Surname	Centre Number	Candidate Number
Other Names		0

GCSE

4473/02

ADDITIONAL SCIENCE/PHYSICS

PHYSICS 2
HIGHER TIER

P.M. THURSDAY, 16 January 2014

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**6**	
2.	**12**	
3.	**6**	
4.	**12**	
5.	**11**	
6.	**13**	
Total	**60**	

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ADDITIONAL MATERIALS

In addition to this paper you may require a calculator.

INSTRUCTIONS TO CANDIDATES

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

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 continuation pages 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.

You are reminded of the necessity for good English and orderly presentation in your answers.

A list of equations is printed on page 2. In calculations you should show all your working.

You are reminded that assessment will take into account the quality of written communication (QWC) used in your answers to questions **3** and **6**(*b*)(i).

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Equations

power = voltage × current	$P = VI$
resistance = $\dfrac{\text{voltage}}{\text{current}}$	$R = \dfrac{V}{I}$
power = current^2 × resistance	$P = I^2R$
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	
momentum = mass × velocity	$p = mv$
resultant force = mass × acceleration	$F = ma$
force = $\dfrac{\text{change in momentum}}{\text{time}}$	$F = \dfrac{\Delta p}{t}$
work = force × distance	$W = Fd$
kinetic energy = $\dfrac{\text{mass} \times \text{speed}^2}{2}$	$KE = \frac{1}{2}mv^2$
change in potential energy = mass × gravitational field strength × change in height	$PE = mgh$

SI multipliers

Prefix	Multiplier
p	10^{-12}
n	10^{-9}
μ	10^{-6}
m	10^{-3}

Prefix	Multiplier
k	10^{3}
M	10^{6}
G	10^{9}
T	10^{12}

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*Answer **all** questions in the spaces provided.*

1. A car is travelling at 15 m/s and decelerates to 0 m/s in 5 s on a dry road.

(i) Use an equation from page 2 to calculate the deceleration of the car. [2]

deceleration = ... m/s^2

(ii) (I) Use the equation:

$$\text{mean speed} = \frac{(\text{initial speed} + \text{final speed})}{2}$$

to calculate the mean speed of the car as it decelerates. [2]

mean speed = ... m/s

(II) Explain how the mean speed of the decelerating car travelling at 15 m/s would have changed (if at all) if the road had been icy instead of dry. [2]

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6

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2. Isotopes of iodine can be used to study the thyroid gland in the body.

A small amount of the radioactive isotope is injected into a patient and the radiation is detected outside the body. Two isotopes that could be used are ${}^{123}_{53}\mathrm{I}$ and ${}^{131}_{53}\mathrm{I}$.

(a) Answer the following questions in terms of the numbers of particles.

(i) State **one** similarity between the nuclei of ${}^{123}_{53}\mathrm{I}$ and ${}^{131}_{53}\mathrm{I}$. [1]

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(ii) State **one** difference between the nuclei of ${}^{123}_{53}\mathrm{I}$ and ${}^{131}_{53}\mathrm{I}$. [1]

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(b) The nucleus of ${}^{131}_{53}\mathrm{I}$ decays into xenon (Xe) by giving out beta (β) and gamma (γ) radiation.

(i) What is beta radiation? [1]

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(ii) Complete the equation below to show the decay of Iodine-131 (I-131). [2]

$${}^{131}_{53}\mathrm{I} \longrightarrow {}^{\dots\dots}_{54}\mathrm{Xe} + {}^{\;0}_{\dots\dots}\beta + \gamma$$

(c) The isotope ${}^{123}_{53}\mathrm{I}$ decays by gamma emission. Explain why it is better to use ${}^{123}_{53}\mathrm{I}$ than ${}^{131}_{53}\mathrm{I}$ as a medical tracer. [2]

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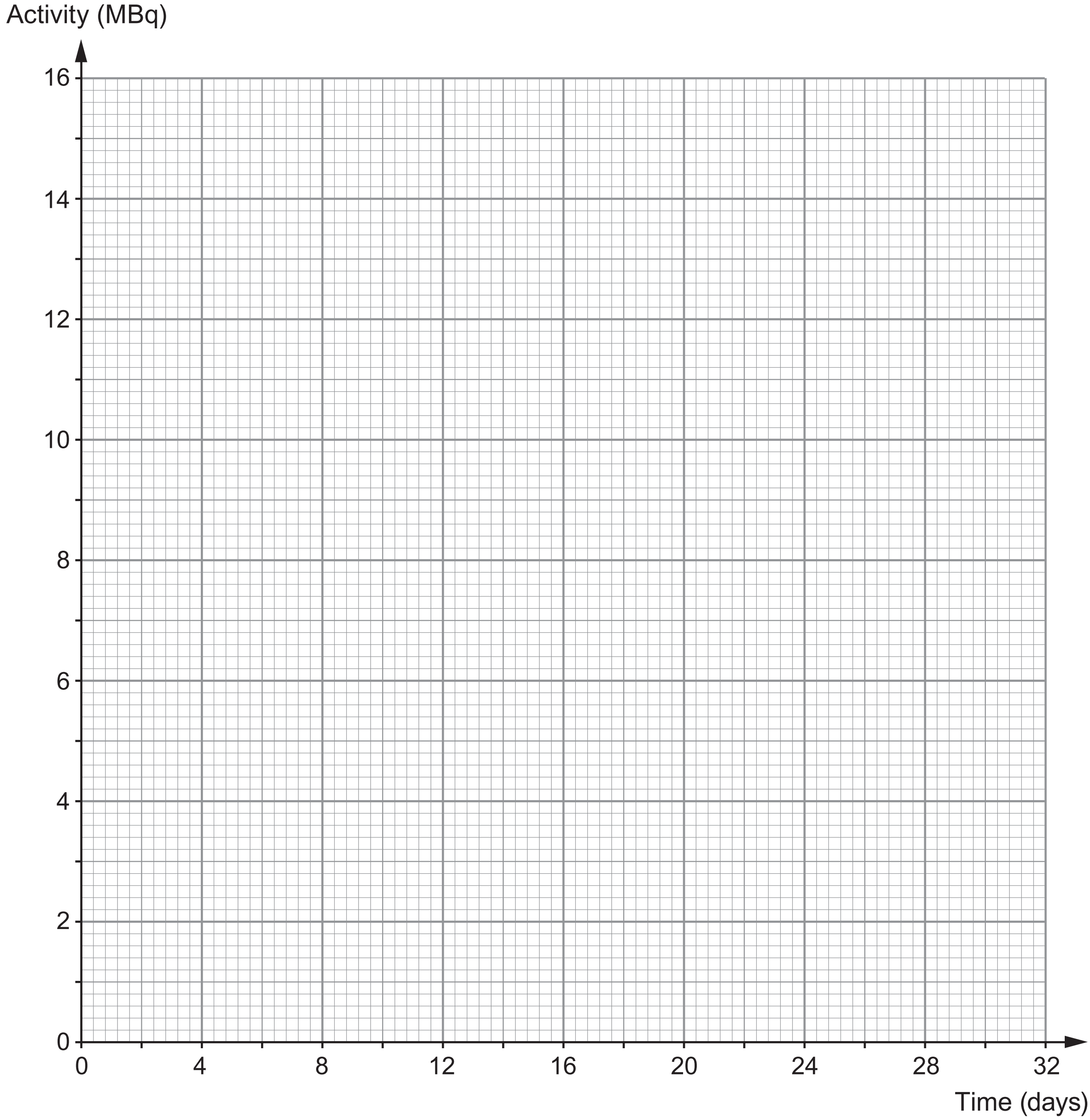
(d) (i) Iodine-131 has a half-life of 8 days. A sample has an initial activity of 16 MBq. Plot the data on the grid and draw a suitable line to show how the activity changes over 32 days. [3]

Time (days)	0	8	16	24	32
Activity (MBq)	16	8	4	2	1



(ii) **Draw lines** on the graph to find the time it takes for the activity to fall from 12 MBq to 3 MBq. Comment on your answer. [2]

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3. A number of safety features appear in modern cars to protect the people in the car in a head-on collision. A passenger safety cage and a collapsible steering column are two safety features. Name **one** *other* safety feature and explain the physics behind its design.

Your answer should include:

- the name of **one** *other* safety feature;
- a description of what it does in a collision;
- an explanation of how it works in terms of either forces or energy. [6 QWC]

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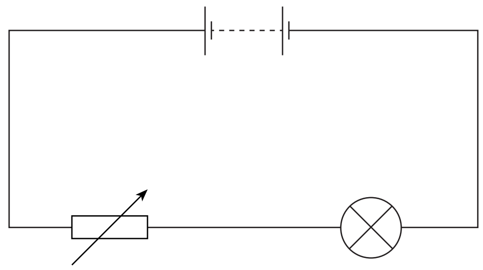
4. The diagram shows a lamp connected to a battery and a variable resistor.



(a) (i) Describe how the circuit is used to obtain a **series of measurements** of the voltage across the lamp and the current through it. **You should add symbols to the circuit** of any additional components you would use. [4]

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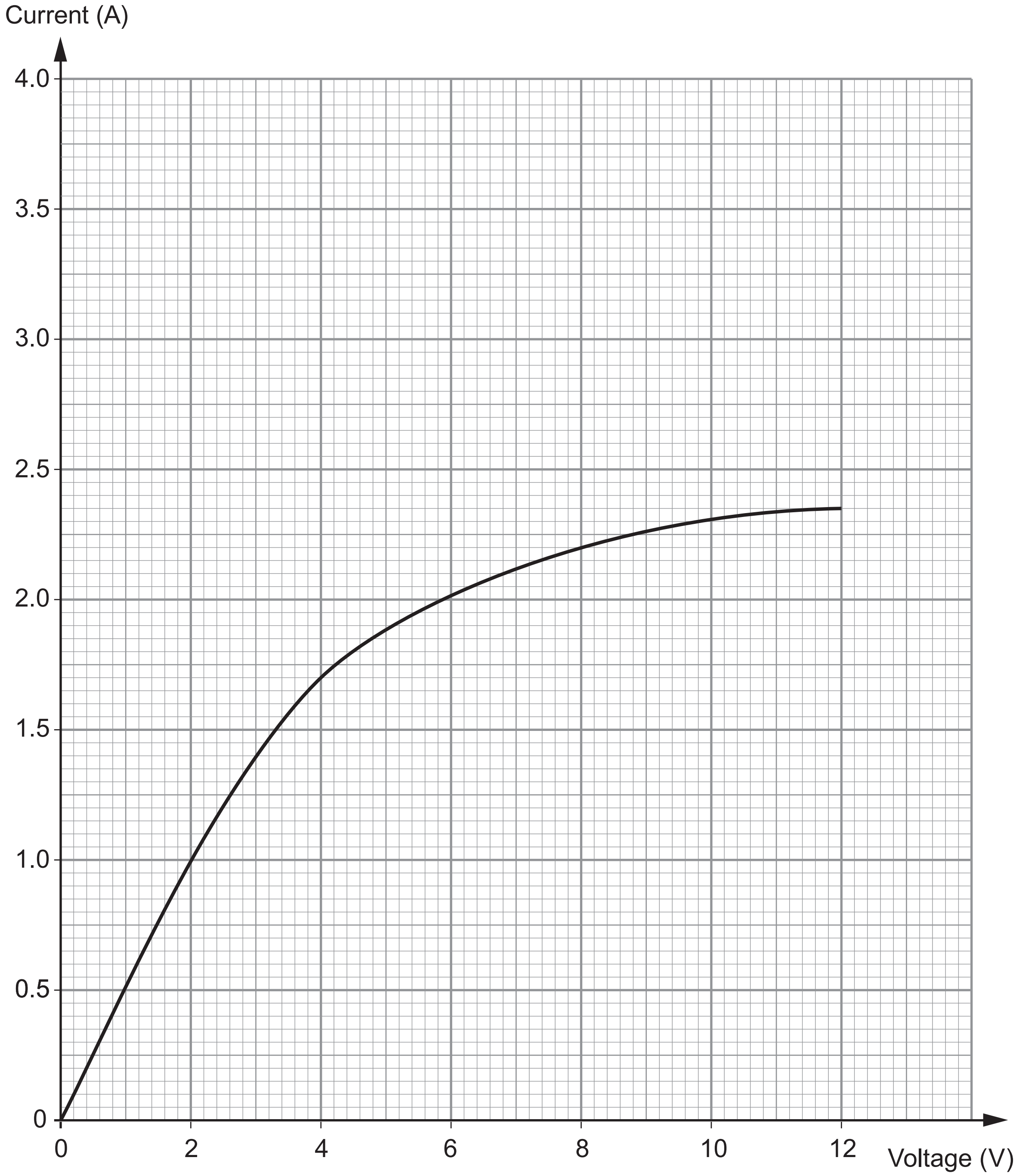
(ii) The results for the lamp are shown on the graph below.



A **resistor** has a resistance of 4 Ω. **Draw a line** on the graph above to show the current through it and the voltage across it up to 12 V. [3]

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(b) (i) Use the graph and an equation from page 2 to find the power of the lamp when it has the same resistance as the resistor. [3]

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(ii) Compare the resistances of the lamp and resistor when a voltage of 12 V is applied to each. Give a reason for your answer. [2]

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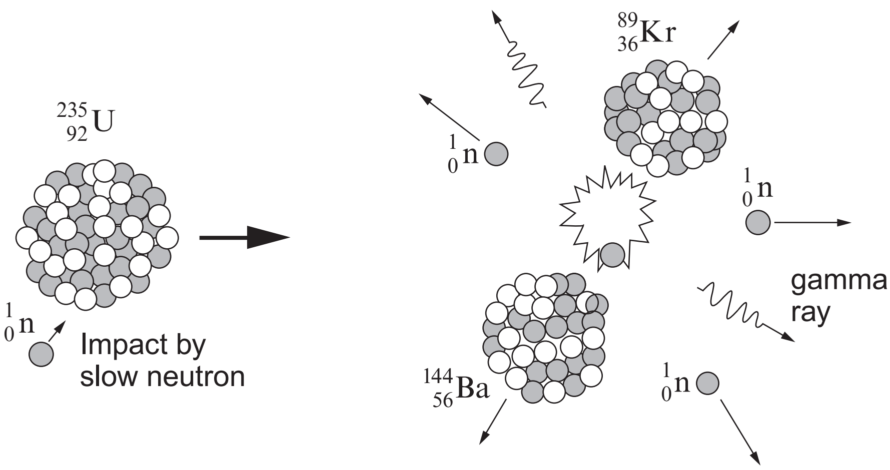
5. The diagram below shows an example of a nuclear fission reaction in which a neutron strikes an atom of $^{235}_{92}U$.



The neutrons that are released in the reaction (3 in this case) have high energies and move very fast.

(a) State which part of the nuclear reactor core is designed to reduce the neutrons' high energies and explain why the reduction in energy is **necessary**. [3]

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(b) (i) Only 1 of the 3 neutrons that are released is needed to maintain a controlled chain reaction. Describe how the others are stopped inside the reactor. [2]

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(ii) Describe how the fission reactions inside a nuclear reactor can be shut down completely. [2]

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(c) (i) Write a balanced nuclear equation for the reaction shown opposite. [2]

$$\longrightarrow$$

(ii) If the barium nucleus in the diagram opposite is released with the same **kinetic energy** as a neutron, explain why the size of its velocity would only be **one twelfth ($\frac{1}{12}$)** of the velocity of a neutron. [2]

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6. *(a)* Describe how Newton's 3rd law applies to a rocket on take-off. [2]

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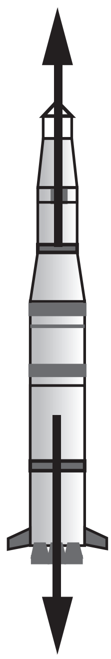
(b) The Cassini spacecraft with its Huygens probe was launched by rocket in 1997 to study one of Saturn's moons. On 14 January 2005 the Huygens probe landed on the moon, Titan, and was slowed down by a parachute which opened 120 km above the surface.

Take-off mass of rocket, spacecraft and probe = $9{\cdot}5 \times 10^5$ kg
Engine thrust of rocket on take-off = $1{\cdot}5 \times 10^7$ N
Gravitational field strength on Earth = 10 N/kg
Gravitational field strength on Titan = 1·35 N/kg
Mass of Huygens probe = 320 kg

(i) Discuss the acceleration of the rocket at its launch. Include in your answer:

- A calculation of the initial acceleration. (Hint: consider the weight of the rocket.)
- An explanation of the way the acceleration changes as the rocket rises. (Hint: ignore the effects of air resistance.) [6 QWC]



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initial acceleration = ... m/s^2

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TURN OVER FOR THE REST OF THE QUESTION

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(ii) Calculate the loss in gravitational potential energy of the Huygens probe during its descent by parachute to the surface of Titan. [3]

change in potential energy = ... J

(iii) Explain what has happened to this potential energy as the probe falls to the surface of Titan. [2]

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END OF PAPER

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