Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

S23-3430U60-1

3430U60-1

THURSDAY, 25 MAY 2023 – MORNING

SCIENCE (Double Award)
Unit 6 – PHYSICS 2

FOUNDATION TIER

1 hour 15 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**5**	
2.	**11**	
3.	**10**	
4.	**11**	
5.	**8**	
6.	**5**	
7.	**10**	
Total	**60**	

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ADDITIONAL MATERIALS

In addition to this examination paper, you may 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 **4(a)**.

Equations

$\text{speed} = \frac{\text{distance}}{\text{time}}$	
$\text{acceleration [or deceleration]} = \frac{\text{change in velocity}}{\text{time}}$	$a = \frac{\Delta v}{t}$
acceleration = gradient of a velocity-time graph	
resultant force = mass × acceleration	$F = ma$
weight = mass × gravitational field strength	$W = mg$
work = force × distance	$W = Fd$
force = spring constant × extension	$F = kx$

SI multipliers

Prefix	Symbol	Conversion factor	Multiplier
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}

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Answer **all** questions.

1. Our Sun is a low mass star. It is currently in the main sequence stage of its life.

(a) **Use words from the box** to complete the life cycle of our Sun. [3]

asteroid	protostar	supernova	white dwarf	red giant

..... → main sequence → ..... → .....

(b) Tick (✓) the **two** boxes next to the forces acting on our Sun that keep it stable. [2]

gas pressure ☐

friction ☐

magnetic ☐

gravity ☐

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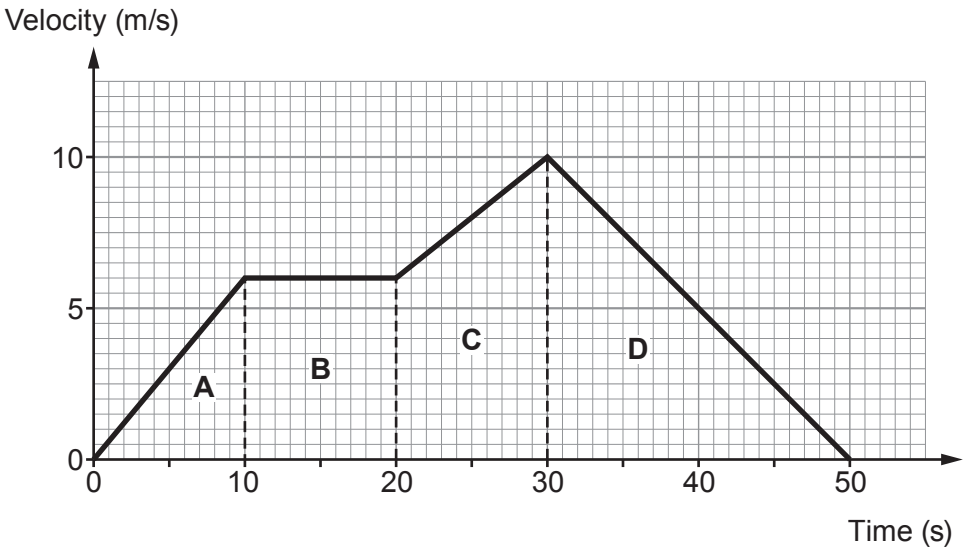
2. The velocity-time graph is for part of a bus journey.



Use the information in the graph to answer the following questions.

(a) **Complete the table** by placing **one** tick (✓) in each row to describe the motion in each region of the graph. Region A has been completed as an example. [3]

Region of graph	Not moving	Constant velocity	Accelerating	Decelerating
A			✓	
B				
C				
D				

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(b) **Complete the following sentences** using numbers from the box. [3]

2	4	6	8	10	20	50

(i) The maximum velocity of the bus is ..... m/s.

(ii) The change in velocity of the bus in region C is ..... m/s.

(iii) The bus accelerates for a **total time** of ..... s.

(c) Use the equation:

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

to calculate the acceleration in **region A**. [3]

acceleration = ... m/s^2

(d) The bus travelled 270 m in the 50 s shown.

Use the equation:

$$\text{mean speed} = \frac{\text{distance}}{\text{time}}$$

to calculate the mean speed of the bus. [2]

mean speed = ... m/s

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3. The picture shows a smoke detector on the ceiling of a room.
It contains the radioactive isotope americium-241 (Am-241) which emits alpha particles.

Smoke getting into the detector absorbs alpha particles.
This changes the electric current inside the detector and the alarm sounds.

(a) Underline the phrase that correctly completes the sentence.

An alpha particle is a **(helium nucleus / hydrogen atom / fast moving electron)**. [1]

(b) Explain why the americium-241 inside the detector is not a risk to humans when the detector is used on the ceiling. [2]

.....

.....

.....

(c) Explain why the smoke detector would not work if the radioactive isotope only emitted gamma rays. [2]

.....

.....

.....

Examiner only

(d) Am-241 is produced when plutonium-241 (Pu-241) decays.

(i) Select values from the box to answer the questions that follow.

94	**95**	**147**	**0**	**241**	**2**

I. **Complete** the decay equation below. [2]

$$^{241}_{94}\mathrm{Pu} \rightarrow {}^{241}_{\cdots\cdots}\mathrm{Am} + {}^{\cdots\cdots}_{-1}\mathrm{e}$$

II. State the number of **protons** in the nucleus of a Pu-241 atom. [1]

.....

III. Calculate the number of **neutrons** in the nucleus of a Pu-241 atom. [1]

.....

(ii) Circle the correct name for the other particle that is produced when Pu-241 decays. [1]

(gamma particle / beta particle / helium particle)

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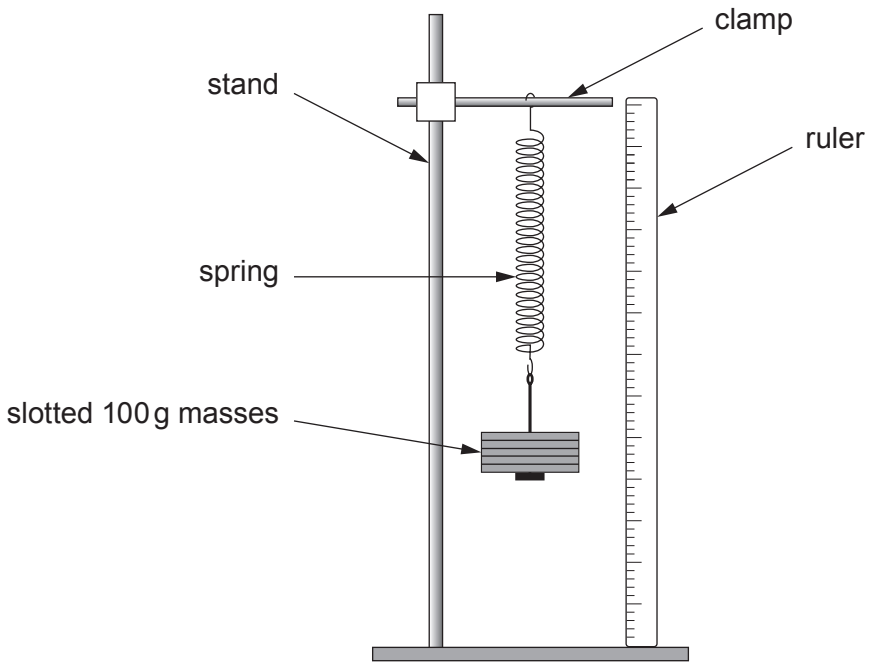
4. (a) Describe how the apparatus shown below is used to investigate the extension of a spring. [6 QER]



Include the following in your answer:

- how the apparatus is set up,
- a description of the method used to obtain the results,
- how the results are analysed.

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(b) A spring is 3 cm long. When an object is added to it, its length increases to 18 cm.

(i) Calculate the extension produced by the object. [1]

extension = ... cm

(ii) The spring constant of the spring is 0.8 N/cm.
Use an equation from page 2 to calculate the force produced by the object on the spring. [2]

force = ... N

(iii) This force is the weight of the object.
Use the equation:

$$\text{mass} = \frac{\text{weight}}{\text{gravitational field strength}}$$

to calculate the mass of the object. (Gravitational field strength, g = 10 N/kg) [2]

mass = ... kg

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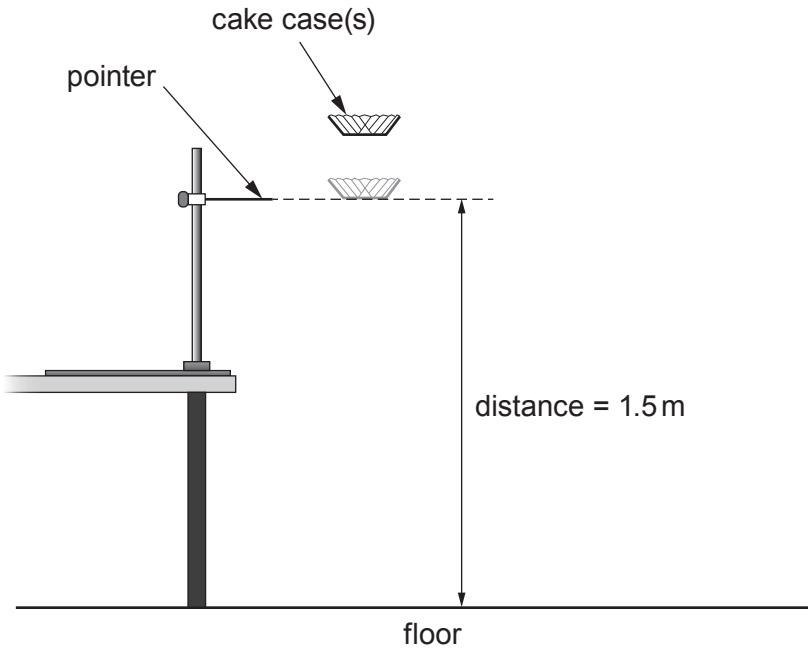
5. Students investigate the terminal speed of falling paper cake cases.
The apparatus they use is shown below.



Their results are given in the table.

Number of cake cases	Time to fall (s)				
	Trial 1	Trial 2	Trial 3	Mean	Terminal speed (m/s)
1	0.85	0.94	0.91	0.90	1.7
2	0.68	0.62	0.65	0.65	2.3
3	0.58	0.62	0.57	0.59	2.5
4	0.52	0.26	0.54	0.44	3.4
6	0.44	0.48	0.46	0.46	3.3

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Use the results in the table to answer the following questions.

(a) (i) **Circle the anomalous result**, in the table, for the time to fall. [1]

(ii) Tom says that the mean time for 4 cake cases to fall is wrong.
Explain whether Tom is correct. [2]
Space for calculation.

.....

.....

(b) Tom thinks that as the number of cake cases doubles the terminal speed doubles.
Explain whether you agree with Tom. [2]

.....

.....

.....

(c) (i) For 6 cases the times taken to fall are 0.44 s, 0.48 s and 0.46 s.

Use the equation:

$$\text{uncertainty} = \frac{\text{maximum value} - \text{minimum value}}{2}$$

to calculate the uncertainty in the measurements of time for 6 cake cases to fall. [2]

uncertainty = ... s

(ii) State **one** random error that is a cause of uncertainty when doing this experiment. [1]

.....

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6. (a) When a car stops the overall stopping distance is made up of two distances: the thinking distance and the braking distance.
Increasing speed increases both the thinking distance and the braking distance.

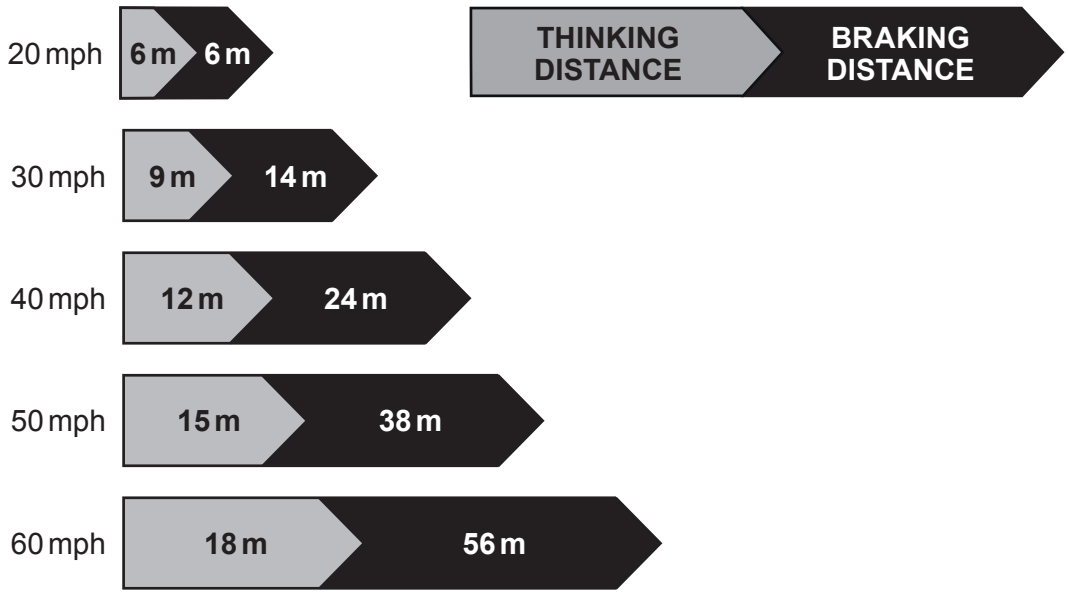
(i) State **one** factor, other than speed, which increases the thinking distance. [1]

.....

(ii) State **one** factor, other than speed, which increases the braking distance. [1]

.....

(b) The diagram gives information about stopping distances at different speeds.



On a dangerous road, it is proposed to reduce the speed limit from 40 mph to 20 mph.

Bethan makes the following 3 suggestions.

1. The thinking distance will halve.
2. The braking distance will halve.
3. The overall stopping distance will halve.

Explain whether you agree with each suggestion.
Include data from the diagram to support your answer. [3]

.....

.....

.....

.....

.....

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7. (a) A class investigates radioactive decay.
They model decay using **8-sided** dice.

Each of the 10 groups has 50 dice.
They throw the dice and remove all which land with an 8 facing upwards.
These represent decayed nuclei.
They repeat 7 more times and record the number of dice remaining after each throw.
Each group's results are then added together.

(i) Freya suggests that it is good practice to add the results together to give a larger sample size.
Explain whether you agree. [1]

.....

.....

(ii) The teacher calculates that after the first throw **around** 440 of the 8-sided dice should remain out of the 500.
Explain how she determined this number. [2]

.....

.....

.....

(b) The results from the experiment are given in the table below.

Number of throws	Number of dice remaining
0	500
1	435
2	380
3	335
4	291
5	256
6	224
7	196
8	171

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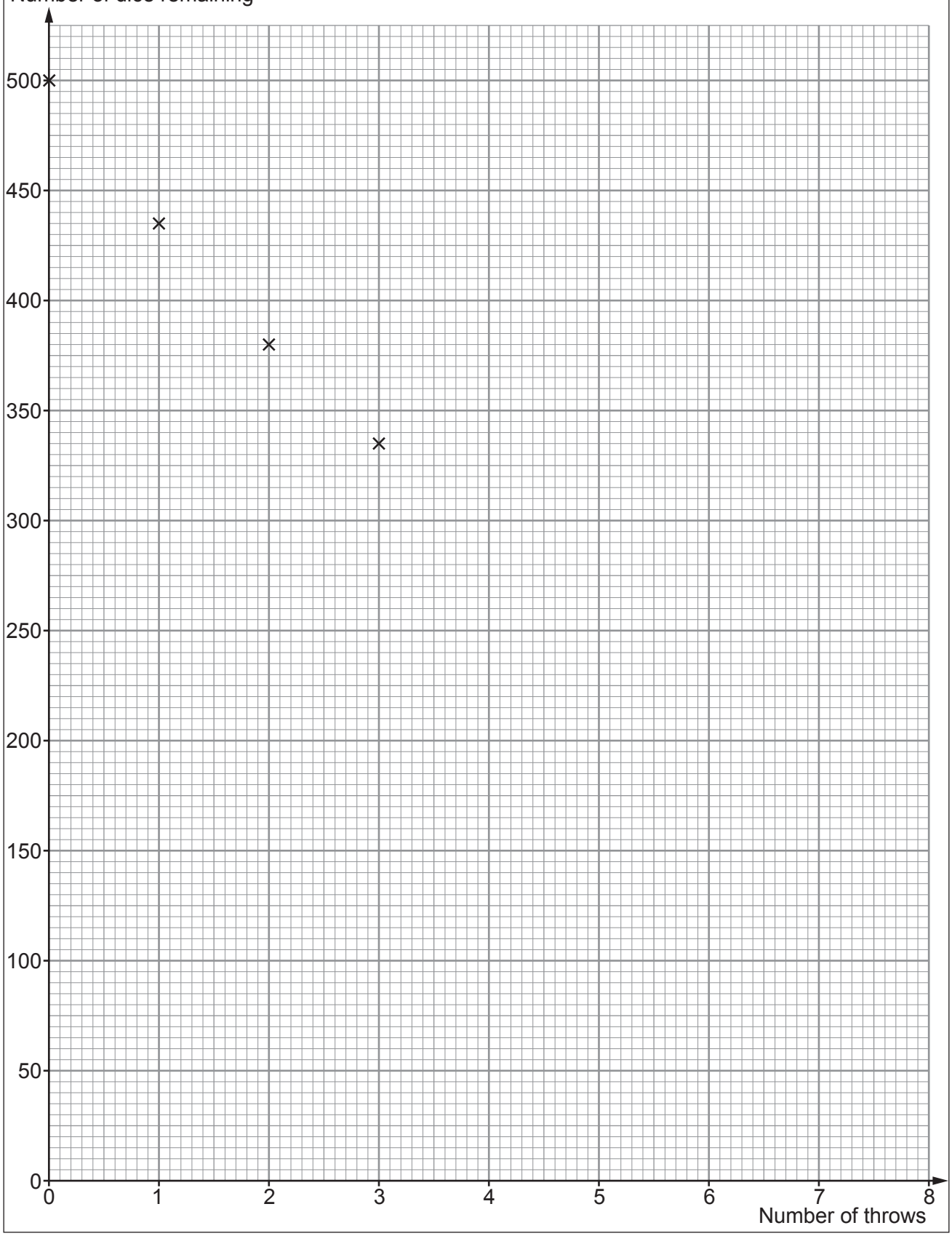
(i) Plot the data on the grid below and draw a suitable curve.
The first 4 points have been plotted for you. [3]



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(ii) **Add lines to the graph** to find the number of throws required to halve the number of dice. This is the half-life.
Give your answer to 1 decimal place. [2]

number of throws = ...

(iii) The experiment is repeated with 10-sided dice.
Ieuan suggests the data could be used to model nuclear decay with a shorter half-life than with 8-sided dice.
Explain whether you agree. [2]

.....

.....

.....

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END OF PAPER

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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