AT350
Homework questions for exam 3
Chapters 9, 10, 11, 12, 13, 15, 16
Fall 2003

Winds/forces

1. If the pressure gradient force remained constant and the earth's rotation became slower than it is now, would you expect the speed of the geostrophic wind to change? If so, how?

2. If the pressure gradient force remained the same but the earth's rate of rotation decreased slightly, would you expect the speed of the geostrophic wind to increase, decrease or remain about the same?

3. If the earth were to begin rotating in the other direction, would air still rise in the center of surface low pressure?

4. Sketch the wind flow patterns around surface high and low pressure centers in the Northern and Southern Hemispheres.

5. Explain briefly why upper-level winds at middle latitudes in the Northern Hemisphere blow from West to East. In what direction do upper level winds at middle latitudes in the Southern Hemisphere blow?

6. If the earth did not rotate, how would you expect winds to blow with respect to high and low pressure centers?

7. Explain why closely-spaced contour lines on an upper-level isobaric chart are associated with fast winds.

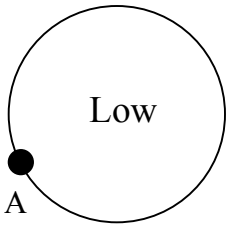
8. Draw a simple Northern Hemisphere upper-air pressure pattern consisting of several straight, uniformly-spaced contour lines running from left to right across your paper. Assume that lower heights are found at the top of your chart. Use arrows to indicate the direction that the wind would blow and the direction of the pressure gradient force and Coriolis force acting on a moving parcel of air.

9. Explain why strong upper-level divergence will cause the pressure in the center of a surface low to decrease.

10. Explain why it is often windy at the beach. What forces are responsible, and how do beachfront conditions differ from conditions farther inland?

11. Sketch the direction of the wind and the direction and relative amplitude of the forces acting on point A (below) if the wind is in geostrophic balance. How does the force balance change if we also consider the centrifugal force? Under what conditions do we need to worry about the centrifugal force?

Latitude is 45 degrees North



12. Now consider a three way balance between the pressure gradient force, the coriolis force, and friction at point A. Sketch the direction of the wind and the direction and relative amplitude of each force.

Local winds/general circulation

13. You are hiking on a mountain trail at sunrise when you smell the smoke from cooking bacon. You can't see where the smoke is coming from. Would you expect the camp to be above you or below you on the mountain?
14. Draw a sketch to show where eddies can form when air blows rapidly over a mountain range. Show on your sketch where you might expect clouds to form. How would these clouds appear when viewed from the ground?
15. Would you expect a well-developed sea breeze circulation to cause clouds to form over the land or over the ocean?
16. Explain in detail the physical processes that lead to the sea-breeze. During summer, during what time of day would you expect thunderstorms to form over Florida? Explain.
17. Explain in detail why afternoon thunderstorms typically form over the mountains before they form over eastern Colorado.
18. Sketch and describe the formation of a chinook wind. Would you expect chinook winds to form more often on the eastern or the western slopes of the Cascade mountains in Oregon?
19. Make sure you understand how to solve the last 10 questions of exam 1, and how this example relates to chinook winds.
20. What is meant by the term monsoon wind system? Briefly describe or sketch the wind and pressure pattern during the summer and winter monsoon in Asia.
21. Will a valley breeze or a mountain breeze produce clouds? Explain.
22. Describe the one cell mode. Why doesn't the one-cell model apply to the real atmosphere?
23. On a large circle, show where the major pressure and wind belts would be found according to the 3-cell model of the earth's general circulation. Where would you expect to find the most/least precipitation? Explain.
24. Explain the difference between a thermally direct and indirect circulation. Where are these found on the earth? What are their names? What drives these cells?
25. Explain why the climatological mean atmosphere is not perfectly "zonally symmetric" (zonal means east-west).

26. Averaged over NH winter, where would you expect to find surface lows and surface highs? How is summer different?
27. What changes might you expect to see in the earth's general circulation if the earth's rotation were in the opposite direction?
28. What is the ultimate source of energy for the general circulation of the atmosphere?
29. Explain what a jet stream is. Where are they found in the real atmosphere? Why drives the two principal jet streams covered in the text?
30. Where does the atmosphere lose momentum to the earth? Where does it gain momentum from the earth?
31. Explain why large high and low pressure systems don't move from east-to-west across the continental United States.
32. What is the ITCZ, and why does it migrate with the seasons?

Air masses/midlatitude cyclones

33. When a warm and cold air mass collide, the warm air is forced upward. Why does this occur?

34. What type of clouds, if any, would you expect to see form when a cold dry air mass moves across warm water? Would conditions be any different when warm moist air moves across a cold land surface? Would types of clouds would form in this latter case?

35. Draw side views of a typical warm and cold front. Clearly indicate the temperatures of the separate air masses and show their directions of motion. What types of clouds would you expect to find and where? Where would you expect precipitation to occur?

36. Describe some of the changes in weather conditions (winds, temperature, clouds, precipitation, pressure changes) you would expect to observe as a cold front approaches and passes through your location.

37. How would a warm front, a cold front, and a center of low pressure appear on a surface weather map in the Southern Hemisphere?

38. Describe or illustrate the various phases in the life cycle of a middle latitude storm according to the polar front theory.

39. Define the term cyclogenesis. List some of the regions in the United States where cyclogenesis is common, when it is most common, and the basic ingredients needed.

40. Draw a sketch of a 500 mb chart that clearly shows a trough and a ridge. Where would you expect to find converging and diverging wind motions? Below what point on your 500 mb chart would you expect middle latitude storm development to occur?

41. What does the term "shortwave" refer to? Why is it important locate and follow the movements of atmospheric shortwaves? How is this done? How is a shortwave different from a "longwave?"

42. Describe, in words or with a sketch, a wind flow pattern that will result in upper-level divergence.

43. Describe some of the ways in which the upper-level wind flow pattern can influence the development and movement of a middle latitude storm system.

44. What does the term vorticity refer to? How is positive vorticity different from negative vorticity? What determines the absolute vorticity of an air parcel?

45. When making a weather forecast, which kind of chart is more important: a surface chart or a 500 mb chart?

46. What direction would the surface wind shift as a cold front passed in the Southern Hemishere?

47. Describe the basic ideas behind baroclinic instability (why midlatitude storms develop).

48. Why is temperature advection more effective at the surface than in the middle troposphere?

49. Why don't baroclinic waves form in the tropics?

50. What is the vertical structure of a developing midlatitude storm? Know where the precipitation, rising motion, lower and upper level convergence/divergence are occuring.

51. Why aren't the 'lows' vertically stacked in a midlatitude storm?

Thunderstorms and Hurricanes

52. List and discuss some of the atmospheric conditions that are needed for a thunderstorm to develop.

53. List and describe the stages of development of an air-mass thunderstorm. About how long does a single air-mass thunderstorm cell last?

54. Where does the energy contained in a mature thunderstorm come from?

55. In what ways are severe thunderstorms different from air mass thunderstorms? What are some of the meteorological or atmospheric conditions that favor the development of severe thunderstorms?

56. What is wind shear? Why does wind shear represent a hazard to aviation?

57. Understand how a convective plume rises. Know how the water vapor content and temperature changes as a parcel rises, and know how to determine cloud base. (Understand Figure 7.16 in the text and how this applies to air mass thunderstorms).

58. Sketch a mature thunderstorm. With arrows, indicate where the updraft and downdraft might be found in the cloud. Where would you expect to find strong vertical wind shear? Indicate where the largest concentrations of positive and negative charge would be found in the cloud.

59. Where and when do severe thunderstorms form most frequently in the US? Why is this the case? Is this also where most tornadoes occur? Explain.

60. Why do tornadoes have low pressure cores? Would it be possible for a tornado to form around a high pressure core?

61. What makes a tornado-producing thunderstorm different from other thunderstorms?

62. The region of greatest tornado activity shifts northward from early spring to summer. Why does this occur?

63. Most tornadoes move from the southwest toward the northeast. Why is this true?

64. In what 2 primary ways are weather conditions in the tropics and at middle latitudes different?

65. With sketches show the structure of a mature hurricane as it would appear from the side and from above. Indicate and label the major features.

66. Where do hurricanes derive their energy? What factors tend to weaken hurricanes? Would you expect a hurricane to weaken more quickly if it moved over land or over cooler water?

67. Very heavy rainfall amounts are often recorded when a hurricane or tropical storm moves over land. Why do these storms produce so much rain?

68. List and describe some of the conditions that are favorable to hurricane development. What atmospheric conditions inhibit hurricane formation and growth?

69. Would you expect hurricanes in the Southern Hemisphere to be any different from hurricanes in the Northern Hemisphere?

70. Hurricane season for the tropical North Atlantic and North Pacific oceans normally runs from June through November. Why don't hurricanes form in these locations at other times of the year?

71. Even though more hurricanes form, on average, over the Eastern Pacific than over the tropical North Atlantic, we generally hear less about them. Why do you think this is so?

72. Compare and contrast the main features of a hurricane with those of a strong mid-latitude cyclone.