

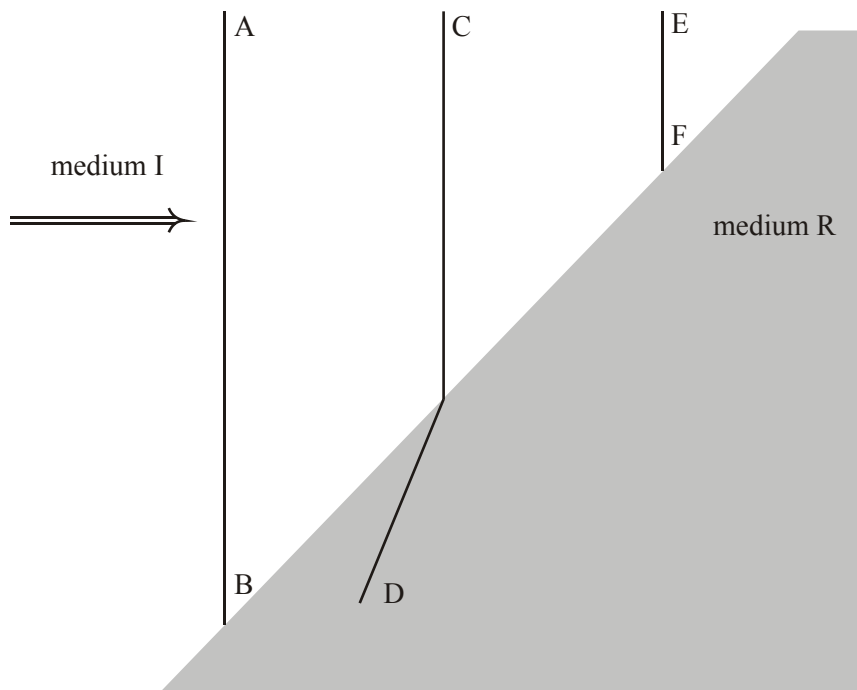
Wave Review Problems [Core curriculum]

1. This question is about waves and wave properties.

(a) By making reference to waves, distinguish between a *ray* and a *wavefront*.

(3)

The diagram below shows three wavefronts incident on a boundary between medium I and medium R. Wavefront CD is shown crossing the boundary. Wavefront EF is incomplete.



(b) (i) On the diagram above, draw a line to complete the wavefront EF.

(1)

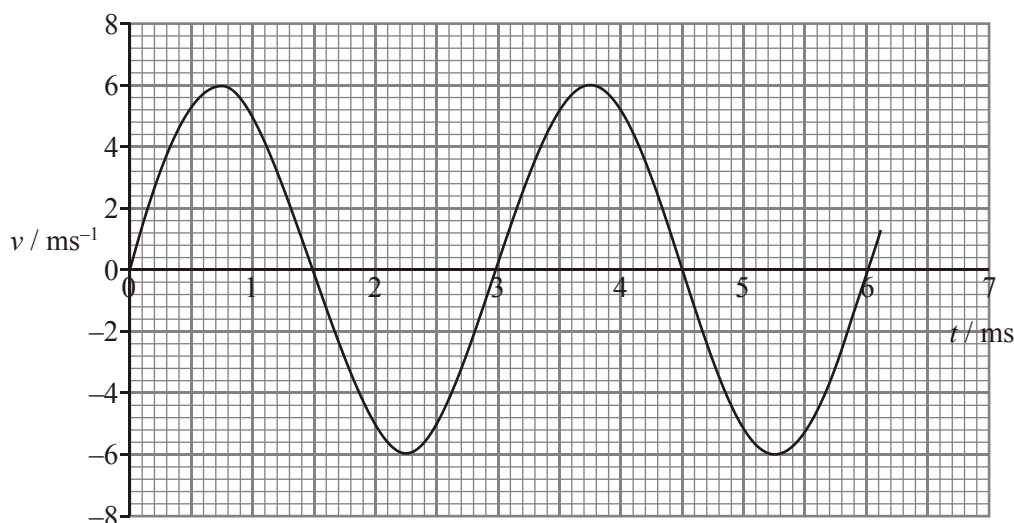
(ii) Explain in which medium, I or R, the wave has the higher speed.

(3)

(iii) By taking appropriate measurements from the diagram, determine the ratio of the speeds of the wave travelling from medium I to medium R.

(2)

The graph below shows the variation with time t of the velocity v of one particle of the medium through which the wave is travelling.

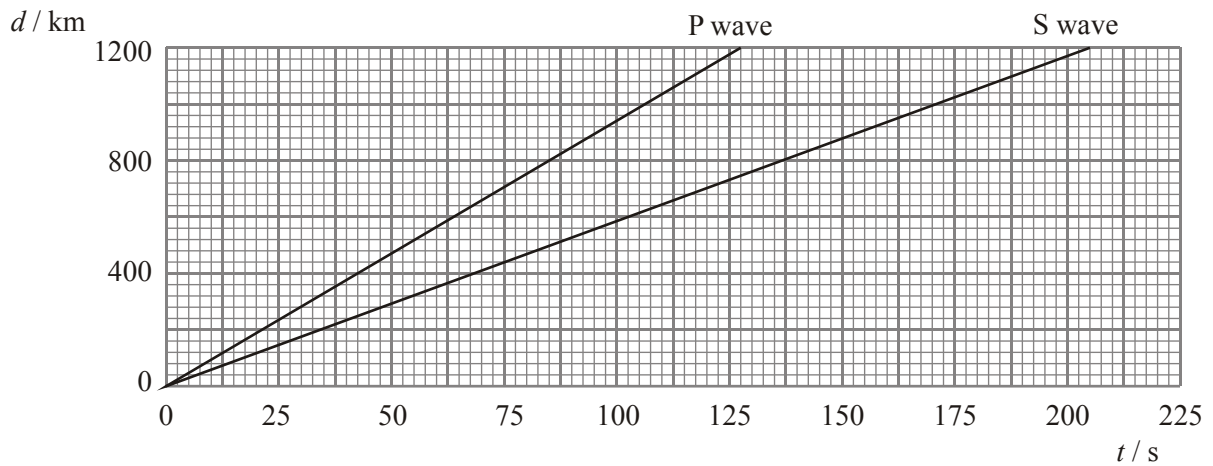


- (c) (i) Explain how it can be deduced from the graph that the particle is oscillating. (2)
- (ii) Determine the frequency of oscillation of the particle. (2)
- (iii) Mark on the graph with the letter M one time at which the particle is at maximum displacement. (1)
- (iv) Estimate the area between the curve and the x -axis from the time $t = 0$ to the time $t = 1.5$ ms. (2)
- (v) Suggest what the area in c (iv) represents. (1)
- (Total 17 marks)**

2. This question is about waves and wave motion.

- (a) (i) Define what is meant by the *speed of a wave*. (2)
- (b) (i) Define, by reference to wave motion, what is meant by *displacement*. (2)
- (ii) By reference to displacement, describe the difference between a longitudinal wave and a transverse wave. (3)

The centre of an earthquake produces both longitudinal waves (P waves) and transverse waves (S waves). The graph below shows the variation with time t of the distance d moved by the two types of wave.



(c) Use the graph to determine the speed of

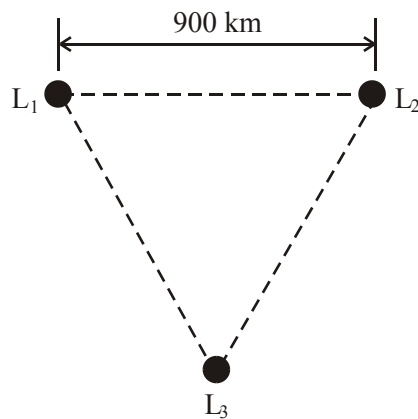
(i) the P waves.

(1)

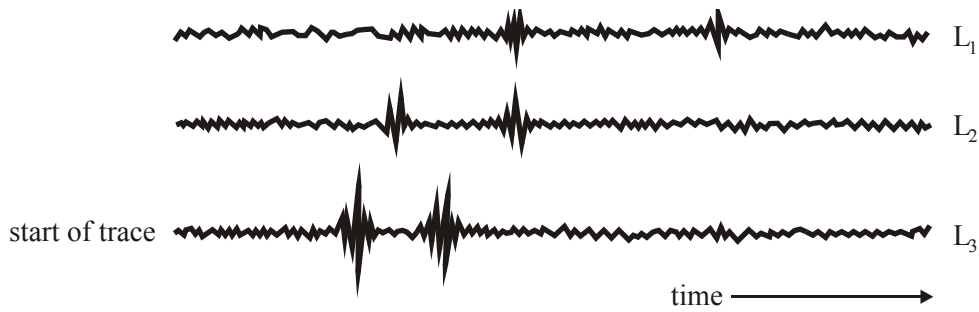
(ii) the S waves.

(1)

The waves from an earthquake close to the Earth's surface are detected at three laboratories L_1 , L_2 and L_3 . The laboratories are at the corners of a triangle so that each is separated from the others by a distance of 900 km, as shown in the diagram below.



The records of the variation with time of the vibrations produced by the earthquake as detected at the three laboratories are shown below. All three records were started at the same time.



On each record, one pulse is made by the S wave and the other by the P wave. The separation of the two pulses is referred to as the S-P interval.

(d) (i) On the trace produced by laboratory L_2 , identify, by reference to your answers in (c), the pulse due to the P wave (label the pulse P). (1)

(ii) Using evidence from the records of the earthquake, state which laboratory was closest to the site of the earthquake. (1)

.....

(iii) State **three** separate pieces of evidence for your statement in (d)(ii). (3)

1.
.....
2.
.....
3.
.....

(iv) The S-P intervals are 68 s, 42 s and 27 s for laboratories L_1 , L_2 and L_3 respectively. Use the graph, or otherwise, to determine the distance of the earthquake from each laboratory. Explain your working.

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.....

.....

Distance from $L_1 = \dots\dots\dots$ km

.....

Distance from $L_2 = \dots\dots\dots$ km

.....

Distance from $L_3 = \dots\dots\dots$ km

.....

(4)

(v) Mark on the diagram a possible site of the earthquake.

(1)

3. Wave properties

(a) By reference to the energy of a travelling wave, state what is meant by

(i) a ray.

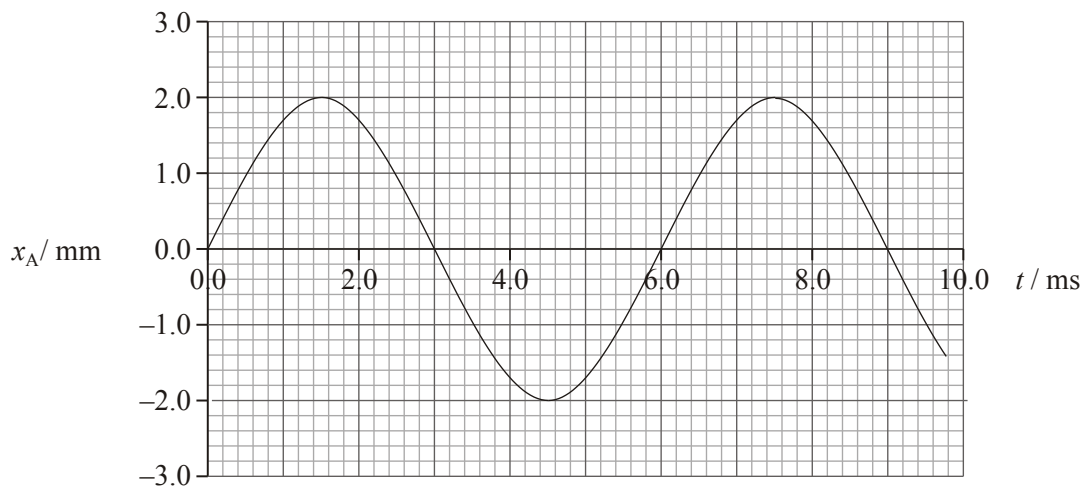
(1)

(ii) wave speed.

(1)

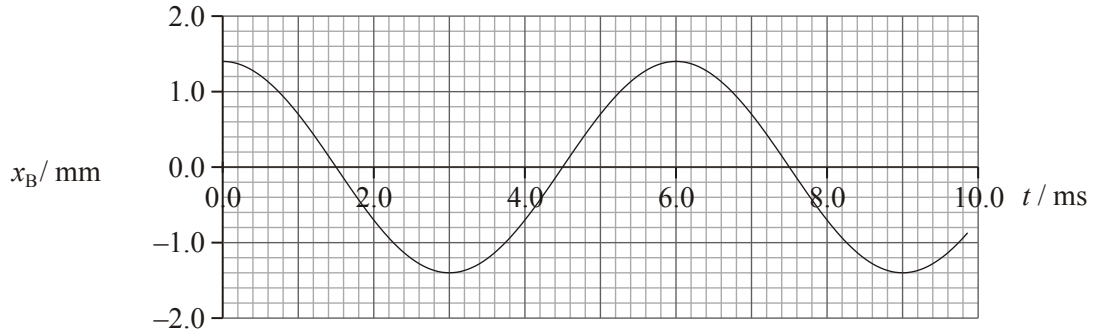
(b) The graph below shows the variation with time t of the displacement x_A of wave A as it passes through a point P.

Wave A



The graph below shows the variation with time t of the displacement x_B of wave B as it passes through point P.

Wave B



(i) Calculate the frequency of the waves.

(1)

(ii) The waves pass simultaneously through point P. Use the graphs to determine the resultant displacement at point P of the two waves at time $t = 1.0$ ms and at time $t = 8.0$ ms.

At $t = 1.0$ ms:

At $t = 8.0$ ms:

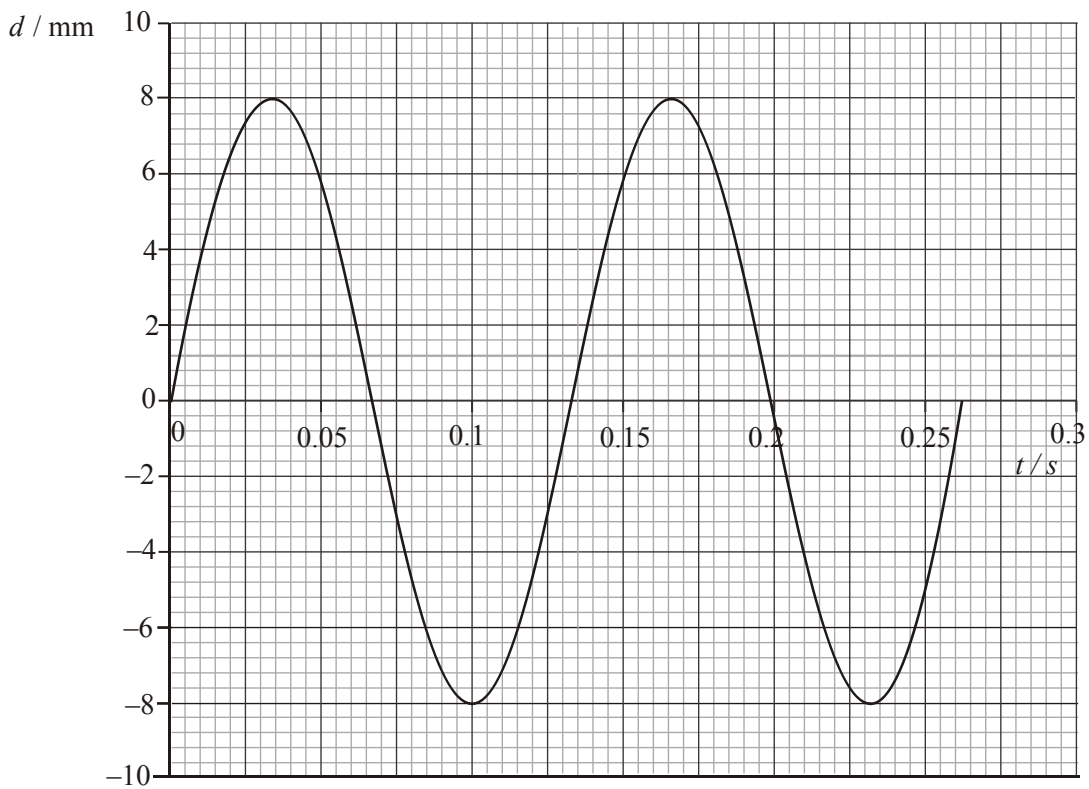
4. This question is about waves.

(a) With reference to the direction of energy transfer through a medium, distinguish between a transverse wave and a longitudinal wave.

.....

(3)

(b) A wave is travelling along the surface of some shallow water in the x -direction. The graph shows the variation with time t of the displacement d of a particle of water.



Use the graph to determine for the wave

(i) the frequency,

(2)

(ii) the amplitude.

.....

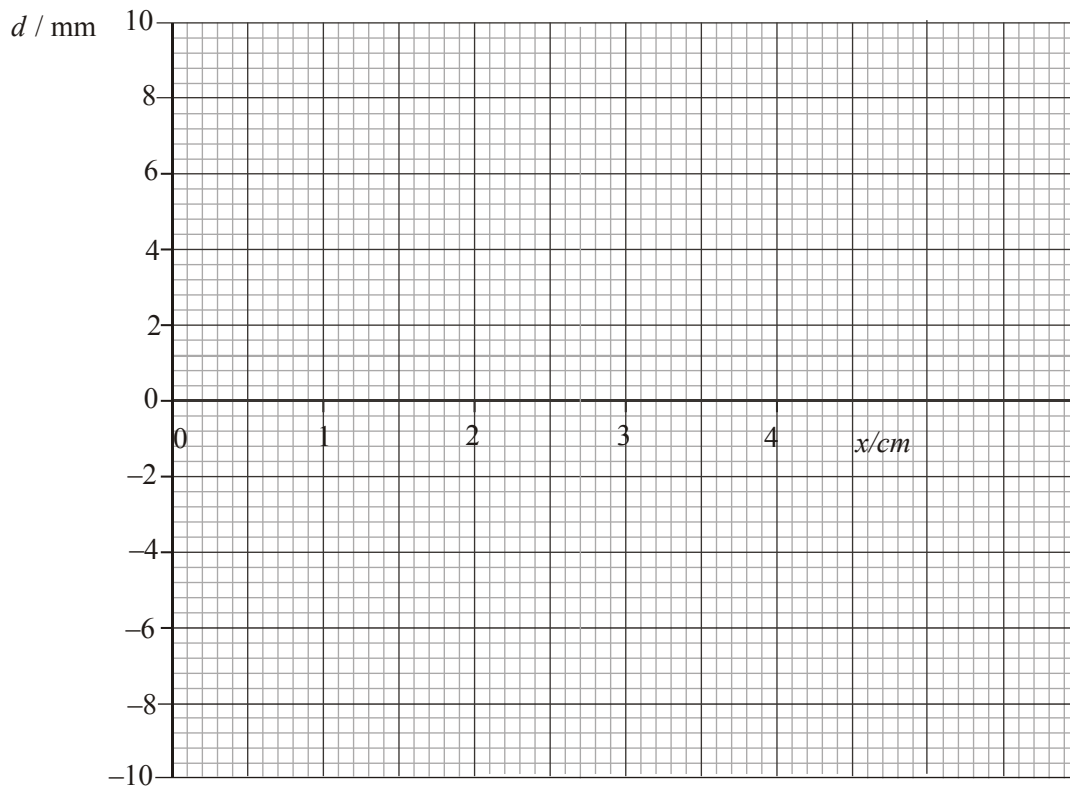
(1)

(c) The speed of the wave in (b) is 15 cm s^{-1} . Deduce that the wavelength of this wave is 2.0 cm.

(2)

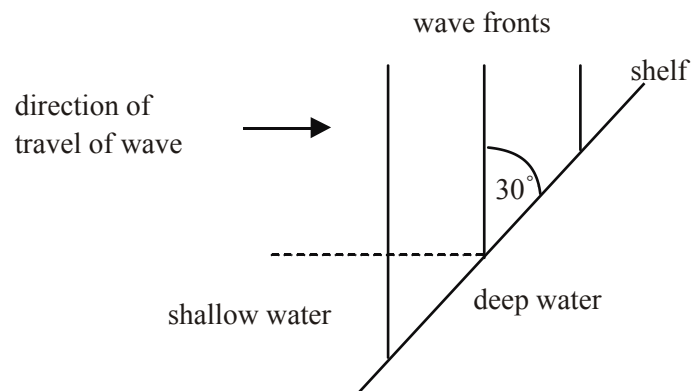
(d) The graph in (b) shows the displacement of a particle at the position $x = 0$.

On the axes below, draw a graph to show the variation with distance x along the water surface of the displacement d of the water surface at time $t = 0.070 \text{ s}$.



(3)

- (e) The wave encounters a shelf that divides the water into two separate depths. The water to the right of the shelf is deeper than that to the left of the shelf.



The angle between the wavefronts in the shallow water and the shelf is 30° . The speed of the wave in the shallow water is 15 cm s^{-1} and in the deeper water is 20 cm s^{-1} . For the wave in the deeper water, determine the angle between the normal to the wavefronts and the shelf.

(3)

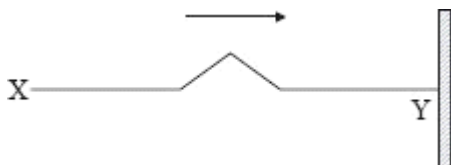
(Total 14 marks)

5. Which of the following correctly describes the change, if any, in the speed, wavelength and frequency of a light wave as it passes from air into glass?

	Speed	Wavelength	Frequency
A.	decreases	decreases	unchanged
B.	decreases	unchanged	decreases
C.	unchanged	increases	decreases
D.	increases	increases	unchanged

(1)

6. The diagram below shows a pulse travelling along a rope from X to Y. The end Y of the rope is tied to a fixed support.



When the pulse reaches end Y it will

- A. disappear.
 B. cause the end of the rope at Y to oscillate up and down.
 C. be reflected and be inverted.
 D. be reflected and not be inverted.

(1)

7. A transverse travelling wave has amplitude A_0 and wavelength λ .

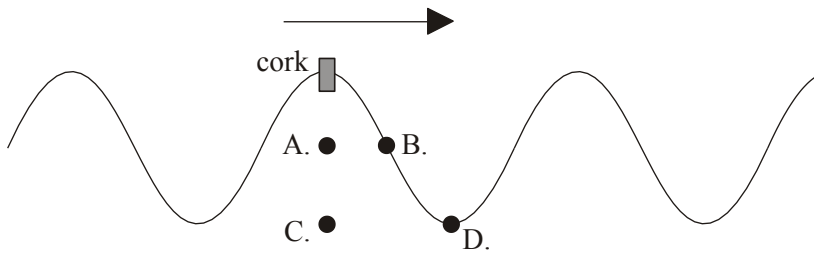
The distance between a crest and its neighbouring trough, measured in the direction of energy transfer of the wave is equal to

- A. A_0 .
 B. $2A_0$.
 C. $\frac{\lambda}{2}$.
 D. λ .

(1)

8. A water surface wave (ripple) is travelling to the right on the surface of a lake. The wave has period T . The diagram below shows the surface of the lake at a particular instant of time. A piece of cork is floating in the water in the position shown.

Which is the correct position of the cork a time $\frac{T}{4}$ later?



(1)

9. A wooden block is at rest on a horizontal frictionless surface. A horizontal spring is attached between the block and a rigid support.



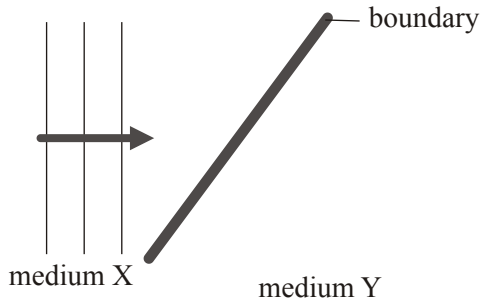
The block is displaced to the right by an amount X and is then released. The period of oscillations is T and the total energy of the system is E .

For an initial displacement of $\frac{X}{2}$ which of the following shows the best estimate for the period of oscillations and the total energy of the system?

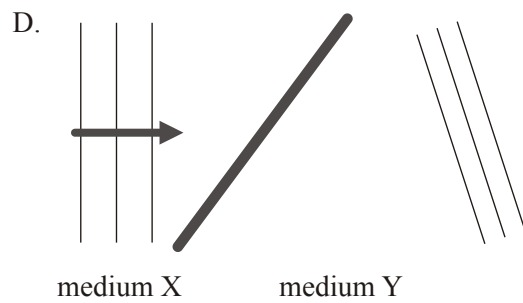
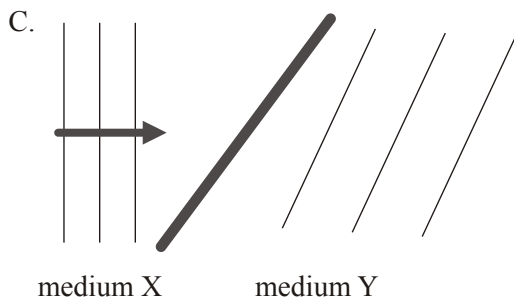
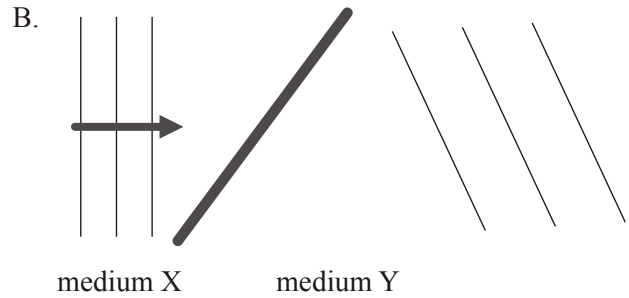
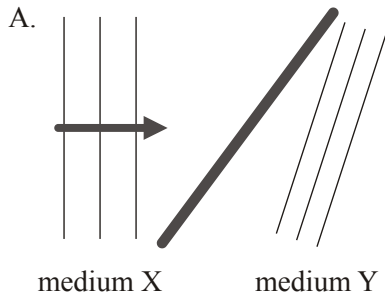
	Period	Total energy
A.	T	$\frac{E}{2}$
B.	T	$\frac{E}{4}$
C.	$\frac{T}{2}$	$\frac{E}{2}$
D.	$\frac{T}{2}$	$\frac{E}{4}$

(1)

10. The diagram below shows plane wavefronts of a wave that is approaching the boundary between two media, X and Y. The speed of the wave is greater in medium X than in medium Y. The wave crosses the boundary.

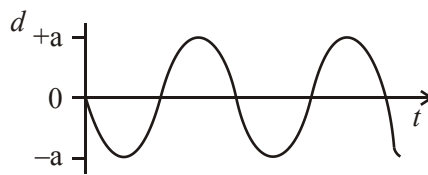
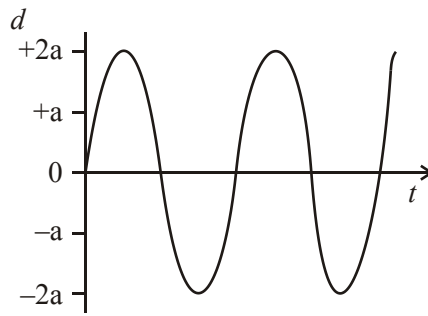


Which of the following diagrams is correct?

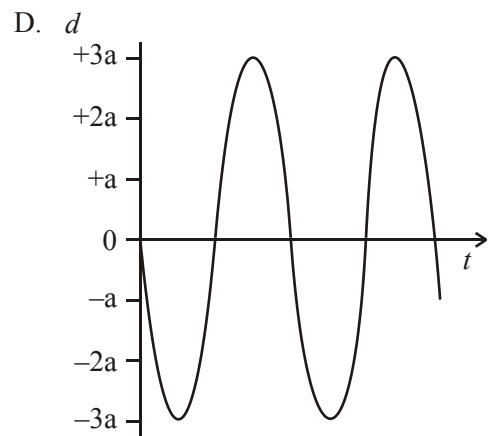
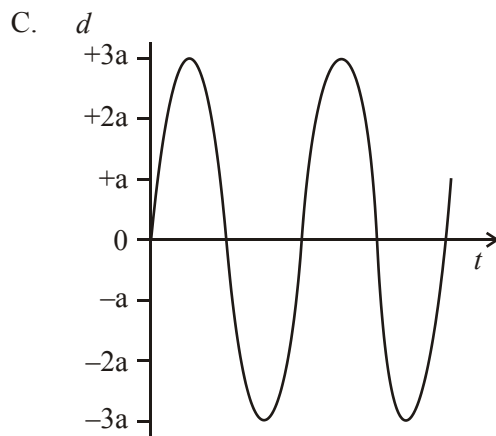
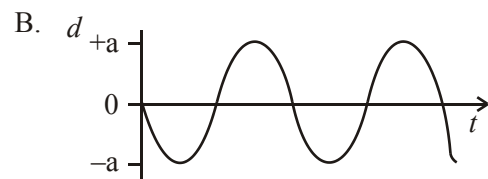
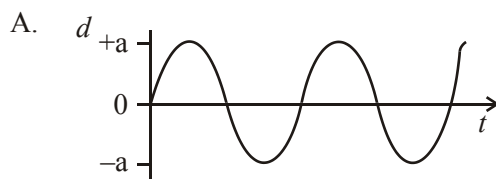


(1)

11. The variation with time t of the separate displacements d of a point in a medium due to two waves is shown below.

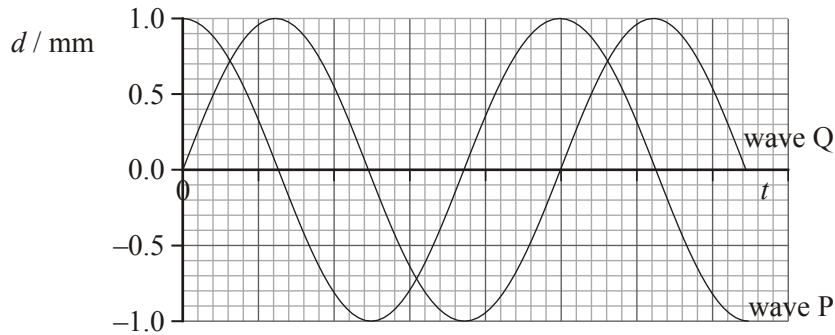


The waves are superposed. Which of the following diagrams shows the variation with time t of the resultant displacement d of the point in the medium?



(1)

12. The graph below shows the variation with time t of the separate displacements d of a medium, at a particular point in the medium due to two waves, P and Q.



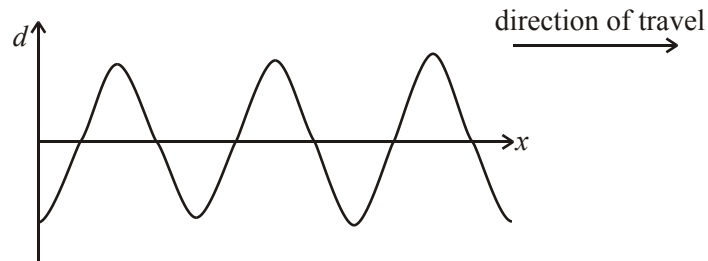
The amplitude of the wave resulting from the interference of P and Q is

- A. 0.0 mm.
- B. 1.0 mm.
- C. 1.4 mm.
- D. 2.0 mm.

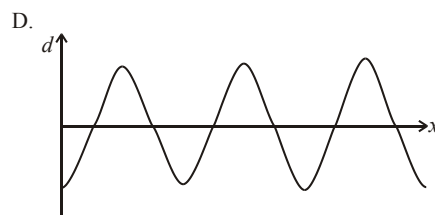
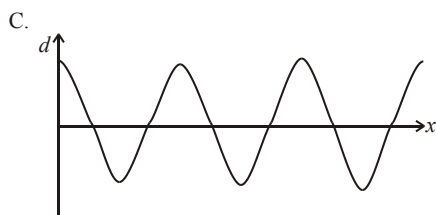
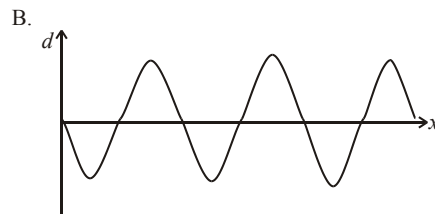
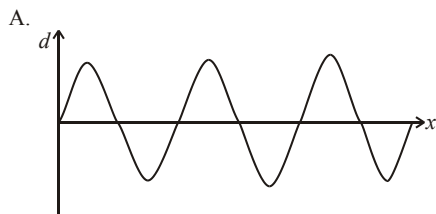
(1)

13. The diagram shows the variation with distance x along a wave with its displacement d .

The wave is travelling in the direction shown.

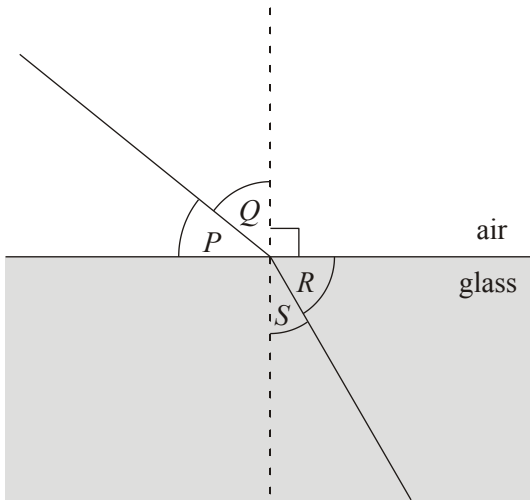


The period of the wave is T . Which **one** of the following diagrams shows the displacement of the wave at $\frac{T}{4}$ later?



(1)

14. Light is incident on an air-glass boundary as shown below.

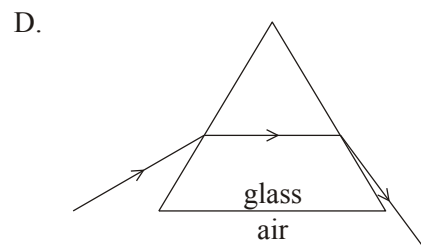
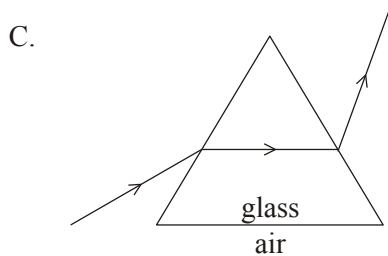
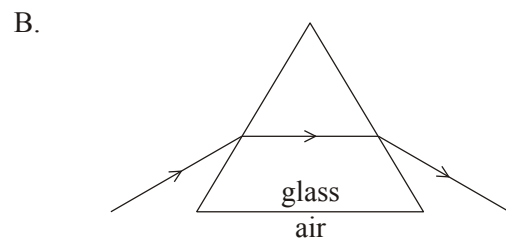
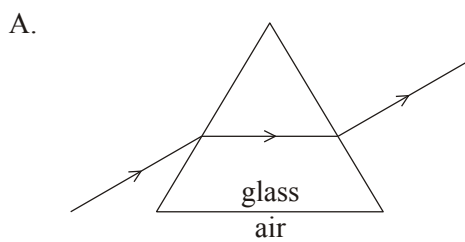


Which **one** of the following is a correct statement of Snell's law?

- A. $\sin P = \text{constant} \times \sin R$
- B. $\sin P = \text{constant} \times \sin S$
- C. $\sin Q = \text{constant} \times \sin R$
- D. $\sin Q = \text{constant} \times \sin S$

(1)

15. Which of the following diagrams best shows the path of a ray of monochromatic light through a glass prism in air?



(1)