Surname	Centre Number	Candidate Number
Other Names		0

GCSE

4473/02

ADDITIONAL SCIENCE/PHYSICS

PHYSICS 2
HIGHER TIER

P.M. MONDAY, 19 May 2014

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**12**	
2.	**12**	
3.	**10**	
4.	**12**	
5.	**14**	
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 gel pen or 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 page 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 **2**(*c*) and **5**(*a*).

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Equations

power = voltage × current	$P = VI$
current = $\frac{\text{voltage}}{\text{resistance}}$	$I = \frac{V}{R}$
power = current^2 × resistance	$P = I^2R$
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	
momentum = mass × velocity	$p = mv$
resultant force = mass × acceleration	$F = ma$
force = $\frac{\text{change in momentum}}{\text{time}}$	$F = \frac{\Delta p}{t}$
work = force × distance	$W = Fd$
kinetic energy = $\frac{\text{mass} \times \text{speed}^2}{2}$	$KE = \frac{1}{2}mv^2$
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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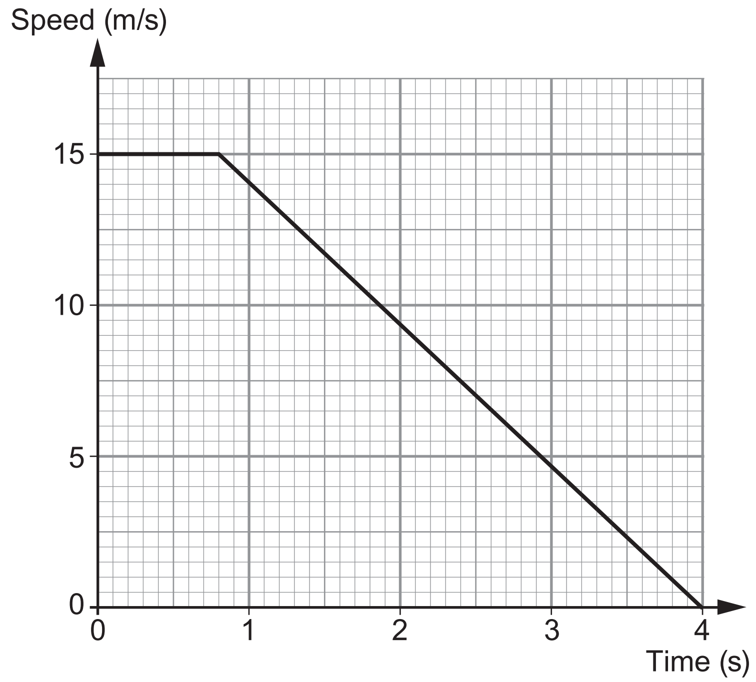
Answer **all** *questions.*

1. A car is moving at a speed of 15 m/s. A child runs out into the road causing the driver to make an emergency stop.

(a) The graph shows how the speed of the car changes from the moment the driver sees the child.



(i) What was the reaction time of the driver? [1]

.... s

(ii) How long did it take the car to stop once the brakes were applied? [1]

.... s

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

deceleration = ... m/s^2

(iv) Explain how the graph would be different for a driver who had drunk alcohol. [2]

....

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(v) Explain how the graph would be different if it had been a wet day. [2]

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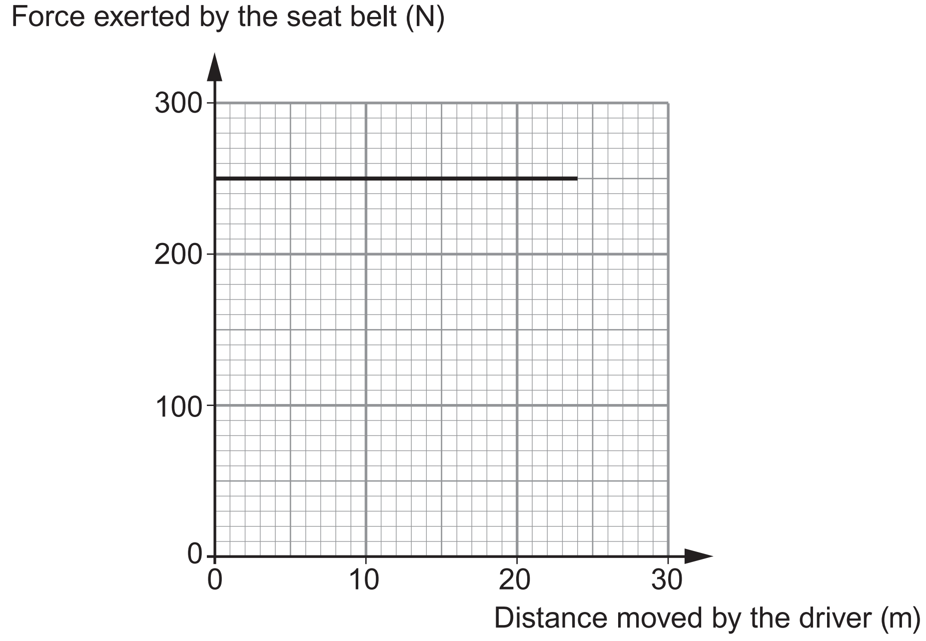
(b) In an emergency stop, the driver in the car moves forward before being stopped by the seat belt.

The graph shows the force exerted by the seat belt on the driver during the emergency stop.



(i) Use an equation from page 2 to calculate the work done to stop the driver. [3]

work done = ... J

(ii) How much energy is transferred from the driver during the emergency stop? [1]

.... J

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2. Nuclear fission and nuclear fusion are examples of nuclear reactions. Typical nuclear fission and nuclear fusion reactions are shown below.

(a) (i) Complete the equation for the first reaction. [2]

$$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{90}_{......}Sr + ^{144}_{54}Xe + ...\ ^{1}_{0}n$$

$$^{2}_{1}H + ^{3}_{1}H \rightarrow ^{4}_{2}He + ^{1}_{0}n$$

(ii) Explain how the first reaction could lead to an uncontrolled chain reaction. [2]

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(b) $^{2}_{1}H$ and $^{3}_{1}H$ are both isotopes of hydrogen.

Compare the structure of the **nuclei** of these two isotopes. [2]

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(c) Nuclear fission and nuclear fusion both produce heat energy. Describe and compare nuclear fission and nuclear fusion reactions. [6 QWC]

Include in your answer:

- what happens in each of the reactions;
- the problems associated with each reaction.

(You are **not** required to include any detail on moderators or control rods.)

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3. Living animals take in small amounts of radioactive carbon-14. After death, the amount of carbon-14 in their bodies decreases, because the carbon-14 atoms decay. The amount of carbon-14 remaining in the bones of an animal's skeleton can be used to estimate its age.

Carbon-14 is a beta emitter, with a half-life of 5720 years.

(a) State what is meant by the following statements: [3]

(i) carbon-14 is a beta emitter;

....

....

(ii) carbon-14 has a half-life of 5720 years.

....

....

....

(b) Complete the decay equation for carbon-14 shown below. [3]

$$^{14}_{6}\text{C} \rightarrow\ ^{\cdots\cdots}_{\cdots\cdots}\text{N} +\ ^{\cdots\cdots}_{\cdots\cdots}\text{e}$$

(c) (i) A bone taken from a skeleton, found at an archaeological site, contains 10 units of carbon-14. An identical bone in a living animal contains 160 units of carbon-14. Use your understanding of half-life to calculate the age of the skeleton. [2]

age = ... years

(ii) Explain why this method of calculating the age of bones is unreliable for skeletons believed to be less than 100 years old. [2]

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4. On 14 October 2012 Felix Baumgartner created a new world record when he jumped from a stationary balloon at a height of 39 km above the surface of the Earth. At 42 s of free fall he reached a terminal velocity of 373 m/s, which was greater than the speed of sound. The total mass of Felix and his suit was 118 kg.

(a) Explain in terms of weight and air resistance how terminal velocity is reached. [3]

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(b) (i) Use an equation from page 2 to calculate Felix's change in momentum in the first 42 s of his fall. [2]

change in momentum = ... kg m/s

(ii) Use an equation from page 2 to calculate the mean resultant force acting on him during the first 42 s. [2]

mean resultant force = ... N

(iii) Calculate the mean value of the air resistance force during the first 42 s. [3]

mean air resistance force = ... N

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(c) At 39 km the air particles are very far apart. Explain how jumping from this height allowed Felix to reach such a high terminal velocity. [2]

....

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12

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5. *(a)* Describe how you would investigate how the resistance of a filament lamp changes with the voltage. [6 QWC]

Include in your answer:

- a labelled circuit diagram;
- how you would obtain a range of results;
- how you would analyse the data.

TURN OVER FOR THE REST OF THE QUESTION.

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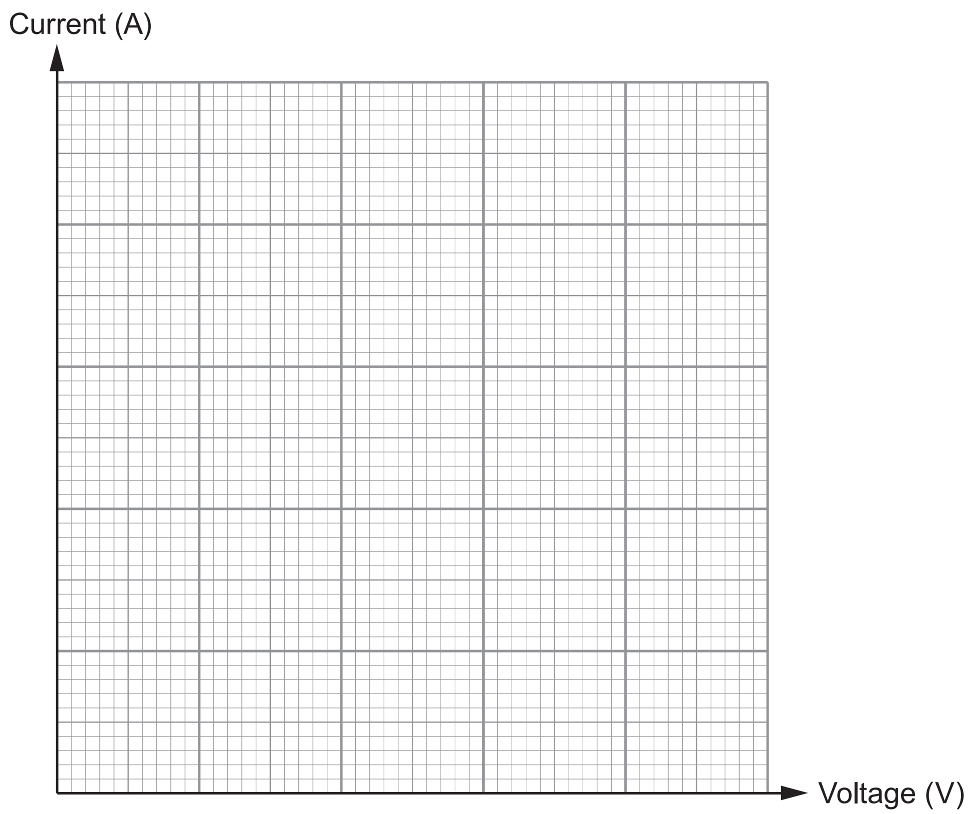
(b) A table of results for a similar investigation is shown below.

Voltage (V)	Current (A)
0	0
2.0	1.0
4.0	1.4
6.0	1.7
8.0	1.9
10.0	2.0

(i) Plot the data on the grid below and draw a suitable line. [3]



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(ii) Use the graph and an equation from page 2 to calculate the resistance of the lamp at 5 V. [3]

resistance = ... Ω

(iii) Use the graph to explain how the resistance of the lamp changes as the voltage increases. [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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