WAVES — Diffraction + Interference ① A-Physics

Formula....

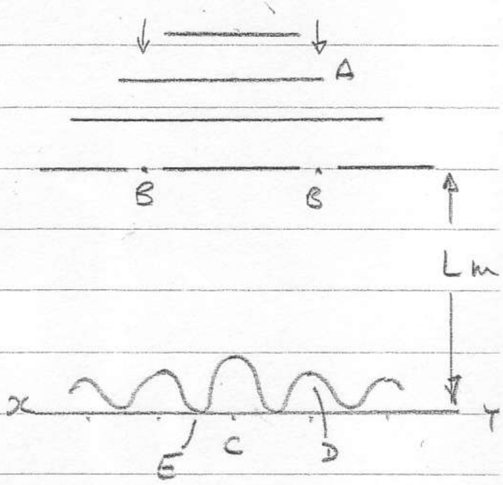
$\frac{\lambda}{d} = \frac{s}{D}$

s – fringe spacing
d – slit spacing
D – slit-screen

data....

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

$V_{sound (air)} = 330$ m/s



1\. A Science teacher is teaching diffraction and interference to his students. After a bit of trouble, he manages to make the demonstration work. In conclusion he says...
"Plane waves at A are diffracted by the narrow gaps (B). These act as two coherent sources of waves, which interfere with each other. The detector, moving along line XY, shows the amplitude of the waves to vary as shown."

(a) What do the underlined words mean? (5)

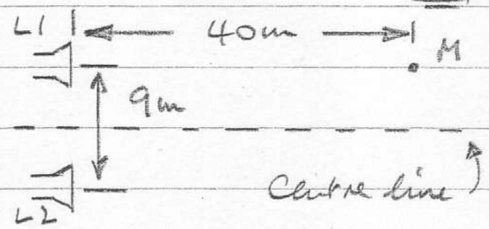
(b) Explain why the amplitude is....

(i) large at C (3)

(ii) large at D (2)

(iii) zero at E (2)

(c) The dimensions of the apparatus are as follows: BB = 15 cm, L = 70 cm, CD = 8.0 cm. What are the frequency and wavelength of the microwaves? (5) $\boxed{17}$



2\. Two loudspeakers (L1, L2) emit sound waves in phase. As the frequency is increased from 100 – 1000 Hz, the amplitude of sound at M varies between zero and a maximum loudness.

(a) What is the path difference L2M – L1M? (2)

(b) Explain why the amplitude varies as f is increased. (3)

(c) The amplitude at M is zero at $f = 165$ Hz. Explain why – use a diagram to help. (4)

(d) There are 2 other frequencies between 100 and 1000 Hz where no sound is heard at M – what are they? (4) ~~9~~ $\boxed{13}$

TJW
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Diffraction + Interference (1) Answers A Physics

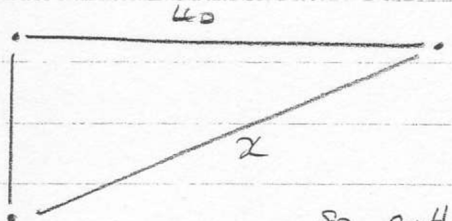
1. (a) plane — straight, from a source a long way off
diffracted — spreading out from a point source in the gap; circular
coherent — in step; same frequency / wavelength; constant phase difference
interfere — waves pass through each other, amplitudes add up: crests add, crest cancels trough
amplitude — "size" of wave from rest line (5)

(b) (i) crests arrive in phase (1) because ... path difference is zero ...
so constructive interference ... 2 crests (or 2 troughs) together 3 wa
(ii) constructive interference ... because path difference (1) ... $= 1\lambda$ (1) (2)
(iii) path difference $= \frac{1}{2}\lambda$ (1) ... destructive interference (1) 2

(c) Interference formula $\frac{\lambda}{d} = \frac{s}{D}$ (1) so... $\lambda = s\frac{d}{D} = \frac{8\times10^{-2} \times 15\times10^{-2}}{70\times10^{-2}} = 0.017$ m $= 1.7$ cm
then... $v = f\lambda$ (1) so $f = v/\lambda = \frac{3\times10^{8} \text{ — m/s !!}}{0.017 \text{ — m !!}} = 1.75\times10^{10}$ Hz (1)
(to get f in Hz, you must get λ in m.) (5)

$\boxed{17}$

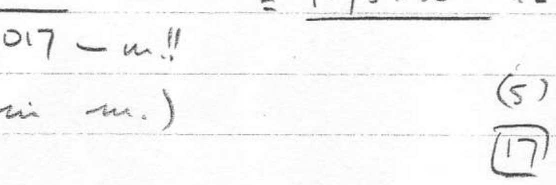
2. (a)



Use Pythagoras
$x^2 = 40^2 + 9^2 = 1681$
so $x = 41$ (1) m (surprize!)
so path difference $= 41 - 40 = 1$ (1) m (2)

(b) the path difference stays constant (1) at 1m ... but the wavelength changes (1) as frequency increases ... so sometimes p.d. $= \lambda$ ...
and sometimes p.d. $= \lambda/2$ (1) (3 max)

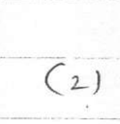
(c) for $f = 165$ Hz ... $\lambda = v/f = 2.0$ (1) m
So path diff $= 1\text{m} = \lambda/2$ (1) ... destructive interference



(4 max)

(d) for no sound at T ... p.d must $= \lambda/2$ or an odd multiple.
p.d. $= 1\text{m} = 1\times\lambda/2$ $\lambda = 2$m $f = v/\lambda = 165$ Hz
p.d $= 1\text{m} = 3\times\frac{\lambda}{2}$ (1) $\lambda = 2/3$ m $= 0.667$ $f = 495$ Hz (1)
p.d $= 1\text{m} = 5\times\frac{\lambda}{2}$ (1) $\lambda = 2/5$ m $= 0.4$ m $f = 825$ Hz (1)
p.d $= 1\text{m} = 7\times\frac{\lambda}{2}$ $\lambda = 2/7$ m $= 0.286$ m $f = 1155$ Hz

That's easy!



(4)

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Q.. (1) /17 (2) /~~9~~ 13. Total /~~26~~ 30.