EAS1600 - INTRODUCTION TO ENVIRONMENTAL SCIENCES

Fall, 2015

Exam 4 – 11/23/15

- **Answer all questions**
- **Show <u>all your work</u> 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: _____

B

Answer the following multiple choice questions (1 – 5) by circling the best answer.

1. The Appalachians were formed when _____.
(5 points)

a) an oceanic and a continental plate converged.
b) two continental plates converged.
c) two oceanic plates converged.
d) two continental plates diverged.

2. Which of the following minerals is most likely to be formed by biological activity?
(5 points)

a) quartz
b) mica
c) olivine
d) calcite

3. Which of the following is an example of a shield volcano?
(5 points)

a) Mt. Everest
b) Mt. Saint Helens
c) Mauna Loa
d) Stone Mountain

4. Bicarbonate (HCO_3^-) is the most abundant form of inorganic carbon in the ocean. The primary source of bicarbonate to the ocean is _____. (5 points)

a) acid rain
b) the presence of a strong acid
c) the weathering of limestone rock
d) atmospheric CO_2

5. An aqueous solution has a pH of 11.5. What is the H^+ concentration in the solution in mol/l?
(5 points)

a) 3×10^{-5}
b) 3×10^{-11}
c) 3×10^{-12}
d) $10^{-2.5}$

6. For the following compounds state the oxidation number of the C and also state if the compound is organic or inorganic. (10 pts)

Compound	Oxidation#	Organic/Inorganic
CHOCHO	___+1_____	____O_____
$C_7H_6O_3$	____0_____	_____O_____
HCO_2^-	____+2_____	_____O_____
CO_3^{-2}	_____+4____	_____I_____
C_8H_{16}	_____-2____	_____O_____

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

a. Halite weathers more rapidly than calcite. _____T_____

b. The Andes Mountains are not volcanic. _____F_____

c. The pH of the rainwater in unpolluted environments is neutral. ____F____

d. Trenches are usually found along divergent oceanic plate boundaries. ____F_____

e. As atmospheric CO_2 increases, the formation of $CaCO_3$ skeletons is favored. ____F____

f. Volcanic eruptions warm the climate in short term. ___F___

g. The Aleutian Islands are formed due to hot spots. ____F_____

h. Granite is an igneous rock. ____T_____

i. The ocean floor is composed of granite. ____F_____

j. The pH of the ocean is buffered only because it contains H_2CO_3. ___F____

k. S waves will be transmitted through liquid. ____F_____

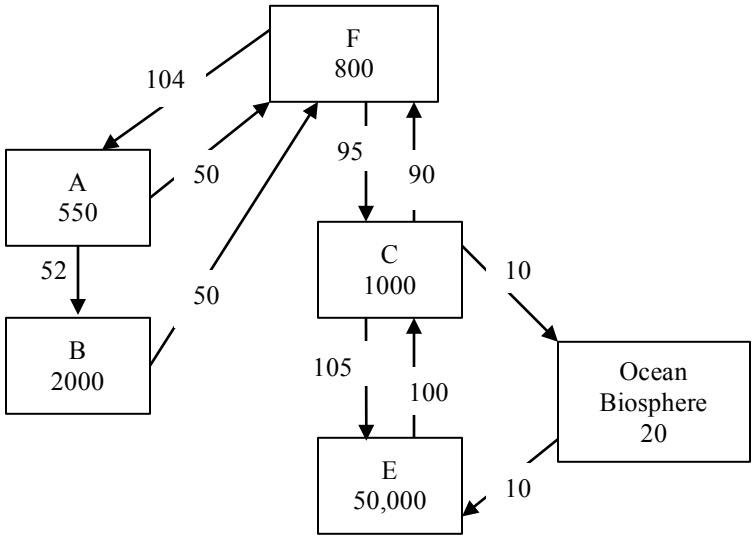
l. Carbon is oxidized during both combustion and respiration processes. ___T_____

8. A seismograph is 2000 km away from the epicenter of an earthquake. What is the difference in arrival times for the P and S waves if their velocities are 9 and 6 km/s, respectively? (6 pts)

$$t_p = \frac{D}{v_p}, t_S = \frac{D}{v_S}$$

$$\Delta t = t_s - t_p = \frac{D}{v_S} - \frac{D}{v_p} = \frac{2000}{6} - \frac{2000}{9} = 111\ s$$

9. Answer the following questions about Earth's short term Carbon Cycle (i.e. a time scale of decades to centuries) based on the diagram below. All reservoir amounts are in Gtons of C and all fluxes (arrows) are in Gtons/yr. (20 pts)



a) Identify the reservoirs labeled A, C, E, and F.
A: land biosphere; C: surface ocean; E: deep ocean; F: atmosphere

b) What is the residence time of carbon in the Atmosphere?

t= 800/190=4.2 yrs

c) Identify two reservoirs that are composed of primarily inorganic carbon.

F, C, or E

d) Identify the processes represented by the fluxes in and out of Reservoir A and write out relevant chemical reactions.
In: photosynthesis $CO_2 + H_2O + light \rightarrow CH_2O + O_2$
Out: respiration $CH_2O + O_2 \rightarrow CO_2 + H_2O$
Litterfall or death.

e) Which parts of the diagram correspond to the biological pump?
C-Ocean biosphere-E

10. A solution initially contains hydrofluoric acid (HF) and fluoride (F^-) each at a concentration of 0.03 mol/l (15 pts).

a) Estimate the pH of the solution. (5 pts)

HF	⟷	H^+	+	F^-
0.03		0		0.03
-x		x		x
0.03-x		x		0.03+x

$$\frac{[H^+][F^-]}{[HF]} = K_a$$

$$\frac{x(0.03+x)}{0.03-x} = 2\times10^{-4}$$

Assume x is small, $\frac{0.03x}{0.03} = 2\times10^{-4}$

$$x = 2\times10^{-4}$$

pH=-log[H^+]=3.7

b) If 0.01 mol/l of HCl were added to the solution above (a) what would be the pH? (5 pts)

HF	⟷	H^+	+	F^-
0.03		0.01		0.03
0.04		0		0.02
-x		x		x
0.04-x		x		0.02+x

$$\frac{[H^+][F^-]}{[HF]} = K_a$$

$$\frac{x(0.02+x)}{0.04-x} = 2\times10^{-4}$$

Assume x is small, $\frac{0.02x}{0.04} = 2\times10^{-4}$

$$x = 4\times10^{-4}$$

pH=-log[H^+]=3.4

c) If 0.2 mol/l of HCl were added to the solution in part (b) what would be the pH? (5 pts)

HF	⟷	H^+	+	F^-
0.03		0.21		0.03
0.06		0.18		0
-x		x		x
0.06-x		0.18+x		x

x is much smaller than 0.18, so $[H^+]$=0.18 mol/l

pH=-log$[H^+]$=0.74

d) Is the pH of the solution in part (a) buffered to the addition of acid? Why? (5 pts)

Yes. The solution contains F^-, which prevents pH from changing a lot when a small or moderate amount of acid is added, e.g., case (b).

Formulas, facts, and constants you may find useful:

1. K_a of hydrofluoric acid (HF) = 2 x 10^{-4}
2. The expression for an acid equilibrium constant for a generic acid (HX) is $K_a = \frac{[H^+][X^-]}{[HX]}$