(16 marks)

Q1 (a) $E = \frac{1}{2} kA^2$

$= \frac{1}{2}(35.0\ N/m)(4.00 \times 10^{-2}\ m)^2$

$= 28.0\ mJ$ marks

(b) $|v| = \omega(A^2 - x^2)^{1/2} = \sqrt{k/m}\,(A^2 - x^2)$

$= 1.02\ m/s$ marks

(c) $\frac{1}{2}mv^2 = \frac{1}{2}kA^2 - \frac{1}{2}kx^2$

$= 12.2\ mJ$ marks

(d) $\frac{1}{2}kx^2 = E - \frac{1}{2}mv^2$

$= 15.8\ mJ$ marks

(16 marks)

Q2 For first pipe,

$$\lambda = v/f = \frac{343\ m/s}{256\ s^{-1}} = 1.34\ m$$

$\therefore$ Length, $d_1 = \lambda/2 = 0.67\ m$

marks

For second pipe,

$$\lambda = v/f = \frac{343\ m/s}{440\ s^{-1}} = 0.78\ m$$

$\therefore$ Length $d_2 = \lambda/2 = 0.39\ m$

marks

(b) $\therefore$ Original length $= d_1 + d_2 = 1.06\ m$

$\therefore \lambda = 2(d_1 + d_2) = 2.12\ m$ marks

(a) $\therefore f = v/\lambda = \frac{343}{2.12} = 162\ Hz$

marks

(c) For closed end, $\lambda = 4d$

$\therefore$ tube 1, $\lambda = 2.68\ m$

$f = v/\lambda = 128\ Hz$ marks

$\therefore$ tube 2, $\lambda = 1.56\ m$

$f = v/\lambda = 220\ Hz$ marks

(16 marks)

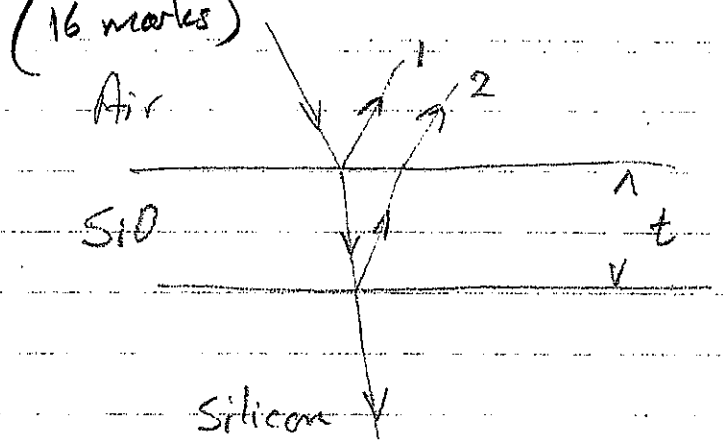
Q3 The mica introduces an optical path length $\Delta L = nt - t$ of 7 wavelengths. marks

$\therefore t(n-1) = 7\lambda$ marks

$\therefore t = \frac{(7)(550 \times 10^{-9})}{(1.58-1)} = 6.64 \times 10^{-6}$ m

marks

Q4 (16 marks)



a) Ray 1 undergoes π phase change on reflection marks
Ray 2 " π " " " marks

∴ Require an addition path length of $\lambda_n/2$ to create destructive interference

$$\therefore \quad t = \lambda_n/4 = \frac{\lambda}{4n} = \frac{550}{4\,(1.45)} = 94.8\ nm$$ marks

b) Maximum reflection when $\lambda_n/2 = t$

$$\therefore \quad \lambda = 2nt = 275\ nm$$ marks

(20 marks)

Q5 At entry, $n_1 \sin\theta_1 = n_2 \sin\theta_2$

$\therefore 1.00 \sin 30^\circ = 1.50 \sin\theta_2$

$\therefore \theta_2 = 19.5^\circ$ marks

The distance h travelled in the medium is

$\cos\theta_2 = 2.00/h$

$\therefore h = 2.12$ cm marks

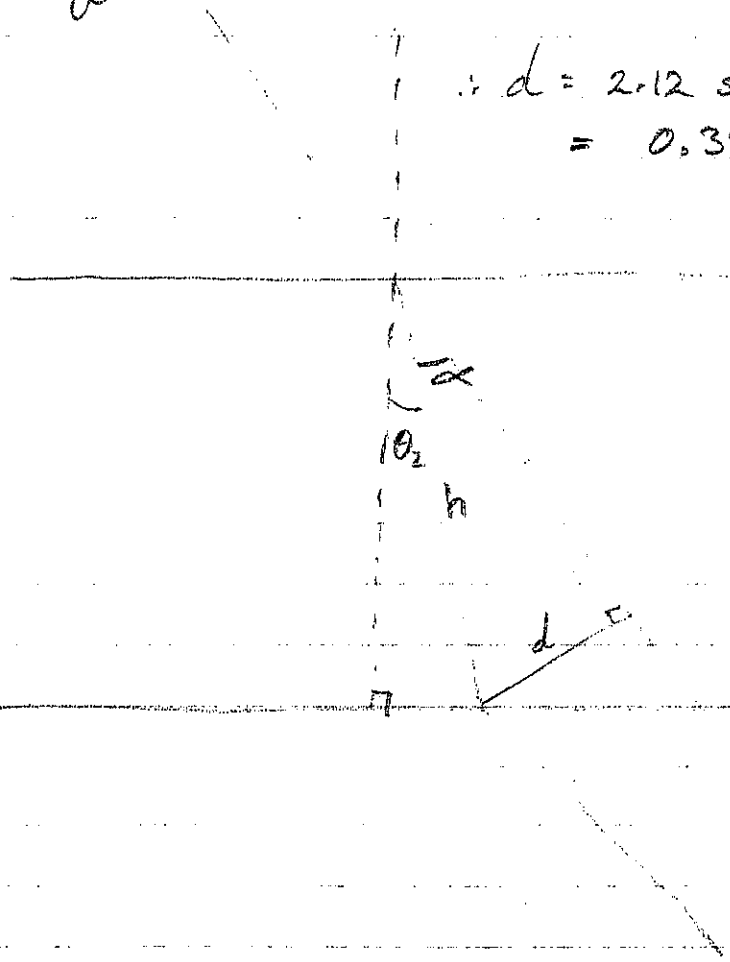
The angle of deviation on entry is

$\alpha = \theta_1 - \theta_2 = 30 - 19.5 = 10.5^\circ$ marks

$\therefore$ The offset distance, d, is $h \sin\alpha$

$\therefore d = 2.12 \sin 10.5$

$= 0.388$ cm marks



(16 marks)

Q6 (a) $\lambda = c/f = 0.020\ m$ marks

To just resolve the ships, $\frac{1.22\lambda}{D} = d/L$ marks

$\therefore d = \frac{(1.22)(0.020)(9\times10^3)}{2.10}$

$= 105\ m$ 4 marks

(b) From Brewster's Law, $n = \tan\theta_p$

$\therefore n = \tan(48.0°) = 1.1$ 3 marks