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Monday 21 May 2012 – Morning

GCSE TWENTY FIRST CENTURY SCIENCE PHYSICS A

A182/02 Modules P4 P5 P6 (Higher Tier)

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)

Duration: 1 hour

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. 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. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- Your quality of written communication is assessed in questions marked with a pencil (✎).
- A list of useful relationships is printed on page two.
- 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**.
- This document consists of **24** pages. Any blank pages are indicated.

TWENTY FIRST CENTURY SCIENCE EQUATIONS

Useful relationships

The Earth in the Universe

distance $=$ wave speed $\times$ time

wave speed $=$ frequency $\times$ wavelength

Sustainable energy

energy transferred $=$ power $\times$ time

power $=$ voltage $\times$ current

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

Explaining motion

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

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

momentum $=$ mass $\times$ velocity

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

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

amount of energy transferred $=$ work done

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

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

Electric circuits

power $=$ voltage $\times$ 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

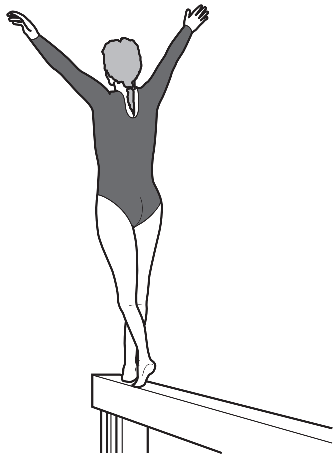
energy $=$ mass $\times$ $[\text{speed of light in a vacuum}]^2$

Answer **all** the questions.

1 There are many sports in the Olympics.

All of them use forces and energy.

(a) A gymnast is balancing on a beam.



(i) All forces arise from interaction pairs.

Which of the following conditions are needed for two forces to form an interaction pair?

Put ticks (✓) in the boxes next to the **two** correct answers.

Each force acts on a different object.	☐
If the object the forces act on is stationary, the forces gradually increase in size.	☐
One force must be bigger than the other.	☐
The forces act in opposite directions.	☐

[1]

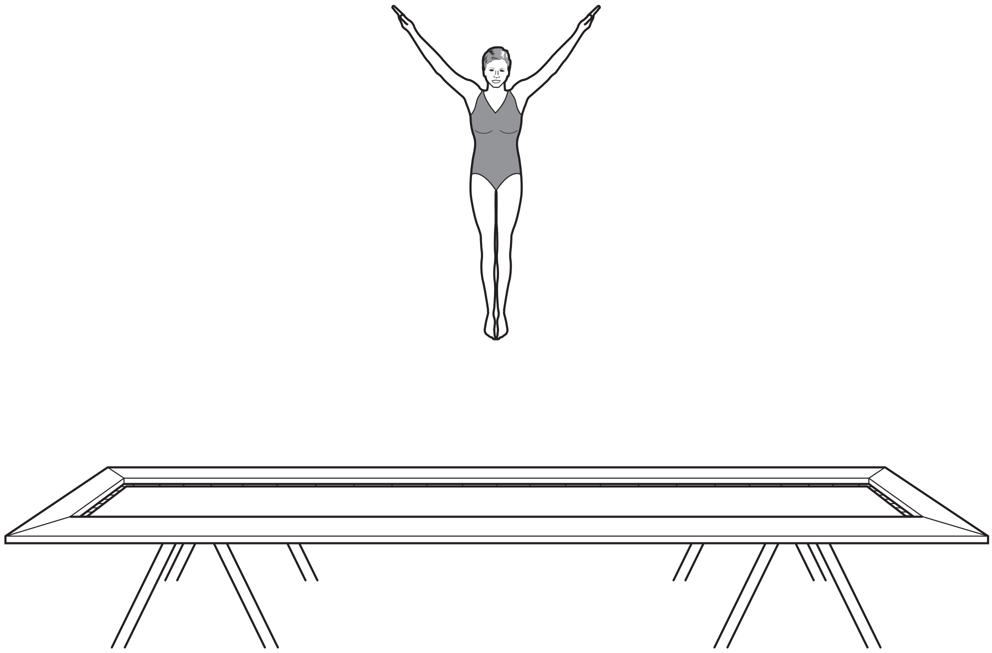
(ii) Which of the following pairs of forces form an interaction pair in this situation?

Put a tick (✓) in the box next to the correct answer.

The friction from the beam and the weight of the beam.	☐
The reaction of the beam and the push of the gymnast on the beam.	☐
The friction from the beam and the reaction of the beam.	☐
The push of the gymnast on the beam and the weight of the beam.	☐

[1]

(b) Another gymnast is jumping on a trampoline.



The weight of the gymnast is 500 N.

The trampoline does 250 J of work on the gymnast when launching her into the air.

(i) What does this mean?

Put a tick (✓) in the box next to the correct answer.

The gymnast's weight increases to 750 N. ☐

The trampoline causes the force on the gymnast to halve. ☐

The gymnast pushes down on the trampoline with a force of 250 N. ☐

The trampoline transfers 250 J of energy to the gymnast. ☐

[1]

(ii) How much height will the gymnast gain from 250 J of work being done on her?

Put a ring around the correct answer.

0.25 m **0.5 m** **2 m** **5 m** **10 m**

[1]

(iii) The trampoline stores elastic potential energy when it stretches.

Describe the energy changes as the gymnast moves from the top of one bounce to the top of the next bounce.

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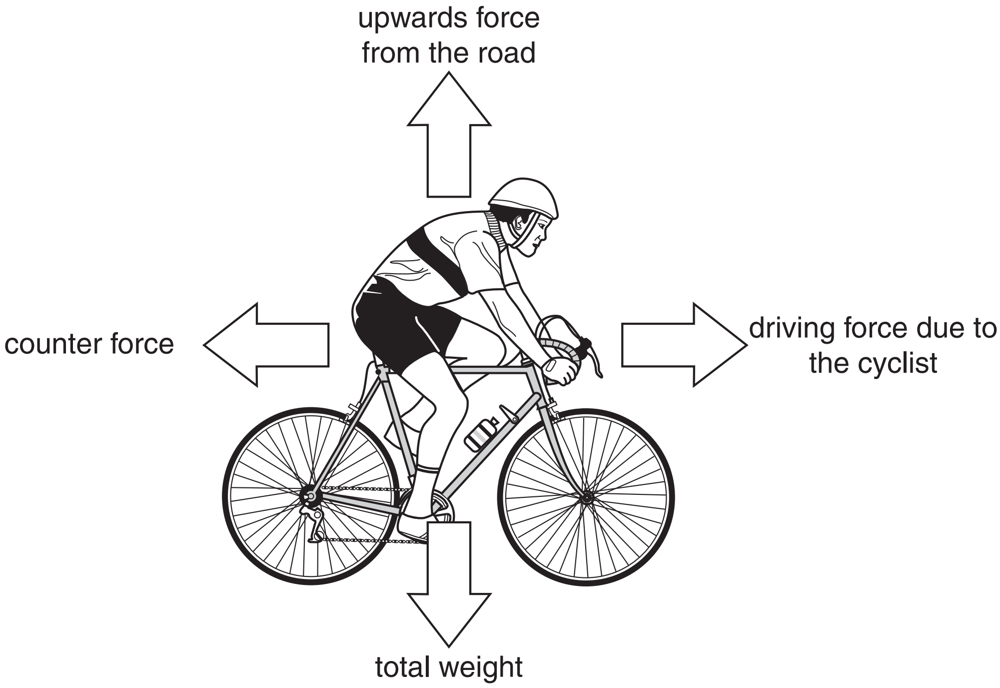
.... **[3]**

(c) A cyclist is travelling along a flat, straight road.
The forces acting on the bicycle are shown below.



The wind blowing into the face of the cyclist increases.
The cyclist pedals harder to maintain the same speed.
Here are some statements about the forces on the bicycle and the motion of the cyclist when these changes take place.

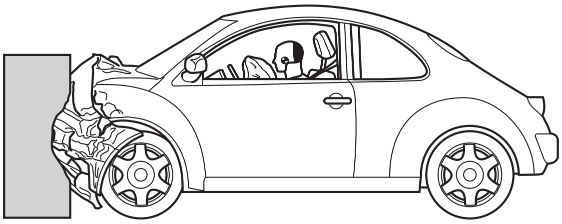
Put a tick (✓) in the correct box to complete each statement.

	… increases.	**… stays the same.**	**… decreases.**
The counter force …			
The upwards force from the road …			
The driving force …			
The weight …			
The momentum of the cyclist …			

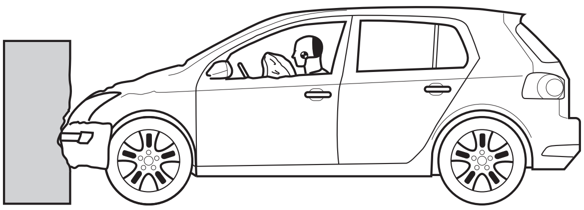
[3]

[Total: 10]

2 Two cars, **A** and **B**, are crash tested by scientists. **Car A** has a crumple zone but **car B** does not.



car A: crumple zone



car B: no crumple zone

Here is some information about the two crash tests.

	Car A	**Car B**
Mass of car in kg	1500	1500
Mass of driver in kg	80	80
Starting velocity of car in m/s	20	20
Time taken to stop in s	0.8	0.2

Using the information given, and by calculating the forces on the drivers, explain why a government might choose to make crumple zones a legal requirement.

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

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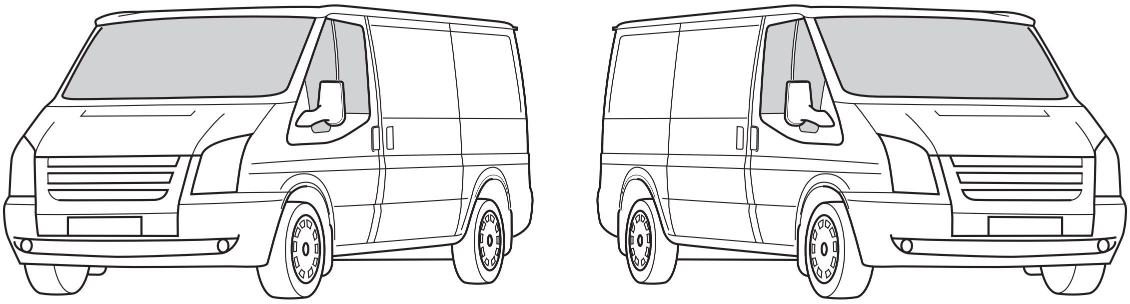
.... **[6]**

[Total: 6]

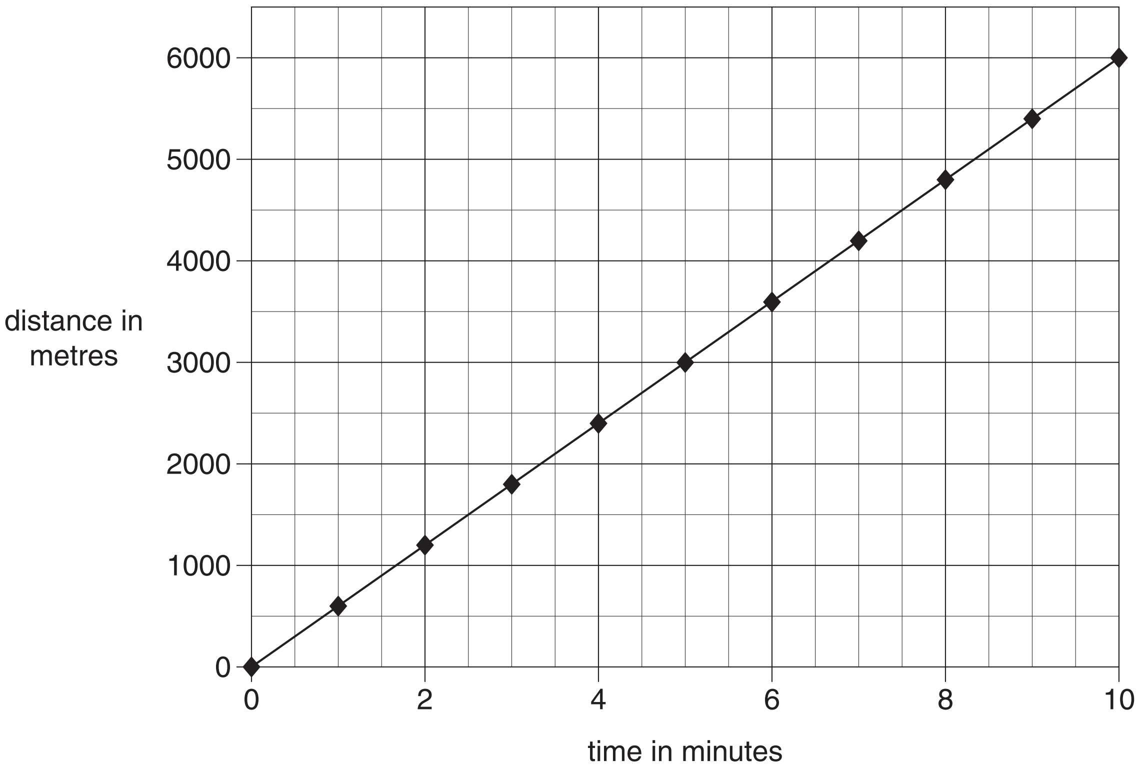
3 A delivery company wants to track where their vehicles are at any time.

They install GPS trackers in two vehicles which transmit the vehicle's positions over time.



van A **van B**

The graph below is a distance-time graph for **van A**.



(a) Use information from the graph to calculate the average speed of **van A** in m/s.

Show your working.

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

(b) This table shows some of the GPS data from **van B**.

Time in minutes	**Distance in metres**
0	0
4	2000
7	3500
10	5000

(i) Add this data to the graph. **[1]**

(ii) Explain how the company can use the **graph** to tell which van had the greatest average speed, without doing any calculations.

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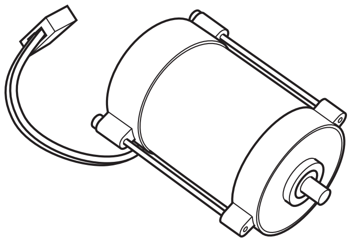
.... **[2]**

[Total: 5]

4 Mike is investigating motors.



(a) Name a device that uses a motor and explain why a motor is used in this device.

device ....

explain why it uses a motor...

.... **[1]**

(b) Mike makes some notes about the motor effect, but misses out some words.

Put a tick (✓) in the box next to each correct choice to complete the sentence.

If a wire carrying a flow of

charge	
potential difference	
protons	
voltage	

is placed

at right angles to	
end to end with	
next to	
parallel to	

an electric	
a force	
a gravitational	
a magnetic	

field, it experiences

induction.	
energy.	
a force.	
a voltage.	

[2]

(c) Mike has one battery, two identical motors and some identical connecting wires.

He connects the components together in two different ways.

In one circuit, he finds that both motors run slowly.

In the other circuit, he finds that both motors run faster.

(i) Draw the two circuits he used.

motors run slowly	**motors run faster**

[2]

(ii) Explain why the motors run faster in one circuit.

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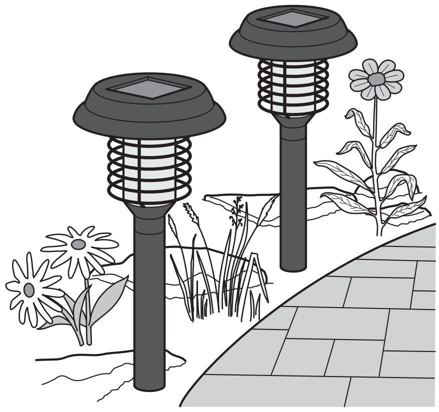
.... **[3]**

[Total: 8]

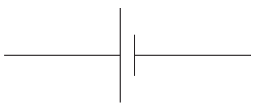
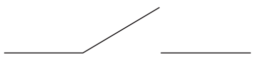
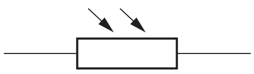
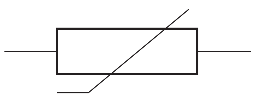
5 Angela is installing some solar-powered lamps in her garden.

They store energy from the Sun during the day and then use it at night.



(a) Here are some circuit components.

Draw straight lines from each **circuit symbol** to the **component** it represents and from the **component** to its **function**.

circuit symbol	**component**	**function**
	switch	breaks or makes a circuit
	cell	resistance varies with temperature
	thermistor	transforms chemical energy into electrical energy
	LDR	resistance varies with light intensity

[2]

(b) The lamps automatically turn on when it becomes dark.

They also have a manual override button to turn the lamp off when it is not wanted.

Which of the components in part **(a)** is **unlikely** to be used in the solar-powered lamp?

name of component .... **[1]**

(c) The manufacturers can choose from two light sources for the lamps, either LEDs or filament lamps.

The data in the table can be used to calculate the power of each source of light.

Component	Voltage in V	Current in A
LED	1.5	0.001
filament lamp	3.0	0.050

Use the data in the table to suggest why LEDs are used instead of filament lamps.

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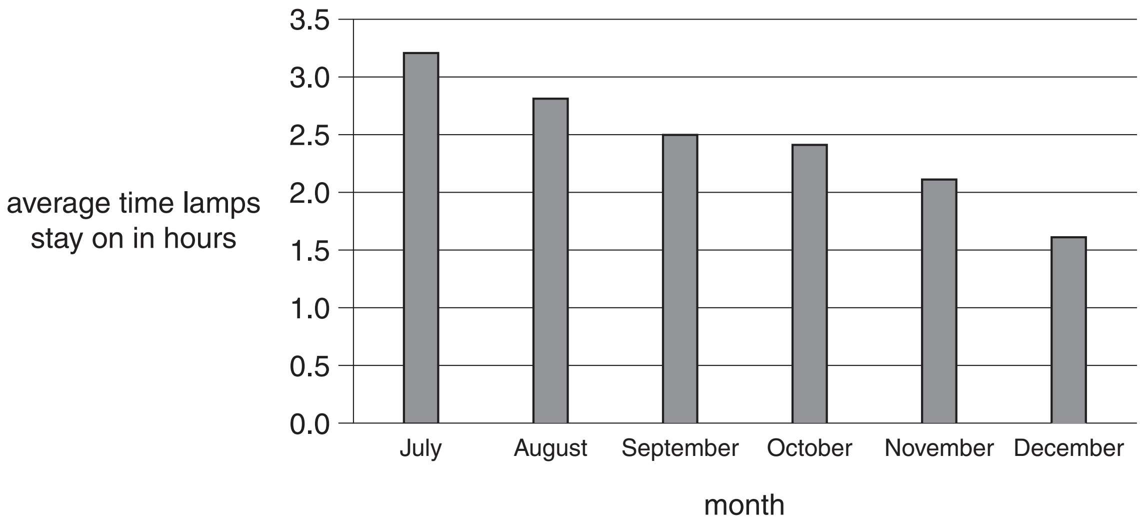
.... **[2]**

(d) Angela sets up the solar-powered lamps in her garden.

Each month she measures how long the solar-powered lamps remain on at night.

Here is a graph of her data.



Angela concludes that the older the solar-powered lamps, the less energy they can store.

Discuss her conclusion with reference to correlation and cause.

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.... **[2]**

[Total: 7]

6 Tim walks on a nylon carpet wearing shoes with rubber soles.

When he touches a metal rail, he feels an electric shock.

Tim is worried about the risk from these electric shocks.

Explain these observations, and discuss what Tim will need to consider to decide the size of the risk.

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

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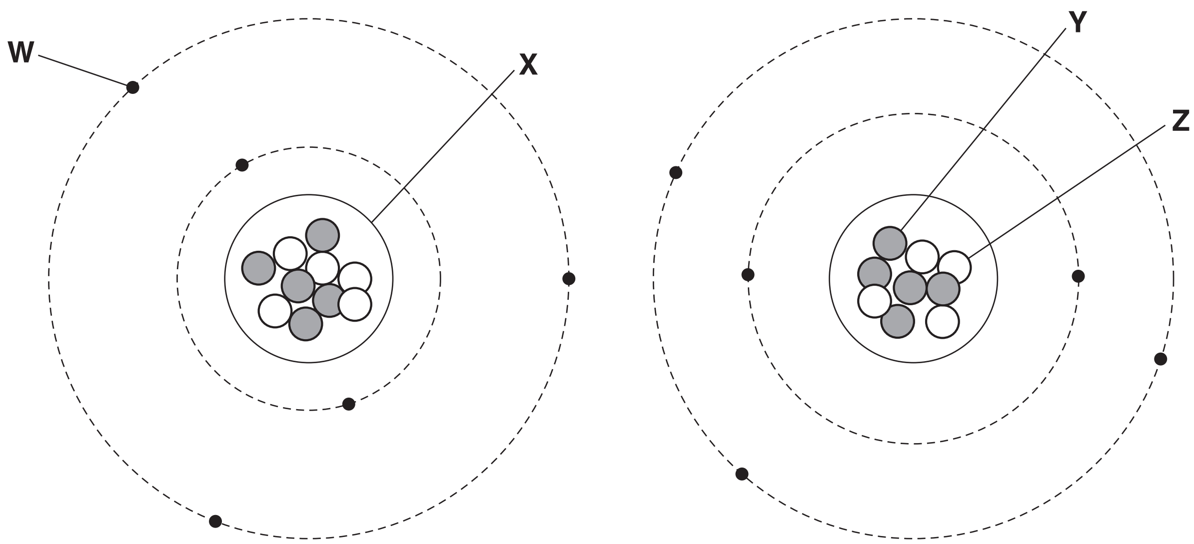
.... **[6]**

[Total: 6]

7 The diagram below shows two atoms that are isotopes of an element.



(a) Which labels should be on parts **W**, **X**, **Y** and **Z**?

Choose the correct labels using words from this list.

atom **electron** **neutron** **nucleus** **molecule** **proton**

W = ...

X = ...

Y = ...

Z = ...

[2]

(b) The nucleus was first discovered by the scientists Rutherford, Geiger and Marsden.

Draw **one** line from their **experimental method** to the **explanation** of their results.

experimental method	**explanation**
alpha particle scattering	The nucleus is small, negative and has no mass.
beta decay	The nucleus is large, negative and has mass.
nuclear fission	The nucleus is small, positive and has mass.
nuclear fusion	The nucleus is small, positive and has no mass.

[1]

(c) The nucleus is held together by a force that only has an effect inside the nucleus.

(i) Which word best describes this force?

electrostatic **gravity** **strong** **magnetic** **weak**

[1]

(ii) Explain why this force must exist to hold the nucleus together.

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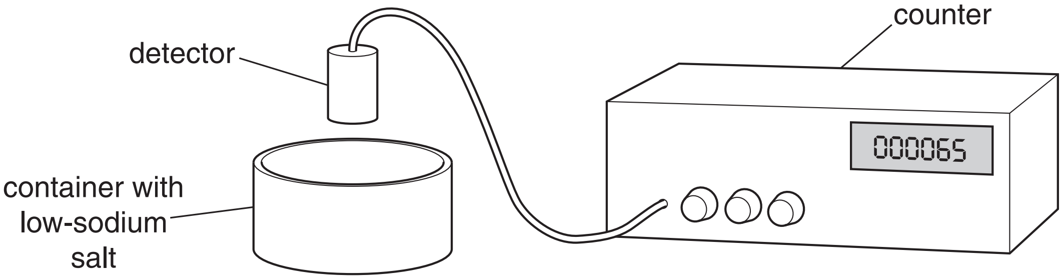
.... **[2]**

[Total: 6]

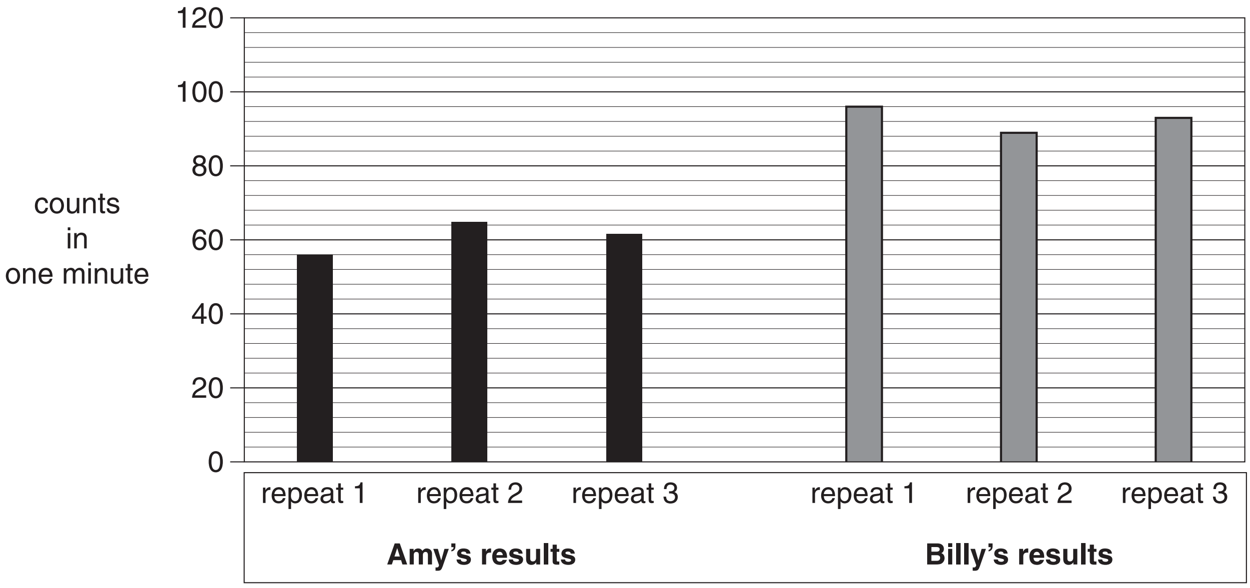
8 Amy reads that low-sodium salt contains a source of ionising radiation.
She measures the amount of radiation coming from a sample of low-sodium salt for one minute.
She does this three times.



These are Amy's results.

Experiment	Counts per minute
1	56
2	65
3	62

(a) Amy's friend Billy carries out the same experiment.
Their results are shown in the graph below.



Amy thinks she must have had a different batch of salt from Billy.
Is she correct?
Justify your answer.

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.... **[2]**

(b) A teacher tells Amy and Billy that they carried out the experiment incorrectly, as they missed out an important step.
What did they forget to do, and why is this step important?
Draw **one** line from the correct **step** to the **reason** why it is important.

step	**reason**
take measurements without the low-sodium salt	to remove gamma rays
repeat the experiment with paper on top of the container	to allow the background radiation to be measured
heat the low-sodium salt	to break down the molecules
dissolve the low-sodium salt in acid	to mix the particles properly

[1]

(c) The teacher carries out an experiment to find the half-life of another radioactive material. The results are shown below.

Time in minutes	**Corrected counts per minute**
0	200
1	170
2	140
3	120
4	100
5	85
6	70
7	60
8	50
9	40
10	35
11	30
12	25
13	20

(i) What is the half-life of this material?

Put a ring around the correct answer.

4 minutes **6 minutes** **6.5 minutes** **13 minutes**

[1]

(ii) Amy reads that an isotope of uranium has a half-life of "4.4 billion years".

The teacher's experiment found a half-life that was only minutes long.

Amy thinks that either the experiment or the book must be wrong.

Put a tick (✓) in the box next to the statement that explains this.

The book was wrong as half-lives are always short. ☐

The experiment was wrong as half-lives are always long. ☐

They could both be right, as half-lives can vary widely for the same isotope. ☐

They could both be right, as half-lives can vary widely between different isotopes. ☐

[1]

(d) Amy takes a different radioactive source.

She carries out an experiment to find out what type of radiation it gives out.

She places different materials between the radioactive source and the detector.

Here are her results.

Material	**Count rate in counts per minute**
air	80
paper	79
aluminium sheet	20
lead block	21

What type of radiation does the sample give out?

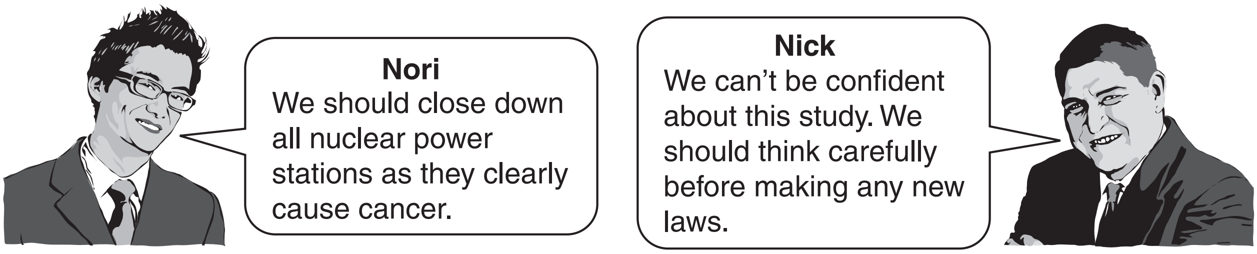
.... **[1]**

[Total: 6]

9 Read the following passage.

> A study for the German Government was carried out by scientists from the University of Mainz. It found that children living within 5 km of nuclear power stations were 2.19 times more likely to get cancer than children living further away.
>
> The researchers looked at a sample of 593 children under five who had leukaemia, which is a type of blood cancer, over a 23-year period. They compared them with a sample of 1766 healthy children. For each child the researchers took into account the distance from the child's home to the nuclear power plant.
>
> Some scientists think that emissions of ionising radiation from the nuclear power stations could be causing cancer. Other scientists think that the increased risk is due to other factors.

Two government ministers talk about the study.



Use ideas about the harmful effects of radiation, together with the information about the study, to discuss whether ministers should write laws based on this study.

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

.... **[6]**

[Total: 6]

END OF QUESTION PAPER

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