1. D We know that the frequency equals the wave speed divided by the wavelength:

$$f = \frac{v}{\lambda}$$

So the period, which is the reciprocal of the frequency, must be equal to the wavelength divided by the wave speed. For those who want to get these right just by thinking about it (the best way): the wavelength equals the distance the wave moves in one cycle. How far you go divided by how fast you're going equals how long it takes you.

2. D The frequency of a wave is how many crests will pass in a second. The wavelength is the distance travelled by the wave in one cycle. The wave number is the amount of angular progress involved in one meter of horizontal displacement. None of these has a direct, generally applicable relationship to the amplitude, the maximum vertical displacement of a wave.

3. A The speed of sound in air is 331 m/s. Dividing this number, how many meters the wave travels in a second, by the frequency (660 Hz), how many cycles the wave undergoes in a second, will give you the wavelength, how many meters there are in a cycle.

$$\lambda = \frac{v}{f}$$

4. C

5. B Only transverse waves can be polarized.

6. B Transverse waves can only travel through solids, not through liquids and gases. Transverse waves occur when one section of a body moves sideways with respect to another and then reverses that motion. Liquids and gases don't transmit transverse waves for the same reason that they don't have a shear modulus. The cohesive intermolecular forces in liquids and gases are not great enough. It should be noted that gravity supplies the necessary restoring force for the partly transverse waves across the surface of water.

7. C The wave speed of a stretched string is proportional to the square root of the tension and inversely proportional to the square root of the mass per unit length:

$$v = \sqrt{\frac{F}{\mu}}$$

The frequencies of the normal modes in a standing wave on a stretched string are directly proportional to the wave speed:

$$f_n = \frac{v}{\lambda_n} = \frac{n}{2L}v \quad (n = 1,2,3,\ldots)$$

Increasing the tension 9 times will increase the wave speed (and thus the fundamental frequency) 3 times.

8. C The speed of sound is proportional to the square root of the bulk modulus of the medium and inversely proportional to the square root of the density:

$$v = \sqrt{\frac{B}{\rho}}$$

The much greater density of water will only act to slow the waves down. It is the fact that the bulk modulus of water is much much greater than the bulk modulus of air that serves as the best explanation.

9. A In the more dense cool air, the speed of sound will be a little slower. Think about walking down the road. When a friend grabs your right arm you involuntarily veer rightwards. Thus the sound waves veer into the more dense media which holds back the motion on that side of the column of disturbance. The same explanation is a valid way to understand the refraction of light.

10. A The wavelength of the first harmonic in a pipe with one closed end is four times the length of a pipe (the nearest antinode to a node is 1/4 of a wavelength away). Therefore, the wavelength of the first harmonic in this case is 3 m. Dividing the speed of the wave (the distance the wave travels in one second, v = 331 m/s) by this wavelength (the distance the wave travels in one cycle) will tell you how many cycles the wave will progress through in one second, the frequency.

$$f = \frac{v}{\lambda}$$

11. D The formula to determine the decibel level is as follows:

$$\beta = 10 \log \left(\frac{I}{I_0}\right)$$

If I_1 is the original intensity with one stack. With two stacks the intensity will be $2I_1$. So the decibel level of sound intensity will be:

$$\beta_2 = 10 \log \left(\frac{2I_1}{I_0}\right) = 10\left[\log \left(\frac{I_1}{I_0}\right) + \log 2\right]$$

You need to be able to estimate your base ten logarithms for the MCAT. Ask yourself: What power of ten produces the number two? Well, for a start, the cube root of eight, a number pretty close to ten, is two ($8^{0.333} = 2$), so it must be a little less than the one-third power of ten, which is a little greater than eight, that will give you two, about 0.3. So the new decibel level will be given by:

$$\beta_2 = 10 \log \left(\frac{I_1}{I_0}\right) + 3$$

So when you double the intensity of sound, the decibel level always increases by 3.

12. B The transverse waves disappear upon encountering the magma. The energy disippates. See question #6 for an explanation of why transverse waves do not travel through a liquid.

13. B This is a Doppler effect problem. There is no relative motion of source and observer in the sidelong view, so 330 Hz is the source frequency. The apparent frequency when his hand is moving towards the stationary camera is 440 Hz. The formula to relating the apparent frequency to source frequency, observer and source speed is as follows:

$$f' = f\left(\frac{v \pm v_0}{v \mp v_s}\right)$$

In this case we would have:

$$440\ s^{-1} = 330\ s^{-1}\left(\frac{331\frac{m}{s}}{331\frac{m}{s} - v_s}\right)$$

The key to MCAT math is finding the quickest way to reach an approximate solution:

$$\frac{4}{3} = \left(\frac{331\frac{m}{s}}{331\frac{m}{s} - v_s}\right)$$

Looking at the right side of the equation, we need to find a value of v_s to subtract to make our denominator 3/4 of our numerator. This number would be 1/4 of 331, or about 80. You could go on and multiply it out, not so hard, but requiring probably about 30 more valuable seconds.