PH202 Recitation 9: Waves and Energy Solutions

Problem 1:

Ocean wave velocity if sea gull bobs up and down every 5s and distance from crest to crest is 10m

Well, $v = \lambda f$ for a wave

$\Rightarrow$

$v = \lambda \frac{1}{T}$

$\Rightarrow v = 10m \left(\frac{1}{5s}\right)$

$\Rightarrow v = 2 m/s$

b)

travel 2000km?

$v = 2 m/s$

$v = \frac{dist}{time}$

$\Rightarrow time = \frac{dist}{velocity}$

$\Rightarrow time\ t = \frac{2000 \cdot 10^3 m}{2 m/s}$

$\Rightarrow t = \frac{2000000}{2} = 1000000 s$

$1000000 s \cdot \frac{min}{60s} \cdot \frac{hr}{60 min} \cdot \frac{day}{24 hr} = 11.6 \text{ days}$

Problem #2:

humpback whales produce 20Hz to 10kHz frequencies
sound travels at 1400m/s in water
determine wavelengths

$V = \lambda f$

$\Rightarrow \frac{V}{f} = \lambda$

$\lambda = \frac{1400 m/s}{20 Hz} = 70m$ wavelength 20Hz

$\frac{V}{f} = \lambda$

$\Rightarrow \lambda = \frac{1400 m/s}{10000 Hz} = .14m$ wavelength 10kHz

If these waves can travel up to 10000 miles, how many waves fit in that distance?

$10000 \text{ miles} \cdot \frac{1609m}{Mi} = 16090000m$

$20Hz \Rightarrow 70m$ wavelength $\Rightarrow \frac{16090000m}{70m} = 229857$ cycles/waves

$10kHz \Rightarrow .14m$ wavelength $\Rightarrow \frac{16090000m}{.14m} = 114928571$ cycles/waves

Scanned with CamScanner

Problem 3:

waves on swimming pool propagate at 0.750 m/s.
30s to travel end to end and back. How far away is end?

$V = \frac{dist}{time}$

$\Rightarrow V \cdot t = d$

$\Rightarrow 0.750 m/s \cdot 30s = d$

$\Rightarrow d = 22.5m$

this is the distance traveled in total

$\Rightarrow$ distance to end of pool $= \frac{d}{2} = 11.25m$

b) If the waves have amplitude of 0.25m and 10 waves fit in the pool at a time, what is the equation of the wave?

Well, in general we know

$D(x,t) = \pm D_{max} \sin_{\text{or } \cos} (\pm kx \pm \omega t)$

$k = \frac{2\pi}{\lambda}$ and $\omega = \frac{2\pi}{T}$

10 waves at a time $\Rightarrow$ 10 waves for 11.25 m $\Rightarrow \lambda = 1.125m$

$\Rightarrow k = \frac{2\pi}{1.125} = 5.59$

$V = f\lambda$

$\Rightarrow V = \frac{1}{T}\lambda$

$\Rightarrow T = \frac{\lambda}{V}$

$\Rightarrow T = \frac{1.125m}{.750 m/s} = 1.5s$

$\Rightarrow \omega = \frac{2\pi}{T}$

$\Rightarrow \omega = \frac{2\pi}{1.5} = 4.19 \frac{rad}{s}$

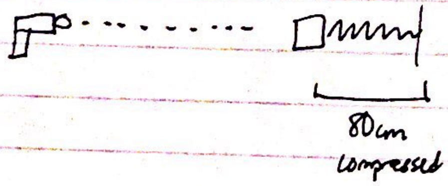
use -sin since starts at 0 and then goes down first, then up

$\Rightarrow D(x,t) = -.25\sin(\pm 5.59x \pm 4.19t)$

assume $+\hat{x}$ direction $\Rightarrow$ 1+ and 1-, just chose +x and -t

$\Rightarrow D(x,t) = -.25\sin(5.59x - 4.19t)$

Problem 4: 12.0g bullet fired into 100g wooden block attached to spring with stiffness 150 N/m. Bullet embeds into block and compresses by a max of 80cm. What was speed of bullet at impact / muzzle velocity?



Well, we need to use momentum here

$$\Sigma P_i = \Sigma P_f \quad \text{where } \Delta p = 0 \text{ since } \Delta t = 0 \text{ from impulse}$$

$$m_1 V_1 = M_2 V_2$$

$$M_B V_B = (M_B + M_{block}) V_{system}$$

$$\Rightarrow V_B = \frac{(M_B + M_{block}) V_{sys}}{M_B}$$

need to know V_{sys}: look at energy of oscillator

so at max compression we only have U^k, which turns into K^E

$$\text{so } U^k = K^E$$

$$\Rightarrow \frac{1}{2}kx^2 = \frac{1}{2}mv^2$$

$$\Rightarrow \sqrt{\frac{kx^2}{m}} = V$$

$$\Rightarrow V_{sys} = \sqrt{\frac{(150\ N/m)(.80m)^2}{(.112\ kg)}} = 29.3\ m/s$$

$$\Rightarrow V_B = \frac{(.112\ kg)(29.3\ m/s)}{(.012\ kg)} = 273\ m/s \text{ of bullet}$$

b)

in general $x(t) = \pm X_{max}\,(\sin \text{ or } \cos(\omega t))$

initial conditions $\Rightarrow$ at $t=0$ $x=0$ $\Rightarrow$ sin not cos

compress first $\Rightarrow +X_{max} = +.80m$

$$\omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{150\ N/m}{.112kg}} = 36.6$$

$$\Rightarrow x(t) = .80 \sin(36.6t)$$