Surname	Centre Number	Candidate Number
Other Names		0

GCSE

4503/02

S15-4503-02

PHYSICS

PHYSICS 3
HIGHER TIER

P.M. WEDNESDAY, 20 May 2015

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**14**	
2.	**11**	
3.	**6**	
4.	**10**	
5.	**9**	
6.	**10**	
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 answers to questions **3** and **6**(*b*).

Equations

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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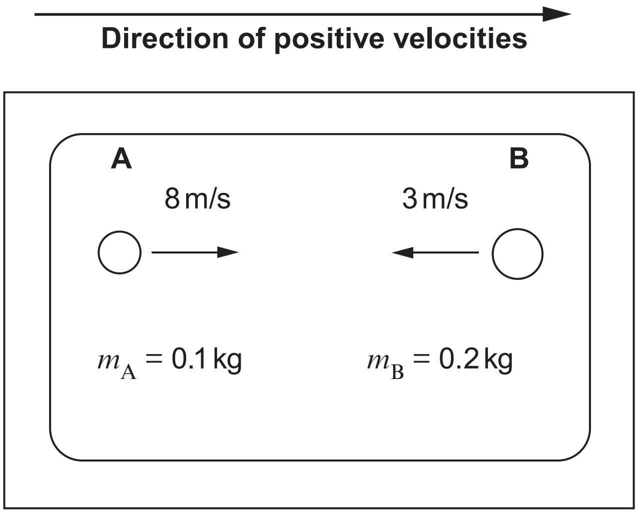
Answer **all** *questions.*

1. *(a)* A sliding disc **A** of mass (m_A) 0.1 kg travelling with a velocity of +8 m/s on a frictionless table hits another disc **B** of mass (m_B) 0.2 kg travelling with a velocity of –3 m/s.



(i) Use an equation from page 2 to calculate the initial momentum of disc **A**. [2]

momentum = ... kg m/s

(ii) Calculate the initial momentum of disc **B**. [1]

momentum = ... kg m/s

(iii) Calculate the **total** momentum before the collision. [1]

total momentum = ... kg m/s

(iv) Write down the **total** momentum after the collision. [1]

total momentum = ... kg m/s

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(v) After the collision, disc **A** stops moving.

Use the equation:

$$\text{velocity} = \frac{\text{total momentum}}{\text{mass}}$$

to calculate the velocity of disc **B** after the collision. [2]

velocity of disc **B** = ... m/s

(b) Disc **A** decelerates at 160 m/s^2 during the collision.

(i) Use the equation:

$$t = \frac{(v - u)}{a}$$

to calculate how long the collision takes. [2]

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time = ... s

(ii) Disc **A** applies a mean force of 1.6 N to disc **B** during the impact. Write down the **size** and **direction** of the mean force applied to disc **A** by disc **B** in the collision. [2]

....

....

(c) Use an equation from page 2 to calculate the loss of kinetic energy in the collision. [3]

energy lost = ... J

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2. The Sun is in a stable state in the main sequence stage of its “life”.

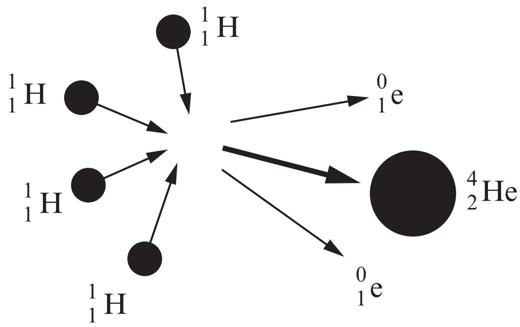
(a) (i) Name the forces acting on the Sun. [1]

....

(ii) State why the Sun is in a stable state at present. [1]

....

(b) The Sun generates most of its energy by the nuclear reaction shown in the diagram.



(i) Write the nuclear equation for this reaction. [1]

$\longrightarrow$

(ii) Describe this reaction, naming the particles involved. [3]

....

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(iii) Use the information below and an equation from page 2 to calculate the energy produced by this reaction. [4]

mass of a proton ($^{1}_{1}H$ nucleus) = 1.00728 u

nuclear mass of $^{4}_{2}He$ = 4.00151 u

1 u = 1.66×10^{-27} kg

$c = 3 \times 10^{8}$ m/s

ignore the mass of $^{0}_{1}e$

energy = ... J

(c) State what happens when a particle $^{0}_{1}e$ collides with a particle $^{0}_{-1}e$. [1]

....

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3. Use your knowledge of the kinetic theory of matter to explain how heat energy is transferred by conduction in **metals** and by convection in **gases**. [6 QWC]

6

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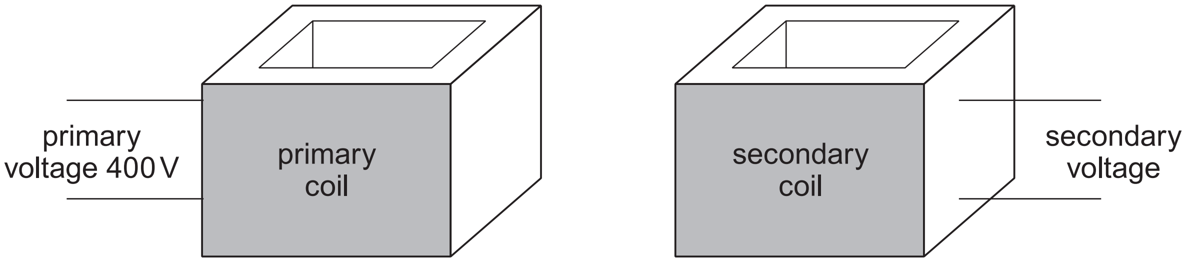
4. The diagram shows parts of a transformer. The diagram is incomplete.



(a) **Draw** and **label** the missing part in the correct position on the diagram above and state its function. [2]

....

....

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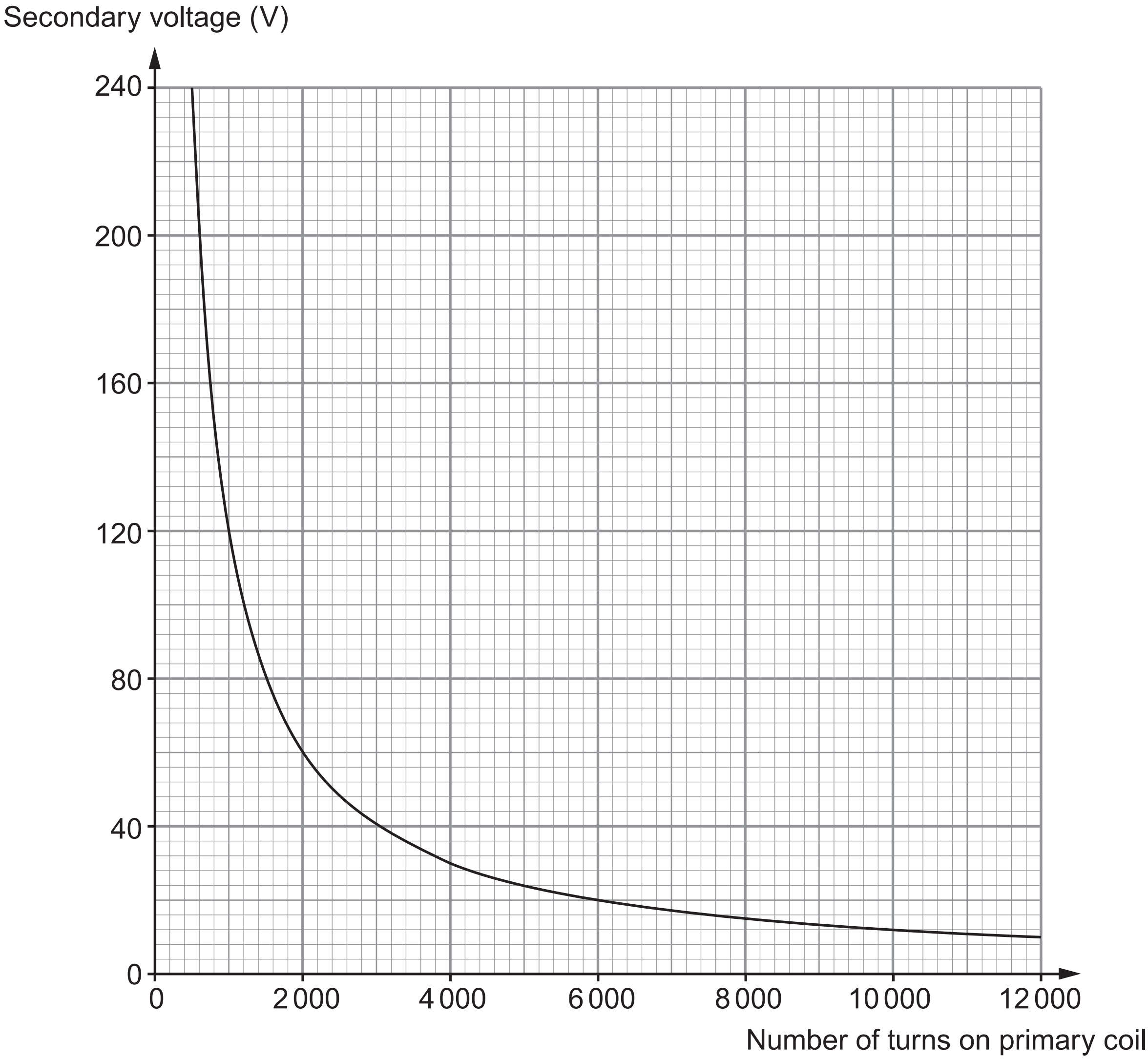
(b) This transformer has a **fixed** number of turns on its **secondary coil**. The number of turns on its **primary coil** can be changed. This affects the **secondary voltage** in the way shown on the graph below.



(i) Describe how the secondary voltage changes as the number of turns on the primary coil is increased. [2]

....

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(ii) The voltage on the primary coil is 400 V. Use an equation from page 2 and a pair of readings from the graph to calculate the number of turns on the **secondary coil**. [2]

number of turns = ...

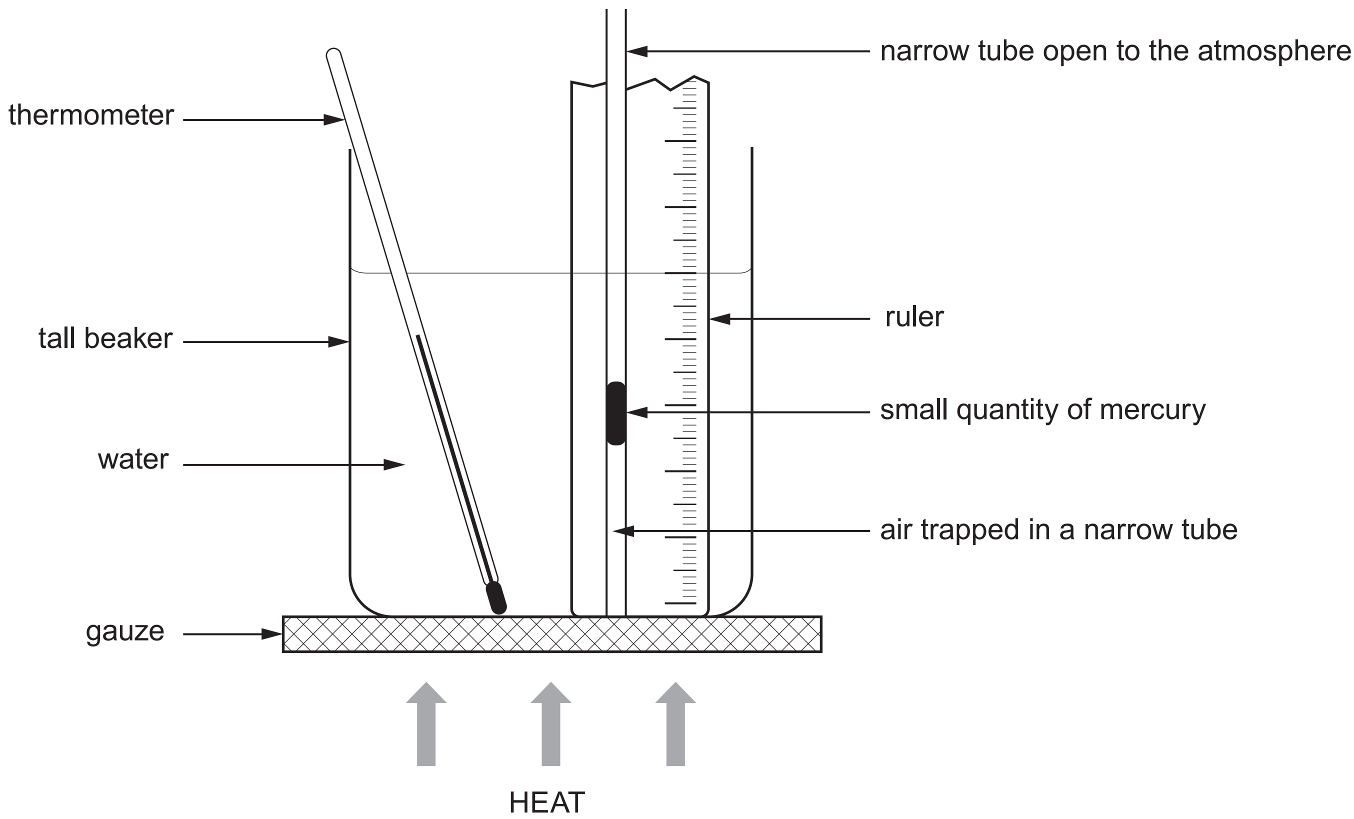
(iii) When the primary coil has 1 000 turns, it is used to power a 480 W heater that is connected to the secondary coil. Use the graph and an equation from page 2 to calculate the current in the secondary coil. [3]

current = ... A

(iv) **Draw a line** on the grid opposite, to show how the secondary voltage would change with the number of turns on the primary coil if this transformer had fewer turns on its secondary coil. [1]

10

5.



(a) In a class experiment the volume of a mass of air changed when it was heated. The air is shown contained in a narrow tube which is open to the atmosphere. The length of trapped air in the tube (which indicates its volume) was measured as the temperature of the water was changed. The results are shown in the table below.

Temperature (°C)	Length of trapped air (cm)
10	10.7
25	11.2
40	11.8
55	12.4
70	12.9
85	13.5

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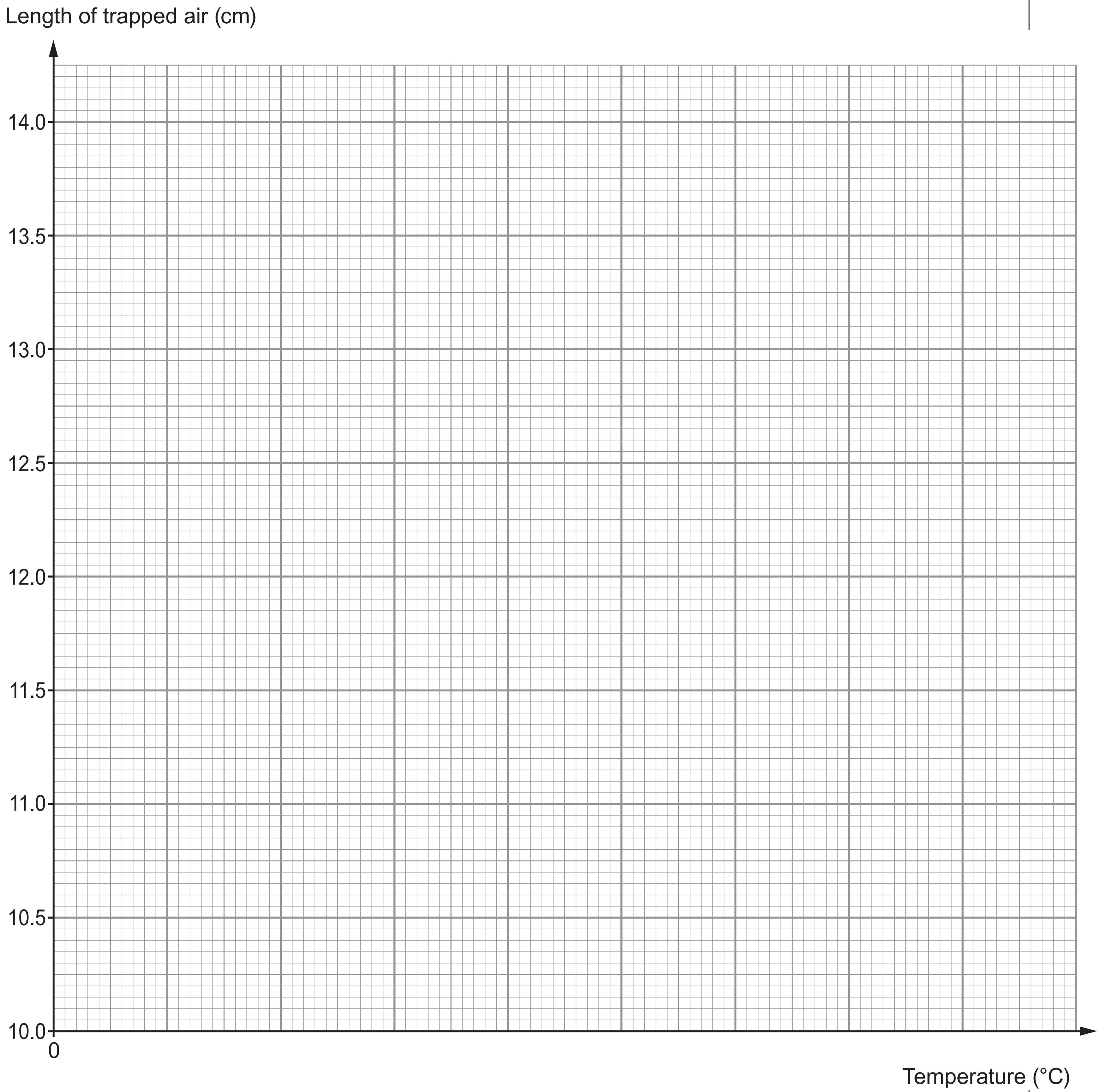
(i) Plot these results on the grid below and draw a suitable line. [3]
(Note that the scale on the length of trapped air axis does not start at zero.)



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(ii) How does the value of the kinetic energy of the gas particles change as the temperature decreases? [1]

....

....

(iii) State the value of the kinetic energy of the gas particles at –273 °C (absolute zero). [1]

kinetic energy = ... J

(b) A butane gas cylinder is kept in a garage where, in the winter, it is at a temperature of – 3 °C. The pressure in the cylinder is 3.0×10^6 N/m^2. In a hot summer, the temperature increases to 42 °C, whilst the **volume** of the gas remains constant.
Use an equation from page 2 to find whether the cylinder is in danger of exploding in the hot summer if the maximum pressure that the container can withstand is 4.0×10^6 N/m^2. Comment on your answer. [4]

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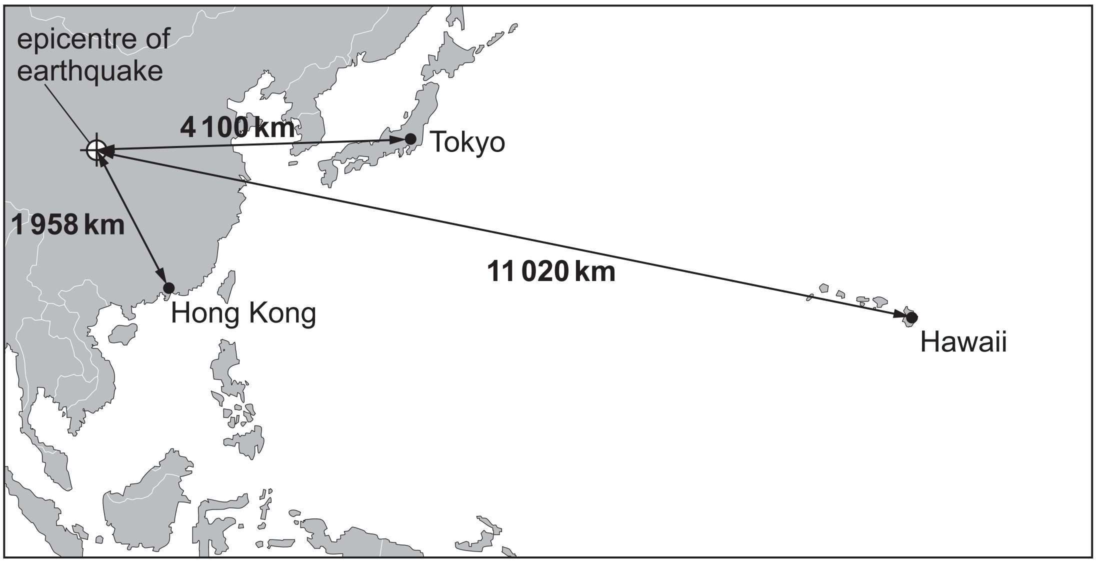
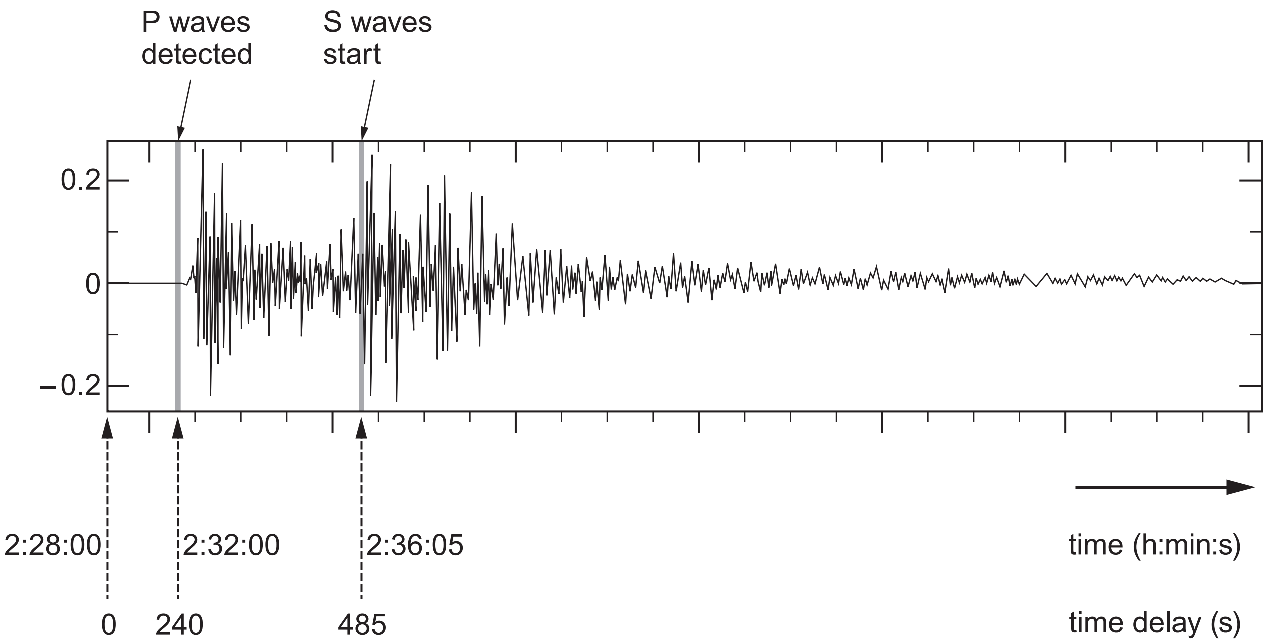
6. The map below shows the epicentre of an earthquake which occurred in China at exactly 2:28 p.m. on 16 December 2013. The positions of seismic recording stations in Tokyo, Hawaii and Hong Kong are also shown. The trace produced by the Hong Kong station is shown below the map.



Hong Kong station trace



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Use information from the map and the Hong Kong station trace, to answer the following questions.

(a) Use an equation from page 2 to calculate the speed of the P waves travelling from the epicentre to Hong Kong. Give your answer in km/s. [3]

speed = ... km/s

(b) Explain what similarities and differences you would expect between the Hong Kong, Hawaii and Tokyo station traces. [6 QWC]

Include in your answer:

- statements describing how the traces would be different;
- statements describing how the traces would be similar;
- calculations showing how the greater distances affect parts of the traces.

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TURN OVER FOR THE LAST PART OF THE QUESTION

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(c) A student calculates the speed of P waves for another earthquake in the San Francisco area and finds that it is different. Suggest a reason why this might be the case. [1]

....

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END OF PAPER

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