

### Chapter 15

1. (a) This is destructive interference ( $n=2$ )

$$\frac{(2-\frac{1}{2})\lambda}{d} = \frac{\lambda}{L}$$

$$\therefore \lambda = \frac{1.5 \times 580 \times 10^{-9} \times 2.8}{0.1 \times 10^{-3}}$$

$$= 2.4 \times 10^{-2} \text{ m}$$

(b) Constructive interference ( $n=4$ )

$$\frac{4\lambda}{d} = \frac{\lambda}{L}$$

$$\therefore \lambda = \frac{4 \times 580 \times 10^{-9} \times 2.8}{0.1 \times 10^{-3}}$$

$$= 6.5 \times 10^{-2} \text{ m}$$

(c) The thickness of the central maximum is equal to  $2x$  the distance to the 1<sup>st</sup> node

$$\therefore 2x = 2 \times \frac{(1-\frac{1}{2}) \times \lambda \times L}{d} = \frac{2 \times 1.5 \times 580 \times 10^{-9} \times 2.8}{0.1 \times 10^{-3}}$$

$$= 1.6 \times 10^{-2} \text{ m}$$

2.  $\lambda = \frac{x \times d}{L(n-\frac{1}{2})} = \frac{2.1 \times 10^{-2} \times 0.15 \times 10^{-3}}{1.8(3-\frac{1}{2})}$

$$= 7 \times 10^{-7} \text{ m} = 700 \text{ nm}$$

3. (a) First Order  $x_c = \frac{n\lambda L}{d}$

$$= \frac{1 \times 4.4 \times 10^{-7} \times 2.4}{0.2 \times 10^{-3}}$$

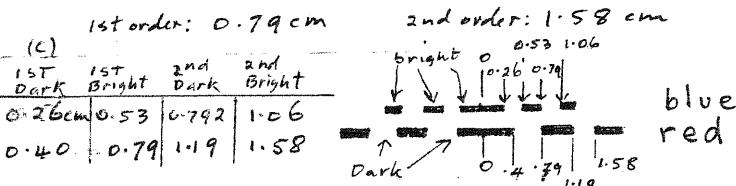
$$= 0.53 \text{ cm}$$

Second Order  $x_c = \frac{n\lambda L}{d}$

$$= \frac{2 \times 4.4 \times 10^{-7} \times 2.4}{0.2 \times 10^{-3}}$$

$$= 1.06 \text{ cm}$$

(b)  $\frac{6.6}{4.4}$  ie 1.5 times the above answers



(d) If  $d$  is doubled all of the above answers would be halved since  $d$  is the denominator.

(e) blue light:  $4.4 \times 10^{-7} \text{ m} = 440 \text{ nm}$   
red light:  $6.6 \times 10^{-7} \text{ m} = 660 \text{ nm}$

4 To find the width of the central maximum, calculate TWICE the distance to the first dark fringe

$$\frac{n\lambda}{w} = \frac{y}{L}$$

$$\therefore y = \frac{n\lambda L}{w}$$

$$\therefore \text{width of central maximum} = \frac{2n\lambda L}{w}$$

$$= \frac{2 \times 1 \times 520 \times 10^{-9} \times 2.8}{0.05 \times 10^{-3}}$$

$$= 5.8 \text{ cm}$$

or Q5:  
 $\frac{+ \text{bright}}{w} = \frac{(1+\frac{1}{2})\lambda L}{w}$



5. (a)

$$y = \frac{1 \times \lambda \times L}{w} = \frac{1 \times 585 \times 10^{-9} \times 1.8}{8 \times 10^{-5} \text{ m}}$$

$$= 1.3 \text{ cm}$$

(b)  $y = 2 \times 1.3 = 2.6 \text{ cm}$

(c) The width of the central maximum is TWICE the distance to the 1<sup>st</sup> order dark fringe:

$$\therefore \text{width} = 2 \times 1.3 = 2.6 \text{ cm}$$

(d) The width of the 1<sup>st</sup> order bright fringe is the DIFFERENCE between the distances to the 1<sup>st</sup> order bright & 2<sup>nd</sup> order dark fringes:

$$\therefore \text{width} = 2.6 - 2.0 = 0.6 \text{ cm}$$

(e) The bright fringes are  $\frac{0.6}{2.6} (\approx \frac{1}{4})$  the width of the central maximum.

6.

$$\frac{n\lambda}{w} = \frac{y}{L}$$

$$\therefore w = \frac{n\lambda L}{y} = \frac{1 \times 632.8 \times 10^{-9} \times 2.8}{8.8 \times 10^{-5}}$$

Note: The highest angular resolution possible is 0.001 arcseconds

7. (a) blue  $\theta = 2.5 \times 10^5 \frac{\lambda}{d} = \frac{2.5 \times 10^5 \times 450 \times 10^{-9}}{0.5 \times 10^{-2}}$

= 22.5 seconds of arc

(b) red  $\theta = 2.5 \times 10^5 \frac{\lambda}{d} = \frac{2.5 \times 10^5 \times 650 \times 10^{-9}}{0.5 \times 10^{-2}}$

= 32.5 seconds of arc

(c) Blue light is better: it gives a larger separation of images (ie more resolving power)

8. (a)  $\frac{n\lambda}{d} = \frac{\lambda}{L} \quad \{ 10000 \text{ lines/cm} = 10^6 \text{ m}^{-1}$

$$\therefore x_c = \frac{n\lambda L}{d} = \frac{2 \times 590 \times 10^{-9} \times 2.2}{10^{-6}}$$

$$= 2.596 \text{ m}$$

(b)  $x_c = \frac{n\lambda L}{d} = \frac{3 \times 590 \times 10^{-9} \times 2.2}{10^{-6}}$

$$= 3.894 \text{ m}$$

9. (a)  $5000/\text{cm} = 2 \times 10^{-6} \text{ m}$

$$\sin \theta = \frac{n\lambda}{d} \quad (d = \frac{1}{5000 \times 100} \text{ m})$$

$$= \frac{2 \times 400 \times 10^{-9}}{2 \times 10^{-6}} = 23.58^\circ$$

(b)  $\sin \theta = \frac{n\lambda}{d} = \frac{3 \times 400 \times 10^{-9}}{2 \times 10^{-6}}$

$$= 36.87^\circ$$

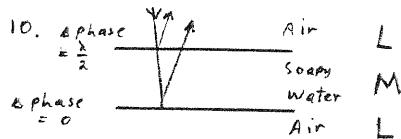
(c) For the last bright spot  $\theta = 90^\circ$

$$\therefore \sin 90^\circ = 1 = \frac{n \times 400 \times 10^{-9}}{2 \times 10^{-6}}$$

$$\therefore n = \frac{1 \times 2 \times 10^{-6}}{400 \times 10^{-9}} = 5$$

This bright spot will not be seen.

Chapter 15 continued....



The distribution is L-M-L and constructive interference occurs:

$$\therefore 2d = \left(m + \frac{1}{2}\right)\lambda$$

$$\therefore \lambda = \frac{2d}{m + \frac{1}{2}}$$

For m=0:

$$\lambda_{\text{water}} = \frac{2 \times 100}{\frac{1}{2}} = 400 \text{ nm}$$

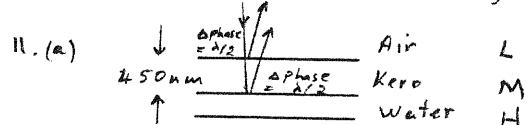
$$\therefore \lambda_{\text{air}} = \lambda_{\text{water}} \times 1.33$$

= 530 nm ie GREEN

(The eye can see 430-690 nm. Outside this range it detects <1% of light.)

$$\lambda_{\text{air}} = 177 \text{ (not able to be seen by human eyes)}$$

There is no need to substitute in more values of m as  $\lambda_{\text{air}}$  is reducing each time.



The distribution is L-M-H and constructive interference occurs:

$$2d = m\lambda_{\text{kero}}$$

$$\therefore \lambda_{\text{kero}} = \frac{2d}{m} = \frac{\lambda_{\text{air}}}{n_{\text{air-kero}}}$$

$$\therefore \lambda_{\text{air}} = \frac{2d \times n_{\text{air-kero}}}{m}$$

Possible values of  $\lambda_{\text{air}}$ :

$$\text{If } m=1: \lambda_{\text{air}} = \frac{2d \times n_{\text{air-kero}}}{1} = 2 \times 450 \times 10^{-9} \times 1.2 = 1080 \text{ nm : can't be seen}$$

$$\text{If } m=2: \lambda_{\text{air}} = 540 \text{ nm ie GREEN}$$

$$\text{If } m=3: \lambda_{\text{air}} = \frac{1080}{3} = 360 \text{ nm (invisible)}$$

(b) For minimum intensity: the distribution is L-M-H and there has to be destructive interference. destructive L-M-H:  $2d = \left(m + \frac{1}{2}\right)\lambda_{\text{kero}}$

$$\therefore \lambda_{\text{kero}} = \frac{2d}{\left(m + \frac{1}{2}\right)} = \frac{\lambda_{\text{air}}}{n_{\text{air-kero}}}$$

$$\therefore \lambda_{\text{air}} = \frac{2d \times n_{\text{air-kero}}}{m + \frac{1}{2}}$$

Possible values of  $\lambda_{\text{air}}$ :

$$\text{If } m=1: \lambda_{\text{air},1} = \frac{2d \times n_{\text{air-kero}}}{1 + \frac{1}{2}} = \frac{2 \times 450 \times 10^{-9} \times 1.2}{1.5} = 720 \text{ nm (outside our range)}$$

$$\text{If } m=2: \lambda_{\text{air},2} = \frac{2 \times 450 \times 10^{-9} \times 1.2}{2 + \frac{1}{2}} \approx 430 \text{ nm (blue)}$$

$$\text{If } m=3: \lambda_{\text{air},3} = \frac{2 \times 450 \times 10^{-9} \times 1.2}{3 + \frac{1}{2}} \approx 310 \text{ nm (outside our range)}$$

12. There has to be constructive interference for L-M-L

$$2d = \left(m + \frac{1}{2}\right)\lambda$$

$$\therefore \lambda_{\text{water}} = \frac{2d}{m + \frac{1}{2}} = \frac{\lambda_{\text{air}}}{n_{\text{air-soapy water}}}$$

$$\therefore \lambda_{\text{air}} = \frac{2d \times n_{\text{air-soapy water}}}{m + \frac{1}{2}}$$

Possible values of  $\lambda_{\text{air}}$ :

$$\text{If } m=1: \lambda_{\text{air},1} = \frac{2d \times n_{\text{air-soapy water}}}{1 + \frac{1}{2}} = \frac{2 \times 400 \times 10^{-9} \times 1.35}{1.5} = 720 \text{ nm (invisible)}$$

$$\text{If } m=2: \lambda_{\text{air},2} = \frac{2 \times 400 \times 10^{-9} \times 1.35}{2 + \frac{1}{2}} \approx 430 \text{ nm (visible: BLUE)}$$

No need to calculate  $\lambda$  for  $m=3$  since  $\lambda$  would be below 430: our sight threshold.

13.

LMH constructive interference occurs for  $\lambda = 650 \text{ nm}$  and  $430 \text{ nm}$

To solve this problem, reorganise the equation to make its subject "d":

$$2d = m\lambda \quad d = \frac{m\lambda}{2}$$

However:  $\lambda_{\text{oil}} = \frac{\lambda_{\text{air}}}{n_{\text{oil}}} \therefore 650 \text{ nm} \rightarrow 500 \text{ nm}; 430 \text{ nm} \rightarrow 331 \text{ nm}$

Now, for  $\lambda$  of 500 nm and 331 nm, substitute in different values of "m" until we get a "match" for  $d$ :

$$\lambda = 500 \text{ nm} \quad \lambda = 331 \text{ nm}$$

For  $m=1$ :

$$d = \frac{1 \times 500}{2} \quad d = \frac{1 \times 331}{2}$$

$$= 250 \text{ nm} \quad = 166 \text{ nm}$$

For  $m=2$ :

$$d = \frac{2 \times 500}{2} \quad d = \frac{2 \times 331}{2}$$

$$= 500 \text{ nm} \quad = 331 \text{ nm}$$

For  $m=3$

$$d = \frac{3 \times 331}{2}$$

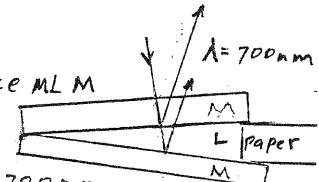
$$= 496 \text{ nm}$$

This matches with 500 nm for a wavelength of 500 nm

$$\therefore d = 500 \text{ nm}$$

14.

Destructive interference M-L-M



$$2d = m\lambda = 200 \times 700 \text{ nm}$$

$$\therefore d = 200 \times \frac{1}{2} \times 700 \times 10^{-9} = 7 \times 10^{-5} \text{ m}$$

Note: we are not counting the dark fringe which occurs where the slides touch. (See Fig. 15.18)

15.

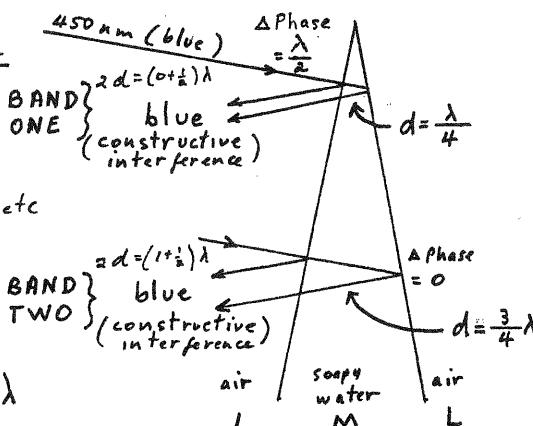
Method 1: Formula

Constructive interference

LM L:

$$2d = \left(m + \frac{1}{2}\right)\lambda$$

where m is 0, 1, 2 etc

band 1  
band 2  
band 3

$$\therefore 2d = \left(4\frac{1}{2}\right)\lambda$$

$$d = \frac{\left(4\frac{1}{2}\right)\lambda}{2}$$

$$= 24\frac{3}{4} \times \lambda_{\text{soapy water}}$$

we must assume that  $n_{\text{soapy water}}$  is roughly that of water is 1.33

$$\therefore \lambda_{\text{soapy water}} = \frac{\lambda_{\text{air}}}{n_{\text{soapy water}}} = \frac{450}{1.33} = 338 \text{ nm}$$

$$\therefore d = 24\frac{3}{4} \times 338 = 8.4 \times 10^{-6} \text{ m}$$

Method 2: First Principles (ie use your brain!)

The first blue band corresponds to a thickness of  $\frac{1}{4}\lambda$ , the second  $\frac{3}{4}\lambda$ . That is, after the first band, each subsequent band corresponds to an increase in thickness of  $\frac{1}{2}\lambda$ .

$$\therefore d = \frac{1}{4}\lambda + 4 \times \frac{1}{2}\lambda$$

$$= 24\frac{3}{4}\lambda$$

$$= 24\frac{3}{4} \times 338 = 8.4 \times 10^{-6} \text{ m}$$

16. Refraction, diffraction and interference are wave properties. Wavelength, amplitude and coherence (phase) refer only to waves but are not "properties".

17. Young's experiment ensured that the waves reaching the screen were coherent.

$$18.(a) \quad \sigma c = \frac{(n - \frac{1}{2})\lambda \times L}{d}$$

$$= \frac{(1 - \frac{1}{2}) \times 620 \times 10^{-9} \times 2.0}{1 \times 10^{-4}}$$

$$\approx 8.7 \times 10^{-3} \text{ m}$$

$$(b) \quad \sigma c = \frac{n L \lambda}{d}$$

$$= \frac{3 \times 2.0 \times 620 \times 10^{-9}}{1 \times 10^{-4}}$$

$$\approx 5.2 \times 10^{-3} \text{ m}$$

(c) If  $d$  gets smaller (the denominator) then the value of  $\sigma c$  gets larger. The pattern would be more spread out.

18(d) If  $L$  gets smaller, the value of  $\sigma c$  gets smaller. The pattern would move closer together.

(e) Yellow light has a shorter wavelength than red. The value of  $\sigma c$  will decrease and the pattern will move closer together.

$$19. \quad d = \frac{n \lambda L}{\sigma c} \\ = \frac{2 \times 1.0 \times 10^{-9} \times 2.0}{2.0 \times 10^{-3}} \\ = 2.0 \times 10^{-6} \text{ m}$$

It would be difficult to put two slits this far apart.

$$20(a) \quad \sigma c = \frac{n \lambda L}{d} \\ = \frac{3 \times 510 \times 10^{-9} \times 2.0}{2.0 \times 10^{-4}} \\ = 1.5 \times 10^{-2} \text{ m}$$

(b) The thickness of the central maximum is equal to twice the distance to the first node:

$$\text{Thickness} = 2 \times \text{dist. to node} \\ = 2 \times \frac{(n - \frac{1}{2})\lambda \times L}{d} \\ = \frac{2 \times \frac{1}{2} \times 510 \times 10^{-9} \times 2.0}{2.0 \times 10^{-4}} \\ = 5.1 \times 10^{-3} \text{ m}$$

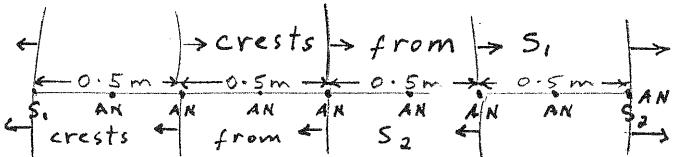
21. For the first order dark band  $n = 1$  and there is DESTRUCTIVE interference:

$$\frac{n \lambda}{w} = \frac{y}{L}$$

$$\therefore \lambda = \frac{y w}{n L} \\ = \frac{2 \times 10^{-3} \times 1 \times 10^{-3}}{1 \times 3} \\ = 667 \text{ nm}$$

$$\approx 670 \text{ nm}$$

2.



In this diagram, crests from  $S_2$  are drawn below the line while crests from  $S_1$  are drawn above. This makes it easier to view.

Imagine that crests are just about to leave  $S_1$  and  $S_2$  as the above snapshot is taken. Antinodes (2 crests or 2 troughs) occur at 0.25m intervals from  $S_1$  to  $S_2$ .

Imagine that all of the waves move on a distance of 0.125 m from the snapshot. Now crests from  $S_1$  are superimposed onto troughs from  $S_2$ . These nodes will be 0.5 m apart and will be found 0.125 m either side of the antinode. The first node is 0.125 m from  $S_1$ .

There is an antinode at 1.5 m from  $S_1$  - this would register as a maximum.

3(a) A series of light and dark bands, either side of a central bright fringe.

$$(b) \frac{y}{L} = \frac{(n + \frac{1}{2})\lambda}{w}$$

$$\therefore y = \frac{(3 + \frac{1}{2})\lambda L}{2 \times 10^{-4} \text{ m}} = \frac{3\frac{1}{2} \times 450 \times 10^{-9} \times 2.5}{2 \times 10^{-4}}$$

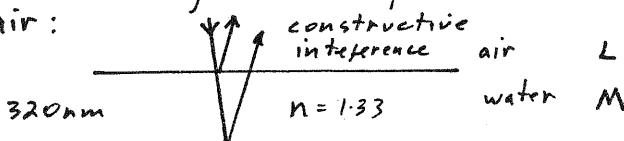
$$= 0.0197 \text{ m} \approx 0.020 \text{ m}$$

(c) The diameter of central maximum equals twice the distance to the 1<sup>st</sup> dark band.

$$\therefore \text{diameter} = \frac{2 \times 1 \times \lambda \times L}{w} = \frac{2 \times 1 \times 450 \times 10^{-9} \times 2.5}{2 \times 10^{-4}}$$

$$= 0.01125 \text{ m} \approx 1.1 \text{ mm}$$

4 This question is not particularly clear. I am assuming a water film surrounded by air:



In this question we are looking for the wavelength of light which undergoes constructive interference as it interacts with the film.

$$\left. \begin{aligned} \lambda_{\text{film}} &= \frac{\lambda_{\text{air}}}{1.33} \\ \text{wavelength of light in film} \\ \text{constructive interference LML:} \\ 2d &= (m + \frac{1}{2})\lambda \end{aligned} \right\} 2d = (m + \frac{1}{2}) \frac{\lambda_{\text{air}}}{1.33}$$

$$\text{For } m = 0 \\ 2d = (0 + \frac{1}{2}) \frac{\lambda_{\text{air}}}{1.33}$$

$$\therefore \lambda_{\text{air}} = 2 \times 320 \text{ nm} \times 2 \times 1.33 \\ \approx 1700 \text{ nm (not visible)}$$

$$\text{For } m = 1 \\ 2d = (1 + \frac{1}{2}) \frac{\lambda_{\text{air}}}{1.33} \Rightarrow \lambda_{\text{air}} \approx 570 \text{ nm (green)}$$

Above  $m = 1$  the light is not visible.

25. The wavelengths are intensified so we have constructive interference: LML constructive

$$\therefore 2d = (m + \frac{1}{2}) \lambda_{\text{film}}$$

$$\therefore 2d = (m + \frac{1}{2}) \frac{\lambda_{\text{air}}}{1.5}$$

For  $m = 0$

$$2d = \frac{1}{2} \times \frac{\lambda_{\text{air}}}{1.5}$$

$$\therefore \lambda_{\text{air}} = 2 \times 1.5 \times 2 \times 10^{-4}$$

$$= 2400 \text{ nm}$$

This cannot be detected by our eyes

For  $m = 1$

$$2d = \frac{3}{2} \times \frac{\lambda_{\text{air}}}{1.5}$$

$$\therefore \lambda_{\text{air}} = \frac{2}{3} \times 1.5 \times 2 \times 10^{-4}$$

$$= 800 \text{ nm}$$

This cannot be detected

For  $m = 2$

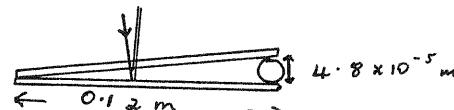
$$2d = \frac{5}{2} \times \frac{\lambda_{\text{air}}}{1.5}$$

$$\therefore \lambda_{\text{air}} = \frac{2}{5} \times 1.5 \times 2 \times 10^{-4}$$

$$= 480 \text{ nm}$$

This can be detected

26.



HMH constructive interference:

$$2d = (m + \frac{1}{2})\lambda$$

If we do not count the dark band where the slides touch, then dark bands occur at:

Path difference:  $\frac{1}{2}, \frac{1}{2}, \frac{1}{2}, \dots, 140\frac{1}{2}$   
Band no 1 2 3 141

$$m + \frac{1}{2} = \frac{2d}{\lambda} = \frac{2 \times 4.8 \times 10^{-5}}{680 \times 10^{-9}}$$

$$= 141$$

$$\therefore m = 140\frac{1}{2}$$

This corresponds to the 141<sup>st</sup> band.

27. All wavelengths of electromagnetic radiation travel at  $3 \times 10^8 \text{ m/s}$  in air.

28. Evidence for light being a wave:

- Young's experiment (interference)
- reflection
- refraction
- diffraction

$$29. f = 105 \times 10^6 \text{ Hz}$$

$$\therefore \lambda = \frac{c}{f} = \frac{3 \times 10^8}{105 \times 10^6} \\ = 2.86 \text{ m}$$

$$30. t = 5.0 \times 10^{-4} \text{ s} \quad \left\{ \begin{array}{l} \text{Time to go} \\ \text{to plane and BACK} \end{array} \right.$$

$$v = 3.0 \times 10^8 \text{ m/s}$$

$$2 \times \text{dist} = v \times t = 5.0 \times 10^{-4} \times 3.0 \times 10^8 \\ = 1.5 \times 10^5 \text{ m}$$

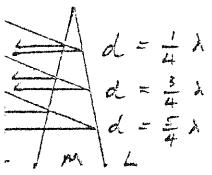
$$\therefore \text{dist} = 75 \text{ km}$$

31. Substances give off infrared light at relatively low temperatures. Infrared images from satellites allow us to calculate cloud height (higher clouds are colder), land temperatures, ocean currents (eg El Niño).

Chapter 15 continued . . .

Question 40 and 41 require the following background information:  
For WEDGES,  $m$  increases as the thickness of the wedge increases.

LML constructive



$$d = \frac{1}{4} \lambda$$

$$d = \frac{3}{4} \lambda$$

$$d = \frac{5}{4} \lambda$$

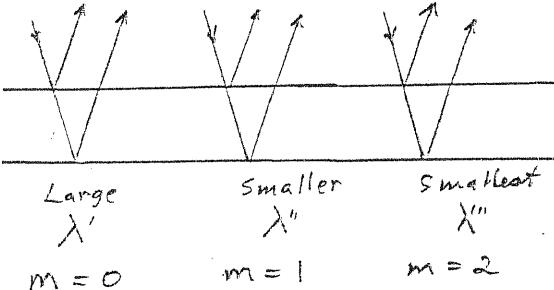
$$m = 0$$

$$m = 1$$

$$m = 2$$

$d$  changes,  $\lambda$  stays the same

For THIN films



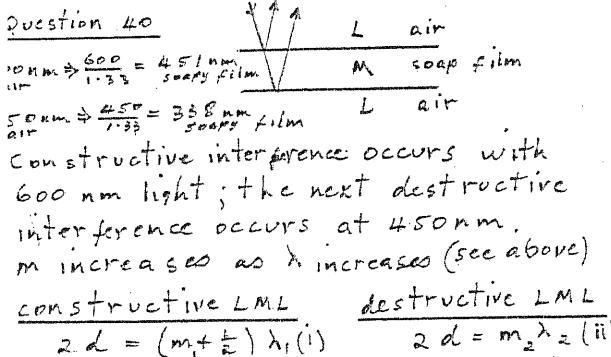
$d$  stays same,  $\lambda$  changes.

Since we are counting constructive interference lines, the first one ( $m=0$ ) occurs when  $d$  corresponds to  $\frac{\lambda}{4}$ . The second one occurs

when  $d$  corresponds to  $\frac{3\lambda}{4}$ . The third corresponds to  $\frac{5\lambda}{4}$  and so on.

for problems on thin films,  $m$  increases with increasing  $\lambda$

Question 40



since there are no minima between  $\lambda_1$  and  $\lambda_2$        $m_1 + 1 = m_2$

$$\therefore 2d = (m_1 + \frac{1}{2}) \lambda_1 = m_2 \lambda_2$$

$$\therefore ((m_2 - 1) + \frac{1}{2}) \lambda_1 = m_2 \lambda_2$$

$$\therefore (m_2 - \frac{1}{2}) \lambda_1 = m_2 \lambda_2$$

$$\therefore (m_2 - \frac{1}{2}) \times 451 = m_2 \times 338$$

$$451m_2 - 226 = 338m_2$$

$$\therefore 113m_2 = 226$$

$$\therefore m_2 = 2$$

substitute in (ii):  $2d = m_2 \lambda_2$

$$\therefore d = \frac{m_2}{2} \lambda_2 = \frac{2}{2} \times 338 \text{ nm}$$

$$= 338 \text{ nm}$$

For Question 40

$m$	0	1	2	3	
LML destructive	$2d = m_1 \lambda_1$	$0\lambda_1$	$\lambda_1$	$2\lambda_1$	$3\lambda_1$
LML constructive	$2d = (m_1 + \frac{1}{2}) \lambda_1$	$\frac{1}{2}\lambda_1$	$\frac{3}{2}\lambda_1$	$\frac{5}{2}\lambda_1$	$\frac{7}{2}\lambda_1$

$\lambda$  gets smaller  
↓

$\lambda$  gets smaller →

For a given thickness of film, if  $m_1 = m_2$  then  $\lambda$  must be LARGER than  $\lambda_2$ . For example, for  $m=1$ :

For destructive interference  $d = \frac{1}{2} \lambda_1$ ,

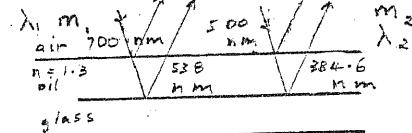
For constructive interference  $d = \frac{3}{4} \lambda_2$

That is:  $\frac{1}{2} \lambda_1 = \frac{3}{4} \lambda_2$

$\therefore \lambda_1 > \lambda_2$   
destructive      constructive

So as long as the destructive wavelength is larger than the constructive wavelength,  $m_1 = m_2$ .

In question 40 the constructive wavelength is larger than the destructive. For this to happen,  $m$  in the constructive formula must be 1 LARGER than  $m$  in the destructive formula. i.e whatever is the  $m$  in the destructive formula, the  $m$  of the constructive formula must be 1 greater.



Question 41

$m_1$  and  $m_2$  are successive dark bands.

$$\therefore m_1 + 1 = m_2$$

LML destructive:  $m_1, \lambda_1$

$$2d = (m_1 + \frac{1}{2}) \lambda_1 \quad \text{--- (i)}$$

$$2d = (m_1 + 1 + \frac{1}{2}) \lambda_2 \quad \text{--- (ii)}$$

$$\therefore (m_1 + \frac{1}{2}) \times 538 \text{ nm} = (m_1 + \frac{3}{2}) \times 384.6 \text{ nm}$$

$$538m_1 + 269 = 384.6m_1 + 577$$

$$153.4m_1 = 308$$

$$\therefore m_1 \approx 2$$

Substitute 1 for  $m_1$  in (i)  $\therefore 2d = (2 + \frac{1}{2}) \times 538 \text{ nm}$

$$d \approx 673 \text{ nm}$$

Question 42

$\lambda_{air} = \lambda_{oil} \times n_{oil}$

LML constructive

$$2d = (m + \frac{1}{2}) \lambda_{oil} = (m + \frac{1}{2}) \lambda_{oil} \times n_{oil}$$

For  $m = 0$

$$\therefore \lambda_{air} = \frac{2 \times d \times n}{(0 + \frac{1}{2})} = \frac{2 \times 673 \times 1.00}{0.5} = 2690 \text{ nm}$$

$$\text{For } m = 1 \quad \lambda_{air} = \frac{2 \times 673 \times 1.45}{1.5} = 967 \text{ nm}$$

$$\text{For } m = 2 \quad \lambda_{air} = \frac{2 \times 673 \times 1.45}{2.5} = 580 \text{ nm (green)}$$

