Physics 256 Assignment 1 Fall 2012
Wednesday September 19th, 2012
75 marks

Hecht question 3.14.

irradiance

$$I = \frac{Power}{A} = \frac{20\ W}{4\pi(1)^2\ m^2} = \frac{5\ W}{\pi\ m^2} \approx 1.59\ W/m^2$$

Note: $A=4\pi r^2$
5marks

2.2 $\lambda = c/\nu$

$$\lambda_{light} = \frac{3.0\times10^8 m/s}{5\times10^{14} s^{-1}} = 6\times10^{-7} m$$

$$\lambda_{EN} = \frac{3.0\times10^8 m/s}{60 s^{-1}} = 5\times10^6 m.$$

3 marks

2.4 The time between crests = the period, $\therefore T = 1/2\ s$ 2

$\nu = \frac{1}{T} = \frac{1}{0.5} = 2 s^{-1} = 2 Hz$ (frequency) 1

$v = \frac{\Delta d}{\Delta t} = \frac{4.5\ m}{1.5\ s} = 3.0\ m/s$ (speed)

$\lambda = \frac{v}{\nu} = \frac{3.0 m/s}{2.0 s^{-1}} = 1.5 m$ wavelength 3

TOTAL 6 marks-must have SI units lose 1 mark if unit missing/ incorrect

2.12 Comparing y with Eq. (2.13) tells us that $A = 0.02$ m. 1 Moreover, $2\pi/\lambda = 157\ m^{-1}$ and so $\lambda = 2\pi/(157m^{-1}) = 0.0400$ m The relationsl between frequency and wavelength is $v = \nu\lambda$, and so. 2 $\nu = v/\lambda = 1.2\ m/s/0.0400\ m = 30$ Hz 2 The period is the inverse of th frequency, and therefore $\tau = 1/\nu = 0.033$ s. 1

TOTAL: 6 marks

Then if this is the form of the wave at t=0, and the wave is travelling leftward, write out the wave equation.

Form of the wave in x was given. Given the speed of 1.2 m/s, travelling leftward, the wave equation is:

$Y(x,t)=(0.02m)\sin(157m^{-1})(x + (1.2m/s)t)$.

5 marks

2.26 $k = \pi 3 \times 10^6$ m^{-1}, $\omega = \pi 9 \times 10^{14}$ Hz, $v = \omega/k = 3 \times 10^8$ m/s.

4 marks

Direction of motion is leftwards 1 mark

Redo using equation 2.34:

$$\mathrm{v} = -\frac{\left.\frac{\partial\psi}{\partial t}\right|_y}{\left.\frac{\partial\psi}{\partial y}\right|_t} = \frac{(-) - A\pi\sin(z)(9X10^{14})}{-A\pi\sin(z)(3X10^6)} = -3X10^8 m/s$$ indicates leftwards

5 marks

2.32a)

Can do as functional form or ratio of partial derivatives of phi or of psi

$$\psi(y,t) = \exp\left[-a(y-\frac{b}{a}t)^2\right] = g\left[f(y-\frac{b}{a}t)\right]$$ where $g(z) = \exp\left(-az^2\right)$,

therefore Conclusion v=b/a travelling in the +y direction.

MARKS: 6 marks

b) $\psi(z,t) = A\sin(az^2 - bt^2) = a\sin\left[(\sqrt{a}z - \sqrt{b}t)(\sqrt{a}z + \sqrt{b}t)\right]$ is not an f(x±vt), not a travelling wave 3 marks

c) $\psi(x,t) = A\sin 2\pi(\frac{x}{a} + \frac{t}{b})^2 = G\left[f\left(\frac{1}{a}h\left\{x + \frac{at}{b}\right\}\right)\right]$ where f(z)=z^2,

$G(y) = A\sin 2\pi y$ gives conclusion v =a/b in the –x direction 6 marks

d) $\psi(x,t) = A\cos^2 2\pi(t-x) = G\left[f(x-t)\right]$ where G(z)=$A\cos^2(-2\pi z)$

gives the conclusion v=1m/s in +x direction 6 marks

Phasor Question

In each part, draw a phasor diagram to represent the sum of the two waves below. Using the diagram, and the resulting trig identities, calculate the equation of the resulting wave.

a) $\psi_1 = 2\sin(kx + \omega t)$
$\psi_2 = 7\sin(kx + \omega t - \pi/4)$

5 marks diagram, 6 marks calculation

TOTAL
11 marks

$\psi_1 = 2\sin(kx+\omega t)$

$\psi_2 = 7\sin(kx+\omega t - \pi/4)$

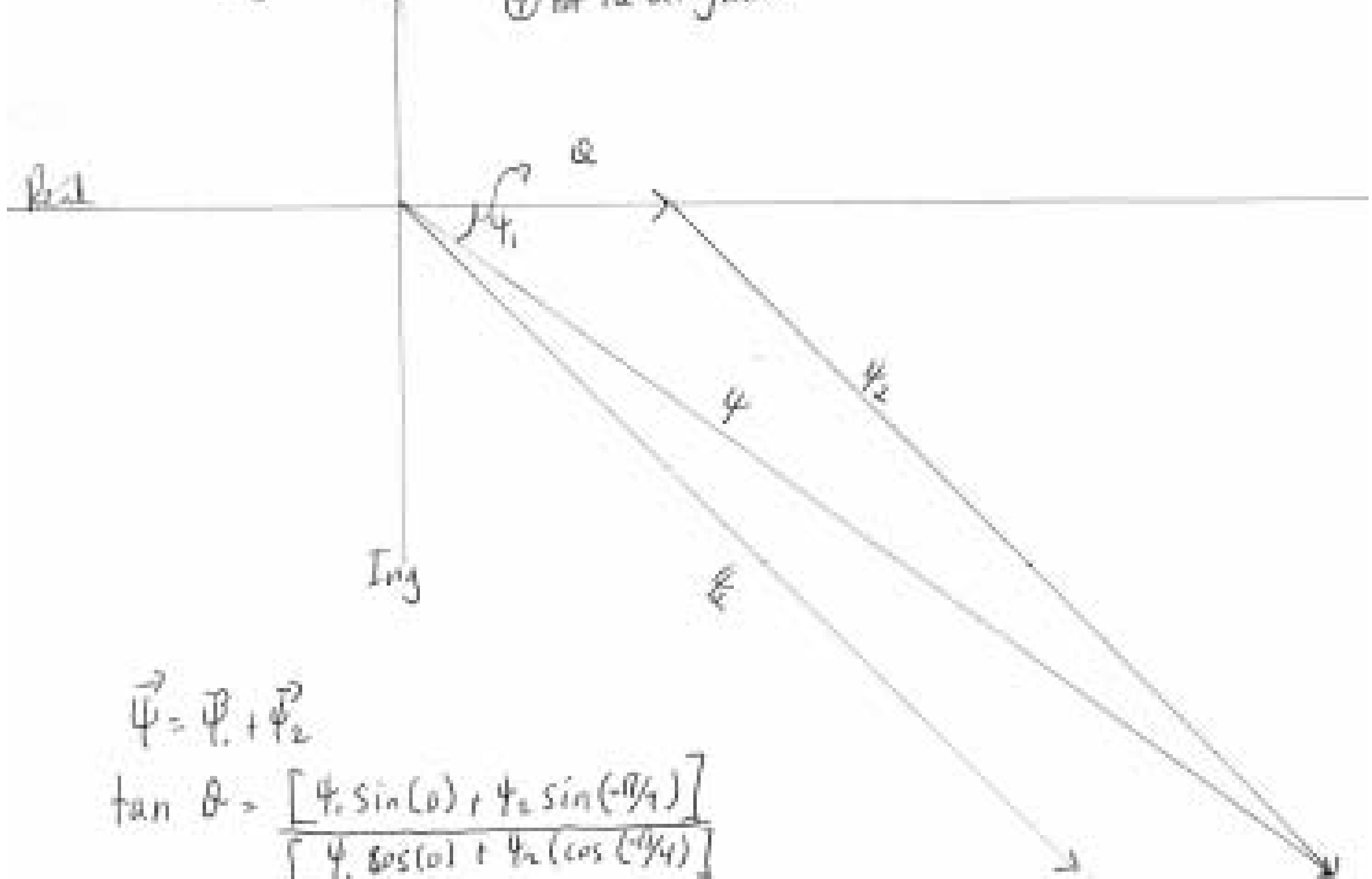
Initially $x=0,\ t=0$

$\psi = A\sin(kx+\omega t+\theta)$

Phasors: $2\angle 0;\ 7\angle -\pi/4\ (45°)$

$(A_1\angle 0;\ A_2\angle -\pi/4)$

(4) for the diagram



$\vec{\psi} = \vec{\psi}_1 + \vec{\psi}_2$

$$\tan\theta = \frac{[\psi_1\sin(0) + \psi_2\sin(-\pi/4)]}{[\psi_1\cos(0) + \psi_2(\cos(-\pi/4)]} = \frac{-7\sqrt{2}/2}{2+7\sqrt{2}/2}$$

$\theta = \arctan\left[\frac{-7\sqrt{2}/2}{2+7\sqrt{2}/2}\right] = -0.618$ radians OR $\pi - 0.618$ rad

By inspection, angle is in 4th quadrant $= -0.618$ radians or $2\pi - 0.618$ rad $= 5.66$ rad

$$A^2 = A_1^2 + A_2^2 + 2A_1A_2\cos(-\pi/4 - 0)$$
$$= 2^2 + 7^2 + 2(2)(7)(\sqrt{2}/2)$$

$A = 8.532$

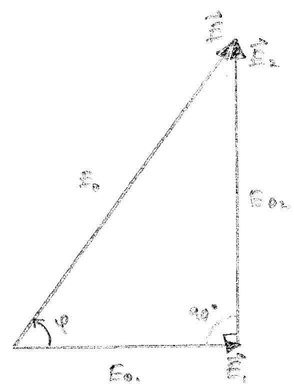
$\psi = 8.53\sin(kx+\omega t - 0.618)$ OR $\psi = 8.53\sin(kx+\omega t + 5.66)$

b)
$$\psi_1 = 3\sin(\omega t)$$
$$\psi_2 = 4\cos(\omega t) = 4\sin(\omega t + \frac{\pi}{2})$$
OR
$$\psi_1 = 3\sin(\omega t) = 3\cos(\omega t - \frac{\pi}{2})$$
$$\psi_2 = 4\cos(\omega t)$$

ψ_0= $\sqrt{3^2 + 4^2} = 5$ IN BOTH CASES

tanφ=$\frac{4}{3}$; $\varphi = 0.93\,\boldsymbol{rad} = 53.1\deg$ OR tanφ=$\frac{-3}{4}$; $\varphi = 0.64\,\boldsymbol{rad} = -36.9\deg$

$$\psi = 5\sin(\omega t + 0.93)\ \boldsymbol{OR}\ \psi = 5\cos(\omega t - 0.64)$$



4 MARKS CALCULATION, 4 MARKS DIAGRAM