Sci 170 Homework #3 Due: March 7, 2005

1. [4] What is the meaning of escape speed? Does the escape speed depend on the mass of the object that is escaping? What happens if your speed is a little less than the escape speed?

If an object is moving fast enough then the gravitional pull of the main body will not be strong enough to pull it back. That means it will not orbit the main body but "escape" into space. No, the escape speed for any distance above the main body depends only on the mass of the main body, the distance from the center of the main body and gravity constant. Any object moving at the escape speed for a given altitude is capable of escaping the main body.

Note: Each object has its own escape speed. For example to launch a robot spacecraft to Saturn from the Earth you have to make it exceed the escape speed for the Earth. Even after the spacecraft escapes from the Earth the spacecraft is bound to orbit the Sun.

If your speed is less than the escape speed then you are "bound" to the main body. You will orbit the body in an elliptical orbit.

2. [4] In what regions of the spectrum is the atmosphere transparent enough to allow observations from the ground? How do astronomers overcome this limitation?

Looking at figure 3.9 the atmosphere is very transparent in the **radio** and **visible** light portions of the spectrum. In addition, it is somewhat transparent in the near **infrared**.

Astronomers overcome the opacity of the atmosphere to observe in other wavelengths by putting the instruments above most/all of the atmosphere. This can be done but launching the instruments into earth orbit above the earth's atmosphere. High altitude balloons and aircraft can be used for some experiments too.

3. [4] On the Kelvin temperature scale what is the lowest possible temperature? At what Kelvin temperature does water freeze? Boil? What is normal human body temperature, 98.6°F, in Kelvins. (Hint: you may want to convert to Celsius first then to Kelvin.)

The lowest possible temperature on the Kelvin scale is zero. The kelvin temperature is the celsius temperature plus 273° degrees since zero on the Celsius scale is the freezing point of water. K= °C + 273

Water freezes 273 kelvins (0°C, 32° F)
Water boils 373 kelvins (100°C, 212°F)

It find human body temperature, 98.6 °F, convert it to Celsius and then to kelvins. To convert a temperature to Celsius from F, use

°C = (°F - 32) / 1.8

(98.6 –32)/1.8 = 37 °C

So human body temperature in kelvins is , 273+37 = 310 kelvins.

4. [4] Everything gives off electromagnetic radiation based on its temperature. What is the peak (most intense) wavelength in nanometers given off by the human? What general region of the spectrum is it in?

From the text:

$$wavelength_{peak} = \frac{0.29cm}{T} = \frac{0.29cm}{310K} = 0.00094cm = 0.0000094m$$

The peak wavelength is 9.4x10-6 meters or 9400 nanometers which is in the infrared part of the electromagnetic spectrum.

You could also read the graph on figure 3.11 to estimate 10,000 nanometers, but you needed to say that's how you got the answer.

5. [4] How is the Doppler effect an important tool for astronomers? What can it be used for?

The Doppler effect is the shift in wavelength (or frequency) of a wave because either the source of the wave or the observer are moving. By measuring the wavelength received from the moving object versus a similar source at rest, the speed of the moving object can be determined.

This effect allows the measurement of velocities along the line of site between the source and observer. This allows astronomers to measure the speed of far away objects based on a measurement of the light from those objects. This is an essential tool for gathering information about the stars, nebulae, galaxies etc….