IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

N02/430/S(2)+

PHYSICS
STANDARD LEVEL
PAPER 2

Tuesday 5 November 2002 (afternoon)

1 hour

Name

Number

INSTRUCTIONS TO CANDIDATES

- Write your candidate name and number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section A: Answer all of Section A in the spaces provided.
- Section B: Answer one question from Section B in the spaces provided.
- At the end of the examination, indicate the number of the Section B question answered in the box below.

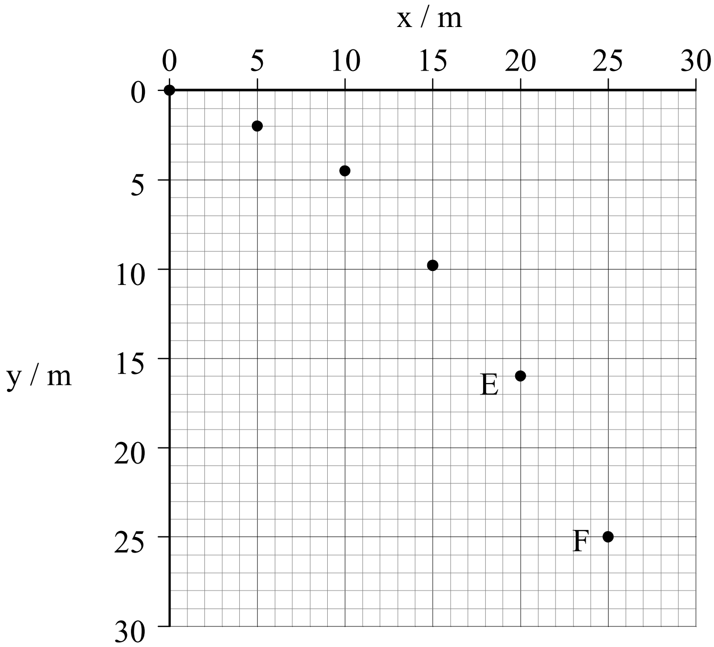
QUESTIONS ANSWERED		EXAMINER	TEAM LEADER	IBCA
SECTION A	ALL	/25	/25	/25
SECTION B	. . . .	/25	/25	/25
		TOTAL /50	TOTAL /50	TOTAL /50

SECTION A

*Candidates must answer **all** questions in the spaces provided.*

A1. Projectile motion on a planet

A projectile is launched horizontally from a cliff on a planet in a distant solar system. The graph below plots the horizontal (x) and vertical (y) positions of the projectile **every 0.5 seconds**.



(a) Determine the initial velocity with which the projectile was launched. *[2]*

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(b) How can you tell from the plotted data that the planet's atmosphere had no significant effect on the motion of the projectile? *[2]*

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(c) State **two** reasons why the value of the acceleration due to gravity on this or any other planet is likely to be different from that on Earth. *[2]*

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(Question A1 continued)

(d) Draw a vector on the graph to represent the **displacement** of the projectile between points E and F of the motion. Then draw vectors to represent the horizontal and vertical **components** of this displacement. *[3]*

(e) Determine the **vertical** component of the average velocity of the projectile between points E and F. *[2]*

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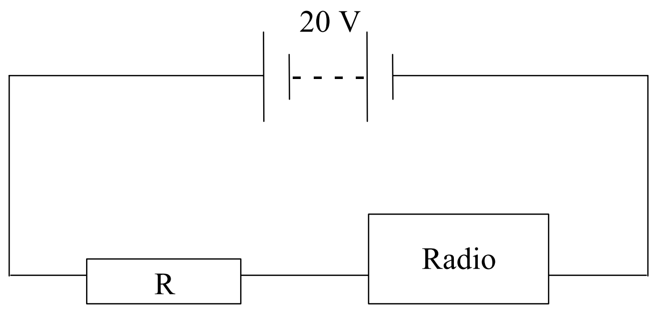
(f) Another projectile is fired at **half the speed** of the first one. On the graph opposite, plot the positions of this projectile for time intervals of 0.5 s. *[2]*

A2. Portable radio power supply

A portable radio requires a potential difference of 12 V to operate. The only supply available is a 20 V supply. In order to use the radio with this supply, a student includes a series resistor, R, as shown in the circuit below.



(a) The radio is designed to draw a current of 0.4 A with 12 V across it. The internal resistance of the 20 V supply is small. Calculate the value of the resistor, R, required for the radio to operate normally, when connected in the circuit above. *[3]*

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(b) Three resistors are available with maximum power ratings 2 W, 5 W and 10 W respectively. Explain which **one** of these resistors the student should choose for the circuit. *[2]*

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(c) Explain what would happen if a resistor with a lower power rating than that required is chosen. *[1]*

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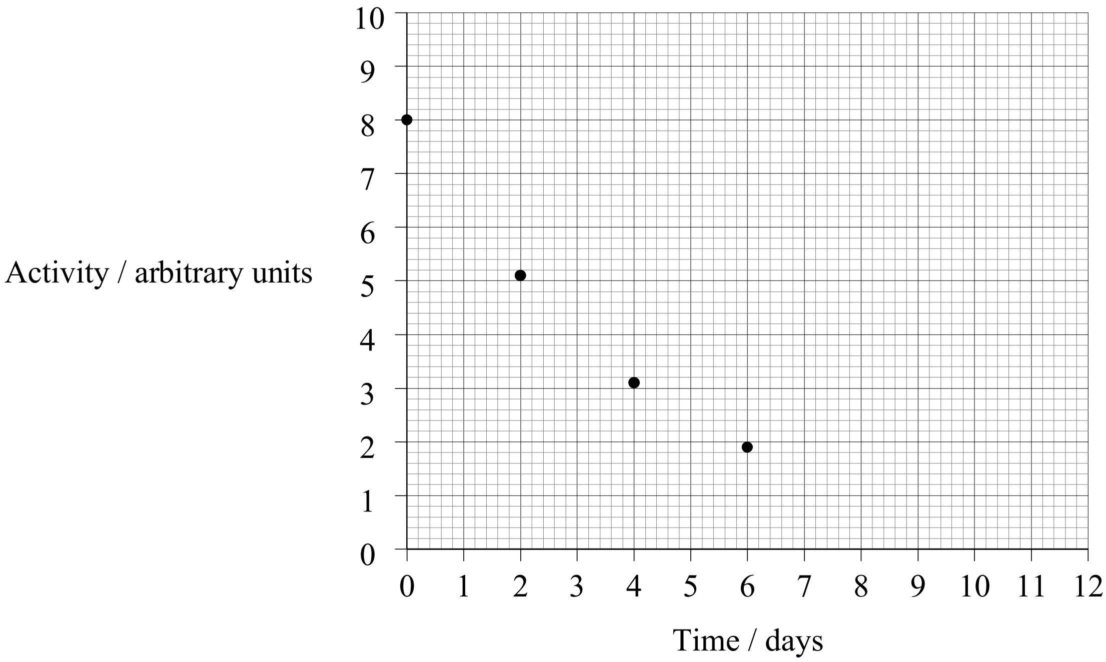
A3. Radioactive decay

The activity of a radioactive sample is shown plotted against time over 6 days, on the graph below.



(a) Draw a best fit curve to the data between 0 and 6 days. *[1]*

(b) Using the graph

(i) estimate the activity after 5 days. *[1]*

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(ii) determine the half-life of the sample and explain your method. *[2]*

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(c) Extend the best fit curve to show the expected activity for times up until 12 days. *[2]*

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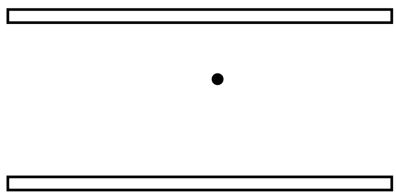
SECTION B

This section consists of three questions: B1, B2 and B3. Answer ***one*** *question in this section.*

B1. This question consists of **three** parts. Part 1 is about a Millikan-type experiment, Part 2 is about a collision between hanging masses and Part 3 is about beats.

Part 1 Millikan-type experiment

Carmel and Juan perform a Millikan-type experiment. Instead of using oil drops, they use tiny plastic spheres. Each sphere has a mass of 2.4×10^{-15} kg. The spheres are introduced into the space between two horizontal parallel plates 4.0 mm apart.



(a) Show that the electric field E between two parallel plates is related to the potential difference V and the distance apart d by the expression $E = \frac{V}{d}$. *[3]*

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(b) Calculate the electric field strength between the plates when the potential difference is 200 V. *[1]*

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(Question B1 part 1 continued)

Carmel reports that she is able to "hold" a particular sphere at rest by applying a potential difference of 200 V between the plates.

(c) Show that the charge on the sphere Carmel is observing is 4.8×10^{-19} C. *[3]*

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Carmel and Juan repeat the experiment by observing other spheres. Carmel holds another sphere stationary using a potential difference of 300 V. Juan reports that he held one stationary using a potential difference of 400 V.

(d) Explain, without calculation, why Carmel is right to think that Juan might have made a mistake but that both of her own measurements could be correct. *[3]*

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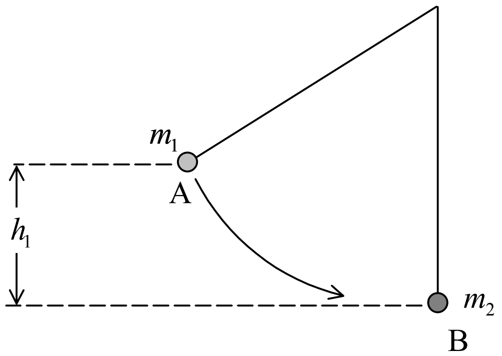
(Question B1 continued)

Part 2 Pendulum collision

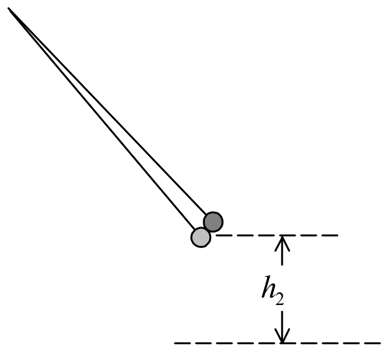
Two balls A and B, of masses m_1 and m_2 respectively, are suspended from a common point by strings of equal length. Ball A is pulled aside to the left, rising a height h_1, as shown in diagram 1 and is then released.

Diagram 1



Ball A swings down, **sticks** to ball B, and the two balls **together** swing up to the right to a height h_2 as shown in diagram 2.

Diagram 2



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(Question B1 part 2 continued)

(a) Deduce an expression for

(i) the speed of m_1 immediately before it collides with m_2. *[2]*

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(ii) the speed of m_1 and m_2 immediately after collision. *[4]*

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(b) If the expression for the speed of m_1 and m_2 immediately after collision is known, state the name of the principle (law) of physics that enable an expression for the height h_2 to be found in terms of h_1, m_1, m_2 and g. *[1]*

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(c) Explain why the height h_2 will always be less than the height h_1. *[1]*

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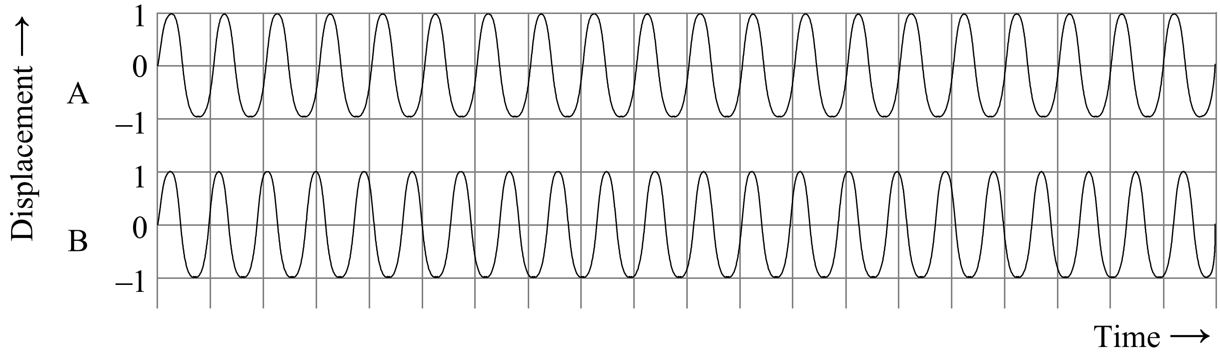
(Question B1 continued)

Part 3 Beats

Two sounds of slightly different pitch (frequency) are generated simultaneously. Each is a continuous, steady sound of fixed frequency and constant loudness. They are represented by the sinusoidal graphs of displacement versus time below.



(a) Explain why the resulting sound heard by a listener will **fluctuate** in loudness (*i.e.* be heard as "beats"). Refer your answer to the diagrams above. Name the physical principle(s) you make use of in your explanation and indicate on the diagram the times when the loudness heard will be a maximum, and when it will be zero. *[5]*

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(Question B1 part 3 continued)

(b) Give physical reasons why, if the two sounds become **closer** in frequency, the loudness fluctuations will **decrease** in frequency. Refer your answer to the diagram. *[2]*

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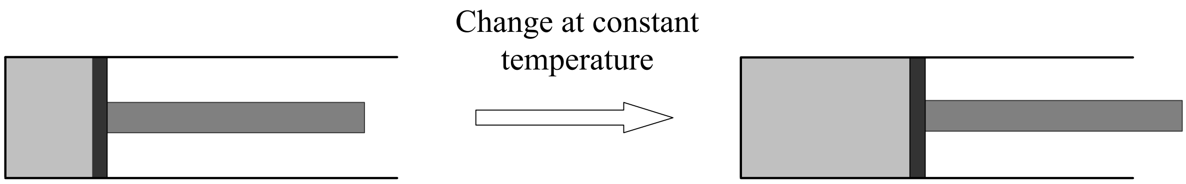
B2. This question consists of **two** parts. Part 1 is about thermodynamics and Part 2 is about the motion of a car on a road.

Part 1 Thermodynamics of two-stage gas process

This question is about pressure, volume and temperature changes of an ideal gas.

An ideal gas is enclosed in a cylinder fitted with a moveable piston. The gas undergoes two processes, as follows:

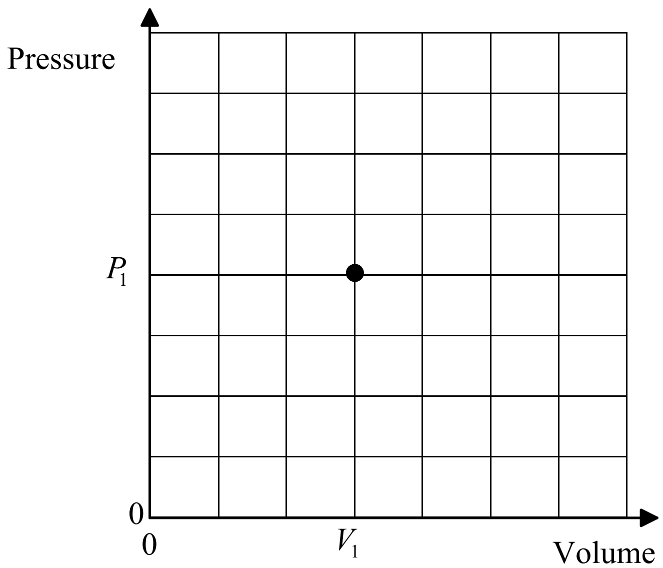
First process:
The gas, initially in state 1, is **expanded at constant temperature** T_1 until its volume is doubled. This is state 2. The two states are represented in the diagram below.



State 1
Pressure: P_1
Volume: V_1
Temperature: T_1

State 2
Pressure: $P_2 = ?$
Volume: $V_2 = 2V_1$
Temperature: $T_2 = T_1$

(a) Using the axes below, sketch a graph to show how **pressure** and **volume** are related for this process. The data point for state 1 is shown plotted. Label the state reached as state 2. *[2]*



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(Question B2 part 1 continued)

(b) Explain in terms of motions of the gas molecules, why the pressure decreases when the volume increases. *[2]*

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(c) Explain whether or not the average kinetic energy of the molecules of the gas changes in the process. *[2]*

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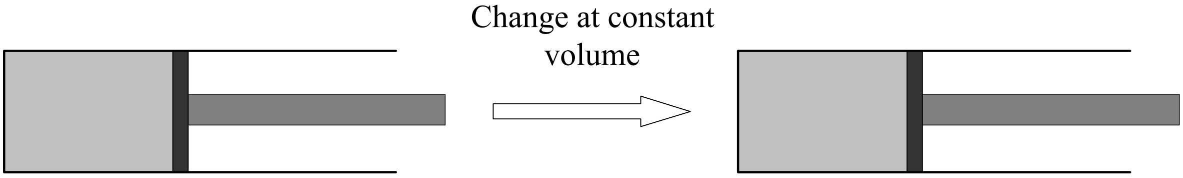
(This question continues on the following page)

(Question B2 part 1 continued)

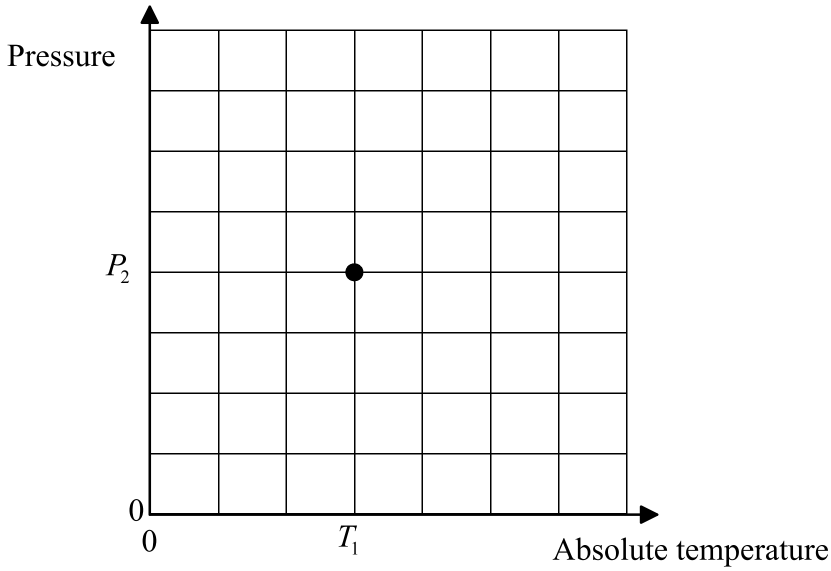
Second process:
The piston is now kept fixed, and the gas is heated until the pressure returns to its original value P_1. This is state 3 and is represented in the diagram below.



State 2
Pressure: $P_2 = ?$
Volume: $V_2 = 2V_1$
Temperature: $T_2 = T_1$

State 3
Pressure: $P_3 = P_1$
Volume: $V_3 = 2V_1$
Temperature: $T_3 = ?$

(d) Using the axes below sketch a graph to show how **pressure** varies with **absolute temperature** for this process. The data point for state 2 is shown plotted. Label the state reached as state 3. *[2]*



(e) Explain in terms of the motions of the gas molecules, why the pressure increases when the gas is heated. *[3]*

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(Question B2 part 1 continued)

(f) Explain whether or not the average kinetic energy of the gas molecules changes in this process. *[1]*

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(g) If the initial temperature of the gas in state 1 is $20\,^{\circ}\mathrm{C}$, determine the final temperature of the gas in state 3, after both processes. *[3]*

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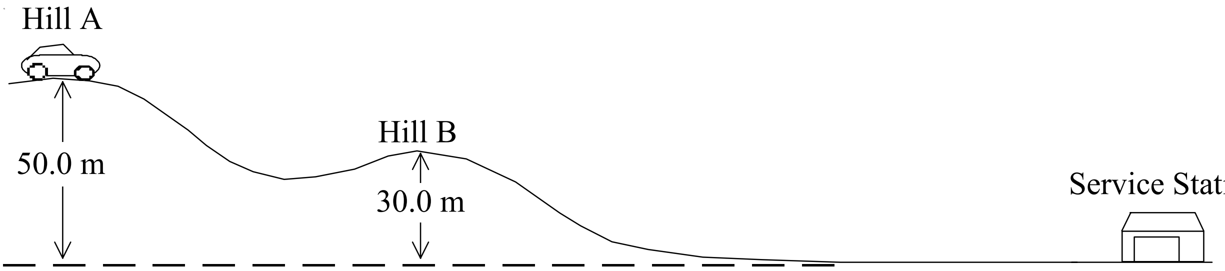
(Question B2 continued)

Part 2 A car rolling down a hill

A car runs out of fuel at the top of hill A. The driver hopes to get to the service station by letting the car roll downhill with its engine switched off. There is a small hill, B, in between as shown. The distance from hill A to hill B along the road is 0.2 km and from hill B to the service station is 0.4 km.



The top of hill A is 50.0 m above the service station and the top of hill B is 30.0 m above the service station.

(a) When the car reaches hill B its speed is $5.0\ \text{m s}^{-1}$. Assuming that the car starts from rest at hill A, show that the average frictional force acting on the car is 750 N. The mass of the car is 800 kg. *[5]*

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(b) Assuming that the frictional force remains constant throughout, determine whether or not the car reaches the service station. *[3]*

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(Question B2 part 2 continued)

(c) Besides friction in the wheels and tyres, name another source of frictional resistance for the moving car, and explain why it will not in fact remain constant during the motion. *[2]*

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B3. This question consists of **two** parts. Part 1 is about transformers and power transmission and Part 2 is about waves on water.

Part 1 Transformers and power transmission

(a) Describe how a transformer works. Include a labelled schematic diagram of a transformer and refer to relevant physics principles in your explanation. *[5]*

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(b) To transmit electrical power across long distances, the output of an AC generator is stepped up to high voltage by a transformer, and then stepped down again at the other end of the power lines. Explain why this is done. *[5]*

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(Question B3 part 1 continued)

The ratio of the number of turns N_s in the **secondary** coil to the number of turns N_p in the **primary** coil of a particular ideal transformer is given below.

$$\frac{N_s}{N_p} = 100$$

(c) If the current in the primary coil is 10.0 A, calculate the current in the secondary coil of the transformer. *[2]*

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(Question B3 continued)

Part 2 Properties of circular waves on water

(a) Ripples on water can be considered as transverse waves. Explain what is meant by a *transverse wave.* *[2]*

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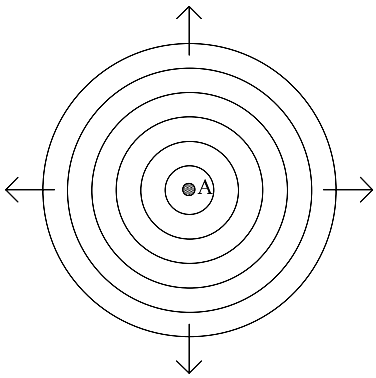
(b) An oscillator with a frequency 3.0 Hz generates ripples on the surface of water. The ripples spread in circles from the point A as shown in the diagram, viewed from the top. The distance between wavefronts is 5.0 cm.



(i) Calculate the speed of the ripples. *[2]*

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(ii) The amplitude of a wave is a measure of the energy carried by the wave. Explain what you think happens to the amplitude of the ripples as they spread out in expanding circles from the point A. *[2]*

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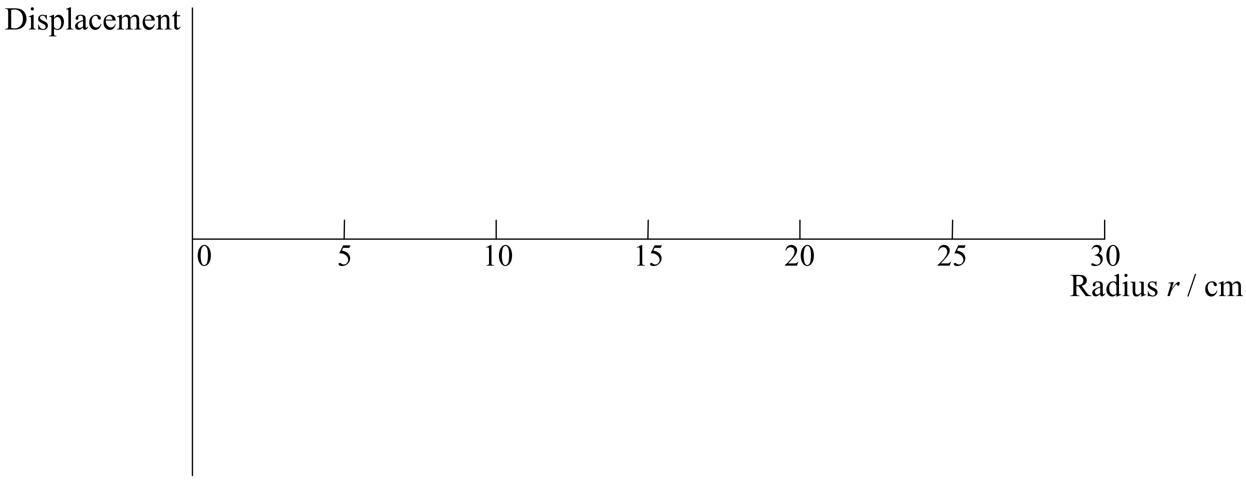
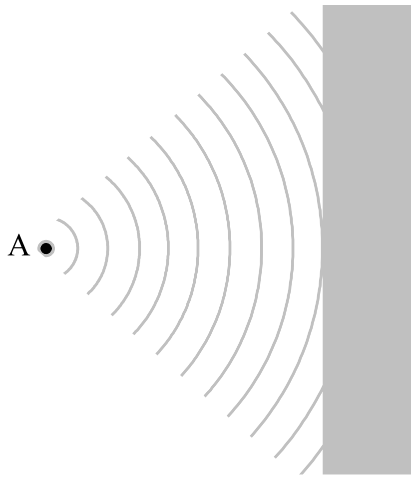
(Question B3 part 2 continued)

(iii) On the axes below, sketch a graph of the water displacement along a straight-line from A at a particular instant of time. *(Note: This is a sketch graph; you do not need to add values to the displacement axis.)* *[3]*



(c) The diagram below shows the circular ripples incident on a plane barrier.



On the diagram,

(i) sketch a wavefront that has been **reflected** from the barrier. *[1]*

(ii) draw **two** rays originating from point A that correspond to the **incident** wavefronts. *[1]*

(iii) locate the position from where the reflected waves **appear** to originate. *[2]*