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Phy 2302
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Hw for 9/20/17

Q7B.7, Q7M.3

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Q7B.7

Consider the sinusoidal ~~traveling~~ travelling wave shown in the figure circled on the page attached to this problem set.
(in black pen)

(This is a snapshot at a certain instant of time) Assume the wave travels at 1.0 m/s

a) What is the wave's amplitude?
The amplitude of a sinusoidal wave is the maximum disturbance of the medium from equilibrium. From the diagram we can clearly see that the amplitude is $\boxed{2\,mm}$

b) What is the wave number K?
The wavenumber is $K = \frac{2\pi}{\lambda}$, where λ is the wavelength of the wave. From the diagram we can see that $\lambda = x_2 - x_1 = 17.5cm - 3.5cm$
$\lambda = 14\,cm$. So $\boxed{K = \frac{2\pi}{14cm} = 0.45 \frac{rad}{cm}}$

c) What is the angular frequency ω?
The angular frequency of a wave is described by
$\omega = K|\vec{v}|$, where $|\vec{v}|$ is the phase speed. In this instance, $|\vec{v}| = 1.0\,m/s$,
so $\omega = \frac{2\pi\ rad}{14\ cm} \cdot \frac{100cm}{m} \cdot 1.0 m/s = \boxed{44.9\ rad/s}$

d) What is the period T?
The period of a wave is described by $T = \frac{\lambda}{|\vec{v}|} = \frac{2\pi}{\omega}$
So $T = \frac{14cm \cdot \frac{1m}{100cm}}{1.0m/s} = \boxed{0.14s}$

e) What is its frequency f?
$f = \frac{1}{T}$, so $f = \frac{1}{0.14s} = \boxed{7.1\,Hz}$

Q7M.3

A typical earthquake produces two types of seismic waves. P ("Primary") seismic waves are longitudinal waves that move through the earth's upper crust at about 3 km/s to 5 km/s. S ("Secondary") waves are transverse waves that move about 60% slower. An observer with a seismograph can distinguish between these two types of waves. If an observer receives the P waves from an earthquake about 12s before the S waves, roughly how far is the observer from the epicenter?

It takes some time t_0 for the P wave to reach the observer a distance d from the epicenter. This is expressed by $t_0 = \frac{d}{|\vec{v}_p|}$ where $|\vec{v}_p|$ is the speed of the P wave

12s later, the S wave reaches the observer, so we can say that $t_0 + 12 = \frac{d}{|\vec{v}_s|}$, where $|\vec{v}_s|$ is the speed of the S wave

So $t_0 = \frac{d}{|\vec{v}_s|} - 12s$. Substituting this into the first equation:

$\frac{d}{|\vec{v}_s|} - 12s = \frac{d}{|\vec{v}_p|} \Rightarrow d\left(\frac{1}{|\vec{v}_s|} - \frac{1}{|\vec{v}_p|}\right) = 12s \Rightarrow d = \frac{12s}{\left(\frac{1}{|\vec{v}_s|} - \frac{1}{|\vec{v}_p|}\right)} = \frac{12s\,|\vec{v}_s|\,|\vec{v}_p|}{|\vec{v}_p| - |\vec{v}_s|}$

But $|\vec{v}_s| = 0.4\,|\vec{v}_p|$ So we get $d = \frac{0.4 \cdot 12s \cdot |\vec{v}_p|^2}{|\vec{v}_p|\,0.6} = 8s\,|\vec{v}_p|$

So $d = 8\,|\vec{v}_p|$

$|\vec{v}_p|$ can be about 3 km/s to 5 km/s, so $d_{3\,km/s} = 8s \cdot 3\,km/s = 24\,km$

$d_{5\,km/s} = 8s \cdot 5\,km/s = 40\,km$

So the observer is between 24 km and 40 km from the epicenter of the earthquake

Eval of answers

Q1B.7
Answers are given in the correct units, magnitudes seem Reasonable.

Q1M.3

My answer has the correct units and seems to be of a reasonable magnitude.

TWO-MINUTE PROBLEMS

Q1T.1 As one approaches the bottom of a body of water, the circles shown in figure Q1.3 for water waves moving along the water's surface become increasingly [illegible] flattened ellipses. This means that the waves near the body's bottom are more (A) transverse or (B) longitudinal than those near the surface?

Q1T.2 Imagine a series of mutually repelling ring magnets strung along a nearly frictionless horizontal rigid rod. If one jostles a magnet near one end of the rod, it can cause a wave of disturbance to move down the rod [illegible] other magnets. Will this be a (A) transverse or (B) longitudinal wave?

Q1T.3 As a sinusoidal wave's wavenumber increases, the wave's wavelength (in a non-dispersive medium)
A. Increases.
B. Decreases.
C. Does not change.

Q1T.4 A sinusoidal wave's angular frequency is (A) larger, (B) smaller, or (C) the same as its frequency in cycles/s.

Q1T.5 Equation Q1.11 implies that a sinusoidal wave's phase speed depends on its wavelength. T or F?

Q1T.6 Consider [illegible] and c are constants [illegible] is this a *traveling* wave [illegible] so, in what direction does it travel?
A. In the +x direction.
B. In the −x direction.
C. The wave does not move.
D. In the y or z direction because the wave is transverse.

Q1T.7 In a specific non-dispersive medium [illegible] is proportional [illegible] T or F?

Q1T.8 In a specific non-dispersive medium [illegible] wave's period is proportional to its wavelength. T or F?

Q1T.9 If one sound is 20 dB louder than another sound, its intensity is
A. 2 times greater.
B. 20 times greater.
C. 100 times greater.
D. 200 times greater.
E. We need to know the actual sound level: 30 dB to 50 dB represents a different factor of intensity increase than 60 dB to 80 dB (for example).

HOMEWORK PROBLEMS

Basic Skills

Q1B.1 Sound waves move through air at a speed of about 343 m/s. Compute the wavelength of the following [illegible]
(a) [illegible]
(b) [illegible]
(c) [illegible]

Q1B.2 Electromagnetic waves move at the speed of light ($c = 3.0 \times 10^8$ m/s). What are the approximate wavelengths of [illegible]
(a) [illegible]
(b) radio waves on [illegible]
(c) EM waves in a microwave oven [illegible]

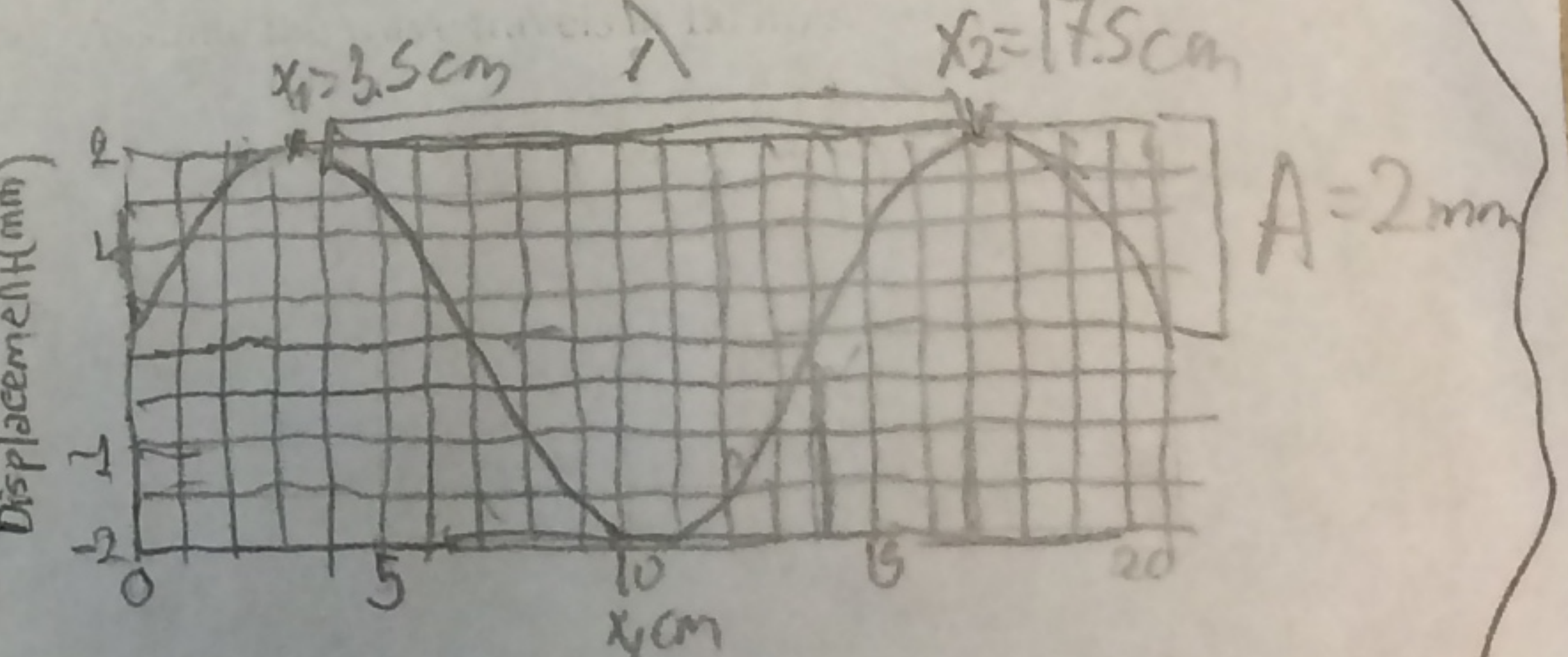
Q1B.3 Sound waves move through air at a speed of about 343 m/s. What would be the frequency of a sound wave that has a wavelength of 1 m? 1 inch? 1 mm?

Q1B.4 Visible light has wavelengths between 700 nm and about 400 nm. If light really is an electromagnetic wave, then what are the corresponding frequencies of these waves?

Q1B.5 A sinusoidal traveling water wave has an observed wavelength of 25 cm and a frequency of 0.60 Hz. What are k and ω for this wave? What is this wave's phase speed?

Q1B.6 A sinusoidal wave moving [illegible] has an observed wavelength of 2.0 m and a period of [illegible]. What are k and ω for this wave? What is this wave's phase speed?

Q1B.7 [illegible]



(a) What is the wave's amplitude?
(b) What is its wavenumber k?
(c) [illegible]
(d) What is its period T?
(e) What [illegible]

Printer was messed up, had to redraw.

Q1B.8 Mars is about 1.52 times farther from the sun than the earth is. Ignoring atmospheric effects, the intensity of sunlight falling on Mars's surface should be about what factor smaller than that falling on the earth?