Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

3430UF0-1

S25-3430UF0-1

THURSDAY, 22 MAY 2025 – MORNING

SCIENCE (Double Award)

Unit 6 – PHYSICS 2
HIGHER TIER

1 hour 15 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**15**	
2.	**13**	
3.	**8**	
4.	**10**	
5.	**14**	
Total	**60**	

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01

ADDITIONAL MATERIALS

In addition to this paper, you will require a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

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

The assessment of the quality of extended response (QER) will take place in question **3**(a).

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Equations

speed = $\frac{\text{distance}}{\text{time}}$	
acceleration [or deceleration] = $\frac{\text{change in velocity}}{\text{time}}$	$a = \frac{\Delta v}{t}$
acceleration = gradient of a velocity-time graph	
distance travelled = area under a velocity-time graph	
resultant force = mass × acceleration	$F = ma$
weight = mass × gravitational field strength	$W = mg$
work = force × distance	$W = Fd$
kinetic energy = $\frac{\text{mass} \times \text{velocity}^2}{2}$	$\text{KE} = \frac{1}{2} mv^2$
change in potential energy = mass × gravitational field strength × change in height	$\text{PE} = mgh$
force = spring constant × extension	$F = kx$
work done in stretching = area under a force-extension graph	$W = \frac{1}{2} Fx$

SI multipliers

Prefix	Symbol	Conversion factor	Multiplier
pico	p	divide by 1 000 000 000 000	1×10^{-12}
nano	n	divide by 1 000 000 000	1×10^{-9}
micro	μ	divide by 1 000 000	1×10^{-6}
milli	m	divide by 1000	1×10^{-3}
centi	c	divide by 100	1×10^{-2}

kilo	k	multiply by 1000	1×10^{3}
mega	M	multiply by 1 000 000	1×10^{6}
giga	G	multiply by 1 000 000 000	1×10^{9}
tera	T	multiply by 1 000 000 000 000	1×10^{12}

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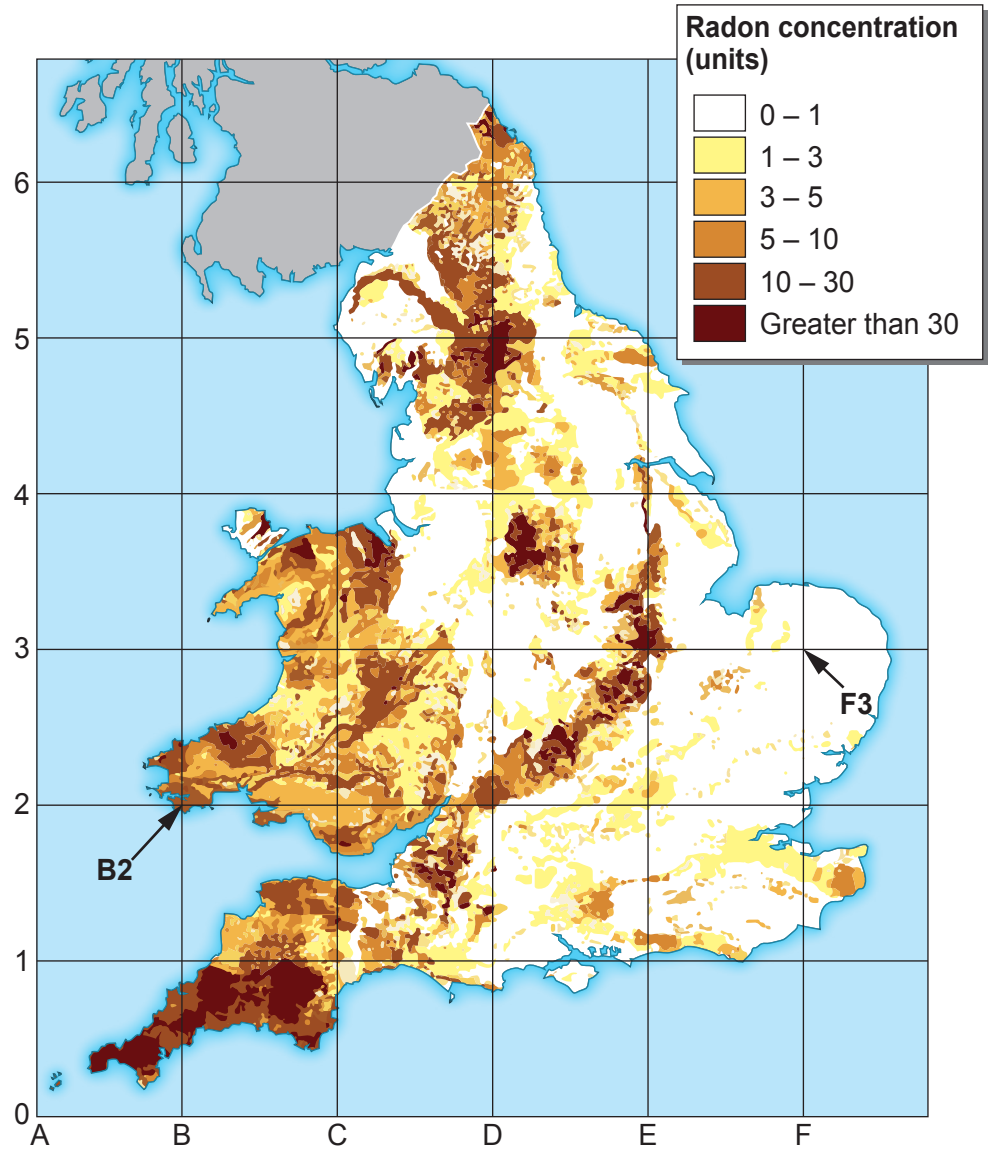
Answer **all** questions.

1. Radon is a radioactive gas that occurs naturally.
Radon is everywhere in the air around us but its concentration varies from place to place.
Special devices are needed to detect it.

The map shows how the concentration of radon varies across England and Wales.



(a) (i) State **one** reason why the concentration of radon varies across England and Wales. [1]

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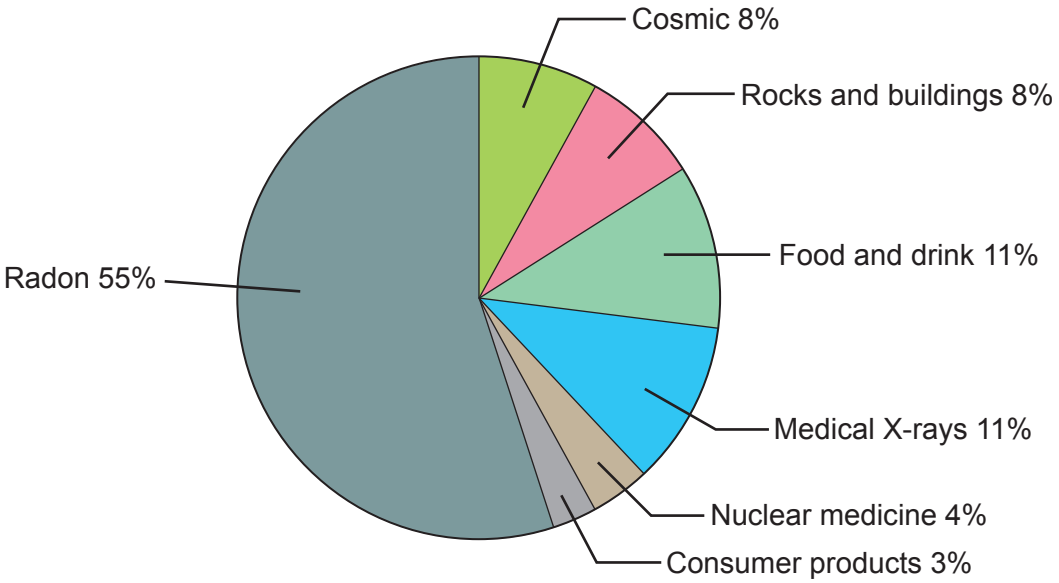
(ii) A pie chart showing sources of background radiation in a part of **Wales** is shown below.
The location is shown by the grid point **B2** on the map.



Explain how the **pie chart** would be different for a part of England shown by grid point **F3**. [3]

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(iii) Alpha track detectors can be used to measure radon concentrations in houses. The testing takes place over a long period of time, at least three months. Explain why this time scale is chosen. [2]

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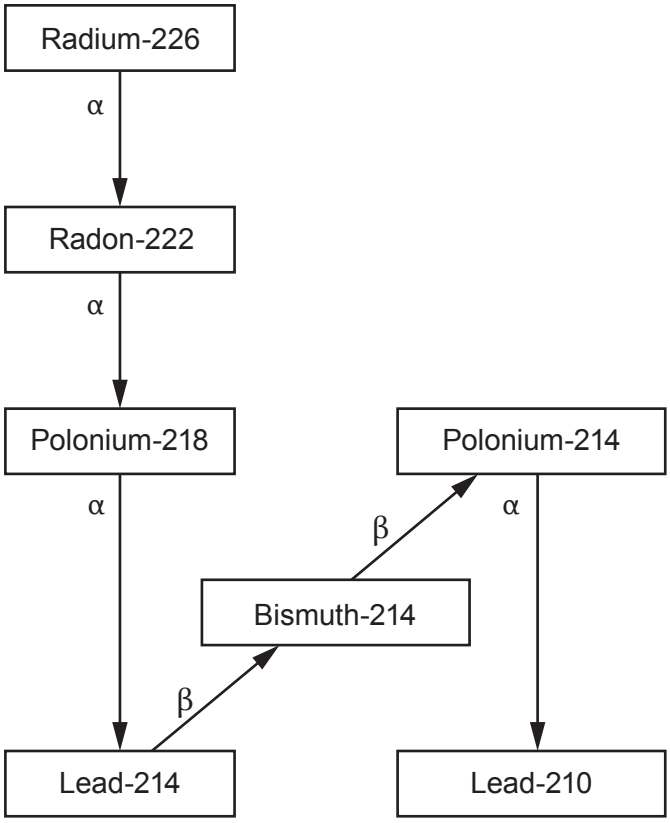
(b) Radon is part of the decay series shown below, where radium-226 decays to lead-210. The chart shows whether each decay is alpha (α) or beta (β).



Use the information in the decay series to answer the following questions.

(i) Explain why radon gas can cause cancer when breathed in. [2]

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(ii) Part of the decay series is shown in the nuclear equations below where polonium-218 (Po-218) decays into lead-214 (Pb-214) which then decays into bismuth-214 (Bi-214).

Complete the equations. [3]

$$^{218}_{.....}\text{Po} \rightarrow ^{214}_{82}\text{Pb} + ...$$

$$^{214}_{82}\text{Pb} \rightarrow ^{214}_{.....}\text{Bi} + ^{0}_{-1}\beta$$

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(iii) State the name given to the different forms of lead. [1]

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(iv) Owain says that the **atoms** of the two forms of lead, Pb-210 and Pb-214, have identical numbers of neutrons and protons.
Explain in terms of particles whether Owain is correct. [3]

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15

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2. As the number of vehicles increases, road safety becomes more important.
Traffic control measures are intended to improve safety when travelling in vehicles on the road.
Also, safety features are included in the design of vehicles and some of these have become compulsory.

(a) One method of controlling traffic flow is by the use of speed cameras and white lines painted on the road that are **1.5 m** apart.

Photograph 1

Photograph 2

The position of the car when each photograph is taken is shown by a red arrow.

(i) Calculate the distance between the two red arrows shown in **Photograph 2**. [2]

distance = ... m

(ii) Use your answer to part (i) and an equation from page 2 to determine by how much over the speed limit the car was travelling if the photographs were taken 0.5 s apart.
The speed limit on the road is 13.4 m/s (30 mph). [2]

answer = ... m/s

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(b) According to data obtained by road safety charity Brake, stopping distances listed in the British Highway Code should be increased because the drivers' thinking time has been underestimated.

Brake asked the British Transport Research Laboratory (TRL) to provide evidence on the time taken by car drivers to recognise and react to an emergency situation.

TRL concluded that the thinking distances were greater than those given in the Highway Code, as shown in the table below.

Speed (m/s)		11	14	17	22	28	31
Thinking distance (m)	Highway Code	7	9	11	15	19	21
	TRL study	17	21	25	33	42	46

Figures in the Highway Code are based on a thinking time of 0.67 s.

(i) Use an equation from page 2 to calculate a value for the thinking time that follows from the TRL study when the speed of a car is 14 m/s. [3]

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thinking time = ... s

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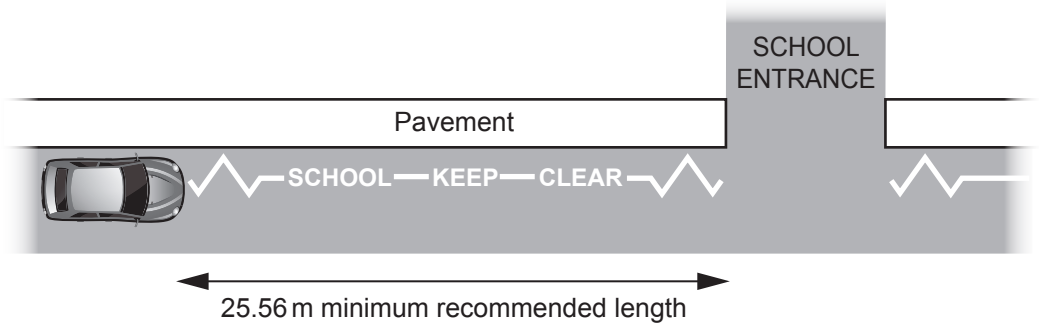
(ii) Zig-zag lines outside school entrances where the speed limit is 8.9 m/s are shown below.
The braking distance at this speed is 6 m.
No parking is allowed on the zig-zags so drivers have a clear view along the section of the road.
The intention is that a driver should be able to stop their car if a child steps onto the road.



Based on the results of the **TRL study**, comment on the suitability of the minimum recommended length for the zig-zags. [2]

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(c) In 1991, it became compulsory for all occupants of a car to wear seat belts.

(i) State Newton's 1st law of motion. [2]

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(ii) Explain how this law applies to the use of seat belts in a collision. [2]

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3. When the Universe was three minutes old, it had cooled enough for protons and neutrons to combine into nuclei.
This process only created the lightest four elements, namely hydrogen, helium, lithium and beryllium.
Today, about 75% of the mass of the Universe is still hydrogen.

(a) Explain how stars create and recycle elements that allow new solar systems to form. [6 QER]

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(b) Explain, in terms of named forces, why main sequence stars are stable. [2]

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4. Nuclear medicine involves the use of radioactive substances in the diagnosis and treatment of disease.

Information about some radioisotopes that emit gamma rays (γ-rays) is given in Table 1.

Table 1

Radioisotope	Half-life
caesium-137	30 years
cobalt-60	5.3 years
iodine-125	59 days
palladium-103	17 days
technetium-99m	6.0 hours
thallium-201	73 hours

(a) (i) Explain what is meant by the statement 'Cobalt-60 has a half-life of 5.3 years'. [2]

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(ii) Use information from Table 1 to explain which is the most suitable radioisotope to inject as a tracer into the human body. [2]

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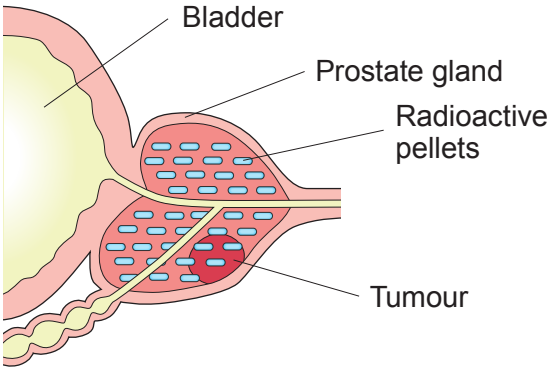
(b) In order to treat prostate cancer, many radioactive pellets of **iodine-125** are placed directly into the prostate gland.
The size of the prostate may measure **50.0 mm** in diameter.
More than one pellet is used because there is uncertainty about the exact position of the cancer.
They remain permanently in place.



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(i) The radioactive emissions from the iodine-125 pellets are too small to detect when their activity decays to $\frac{1}{32}$ of its original value.
Use data from Table 1 to calculate the time for this reduction to occur. [3]

time = ... days

(ii) Table 2 gives the penetrating power of gamma rays of different energies through different materials.

Table 2

Material	Thickness of material (mm) to absorb half the radiation at different energies		
	30 units of energy	60 units of energy	120 units of energy
body tissue	20.0	35.0	45.0
aluminium	2.3	9.3	16.6
lead	0.02	0.13	0.15

The gamma rays emitted by iodine-125 have an energy of 30 units.
The size of the prostate may measure 50.0 mm in diameter.
Explain why **more than one** pellet of iodine-125 is used for treating prostate cancer. [3]

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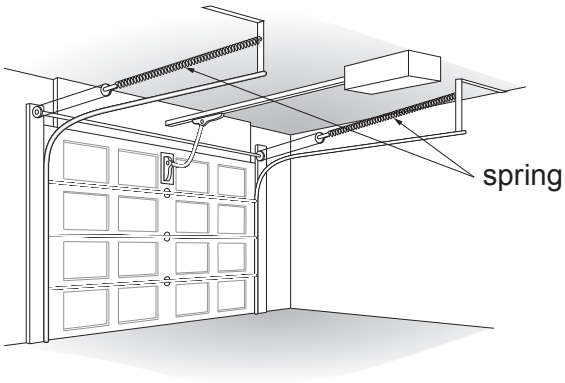
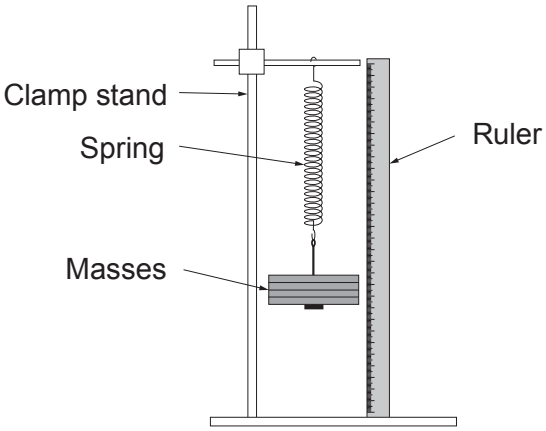
5. Springs can be used in garage doors.
When the door shuts, the two springs are stretched and put under tension.
When the door opens, the springs return to their original unstretched length making it easier to raise the door.



It is important that springs are designed so that they do not become permanently stretched during the process.
Springs become permanently stretched once they pass their **elastic limit**.
This is the point where extension is no longer proportional to the stretching force.

(a) A spring is tested until it is permanently stretched using the apparatus shown below.



(i) Describe how the apparatus is used to obtain results. [2]

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(ii) Explain how the results are analysed to determine the spring's elastic limit. [2]

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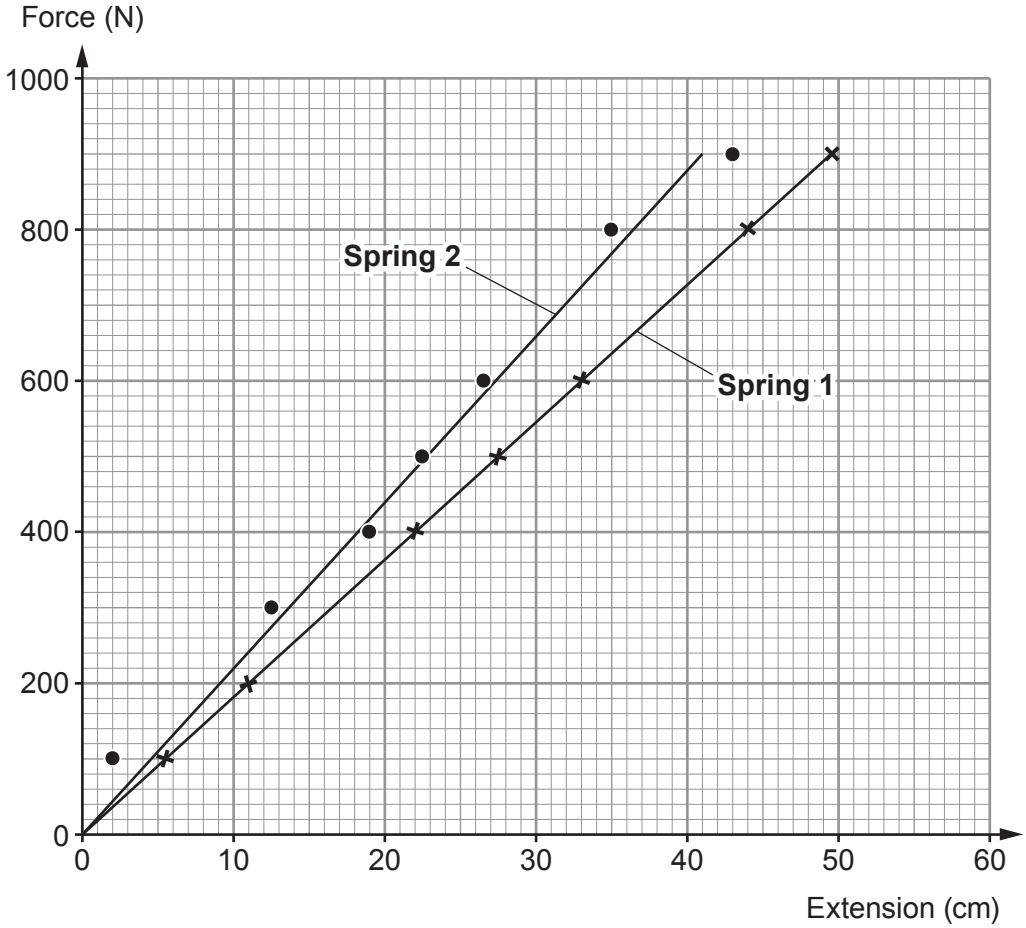
(b) Results from an experiment testing springs for their suitability for a garage door are shown in the graph below.
It was decided to use springs identical to **Spring 1**.



(i) Use the graph to explain why there is more confidence in the results for **Spring 1**. [1]

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(ii) Use an equation from page 2 to calculate the spring constant of **Spring 1** to **two significant figures**. [3]

spring constant = ... N/cm

(iii) During the closing of the garage door, each of the **two** springs will extend by 44 cm.
Use an equation from page 2 to calculate the **total** energy stored by the springs when the garage door is closed. [3]

energy = ... J

(iv) When the centre of the garage door is lifted 1.2 m and fully opened, it gains 540 J of potential energy.

I. Use your answer to part (iii) to calculate the work done to lift the garage door. [1]

work done = ... J

II. Use the equation:

work done = force × distance

to calculate the lifting force required. [2]

force = ... N

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END OF PAPER

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