107 Answer Key HW #5- Chapters 8 & 9 assignments

Conceptual: Ch.8: 6, 20, 26, Ch.9: 4, 8
Problems: Ch.8: 8, Ch.9: 2, 4, 8

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1 Chapter 8

1.1 Conceptual Exercises

6.) "The two waves shown in the Figure are moving toward each other along a string. Sketch the string during the interference of the two waves."

We can use the principle of superposition, and just add the displacements of each individual pulse.

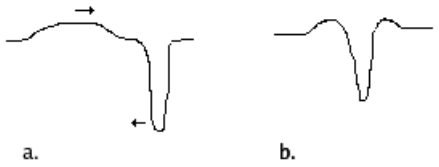

Figure 1: a.) Two wave pulses approaching each other. b.) Wave pulses from a.) interfering.

20.) "When you remove a wool dress from a garment bag, the sides of the bag might tend to stick to the dress. Explain."

The wool and the bag are rubbing together. When objects rub together, they can transfer charge (this is triboelectrics). Wool is particularly good at this. The wool will tend to get one kind of charge, and the bag is left with the other. They are now oppositely charged, so they attract.

26.) "Highway trucks can become electrically charged as they travel. How can this happen? This can be dangerous, especially for gasoline tank trucks. How can it be prevented?"

The charging of the truck is due to triboelectric charging, either with the air or the ground (although, since the tires are not sliding, most of the charging may come from the air). One could prevent the buildup of charge by dragging chains or wires along the ground, or by making the tires out of electrically conducting material, so that the excess charge can flow easily to the ground.

1.2 Problems

8.) "In the preceding question, suppose that Tom speeds up his tapping to 4 Hz. Find the new wavelength (of the water waves), assuming that the wavespeed (2 m/s) is unchanged."

We want to use the equation $(speed) = (wavelength) * (frequency)$; with the values for the frequency and speed above, we obtain $\boxed{wavelength = .5m.}$

2 Chapter 9

2.1 Conceptual Exercises

4.) "A proton is placed, at rest, at some point A within a room that is otherwise devoid of all matter. At some other point B within the room is there an electric field? An electric force? A magnetic field? A magnetic force? Is there energy at point B?"

First, lets remember what can create an electric or magnetic field:

Electric Field: 1) An electric charge, 2) A moving magnet or changing magnetic field

Magnetic Field: 1) A magnet, 2) A moving charge or changing electric field

Is there an Electric Field at B? $\boxed{\text{Yes,}}$ there is an electric field because there's an electric charge nearby.

Is there an Electric Force at B? $\boxed{\text{No,}}$ there is not an electric force at B because there is no object there - an object is needed to feel a force.

Is there a Magnetic Field at B? $\boxed{\text{No,}}$ there is neither a magnet nearby or a changing electric field/current (the proton is at rest).

Is there a Magnetic Force at B? $\boxed{\text{No,}}$ there cannot be a magnetic force if there is no magnetic field (or if there is nothing to feel it).

Is there Energy at B? Yes, electric and magnetic fields carry energy (that's what's carrying the energy that makes sunlight feel warm), and we do have an electric field.

8.) "Which travels faster, light or radio waves? Which has a longer wavelength? Which has a higher frequency?"

Light and Radio waves are both different forms of Electromagnetic waves, and all electromagnetic waves travel at the same speed. Looking at Figure 9.7 on page 234, we see that Radio waves have a longer wavelength than Light, and Light waves have a higher frequency than Radio waves.

2.2 Problems

2.) "A radar transmitter pointed at the moon receives a reflection 3 seconds after the signal is sent. How far is it to the moon?"

RADAR technology uses radio waves, which travel at the speed of light, $3*10^8 m/s$. We are told it takes 3 seconds for a signal to go to the moon and back, so it takes the RADAR pulse only 1.5 seconds to go to the moon. The distance traveled is the speed times the time, so $dist = (speed) * (time) = 3 * 10^8 m/s * 1.5s = 4.5 * 10^8\ m = 450,000\ km.$

4.) "What is the time delay for a television signal that is sent via satellite? Communications satellites orbit above the equator in circles of radius 36,000 km (6 times larger than the Earth's radius!). To simplify the problem, assume that the signal goes straight up and straight down."

Television signals are also sent using electromagnetic waves, so the speed of the signal is $3*10^8\ m/s = 3*10^5\ km/s$. The distance up to the satellite is the radius of the circular orbit of the satellite minus the radius of the Earth (since the signal is sent and received on the surface of the Earth); thus the distance is $36,000\ km - 6000\ km = 30,000\ km$. The signal travels twice this distance, once going up and once going down, so the total distance traveled is $60,000\ km$. Using $dist = (speed) * (time)$ we find a delay time of $.2\ sec.$

8.) "Find the wavelength of blue-green light having a frequency of $6*10^{14}$ Hz. How does this wavelength compare with the size of an atom, which is about 10^{-10} m?"

We will use $(speed) = (wavelength) * (frequency)$ with the speed of light $= 3 * 10^8\ m/s$; remembering that the units of Hertz are $[Hz] = \frac{1}{sec}$, we have

$$wavelength = \frac{3 * 10^8\ m/s}{6 * 10^{14}\ Hz} = .5 * 10^{8-14}\ m = 5 * 10^{-7}\ m. \qquad (1)$$

A wavelength of $\boxed{5 * 10^{-7}\ m}$ is about $\boxed{5000 \text{ times larger}}$ than the size of an atom.