

AST 301  
Test #2  
Friday Oct. 15

Name: \_\_\_\_\_

1. The Sun has a surface temperature of about 6000 K. Betelgeuse (a star in the constellation Orion) has a surface temperature of about 3000 K. The Sun is brightest at a wavelength of about 500 nm. (1 nm =  $10^{-9}$  m)

a) At about what wavelength is Betelgeuse brightest?

1000 nm (cut the temperature in half; double the wavelength)

b) How does the energy of a typical photon from Betelgeuse (a photon with the wavelength you gave in part a) compare to the energy of a typical photon from the Sun (at a wavelength of 500 nm)? (Which is larger, and how many times larger?)

A Betelgeuse photon has half the energy. Energy/photon  $\propto$  temperature.

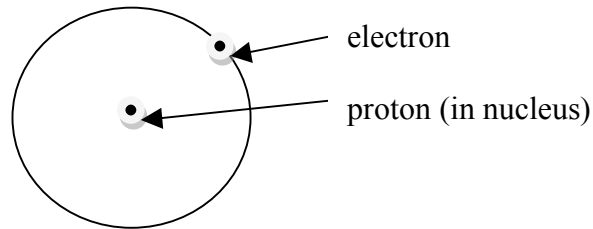
c) Which of these objects (the Sun or Betelgeuse) emits more 1000 nm wavelength photons from each square meter of its surface?

The Sun. Hotter objects emit more light at all wavelengths.

d) Betelgeuse's diameter is about 100 times the diameter of the Sun. How does its surface area compare to that of the Sun? (Which is larger, and how many times larger?)

It is  $100^2 = 10,000$  times larger.

2. a) Make a sketch of a hydrogen atom, labeling the particles in it.

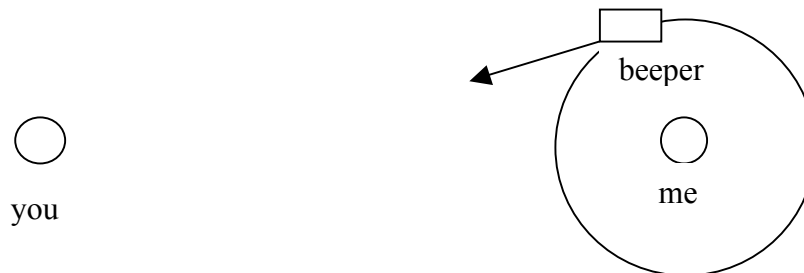


b) Give two ways other atoms differ from hydrogen atoms.

1. They have more protons in their nuclei.
2. They have more electrons.
3. They have neutrons in their nuclei (heavy hydrogen does too).

c) Describe a change that might occur to your hydrogen atom if it absorbed a photon.  
The electron could jump to a bigger orbit. Or it could jump out of the atom entirely.

3. I have a device that beeps (puts out sound waves) with a sound wave frequency of 1 kHz (1000 waves/sec). It is on the end of a string, and I am swinging it around my head in a circle. It is moving at a speed of 30 meters/sec (that's about 70 mph, which is about 1/10 the speed of sound). The path of the beeper, my head, and your head are sketched below.



a) Mark the place on the beeper's path where it is when you hear the highest pitch (or sound frequency).

It's where it's moving toward you (not where it is closest to you).

b) What is the frequency you hear when the beeper is there?

1.1 kHz (if it moves at 1/10 the speed of sound, the frequency changes by 1/10 of the emitted frequency)

c) What frequency do I hear then?

1 kHz (it isn't moving toward or away from me)

4. Give one fact about the solar system that a theory of its origin should explain, and say how the nebular theory of the origin of the solar system explains that fact.  
(there are many correct answers)

The planets all orbit in nearly the same plane and in the same direction.  
The planets formed out of a disk of gas and dust that settled around the young Sun. Since they formed out of a disk, they orbit like the gas and dust in the disk orbited.

The inner planets are made of rocks and metals. The outer planets also have ices and gasses.  
Only rocks and metals were solids near the Sun, so the planetesimals were made of rocks and metals. Out farther, ices could freeze onto the dust grains, so they got included in the planetesimals. In addition, the more massive planetary cores made of rocks, metals, and ices could pull gasses in. This made them even more massive.

There are many asteroids, mostly outside of Mars' orbit, and comet nuclei, mostly outside of Neptune's orbit.  
These are the leftover or broken up planetesimals that formed in these regions of the solar system.

5. a) Why are asteroids which orbit near the Sun hotter than asteroids which orbit farther away from the Sun?

Close to the Sun, the flux of sunlight was greater because the sunlight spreads out as it goes away from the Sun. The heating of an asteroid, which is due to absorption of sunlight, is proportional to the flux of sunlight.

b) Some asteroids have lighter colors (or aren't as black) as other asteroids. How does the color of an asteroid affect its temperature, and why?

The color of an asteroid tells us what sunlight it reflects (they aren't hot enough to glow visibly). Black asteroids absorb all of the sunlight that hits them, so they are heated more than asteroids that reflect some of the sunlight.

6. Why should increasing the amount of CO<sub>2</sub> and other greenhouse gasses cause the temperature of the surface of the Earth to increase?

Greenhouse gasses absorb the infrared light that is emitted by the Earth and return some of it to the Earth, helping to keep the Earth warm. (They don't block or trap visible sunlight. To make the greenhouse effect work, they need to be transparent to visible light so the sunlight can get in.) More greenhouse effect will result in higher temperatures.