

EAS 1600 - INTRODUCTION TO ENVIRONMENTAL SCIENCES

Fall, 2015

Exam 3 – 10/28/15

- < **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. The biological pump transports _____ from the surface ocean to the _____.
(5 points)

- a) nutrients, atmosphere
- b) carbon, deep ocean and then back to the atmosphere
- c) carbon, deep ocean**
- d) nutrients, deep ocean and then back to the surface ocean

2. How much salt is in a 320 kg sample of ocean water that has a salinity of 35 ‰?
(5 points)

- a) 112 g
- b) 11.2 kg**
- c) 35 kg
- d) 35 g

3. Aerosols indirectly impact climate by _____?
(5 points)

- a) reducing the greenhouse effect
- b) enhancing levels of carbon dioxide
- c) scattering light
- d) modifying cloud properties such as the size of cloud drops**

4. Where do you expect to find upwelling? Circle all that apply
(5 points)

- a) On the eastern boundaries of the gyres**
- b) At the equator**
- c) 30° N in the middle of Pacific Ocean
- d) 60° N in the Atlantic Ocean near Alaska

5. Where do you expect to find a cold 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 a maximum 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. Wegener's Theory of Continental Drift was based on _____?

(5 points)

- a) The similarity of fossils between widely separated continents.**
- b) Seismic data that defined the epicenter of earthquakes
- c) The magnetic pattern of rocks on the ocean floor
- d) Metrological observations in Greenland

8. Which of the following is an important nutrient in the ocean?

(5 points)

- a) sodium
- b) chloride
- c) calcium
- d) phosphorous**

9. Solar radiation impacts the ocean by _____ (circle all that apply)

(5 points)

- a) Inhibiting vertical transport of ocean water**
- b) Enhancing vertical transport of ocean water
- c) Decreasing the salinity of the mid-latitude oceans
- d) Warming the top layer of the mid-latitude oceans**

10. Which location has the most saline waters?

(5 points)

- a) Atlantic Ocean at 25° N**
- b) Pacific Ocean at 25° N
- c) Pacific Ocean at 55° N
- d) Atlantic Ocean at the equator

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

- a. The presence of aerosol in the atmosphere increase the albedo of the Earth and cools the climate. _____T_____
- b. Pangea was a large land mass that was made up of most of the present day continents. _____T_____
- c. The magnetic pattern of the rock on the floor of the Atlantic Ocean is an alternating band of positive and negative anomalies. _____T_____
- d. Ocean photosynthesis tends to decrease the Greenhouse Effect in the atmosphere. __T_____
- e. Photosynthesis is very active in the center of the Pacific Ocean near 30° N. ___F_____
- f. The California Current is a cold current along the Atlantic coast of the U.S. _____F_____
- g. The melting of the Greenland ice sheet decreases the density of the seawater in the North Atlantic. ____T_____
- h. The densest waters are found at high latitudes. _____T_____
- i. The Gulfstream is part of a clockwise gyre in the North Atlantic Ocean. _____T_____
- j. The thermohaline circulation of the ocean is driven by transport of high salinity waters to high latitudes. _____T_____

12. A cube with a total mass of 10 g and sides of length 1 cm is dropped from an airplane. Estimate its velocity just before it hits the ground. You can assume that one side of the cube is parallel to the ground as it falls.

(10 pts).

$$\begin{aligned}
 D &= W \\
 0.4 \times A \times \rho_{air} \times v^2 &= mg \\
 A &= l^2; m = 10 \text{ g} \\
 v^2 &= \frac{mg}{0.4l^2\rho_{air}} \\
 v &= \sqrt{\frac{10 \times 10^{-3} \text{ kg} \times 9.8 \text{ ms}^{-2}}{0.4 \times 0.01 \text{ m} \times 0.01 \text{ m} \times 1.2 \text{ kg m}^{-3}}} = 45 \text{ m s}^{-1}
 \end{aligned}$$

13. Consider two clouds both of which contain 1.6 kg of water. **Cloud A** has an average drop radius of 25 μm and **Cloud B** has an average drop radius of 5 μm . Answer the following questions about these clouds

a) What is the total volume of water in each cloud? (4 pts)

$$V_A = V_B = \frac{M}{\rho} = 0.0016 \text{ m}^3$$

b) What is the number of drops in each cloud? (5 pts)

$$N_A = \frac{M}{m} = \frac{M}{\rho \frac{4}{3} \pi r_A^3} = \frac{1.6}{1000 \times \frac{4}{3} \pi \times (25 \times 10^{-6})^3} = 2.45 \times 10^{10}$$

$$N_B = \frac{M}{m} = \frac{M}{\rho \frac{4}{3} \pi r_B^3} = \frac{1.6}{1000 \times \frac{4}{3} \pi \times (5 \times 10^{-6})^3} = 3.06 \times 10^{12}$$

c) What is the total surface area in each cloud? (5 pts)

$$\begin{aligned}
 S_A &= 4\pi r_A^2 N_A = 192 \text{ m}^2 \\
 S_B &= 4\pi r_B^2 N_B = 961 \text{ m}^2
 \end{aligned}$$

d) Which cloud is more likely to rain? Why (3 pts)
 Cloud A. Cloud A has larger droplets, which have a larger terminal velocity.

e) Which cloud is more reflective? Why (3 pts)
 Cloud B. Cloud B has a larger surface area.

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. $D = 0.4 A \rho_{\text{air}} v^2$ (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 $= \frac{4}{3}\pi r^3$
12. Density of liquid water $= 1 \text{ g cm}^{-3}$