Phy 131 - Assignment 11

A. 1. Any four of these: Radio waves, microwaves, infrared, visible light, ultraviolet, x-rays, gamma rays. Sound is <u>not</u> an electromagnetic wave, and neither is heat (heat can flow in ways other than radiation.)

2. For parts a, b and c, just compare y = (.25 m)sin(.30x – 40t) to the general form y = Asin(kx – ωt).

a. A = .25 m

b. ω = 40 rad/s

c. k = .30 m^{-1}

d. $k = \frac{2\pi}{\lambda} \Rightarrow \lambda = \frac{2\pi}{k} = \frac{2\pi}{.3} = \boxed{20.9\text{ m}}$

e. $v = f\lambda = \left(\frac{\omega}{2\pi}\right)\lambda = \left(\frac{40}{2\pi}\right)(20.9) = \boxed{133\text{ m/s}}$

f. As it says on the formula sheet, a wave going to the right is of the form y = A sin(kx – ωt + ϕ), while one going toward the left is y = A sin(kx + ωt + ϕ). In this case, the t term has a minus in front of it, so it's going <u>right</u>, or <u>+x</u> direction.

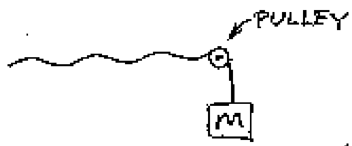
g. y = (.25 m)sin[(.30)(3.20) – (40)(.190)] = (.25)sin(.96 – 7.6) = (.25)sin(–6.64 rad)

$= \boxed{-.0873\text{ m}}$

B. 1. Transverse: Medium is displaced ⊥ to direction of propagation.

Longitudinal: Medium is displaced ∥ to direction of propagation.

2.



Compare $Y = .2 \sin(.75\pi X - 18\pi t)$

to standard form: $Y = A \sin(kX - \omega t + \phi)$

$k = .75\pi$ $\qquad$ $\omega = 18\pi$

$\frac{2\pi}{\lambda} = .75\pi$ $\qquad$ $2\pi f = 18\pi$

$\frac{2}{.75} = \lambda$ $\qquad$ $f = 9 \text{ Hz}$

$2.6\overline{6} = \lambda \longrightarrow$ $\qquad$ $v = f\lambda = (9)(2.6\overline{6}) = 24 \text{ m/s}$

$v = \sqrt{\frac{F}{\mu}} \Rightarrow F = v^2 \mu = (24)^2 (.25 \text{ kg/m}) = 144 \text{ N}$

$F = mg \Rightarrow m = \frac{F}{g} = \frac{144 \text{ N}}{9.8 \text{ m/s}^2} = \boxed{14.7 \text{ kg}}$ ANS

C. 1. a. Higher. The Doppler effect increases the frequency of a wave from an approaching source.

b. Same. (The loudness increases as the car gets closer, not the pitch.) Since the car is still approaching you and still has the same speed, the sound has the same Doppler shift that it did when coming from A.

c. Lower. At B, the car was approaching you, which increases the frequency. At C, the car is moving away from you, which decreases the frequency. So, as the car passed you, the sound's pitch dropped.

d. Lower. The car is moving away from you, which decreases the frequency.

2. f = the number of cycles per second (by definition). $\frac{40 \text{ cy}}{30 \text{ s}} = 1.333 \text{ Hz}$

Also by definition, $v = \frac{\Delta x}{\Delta t} = \frac{4.25 \text{ m}}{10 \text{ s}} = \; = .425 \text{ m/s}$

$\lambda = \frac{v}{f} = \frac{.425}{1.333} = \boxed{.319 \text{ m}}$

D. 1. ROY G. BIV: Red, orange, yellow, green, blue, indigo, violet. Violet is the high frequency (short λ) end. Red is the long λ (low f) end.

2.

$v = 343\ \text{m/s}$, $v_o = 0$ (observer at rest), $v_s = 40\ \text{m/s}$

$f = 320\ \text{Hz}$

Train approaching: $f' = f\left(\frac{v + v_o}{v - v_s}\right) = (320)\left(\frac{343+0}{343-40}\right) = 362.2\ \text{Hz}$

after passed: $f' = f\left(\frac{v - v_o}{v + v_s}\right) = (320)\left(\frac{343-0}{343+40}\right) = 286.6\ \text{Hz}$

change = $\boxed{75.6\ \text{Hz}}$

E.

$100\ \text{dB} = 10 \log\left(\frac{I}{10^{-12}}\right)$

$10 = \log\left(\frac{I}{10^{-12}}\right)$

$10^{10} = \frac{I}{10^{-12}}$

$10^{-2}\ \text{W/m}^2 = I$ at $r = ?\ \text{m}$.

$120\ \text{dB} = 10 \log\left(\frac{I}{10^{-12}}\right)$

$12 = \log\left(\frac{I}{10^{-12}}\right)$

$10^{12} = \frac{I}{10^{-12}}$

$1\ \text{W/m}^2 = I$ at $r = 3\ \text{m}$

$$\frac{I_1}{I_2} = \frac{r_2^2}{r_1^2}$$

$$\frac{1\ \text{W/m}^2}{10^{-2}\ \text{W/m}^2} = \frac{r_2^2}{(3\ \text{m})^2}$$

$9 \times 10^2 = r_2^2$

$\boxed{30\ \text{m}} = r_2$ ANS.

F. I_{100} = intensity from 100 people

I_5 = intensity from 5 people = $\frac{5}{100}\ I_{100}$ = .05 I_{100}

$$\beta_{dB} = 10 \log\left(\frac{I_5}{10^{-12}}\right)$$

$$\beta = 10 \log\left(\frac{.05\, I_{100}}{10^{-12}}\right)$$

You could calculate that 80 dB corresponds to $1\text{X}10^{-4}$ W/m^2 and stick that in for I_{100}. It seems easier to me to just do this:

$$\beta = 10 \log(.05) + 10 \log\left(\frac{I_{100}}{10^{-12}}\right)$$

Punch up first term; notice second is the original sound level. → = - 13.0 + 80

= **67.0 dB**