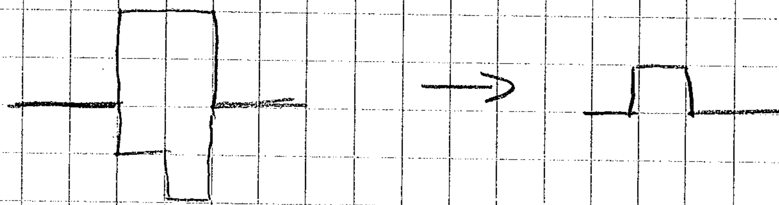
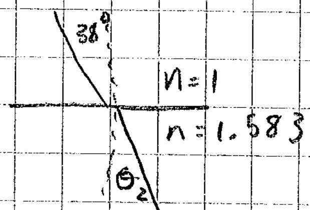
Waves

(1)



(2)



(a) $\dfrac{\sin\theta_2}{\sin\theta_1} = \dfrac{n_1}{n_2}$

$\sin\theta_2 = \dfrac{n_1 \sin\theta_1}{n_2} = \dfrac{(1)\sin(38^\circ)}{1.583}$

$\theta_2 = \underline{23^\circ}$

(b) $\dfrac{n_1}{n_2} = \dfrac{v_2}{v_1}$

$v_2 = \dfrac{n_1 v_1}{n_2} = \dfrac{(1)(3\times10^8\,ms^{-1})}{1.583} = \underline{1.9\times10^8\,ms^{-1}}$

(c) frequency of the light remains the same in air

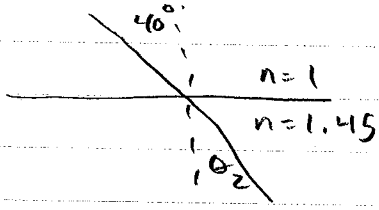
$v = f\lambda$

$f = \dfrac{v}{\lambda} = \dfrac{3\times10^8\,ms^{-1}}{6.8\times10^{-7}\,m} = 4.4\times10^{14}\ Hz$

so in glass

$\lambda = \dfrac{v}{f} = \dfrac{1.9\times10^8\,ms^{-1}}{4.4\times10^{14}\,Hz} = \underline{4.3\times10^{-7}\,m}$

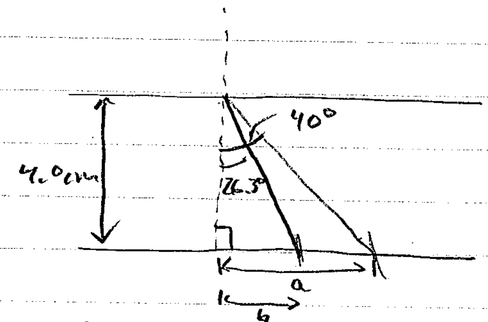
(3)



$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{n_2}{n_1}$$

$$\sin\theta_2 = \frac{n_1 \sin\theta_1}{n_2} = \frac{(1)\sin 40^\circ}{1.45}$$

$$\theta_2 = 26.3^\circ$$



unfracted distance = a

$$\tan 40^\circ = \frac{a}{4\text{cm}}$$

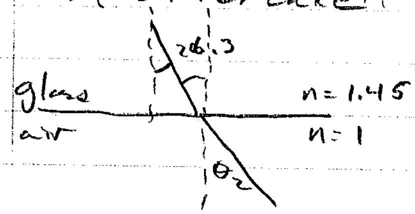
$$a = 3.356 \text{ cm}$$

refracted distance = b

$$\tan 26.3 = \frac{b}{4\text{cm}}$$

$$b = 1.977 \text{ cm}$$

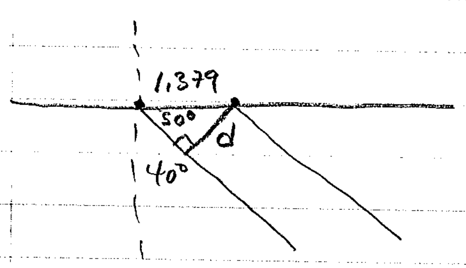
$\therefore$ difference is $3.356 - 1.977$ cm $= 1.379$ cm.



$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{n_2}{n_1}$$

$$\sin\theta_2 = \frac{n_1 \sin\theta_1}{n_2} = \frac{1.45\sin(26.3^\circ)}{1}$$

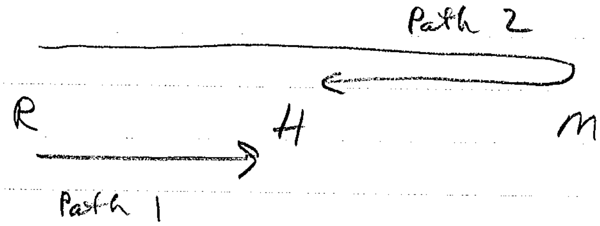
$$\theta = 40^\circ$$



$$\sin 50^\circ = \frac{d}{1.379\text{cm}}$$

$$\underline{d = 1.06 \text{ cm}}$$

(4)



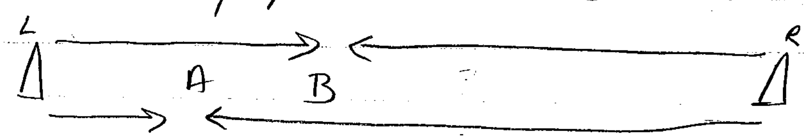
- the reception is poor so there must be destructive interference at H
- therefore the path difference must be $\frac{\lambda}{2}$

$$(RH + HM + HM) - (RH) = \frac{\lambda}{2}$$

$$2HM = \frac{\lambda}{2}$$

$$HM = \frac{\lambda}{4} = \frac{1600\,m}{4} = \underline{400\,m}$$

(5) A – constructive; path difference to A must be λ
B – destructive; path difference to B must be $\frac{\lambda}{2}$



$$\lambda = AR - LA = AB + BR - LA$$

$$\frac{\lambda}{2} = BR - LB = BR - (LA + AB) = BR - LA - AB$$

$$BR - LA = \lambda - AB$$

$$BR - LA = \frac{\lambda}{2} + AB$$

$$\lambda - AB = \frac{\lambda}{2} + AB$$

$$\frac{\lambda}{2} = 2AB$$

$$AB = \frac{\lambda}{4}$$

$$v = f\lambda$$

$$\lambda = \frac{v}{f} = \frac{3 \times 10^{8}\,ms^{-1}}{90 \times 10^{6}\,Hz} = 3.33\,m$$

$$AB = \frac{\lambda}{4} = \frac{3.33\,m}{4} = \underline{0.833\,m}$$

(6) (a) unpolarized light - the intensity will always be reduced by one-half

(b) polarized light - only light that is parallel to the plane of polarization will be transmitted.

(c) partially polarized light - only light that is parallel to the plane of polarization will be transmitted; In this case, there is always light parallel as the original light is not completely polarized to one plane.

(7) The fraction of intensity transmitted is proportional to the square of the cosine of the angle.

$$I = I_0 \cos^2\theta$$

(8) $I = I_0 \cos^2\theta$

$\frac{I}{I_0} = \cos^2(25°) = \underline{0.82}$

(9) unpolarized light is at all angles $(0-360°)$

Therefore, since a polarizer only allows light parallel to the transmission axis to pass it would be reasonable to take an average.

The average value of $\cos^2\theta$ from $0-360°$ is $1/2$

$$\therefore I = \frac{I_0}{2}$$

(10) Light reflecting off the surface of the water causes a "glare."
This reflected light is polarized parallel to the surface of the water (ie) horizontally.
Polarized sunglasses have a vertical transmission axis.
Since the polarized sunglasses have an axis of transmission at 90° to the polarized reflected light, the reflected light is blocked.
Therefore, the "glare" is eliminated allowing the fisherman to better see the fish.