**ASTR 503 Homework 2: Wavelengths and Doppler**

Always use **scientific notation,** always **give units**, and **show your steps!**

1. The International Space Station a while back launched a "suit-sat" satellite, which is an empty

space suit, that broadcasts a message, using radio waves at a frequency of 145.990 MHz.

One Hertz = Hz = one cycle per second.

Calculate to 3 significant digits the wavelength, in meters, of that radio emission. (wavelength = c / f), where c = 3.00 x 105 km/s .

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. What is the frequency (Hz) of a photon whose wavelength is 1 angstrom = 0.1 nm?

(the size of a small atomic nucleus).

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3. What is the energy (J) of the photon in the previous question?

Use E (J) = hf where h = 6.6 E-34 (J-s).
\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

4. A Joule is a huge unit for a single particle (or photon) = one watt of energy flow times one second, or the force of one Newton moving one meter. So the unit is equal to one kg - m\*m/s\*s. Or one Coulomb times a Volt (a current of one Amp flowing through a battery of one Volt for one second). A more convenient unit for the energy of a particle or a photon is an "electron volt" - the energy gained by a particle with a single electric charge falling through an electric potential of one volt. Since the charge of one electron = 1.6 E-19 V, then one electron volt = eV = 1.6 E-19 J.

What would be the energy of that same photon (question 2) in electron volts?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

5. The bright red line of Hydrogen is called H-alpha. We frequently use a filter at that wavelength to see the prominences on the Sun. Its wavelength is 656.28 nm. What is its frequency?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

6. If a prominence is "erupting", it is being blasted off the surface of the sun at speeds of 1500 km/s or more. If that prominence is on the limb on the sun, and is traveling perpendicular to our line of sight at 1500 km/s, what wavelength will we observe the H-alpha?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

7. If the prominence is near the center of the Sun, and is heading towards us at 1500 km/s, what wavelength will we observe the H-alpha? Is that a red shift or blue shift?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

8 (2 pts). The speed of sound in dry air at room temperature is about 770 mph. What is that in meters per second? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

If a train horn is at middle "A" (440 Hz) and is approaching us at 60 mph, what frequency will that horn sound to us? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What frequency if it is receding at that same speed? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 What speed would it need to be approaching us to have its sound exactly one octave higher (doubled in frequency?) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(Note, to really do this correctly you would need the relativistic version of the Doppler effect formula which valid for when the velocities approach c).

 (for a chart of frequencies of musical notes, see  [http://www.phy.mtu.edu/~suits/notefreqs.html](%20http%3A//www.phy.mtu.edu/~suits/notefreqs.html).

Last updated 1/31/2022