Intermediate Meteorology
Unit 1
Reading Guide and Questions

Read Chapter 1

1. Meteorologist refers to more than just a weather forecaster. What else is involved according to the authors?

2. What conclusions can you draw from Figure 1.1?

3. Define the word *coherent*. (See page 3 for context.)

4. Answer problem 1.6 – a, b and f.

5. What does Fig 1-6 represent?

6. In equation 1.1, why is dx dependent upon $\cos\theta$?

7. Define zonal, meridional and vertical velocity.

8. Forecast uncertainty in a chaotic non-linear system is mostly a result of ___________________________________.

9. Go to http://www.physics.nist.gov/cuu/Units/ and read through this web site to answer the questions below.

    a. What is an SI unit?
    b. What are the base SI units?
    c. What is the SI unit (give symbol and the root expression) for the following: force, acceleration, pressure, specific energy, power and temperature.
    d. What is a millibar in terms of SI units?

10. Read the material on an Eulerian and Lagrangian perspective once through. Do not worry about complete understanding.

11. Go to the following web site and make sure you know your Greek letters:
    http://www.mathacademy.com/pr/prime/articles/greek/index.asp

12. Define atomic weight and atomic number. Why is the molecular weight of atmospheric oxygen 32? (See Table 1.1 and http://en.wikipedia.org/wiki/Periodic_table)

13. Define scale height. Check on-line resources for help.

14. What is the only constituent of the atmosphere that escapes the earth's gravity?

15. Take notes on pages 12-21. This should be a nice summary of information that you should know or be able to understand easily. Is there anything that confuses you?

16. Define the following: baroclinic waves, cyclonic/anticyclonic, trade winds, Hadley cells, advection, ITCZ, atmospheric boundary layer, Richardson's Rhyme, CAT and subsidence.

17. Given this PIA 00Z 23 September 1991 sounding, answer the following questions.

Height (m)	**Pressure (mb)**	**ln(p)**
200	994	
914	913	
1509	850	
2743	732	
3811	642	
4268	606	
5792	498	
7317	407	
9146	315	
10670	252	
12158	200	
13957	150	
16475	100	
21054	48	
24515	28	
29568	13	
32015	9	

a. Plot z vs. p
b. Plot z vs. ln(p)
c. What is the scale height, H?

Logarithms

$x=2^y$, where x is some number, 2 is the base and y is the exponent. In logarithms, this would be written as $\log_2 x=y$. We use a natural log ($\ln$) when the base is e. (e is an unending number (like π) where $e \approx 2.718$.) Natural logs describe a common exponential growth pattern seen frequently in science. In applied mathematics, it is common to use e^{kx}.

$$x = e^y \text{ or } \ln x = y$$

$$\therefore \ln e^y = y$$

$$\ln x + \ln y = \ln(x \cdot y)$$

$$\ln x - \ln y = \ln(x/y)$$

$$x \ln y = \ln y^x$$

Graph $y=x$, $y=2x$, $y=x^2$, $y=\ln x$, $y=e^x$, $y=\sin x$, $y=\cos x$

Derivatives

We know that $v_{ave} = \Delta x / \Delta t$. How would this be graphed?

Since the slope between any two points on a straight line is equal to the slope *at* a point. At a point, Δx and Δt are both getting smaller. So as the denominator approaches zero (which cannot be true) we should note that the average velocity is not changing. The value of this fraction as the denominator approaches zero (called a limit) is defined as a derivative, $v = dx/dt$. The velocity is the instantaneous velocity at some point in time, t.

The same is true for any graph as long as a tangent line can be defined. Therefore the derivative is really the value of the slope of the tangent. Any endpoints of a line cannot have a derivative defined.

In words, what does the value of the slope of the tangent line do as you move left and right along the x-axis of the graphs plotted above?

For additional help, check out a few pages starting at
http://www.ugrad.math.ubc.ca/coursedoc/math100/notes/derivative/deriv-const-mult.html

$\frac{dc}{dx} = \_\_\_\_\_$ $\frac{dx^2}{dx} = \_\_\_\_\_$ $\frac{dax}{dx} = \_\_\_\_\_$ $\frac{d\cos x}{dx} = \_\_\_\_\_$

$\frac{dx}{dx} = \_\_\_\_\_$ $\frac{dx^3}{dx} = \_\_\_\_\_$ $\frac{dax^2}{dx} = \_\_\_\_\_$ $\frac{d\sin x}{dx} = \_\_\_\_\_$

$\frac{d(ax+bx^2)}{dx} = \_\_\_\_\_$ $\frac{d\ln x}{dx} = \_\_\_\_\_$ $\frac{de^{2x}}{dx} = \_\_\_\_\_$

$\frac{dx^{-1}}{dx} = \_\_\_\_\_$ $\frac{de^x}{dx} = \_\_\_\_\_$ $d(a \cdot b) = \_\_\_\_\_$

Integration

Integration, represented by the symbol ∫ is more than just finding an "antiderivative" even though, to solve the function, you must think in reverse. In order to solve integration, you must know several techniques. That is what Calc II is all about! However, we must understand some ideas of integration so that we can apply it to concepts in the book.

First, let's look at some examples that you will need to learn by rote.

$\int dx = \_\_\_\_\_$ $\int axdx = \_\_\_\_\_$ $\int \cos xdx = \_\_\_\_\_$

$\int xdx = \_\_\_\_\_$ $\int \frac{dx}{x} = \_\_\_\_\_$ $\int \sin xdx = \_\_\_\_\_$

Here is an interesting one and extremely important!

$\int pdV = \_\_\_\_\_$

The above examples are known as indefinite integrals. True integration requires limits from *a* to *b* on which to evaluate the integral. Confused? Try this. Graph *y=x* but only graph it from *x=0* to *x=1*. The integral would be as follows:

$\int_0^1 xdx = \_\_\_\_\_$ Do you see that the solution is the area underneath the graph? That is what integration does. It solves for area. It sums up many different areas? What are they? Think about what *xdx* is. How wide is *dx*? How many can fit in between 0 and 1. If you said infinite you are right! And that is what integration does – it sums up an infinite number of infinitely small regions. The solutions would be as follows:

$$\int_0^1 x\,dx = \frac{x^2}{2}\Big|_0^1 = \frac{1^2}{2} - \frac{0^2}{2} = \frac{1}{2}$$

Weight of the Atmosphere

Surface area of a sphere is _______.

The radius of the earth is ________.

Pressure is defined as ________ and MSLP is ________ pa.

Total force of the atmosphere is ______________N.

F=ma so solve for m. mass = ____________kg.

Do problem 1.17.

Scale Height

It is shown that pressure (and density) decrease exponentially with z. Although the exact relationship may vary slightly, the exponential decrease with height is exact in a standard atmosphere. Since we accept this to be true, we can then determine the pressure (or likewise density) at some height, z, by the following equation:

$$p(z) = p_0 e^{-z/H}$$
$$\frac{p(z)}{p_0} = e^{-z/H}$$

Taking the natural log of both sides,

$$\ln\left(\frac{p_0}{p(z)}\right) = -z/H$$
$$\ln[p(z)] - \ln[p_0] = -z/H$$
$$\ln[p(z)] - \ln[p_0] = -1 \; when\; z = H$$

The same is true for density.

Now, try problem 1.19. Remember the definitions for pressure and density.