

EAS 1600 - INTRODUCTION TO ENVIRONMENTAL SCIENCES

Fall, 2014

Exam 3 – 10/29/14

- < **Answer all Questions**
- < **Show all your work and be sure and report units where appropriate**
- < **Place your name on each page**
- < **This is a closed-book exam; all are expected to comply with Georgia Tech Honor Code**

I am aware and in compliance with the Georgia Tech Honor Code and I agree to abide by the grading policies of this class.

Signature: _____

Print Name: _____

Lab Section: _____

A

Answer the following multiple choice questions (1 – 10) by circling the appropriate answer.

1. An ice cube (mass = 97 grams) sublimates. The surrounding air is _____ by the transfer of _____.

(5 points)

- a) heated, 274 kJ
- b) cooled, 243 kJ
- c) cooled, 274 kJ**
- d) neither heated or cooled, 0 kJ

2. How much salt is in a 5 kg sample of ocean water that has a salinity of 35 ‰?

(5 points)

- a) 0.175 kg**
- b) 175 kg
- c) 0.32 kg
- d) 35 g

3. Where would you expect to find the least saline ocean waters among the following choices?

(5 points)

- a) Near the Atlantic Ocean around 20~30° N
- b) Near the Pacific High
- c) At the Equator**
- d) The Mediterranean Sea

4. Where do you expect to find high productivity ocean waters (i.e. active photosynthesis)? Circle all that apply

(5 points)

- a) On the eastern boundaries of the gyres**
- b) 5° N in the Pacific Ocean
- c) 30° N in the Pacific Ocean
- d) 60° N in the Pacific Ocean**

5. Where do you expect to find a warm current? Circle all that apply

(5 points)

- a) Along the west coast of the U.S.
- b) Along the east coast of South America**
- c) Along the west coast of South America
- d) Along the west coast of South Africa

6. Which of the following has a depth profile that is minimum at the surface? Circle all that apply.

(5 points)

- a) **Concentration of carbon dioxide**
- b) **Concentration of Phosphorus**
- c) Concentration of Oxygen
- d) Temperature

7. Which of the following drives the formation of deep water?

(5 points)

- a) The upwelling in the Southern Ocean
- b) A decrease in the strength of the Gulf Stream
- c) **The transport of high salinity water to high latitudes**
- d) The southward movement of the deep water in the Atlantic Ocean

8. Aerosols can impact climate by _____ (circle all that apply).

(5 points)

- a) **increasing the albedo of the Earth.**
- b) **increasing cloud reflectivity**
- c) **decreasing the chance of precipitation**
- d) enhancing the Greenhouse Effect
- e) increasing the number of clouds in the sky

9. Consider two air parcels that are identical (i.e. temp., RH, etc.) except that one air parcel has three times the number of CCN of the other. Both parcels move up in the atmosphere and form clouds. Which statement is true?

(5 points)

- a) The air parcel with fewer CCN will form a cloud that is less likely to rain
- b) The air parcel with more CCN will form a cloud that is less reflective
- c) **The air parcel with more CCN will form a cloud that is more reflective**
- d) Neither cloud is more likely to rain

10. The heating of water at the surface _____ the density of surface water, which _____ the vertical motion of the ocean.

(5 points)

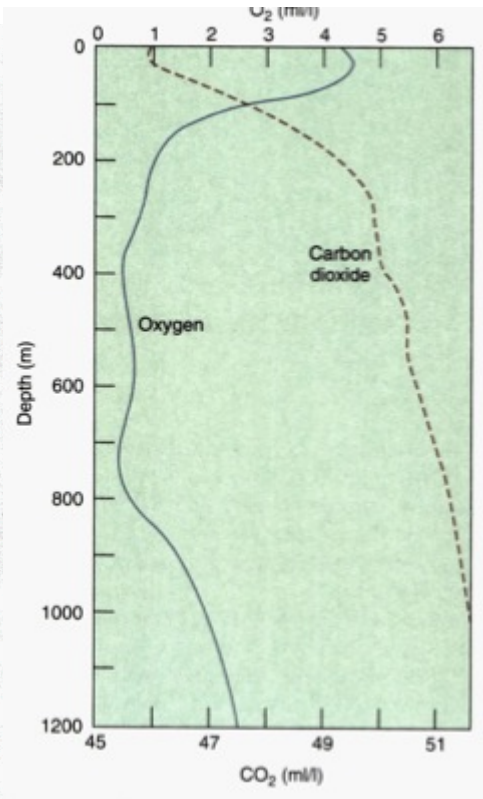
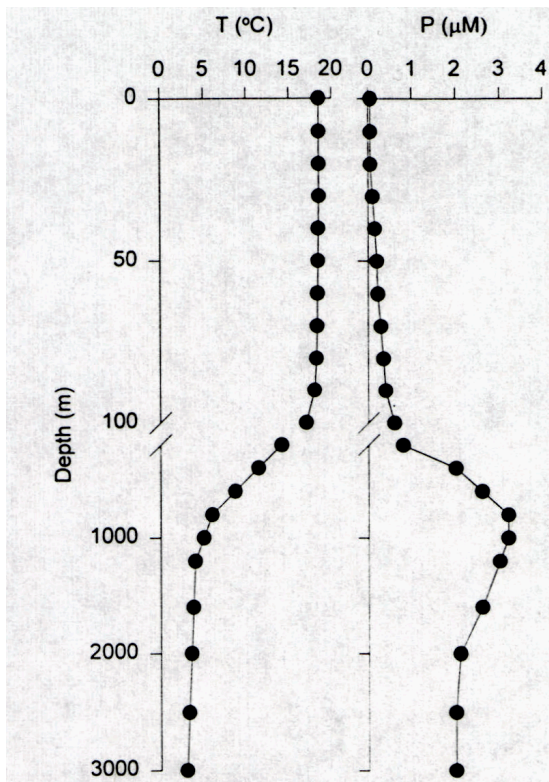
- a) increases; promotes
- b) increases; inhibits
- c) lowers; promotes
- d) **lowers; inhibits**

11. True or False. Mark each statement below as True or False (2 pts each)

- a. Fishing is usually good due to high photosynthesis rates in waters on the eastern coasts of North and South America. ____F____
- b. Aerosols scatter light and decrease visibility and increase the albedo of the Earth. ____T____
- c. The biological pump move carbon and nutrients from the deep ocean to the surface ocean. ____F____
- d. North Atlantic deep water formation is driven by low salinity water that originates from 30° N. __T____
- e. Photosynthesis is very active in the center of the Pacific Ocean near 30° N. ____F____
- f. The Gulfstream is a cold current along the Atlantic coast of the U.S. ____F____
- g. The formation of sea ice will decrease the density of the surrounding seawater. ____F____
- h. As a cloud forms in the atmosphere the surrounding air is cooled. ____F____
- i. The South Pacific gyre moves counterclockwise. ____T____
- j. The thermohaline circulation of the ocean is driven by transport of high salinity waters to high latitudes. ____T____

12. Sketch depth profiles of temperature, oxygen, and phosphorous in the ocean from 0 to 1 km. Be sure and include at least relative units.

(10 pts)



13. A spherical bullet with radius $r = 2.5$ mm starts to fall from an altitude of 1 km. How long will it take for the droplet to reach the ground? (Density of lead = 11.3 g cm^{-3}) (10 pts).

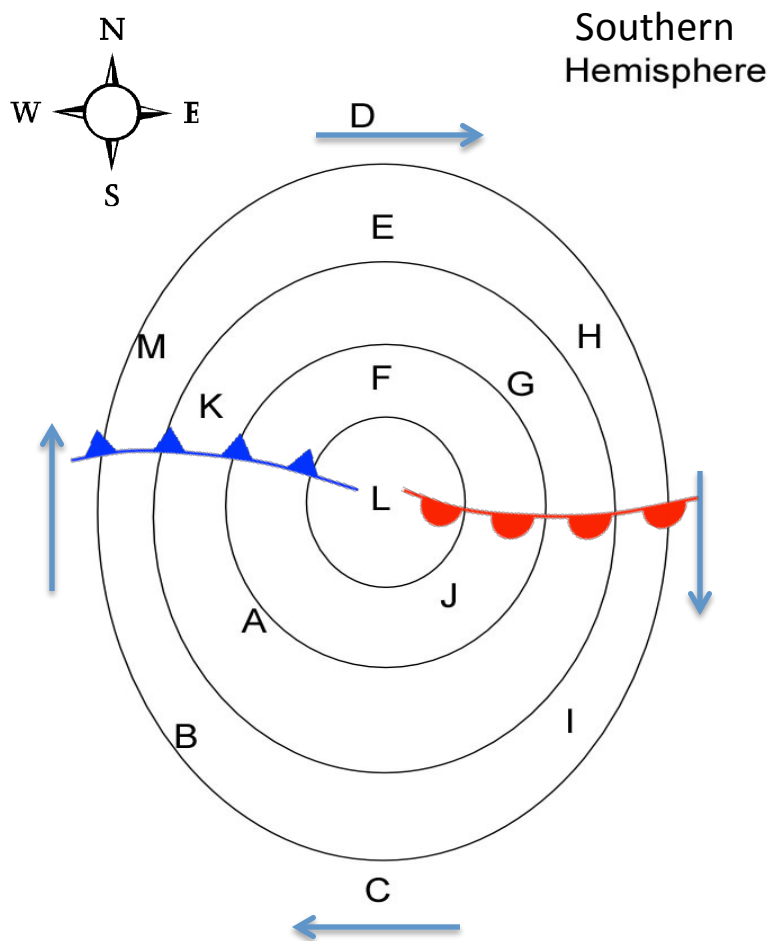
Force balance: $D = W$

So

$$\begin{aligned}
 0.4 * A \rho_{air} * v^2 &= mg \\
 A &= \pi r^2; m = \rho_{lead} * V; V = \frac{4}{3} \pi r^3 \\
 v^2 &= \frac{\rho_{lead} * \frac{4}{3} \pi r^3 * g}{0.4 * \pi r^2 * \rho_{air}} = \frac{\rho_{lead} * \frac{4}{3} r * g}{0.4 * \rho_{air}} \\
 v &= \sqrt{\frac{11300 \frac{kg}{m^3} * \frac{4}{3} * \frac{2.5}{1000} m * 9.8 \frac{m}{s^2}}{0.4 * 1.2 \frac{kg}{m^3}}} \\
 v &= 27.7 \frac{m}{s} \\
 t &= \frac{z}{v} = \frac{1000 m}{27.7 m/s} = 36.1 s
 \end{aligned}$$

14. Draw a diagram of a low pressure system in the Southern Hemisphere. Indicate the wind direction around the low with arrows. Draw in reasonable cold and warm fronts and state where you expect to find precipitation. Be sure and pay attention to the compass directions below (10 pts)

Precipitation: Low pressure center, cold and warm fronts



Formulas, facts, and constants you may find useful:

1. The latitude of a point on earth is defined as the angle defined by that point, the center of the Earth, and the Equator. For Example, Atlanta is at 34° N, The Equator is 0° , and the South Pole is 90° S.
2. Surface area of a sphere with radius r ; $A = 4\pi r^2$,
3. Pressure units $1 \text{ atm} = 1013 \text{ mb} = 10^5 \text{ Pa}$, $1 \text{ Pa} = 1 \text{ kg m}^{-1} \text{ s}^{-2}$
4. Ideal Gas Law $P = \rho R_d T$
where R_d is the gas constant for air $= 287 \text{ J K}^{-1} \text{ kg}^{-1}$
 ρ is the gas density.
For example the density of air is 1.2 kg m^{-3} at 1 atm. and 20 C.
5. $P = P^0 \exp(-z/H)$ is the barometric pressure law, where $H=8 \text{ km}$ and z is altitude
6. $1.0 \text{ ft} = 0.3048 \text{ meters}$
7. $d=vt$ (d -distance, v -velocity, t -time)
8. for water the heat of condensation/evaporation $= 2500 \text{ J/g}$, heat of melting/freezing $= 333 \text{ J/g}$
9. $D=0.4A\rho_{\text{air}}v^2$ (D - drag force, A -cross sectional area, v -velocity, ρ_{air} – density of air)
10. $g = 9.8 \text{ m s}^{-2}$
11. Volume of a sphere $= 4/3\pi r^3$
12. Density of liquid water $= 1 \text{ g cm}^{-3}$