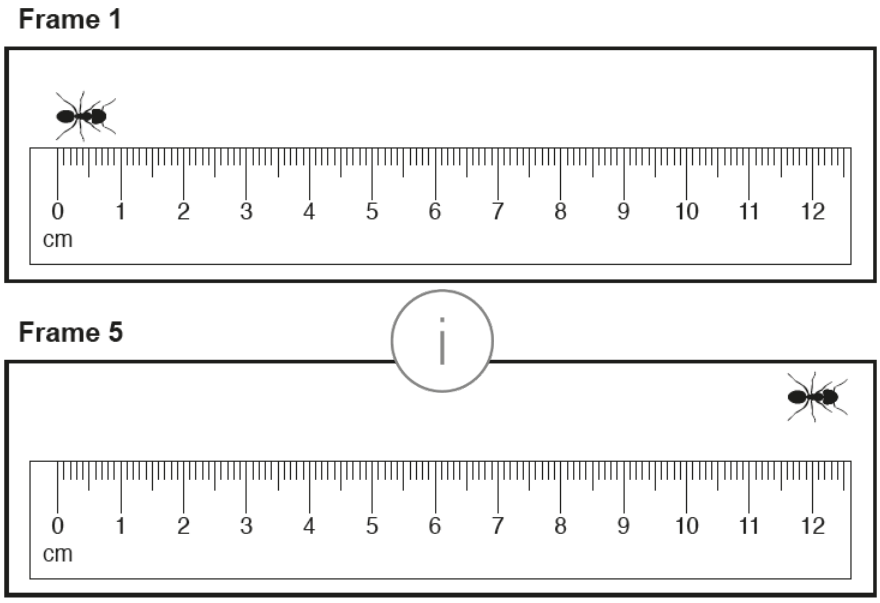
Question 6 (a) (i)

6 Silver ants live in the Sahara desert. If they are in the sunshine for too long they die, so the ants must be able to move out of the sun very quickly.

Sarah wants to find out how quickly they can move.

She places a ruler on the ground. When an ant starts to run along the edge of the ruler she uses a video camera to record the ant's movement.

(a) The diagram shows the 1st and the 5th frame of the video she recorded.



(i) How far does the ant move between frame 1 and frame 5?

Give your answer in metres.

Distance = ...m **[3]**

This question tested whether candidates could take accurate measurements to the appropriate resolution and make a conversion of units (AO2and AO1). Candidates whose measurements were not accurate were given credit for the correct conversion if they showed their distance in cm in the working space or on the diagram. Many responses were only credited with this mark as the distance they measured was not recorded to three decimal places (i.e. the nearest mm).

OCR support Mathematical Skills handbook http://www.ocr.org.uk/Images/310651-mathematical-skills-handbook.pdf

Question 6 (a) (ii)

(ii) The camera takes one frame every 4 ms.

Calculate the speed of the ant in **m/s**.

Speed = ...m/s **[5]**

Milliseconds (ms), as a unit of time, was not well understood. Some candidates ignored the units or tried to convert it to s using the wrong scale factor (IaS2).

Appreciating that there is a time interval equal to 4 x frame time between frames 1 and 5 was only shown by the higher ability candidates. Many answers lacked a word or symbol equation for speed and working was neither clear nor logically set-out.

Question 6 (a) (iii)

(iii) Use evidence from the photos to judge whether this calculation underestimates or overestimates the speed of the ant.

Give a reason for your answer.

.....

.....

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

The correct response, underestimate, was credited a mark if it was accompanied by some reason involving distance or direction. Only a very few higher ability candidates realised that because the ant had not travelled parallel to the ruler the distance it moved was greater than that measured in the previous part.

Question 6 (b)

(b) The ants are covered with hairs that both reflect light and radiate infra-red radiation.

Explain how this affects the temperature of the ants when they are out in the desert sunshine.

.....

.....

.....

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

The question asks about temperature of the ants. Therefore answers which discussed thermal energy or heat rather than temperature did not gain any credit.

Question 7 (a)

7 Drones are unmanned aerial vehicles.

The vertical upward lift force on the drone is increased or decreased by changing the speed of the rotors.

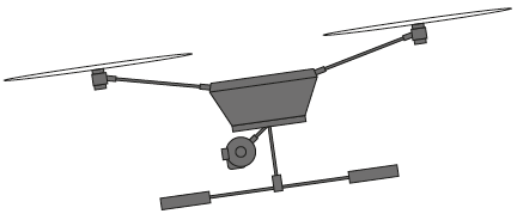
(a) Draw a free body force diagram for the drone when it is hovering in a stationary position.

[2]

Most candidates attempted this question but very few were able to draw a free body diagram and fewer than 5% of candidates were credited with both marks. This was a straight forward question which asked candidates to demonstrate an on specification skill (P4.3.2).

Question 7 (b) (i)

(b) To move forward the drone tilts, so the lift force now carries it forward. The air resistance increases as the drone moves faster.



(i) Draw the free body force diagram for the moving drone.

[3]

Arrows without labels did not gain any credit. Gravity appeared quite often as the label for the weight arrow. This did not get credit in Q7(a) but if it was used again in Q7(b)(i) it was treated as an error carried forward. Only a very few candidates showed the lift arrow at a diagonal to the left in Q(b)(i).

Question 7 (b) (ii)

(ii) The drone has a mass of 1.8 kg. The horizontal forward thrust provided by the lift force is 6 N and the air resistance is 2 N.

Calculate the acceleration of the drone.

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

Acceleration = ...m/s^2 **[5]**

In this calculation candidates needed to recall the appropriate acceleration equation. Some chose to try to use rate of change of velocity instead of force = mass x acceleration. Various things were done with the 6 N and 2 N forces. Credit was given if the working clearly showed that 4 N was the resultant force acting. As in other calculation questions, candidates need to state the equation they are using in words or symbols. Some candidates had difficulty rearranging the equation to obtain acceleration.

Question 7 (b) (iv)

(iv) The drone has kinetic energy of 58 J.

Calculate its speed.

Use the equation: kinetic energy = $\frac{1}{2}$ × mass × speed^2

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

Candidates had difficulty with rearranging the given equation and dealing with the square of speed. The majority of marks were either 5 or 0.

Question 8 (a)

8 Aerosol cans of oxygen are sold in some sports shops.

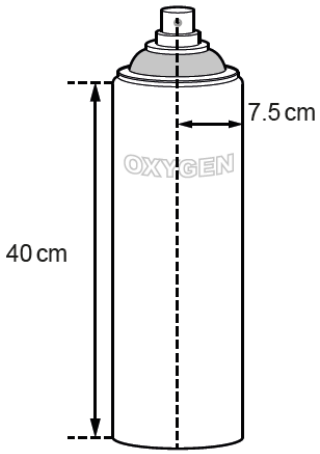


Fig. 8.1

(a) Calculate the mass of gas in the can in **Fig. 8.1**.

The density of the gas is 7.1 × 10^{-3} g/cm^3.

Use the equation: volume of a cylinder = π × (radius)^2 × height

Mass = ... g **[4]**

This calculation question was answered well. Many responses received full marks.

Question 8 (b)

(b) The can is left in a car on a hot day.

Explain how the motion of the oxygen molecules in the can changes on a hot day and how this increases the pressure.

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.....

.....

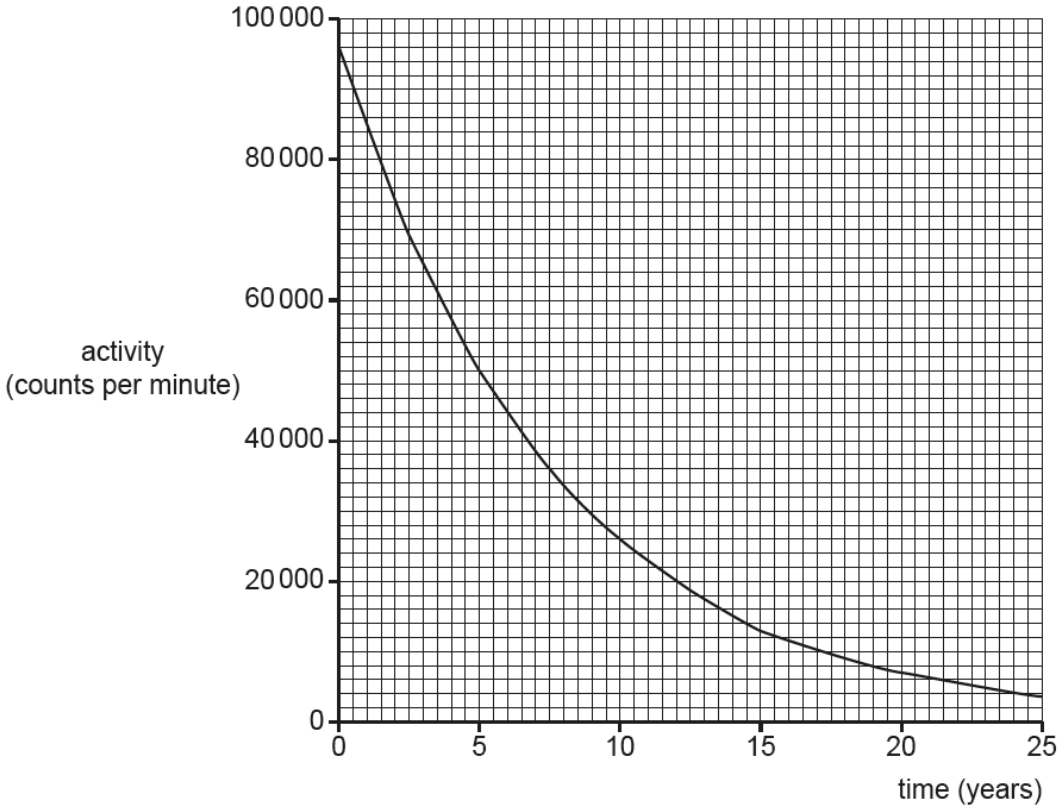
..... **[3]**

This question required candidates to demonstrate their knowledge and understanding of the effect of heating a gas using the particle model (AO1). Many answers showed some understanding but used terms that were too vague. 'Molecules move about more' did not gain credit. Molecules moving faster or having more kinetic energy were credited. Some candidates described the molecules vibrating which would not affect the pressure inside the can. Similarly 'molecules make more collisions' did not gain credit. The answer needed to specify that it is collisions between the molecules and the sides of the container that increases in pressure. No candidates referred to the effect due to a change in momentum of the gas molecules when they collide with the walls of the can.

Question 9 (a)

9 Cobalt-60 radioactive sources are used to sterilise medical equipment. The sterilising source is a rack containing an array of up to 96 smaller cobalt-60 sources.

This graph shows the activity of a cobalt-60 source.



(a) Use the graph to find the half-life of cobalt-60.

Show your working on the graph.

Half-life = ... years **[2]**

The meaning of half-life was understood by most candidates who were able to calculate a value for half-life within the acceptable range. In order to be credited with the second mark candidates needed to show their working on the graph. This was as stated in the stem of the question. Some did not show any working and others misread the activity at time zero from the graph as 100000 cpm rather than 96000 cpm.

Question 9 (b)

(b) One of the sources from the rack of cobalt-60 has an activity of 1.2×10^{13} counts per second. The source must be replaced when the activity falls to 7.5×10^{11} counts per second.

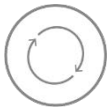
Calculate the number of half-lives and the time until the source must be replaced.

Number of half-lives = ...

Time before replacement = ... years

[4]

Most candidates attempted this question although only a third gained some credit and very few, even of more able candidates, got four marks. Candidates had difficulty handling powers of 10 and with the process of finding the number of half-lives.



AfL

When a question uses the command word 'calculate' or 'show that' or 'show your workings' it is important for candidates to write down what they are doing. A candidate using a calculator should note down the mathematical steps that they are taking. Drawing out and sketch notes can help candidates to clarify their thinking. Any relevant mathematical workings, including sketches and notes, can be credited

Question 9 (c)

(c) Medical equipment is placed in a container which is moved around the source rack so that all sides are irradiated. The speed of the container past the source rack can be changed.

The amount of radiation received is called the dose. It is monitored because it must be high enough to sterilise the equipment, but not high enough to damage it.

Mia and Sundip are discussing how the amount of radiation can be controlled.

Mia
The dose will change as time passes. One small cobalt source could be added or replaced at a time. The speed the container moves at will not make any difference.

Sundip
It would be easier to replace just one large cobalt source because a source with a very high activity would not have to be changed for a long time. The speed the container moves would change the dose.

Both Mia and Sundip have made statements that are only partly correct.

Use Mia and Sundip's statements to explain how the exposure to the source could be kept as constant as possible.

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

The responses indicated that candidates had not read the instruction line of the question carefully enough and so misinterpreted what they were being asked to do. Most answers concentrated on saying which parts of Mia's and Sundip's statements were true or false. They did not say how the exposure and hence the dose could be kept constant. For example, rather than stating that the speed changes the dose, the answer needed to explain that that the higher the speed of the container the shorter the exposure time and the lower the dose received.

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