

Introduction to Weather & Climate

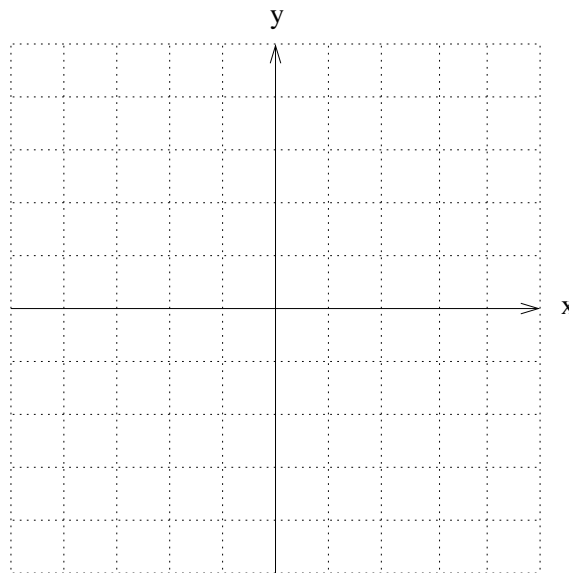
PHYS 189

Fall 2017

Problem Assignment # 8

due 11-27-2017

1. Wind
 - (a) What causes wind?
 - (b) List 3 forces that determine the movement of air in the free troposphere and in the boundary layer.
 - (c) What is a pressure gradient?
 - (d) On a weather map, how do you know where the strongest wind is?
2. A parcel of air is released from rest in Socorro, NM. It is traveling due north. Assume that it remains in the atmosphere long enough that we cannot neglect the Coriolis force. Why does the Coriolis force deflect the parcel to the right rather than to the left?
3. Either use the grid below or draw one on your paper. Draw the vector $\vec{A} = (-2, 3)$. Follow the steps below and note that vectors written in terms of *components* have the form $\vec{A} = (A_x, A_y)$, where A_x and A_y are the x and y components of vector \vec{A} .



- (a) Start at the origin and move along the x -axis by A_x , then move in the y -direction by A_y . Mark the final position (with a dot).
 - (b) Draw an arrow which starts at the origin and terminates at the point you drew in part a.
 - (c) Calculate $|\vec{A}|$, the length of vector \vec{A} .
 - (d) Calculate (or measure) the angle from the x -axis to the vector \vec{A} .
4. Conservation of angular momentum. The magnitude of angular momentum is $\tilde{M} = mvr$. Let $M = \tilde{M}/m$ be the angular momentum *per unit mass* (as given by equation (4.1) in your text). Then $M = vr$, with

- $r = a \cos \phi$, with a the radius of the Earth and ϕ latitude
- $v = v_{rotation} + u$, with $v_{rotation}$ the eastward velocity due to the Earth's rotation and u the eastward velocity *relative* to Earth's surface.
- $v_{rotation} = r\Omega$, where r is given above and Ω is the rotational velocity of the earth

Suppose an air parcel is at rest relative to the Earth at a latitude of 10°N .

- Calculate the total angular momentum per mass (M) of the air parcel.
 - Assuming the parcel does not experience friction and M is conserved, how fast is it moving eastward if it moves northward to 40°N ?
 - Now assume there is an air parcel at rest relative to the Earth at 20°N . It moves south to the equator. What is its speed relative to the Earth? Is it moving toward the east or west?
 - Now assume there is an air parcel at rest relative to the Earth at 20°S . It moves north to the equator. What is its speed relative to the Earth? Is it moving toward the east or west?
 - How do the results of the previous two parts explain the average winds at the equator?
5. The Hadley cell is a buoyancy driven circulation.
- Draw a picture of the Earth and a Hadley cell. Include the approximate latitudes of the ascending and descending branches.
 - Is there any evidence for the existence of Hadley cells in the real world? If so, what is it.
 - What is an important role of the Hadley circulation?
6. Geostrophic balance
- What is *geostrophic balance*?
 - What two forces balance?
 - What is the acceleration of a parcel in geostrophic balance?
7. How does the thermal wind explain the jet stream?
8. Warm fronts and cold fronts.
- What is a warm/cold front?
 - What determines whether a front is warm or cold?
 - What are some distinguishing features of warm and cold fronts?