OCR
Oxford Cambridge and RSA

Friday 14 June 2024 – Afternoon

GCSE (9–1) Combined Science A (Gateway Science)

J250/12 Physics (Higher Tier)

Time allowed: 1 hour 10 minutes

H

You must have:
- a ruler (cm/mm)
- the Equation Sheet for GCSE (9–1) Combined Science A (Physics) (inside this document)

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

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **60**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **20** pages.

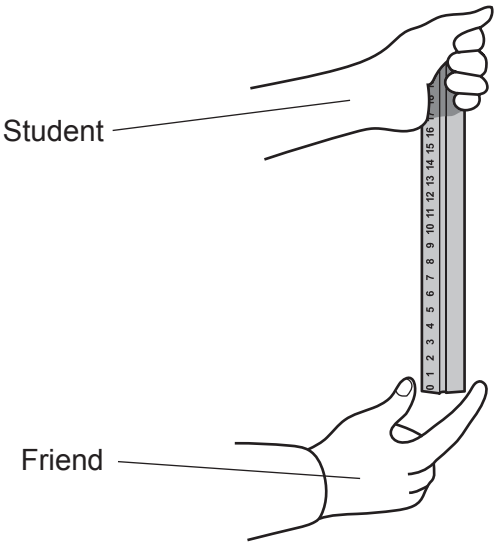
ADVICE
- Read each question carefully before you start your answer.

Section A

You should spend a **maximum** of **20 minutes** on this section.

Write your answer to each question in the box provided.

1 A student uses a ruler to measure a friend's reaction time.



How does the student determine the friend's reaction time?

A Divide the length of the ruler by the time taken to catch the ruler.

B Measure the length of the ruler where the friend catches it and convert to a time.

C Multiply the length of the ruler by the time taken to catch the ruler.

D Time how long it takes the ruler to hit the floor.

Your answer ☐ **[1]**

2 Some students design a practical to model radioactive decay.

Which model is correct?

A Throw a coin in the air 100 times and count the number of heads or tails.

B Throw 10 dice in a tray 10 times and add up the scores.

C Throw 100 dice in a tray and remove the ones with a 6 facing up.

D Throw 100 identical wooden blocks in a tray.

Your answer ☐ **[1]**

3 A bird sits on a branch in a tree.

The mass of the bird is 2.0 kg.
The gravitational potential energy of the bird is 170 J.

What is the height of the bird above the ground?

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

Gravitational field strength = 10 N / kg

A 8.5 m

B 17 m

C 34 m

D 85 m

Your answer ☐ **[1]**

4 A bus travels at 11 m / s. The kinetic energy of the bus is 726 000 J.

What is the mass of the bus?

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

A 3000 kg

B 6000 kg

C 12 000 kg

D 132 000 kg

Your answer ☐ **[1]**

5 In energy transfers, some energy is dissipated.

Into which store does the dissipated energy go?

A A chemical store

B A gravitational store

C A nuclear store

D A thermal store

Your answer ☐ **[1]**

6 Wave **X** and wave **Y** are two electromagnetic waves in space.

The frequency of wave **X** is double the frequency of wave **Y**.

Which answer describes the wavelength of wave **X**?

A Double the wavelength of wave **Y**

B Half the wavelength of wave **Y**

C Quadruple the wavelength of wave **Y**

D The same as the wavelength of wave **Y**

Your answer ☐ **[1]**

7 How can a house be heated more efficiently?

A Increase the temperature in the house.

B Turn the radiators on for a longer time.

C Use insulation with a greater thickness.

D Use insulation with a higher thermal conductivity.

Your answer ☐ **[1]**

8 A radio wave has a frequency of 88 MHz.

What is 88 MHz converted to kHz?

A 0.088 kHz

B 88 000 kHz

C 88 000 000 kHz

D 88 000 000 000 kHz

Your answer ☐ **[1]**

9 0.18 J of energy is stored in a spring when it stretches by 12 cm.

What is the spring constant of the spring?

Use the Equation Sheet.

A 0.0025 N / m

B 3 N / m

C 12.5 N / m

D 25 N / m

Your answer ☐ **[1]**

10 How do crumple zones make it safer for passengers in cars in a crash?

A They increase the force needed to stop the car.

B They increase the rate of change of momentum of the car.

C They increase the time taken for the car to stop.

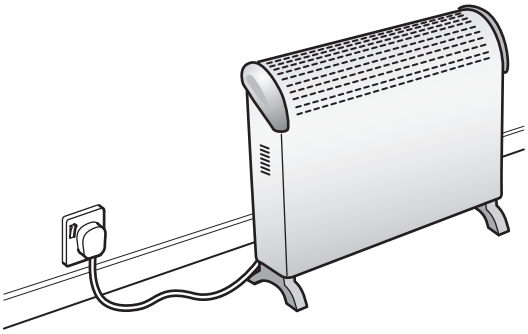
D They increase the work done by the brakes.

Your answer ☐ **[1]**

Section B

11 **Fig. 11.1** shows a heater plugged into an electrical socket.

Fig. 11.1



(a) The heater is operating normally.

What are the names of the two wires in the plug that carry a current?

Tick (✓) **one** box.

- Earth and fuse ☐
- Earth and neutral ☐
- Live and fuse ☐
- Live and neutral ☐

[1]

(b) A live wire is accidentally connected to the earth wire in the house. This causes a large current to flow in the earth wire.

This can cause electrocution.

Suggest **another** reason why this is dangerous.

.....

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

(c) A 2.4 kW heater is used for 2.5 hours each day for 1 week.

Calculate the energy transferred in kW h by the heater in 1 week.

Use the equation: energy transferred = power × time

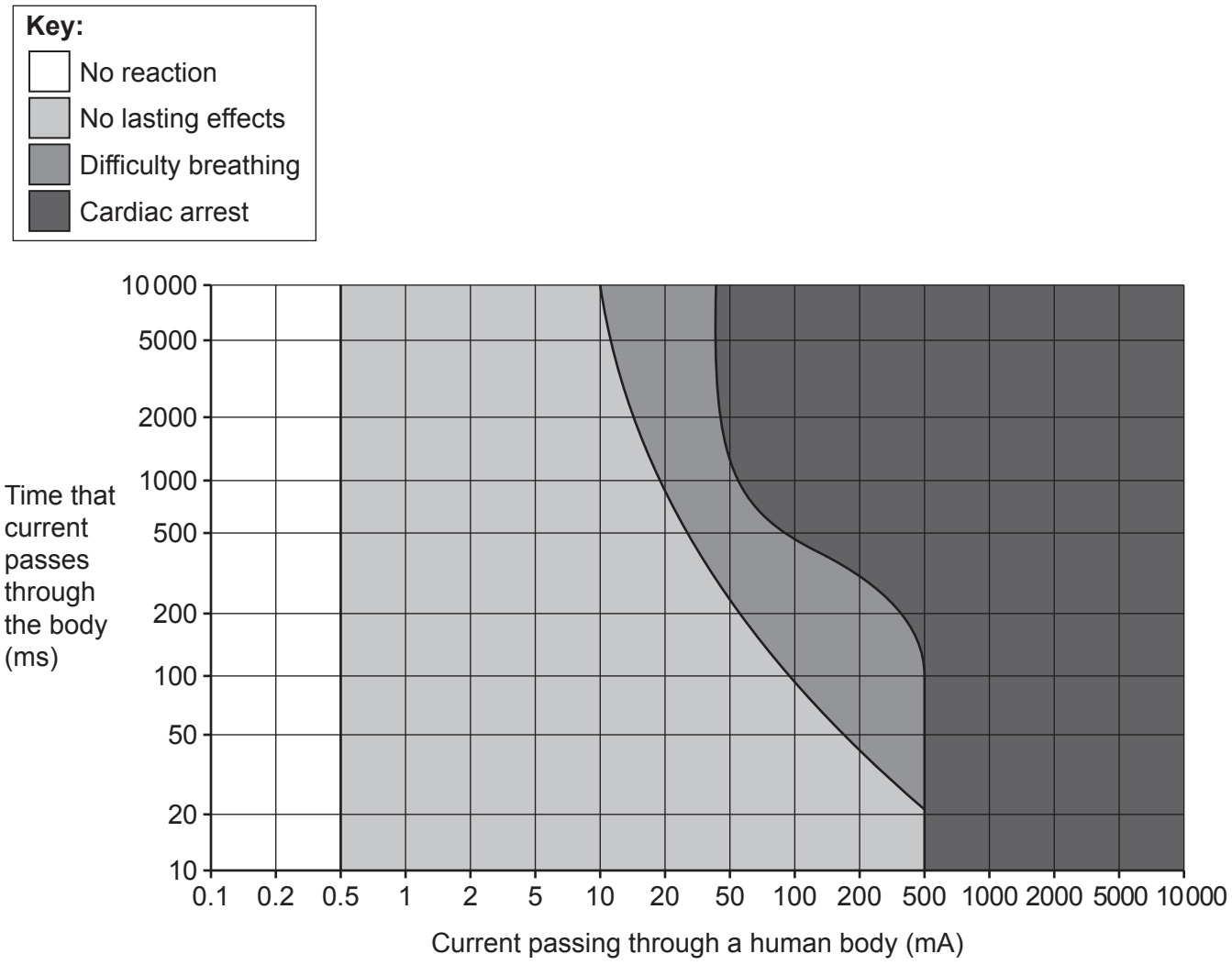
Energy transferred in 1 week = ... kW h **[2]**

(d) A residual current device (RCD) is a safety feature found in homes.

The RCD turns off the electricity quickly if it detects a fault due to a difference between the current in the live wire and the current in the neutral wire.

Fig. 11.2 shows the effects that mains current has on a human body.

Fig. 11.2



(i) Describe **one** trend shown by **Fig. 11.2**.

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

(ii) A current of 10 mA is passing through a human body.

How long can the current pass through the body before the person has difficulty breathing?

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

(iii) Calculate the charge flowing when 150 mA is in the human body for 0.3 s.

Use the equation: charge flow = current × time

Charge flow = ... C **[3]**

(iv) Sensitive RCDs are designed to shut off the electricity supply within 40 ms.

Suggest why this is an important feature for a current of 200 mA. Use **Fig. 11.2**.

.....

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

(v) An electrician has a choice of two different RCDs, **A** and **B**, to use in a house.

	RCD A	**RCD B**
Minimum difference in current needed between the live wire and neutral wire before electricity turns off (mA)	10	30
Time taken to turn off electricity (ms)	100	40

Suggest which RCD the electrician should use in the house.

Give **two** reasons. Use **Fig. 11.2**.

1 .....

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2 .....

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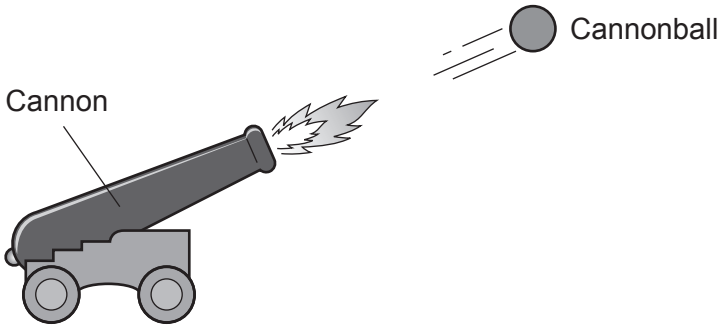
[2]

12 In 1709, William Derham measured the speed of sound using a cannon.



(a) A cannon contains an explosive called gunpowder. When a cannon is fired, the gunpowder acts as a fuel and is ignited. A cannonball moves upwards through the air.

Describe the change in energy stores when a cannon is fired.

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

(b) Derham climbed a church tower to look for the flash from the cannon and to hear its bang.

The cannon was fired a long distance away from the church.

Derham measured the distance between the cannon and the church.

(i) Describe how Derham used the firing of the cannon to work out the speed of sound.

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

(ii) Why is it important that the cannon is a long distance away?

.....

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

(c)

(i) Derham calculated the speed of sound using an old unit of distance called the Parisian foot.

One value he calculated for the speed of sound was 1122 Parisian feet per second.

1 Parisian foot = 32.5 cm

Calculate Derham's value for the speed of sound in **m / s**.

Speed = ... m / s **[2]**

(ii) Today, scientists know the speed of sound is 1056 Parisian feet per second.

The percentage difference between Derham's value and today's value for the speed of sound is calculated using this equation:

$$\text{percentage difference} = \frac{(\text{Derham's value} - \text{today's value})}{\text{today's value}} \times 100\%$$

Use this equation to evaluate the accuracy of Derham's value for the speed of sound.

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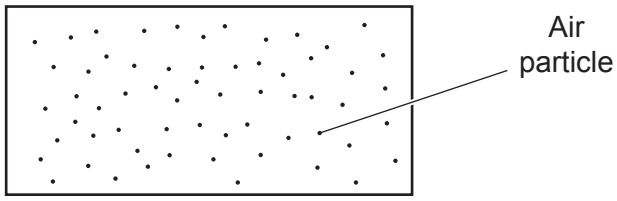
..... **[3]**

(d) **Fig. 12.1** shows air particles in a room.

Fig. 12.1

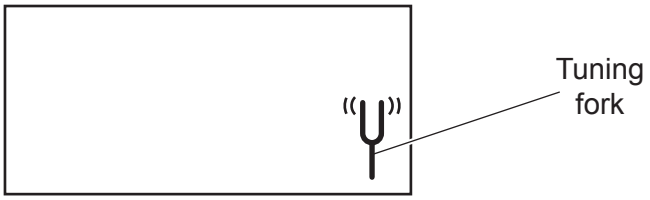


A scientist produces a sound wave in the room using a vibrating tuning fork.

Describe what happens to the air particles when the sound wave travels through the room as a longitudinal wave.

You can draw on **Fig. 12.2** to support your answer.

Fig. 12.2



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

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13 This question is about transformers.

(a) Complete the sentences to describe how transformers are used in the national grid.

Put a (ring) around each correct option.

A **step-up** / **step-down** transformer increases **current** / **potential difference** at the power station.

A **step-up** / **step-down** transformer **increases** / **decreases** potential difference locally for domestic use. **[1]**

(b) A student researches three different transformers **A**, **B** and **C**.

(i) Transformer **A** is used to decrease a potential difference from 240 V to 20 V.

The current in the primary coil is 0.8 A.

Calculate the current in the secondary coil.

Use the Equation Sheet.

Current = ... A **[2]**

(ii) Transformer **B** is used in a lighting circuit.

The energy input to the primary coil is 175 J.

The energy output from the secondary coil is 140 J.

Calculate the efficiency of the transformer.

Use the Equation Sheet.

Efficiency = ... **[3]**

(iii) A lamp is connected to the secondary coil of transformer **C**.

The current in the lamp is 0.25A. The resistance of the lamp is 800Ω.

The lamp is at its normal brightness.

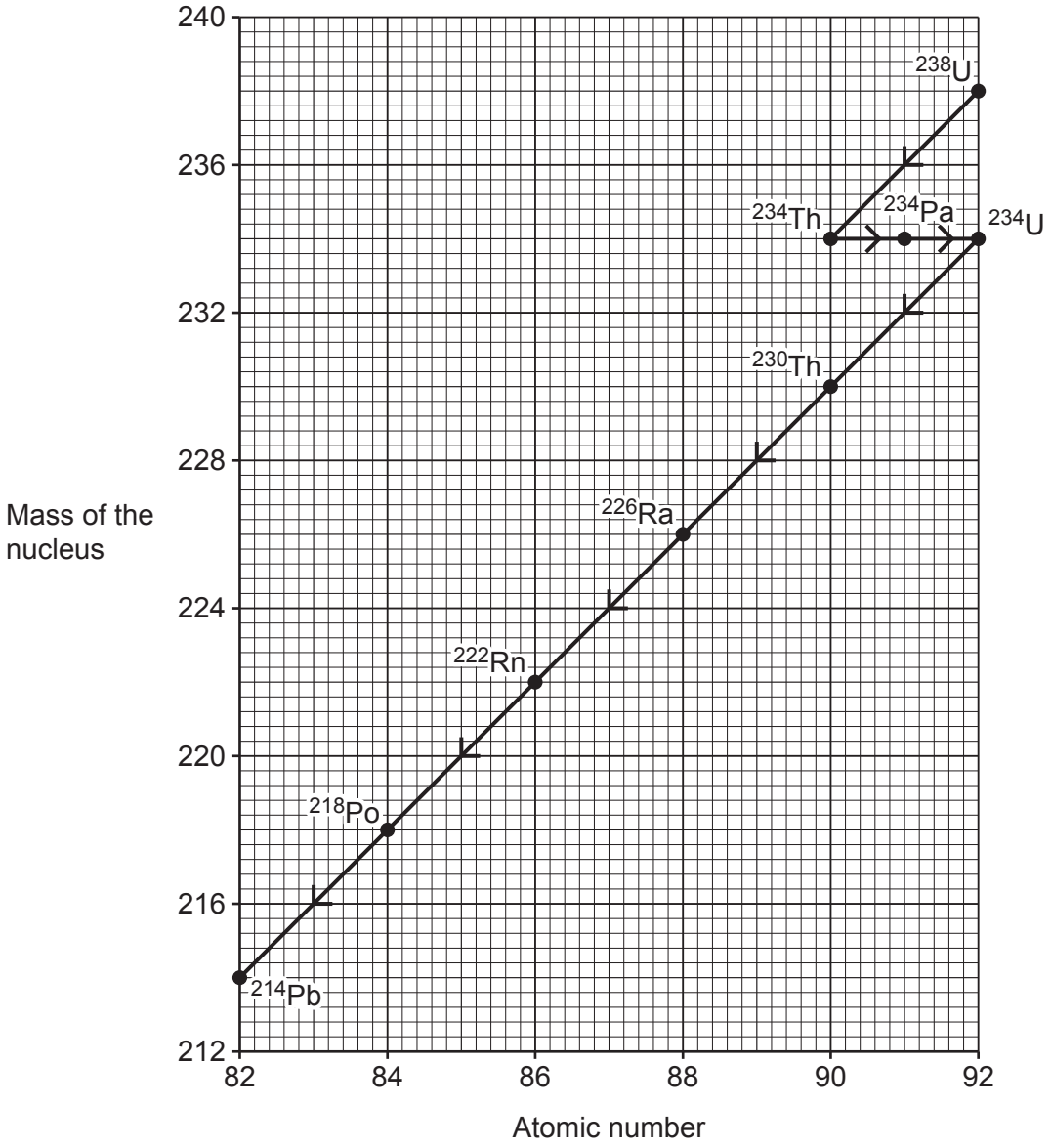
Calculate the output power of transformer **C**.

Use the Equation Sheet.

Power = ... W **[3]**

14 When uranium-238 decays, it forms isotopes of different elements.

The graph shows part of the decay chain produced when uranium-238 decays.



(a) Circle **two** points on the graph which are isotopes of the same element.

Explain how you worked out your answer.

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

(b)

(i) Describe what happens to the atomic number and mass of a nucleus of ^{234}Th as it decays into ^{234}Pa.

Atomic number .....

Mass .....

[2]

(ii) Which type of radiation is emitted when ^{234}Th decays into ^{234}Pa?

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

(c) Complete the **balanced nuclear decay equation** for the decay of ^{222}Rn into ^{218}Po.

$$\text{.....}^{222}\text{Rn} \longrightarrow \text{.....}^{218}\text{Po} + \text{.....}^{\text{.....}}\text{He}$$

[2]

(d) Eventually the isotope ^{206}Pb is formed and the decay chain stops.

Explain why the decay chain stops at ^{206}Pb.

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

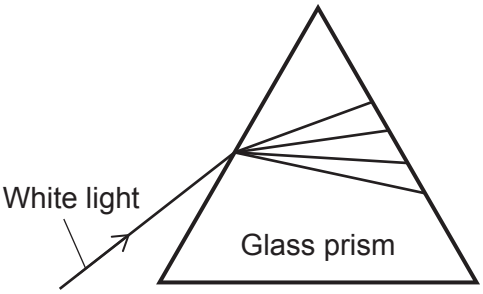
(e) The half-life of ^{238}U is 4.5×10^9 years.

Determine the ratio of ^{238}U : ^{234}Th after 1.8×10^{10} years.

Ratio of ^{238}U : ^{234}Th = ... : ..... **[3]**

15* A student shines a ray of white light from air into a glass prism.

White light is made up of many different colours of light. The diagram shows the path of **four** of these colours of light in the prism.



The speed of these four colours of light in air is 3.0×10^8 m/s.

The table shows the wavelengths and the speeds of these four different colours of light in the glass prism.

Colour	Wavelength in glass prism (nm)	Speed in glass prism (m/s)
Red	640	1.986×10^8
Yellow	589	1.984×10^8
Blue	486	1.976×10^8
Violet	434	1.971×10^8

Describe:

- what the student sees when the light travels into the glass prism
- the relationship between the wavelengths of the four different colours of light and their speeds in the glass prism.

Explain your answer using the data in the table and ideas about refraction.

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

END OF QUESTION PAPER

EXTRA ANSWER SPACE

If you need extra space use this lined page. You must write the question numbers clearly in the margin.