Assignment 7

1. Consider the wave $y = 4 \cos (3z - 6t)$. Units are in meters and seconds. Find the following.
   a) Amplitude
   b) Frequency
   c) Period
   d) Wavelength
   e) Direction
   f) Phase Velocity

2. Consider an organ pipe of length L. The pipe is closed at one end and open at the other allowing a standing wave where a node exists at the closed end and a maximum exists at the open end.
   a) What are the resonant wavelengths?

   b) Sketch the resonant nodes corresponding to the 3 longest wavelengths.

   c) If L = 2 meters, what is the lowest frequency?

3. An orchestra wishes to have a listener in front of the conductor hear notes at the same time, played by the violinist located next to the conductor and from a drummer located 50 meters further back.
   a) Assuming that the drummer plays as soon as he sees the conductor give the command, how long should the violinist wait before playing her note?

   b) Why may one assume that the two players see the conductor command at the same time?

4. A singer sings middle C. She then gulps helium and tries to sing the same note i.e. her vocal chords remain the same. What note will the listener hear?

5. Professor Zoom travels down the 401 in his car whistling middle C. A policeman has a defective radar gun but passed PHYS 1410. He hears the pitch change from D immediately above middle C to A# immediately below middle C as the car passes.
   a) How fast is Professor Zoom traveling?

   b) Should Professor Zoom get a ticket?

6. A tank holding a gas initially at one atmosphere pressure at a temperature of 300 K is heated to 400 K.
   a) What is the increase in pressure?

   b) Assuming the tank is a sphere of radius 10 meters, what force does the gas exert on the walls of the tank?

   c) How does the force calculated in b) compare to the force exerted by the gas on the tank walls before it was heated?

   d) Why is one normally not concerned about the force in c) but only worried about the difference in the answers to b and c.

7. Five moles of gas expand at a constant temperature of 373 K from a volume of 1 cm^3 to a 100 cm^3. Evaluate the work done by the expanding gas on a piston.

8. Professor X wishes to construct a so called atomic beam which means that the atoms can travel the length of a 5 meter vacuum chamber without colliding with gas molecules. What pressure should the chamber be pumped down to?

9. Estimate the average time between collisions for a gas at one atmosphere pressure and at room temperature.

10. For the Maxwell speed distribution find the following.
    a) Find the highest probability occurs at a speed $v_P = (2RT/M)^{1/2}$

    b) Evaluate v_{ave}, v_{rms} and v_P for a gas of N_2 at room temperature.

    c) Suppose the moon had an atmosphere consisting of hydrogen atoms. (Here, we assume the hydrogen atoms don't combine to form hydrogen molecules.) For a temperature T= 300 Kelvins, estimate the fraction of hydrogen atoms having speed greater than the escape velocity.