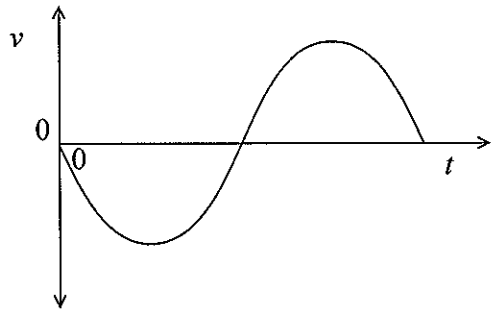
# Waves Test

## IB Physics SL

March 22, 2012

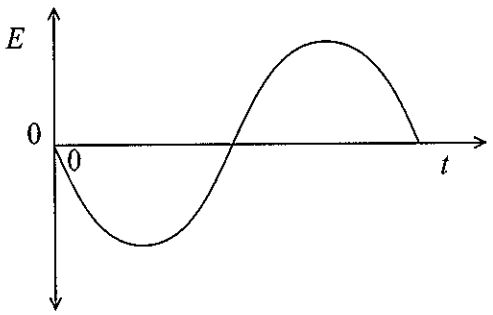
Name: _____

1 **12.** The graph shows how the velocity $v$ of an object undergoing simple harmonic motion varies with time $t$ for one complete period of oscillation.

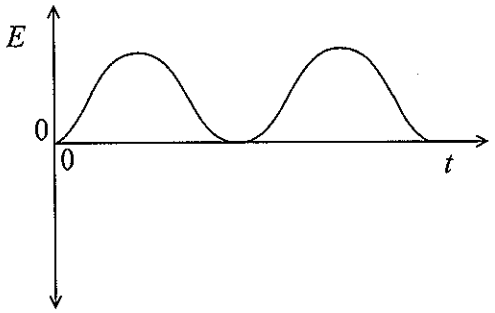



Which of the following sketch graphs best shows how the total energy $E$ of the object varies with $t$?

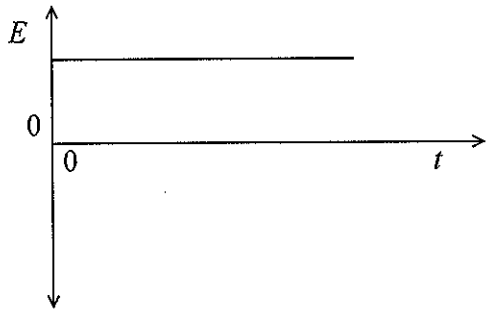
A.



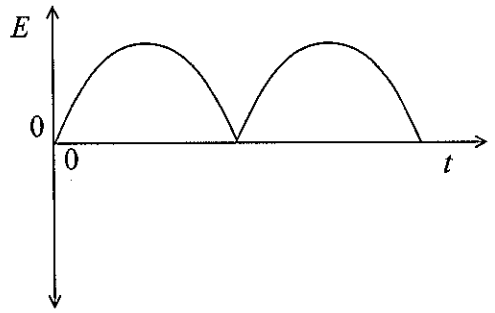

B.




C.




D.




2 **13.** A force that varies sinusoidally is applied to a system that is lightly damped. Which of the following must be true of the force for resonance to occur?

A. It must always be in anti-phase with the oscillations of the system.

B. Its direction must always be in the direction of motion of the oscillations of the system.

C. Its frequency must be equal to the frequency of oscillation of the system.

D. Its amplitude must be equal to the amplitude of oscillation of the system.

3 ~~15.~~ What is the best estimate for the refractive index of a medium in which light travels at a speed of $2.7 \times 10^8\ \text{m s}^{-1}$?

A. 0.9

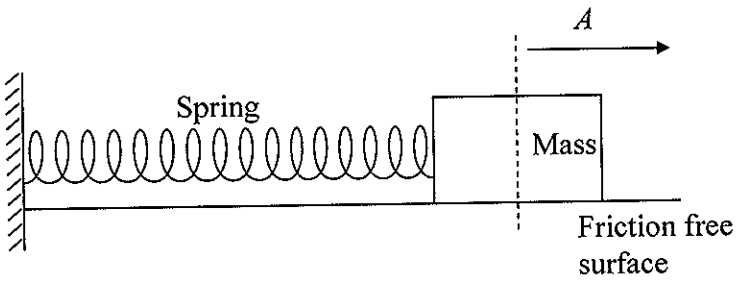
B. 1.0

C. 1.1

D. 2.7



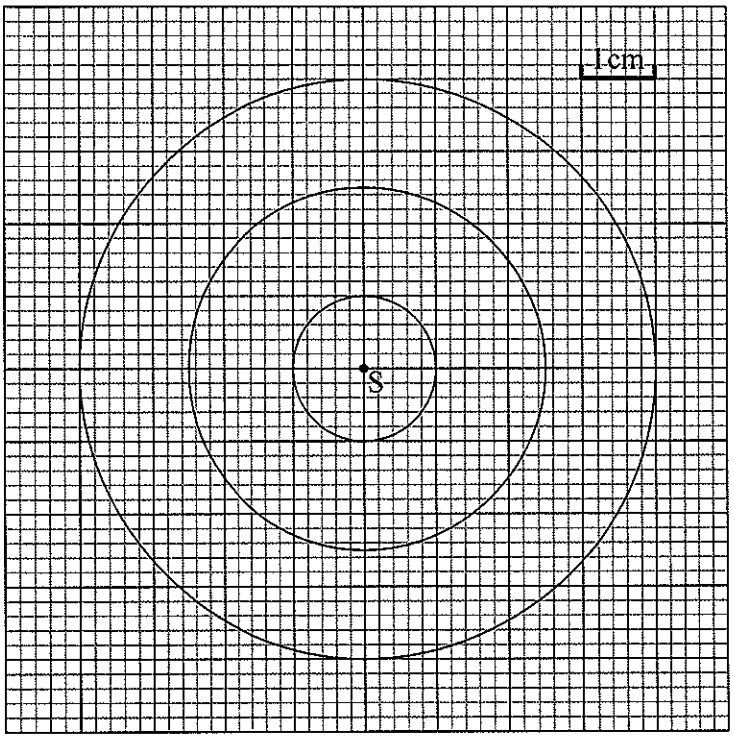
4 ~~13.~~ A mass on the end of a horizontal spring is displaced from its equilibrium position by a distance $A$ and released. Its subsequent oscillations have total energy $E$ and time period $T$.




An identical mass is attached to an identical spring. The maximum displacement is $2A$. Assuming this spring obeys Hooke's law, which of the following gives the correct time period and total energy?

| | New time period | New energy |
|---|---|---|
| A. | $T$ | $4E$ |
| B. | $T$ | $2E$ |
| C. | $\sqrt{2}T$ | $4E$ |
| D. | $\sqrt{2}T$ | $2E$ |

5 14. The diagram below is a snapshot of wave fronts of circular waves emitted by a point source S at the surface of water. The source vibrates at a frequency $f = 10.0\,\text{Hz}$.




The speed of the wave front is

A. $0.15\,\text{cm}\,\text{s}^{-1}$.

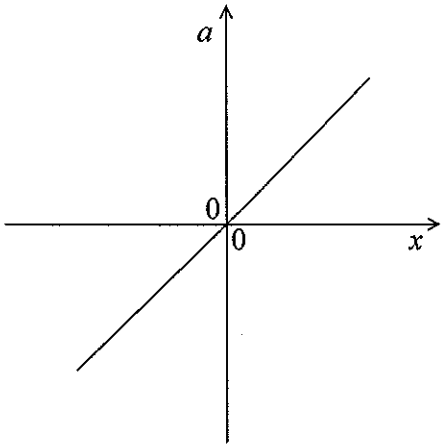
B. $1.5\,\text{cm}\,\text{s}^{-1}$.

C. $15\,\text{cm}\,\text{s}^{-1}$.

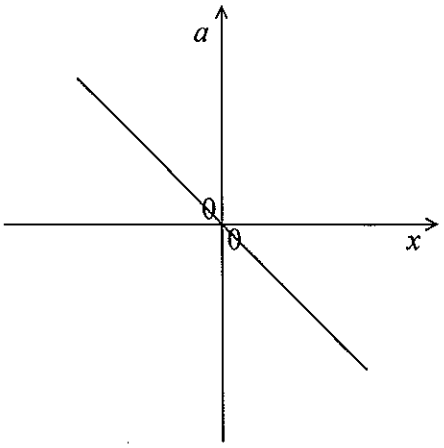
D. $30\,\text{cm}\,\text{s}^{-1}$.

13. The graphs show how the acceleration $a$ of four different particles varies with their displacement $x$. Which of the particles is executing simple harmonic motion?

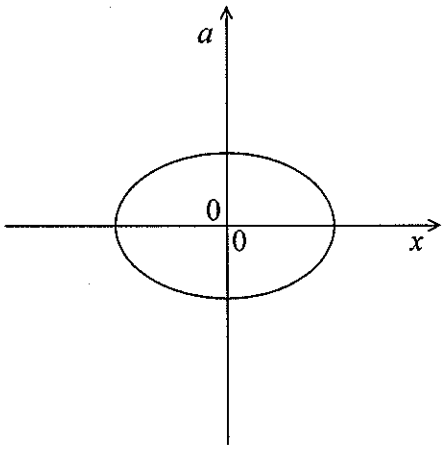
A.



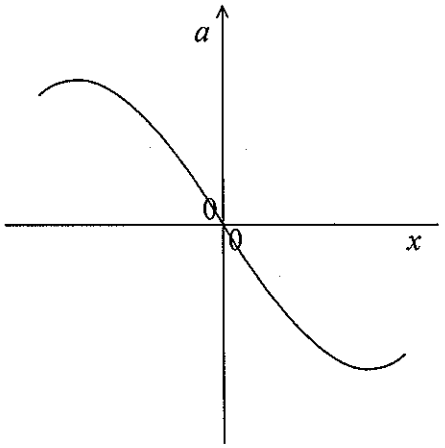

B.



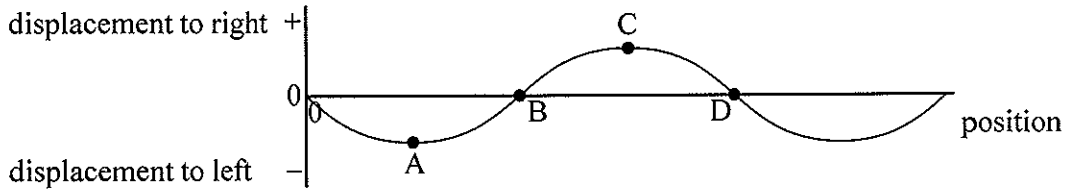

C.




D.



7 ~~22.~~ The diagram below shows the displacement-position graph at a particular instant for a longitudinal wave travelling along a spring.




A positive displacement on the graph indicates that the coils of the spring are displaced to the right of their equilibrium position.

At which position along the spring is the displacement of two adjacent coils a maximum?

A. A

B. B

C. C

D. D

8 ~~18.~~ A transverse travelling wave has amplitude $A_0$ and wavelength λ. M08 TZ1

The distance between a crest and its neighbouring trough, measured in the direction of energy transfer of the wave is equal to

A. $A_0$.

B. $2A_0$.

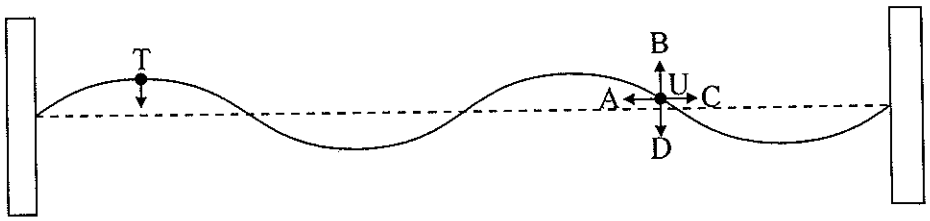
C. $\frac{\lambda}{2}$.

D. λ.

9 ~~19.~~ A light wave travelling through a vacuum is incident on a block of glass. What change, if any, occurs in the frequency and amplitude of the wave as it travels into the glass?

| | frequency | amplitude |
|---|---|---|
| A. | decreases | decreases |
| B. | decreases | constant |
| C. | constant | decreases |
| D. | constant | constant |

10. A standing wave is established on a string between two fixed points.




At the instant shown, point T is moving downwards. Which arrow gives the direction of movement of point U at this instant?

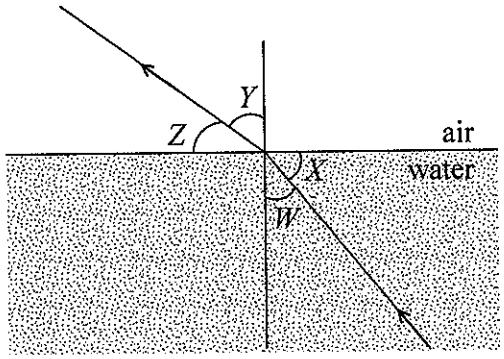
A. A

B. B

C. C

D. D

11. Light travelling from water to air is incident on a boundary.




Which of the following is a correct statement of Snell's law for this situation?

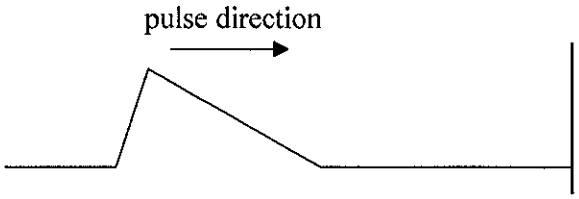
A. $\sin Z = constant \times \sin Y$

B. $\sin W = constant \times \sin Z$

C. $\sin X = constant \times \sin Z$

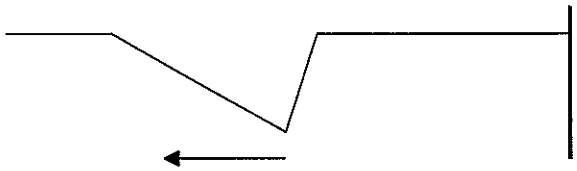
D. $\sin W = constant \times \sin Y$

12. ~~21.~~ A pulse is travelling along a string attached to a wall.

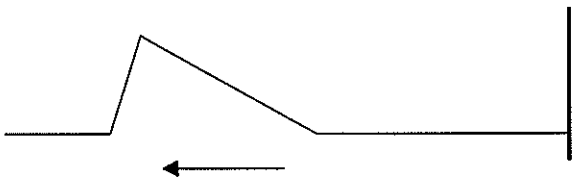



Which of the following shows the shape of the string after reflection from the wall?

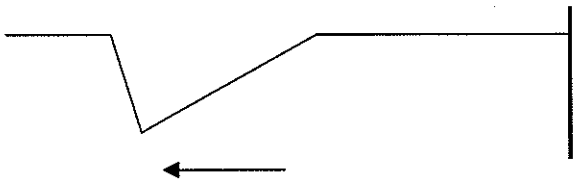
A.



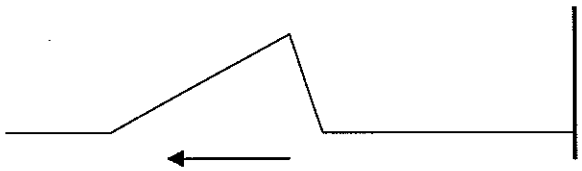
B.



C.

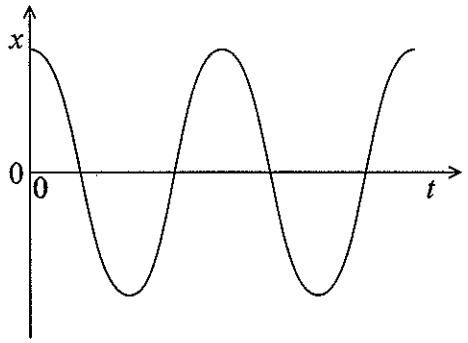


D.



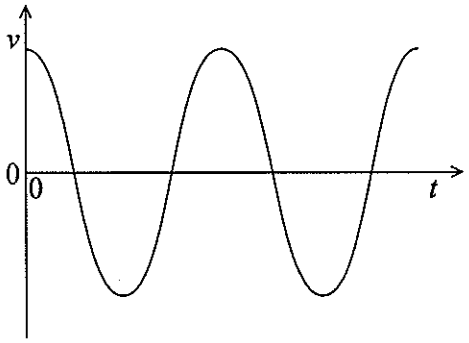
*The following graph refers to questions 13 and*

The graph below shows how the displacement $x$ of a particle undergoing simple harmonic motion varies with time $t$. The motion is undamped.

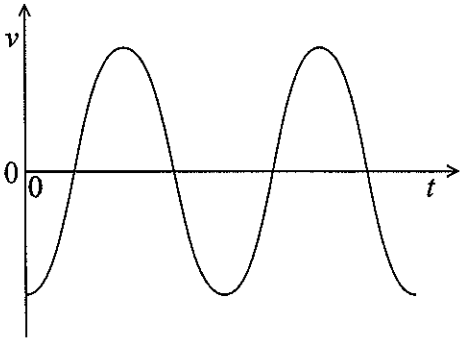



**13.** Which of the following graphs correctly shows how the velocity $v$ of the particle varies with $t$?

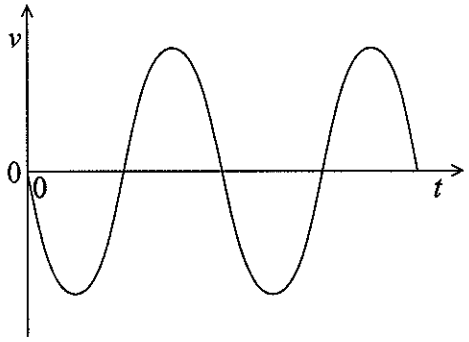
A.



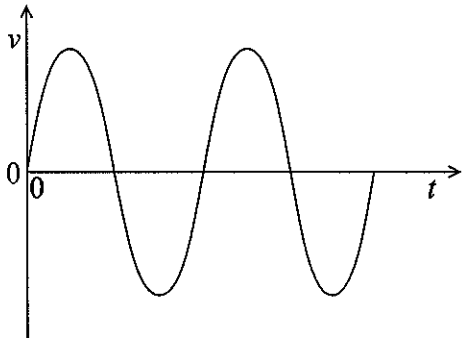

B.




C.




D.



14 **B2.** This question is in **two** parts. **Part 1** is about simple harmonic motion and waves and **Part 2** is about the decay of radium-226.

**Part 1** Simple harmonic motion and waves

(a) A particle of mass $m$ that is attached to a light spring is executing simple harmonic motion in a **horizontal direction.**

State the condition relating to the net force acting on the particle that is necessary for it to execute simple harmonic motion. *[2]*

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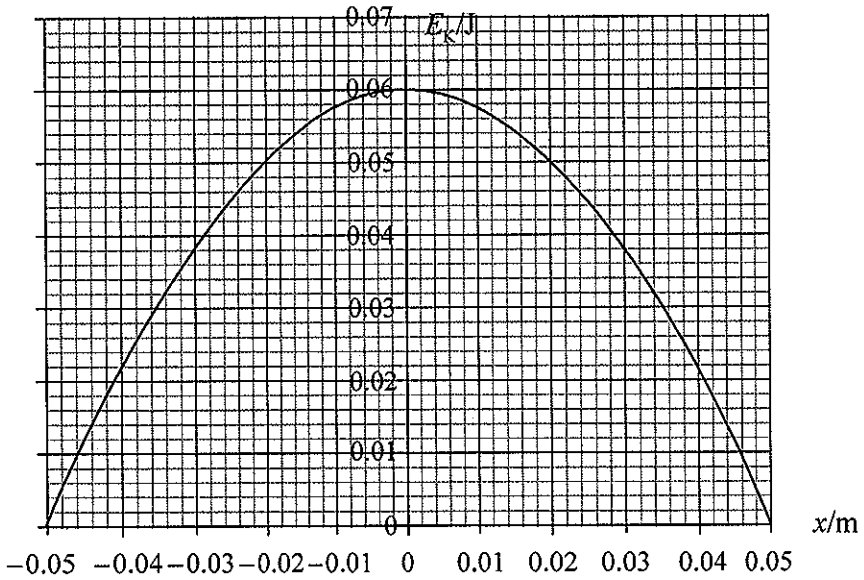
(b) The graph shows how the kinetic energy $E_K$ of the particle in (a) varies with the displacement $x$ of the particle from equilibrium.




(i) Using the axes above, sketch a graph to show how the potential energy of the particle varies with the displacement $x$. *[2]*

*(This question continues on the following page)*

*(Question B2, Part 1 continued)*

(ii) The mass of the particle is 0.30 kg. Use data from the graph to show that the frequency $f$ of oscillation of the particle is 2.0 Hz. *[4]*

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(c) The particles of a medium $M_1$ through which a transverse wave is travelling, oscillate with the same frequency and amplitude as that of the particle in (b).

(i) Describe, with reference to the propagation of energy through the medium, what is meant by a transverse wave. *[2]*

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(ii) The speed of the wave is 0.80 m s$^{-1}$. Calculate the wavelength of the wave. *[1]*

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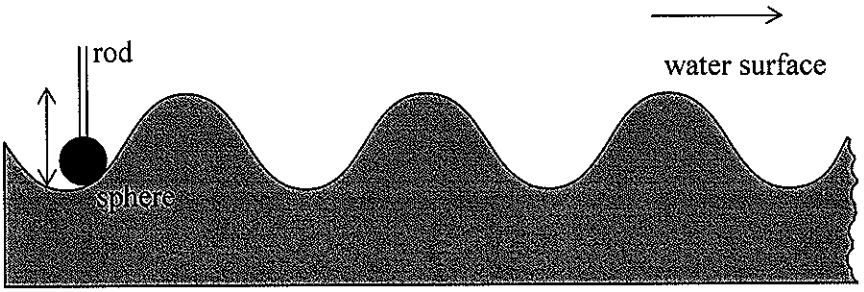
*(This question continues on the following page)*

15 ~~B2.~~ This question is in **two** parts. **Part 1** is about water wave motion. **Part 2** is about nuclear processes.

**Part 1** Water waves

A small sphere, mounted at the end of a vertical rod, dips below the surface of shallow water in a tray. The sphere is driven vertically up and down by a motor attached to the rod. The oscillations of the sphere produce travelling waves on the surface of the water.

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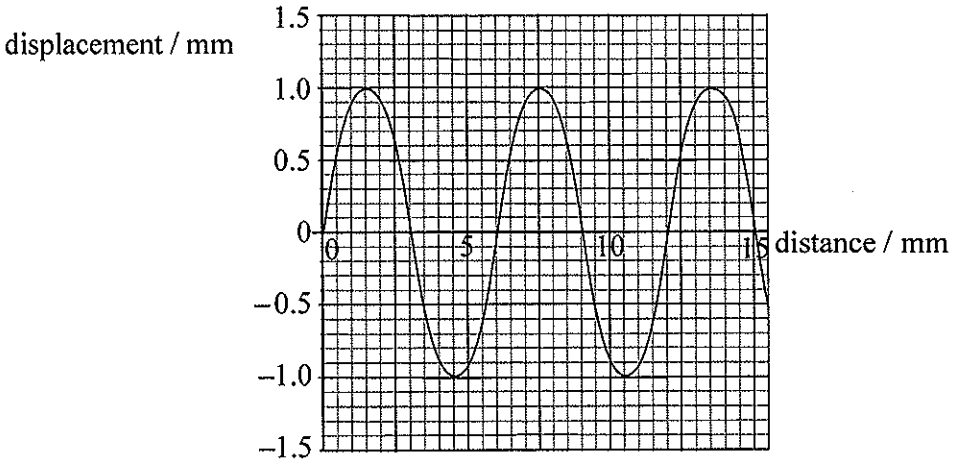
*(Question B2, part 1 continued)*

(a) The diagram shows how the displacement of the water surface at a particular instant in time varies with distance from the sphere. The period of oscillation of the sphere is 0.027 s.




Use the diagram to calculate, for the wave,

(i) the amplitude. *[1]*

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. . . . . .

(ii) the wavelength. *[1]*

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(iii) the frequency. *[1]*

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(iv) the speed. *[1]*

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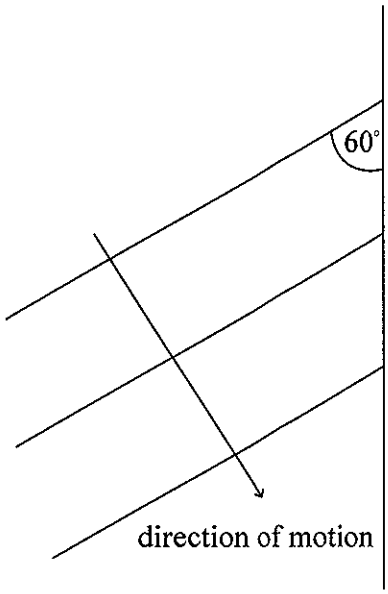
*(This question continues on the following page)*

*(Question B2, part 1 continued)*

(b) The wave moves from region A into a region B of shallower water. The waves move more slowly in region B. The diagram (not to scale) shows some of the wavefronts in region A.




(i) With reference to a wave, distinguish between a ray and a wavefront. *[2]*

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(ii) The angle between the wavefronts and the interface in region A is 60°. The refractive index ${}_{A}n_{B}$ is 1.4.

Determine the angle between the wavefronts and the interface in region B. *[2]*

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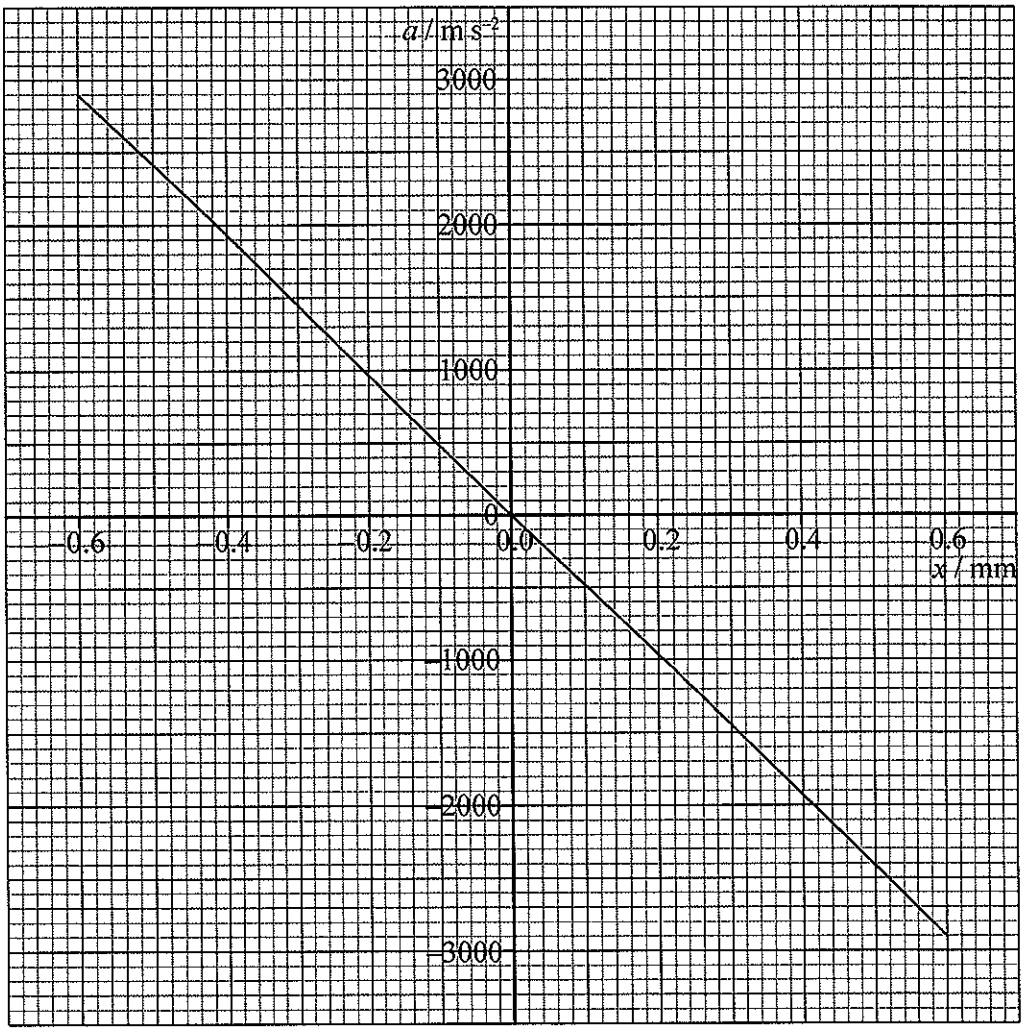
(iii) On the diagram above, construct **three** lines to show the position of three wavefronts in region B. *[2]*

*(This question continues on the following page)*

16 ~~18~~. This question is in **two** parts. **Part 1** is about simple harmonic motion and waves. **Part 2** is about α-particle scattering and nuclear processes.

**Part 1** Simple harmonic motion and waves

An object is vibrating in air. The variation with displacement $x$ of the acceleration $a$ of the object is shown below.




*(This question continues on the following page)*

*(Question B2, part 1 continued)*

(a) State and explain **two** reasons why the graph opposite indicates that the object is executing simple harmonic motion. *[4]*

1. .....
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2. .....
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(b) Use data from the graph to show that the frequency of oscillation is 350 Hz. *[4]*

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(c) State the amplitude of the vibrations. *[1]*

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(d) The motion of the object gives rise to a longitudinal progressive (travelling) sound wave.

(i) State what is meant by a longitudinal progressive wave. *[2]*

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(ii) The speed of the wave is $330\,m\,s^{-1}$. Using the answer in (b), calculate the wavelength of the wave. *[2]*

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*(This question continues on the following page)*