

EAS 1600 - INTRODUCTION TO ENVIRONMENTAL SCIENCES

Fall Semester 2012

FINAL EXAM – December 14, 2012

- ❖ **Relevant formulas are included at the end of the exam.**
- ❖ **Place your name on each page.**
- ❖ **Answer all questions, and show all calculations and units where applicable.**
- ❖ **This is a closed-book exam; all are expected to comply with Georgia Tech Honor Code.**
Please also note that cell phone use or contact with any other person is not allowed.

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

Print Name: _____

Signature: _____

Lab Section: _____ -

GT ID# _____

B

1. Multiple Choice. (4 pts each)

Choose the best answer to the following multiple choice questions

1. Approximately how many hours of sunlight will Moscow (56°N) receive today?
 - a. 12
 - b. 10.5
 - c. 8
 - d. 13.5
2. What is the ratio of the noon time radiative flux that impacts Miami, FL (25°N) in summer (June 22) to that in Helsinki, Finland (60°N) winter?
 - a. 11.1
 - b. 0.92
 - c. 5.4
 - d. 8.8
3. What is the approximate radiative flux emitted by the surface of the Earth?
 - a. 100 W m^{-2}
 - b. 400 W m^{-2}
 - c. 1400 W m^{-2}
 - d. 700 W m^{-2}
4. Approximately how many hours of sunlight will St. Petersburg, Russia (60°N) receive on March 21?
 - a. 7
 - b. 10
 - c. 12
 - d. 15
5. At noon today what is the approximate incident angle (q) of the Sun in Summit, Greenland today (72°N). Give the best answer.
 - a. 72°
 - b. 5°
 - c. The sun will never be above the horizon
 - d. 56°
6. A star appears blue, what is the best estimate of its temperature?
 - a. 4500 K
 - b. 1200 K
 - c. 3500 K
 - d. 7200 K

7. You are flying on a plane equipped with a barometer that reads 125 mb. What is the approximate altitude of the plane?
- 16 km
 - 35,000 ft
 - 11 km
 - 2000 ft
8. Which of the following is a Greenhouse Gas?
- All the gases listed below
 - Carbon Dioxide (CO_2)
 - Methane (CH_4)
 - Ozone (O_3)
9. What is needed to form a cloud? Give the best answer.
- Relative Humidity = 100%
 - CCN
 - CCN and Relative Humidity = 100%
 - CCN and Relative Humidity = 10%
10. The maximum emission from Earth is in the _____ part of the electromagnetic spectrum, while the Sun's maximum emission is in the _____.
- infrared; x-ray
 - infrared; visible
 - visible; x-ray
 - visible; infrared
11. The transfer of sensible heat is always accompanied by a:
- temperature change
 - phase change
 - temperature and phase change
12. Where would you expect to find the densest ocean waters?
- Near the outflow of the Amazon River
 - The High Latitude Atlantic Ocean
 - The Mid-Latitude Atlantic Ocean
 - The Equatorial Atlantic Ocean

13. The clockwise gyre in the North Atlantic is driven by the circulation about the _____.

- a) Icelandic High
- b) Icelandic Low
- c) Bermuda High
- d) Bermuda Low

14. Which of these ocean currents is cold?

- a. North Atlantic Drift
- b. Gulfstream
- c. California
- d. Lagrangian

15. What would you expect to be true about an ocean nutrient such as nitrogen or phosphorous at mid-latitudes?

- a. High concentrations near the surface
- b. Very low concentrations near the surface
- c. Concentrations would correspond to the oxygen levels
- d. None of the above.

16. If a cloud is formed in an air parcel which of the following is true?

- a. The air parcel warms
- b. The air parcel cools
- c. The air parcel is neither cooled or warmed
- d. The air condenses to offset the evaporation

17. Which of the following is a sedimentary rock?

- a. Granite
- b. Sandstone
- c. Basalt
- d. Marble

18. Which of the following is not a nutrient in the ocean?

- a. Calcium
- b. Bicarbonate
- c. Sodium
- d. All of the above

19. Which of the following minerals is likely to weather the slowest?
- Limestone
 - Halite
 - Quartz
 - Gypsum.
20. Which of the following minerals is likely to be found in a cave?
- feldspar
 - calcite
 - quartz
 - olivine
21. Which of the mountain ranges is volcanic?
- Himalayas
 - Appalachians
 - Andes
22. Which of the following is due to a divergent ocean-ocean plate boundary
- Marianas Islands
 - Andes Mountains
 - Mid-ocean ridge
23. A range of stratovolcanoes is associated with which type of plate boundary?
- Continent-Ocean Convergent
 - Continent-Continent Convergent
 - Ocean-Ocean Convergent
 - Ocean-Ocean Divergent
24. Where do you expect to find the most saline ocean waters?
- North Atlantic (Northern Hemisphere)
 - Tropical Atlantic (Northern Hemisphere)
 - Mid-Latitude Atlantic (Northern Hemisphere)
 - Tropical Pacific (Southern Hemisphere)
25. Where would you expect the most precipitation?
- 55 to 65° N
 - 25 to 35° N
 - 5° S to 5° N

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

- a. Mercury is emitted to the atmosphere by coal burning. _____
- b. Shield volcanoes are generally much smaller than stratovolcanoes. _____
- c. Most of the bicarbonate in the ocean is formed from carbonic acid in rain water. _____
- d. Milankovitch Cycles impact climate on the time scale of the short term carbon cycle. _____
- e. Volcanoes can impact climate in both the short and long term. _____
- f. In the short term carbon cycle only photosynthesis, deforestation, and ocean uptake remove carbon from the atmosphere. _____
- g. Photosynthesis oxidizes organic carbon to produce inorganic carbon. _____
- h. The pH of the ocean is buffered by the presence of carbonic acid and bicarbonate. _____
- i. In the long term rock weathering leads to cooling of the climate. _____
- j. Mt. Everest is a stratovolcano. _____
- k. Predator fish are likely to have higher levels of mercury than fish that feed only on plants. _____
- l. CO₂ is the greenhouse gas that traps the most outgoing radiation. _____
- m. Basalt is an igneous rock associated with continental mountain ranges. _____
- n. As the temperature of the atmosphere increases, atmospheric pressure decreases. _____
- o. As the Earth warms, sea level rises. _____

27. A helium balloon floats at an altitude of 11 km and has a total mass of 53 kg and a volume of 144 m^3 . What is the temperature of the air at this altitude? (10 pts)

28. Estimate the effective temperature of Uranus you can assume an albedo of 0.35 and that Uranus is 5 times further from the Sun than the Earth. (10 pts)

29. A satellite orbits the Earth so that it is always in the shadow of the Earth (i.e. the Sun never shines directly on the satellite). What is the temperature of the satellite if it is a sphere with an albedo of 0.2 and a radius of 2 m and it orbits the Earth with a radius of 12,000 km. You can assume the radius of the Earth is 6,000 km. (10 pts)

30. A planet has a radius of 25,000 km and an atmosphere with a mass of 5×10^{21} kg. Assuming a gravitational constant of 21 m s^{-2} , what is the surface pressure on this planet? (10 pts)

31. **(10 pts)** Draw a diagram(s) of a low pressure system in the Southern Hemisphere. Be sure to show the horizontal (wind directions) and vertical motion. Label the compass directions on your diagram (i.e. North, etc). Indicate what type of weather is associated with this system and explain why. Be sure to draw in a cold front and a warm front (10 pts)
32. List three important forms of inorganic carbons (i.e. chemical compounds). What is the oxidation number of carbon in each of these compounds? (10 pts)

33. A large spherical hailstone has a terminal velocity of 50 m/s near the surface of the Earth ($T=293$ K). The density of ice is 0.88 g/cm^3 . What is the radius of the hailstone? (10 pts)

34. A solution initially contains hydrobromic acid (HF) and fluoride (Br^-) each at a concentration of 0.03 mol/l .

a. What is the pH of the solution? (10 pts)

b. If 0.01 mol/l of HCl were added to the solution above (a) what would be the pH? (10 pts)

c. If 0.1 mol/l of HCl were added to the solution in part (a) what would be the pH? (10 pts)

Equations

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. $\text{Pop}(t) = \text{Pop}(t_0)e^{rt}$

population at time t related to original population at t_0 and the growth rate constant - r

3. speed of light = $c = \lambda \nu = 3 \times 10^8 \text{ m/s}$

where λ = wavelength and ν = frequency

4. energy of a photon = $E = h\nu = hc/\lambda$

where h = Planck's constant = $6.63 \times 10^{-34} \text{ Js}$

5. $S(r)$ = radiant flux at a distance r from a point source = $S(r_0) [r_0/r]^2$

6. Surface area of a sphere with radius r; $A = 4\pi r^2$

7. λ_{max} = the wavelength (in μm) at which a blackbody at temperature T (in K) has its maximum radiant flux

$$= \frac{2898 \mu\text{mK}}{T}$$

8. S = radiant flux leaving the surface of a blackbody at temperature T (in K)

$$= \sigma T^4$$

where σ = Stefan-Boltzman constant = $5.67 \times 10^{-8} \text{ W/(m}^2 \text{ K}^4)$

9. T_{eff} = planet's effective temperature = $[(S^*/4) (1/\sigma) (1 - \text{albedo})]^{1/4}$

where (S^*) is the radiant flux impinging on the planet from its "sun"

for the Earth/Sun system $S=1370 \text{ W/m}^2$

10. $S=S^0 \cos(q)$ where q is the angle of incidence of a radiation striking a surface. S^0 is the flux of the radiation above the surface. S is the flux on the surface.

11. Pressure units $1 \text{ atm} = 1013 \text{ mb} = 10^5 \text{ Pa}$, $1 \text{ Pa} = 1 \text{ kg m}^{-1} \text{ s}^{-2}$

12. Ideal Gas Law $P = \rho R_m T$

where R_m is the gas constant for air = $287 \text{ J K}^{-1} \text{ kg}^{-1}$

ρ is the gas density, for example the gas density at sea level is $\sim 1.2 \text{ kg m}^{-3}$

13. $P=P_0 \exp(-z/H)$ is the barometric pressure law, where $H=8 \text{ km}$.

14. $1.0 \text{ ft} = 0.3048 \text{ meters}$

15. $d=vt$ (d -distance, v -velocity, t -time)

16. for water the heat of condensation/evaporation = 2500 J/g , heat of melting/freezing = 333 J/g

17. $D=0.4A\rho_{\text{air}}v^2$ (D - drag force, A -cross sectional area, v -velocity, ρ_{air} – density of air)

16. for hydrobromic acid (HBr), $K_a = 3.3 \times 10^{-6}$

17. $1 \text{ ft} = .305 \text{ m}$