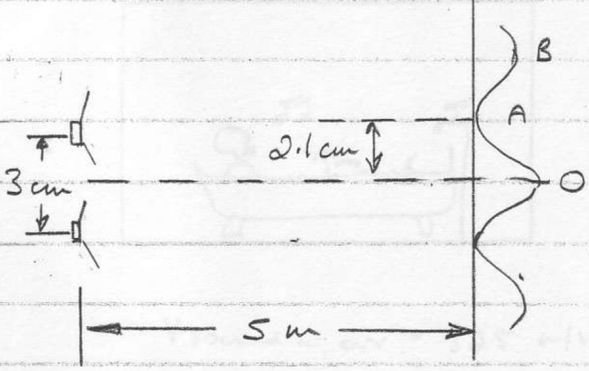
 A Physics

Topic Test - Waves (2)

Waves upon waves: interference — double slit — diffraction grating ... standing waves

1. Two microwave sources emit microwaves in phase and produce an interference pattern.



a) Explain the words underlined (3)

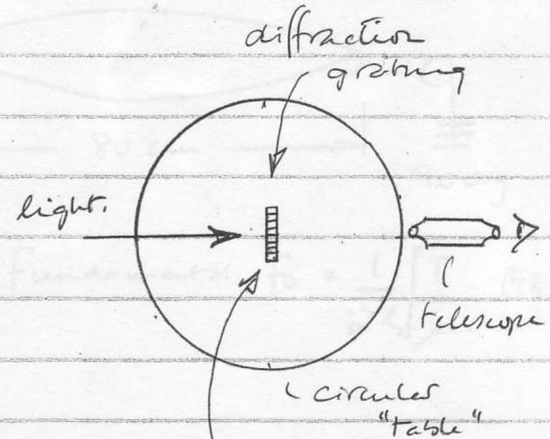
b) Explain how there can be no signal at A, but a strong signal at B. (4)

c) Use the information in the diagram. $V_{microwaves} = 3 \times 10^8$ m/s to calculate the frequency of the microwaves (3)

d) Describe and explain what happens if source S1 emits microwaves of twice the intensity of S2 (2)

e) A science student tries to produce a light interference pattern by putting identical small light bulbs at S_1 and S_2. Would an interference pattern be produced? Explain. (3)

2. A scientist wants to measure the wavelength of light emitted by a newly discovered element, using a spectrometer and diffraction grating.



The spectrum has only 2 colours in it - a purple, and an orange.

Here are the scientist's readings for the purple

zero order: 152.8°, 1st order left 170.0° : 1st order right 135.8°

a) Calculate the wavelength of the purple light (4)

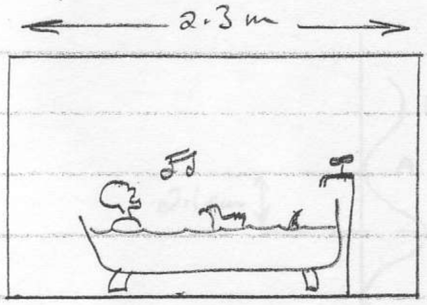
b) The scientist notes that the 3rd order purple line is at the same angle as the 2nd order orange line. Calculate the orange wavelength. (2)

c) How many orange lines can be seen in the complete spectrum from the diffraction grating? (3)

11.00

Topic Test – Waves 2 A Physics

3 A famous opera singer with a passion for Physics sings in his bath, and observes that he can produce a standing wave at the fundamental frequency when he sings a steady low note of a certain frequency.



V sound in air = 325 m/s

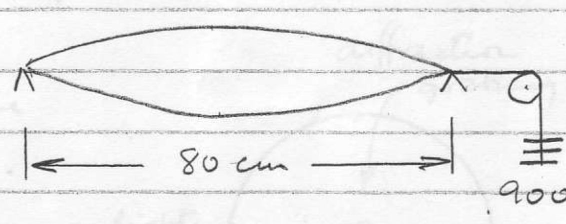
a) Explain the words underlined (3)

b) Sketch a labelled diagram of the standing wave, (2) and... Calculate its frequency (3)

c) The singer increases the pitch of his note until he produces another standing wave. Sketch this and calculate its frequency. (2)

4 A wire is stretched by a hanging mass, and made to vibrate as shown. The wire has a mass of 0.8 g/m.

$g = 10$ N/kg



a) Calculate the frequency of this standing wave (3)

fundamental $f_0 = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$ (Hz)

b) Calculate the velocity of the progressive waves producing it. (3)

c) What effect, will there be on the fundamental frequency if you...

... halve the wire length?

... double the tension? (3)

d) Explain the differences between a standing wave and a progressive wave (4)

Q.	1	2	3	4	Total
	/15	/9	/8	/13	/45.

phew!
[illegible]
4.00

Waves – Test (2) waves upon waves **Answers** A Physics

1. a) in phase – peaks are emitted simultaneously (1)

interference – 2 sets of waves overlap (1) ... amplitudes are added (1) (3

b) At A .... the path difference is $\lambda/2$ (1) ... destructive interference (1)

at B path difference is λ (1) ... constructive interference (1) (4

c) use $\lambda/d = s/D$ (1) $\rightarrow \lambda_{microwave} = \frac{4.2\times10^{-2} \times 3\times10^{-2}}{5.0} = 2.52\times10^{-4}$ m (1)

Since $v = f\lambda \rightarrow f_{microwave} = v/\lambda = 3\times10^{8} / 2.52\times10^{-4} = 1.2\times10^{12}$ Hz (1) (3

d) ... there will not be complete destructive interference (the waves will not "cancel") eg + = (2

e) No interference pattern (1) ... bulbs emit a range of frequencies (1)

there will be no destructive interference (1) ... and not in phase (1) (3 max

2. a) diffraction angles ... $170.0 - 152.8 = 17.2°$ and $152.8 - 135.8 = 17.0$ average $17.1°$ (1)

$n\lambda = d \sin\theta$ (1) 700 lines/mm $\rightarrow d = \frac{1}{700 \times 1\times10^{3}} = 1.43\times10^{-6}$ m (1)

so $\lambda_{purple} = d\sin\theta / n = 1.43\times10^{-6} \times \sin 17.1 / 1 = 420\times10^{-9}$ m (1) (4

b) hmm... $3\lambda_{purple} = d\sin\theta = 2\lambda_{orange}$ (1) $\rightarrow \lambda_{orange} = \frac{3}{2} \times 420$ nm $= 630$ nm

c) set $\theta = 90°$ for orange and see what n comes out as...

$n\lambda_{orange} = d\sin 90$ (1) $\rightarrow n = 1.43\times10^{-6} \times 1 / 630\times10^{-9} = 2.3$ (1)

so you see $n=2$ $n=1$ $n=0$ (centre) $n=1$ $n=2$ 4 orange lines (1) (3

3. a) standing wave ... 2 sets of waves pass through each other (1) .... same f and λ ...

fundamental – lowest frequency (1) A N A N (1) 2

b) N (1) A (1) $\lambda = 2\times2.3$ m $= 4.6$ m (1) $\Rightarrow f = v/\lambda$ (1) $= 70.6$ Hz (1) (5

c) (1) $\lambda = 2.3$ m = half previous, so $f = 2\times$ previous $= 141$ Hz (1) (2

4. a) $f_0 = \frac{1}{2l}\sqrt{\frac{T}{\mu}} = \frac{1}{2\times0.8}\sqrt{\frac{9}{0.8\times10^{-3}}}$ ← kg! (1) N! (1) $= 66.3$ Hz (1) (3

b) λ standing wave $= 2l = 1.6$ m (1) so $v = f\lambda$ (1) $= 66.3 \times 1.6 = 106$ (1) m/s (3

c) halve l ... $f_0 \propto 1/l$ (1) halve $l \rightarrow 2\times f_0$ (1) (132 Hz)

double T ... $f_0 \propto \sqrt{T}$ (1) so.. $2T \rightarrow \sqrt{2}\times f_0$ (1) (94 Hz) (4

d) standing wave $\Rightarrow$ - all points have same amplitude (1)

- at different phase at any 1 time (1)

progressive wave - different points have different amplitude (1)

- all at the same phase in oscillation (1) (4

TLW 11.00 (just)

(1) ... [1] /15 [2] /9 [3] /10 [4] /14 $\Rightarrow$ /48