SOLUTIONS TO QUESTIONS IN CHAP 21 OF THE TEXT

Q4 The speed of light (in a vacuum) does not depend on the temperature because there is no meaning to temperature of a vacuum. A vacuum is just nothing there. You can’t add energy to a vacuum. By the way, however, the speed of light IN A MEDIUM (like in glass) DOES depend (very slightly) on temperature.

Q7 The sound has to travel over and back, i.e. a distance $2d$, where $d$ is the distance from you to the cliff. If $t$ is the time for the echo to return, then $2d = ct$, or $d = ct/2$, where $c$ is the speed of sound. Clearly this phenomenon is also useful in radar detection of submarines, in radar detection of aircraft, and a variant of this is useful in motion detectors (like those which turn on the classroom light when a person’s motion is detected.)

Q8 The electric discharge causes an emission of light (lightning) and of sound (thunder) at the point of creation. Since light travels much faster than sound, you see the result first (almost instantaneously because the speed of light 186,000 miles PER SECOND is so great). The sound travels about 1000 ft/sec or one miles in 5 seconds.

Q11 The energy comes from the stone hitting the water. As far as the water is concerned, the stone is the only external source of energy. The ripples can not create more energy. We know that the energy is proportional to the square of the amplitude, $A^2$. The amount of water that is oscillating as the ripple goes out is proportional to the circumference which in turn is proportional to the radius. Therefore you might think that $2\pi r A^2$ would be constant. This means $A$ would have to decrease as $r$ increases.

Q12 The speed of sound does not depend on the frequency. So using $c = f\lambda$, we see that as $f$ decreases, $\lambda$ increases. This means that to create a low pitch wave we need a larger device than to create a high pitch wave. Note this also in comparing a violin to a double bass or a piccolo to a flute.

Q13 The frequency does not change. This follows from the idea that cause and effect are related. It takes a certain length of time for the cause to create the effect. (You can’t say that its takes the same distance to connect cause and effect if the distances are inequivalent, i.e. if they pertain to different media. Note that one interval of time IS equivalent to another interval of time.) So on going from air into water (or vice versa) the frequency stays the same. The wavelength can increase (or decrease) in which case (using $c = f\lambda$) we see that the speed of propagation will increase (or decrease) correspondingly.

Q14 The wave is described by the amplitude, the wavelength, and the period, as you see in Eq. (21-11). The period $T = 1/f$ is the only parameter that affects the pitch.