CHAPTER 20 (Knight, 2nd edition)

(SCROLL DOWN FOR BOOK-RELATED PRE-READING)

COMPUTER SIMULATION:

THIS WEEK: Using a PhET simulation to answer questions (its just like playing a game!) and 2 more pages on waves; you have already completed most of the reading for waves, but I would like you to review 20.1-20.3 as well and think about a few questions (to target your reading).

PhET simulation:
http://phet.colorado.edu/en/simulation/wave-on-a-string OR Google: "PHYSICS PhET simulations " and scroll down to the 'wave on a string' app. It is FREE (and safe) to download and should easily run on all computers.
PLAY with the different settings and make observations.

<u>PhET related questions:</u>
Q1. PhET waves.
In the PhET: in the lower-right corner click on 'No End'. What happens?
1. The wave pulse turns a different color.
2. The wave pulse inverts itself.
3. **The wave pulse now escapes out a window.**
4. The wave pulse now reflects off a wall.

Feedback: Using an 'No End' allows us to look at the wave properties more carefully. We will later discuss the reflections that occur with fixed and and open ends.

Q2. PhET waves.
Looking at the PhET, do the following:
1) click on 'No End' in the bottom right corner.
2) click on 'Oscillate' in the bottom left corner.
3) set the damping to ZERO in the top bar.

When you INCREASE the amplitude (and allow for the string to stabilize) what happens to the frequency?
1. frequency increases.
2. **frequency stays the same.**
3. frequency decreases.

Q3. PhET waves.
Set the PhET simulation to oscillate at a frequency to “17”. (This is not 17Hz.) Select the timer.

How long does it take for one sphere to complete one full up/down cycle? (chose closest answer)
1. 5.4 ± 0.15 s
2. **1.6 ± 0.15 s**
3. 0.6 ± 0.15 s
4. 3.2 ± 0.15 s

Q4. PhET waves.
If you increase the amplitude, how does that effect the speed of the (individual) spheres in the string?

1. The speed of the spheres decreases.
2. **The speed of the spheres increases.**
3. The speed of the spheres does not change.

Feedback: The particle speed is determined by x/t. So if the frequency remains CONSTANT, then so does t. However, when you increase the amplitude, you increase x --> so you increase the speed of the particle.

Q5. PhET waves.
In the PhET simulation: (damping should still be at ZERO).
If you decrease the tension, how does that affect the wave speed (or propagation speed)?

1. the wave speed will increase
2. the wave speed will stay the same since neither the mass nor the length changed.
3. **the wave speed will decrease.**

Feedback: The tension changes the 'restoring force' that pulls the spheres back. So the wave travels slower. Also look at equation 20.1.

20.1 The Wave Model. Try to understand what a wave is. What is actually moving in a travelling wave? Important concept: wave speed.

20.1 Q1. Two children are playing with a string that is fixed at one end. By moving their hand up and down they can generate a wave pulse. They want to take a picture of it, but it's too fast. How can they make the pulse move slower?
(choose ALL that apply)

1. **They could loosen the string tension.**
2. They could move their hand up and down slower.
3. **They could use a heavier string.**
4. They could use a lighter string.
5. They could tighten the string tension.
6. They could move their hands up and down a larger distance as they generate the pulse.

Feedback: review p. 604 'wave speed'. Looking at equation 20.1, there are two clear variables that can change wave speed along a string. Remember: wave speed is a PROPERTY of the medium.

20.1 Q2. Increasing the amplitude of a traveling wave with a period T will
1. increase the speed of the wave moving through the medium.
2. **increase the speed of the individual particle in the medium.**
3. not have an effect on either the wave speed or the particle speed.
4. change T, but how it changes will depend on the shape of the wave.
5. will decrease the period T.
6. will increase the period T.

20.2 One-Dimensional Waves. This section shows how waves can be represented graphically: as a history graph and a snapshot graph. Look at the horizontal axis in both graphs: a snapshot graph "freezes" a wave in time and shows the wave pattern (x-axis). The history graph shows what happens at a particular location while a travelling wave moves through this location (t-axis).

20.2 Q1**. Which statement best describes a snapshot and a history graph?

1. A snapshot graph gives you information about how a wave pulse looks in space AND time, while a history graph gives you information about how a particular point in the medium varies in time.
2. A snapshot graph gives you information about how a wave pulse looks in space, while a history graph gives you information about how a particular point in the medium varies in time AND space.
3. A snapshot graph gives you information about how a wave pulse looks in space, while a history graph gives you information about how a particular point in the medium varies in time.
Feedback: review p. 605-606. A snapshot graph gives you information about how things look through ALL of SPACE. Since a wave carries information of both position and time, you need a second graph -- the history graph -- to tell you how things look at ALL TIMES.

*** I think I would change this question to read: Fill in the blanks in the statement below.*
A snapshot graph gives you information about how a wave pulse looks in _________, while a history graph gives you information about how a particular point in the medium varies in _______.
1. space and time; time
2. space; space and time
3. space; time
4. time; space
(5. time; space and time)

20.2 Q3. How are the snapshot graph (top) and the history graph in figures 20.4 and 20.5, respectively, related to each other?

1. The graphs look the same.
2. The graphs have no relationship.
3. The graphs look like mirror-images.
Feedback: review Fig. 20.4. Try to picture a buoy fastened to an anchor with a wave passing under it. The buoy lifts up and is dropped (change in y-position) as it stays in one fixed (x-)position. Graphing it's movement in y vs. time (history graph) will be a different graph than a graph of the wave

(itself) moving along in x-position vs. time (snapshot graph).
20.2 Q4. What feature is NOT defined for a wave pulse?

1. a wave shape
2. **period**
3. a defined source
4. wave speed
5. the position of a particle at a certain time

20.3 Sinusodial Waves (but SKIP subsection 'Wave Motion on a String' p. 612 - 613). Think about what it means to have TWO VARIABLES, position (x) and time (t), in the wave equation. Look carefully at equation 20.6. What does it mean that v is a 'property of the medium'? To understand this, look at equation 20.1 for determining wave speed. Include example 20.4 in your reading. (Make sure you distinguish the wave number, k, from the spring constant, k!)

20.3 Q1. In the equation for a traveling wave, the constant k is related to

1. the speed of the wave
2. the elasticity of the medium
3. **how often the wave pattern repeats per meter**
4. the spring constant of the wave

Feedback: review p. 610 - 611 & Eq. 20.11. The wave number is related to how many full wave patterns (λ) fit in a 2-pi cycle.

20.4 Waves in Two and Three Dimensions. Think of an example of a circular wave front. Try to explain the phase difference for a wave and compare it to the phase constant/shift for harmonic oscillators.

20.4 Q1. The distance between the crests of a history graph gives the .... while the distance between the crests of a snapshot graph gives the ... (hint: look at Fig. 20.11).

1. wavelength, frequency
2. wavelength, amplitude
3. particle velocity, wavelength
4. **period, wavelength**
5. frequency, wavelength

Feedback: looking at Fig. 20.11(a), the history graph shows the movement over time, or the period [s] from crest to crest.
looking at Fig. 20.11(b), the snapshot graph takes a shot at an instance of the entire wave [m] -- so the distance between crests is one full wavelength.

20.4 Q2. Wave fronts represent the crests of the waves. What is the phase difference between two adjacent wave fronts?

1. π/2
2. π
3. **2π**
4. 0
5. Not possible to answer without knowing the wavelength.

Feedback: review p. 615. The difference between two crests corresponds to the distance between ONE wavelength --> which is always 2π.

20.4 Q3. Consider a wave on a long wire with a wavelength of 10 m. What is the phase difference between two points that are a distance 2.5 m apart?

1. 2 pi radians
2. pi radians
3. **pi/2 radians**
4. pi/4 radians
5. other

20.4 Q4. A wave front diagram shows

1. the wavelengths of a wave.
2. **the crests of a wave.**
3. how the wave looks as it moves toward you.
4. the forces acting on a string that's under tension.
5. Wave front diagrams were not discussed in this chapter.

20.5 Sound and Light, subsection Sound Waves (only p. 616-617). Briefly read the section on sound waves and look at Example 20.6. Skip the paragraph on electromagnetic waves and the index of refraction. We will do this later.
(For a later reading: → **20.5 Sound and Light** - Read the portion on electromagnetic waves and concentrate on the index of refraction(p. 619-620; or in the 1st ed. p631-632). Which properties of light are different in window glass and in air?)

20.5, subsection The Index of Refraction (p.618-619). We have already discussed this in class, but make sure you understand the change to properties of a light wave inside a medium. These formulas are not difficult, but be sure you understand where they come from.

NEED A QUESTION! For SOUND WAVES subsection: Maybe something about speed of sound (Table 20.1) and/or definitions of compression & rarefactions.

20.5 Q1. A light wave passes through window glass. What happens to the wave inside the glass?

1. Nothing happens. Glass is transparent.
2. The frequency and the wave speed change.
3. **The wavelength and the wave speed change.**
4. Only the frequency changes.
5. Only the wavelength changes.

20.5 subsection Q1. Looking at the Figure in the Stop to Think 20.5, rank in order, from largest to smallest, the speed of the wave inside the material.

1. v_b > v_c > v_a
2. v_c > v_a > v_b
3. **v_b > v_a > v_c**
4. v_a > v_c > v_b
5. v_a > v_b > v_c

Feedback: review p. 618-619. The higher the index of refraction, the SLOWER the light moves. If v goes down, then wavelength goes down (frequency is CONSTANT), so a shorter wavelength corresponds to a slower speed.

20.6 Power, Intensity, and Decibels. Please read this section carefully. It is important that you know the definitions and units of power and intensity. Make sure that you are able to follow example 20.9 and 20.10. Is the decibel a intensity level or a true intensity?
I STRONGLY urge you to look at Appendix A and briefly review logarithms.

20.6 Q1. A 10 Watts point source emits sound waves radially in all directions. Which statement about the intensity of the sound wave is correct?

1. The intensity is proportional to r.
2. The intensity is proportional to r^2 .
3. The intensity does not depend on the distance "r" from the source.
4. The intensity is proportional to 1/(r) .
5. **The intensity is proportional to 1/(r^2).**

*Feedback: review p. 620-621. The 10 W is the emitted power from the source. Looking at equation 20.31, we clearly see that the intensity = power/area. As area is pi*r^2, I must be proportional to 1/r^2 (equation 20.32).*

20.6 Q2. Two trumpet players are playing the same note. If one of them suddenly stops, the sound intensity level decreases by
(hint: use equation 20.35)

1. 1 dB
2. 2 dB
3. **3 dB**
4. 5 dB
5. 10 dB

Feedback: review p. 622. The initial intensity (Io) would be 2 trumpets, and the intensity when one stops playing is (1/2 Io). So we can set up the ratio (I/Io) as (2/1) in equation 20.35.

20.6 Q3. Which statements about traveling waves are TRUE?
chose ALL that apply.

1. **A traveling wave transfers energy from one point to another.**
2. **A speaker that beams its sound forward into a small area produces a louder sound.**
3. The rate at which a wave transfers energy is defined as the power, with units J.
4. At an intensity level of 0 dB there is NO sound.
5. **The rate at which a wave transfers energy is defined as the power, with units J/s.**

Feedback: review sec. 20.6

20.7 The Doppler Effect. Please read this section carefully. Figure 20.26 has a lot of critical information -- review it thoroughly. Make sure you understand example 20.11. Do the calculation for the moving observer using equations 20.40.
Try to think about situations of the Doppler Effect that you have experienced: does the pitch of a race car sound higher or lower when it is approaching you?

20.7 Q1. Looking at the figure in the 'Stop and Think 20.7', Amy and Zack are both listening to the source of sound waves that is moving to the right. Compare the frequencies that each one hears.

1. fAmy > fZack
2. fAmy = fZack
3. fAmy < fZack
Feedback: review sec 20.7. As Zack moves towards the source, he will be 'hit' by the wave more frequently, so his frequency will be higher.

20.7 Q2. Looking at Fig 20.26, rank the frequencies of the source (f_source), and that Pablo (f_Pablo) and Nancy (f_Nancy) detect.

1. f_Pablo > f_source > f_Nancy
2. f_Pablo < f_source = f_Nancy
3. f_Pablo = f_source > f_Nancy
4. f_Pablo < f_source < f_Nancy
5. f_Pablo > f_source = f_Nancy
6. f_Pablo = f_source < f_Nancy
Feedback: The frequency of the source ALWAYS remains constant. Since the source moves towards Nancy she will be 'hit' by the wave more frequently, so her frequency will be higher than f_source. Conversely, as the source moves away from Pablo, he will receive a wave less frequently (as the wave crest travels a larger and larger distance), so his frequency is lower than f_source.
