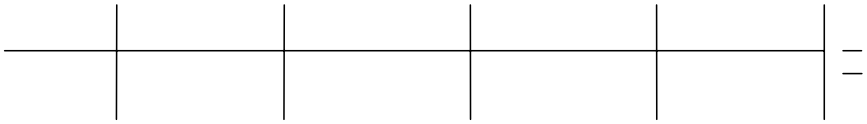
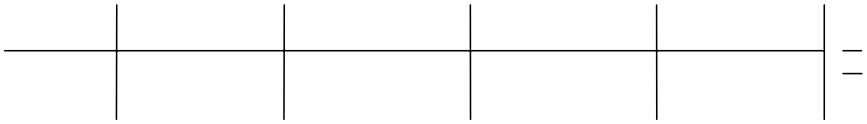
Are U Still Nuts?

That's right… It's time for more unit conversion exercises!

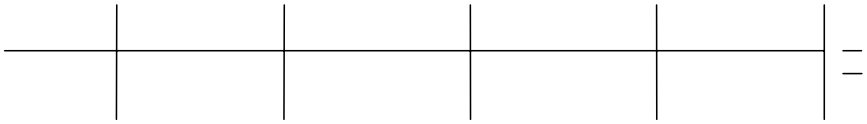
Problem 1: The Solar Constant is the amount of energy that the sun delivers to the surface of Earth each second. If it is measured to be 1350000 ergs/cm^{2} each second, how many watts per square meter is this? (1 watt = 10,000,000 ergs each second).



Problem 2: A supermassive black hole in the center of the quasar 3C273 swallows one star a year, and the heated gases emit 1.3 x 10^{53} ergs of energy. How much energy does 3C273 emit, in watts? (1 year = 31,000,000 seconds).



Problem 3: An astronaut is preparing a meal that includes 50 grams of cocoa mixed with 8 ounces of milk. What is the concentration of the chocolate in kilograms per liter? (128 oz = 1 gallon; and 9 gallons = 34 liters)



Problem 1: The solar constant is an important number if you are trying to build a solar, hot water heater or generate electricity using solar panels. Although astronomers use ergs and centimeter units, solar energy system design uses watts and square-meters for greater convenience.

In 1 second:

$$\frac{1350000 \text{ ergs}}{\text{cm}^2} \times \frac{1 \text{ watt}}{10{,}000{,}000 \text{ ergs}} \times \frac{100 \text{ cm}}{1 \text{ meter}} \times \frac{100 \text{ cm}}{1 \text{ meter}} = \mathbf{1350 \text{ watts/m}^2}$$

Notice how the units cancel, leaving behind the units of watt / (meter x meter) which can be re-written as watts/meter^2. This problem is a bit tricky because 1 watt is equal to 10,000,000 ergs per second, and not just 'ergs'. To avoid confusing students with compound unit conversions which come up all the time in science, the above conversion is for 1 second of time.

Problem 2 :

$$\frac{1.3 \times 10^{53} \text{ ergs}}{1 \text{ year}} \times \frac{1 \text{ year}}{31{,}000{,}000 \text{ sec}} \times \frac{1 \text{ watt}}{10{,}000{,}000 \text{ ergs/s}}$$

The first two rungs of the ladder convert the energy emitted into units of power in terms of ergs/sec. Note that the unit 'year' cancels in the numerator and denominator. The third rung converts the power units from ergs/s to watts. The answer is 4.2 x 10^{38} watts. Note that the sun produces 3.8 x 10^{26} watts, so 3C273 is about 1 trillion times as powerful as a single star.

Problem 3:

$$\frac{50 \text{ grams}}{8 \text{ ounces}} \times \frac{128 \text{ ounces}}{1 \text{ gallon}} \times \frac{9 \text{ gallon}}{34 \text{ liters}} \times \frac{1 \text{ kilogram}}{1000 \text{ grams}}$$

Note that all but the units kilogram/liter cancel out, leaving the answer **0.21 kg/liter.**