Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

3430UF0-1

S24-3430UF0-1

FRIDAY, 24 MAY 2024 – 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.	**6**	
2.	**9**	
3.	**10**	
4.	**15**	
5.	**6**	
6.	**14**	
Total	**60**	

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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).

Equations

speed $= \dfrac{\text{distance}}{\text{time}}$	
acceleration [or deceleration] $= \dfrac{\text{change in velocity}}{\text{time}}$	$a = \dfrac{\Delta v}{t}$
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 $= \dfrac{\text{mass} \times \text{velocity}^2}{2}$	$\text{KE} = \frac{1}{2} mv^2$
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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03

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Answer **all** questions.

1. Our solar system formed about 4.5 billion years ago.

(a) Tick (✓) the boxes next to the **two** correct statements. [2]

Our solar system originated from a cloud of gas and dust. ☐

The heavy elements in our solar system originated from a supernova. ☐

The Sun formed when large asteroids clumped together. ☐

At the end of our Sun's life, heavy elements will be returned to space. ☐

(b) The table gives information about some planets in our solar system.

Planet	Mean distance from Sun (AU)	Diameter (1000 km)	Length of day (Earth days)	Length of year i.e. time to orbit the Sun (Earth years)
Venus	0.7	12	243	0.6
Earth	1.0	13	1	1
Mars	1.5	7	1	2
Saturn	9.5	120	0.4	29
Uranus	19.2	50	0.7	84
Neptune	30.0	50	0.7	165

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

(i) State which planet is closest in size to Earth. .... [1]

(ii) State which planet has a day length longer than its year. .... [1]

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(iii) Natalie says the larger the gas giant planet the longer its days are.
Rhian says Natalie is wrong.
Explain whether you agree with Natalie or Rhian. [2]

....

....

....

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6

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2. Three different radioactive isotopes, **X**, **Y** and **Z** are investigated.
The table below shows the count rate detected when different absorbers are placed between each radioactive isotope and a detector.
The distance between the detector and the radioactive isotopes is fixed.

The count rates have been corrected for background radiation.

Radioactive isotope	Count rate (units)			
	No absorber	Paper	Aluminium	Lead
X	20	20	20	6
Y	74	74	56	15
Z	44	32	32	12

(a) Explain how to correct count rates for background radiation. [2]

....

....

....

(b) The radioactive isotopes used and the radiation they emit is shown in the table below.

Radioactive isotope	Radiation emitted
silver-110	beta and gamma
cobalt-60	gamma
radium-226	alpha and gamma

Use the information in both tables to identify the radiation(s) emitted by **X and Y** and identify these isotopes.

(i) Radioactive isotope **X** emits ....

Radioactive isotope **X** is .... [2]

(ii) Radioactive isotope **Y** emits ....

Radioactive isotope **Y** is .... [3]

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(c) One isotope of silver has the symbol $^{110}_{47}\mathrm{Ag}$.

Complete the following sentences using numbers from the box.

47	63	110	157

(i) The number of protons in an atom of silver is .... [1]

(ii) The number of neutrons in an atom of this isotope of silver is .... [1]

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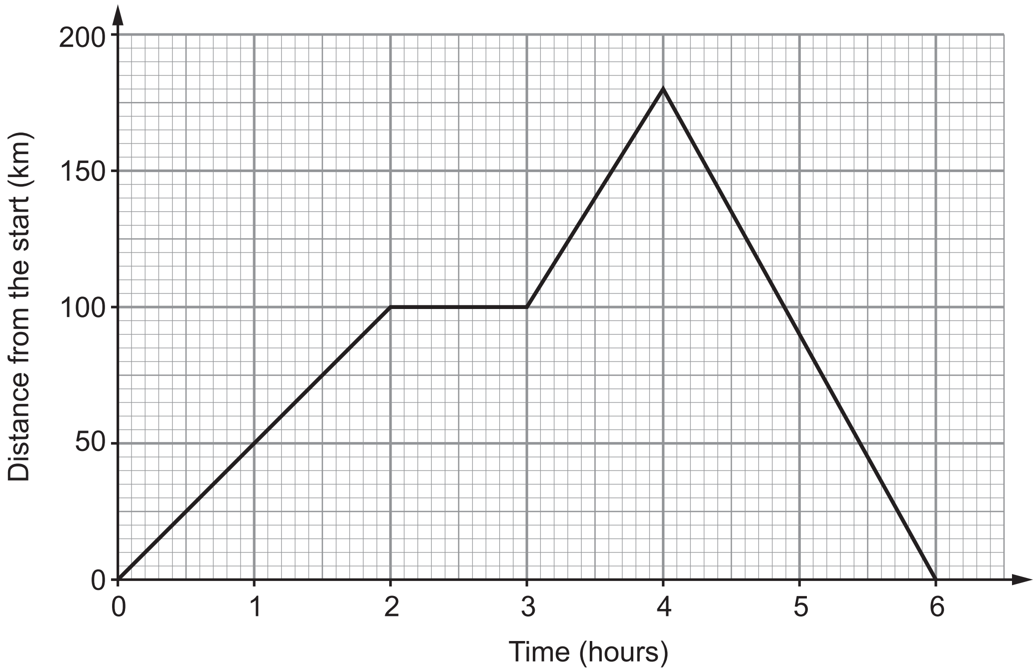
3. The **distance-time** graph below shows a journey by car.



(a) Describe the motion shown by using data from the graph.
Include a **comparison of the speeds** in each part of the journey. [6 QER]

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(b) Use the information in the graph to answer the following questions.

(i) Calculate the total distance travelled during the journey. [1]

distance = ... km

(ii) Use an equation from page 2 to calculate the mean speed of the journey. [3]

mean speed = ... km/h

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4. A ball of mass 3 kg has 750 J of potential energy when held at the top of a building. The ball is then dropped from rest.

(a) (i) Use an equation from page 2 to calculate the height, h, of the building. (acceleration due to gravity, $g = 10\,\text{m/s}^2$) [3]

height, h = ... m

(ii) When the ball hits the ground it has 600 J of kinetic energy. Use an equation from page 2 to calculate the velocity of the ball at this moment. [3]

velocity = ... m/s

(iii) Use the information above to calculate the work done against air resistance as the ball falls. [1]

work done = ... J

(iv) Use an equation from page 2 and your answers to parts (a)(i) and (iii) to calculate the mean force of air resistance during the fall. [3]

mean force = ... N

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(b) (i) Explain, in terms of named forces, why the ball reaches a terminal speed as it falls through the air. [3]

....

....

....

....

....

(ii) Newton's 3rd law of motion applies to the ball as it falls.
Complete the table to describe the Newton's 3rd law force for each of the actions given. [2]

Action	Newton's 3rd law force
Earth pulls downwards on the ball	....
Ball pushes downwards against the air	....

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5. (a) State what is meant by the inertia of a car. [1]

....

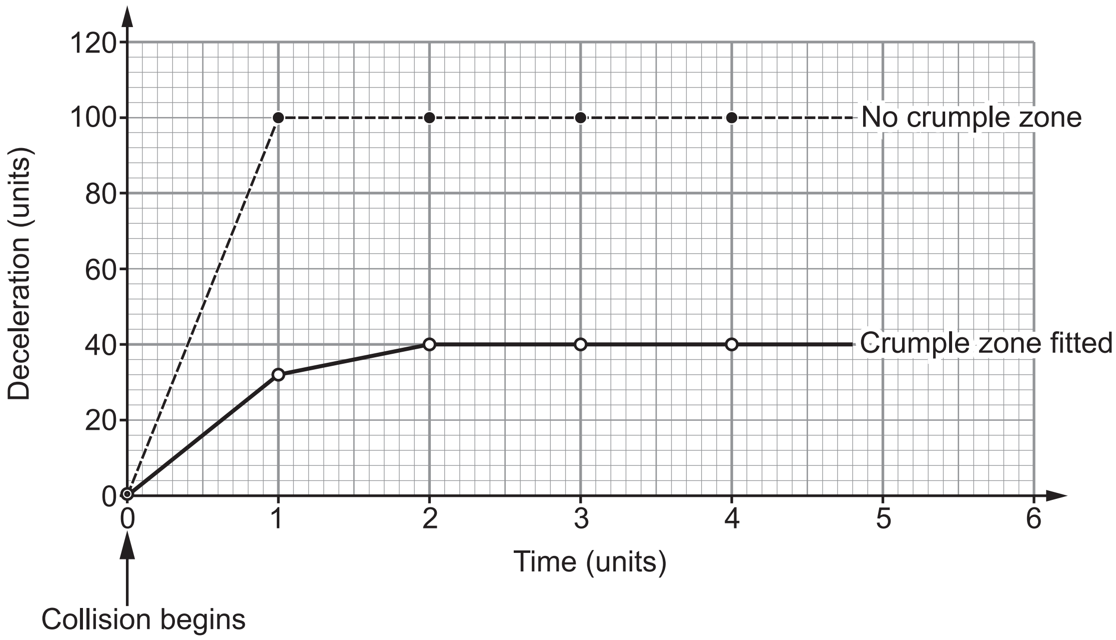
....

(b) State **two** ways of improving the efficiency of motor cars. [2]

1. ....

2. ....

(c) The graphs below show how the deceleration of a car compares during a collision with and without crumple zones fitted.



Use data from the graphs to explain why crumple zones provide some protection during a collision. [3]

....

....

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....

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6

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6. Radioactive isotopes decay at different rates.
The decay rate depends on the half-life of a particular radioisotope and the number of radioactive atoms remaining.

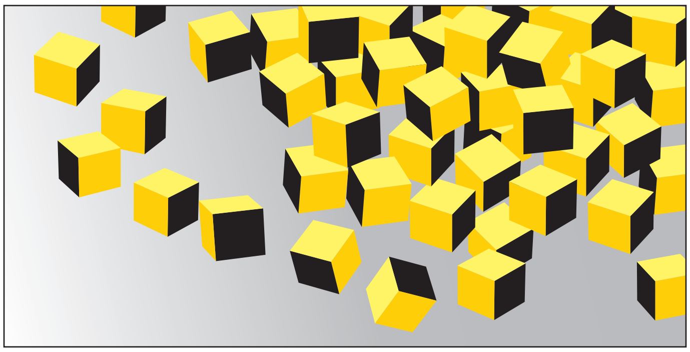
(a) State what is meant by the term half-life. [2]

....

....

....

(b) The decay of a radioactive isotope can be modelled using 60 cubes.
Each cube has **one face** shaded black.
These cubes are shown in the picture below and are called **1F** cubes.



Describe the method used to collect results to find the half-life. [3]

....

....

....

....

....

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(c) In a class experiment, 12 groups of students are each given 60 of these **1F** cubes. The table below shows the results from one group and for the entire class.

Throw	Number of **1F** cubes remaining	
	For the group	For the class
0	60	720
1	50	600
2	42	500
3	36	420
4	29	350
5	24	290

(i) The results of all the groups were added to give a class result. State why the class result is used to plot a graph and not just the result for one group. [1]

....

(ii) The class repeats the experiment with different cubes. The **2F** cubes have **two faces** shaded black and the **3F** cubes have **three faces** shaded black. The class results are shown below.

Throw	Number of cubes remaining in the class	
	For **2F** cubes	For **3F** cubes
0	720	720
1	480	360
2	320	180
3	210	90
4	144	45
5	95	23

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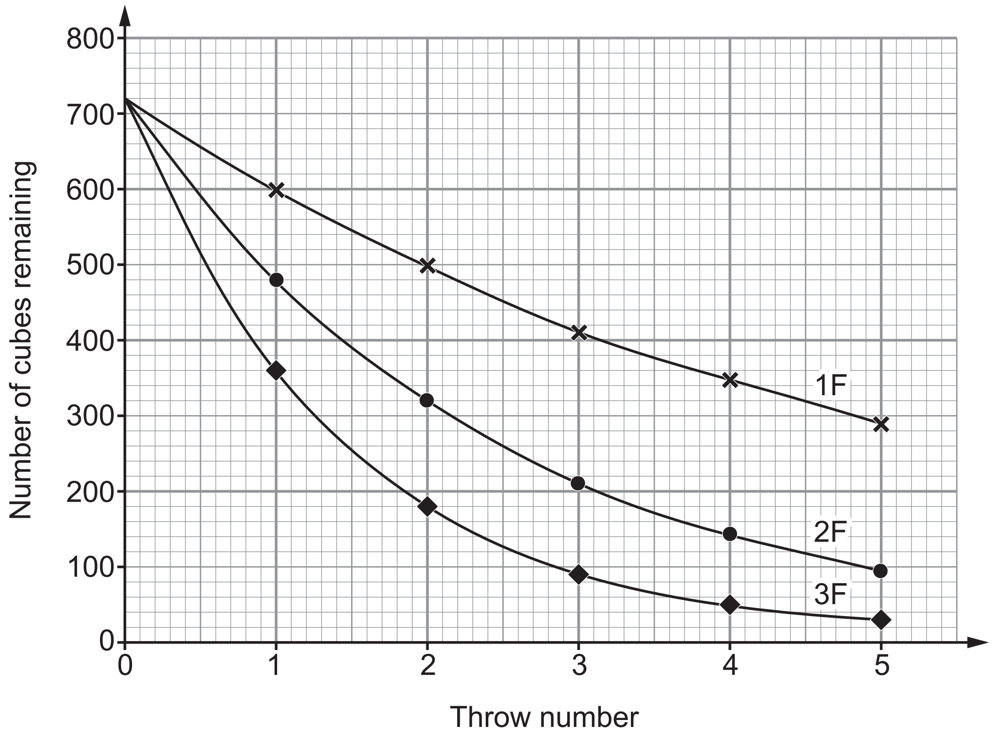
The class results for **1F**, **2F** and **3F** cubes are plotted on the grid below.



I. **Add lines** to the graph to determine the half-life of the **2F** cubes. [2]

half-life = ... throws

II. Use the information in the graphs or tables to tick (✓) the boxes next to the **three** correct statements. [3]

1F cubes show decay at the slowest rate	☐
2F cubes show decay of the quickest rate	☐
3F cubes show the equivalent of two half-lives after 2 throws	☐
3F cubes have the longest half-life	☐
1F cubes could also have been replaced with 720 coins and the number of 'heads' counted after each throw	☐
The number of **2F** cubes remaining after 4 throws is about $\frac{1}{5}$ of the original	☐

TURN OVER FOR THE LAST PART OF THE QUESTION

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(d) Sodium-24 is a radioactive isotope with a half-life of 15 hours.
A solution containing 48.0 mg of sodium-24 was injected into a patient for a medical investigation.

Calculate the mass of sodium-24 that will be left after 75 hours. [3]

mass = ... mg

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END OF PAPER

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

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Turn over.

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