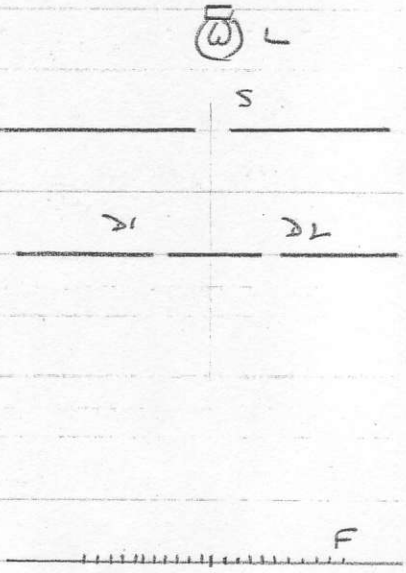
Diffraction + Interference — Question 2 — A Physics

$v_{EM\ waves} = 3 \times 10^8$ m/s

1. **Laser Light**

A student set up a laser interference pattern with a distance between the slits of 0.8 mm, a distance from slits to screen of 4.5 m, and measured 15 complete fringes in 50 mm. What is the wavelength of the laser light? (3)

2. **Young's experiment** was set as shown.



Light L produces monochromatic green light, shining on single slit S.

(a) What does "monochromatic" mean? (1)

(b) What is the purpose of single slit S (2)

(c) What do slits D1 and D2 do? (2)

(d) Fringes appear at F on the screen. Explain briefly how they are produced. (5)

What is the effect on the fringes of...

(e) increasing the wavelength of the light? (1)

(f) increasing the frequency of the light? (2)

(g) making single slit S a bit wider? (1)

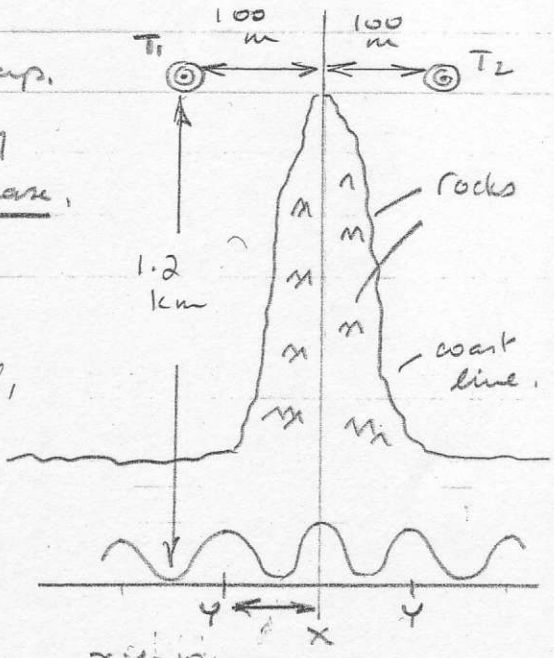
(h) moving screen F towards double slit D1 D2? (1)

(i) covering slit D1 only? (2)

(j) producing white light at L? (3) (20)

3. **We are sailing...**

A radio guidance system has been set up. Two transmitters, T_1 and T_2, emit steady radio signals, of the same frequency, in phase. A boat finds the maximum signal strength at the centre of the interference pattern, X, and follows this up the channel, avoiding the rocks.



(a) How far off the central position does the signal strength fall to zero? (1)

(b) For the distances shown, what radio wavelength and frequency are needed? (5)

(c) If the radio frequency is only 1.0×10^8 Hz, what is XY? (4)

10 marks

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Diffraction + Interference 2 — Answers A Phy 1.4

1. The formula... $\frac{\lambda}{d} = \frac{s}{D}$ (tiny λ, small d, medium s, big D) (1) $s = \frac{50}{15} = 3.3$ mm $= 3.33 \times 10^{-3}$ m

So $\lambda = 3.33 \times 10^{-3} \times 0.8 \times 10^{-3} / 4.5 = 593$ nm $= 5.93 \times 10^{-7}$ m (1) (3

2. (a) "Single colour" – one frequency / wavelength. (1

(b) light diffracts (1) from a single point source (1) (coherent) (2)

(c) diffract (1) light to produce 2 coherent (1) sources (2)

(d) Light is diffracted by slits D1 + D2, diffracted beams overlap and interfere (1). Where path difference (1) (D1 screen – D2 screen) is 0 or whole number of wavelengths, light waves arrive in phase (crest with crest) (1), constructive interference (1), bright fringe. Where path difference is ½λ, 3/2 λ, 5/2 λ etc, then destructive interference (crest with trough) (1), dark fringe (1). (6)

(e) recall $\lambda/d = s/D \rightarrow s = \lambda \times D/d$ ∴ if λ↑ then s↑ (1)

(f) f↑ so λ↓ so spacing ↓ (1)

(g) S still point source but brighter → fringes brighter (1)

(h) distance D ↓ so spacing s ↓ (1)

(i) no interference (1), fringes disappear (1), single slit diffraction pattern (1)

(j) White light is a mixture of wavelengths (1) (colours) 2 max
different colours interfere + cancel separately (1), coloured fringes (1) (

(20)

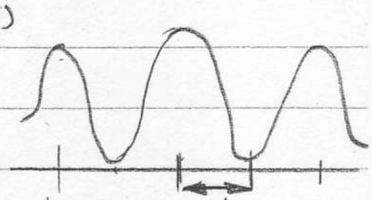
3. (a) XY = 10 m so distance d = 10/2 = 5 m (1)

(b) use $\lambda/d = s/D$ (s = XY)

so $\lambda = s \times d / D$ (1) $= 10 \times 200$ (1) $/1200 = 1.67$ m (1)

$v = f\lambda$ (1) $\rightarrow f = v/\lambda = 3 \times 10^8 / 1.67$

$= 1.8 \times 10^8$ Hz (1) (5)



(c) If $f = 1.0 \times 10^8$ ... $v = f\lambda$ (1) so λ now $= v/f = 3$ m (1)

use $\lambda/d = s/D$ (1) → (XY) or $s = \frac{\lambda D}{d} = 3 \times 1200/200 = 18$ m (1) (4

(10)

Q...	1	2	3	
out of	/3	/20	/10	Total /33

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Mar. '04