Introduction to Meteorology
ATMS 103 – Fall 2022
Study Guide for Exam I

The following is not intended to be a comprehensive list of everything that may appear on the first exam, but I have tried to put together some questions that will guide you toward an understanding of the subjects we have covered so far this semester. It would be a very good idea to look over the homework assignments, read the book, and of course review the class notes. I expect that you will have either attended class or viewed all of the class lecture videos. Bring a calculator to the exam, but do *not* use a cell phone, the Internet (besides the Moodle page), or book. Do not memorize equations, but do know how to use them. You will receive an equation sheet similar to the one at the end of this study guide. The exam will take place **via Moodle** on **27 September 2022 during your regular class time.** As always, ask questions and good luck!

1. Geography is essential to the study of meteorology. Make sure you know where states and oceans are located (see the states quiz study guide for help).
2. What is the difference between the hydrosphere, lithosphere, biosphere, cryosphere, and atmosphere and what kind of scientists study each?
3. What are the main gases in the modern atmosphere and what are their concentrations by volume?
4. Understand the units and meaning of velocity, acceleration, force, pressure, work, density, and temperature. Be able to manipulate and convert these units in calculations.
5. How do you convert between different units of temperature and what are the boiling and freezing points of water using each scale?
6. What holds the atmosphere in place?
7. What property of the atmosphere always decreases with height, no matter what?
8. What are the layers of the atmosphere and how do we define them?
9. What is the tropopause? How would we find it?
10. What is a lapse rate?
11. Understand how energy is always conserved and how it is converted into different forms.
12. How is heat transferred in the processes of conduction and convection?
13. What is the hydrologic cycle?
14. Understand the concepts of saturation and moist processes in the atmosphere, including relative humidity, different measures of humidity, condensation nuclei, Dalton's Law, dewpoint, and how to measure atmospheric moisture.
15. How many physical states can water have in the atmosphere? What is the type of energy that is absorbed or released as water changes phase? How does this affect the atmosphere?
16. What are the laws of radiation and how are they used? Identify which laws pertain to which parts of a plot of radiative intensity vs. wavelength.
17. What is the Earth's energy budget and what happens if the balance is changed?
18. What is the greenhouse effect?
19. Why does Earth have seasons? (NOTE: It's *not* because of the Earth–Sun distance!)
20. Where and when can the sun be directly overhead? What is the Tropic of Capricorn and what is the Tropic of Cancer and where are they located? Why are they located there?
21. Understand surface and upper-air measurements, how atmospheric properties are observed, and how to read a surface station plot.
22. What are the forces that affect horizontal motion?
23. What causes the wind to blow?
24. Be able to deduce the wind direction based on a pressure field drawn for a particular hemisphere at a particular height above the surface.
25. What is the difference between gradient, geostrophic, and cross-isobaric flow?
26. What is Buys-Ballots's Law and how do you use it?
27. Where in the atmosphere does friction play a role in the force balance and where can it be ignored?
28. What are convergence and divergence and what role does each play in the formation of cyclones and anticyclones?
29. Locate troughs, ridges, upper-level divergence, and upper-level convergence on an upper-air map.
30. Why do surface high and low pressure systems tend to move in a certain direction?

Some potentially useful equations and constants:

$$F = ma$$

$$\frac{\partial p}{\partial z} = -\rho g$$

$$\Gamma = -\frac{\Delta T}{\Delta z}$$

$$p = \rho R_d T$$

$$p\alpha = R_d T$$

$$C = 2\Omega v \sin\phi$$

$$\frac{\partial \rho}{\partial t} = -\vec{\nabla} \cdot \rho\vec{V}$$

$$KE = \frac{1}{2} m v^2$$

$$\Phi = g\Delta z$$

$$^\circ C = \frac{5}{9}\left({}^\circ F - 32^\circ\right)$$

$$K = {}^\circ C + 273.15$$

$$c = f\lambda$$

$$Z = 300R^{1.4}$$

$$\theta = T\left(\frac{p_0}{p}\right)^{\kappa}$$

$$\lambda_{max} = \frac{2897\ \mu mK}{T} \qquad \text{T in Kelvin}$$

$$E = \varepsilon\sigma T^4$$

$$2d = ct$$

$$\Gamma_d = 9.8^\circ C/km$$

$$\Gamma_m \approx 6.0^\circ C/km$$

$$\sigma = 5.67 \times 10^{-8}\ \frac{W}{m^2\ K^4}$$

$$c = 2.9979 \times 10^8\ \frac{m}{s}$$

$$RH = \frac{e}{e_s} \times 100\%$$

$$c_p = 1005\ \frac{J}{kg\ K}$$

$$S_o = 1367\ \frac{W}{m^2}$$

$$^\circ F = \left(\frac{9}{5}{}^\circ C\right) + 32$$

$$\Omega = 7.292 \times 10^{-5}\ s^{-1}$$

$$V_1 r_1 = V_2 r_2$$