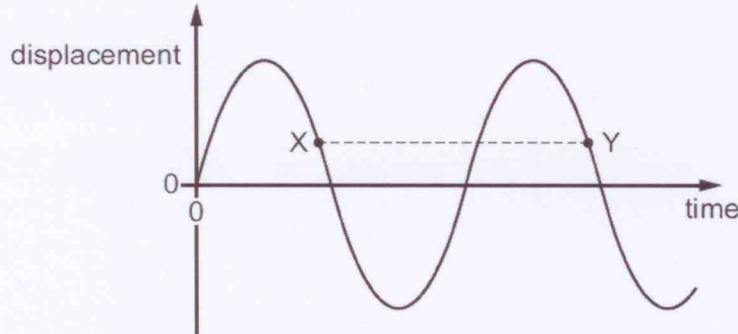


Waves - 2018

1. 9702/11/M/J/18/No.20

A transverse progressive wave is set up on a string.

The graph shows the variation with time of displacement for a point on this string.



The separation XY on the graph represents the1..... of the wave.

X and Y have equal2.....

Which words correctly complete gaps 1 and 2?

	1	2
A	time period	amplitudes
B	time period	displacements
C	wavelength	amplitudes
D	wavelength	displacements

2. 9702/11/M/J/18/No.21

Which region of the electromagnetic spectrum includes waves with a frequency of 10^7 MHz?

- A** infra-red waves
- B radio waves
- C ultraviolet waves
- D X-rays

$$f = \frac{v}{\lambda}$$

microwaves

$$f = \frac{3 \times 10^8}{1 \times 10^{-3}}$$

$$= 3 \times 10^{11}$$

$$= 3 \times 10^5 \times 10^6$$

$$= 3 \times 10^5 \text{ MHz}$$

infrared

$$f = \frac{3 \times 10^8}{7 \times 10^{-7}}$$

$$= 43 \times 10^{14}$$

$$= 43 \times 10^8 \times 10^6$$

$$= 43 \times 10^8 \text{ MHz}$$

visible

$$f = \frac{3 \times 10^8}{4 \times 10^{-7}}$$

$$= 7.5 \times 10^{14}$$

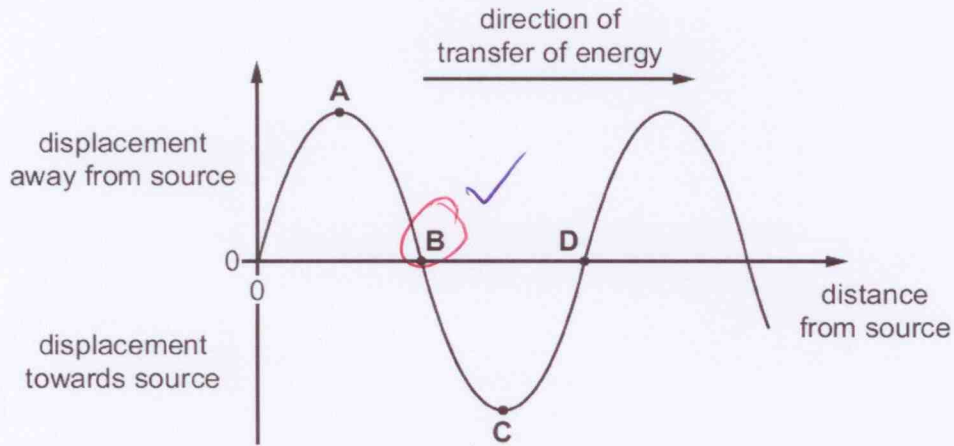
$$= 7.5 \times 10^8 \text{ MHz}$$

3. 9702/11/M/J/18/No.22

A longitudinal wave has vibrations parallel to the direction of transfer of energy by the wave.

The wave can be represented on a graph showing the variation of the displacement of the particles with distance from the source.

Which point on the graph is the centre of a compression?



4. 9702/11/M/J/18/No.23

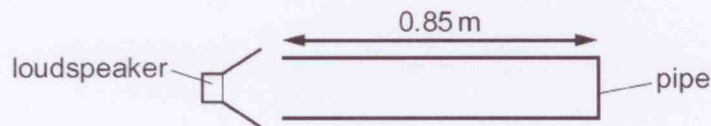
What can be deduced from a table of wavelengths of the waves in the electromagnetic spectrum?

- A Green light has a shorter wavelength than X-rays.
- B Red light has a shorter wavelength than green light.
- C The wavelength range for radio waves is less than that for infra-red waves.
- D The wavelength range for X-rays is less than that for radio waves.

Radio waves: Range $1 \times 10^6 - 1 \times 10^1$
 $= 999,999.9 \approx 1,000,000$
 X-ray: $1 \times 10^{-8} - 1 \times 10^{-13}$
 $= 0.000,000,000$

5. 9702/11/M/J/18/No.27

A pipe, closed at one end, has a loudspeaker at the open end. A stationary sound wave is formed in the air within the pipe with an antinode at the open end of the pipe.



The length of the pipe is 0.85 m.

The speed of sound in air is 340 ms^{-1} .

Which frequency of sound from the loudspeaker would **not** produce a stationary wave?

- A 100 Hz
- B 200 Hz
- C 300 Hz
- D 500 Hz

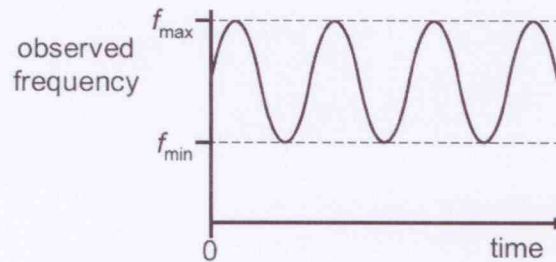
$\frac{1}{4} \lambda = 0.85$
 $\lambda = 0.85 \times 4 = 3.4 \text{ m}$
 $f = \frac{v}{\lambda} = \frac{340}{3.4} = 100 \text{ Hz}$
 $f_0 = 3f_0 = 5f_0$
 $100 \text{ Hz}, 300 \text{ Hz}, 500 \text{ Hz}$

6. 9702/11/M/J/18/No.24

A binary star consists of two stars rotating around a common centre. Light from one of the stars is observed on the Earth.



The observed frequency of the light varies between a minimum frequency f_{\min} and a maximum frequency f_{\max} , as shown.



The rate of rotation of the binary star increases.

What is the change to f_{\max} and the change to f_{\min} ?

	f_{\max}	f_{\min}
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

$$f_{\max} = \frac{f_s v}{v - v_s} \quad f_{\min} = \frac{f_s v}{v + v_s}$$

v_s is the speed of moving star.
 - If v_s increases, the factor $v - v_s$ will become less, so f_{\max} will increase.
 - The factor $v + v_s$ will become large, so f_{\min} will decrease.

7. 9702/12/M/J/18/No.22

Two lasers emit light in a vacuum. One laser emits red light and the other emits green light.

Which property of the two laser beams **must** be different?

- A amplitude
- B frequency**
- C intensity
- D speed

8. 9702/11/M/J/18/No.25

A teacher sets up the apparatus shown to demonstrate a double-slit interference pattern on the screen.



Which change to the apparatus will increase the fringe spacing?

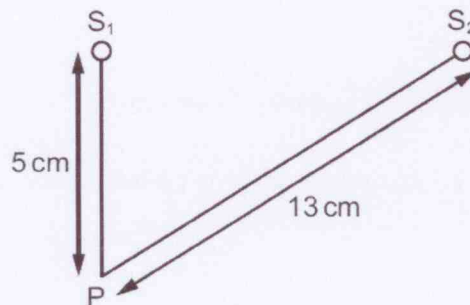
- A decreasing the distance p
- B** decreasing the distance q
- C decreasing the distance r
- D decreasing the wavelength of the light

$$x = \frac{\lambda \Delta}{a}$$

*- a is the slit separation
- decreasing a will increase x since $x \propto \frac{1}{a}$
- a = q.*

9. 9702/11/M/J/18/No.26

The diagram shows two sources of waves S_1 and S_2 . The sources oscillate with a phase difference of 180° .



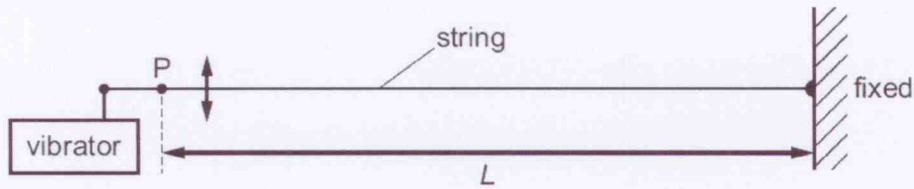
The sources each generate a wave of wavelength 2.0 cm. Each source produces a wave that has amplitude x_0 when it reaches point P.

What is the amplitude of the oscillation at P?

- A** 0
- B $\frac{x_0}{2}$
- C x_0
- D $2x_0$

10. 9702/12/M/J/18/No.24

A string is fixed at one end and the other end is attached to a vibrator. The frequency of the vibrator is slowly increased from zero. A series of stationary waves is formed. Assume that for a stationary wave there is a node at point P.



What are the first five wavelengths of the stationary waves that could be formed?

A $2\frac{L}{1}, 2\frac{L}{2}, 2\frac{L}{3}, 2\frac{L}{4}, 2\frac{L}{5}$

$2L, L, \frac{2}{3}L, \frac{2}{4}L, \frac{2}{5}L.$

B $2\frac{L}{2}, 2\frac{L}{3}, 2\frac{L}{4}, 2\frac{L}{5}, 2\frac{L}{6}$

C $4\frac{L}{1}, 4\frac{L}{2}, 4\frac{L}{3}, 4\frac{L}{4}, 4\frac{L}{5}$

D $4\frac{L}{1}, 4\frac{L}{3}, 4\frac{L}{5}, 4\frac{L}{7}, 4\frac{L}{9}$

11. 9702/12/M/J/18/No.25

Which region of the electromagnetic spectrum has waves of wavelength 1000 times smaller than the wavelength of visible light?

A infra-red

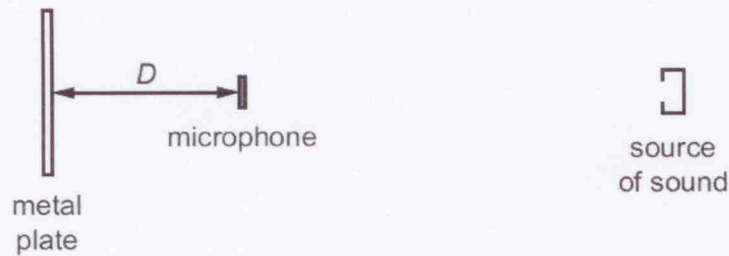
B microwaves

C ultraviolet

D X-rays

12. 9702/12/M/J/18/No.26

The diagram shows apparatus for the measurement of the frequency of a sound wave.

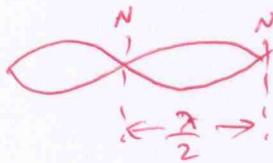


Sound of the unknown frequency is reflected back from a metal plate. A microphone placed at a distance D from the metal plate detects the sound intensity. A minimum intensity is detected with $D = 12.0$ cm. The plate is moved further away from the microphone until the next minimum is detected with $D = 15.0$ cm.

The speed of sound in air is 336 ms^{-1} .

What is the frequency of the sound?

- A 56 Hz B 112 Hz C 5600 Hz D 11200 Hz



$$\frac{\lambda}{2} = 15 - 12 = 3$$

$$\lambda = 3 \times 2 = 6 \text{ cm}$$

$$f = \frac{v}{\lambda} = \frac{336}{6 \times 10^{-2}}$$

$$= \underline{\underline{5600 \text{ Hz}}}$$

13. 9702/12/M/J/18/No.27

An astronomer observes the light from a star that is moving away from the Earth.

For the observed light, what has been increased due to the star's motion?

- A amplitude
B frequency
C speed
D wavelength

- moving away
 λ - increases
 f - decreases
 - moving towards
 λ - decreases
 f - increases

} Doppler effect

14. 9702/12/M/J/18/No.28

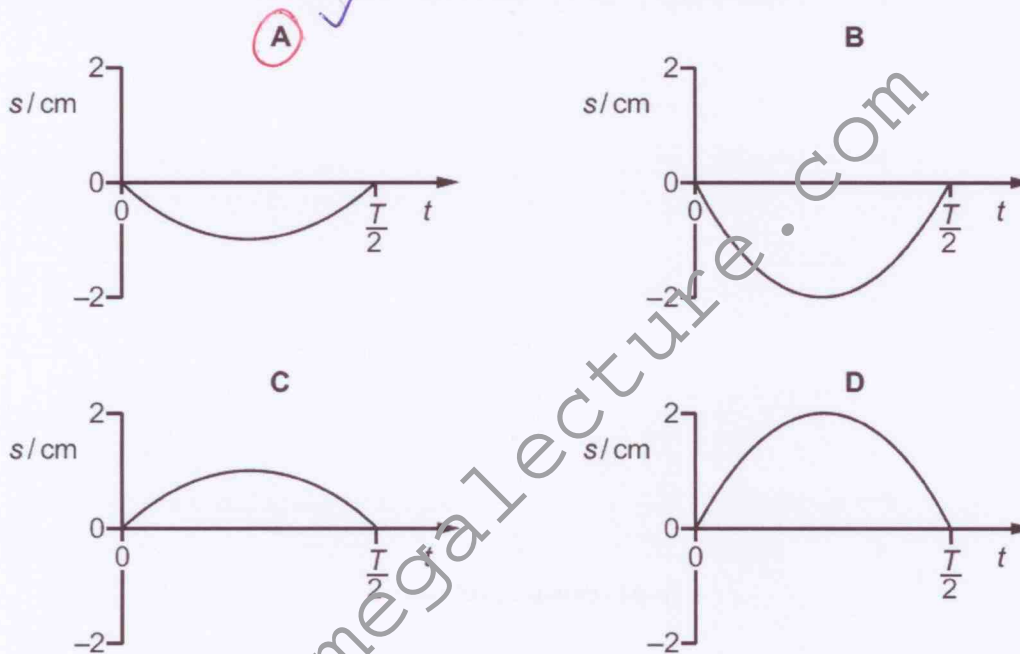
The diagram shows a stationary wave, at time $t = 0$, that has been set up on a string fixed between points P and S.



The nodes of the stationary wave occur on the string at P, Q, R and S. Point X is moving down at time $t = 0$. The points on the string vibrate with time period T and maximum amplitude 2 cm.

The displacement s is positive in the upward direction.

Which graph best shows the variation with t of the displacement s of point Y on the string?



15. 9702/13/M/J/18/No.23

A police car travels at a velocity of 30.0 m s^{-1} directly towards a stationary observer. The horn of the car emits sound of frequency 2000 Hz . The speed of sound is 340 m s^{-1} .

What is the frequency of the sound heard by the observer?

- A 1840 Hz B 2000 Hz C 2180 Hz **D 2190 Hz**

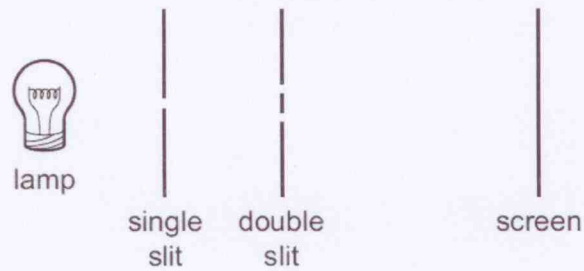
$$f_o = \frac{f_s v}{v - v_s}$$

$$= \frac{2000 \times 340}{340 - 30}$$

$$= 2194 \text{ Hz}$$

16. 9702/12/M/J/18/No.29

A two-source interference experiment uses the apparatus shown.

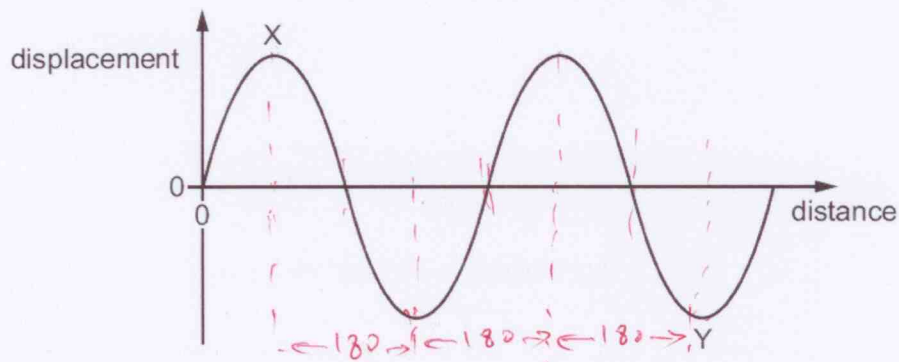


What is the main purpose of the single slit?

- A to make a narrow beam of light
- B to make the same amplitude of light incident on each slit
- C to provide coherent light
- D to provide monochromatic light

17. 9702/13/M/J/18/No.20

The displacement-distance graph for a transverse progressive wave is shown.



The phase difference between points X and Y can be expressed as $(180n)^\circ$.

What is the value of n ?

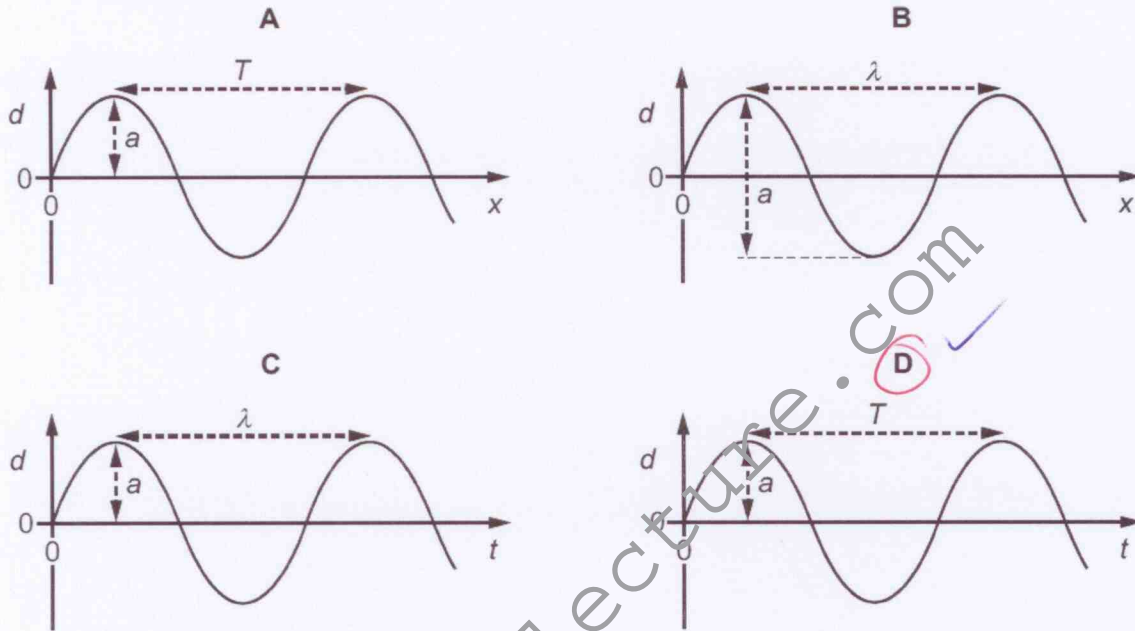
- A 1.5
- B 2.5
- C 3.0
- D 6.0

18. 9702/13/M/J/18/No.21

The four graphs represent a progressive wave on a stretched string. Graphs **A** and **B** show how the displacement d varies with distance x along the string at one instant. Graphs **C** and **D** show how the displacement d varies with time t at a particular value of x .

The labels on the graphs are intended to show the wavelength λ , the period T and the amplitude a of the wave, but only one graph is correctly labelled.

Which graph is correctly labelled?



λ on $d-x$ graph.
 T on $d-t$ graph.

19. 9702/13/M/J/18/No.25

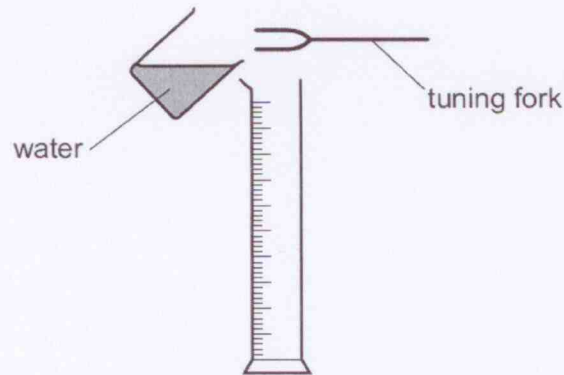
A water wave in a ripple tank is diffracted as it passes through a gap in a barrier.

Which two factors affect the angle of diffraction of the wave?

- A the amplitude and frequency of the incident wave
- B the amplitude of the incident wave and the width of the gap
- C the wavelength and amplitude of the incident wave
- D the wavelength of the incident wave and the width of the gap

20. 9702/13/M/J/18/No.24

A vibrating tuning fork is held over a measuring cylinder, as shown.



Water is then gradually poured into the measuring cylinder. A much louder sound is first heard when the water level is 2.9 cm above the base of the measuring cylinder. A second much louder sound is heard when the water level reaches a height of 67.3 cm above the base.

The speed of sound in air is 330 ms^{-1} .

What is the frequency of the tuning fork?

- A 128 Hz **B 256 Hz** C 512 Hz D 1024 Hz

- Louder sound occurs at antinodes.

$$\frac{\lambda}{2} = 67.3 - 2.9$$

$$\lambda = 64.4 \times 2 = 128.8$$

$$f = \frac{330}{128.8 \times 10^{-2}}$$

$$= \underline{\underline{256 \text{ Hz}}}$$

21. 9702/13/M/J/18/No.26

A double-slit interference pattern using red light of wavelength $7.0 \times 10^{-7} \text{ m}$ has a fringe spacing of 3.5 mm.

Which fringe spacing would be observed for the same arrangement of apparatus but using blue light of wavelength $4.5 \times 10^{-7} \text{ m}$?

- A 2.3 mm** B 3.5 mm C 5.4 mm D 9.0 mm

$$\lambda = \frac{ax}{D}$$

$$\frac{D}{a} = \frac{x}{\lambda}$$

$$\frac{x}{4.5 \times 10^{-7}} = \frac{3.5 \text{ mm}}{7.0 \times 10^{-7}}$$

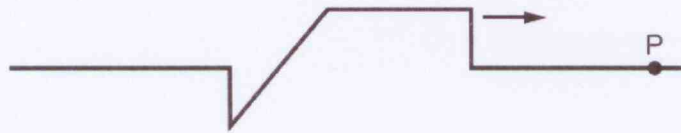
$$x = \frac{3.5 \times 4.5 \times 10^{-7}}{7.0 \times 10^{-7}}$$

$$= 2.25$$

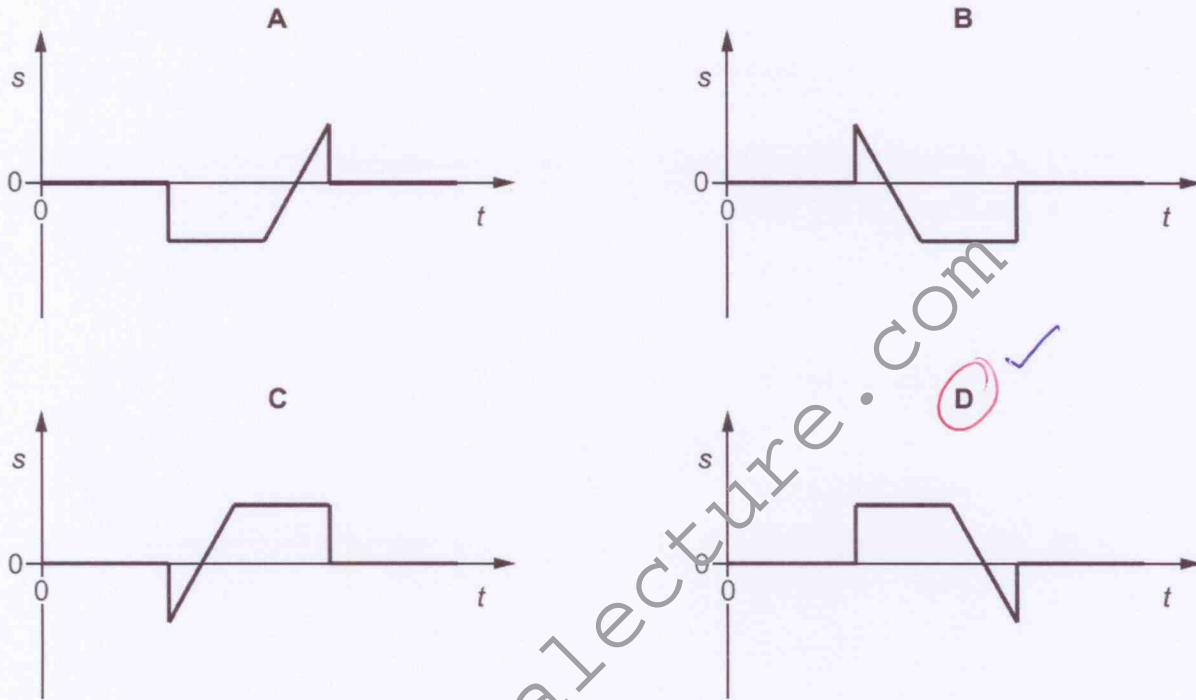
$$= \underline{\underline{2.3 \text{ mm}}}$$

22. 9702/12/F/M/18/No.21

A wave pulse moves along a stretched rope in the direction shown.



Which diagram shows the variation with time t of the displacement s of the particle P in the rope?



23. 9702/12/F/M/18/No.23

The table lists possible orders of magnitude of the wavelengths of some of the principal radiations of the electromagnetic spectrum.

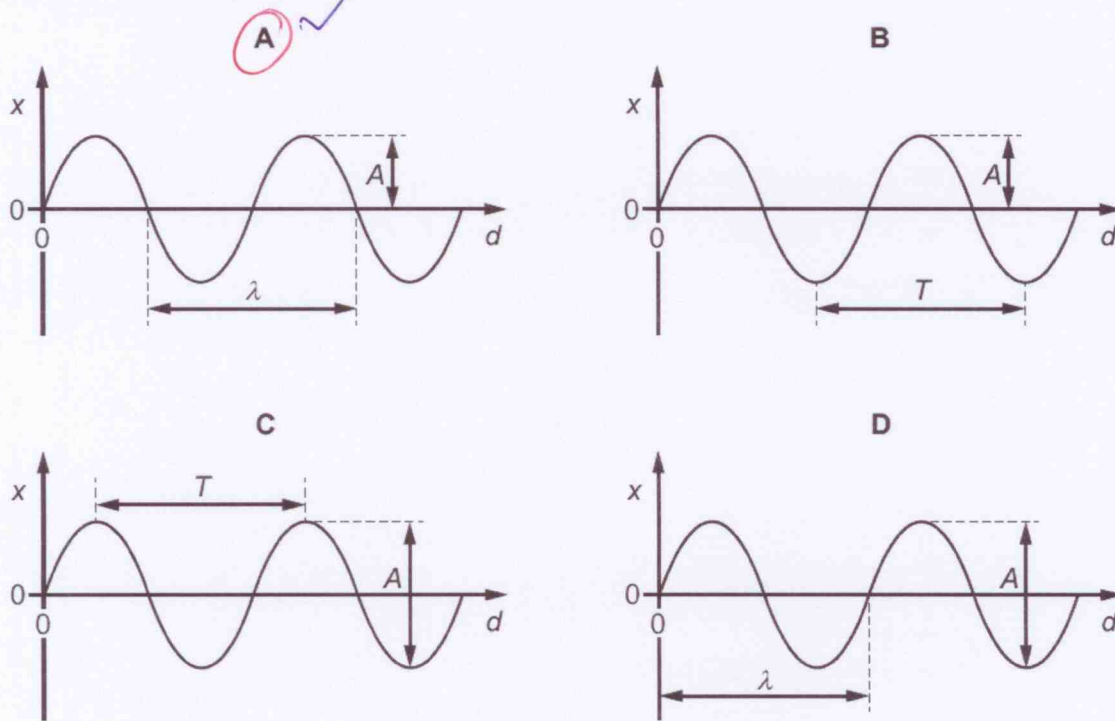
Which row shows the correct orders of magnitude of the wavelengths?

	wavelength / m			
	microwaves	infra-red	ultraviolet	X-rays
A	10^{-6}	10^{-10}	10^{-12}	10^{-14}
B	10^{-4}	10^{-8}	10^{-10}	10^{-12}
C	10^{-2}	10^{-6}	10^{-8}	10^{-10}
D	10^2	10^{-4}	10^{-6}	10^{-8}

24. 9702/12/F/M/18/No.22

A wave has period T , wavelength λ and amplitude A . The wave is shown on a graph of displacement x against distance d .

Which graph is correctly labelled?



25. 9702/12/F/M/18/No.24

A vehicle carries a microwave transmitter that emits microwaves of a constant frequency. A stationary observer has a microwave receiver.

The vehicle moves directly towards the observer at constant speed. The observer detects microwaves of frequency F_0 .

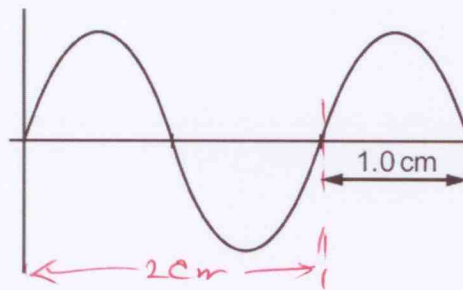
The vehicle then accelerates, still moving towards the observer, travels at higher steady speed for a time and then decelerates until it stops.

What is the variation in the frequency of the microwaves that are detected by the observer?

- A The observed frequency will fall, then remain steady then return to the frequency F_0 .
 - B The observed frequency will fall, then remain steady then rise to a higher frequency than F_0 .
 - C The observed frequency will rise, then remain steady then fall to a lower frequency than F_0 .
 - D The observed frequency will rise, then remain steady then return to the frequency F_0 .
- A red circle around the letter 'C' and a blue checkmark indicate that option C is the correct answer.

26. 9702/12/F/M/18/No.25

The diagram shows a cathode-ray oscilloscope display of an electromagnetic wave.



$$T = \frac{2 \text{ cm}}{c} = \frac{2 \times 10^{-2} \text{ m}}{3 \times 10^8 \text{ m/s}} = 6.67 \times 10^{-11} \text{ s}$$

$$f = \frac{1}{T} = \frac{1}{6.67 \times 10^{-11} \text{ s}} = 1.5 \times 10^{10} \text{ Hz} = 15 \text{ GHz}$$

The time base setting is $0.20 \mu\text{s cm}^{-1}$.

Which statement is correct?

- A The frequency of the wave is 2.5 MHz and it lies in the microwave region of the electromagnetic spectrum.
- B The frequency of the wave is 2.5 MHz and it lies in the radio-wave region of the electromagnetic spectrum.
- C The frequency of the wave is 5.0 MHz and it lies in the microwave region of the electromagnetic spectrum.
- D The frequency of the wave is 5.0 MHz and it lies in the radio-wave region of the electromagnetic spectrum.

27. 9702/12/F/M/18/No.26

In a double-slit interference experiment, light of frequency $6.0 \times 10^{14} \text{ Hz}$ is incident on a pair of slits. Bright fringes that are 3.0 mm apart are observed on a screen some distance away.

What is the separation of the bright fringes when the frequency of the light is changed to $5.0 \times 10^{14} \text{ Hz}$?

- A 1.8 mm
- B 2.5 mm
- C 3.0 mm
- D 3.6 mm

$$\lambda = \frac{ax}{\Delta}$$

$$\frac{x}{\lambda} = \frac{\Delta}{a}$$

$$\lambda = \frac{v}{f}$$

$$= \frac{3.0 \times 10^8}{6.0 \times 10^{14}}$$

$$= 5.0 \times 10^{-7} \text{ m}$$

$$\lambda = \frac{3.0 \times 10^8}{5.0 \times 10^{14}}$$

$$= 6.0 \times 10^{-7} \text{ m}$$

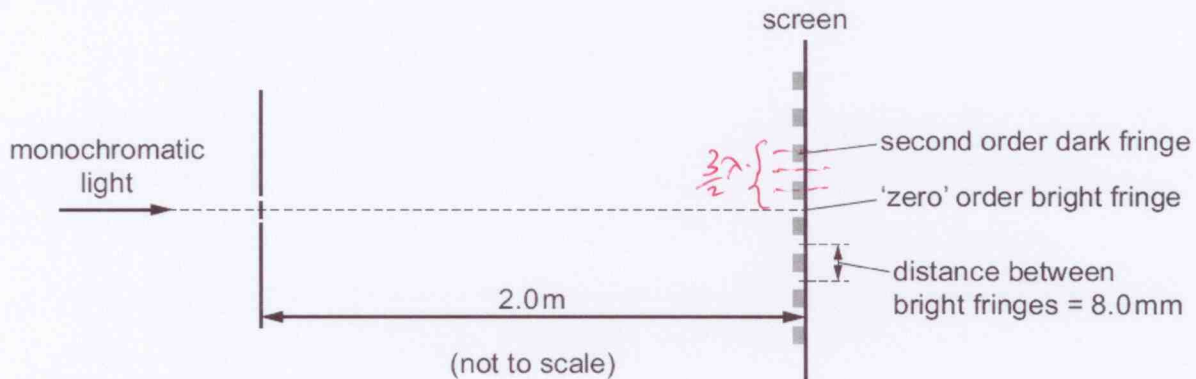
$$\frac{x}{6.0 \times 10^{-7}} = \frac{3.0 \text{ mm}}{5.0 \times 10^{-7}}$$

$$x = \frac{3.0 \text{ mm} \times 6 \times 10^{-7}}{5.0 \times 10^{-7}}$$

$$= 3.6 \text{ mm}$$

28. 9702/12/F/M/18/No.27

Monochromatic light is incident on a pair of narrow slits a distance of 0.1 mm apart. A series of bright and dark fringes are observed on a screen a distance of 2.0 m away. The distance between adjacent bright fringes is 8.0 mm.



What is the path difference between the light waves from the two slits that meet at the second order dark fringe?

- A $2.0 \times 10^{-7} \text{ m}$
- B $4.0 \times 10^{-7} \text{ m}$
- C $6.0 \times 10^{-7} \text{ m}$
- D $8.0 \times 10^{-7} \text{ m}$

$$\begin{aligned}
 a &= 0.1 \text{ mm} \\
 \Delta &= 2.0 \text{ m} \\
 x &= 8.0 \text{ mm} \\
 \lambda &= ? \\
 \lambda &= \frac{ax}{\Delta} \\
 &= \frac{0.1 \times 10^{-3} \times 8.0 \times 10^{-3}}{2} \\
 &= 4.0 \times 10^{-7} \text{ m} \times \frac{3}{2} \\
 &= \underline{\underline{6.0 \times 10^{-7} \text{ m}}}
 \end{aligned}$$

29. 9702/12/F/M/18/No.29

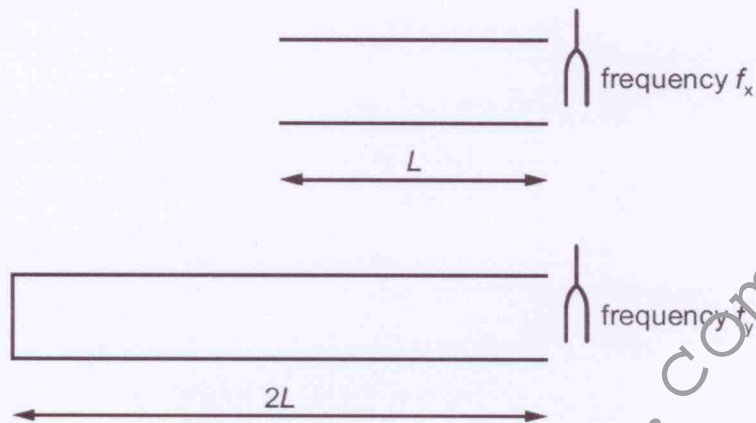
Which statement gives a condition that enables diffraction to occur?

- A A source of waves moves towards a stationary observer.
- B A wave is partially blocked by an obstacle.
- C Two coherent waves are superposed.
- D Two waves of equal speed and frequency are travelling through the same part of a medium in opposite directions.

30. 9702/12/F/M/18/No.28

A tube of length L is open at both ends. A stationary wave is set up in this tube when a tuning fork vibrating with frequency f_x is held at one end. This is the lowest frequency of stationary wave that can be formed in this tube.

Another tube of length $2L$ is closed at one end. A stationary wave is set up in this tube when a tuning fork vibrating with frequency f_y is held at the open end. This is the lowest frequency of stationary wave that can be formed in this tube.



Assume the end correction for each tube is negligible.

Which equation is correct?

A $f_x = \frac{f_y}{4}$

B $f_x = \frac{f_y}{2}$

C $f_x = 2f_y$

D $f_x = 4f_y$