Problem 1:
(check the table of nuclides at http://ie.lbl.gov/toi/ to obtain the additional information that you need for Problems 1 and 2)

Two techniques are available to measure radionuclides. Mass spectrometry measures atoms and counting techniques measures decay rate (disintegrations)

If mass spectrometry requires 10^8 atoms for precise measurements and counting methods require 0.5 dpm:

A – Which technique would you use to measure (a) ^{210}Pb and (b) ^{231}Pa on the smallest possible sample?

B – How much smaller would the sample size for your technique of choice be, compared to the other one?

C – At what half-life does it become advantageous to use mass spectrometry?

Problem 2:
The relative abundance of uranium isotopes in today's earth crustal material is:
99.2745% ^{238}U
0.7196% ^{235}U
0.0055% ^{234}U

What were the relative abundances when the earth was formed 4.6×10^9 years ago?

Problem 3:
Considered the radiative balance of the earth assuming that the surface and atmospheric properties are uniform over the globe (i.e., do all calculations for a single planetary mean):

a) Compute the steady-state surface temperature of the planet for a no atmosphere case for (Note: for radiation equations, use absolute temperature in K):
F_{in}= solar input = $S_o/4$=342 W m^{-2}
σ= Stefan boltzman constant = 5.7×10^{-8} Wm^{-2}K^{-4}
α= albedo=0.33

b) Assume the atmosphere can be treated as a single layer with a uniform temperature Ta and that it is transparent to solar radiation and absorbs all the planetary radiation emitted by the earth. What is the atmospheric temperature? What is the surface temperature? The sketch below might help you think about the problem. Hint: Consider the net flux into the system and at the earth's surface.
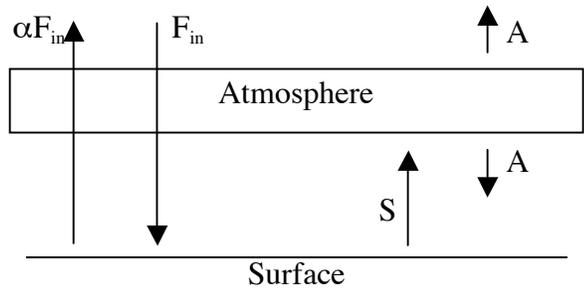
A= energy emitted by atmosphere
S= energy emitted by surface

c) Actually, the atmosphere does not absorb all the radiation emitted by the earth – it only absorbs a fraction ε. If ε = 0.85 and the other constants are the same as in part a, what is the atmospheric temperature? What is the surface temperature? The sketch below might help you. Note: Kirchhoff's law implies that the emissivity of the atmosphere equals its absorptivity. In other words: $A= \varepsilon \sigma T_a^{4}$
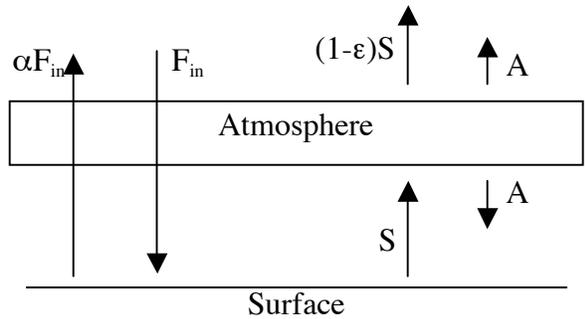
d) Compare the surface temperature calculated in c to the observed surface temperature of the earth. Explain possible reasons for the discrepancy.

Problem 4:
Print out a daily map of atmospheric surface pressure for some large region of the globe (one with enough detail where you can see actual pressure values and some wind vectors). Good examples can be found on the National Center for Environmental Prediction web pages:

NCEP Unified Surface Analysis: http://www.opc.ncep.noaa.gov/UA.shtml

NCEP Ocean Prediction Center: http://www.opc.ncep.noaa.gov/index.shtml

See also http://www.opc.ncep.noaa.gov/product_description/keyterm.shtml for a discussion of weather symbols (e.g., wind vectors).

a) Discuss the main features of the surface map in terms of the geostrophic relationship between surface pressure and surface wind speed and direction.

b) Compare the forecast or analysis map in a) to the measured QuikSCAT satellite wind speeds (daily maps available from http://manati.orbit.nesdis.noaa.gov/quikscat) in terms of time/space data sampling.

c) How does an QuikSCAT instantaneous wind field compare with the climatological fields we discussed in class? Why do they differ? What implications might this have for ocean gas exchange, which depends on wind speed perhaps in a non-linear way?