Optics and Waves (week 5)

Here are a few questions selected from Young and Freedman. None of them requires lengthy calculations, but going through these questions will help to improve your understanding of the basic concepts of waves.

1. Two waves travel on the same string. Is it possible for them to have (a) different frequencies; (b) different wavelengths; (c) different speeds; (d) different amplitudes; (e) the same frequency but different wavelength?
2. The amplitude of a wave decreases gradually as the wave travels down a long, stretched string. What happens to the energy of the wave when this happens?
3. For transverse wave on a string, is the wave speed the same as the speed of any part of the oscillating string?
4. A long rope with mass m is suspended from the ceiling and hangs vertically. A wave pulse is produced at the lower end and the pulse travels up the rope. Does the speed of the wave pulse change as it moves up, and if so, does it increase or decrease?
5. In a transverse wave on a string, the motion of the string is perpendicular to the length of the string. How, then, is it possible for energy to move along the length of the string?
6. A fisherman notices that his boat is moving up and down periodically, owing to waves on the surface of the water. It takes 2.5 s for the boat to travel from its highest point to its lowest, a total distance of 0.62 m. the fisherman sees that the wave crests are spaced 6. 0 m apart. (a) How fast is the wave travelling? (b) What is the amplitude of the wave?
7. A sound source and a listener are both at rest on the earth, but a strong wind is blowing from the source towards the listener. Is there a Doppler effect? If the listener runs towards the source with speed 25 m/s and the source emits a sound with frequency 600 Hz, what frequency does the listener hear? Sound velocity in air 340 m/s and wind speed is 30 m/s.
8. Sound is detected when a sound wave causes the eardrum to vibrate. The eardrum for human being is about 8.4 mm in diameter. How much energy is delivered to the eardrum when a 20 dB sound is heard?

9. A turntable 1.50 m in diameter rotates at 75 rpm. Two speakers, each giving off sound of wavelength 31.3 cm, are attached to the rim of the table at opposite ends of a diameter. A listener stands in front of the turntable. What is the greatest beat frequency the listener will receive from this system?
10. A women stands at rest in front of a large, smooth wall. She holds a vibrating tuning fork of frequency f_0 directly in front of her (between her and the wall). (a) The women now runs toward the wall with speed v_w. She detects beats due to the interference between the sound waves reaching her directly from the fork and those reaching her after being reflected from the wall. How many beats per second will she detect?
11. Two loudspeakers, A and B, are driven by the same amplifier and emit sinusoidal waves in phase. Speaker B is 12.0 m to the right of speaker A. The frequency of the waves is 688 Hz. You are standing between the speakers, along the line connecting them, and are at a point of constructive interference. How far must you walk towards speaker B to move to a destructive interference? Speed of sound is 344 m/s.