Surname	Centre Number	Candidate Number
Other Names		0

GCSE

4503/02

S16-4503-02

PHYSICS

PHYSICS 3
HIGHER TIER

P.M. WEDNESDAY, 25 May 2016

1 hour

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1.	14	
2.	10	
3.	9	
4.	13	
5.	14	
Total	60	

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ADDITIONAL MATERIALS

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

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.
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.

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 answer to question **2**(*a*)(ii) and **5**(*b*).

Equation

V_1 = voltage on the primary coil V_2 = voltage on the secondary coil N_1 = number of turns on the primary coil N_2 = number of turns on the secondary coil	$\frac{V_1}{V_2} = \frac{N_1}{N_2}$
power = voltage × current	$P = VI$
speed = $\frac{\text{distance}}{\text{time}}$	
u = initial velocity v = final velocity t = time a = acceleration x = displacement	$v = u + at$ $v^2 = u^2 + 2ax$ $x = ut + \frac{1}{2}at^2$ $x = \frac{1}{2}(u + v)t$
momentum = mass × velocity	$p = mv$
kinetic energy = $\frac{\text{mass} \times \text{speed}^2}{2}$	$KE = \frac{1}{2}mv^2$
pressure = $\frac{\text{force}}{\text{area}}$	$p = \frac{F}{A}$
	T / K = θ / °C + 273
p = pressure V = volume T = kelvin temperature	$\frac{pV}{T}$ = constant
density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$
	$E = mc^2$

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)* State how the construction of a step-up transformer is different from a step-down transformer. [1]

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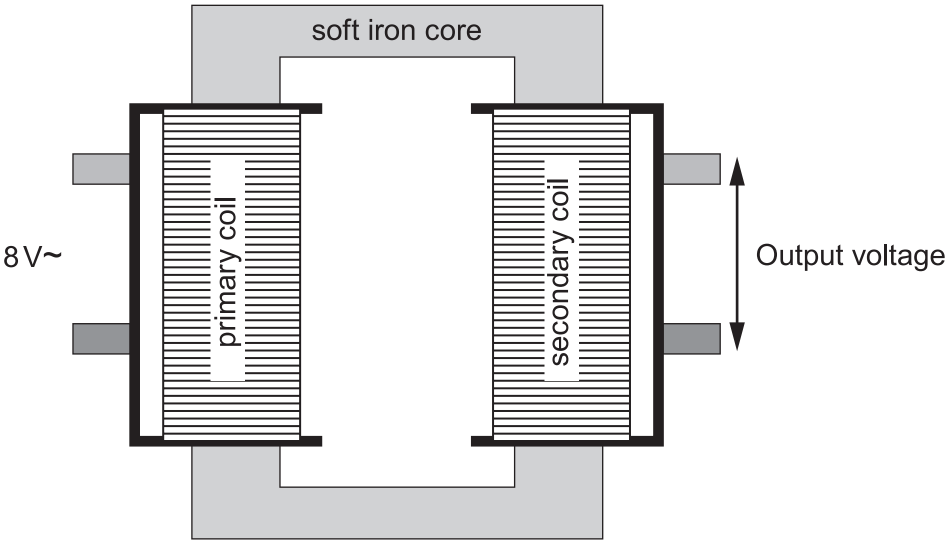
....

The diagram shows a transformer that can be used for an investigation in a laboratory.



(b) Put a **tick (✓)** in the boxes next to the statements that would cause the output voltage to increase. [2]

Increasing the number of turns on the primary coil	☐
Decreasing the number of turns on the primary coil	☐
Decreasing the input voltage	☐
Increasing the number of turns on the secondary coil	☐
Decreasing the number of turns on the secondary coil	☐

(c) Explain why there must be an alternating input voltage for the transformer to work. [2]

....

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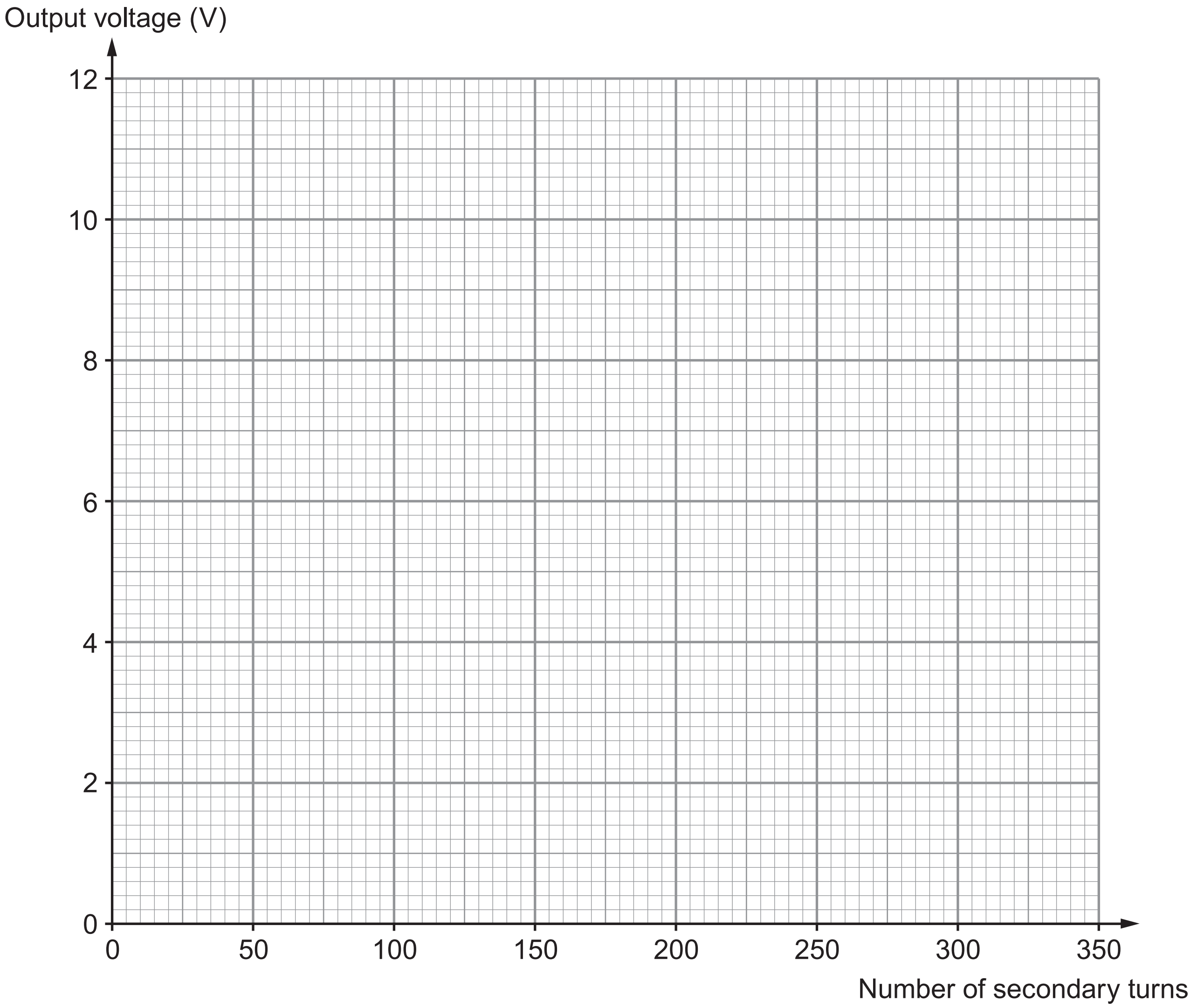
(d) An investigation is carried out to determine how the output voltage depends on the number of turns on the secondary coil. The input voltage (8 V) and the number of turns on the primary coil (200) are kept constant throughout the investigation.

The results of the investigation are recorded in the table below.

Input voltage (V)	Primary turns	Secondary turns	Output voltage (V)
8	200	50	2
8	200	....	4
8	200	150	6
8	200	200	8
8	200	300	12

(i) **Complete the table.** [1]

(ii) Plot a graph of the output voltage against the number of secondary turns on the grid below and draw a suitable line. [3]



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(iii) Describe the relationship between the output voltage and the number of secondary turns. [2]

....

....

(iv) Use the graph to find the number of secondary turns required to give an output voltage of 5 V. [1]

number of turns = ...

(v) Explain how the graph would be different if the investigation were repeated with a primary coil containing 400 turns. [2]

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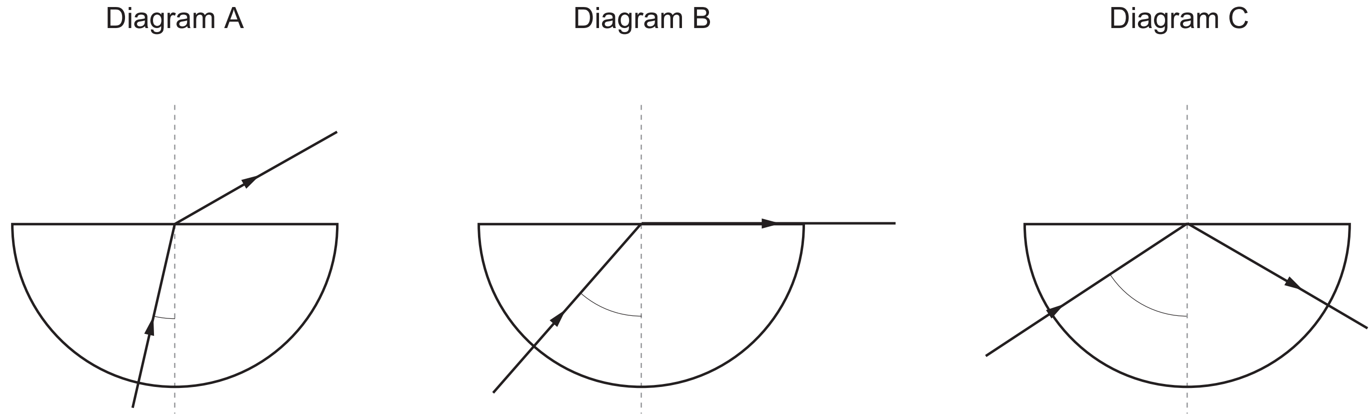
2. *(a)* The diagrams below are drawings made by a student investigating how light rays pass through a semi-circular glass block.



(i) **Label the critical angle (*c*)** on the appropriate diagram above. [1]

(ii) Describe and explain the observations shown in the drawings as fully as you can. [6 QWC]

You should:

- describe what happens to the light ray in each of the diagrams above;
- explain why the light ray follows the path shown in each diagram.

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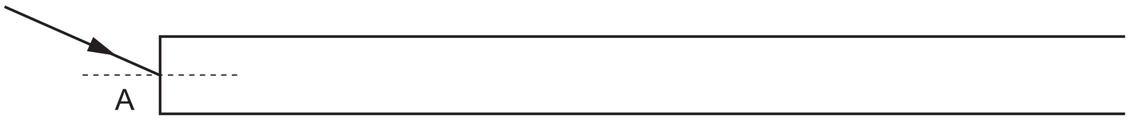
(b) Complete the diagram below to show how the light entering at A travels along the optical fibre. [3]



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3. *(a)* (i) Explain why our Sun remains the same size in the main sequence stage of its life. [2]

....

....

(ii) Name, in order, the next **two** stages in the life of our Sun. [2]

.... and ....

(iii) **Complete the nuclear equation below** which shows the nuclear fusion reaction occurring in the Sun. [2]

$$\ldots\ldots {}^{1}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He} + \ldots\ldots {}^{0}_{1}\mathrm{e}$$

(b) Each second, the Sun produces 3.9×10^{26} J of energy in the form of electromagnetic radiation. Use an equation from page 2 to calculate the mass loss of the Sun per second. (Speed of light, $c = 3 \times 10^{8}$ m/s) [3]

mass loss = ... kg

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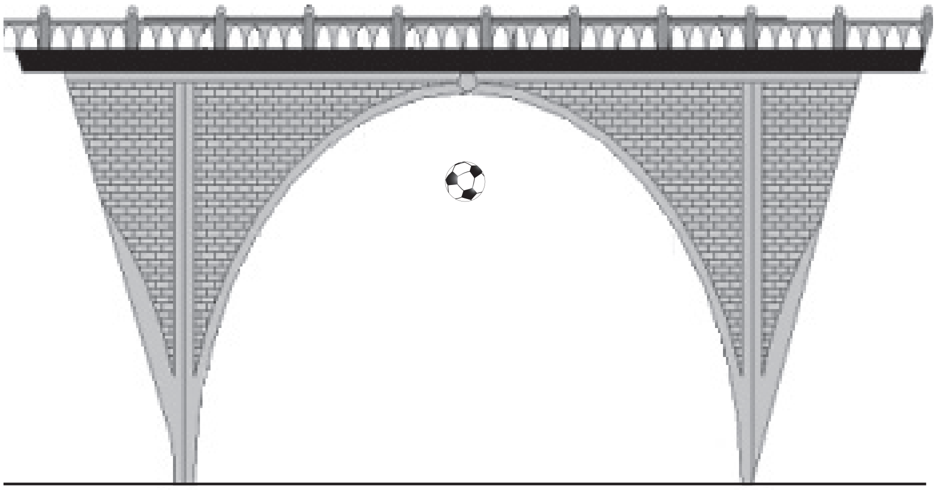
4. A football of mass 0.3 kg is dropped from rest off a bridge and takes 2.8 seconds to reach the ground below.



The diagram is not drawn to scale

Use equations from page 2 to answer the questions below.
Assume the acceleration due to gravity = 10 m/s^2 and that air resistance is negligible.

(a) Calculate the height of the bridge. [2]

height = ... m

(b) Calculate the momentum of the ball just before it hits the ground. [3]

momentum = ... kg m/s

Examiner only

(c) The ball rebounds from the ground with a speed of 14 m/s.

(i) Calculate the kinetic energy of the football as it leaves the ground. [2]

kinetic energy = ... J

(ii) Calculate the change in momentum of the ball due to the bounce. [2]

change in momentum = ... kg m/s

(iii) Explain how momentum is conserved when the ball rebounds from the Earth. [2]

....

....

....

(d) Describe how Newton's third law of motion applies when the ball hits the ground. [2]

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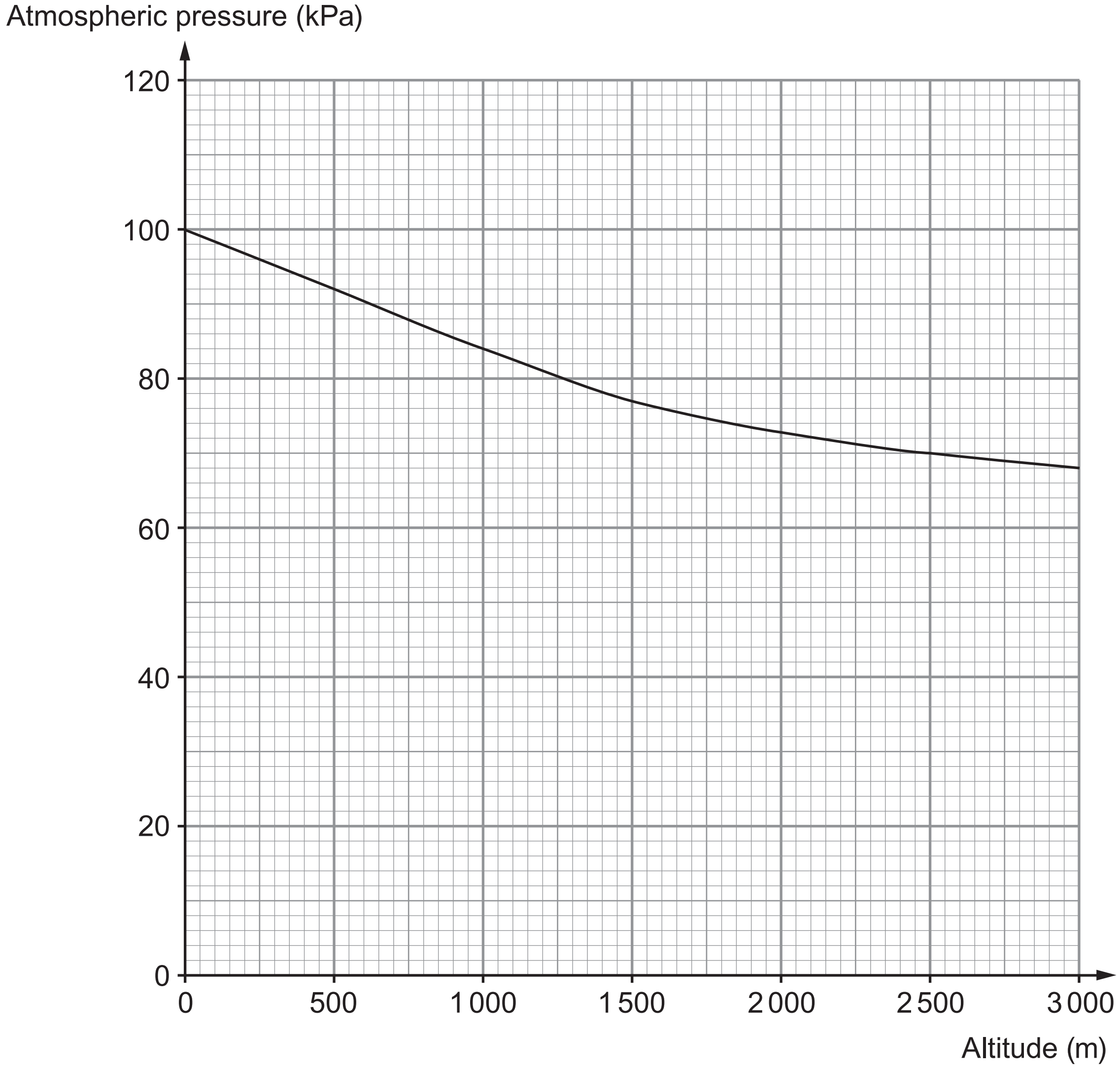
5. Dan is on holiday in Denver USA. He packs a sealed plastic water bottle containing only air in his luggage. When he arrives home in Cardiff he notices that the water bottle appears crushed. He works out the volume of the bottle in both Denver and Cardiff.

The table below shows his results together with other relevant information.

Volume of bottle in Denver	$5.0 \times 10^{-4}\,m^3$
Volume of bottle in Cardiff	$3.8 \times 10^{-4}\,m^3$
Temperature in Cardiff	293 K
Temperature in Denver	293 K
Altitude of Cardiff	0 metres

The graph shows how atmospheric pressure changes with altitude (height above sea level).



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(a) (i) Use the graph to write down the air pressure in Cardiff in Pa. [1]

pressure = ... Pa

(ii) Use the information opposite together with equations from page 2 to answer the following questions.

(I) Calculate the atmospheric pressure in Denver and use your answer to find the altitude of Denver. [4]

atmospheric pressure = ...

altitude = ... m

(II) Calculate the temperature required for the bottle in Cardiff to have the same volume as in Denver. Give your answer in °C. [3]

temperature = ... °C

TURN OVER FOR THE LAST PART OF THE QUESTION

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(b) Explain, in terms of the motion of molecules, how the behaviour of gases leads to the idea of absolute zero and an absolute scale of temperature. [6 QWC]

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END OF PAPER

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