PHYSICS 262 FALL 2010 EXAM 1

Closed book, closed notes calculators OK. Enter all answers on the scantron sheet in the form $ans1 \times 10^{ans2}$, rounded to the nearest one significant figure. Sometimes you may have to round up. If you need to use an answer from a previous question, use the exact number, **not** the rounded number.

An electromagnetic plane wave wave traveling in a medium is described by $\vec{E} = 4\cos(12x + 880t)\hat{j}$ in (V/m) where x is in microns and t is in picoseconds. (1 ps = 10^{-12} s)

$k = 12\ \mu m^{-1}$ $\omega = 880\ ps^{-1}$ $V = \frac{\omega}{k} = \frac{880}{12}\frac{\mu m}{ps} = 7.3\times10^{7}\frac{m}{s}$.

1,2] What is the speed of the wave, in m/s?

3,4] What is the index of refraction of the medium? $n = \frac{c}{V} = 4.1$

5,6] What is the frequency, **in MHz** (1 MHz = 10^6 Hz) ? $f = \frac{\omega}{2\pi} = \frac{880}{2\pi\cdot10^{-12}\,s} = 140\times10^{12}$ Hz $= 140\times10^{6}$ MHz

7] What part of the electromagnetic spectrum is this?

a) gamma ray
b) x-ray
c) ultraviolet
d) visible
e) infrared
f) terahertz
g) microwave
h) radiowave

$\lambda = \frac{2\pi}{k} = 0.52\ \mu m$

8] What is the direction in which the wave is traveling?

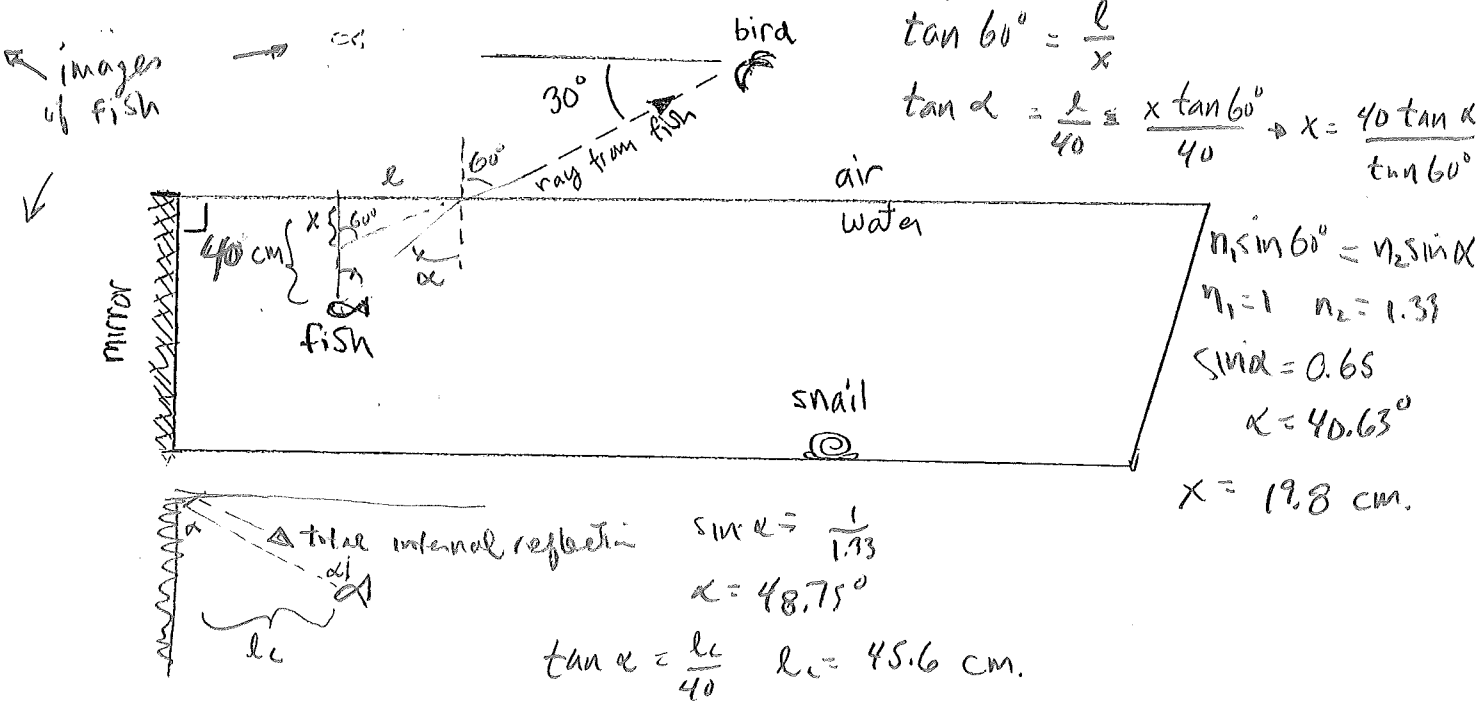
a) +x
b) −x
c) +y
d) −y
e) +z
f) −z
g) 45° between x and y
h) 45° between −x and −y

J to t & x to keeps phase same

9,10] A small fish is swimming in water (n=1.33) 40 cm below the surface. What is the apparent depth of the minnow to a bird which sees the minnow at an angle of 30° below horizontal? see below

11,12] The pool the fish is in has a reflecting (mirrored) side. (The bottom is *not* reflective.) The mirror does not extend above the water. What is the closest to the wall the fish can be such that its reflection in the mirror is not visible from anywhere in the air? (OR enter 0,0 if the fish's reflection can always be seen from somewhere in the air.)

13] A snail is on the bottom of the tank as shown. How many reflected images of the fish can the snail see, not counting the fish itself? (Assume snails have good eyesight.) 3



$\tan 60° = \frac{\ell}{x}$

$\tan\alpha = \frac{\ell}{40} = \frac{x\tan 60°}{40} \Rightarrow x = \frac{40\tan\alpha}{\tan 60°}$

$n_1\sin 60° = n_2\sin\alpha$

$n_1 = 1$ $n_2 = 1.33$

$\sin\alpha = 0.65$

$\alpha = 40.63°$

$x = 19.8$ cm.

$\sin\alpha = \frac{1}{1.33}$

$\alpha = 48.75°$

$\tan\alpha = \frac{\ell_c}{40}$ $\ell_c = 45.6$ cm.