Physics 11 – Wave Worksheet

1. A physics student sitting on the beach notices that a wave hits the beach every 5.0 seconds, and the waves seem to be about 15m apart. What is the speed of these waves?

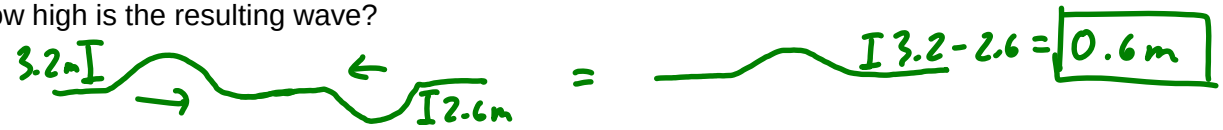
$$v = \frac{d}{t} = \frac{15\,m}{5.0\,s} = 3.0\,m/s$$

2. What is the frequency of laser light that has a wavelength of 623nm?

$623\,nm = 623\times10^{-9}\,m = 6.23\times10^{-7}\,m$

$$v = \lambda f \qquad f = \frac{v}{\lambda} = \frac{3.00\times10^{8}\,m/s}{6.23\times10^{-7}\,m} = 4.82\times10^{14}\,Hz$$

3. Out in the ocean, a wave crest 3.2m high meets a wave trough from another direction which is 2.6m deep. How high is the resulting wave?



4. Fill out the following table with the correct name of the wave phenomena:

reflection	A wave hits the beach at a 30 degree angle, and a wave is observed leaving the beach at 30 degrees.
refraction	A wave enters shallow water and the wavelength decreases
diffraction	A sailboat seeks shelter behind an island in a storm, but finds that there are still waves behind the island
refraction	A fisherman throws his spear directly at a fish seen in the water, but misses.
Doppler Effect	A student walking beside the E&N railway track notices that the pitch of the train sound increases as the train approaches
polarization	A student puts on a pair of sunglasses when snowboarding, and notices that it is now easier to see the moguls.
refraction	A laser light shines into a beaker of water. The beam is seen to bend at the point where the light enters the water.
interference	A rogue wave capsizes a small freighter in the North Sea.

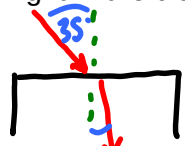
5. Ocean waves enter a harbour through two entrances 50m apart. On the seawall which is 200m from the entrances, an observer notices very large waves hitting the wall every 35m. What is the wavelength of these waves?

Don't Do!

6. Laser light with a wavelength of 632 nm is put through a diffraction grating where the openings are 0.40 mm apart. How far from the central bright beam will the 3rd bright spot be on the wall 1.0 m away?

Don't Do!

7. A beam of light travels from air into diamond at an angle of 35°. What is the angle of refraction of the light in the diamond (n = 2.42)?



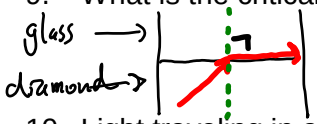
$n_i \sin\theta_i = n_r \sin\theta_r$ $\quad \sin\theta_r = \frac{n_i \sin\theta_i}{n_r} = \frac{(1.0003)\sin 35}{2.42} = 0.237$

$\theta_r = 14°$

8. Light traveling in water enters an unknown substance at an angle of 43°. The angle of refraction in the unknown substance is 48°. What is the index of refraction of the unknown substance?

$n_i \sin\theta_i = n_r \sin\theta_r$ $\quad n_r = \frac{n_i \sin\theta_i}{\sin\theta_r} = \frac{(1.33)\sin 43°}{\sin 48°} = 1.22$

9. What is the critical angle for light traveling from diamond (n = 2.42) into glass (n=1.6)?



$n_i \sin\theta_i = n_r \sin\theta_r$ $\quad \sin\theta_i = \frac{n_r \sin\theta_r}{n_i} = \frac{1.6 \sin 90°}{2.42} = 0.661$

$\theta_i = 41°$

10. Light traveling in a vacuum with a wavelength of 710nm enters a plexiglass window on the space station at an angle of 65°. The index of refraction for plexiglass is 1.50

a) What is the frequency of this light in a vacuum?

$v = \lambda f$ $\quad f = \frac{v}{\lambda} = \frac{3.00\times10^8 \text{ m/s}}{7.10\times10^{-7} \text{ m}} = 4.2\times10^{14} \text{ Hz}$

b) What is the frequency of this light in the plexiglass?

frequency does not change when refraction occurs

$\therefore \quad f = 4.2\times10^{14} \text{ Hz}$

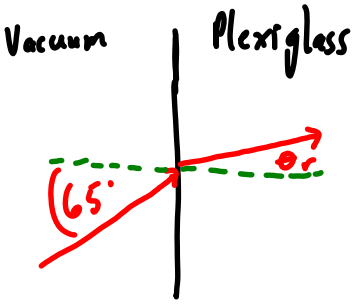
c) What is the speed of the light in plexiglass?

$n = \frac{c}{v}$ $\quad v = \frac{c}{n} = \frac{3.00\times10^8 \text{ m/s}}{1.50} = 2.00\times10^8 \text{ m/s}$

d) What is the wavelength of the light in plexiglass?

$v = \lambda f$ $\quad \lambda = \frac{v}{f} = \frac{2.00\times10^8 \text{ m/s}}{4.2\times10^{14} \text{ Hz}} = 4.76\times10^{-7} \text{ m} = 476 \text{ nm}$

e) What is angle of refraction of the light in plexiglass?



$n_i \sin\theta_i = n_r \sin\theta_r$

$\sin\theta_r = \frac{n_i \sin\theta_i}{n_r} = \frac{(1)\sin 65°}{1.50} = 0.604$

$\theta_r = 37°$