OCR
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GCSE (9–1) in Combined Science B (Twenty First Century Science)

J260/07 Physics (Higher Tier)

Wednesday 23 May 2018 – Afternoon

Time allowed: 1 hour 45 minutes

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

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

J260/07

First name										
Last name										
Centre number						Candidate number				

INSTRUCTIONS
- The Data Sheet will be found inside this document.
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

INFORMATION
- The total mark for this paper is **95**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in the question marked with an asterisk (*).
- This document consists of **24** pages.

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Answer **all** the questions.

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]**

(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]

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

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

(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]**

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

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

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

What is the difference between these two isotopes?

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

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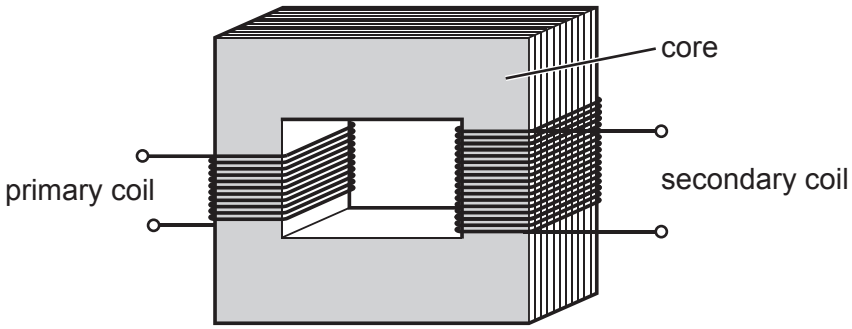
2* Eve wants to connect an electric pump to the mains electricity supply.

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

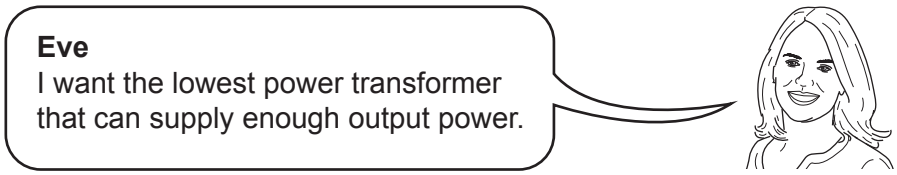


input power = potential difference across primary coil × current in primary coil

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



7

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

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

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

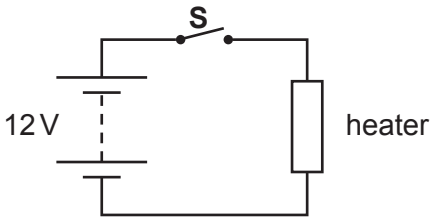

Fig. 3.1

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

Calculate the resistance of the heating element.

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

Give the units in your answer.

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

(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]

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

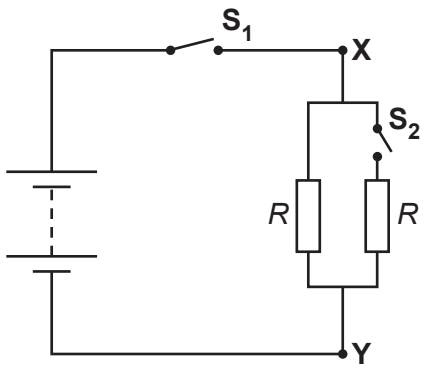

Fig. 3.2

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.

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

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

Renewable resources generated 83.3 TW h, 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]**

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

.....

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

(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.....

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Gas-fired power station

Advantage .....

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Disadvantage.....

.....

[4]

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**.

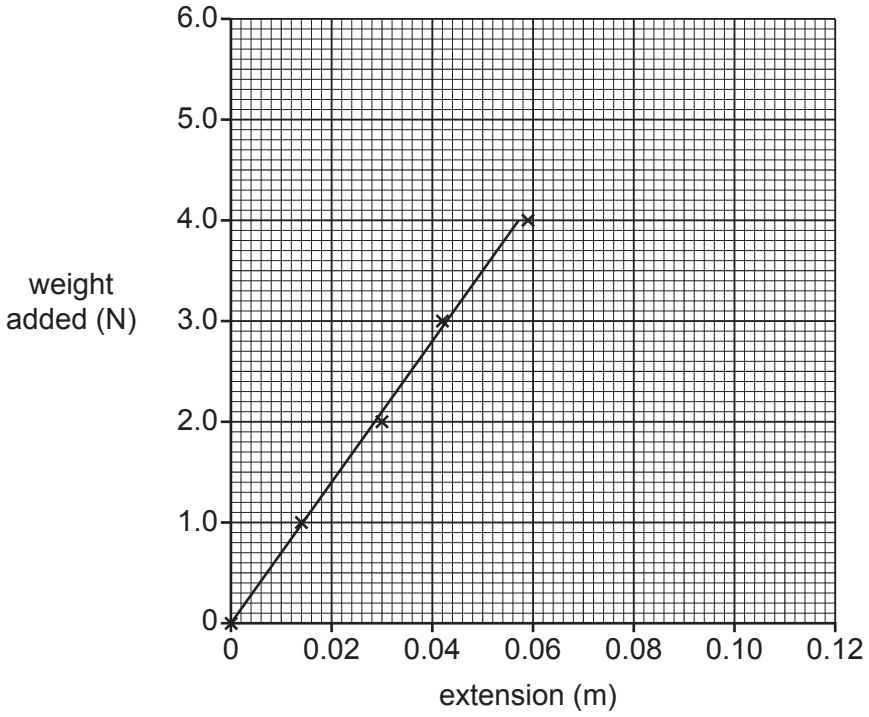

Fig. 5.1

(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]**

(b) Amir collects four more measurements. He first adds more weights, then removes weights from the spring. His results are shown in **Table 5.1**.

Force (N)	Extension (m)
5.0	0.09
5.5	0.12
4.0	0.10
1.0	0.06

Table 5.1

(i) Plot the results from **Table 5.1** on the graph in **Fig. 5.1**. **[1]**

(ii) Describe the relationship shown in the graph in **Fig. 5.1**, between the force and the extension, and how it changed.

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

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

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

(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]**

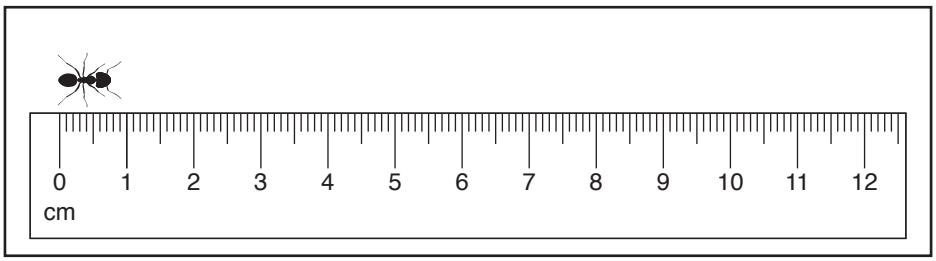
6 Silver ants live in the Sahara desert. If they are in the sunshine for too long they die, so the ants must be able to move out of the sun very quickly.

Sarah wants to find out how quickly they can move.

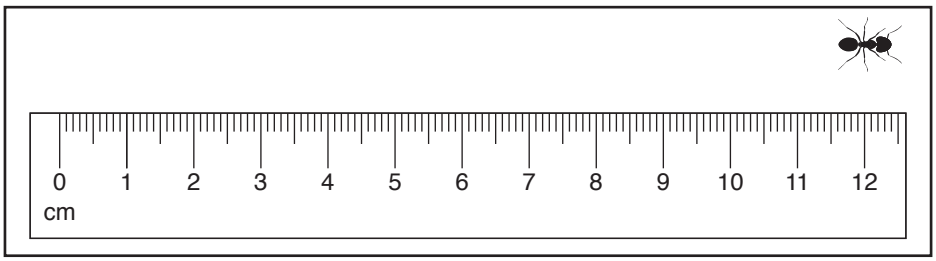
She places a ruler on the ground. When an ant starts to run along the edge of the ruler she uses a video camera to record the ant's movement.

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

Frame 1



Frame 5



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

Give your answer in metres.

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

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

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

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

(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.

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

(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.

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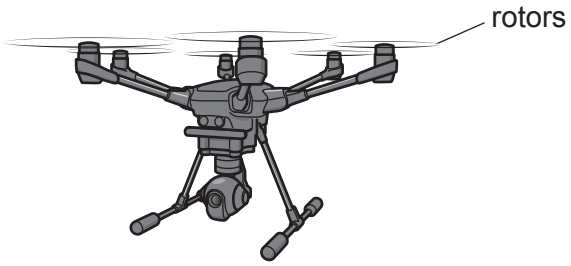
..... **[3]**

7 Drones are unmanned aerial vehicles.

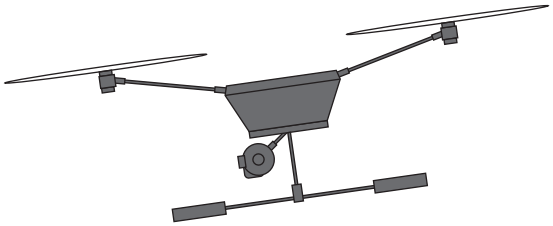


The vertical upward lift force on the drone is increased or decreased by changing the speed of the rotors.

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

[2]

(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.

direction of travel

[3]

(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]**

(iii) The air resistance increases to 6 N. The drone travels at a steady horizontal speed.

What is the magnitude of the resultant horizontal force on the drone?

Put a (ring) around the correct answer.

0 N **2 N** **4 N** **6 N** **18 N**

[1]

(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]**

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

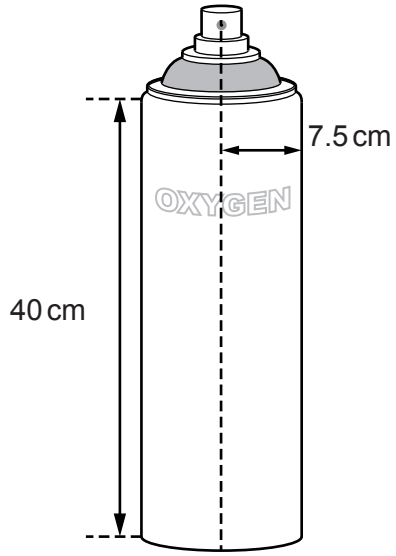


Fig. 8.1

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

The density of the gas is $7.1 \times 10^{-3}\,g/cm^3$.

Use the equation: volume of a cylinder = $\pi \times (\text{radius})^2 \times \text{height}$

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

(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]**

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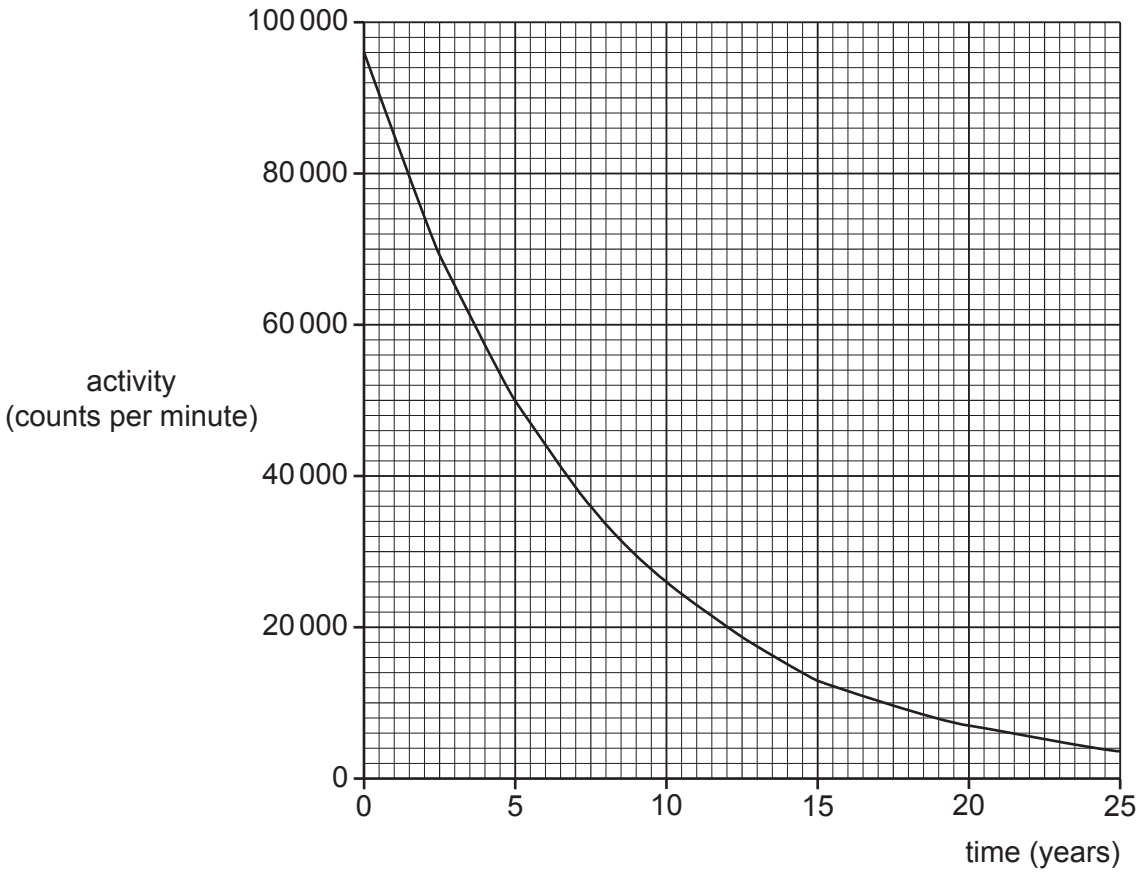
9 Cobalt-60 radioactive sources are used to sterilise medical equipment. The sterilising source is a rack containing an array of up to 96 smaller cobalt-60 sources.

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]**

(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]

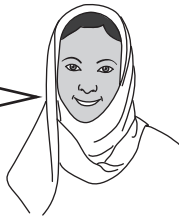
(c) Medical equipment is placed in a container which is moved around the source rack so that all sides are irradiated. The speed of the container past the source rack can be changed.

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]**

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).