Please complete the following homework assignment in the space provided. It is due on Thursday, February 3rd at 9:00 am.

1. A block vibrates on the end of a spring. In order to double the period of oscillation the block should be replaced with one which has

   (a) twice the mass.

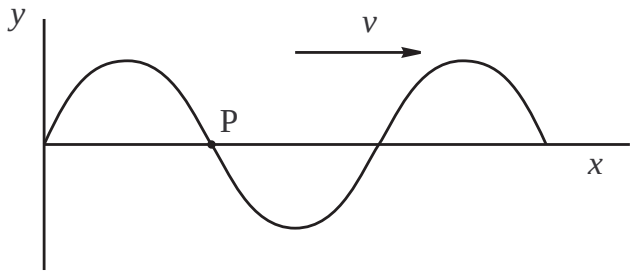
   (b) half the mass.

   (c) quadruple the mass.

   (d) one quarter the mass.

   Answer (c): Period is proportional to the square root of the mass

2. The diagram below shows a wave at a particular moment in time as it travels to the right along a rope in the direction shown. Which one of the following statements is true about the point P on the rope?



   (a) It is moving upwards.

   (b) It is moving downwards.

   (c) It is moving to the right.

   (d) It is momentarily at rest.

   Answer (a): Although it is at equilibrium displacement it is moving upwards at maximum speed

3. A clock maker wants to design a clock which keeps time from a 1.0 kg mass which vibrates on the end of a spring. What should the spring constant be if the mass is designed to oscillate with a period of 1 second?
   $T = 2\pi\sqrt{m/k} \Rightarrow 1.0 = 2\pi\sqrt{1/k} \Rightarrow \sqrt{k} = 2\pi \Rightarrow k = 4\pi^2 = 39.5$ N/m.

4. A 0.5 kg seagull lands on a 2.0 kg log that floats in the ocean. As a result the equilibrium position of the log sinks by about 1.0 cm further into the water.

   (a) If we interpret this situation as the log and water being like a spring and the seagull, by resting on the log compresses the spring, what is the effective spring constant?
   The force of the seagull pushing down is $w = mg = 0.5 * 9.8 = 4.9$ N. This force causes a displacement of 0.01 m. The spring constant is force per meter so $k = 4.9/0.01 = 490$ N/m.

   (b) If the seagull rocks the log a little the system vibrates at a certain frequency – find the frequency assuming the spring constant above and the total mass oscillating being the seagull and the log.

First we find the period: $T = 2\pi\sqrt{m/k}$ and the total mass m is 2.5 kg. Thus $T = 2\pi\sqrt{2.5/490} = 0.45$ seconds. So the frequency is $1/T = 2.2$ hz.

5. Two Seagulls are observed to be bobbing up and down completely out of phase in the sea. The frequency of their oscillation is 0.4 Hz and the wave speed is 4.0 m/s. What is the shortest possible distance between them?
   Since they are out of phase they are separated by half a wavelength. Since $v = \lambda f$ it follows that $\lambda = v/f = 4/0.4 = 10$ m. So the seagulls are 5 m apart.

6. On a keyboard you strike low C, which is 262 Hz

   (a) What is the period of one vibration at this frequency?
   The period is the reciprocal of the frequency $T = 1/f = 1/262$ Hz $= 0.0382$ seconds.

   (b) What is its wavelength in air? (The speed of sound in air is about 340 m/s.
   The wavelength is given by $\lambda = v/f = 340/262 = 1.30$ metres.

7. The buzz of a bee is the sound made by its wings as they flap 600 times per second. How far does the sound travel in the time it takes its wings to flap once?
   The wave travels one wave length in one complete beat of the wings. Given the speed of sound in air is 340 m/s and the frequency is 600 Hz, we get $\lambda = v/f = 340/600 = 0.57$ metres.

8. A cello has a string 0.75 m and has a 220 Hz fundamental frequency. How fast is the wave speed along the string?
   Here we use the fact that the fundamental frequency is $f = v/2L$, where L is the length of the string. From this equation we see that $v = 2Lf = 2(0.75)(220) = 330$ m/s.