Name_____

Dynamics of the Oceans and Atmosphere 11:670:324
Spring 2012
Hourly Exam #1
March 2, 2012

Please answer each of the following questions in the blue book. **Read each question carefully before formulating your answer.** Show intermediate steps in any calculations or mathematical manipulations.

1. (3 points) In an inertial frame of reference (i.e., one that is not rotating), what are the fundamental forces acting on a parcel of air?

2. (4 points) Please write an equivalent version of $-2\vec{\Omega}\times\vec{V}$ without using vector notation. Assume all vectors are three-dimensional. What physical quantity does this mathematical expression represent?

3. (4 points) The surface wind $\vec{V}_{sfc}$ at a weather station is blowing from 340° at 10 m s^{-1}. What are the u and v wind components of $\vec{V}_{sfc}$? (Note: Values of trigonometric functions are given in the table below.)

Angle	**10°**	**20°**	**30°**	**40°**	**50°**	**60°**	**70°**	**80°**
Sine	**0.174**	**0.342**	**0.5**	**0.643**	**0.766**	**0.866**	**0.940**	**0.985**
Cosine	**0.985**	**0.940**	**0.866**	**0.766**	**0.643**	**0.5**	**0.342**	**0.174**

4. (6 points) Give the dimensions of: (a) velocity, (b) horizontal pressure gradient, and (c) temperature advection, in terms of length (L), time (T), mass (M) and temperature (K).

5. (4 points) The Amundsen-Scott South Pole Station is located in Antarctica. Imagine that you are visiting this station and you wander outside to find a small circle marked on the ice that indicates the position of the South Pole. Describe the motion of an infinitesimally small point at the center of this circle in an inertial reference frame. Is it accelerating?

6. (2 points) In using the concept of a parcel of air, which of the following best describes the amount of air contained in a parcel?

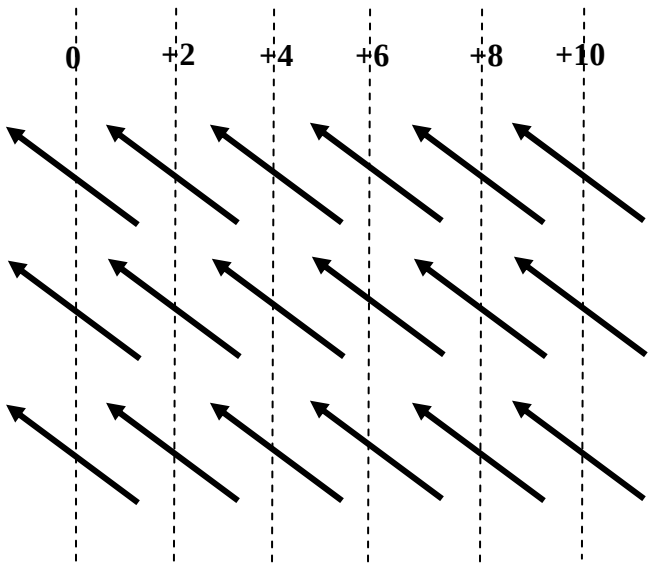
a) a single molecule
b) a small number of molecules
c) a very large number of molecules, but very small compared to the total fluid volume
d) a very large number of molecules that is comparable to the total fluid volume.

7. (3 points) Please write an expression in vector form for the centrifugal acceleration for an object at rest on the earth's surface.

8. (4 points) Please list the names of any three of the six primitive equation.

9. (5 points) The diagram below is a weather map (oriented with north at the top) in which the arrows represent the wind vectors and the labeled dashed lines are isotherms. Please indicate if each of the following quantities is positive, negative, or zero:

a) u, **b)** $\frac{\partial T}{\partial y}$, **c)** v, **d)** $\frac{\partial T}{\partial x}$, **e)** $v\frac{\partial T}{\partial y}$



10. (6 points) Based on the individual terms in the temperature tendency equation, please list all of the processes which can cause the local temperature to change. Please describe each process using words rather than mathematical symbols.

11. (4 points) Please write the mass divergence form of the continuity equation and explain the physical process represented by each term.

12. (4 points) For the following equation, give a brief physical explanation for each term in the equation using its identifying letter with your answer.

$$\underbrace{\frac{dv}{dt}+\frac{u^2\tan\phi}{a}+\frac{vw}{a}}_{A}=\underbrace{-\frac{1}{\rho}\frac{\partial p}{\partial y}}_{B}\underbrace{-2\Omega u\sin\phi}_{C}+\underbrace{F_{ry}}_{D}$$

13. (3 points) Which of the following arrows illustrates the proper orientation of the pressure gradient force vector? The thin solid lines represent isobars, with low pressure at the top and high pressure at the bottom.