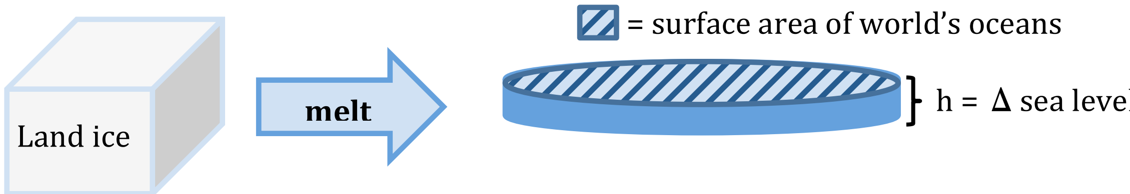
1. You may have heard that glaciers and polar ice sheets are receding. How much would sea level rise if the Antarctic and Greenland ice sheets melted entirely? Here's a diagram to envision what we need to calculate:



Important Formulas and Values (everything you need to succeed!):
Greenland + Antarctic ice sheet volume = 3.27×10^{16} m^3
Density of ice = 917 kg/m^3
Density of water = 1000 kg/m^3
Surface Area of World's Oceans = 3.61×10^{14} m^2
mass (kg) = density (kg/m^3) x volume (m^3)
volume (m^3) = surface area (m^2) x height (m)

a. Starting with the total volume (m^3) of the ice sheets, calculate the mass (kg) of ice.

b. If this whole ice mass melts into liquid water, what is the mass of the water?

c. What is the volume (m^3) of the liquid water?

d. How much does the sea level rise (m)?

2. Suppose a clothed person can be represented as a cylinder 170 cm tall with a radius of 15 cm, with a skin temperature of 30 °C. Assume the person radiates as a blackbody.

a. Calculate the radiative power of the person in Watts.

b. Imagine that this person is standing alone in the middle of a room in which all the walls, ceiling, and floor have a constant temperature of 22 °C.

   Calculate the net rate of energy gain or loss by the person in Watts.

c. Using your answer from part (b), calculate the number of *dietary calories* the person must consumer each day to stay "warm" (alive!). **[HINT: 1 dietary calorie (kcal) = 1000 calories; 1 calorie = 4.186 Joules]**

3. Imagine that NASA's Kepler mission discovers a new exoplanet. The brightness of the star around which the planet orbits is easily measured, and the size of the planet's orbit is determined by the timing of the brightness drops measured when the planet crosses the star in Kepler's telescope.

   Using the measurements described above, assume that the star's radiation at the distance of the planet is 2500 Watts per square meter.

   a. Calculate the radiative equilibrium temperature of the planet assuming that the planet's albedo equal to that of the Earth, Venus, and the Earth's Moon.

   b. Under what conditions might this planet be inhabitable?
      (HINT: consider different atmospheric gases & different values of albedo)

4. Surface temperature at sunset in Fort Collins in May is about 15 °C.

   a. Using this temperature and assuming the surface emits thermal radiation as a blackbody, calculate the rate of radiative cooling of the surface in Watts per square meter.

   b. The volumetric heat capacity soil is about 1.5 x 10^6 J K^{-1} m^{-3}. This means it take 1.5 million Joules of heat to heat or cool a cubic meter of soil by 1 degree Kelvin (same as Centigrade).

      Assuming that the rate of cooling of the surface you found in (a) is the only energy transfer, and that the top 10 cm (0.1 m) of soil cools at night, calculate how many degrees would the soil cool during a 10-hour May night in Fort Collins. Using this value, estimate the surface temperature at sunrise.

   c. In reality, the average morning low temperature in Fort Collins is about 44 °F (7 °C), so there has to be another source of energy besides the one we calculated in part (a). A tiny amount comes from the air and from deep underground, but not even close to enough to keep the surface warm. Where does the extra energy come from?