

**OXFORD CAMBRIDGE AND RSA EXAMINATIONS**  
**GCSE**  
**A182/02**  
**TWENTY FIRST CENTURY SCIENCE**  
**PHYSICS A/ADDITIONAL SCIENCE A**  
**Modules P4 P5 P6 (Higher Tier)**  
**FRIDAY 17 JUNE 2016: Morning**  
**DURATION: 1 hour**  
**plus your additional time allowance**  
**MODIFIED ENLARGED 24pt**

<b>Candidate forename</b>		<b>Candidate surname</b>	
<b>Centre number</b>			

**Candidates answer on the Question Paper.**  
**A calculator may be used for this paper.**

**OCR SUPPLIED MATERIALS:**  
**None**

**OTHER MATERIALS REQUIRED:**  
**Pencil**  
**Ruler (cm/mm)**

**READ INSTRUCTIONS OVERLEAF**



## **INSTRUCTIONS TO CANDIDATES**

**Write your name, centre number and candidate number in the boxes on the first page. Please write clearly and in capital letters.**

**Use black ink. HB pencil may be used for graphs and diagrams only.**

**Answer ALL the questions.**

**Read each question carefully. Make sure you know what you have to do before starting your answer.**

**Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.**

## **INFORMATION FOR CANDIDATES**

**The quality of written communication is assessed in questions marked with a pencil ().**

**A list of useful relationships is printed on pages 4–6.**

**The number of marks is given in brackets [ ] at the end of each question or part question.**

**The total number of marks for this paper is 60.**

**Any blank pages are indicated.**

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# **TWENTY FIRST CENTURY SCIENCE EQUATIONS**

## **USEFUL RELATIONSHIPS**

### **THE EARTH IN THE UNIVERSE**

$$\text{distance} = \text{wave speed} \times \text{time}$$

$$\text{wave speed} = \text{frequency} \times \text{wavelength}$$

### **SUSTAINABLE ENERGY**

$$\text{energy transferred} = \text{power} \times \text{time}$$

$$\text{power} = \text{voltage} \times \text{current}$$

$$\text{efficiency} = \frac{\text{energy usefully transferred}}{\text{total energy supplied}} \times 100\%$$

## **EXPLAINING MOTION**

$$\text{speed} = \frac{\text{distance travelled}}{\text{time taken}}$$

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$$

$$\text{momentum} = \text{mass} \times \text{velocity}$$

$$\text{change of momentum} = \text{resultant force} \times \text{time for which it acts}$$

$$\text{work done by a force} = \text{force} \times \text{distance moved in the direction of the force}$$

$$\text{amount of energy transferred} = \text{work done}$$

$$\text{change in gravitational potential energy} = \text{weight} \times \text{vertical height difference}$$

$$\text{kinetic energy} = \frac{1}{2} \times \text{mass} \times [\text{velocity}]^2$$

## **ELECTRIC CIRCUITS**

$$\text{power} = \text{voltage} \times \text{current}$$

$$\text{resistance} = \frac{\text{voltage}}{\text{current}}$$

$$\frac{\text{voltage across primary coil}}{\text{voltage across secondary coil}} = \frac{\text{number of turns in primary coil}}{\text{number of turns in secondary coil}}$$

## **RADIOACTIVE MATERIALS**

$$\text{energy} = \text{mass} \times [\text{speed of light in a vacuum}]^2$$

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## Answer ALL the questions

1 Roy is stacking shelves at the supermarket.

He lifts boxes of tins from the floor to the shelves.

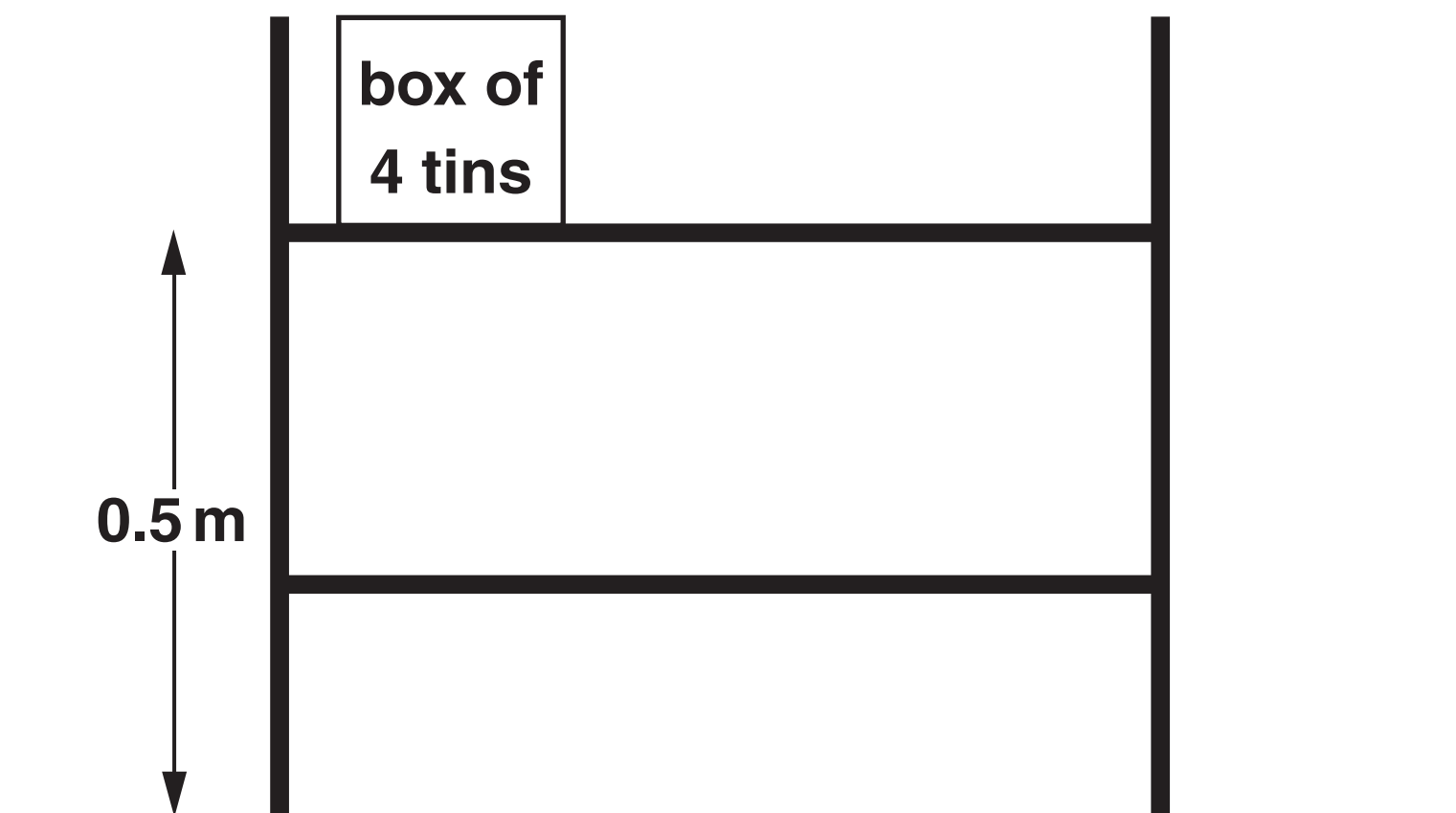
(a) Each tin weighs 5 N.

An empty box weighs 2 N.

(i) What is the smallest force that Roy has to pull on a BOX OF 4 TINS when lifting it?

force = \_\_\_\_\_ N [1]

(ii) Roy lifts a box of 4 tins from the floor to a shelf 0.5 m above the floor.





**Calculate how much gravitational potential energy the box gains.  
Include the correct unit in your answer.**

**gain in gravitational potential energy =**

\_\_\_\_\_ unit \_\_\_\_\_ **[2]**

- (iii) Roy says, ‘I get hot when lifting the tins. I must be using more energy than the tins gain.’**

**State what is meant by CONSERVATION OF ENERGY  
and explain how it applies to Roy.**

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ **[2]**

**(b) A box of tins of total mass 3.2 kg, weight 32 N, falls from a shelf.**

**The shelf is 1.5 m above the ground.**

**Calculate the speed of the box just before it hits the ground. Show your working.**

**You may assume that the effect of air resistance is negligible.**

**speed = \_\_\_\_\_ m/s [3]**

**[TOTAL: 8]**

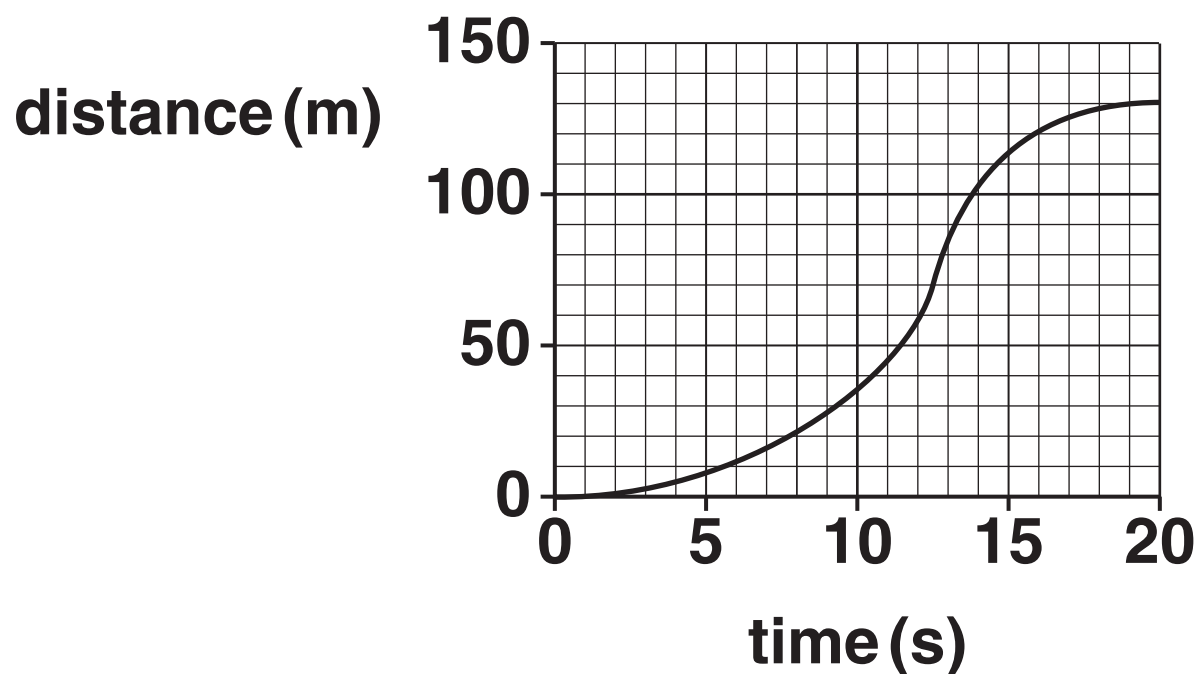
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- 2 Lorries are fitted with tachometers that automatically record their speed and distance travelled.

The data from the tachometer can be used to produce graphs.

- (a) Here is the distance-time graph for a journey lasting 20s.



Use the graph to determine:

- (i) The time when the lorry has the greatest instantaneous speed.

time = \_\_\_\_\_ s [1]

- (ii) The average speed for this journey.

average speed = \_\_\_\_\_ m/s [2]

**(iii) Here are some descriptions of the motion of the lorry during this 20 s journey.  
Put a tick (✓) in the box next to the correct description.**

**Speed increases, then decreases until the lorry becomes stationary.**

☐

**Speed increases, then decreases until the lorry is moving at constant speed.**

☐

**Speed increases until the lorry moves at constant speed.**

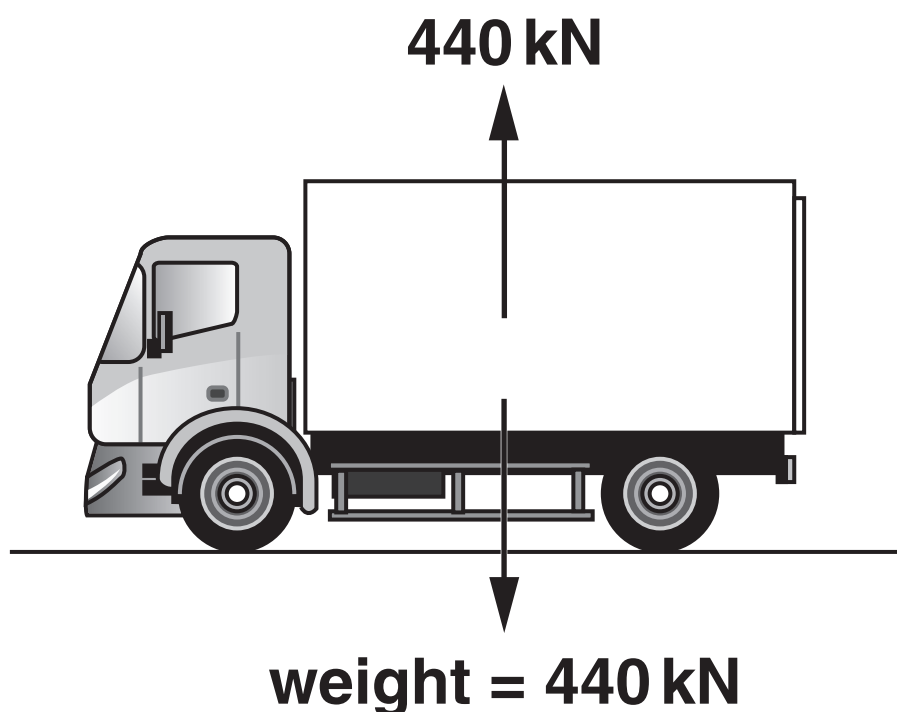
☐

**Speed increases until the lorry becomes stationary.**

☐

**[1]**

- (b) The diagram shows the forces acting on a stationary lorry.**



- (i) The downward force on the lorry is called weight. What is the name of the upward force?**

\_\_\_\_\_

**[1]**

- (ii) The lorry driver says that these two forces must be an interaction pair of forces as they are equal and opposite.**

**Explain why the driver is wrong.**

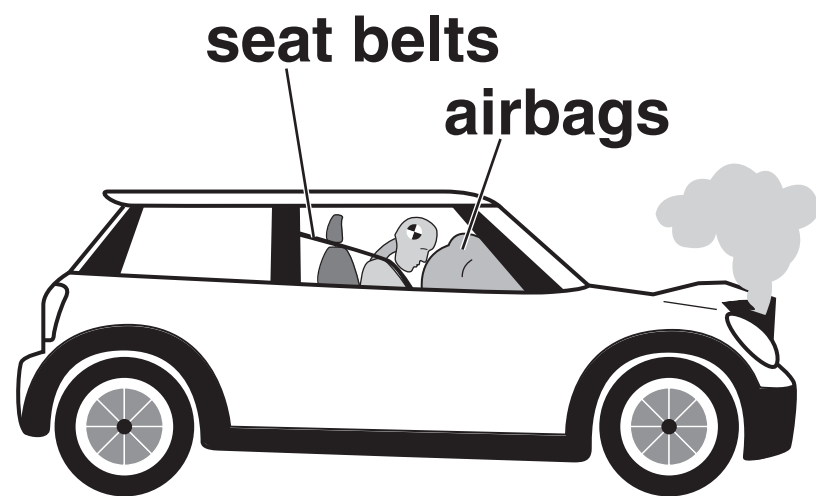
\_\_\_\_\_  
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\_\_\_\_\_

**[2]**

**[TOTAL: 7]**

3 Cars are built with a number of safety features to reduce the chance of injury to the passengers during a collision.

Seat belts and airbags are two of these features.



Use ideas about forces to explain why passengers are injured in a collision and how seat belts and airbags reduce the injury.



The quality of written communication will be assessed in your answer.

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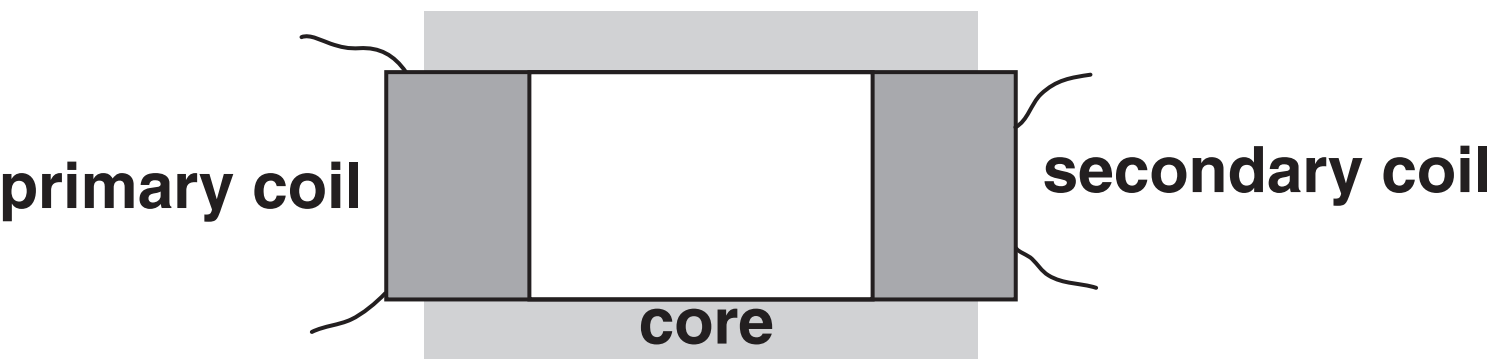
[6]

[TOTAL: 6]

4 The electrical energy supplied to homes in the UK comes from power lines that carry the energy at very high voltage.

Transformers are used to change the voltage between the power lines and homes.

The diagram shows a transformer.



Explain how the voltage across the secondary coil is produced.

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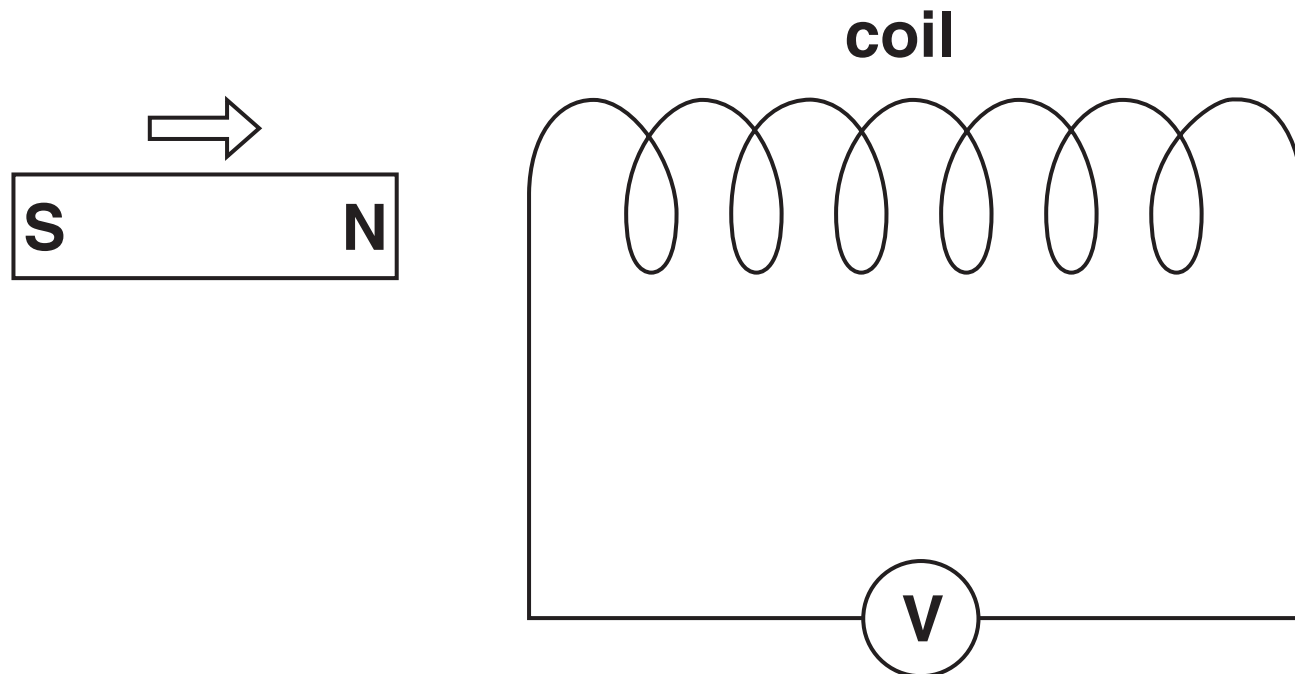
[3]

[TOTAL: 3]



**5 (a) Maria is investigating the generation of electricity.**

**She pushes the north pole of a magnet into a coil of wire.  
The coil is connected to a sensitive voltmeter.**



**The voltmeter gives a reading when the magnet is moving.**

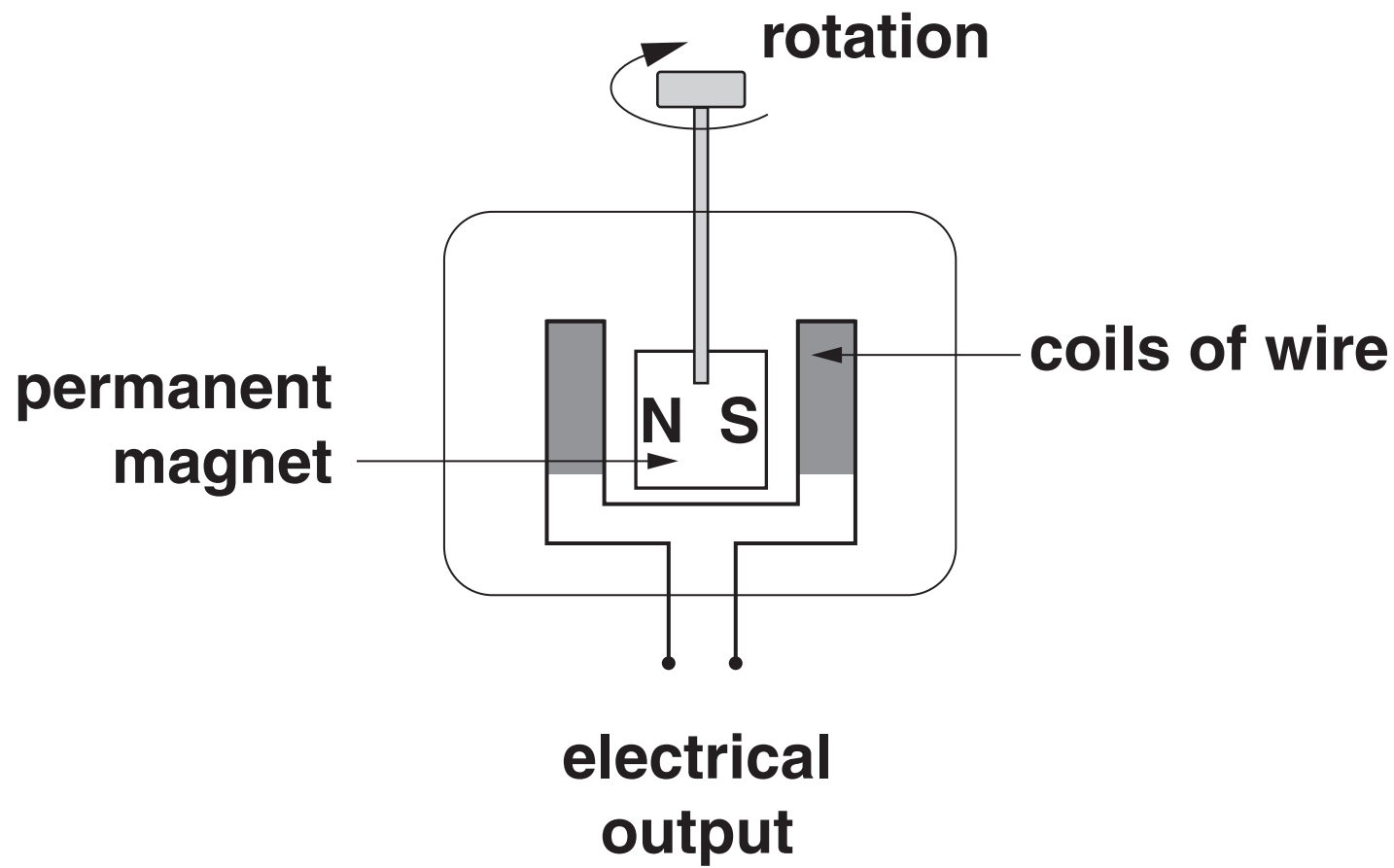
**(i) What is the name of the process that produces the voltage?**

\_\_\_\_\_ **[1]**

**(ii) State one change that Maria can make to produce a voltage in the opposite direction.**

\_\_\_\_\_ **[1]**

**(b) Maria investigates an a.c. generator (dynamo) from a bicycle.**



**A voltage is produced when the magnet rotates.**

**(i) She connects a lamp to the output of the generator.**

**The lamp glows more brightly when she rotates the magnet faster.**

**State why the lamp glows more brightly.**

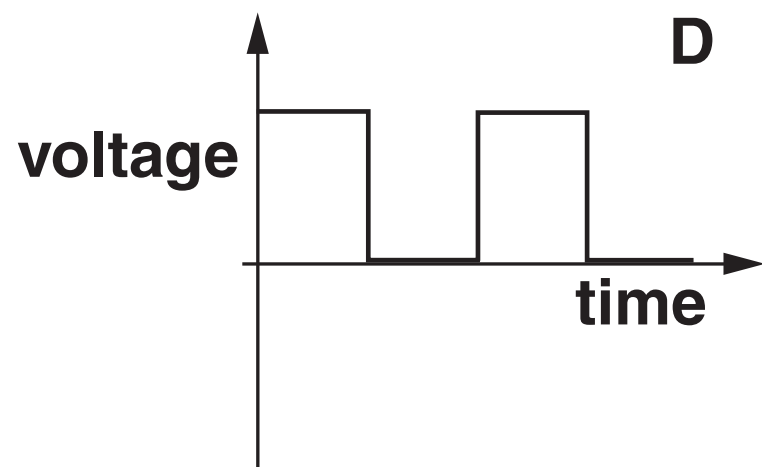
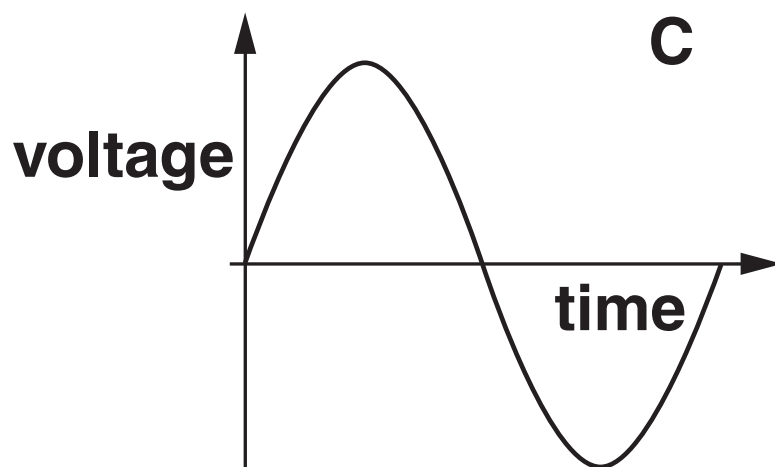
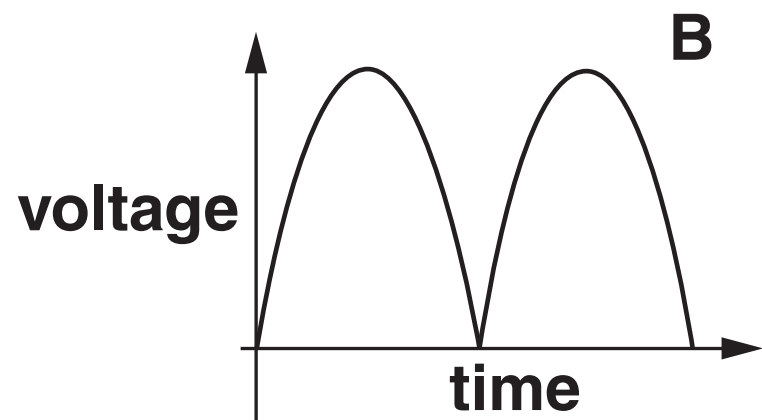
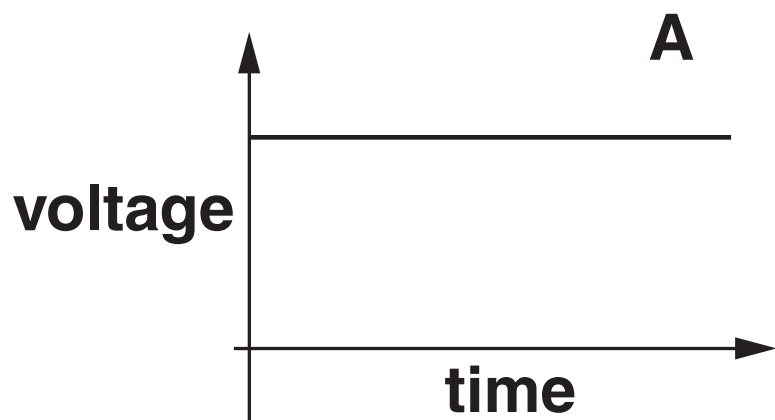
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**[1]**

(ii) The magnet is rotated at a constant speed.

Which graph shows how the voltage of this a.c. generator changes during one complete rotation of the magnet?

Put a ring around the letter next to the correct answer.



[1]

(iii) In some generators the coil is wound on a solid core so that a lamp lights at slower speeds of rotation.

State the name of the material used for the solid core.

\_\_\_\_\_ [1]

[TOTAL: 5]

6 Tim is investigating whether the resistance of a piece of wire varies with the current through it.

Here are his results.

Current (A)	0.2	0.4	0.6	0.8	1.0
Resistance ( $\Omega$ )	8.2	8.2	8.3	8.8	9.4

(a) Tim’s friends talk about his results.

Abe says, ‘Tim needs to make more readings.’

Chris says, ‘A graph would help to interpret the results.’

Dan says, ‘Tim has kept the wire at the same temperature.’

Eve says, ‘There is a positive correlation between the current and resistance.’

Ben says, ‘There are more collisions between the moving charges and ions in the wire as the current increases.’

(i) Who draws a valid conclusion from the data?

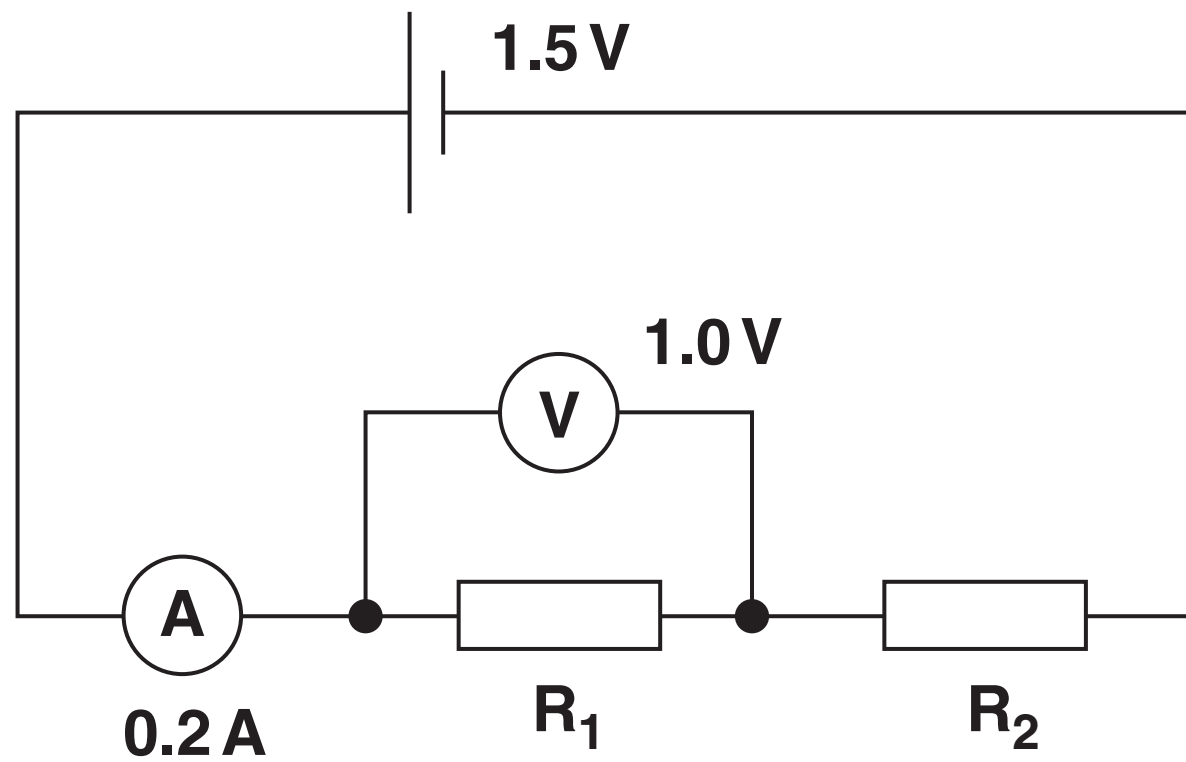
\_\_\_\_\_ [1]

(ii) Who suggests an explanation?

\_\_\_\_\_ [1]

Tim also connects resistors in series and parallel.

(b) He sets up this series circuit.



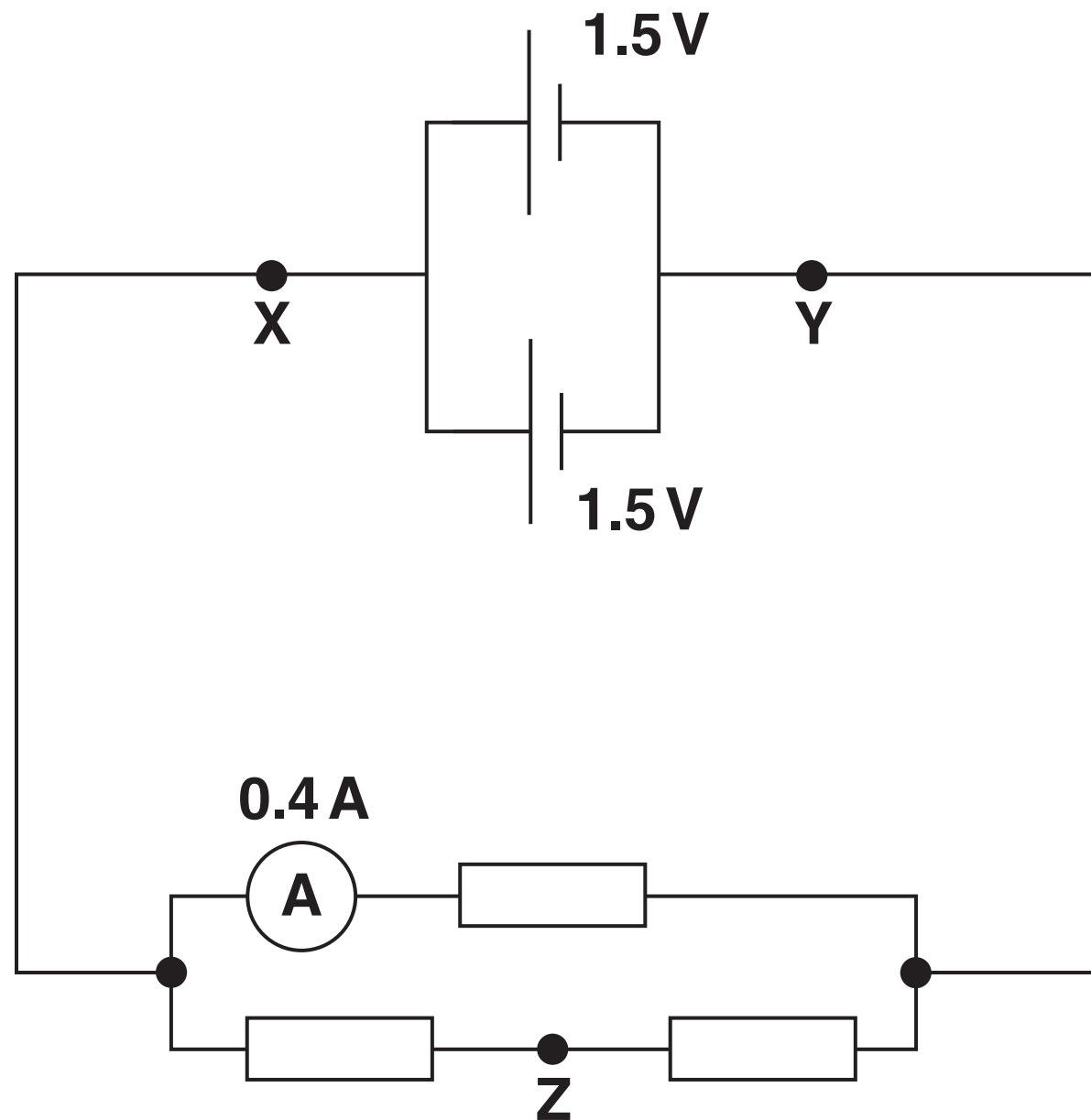
(i) Calculate the resistance of  $R_1$ .

resistance of  $R_1 =$  \_\_\_\_\_  $\Omega$  [1]

(ii) What is the voltage across  $R_2$ ?

voltage across  $R_2 =$  \_\_\_\_\_  $\text{V}$  [1]

(c) He sets up this parallel circuit.



(i) What is the voltage between points X and Y?

voltage = \_\_\_\_\_ V [1]

(ii) All the resistors have the same resistance.

What is the current through point Z?

current = \_\_\_\_\_ A [1]

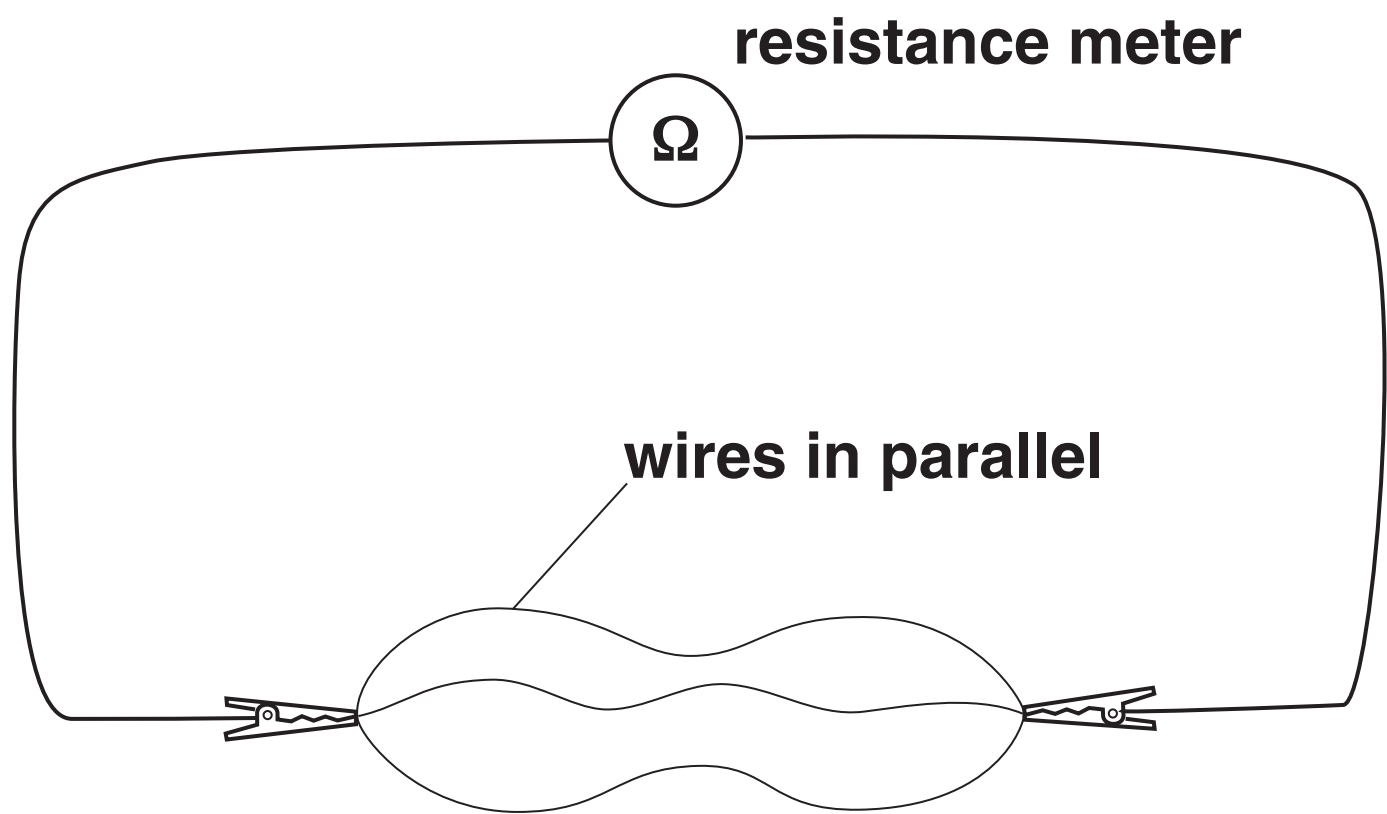
[TOTAL: 6]

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7 Sarah is investigating the resistance of wires connected in parallel.

She uses three wires that are all the same as each other.

She connects the three wires in parallel and uses a resistance meter to measure the resistance.



Sarah does this again for two wires in parallel.

These are her results:

Number of wires in parallel arrangement	Resistance ( $\Omega$ )
2	6
3	4



Sarah thinks that there is a correlation between the number of wires and the resistance of the parallel arrangement.

Explain the correlation in Sarah’s results and describe ways she could improve this investigation.



The quality of written communication will be assessed in your answer.

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[6]

[TOTAL: 6]

## 8 Radioactive sources are used in hospitals.

**Radioactive tracers allow the doctor to investigate organs in a patient's body without surgery.**

**The patient has a radioactive tracer injected into a vein.**

**The hospital has four radioactive sources, A, B, C and D.**

RADIOACTIVE SOURCE	RADIATION EMITTED	ACTIVITY (COUNTS PER MINUTE)		
		At start	After 1 hour	After 2 hours
A	$\alpha$	2000	140	8
B	$\alpha$	1000	490	240
C	$\gamma$	2000	950	485
D	$\gamma$	1000	75	5

**The doctor wants to use a tracer with a half-life of about 1 hour.**

**Which radioactive source should the doctor use as the tracer?**

**Justify your choice using the data in the table.**

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**[3]**

**[TOTAL: 3]**

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**9 Pete lives near the site of a planned new nuclear power station.**

**He has read about how nuclear power stations produce energy.**

**(a) In the new power station the maximum amount of uranium converted to energy every second will be  $5.0 \times 10^{-8}$  kg.**

**Calculate the maximum energy that will be released every second.**

**The speed of light is  $3.0 \times 10^8$  m/s.**

**Show your working.**

**maximum energy every second =**

**\_\_\_\_\_ J [2]**

**(b) Pete is concerned about the high level waste produced by the nuclear power station.**

**Describe how high level waste is disposed of.**

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [2]

**(c) Pete expresses another concern to Ali.**

**Pete says, ‘I’m very concerned that it is highly likely a nuclear accident will occur at the power station.’**

**Ali says, ‘Statistics show that the chance of a nuclear accident at a power station is far less than being involved in a road accident.’**

**Suggest reasons why Pete over-estimates the risks from a nuclear accident at a power station.**

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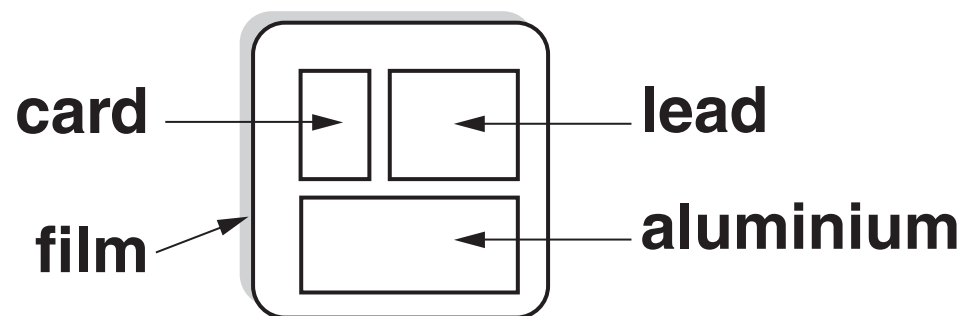
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[3]

- (d) People who work in nuclear power stations wear a badge to monitor the type of ionising radiation they are exposed to.

One type of badge consists of a photographic film behind three windows made of different materials, aluminium, lead and card.



The film becomes fogged (darkened) if radiation passes through the window.

Fogged areas are shown as  in the following diagrams.

- (i) Suggest why this badge cannot be used to detect  $\alpha$  radiation.

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[1]

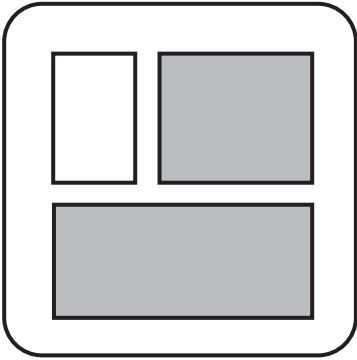
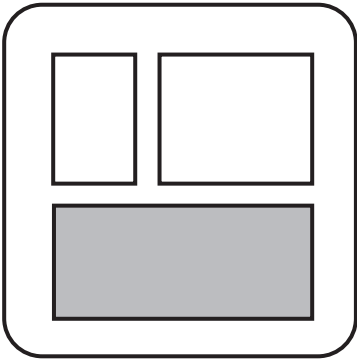
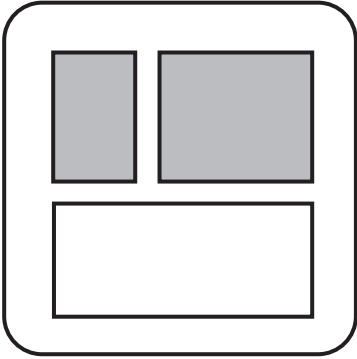
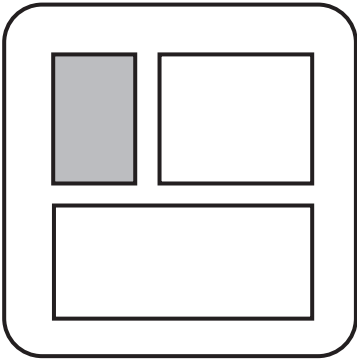
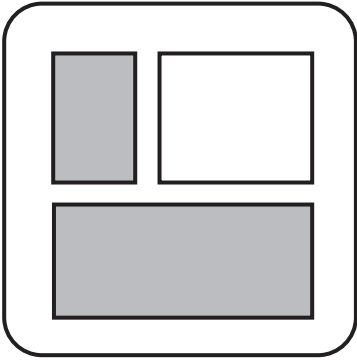
(ii) Draw one straight line from each TYPE OF RADIATION on the left to its correct FILM on the right.

TYPE OF RADIATION

$\beta$  only

$\gamma$  only

FILM



[2]

[TOTAL: 10]

**10 In the UK some vegetables are sterilised by radiation during processing in order to extend their shelf-life.**

**The radiation is from a radioactive source.**

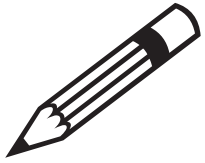
**A label on the pack states that the vegetables have been irradiated.**

**Donna is shopping and reads the information on the pack. She expresses her concerns to her friend.**

**‘I’m worried that I will be contaminated if I eat these vegetables.’**



**Explain how irradiating vegetables extends their shelf-life and give reasons why Donna's concerns are unfounded.**



**The quality of written communication will be assessed in your answer.**

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[6]

**[TOTAL: 6]**

**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).**

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