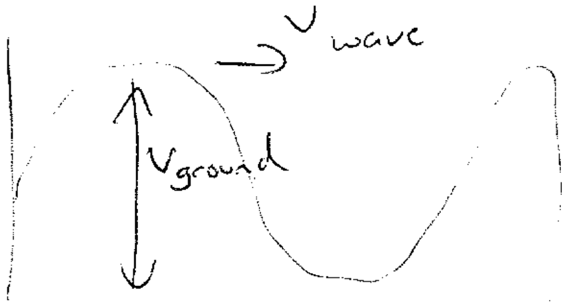
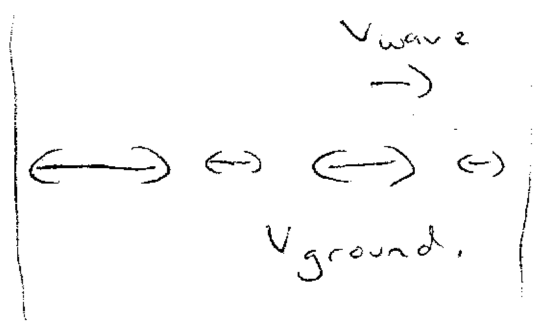
PHYS 1221 S II 2003 TEST 1

Q1 (a) (i) A transverse wave has the direction of oscillation of mass element perpendicular to the direction of motion. Longitudinal in the same dir as propagation.

Transverse



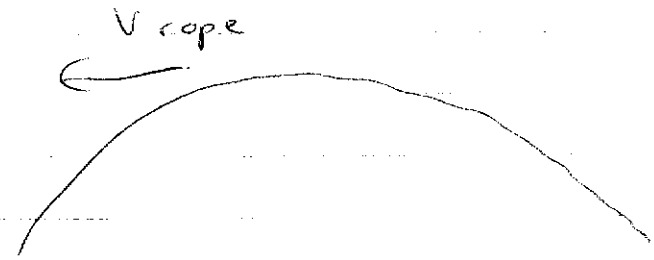
Longitudinal



(ii) The different velocities ~~waves~~ come from the elastic properties of the ground i.e. the tension experienced for a small compression. This is far greater for the longitudinal wave as the ~~Earth~~ compression strength is greater than the shear strength.

Q 1 (b)

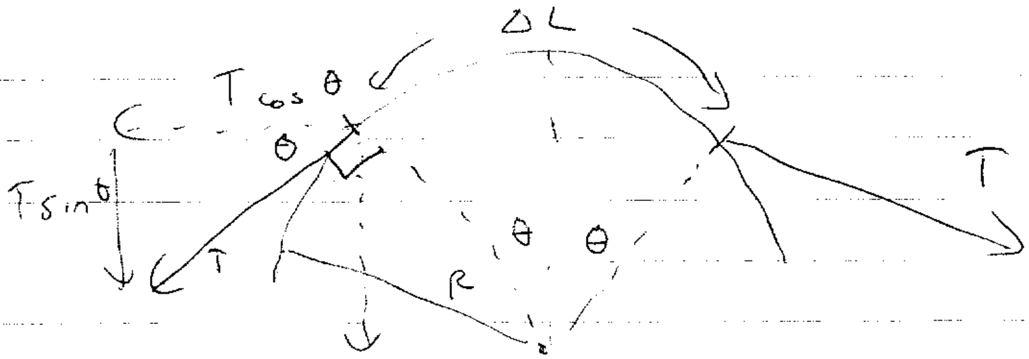
R.T.S $v = \sqrt{\frac{T}{\mu}}$



Reference frame is that of wave: i.e. wavefront is stationary, rope moves to left.

assume that small portion of rope can be considered as undergoing uniform circular motion.

Forces on rope:



The net force is $2T\sin\theta$

If θ is small, $2T\sin\theta \simeq 2T\theta$

Also for uniform circular motion,

$$\Sigma F = \frac{mv^2}{R}$$

$$2T\theta = \frac{mv^2}{R} \quad \text{--- (1)}$$

and $2\theta R = \Delta L$ (from $s = R\theta$)

$$2\theta = \frac{\Delta L}{R} \quad \text{--- (2)}$$

Substituting (2) into (1) gives:

$$T\frac{\Delta L}{R} = \frac{mv^2}{R}$$

$$v^2 = T\frac{\Delta L}{m}$$

Also $\mu = \frac{m}{\Delta L}$ $\therefore$ $\frac{\Delta L}{m} = \frac{1}{\mu}$

so $v^2 = \frac{T}{\mu}$

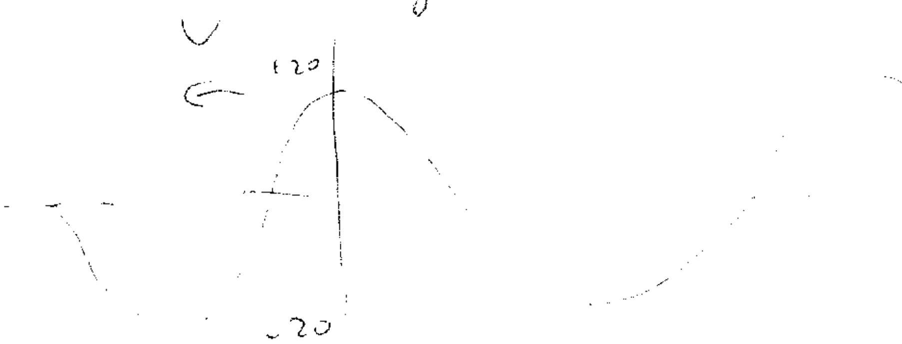
$$v = \sqrt{\frac{T}{\mu}}$$

PHYS 1221 S2 2003 Test 1

Q2

$L = 3m \qquad f = 50\ Hz \qquad A = 20\ cm = 0.2m$

$m = 75g \qquad T = 3.6N \qquad \phi = +\frac{\pi}{2}$



(i) $v = \sqrt{\frac{T}{\mu}}$ 1 $\qquad$ 1 $\mu = \frac{75 \times 10^{-3}}{3}$

$= 25 \times 10^{-3}$ kg

1 $= \sqrt{\frac{3.6}{25 \times 10^{-3}}} = \sqrt{144} = \boxed{12\ m/s}$

(ii) 1 $v = f\lambda \Rightarrow \lambda = \frac{v}{f} = \frac{12}{50} = \boxed{0.24m}$

(iii) 1 $\omega = 2\pi f = 2\pi(50) = \boxed{100\pi} = 314.2$ rad s^{-1}

(iv)

$$y = 0.2 \sin\left(8.3\pi x + 100\pi t + \frac{\pi}{2}\right)$$

3

$k = \frac{2\pi}{\lambda} = \frac{2\pi}{0.24} = \boxed{8.3\pi}$

$= 26.2$

(v) $y = 0.2 \sin\left(100\pi t + \frac{\pi}{2}\right)$ 1

(vi) $v = \frac{dy}{dt} = 0.2(100\pi)\cos\left(100\pi t + \frac{\pi}{2}\right)$ 1

1 $= \boxed{20\pi}\cos(100\pi t + \pi/2)$

$= 62.8 \cos(100\pi t + \pi/2)$

$v_{max} = \boxed{62.8}$ m/s 1

PHYS 1221 S2 2003 Test 1

Q 3 (a) (i)

(ii) path diff $= d\sin\theta$ 1

(b) $d\sin\theta = m\lambda$ $m =$ integer 1

(c) coherent light! 1

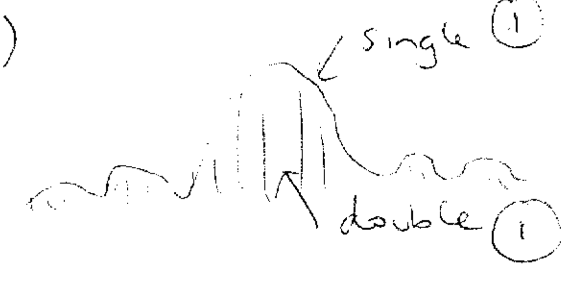
θ small, rays essentially // 1

$d\sin\theta = m\lambda$ $\tan\theta = \frac{y}{D}$ 1

$\tan\theta \simeq \sin\theta$ 1

$d\frac{y}{D} = m\lambda$ 1

(d)



single slit

$a\sin\theta = \lambda$ 1

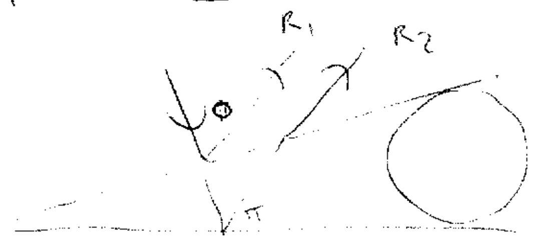
double slit

$d\sin\theta = 6\lambda$ 1

$\frac{a\sin\theta}{d\sin\theta} = \frac{\lambda}{6\lambda}$ $\frac{a}{d} = \frac{1}{6}$ $d = 6a$ 1

PHYS 1221 S II 2003 Test 1

Q4 (a)



(2)

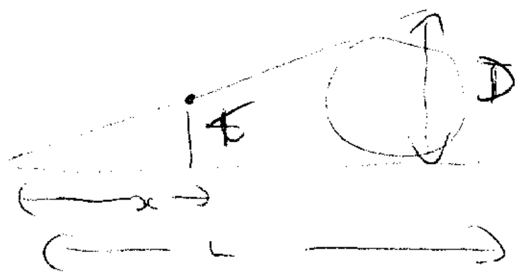
glass to water 0; water to glass π

(b) (2)

(c) dark as both out of phase where (2)

path diff $= m\lambda$, & here $m = 0$

(d)



From similar △,

$$\frac{T}{x} = \frac{D}{L} \quad (1)$$

Also, path diff $= 2T$ (1) so $T = \frac{xD}{L}$

$$= 2\left(\frac{Dx}{L}\right) \quad (1)$$

(e) (1) $\lambda_n = \frac{\lambda}{n} = \frac{\lambda}{1.33} = \frac{680}{1.33} = 511.3$ nm

(f) (1) path diff $= (m + \frac{1}{2})\lambda$

(g) $m = 130$ (1)

$$2\left(\frac{Dx}{L}\right) = (m + \tfrac{1}{2})\frac{\lambda}{n}$$

Here $x = L$ (1)

$$2nD = (m + \tfrac{1}{2})\lambda$$

$$D = \frac{(m + \frac{1}{2})\lambda}{2n} \quad (1)$$

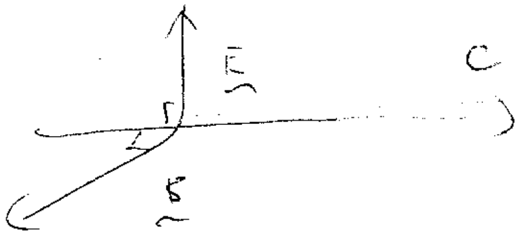
$$= \frac{(130.5)(511.3 \times 10^{-9})}{2}$$

$= 33.4\ \mu$m

$= 3.34 \times 10^{-5}$ m

PHYS 1221 S2 2003 TEST 1

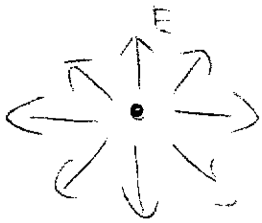
$\boxed{Q5}$ (a)



3

(b) Unpolarised light has the electric field vector direction at right angles to the direction of propagation, but randomly at any of the 360° possible to satisfy this condition. The average is 50% in y-dir, 50% in z-dir (assuming prop along x-dir) diagram e.g.

3

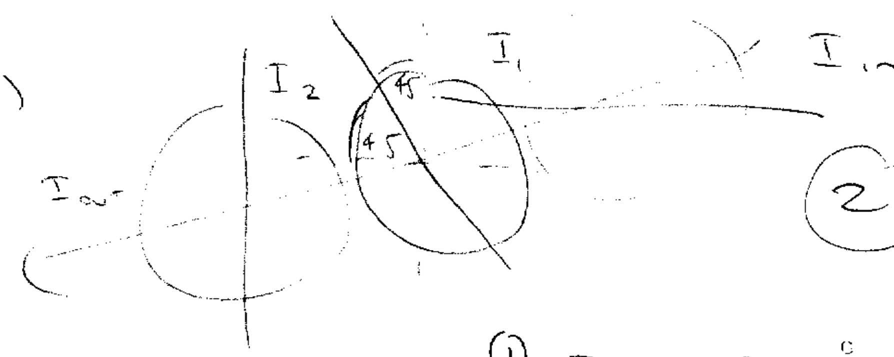


wave prop out of page.

(c) (i) $I_{in} = \frac{1}{2} I_0$ 1

(ii) $I_{out} = I_1 \cos^2\theta$
$= I_1 \cos^2 90°$
$= 0$ 2

(iii)



2

(iv) $I_1 = \frac{1}{2} I_{in}$ $I_2 \overset{1}{=} I_1 \cos^2 45°$
$= \frac{1}{2} I_1 = \frac{1}{4} I_0$

$I_{out} \overset{1}{=} I_2 \cos^2\theta = I_2(\frac{1}{2}) \overset{1}{=} \frac{1}{8} I_0$