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EAS 1600 - INTRODUCTION TO ENVIRONMENTAL SCIENCES

Fall, 2014

Final Exam Dec 10, 2014

<   **Relevant formulas, etc are included at the end of the exam**
<   **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. I also agree to abide by the grading policies of this class.

Signature: _____

A

Answer the following multiple choice questions (1-25)
(4 pts each)

1. Consider a parking lot in Sydney, Australia (34 ^{o}S) on June 21 at local noon. Estimate the incident angle of solar radiation (i.e. q) impacting the parking lot.

a) 56°
b) 10.5^o
c) 34°
d) 57.5^o

2. How much salt is in a 2 kg sample of ocean water that has a salinity of 33 ‰?

a) 0.175 kg
b) 6.6 kg
c) 0.66 kg
d) 66 g

3. Estimate the ratio of the solar radiation impacting Moscow (latitude = 56° N) in winter to that on the equinox.

a) 4.6
b) 0.33
c) 1.5
d) 2.7

4. A cylinder of compressed air has a pressure of 2 atm and a temperature close to 75 ^{o}C. What is the density of the air?

a) 1.2 kg m^{-3}
b) 190 g m^{-3}
c) 2.0 kg m^{-3}
d) 0.2 g cm^{-3}

5. Which of the following processes can impact the temperature of the Earth on time scales longer than one thousand years? Circle all that apply

a) volcanic explosions
b) changes in the Earth's orbit around the Sun
c) plate tectonics
d) rock weathering

6. Roughly how many hours of daylight will Moscow (latitude = 56° N) receive on March 21?

a) 8
b) 0
c) 12
d) 24

7. Which of the following is formed due to Continent-Continent plate convergence? Circle all that apply.

a) The Himalayas
b) Hawaiian Islands
c) Aleutian Islands
d) The Andes Mountains

8. What is the difference in air pressure between the top of Stone Mountain which is at an elevation of 1700 ft. and Decatur, GA which is at an elevation of 1000 ft.?

a) 0.94 atm
b) 0.023 atm
c) 0.084 atm
d) 15 Pa

9. The atmospheric pressure at 5.5 km altitude is approximately _____.

a) 2.3×10^4 Pa
b) 150 mb
c) 2.3 kPa
d) 0.5 atm

10. Outer Mongolia (population = 8 million) fears that its native population may be extinct by the year 2414. What is the best estimate of the population growth rate in Outer Mongolia?

a) 0.3 % year^{-1}
b) -4.0 % year^{-1}
c) -0.04% year^{-1}
d) -0.012 year^{-1}

11. What is the pressure at 30m below the surface of the ocean?

a) 4000 mb
b) 3000 mb
c) 2 atm
d) 1.1×10^5 Pa

12. As an air parcel ascends in the atmosphere it _____ and _____.

a) compresses, cools
b) expands, cools
c) expands, warms
d) compresses, warms

13. What is the mass of the Earth's atmosphere assuming that the radius is 6400 km?

a) 4000 tons
b) 5.3×10^{13} kg
c) 1.3×19^{19} kg
d) 5.3×10^{18} kg

14. Which of the following locations is most likely to be hit by a hurricane?

a) Los Angeles, CA
b) Cape Hatteras, NC
c) London, UK
d) San Francisco, CA

15. Which of the following is a key property of a greenhouse gas in the Earth system?

a) absorbs ultraviolet radiation
b) is less dense than air
c) contains a carbon atom
d) absorbs infrared radiation

16. A star emits light with a primary wavelength of 300 nm. This star is _____ than our Sun.

a) hotter than
b) colder than
c) the same temperature as

17. Where would you expect to find most saline ocean waters among the following choices?

a) In the Atlantic Ocean around 20~30° N
b) Near the coast of Greenland
c) At the Equator

18. 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.

19. Which of the following describes the subtropical high? Mark all that apply.

a)   High precipitation
b)   Low precipitation
c)   Rising air
d)   Sinking air

20. 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?

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

21. Which of the following has a depth profile that is maximum at the surface of the ocean? Circle all that apply.

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

22. What type of rock would be most likely found in a continental mountain range composed of igneous rock?

a) granite
b) limestone
c) basalt
d) marble

23. Which of the following minerals would you expect to weather the slowest?

a) Calcite
b) Halite
c) Quartz
d) Gypsum

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

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

25. Temperature increases with altitude in the stratosphere because_____.

a)   Hot air rises
b)   Ozone absorbs ultraviolet radiation
c)   There are a large number of clouds in the stratosphere
d)   None of the above.

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26. True or False. Mark each statement below as True or False (2 pts each)
  a. Chlorofluorocarbons (CFCs) lead to the destruction of ozone in the stratosphere. _____

  b. Photosynthesis oxidizes inorganic carbon to produce organic carbon. _____

  c. As the temperature of the atmosphere increases, atmospheric pressure increases._____

  d. CO_2 is the greenhouse gas that traps the most outgoing radiation._____

  e. Volcanoes can impact climate in both the short and long terms._____

  f. In the short term carbon cycle only photosynthesis, deforestation, and ocean uptake remove carbon from the atmosphere. _____

  g. Shield volcanoes are generally much larger than stratovolcanoes. _____

  h. The pH of rain water is buffered. _____

  i. In the long term rock weathering leads to warming of the climate. _____

  j. As the Earth warms, sea level rises._____

  k. The pH of the ocean is acidic._____

  l. Milankovitch Cycles impact climate on the time scale of the long term carbon cycle._____

  m. Basalt is an igneous rock associated with continental mountain ranges. _____

  n. Most of the bicarbonate in the ocean is formed from carbonic acid in rain water. _____

  o. Mt. Everest is a stratovolcano. _____

27. (10 pts) Draw a systems diagram that shows the relationship between the following components: 1) organic carbon in soils, 2) forest fires, and 3) atmospheric oxygen.
Be sure and label all couplings and indicate any feedback loops (positive or negative) and state if they are stable or unstable.

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28. (10 pts) List three inorganic carbon compounds and state the oxidation state of carbon in each one.

29. (10 pts) What is the maximum energy that could be absorbed by a 70 by 300 cm rectangle of blacktop in one minute assuming that it is located in Miami (25° N).

30. (10 pts) Assuming that Mars is 50% further away from the Sun than the Earth and that it has an albedo of 0.2. Estimate the average temperature of Mars.

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31. (10 pts) Draw a diagram(s) of a <u>low pressure</u> system in the <u>Southern Hemisphere</u>. Be sure to show the horizontal (wind directions) and vertical motion. Label the compass directions on your diagram (i.e. North, East, 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.

32. (10 pts) Estimate the terminal velocity of a 25 cm dia. hailstone near the surface of the Earth. The density of ice is .94 g cm^{-3}.

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33. (15 pts) Calculate the pH of the aqueous solutions below that contain the following components.

    a)   0.25 mole/l of carbonic acid.

    b)   0.15 mole/l of HCl and 0.5 mole/l of bicarbonate

    c)   0.2 mole/l of HCl, 0.5 mole/l of carbonic acid, and 0.2 mole/l of bicarbonate

Formulas, facts, and constants you may find useful:

1. The latitude of a point is earth is defined as the angle defined by that point, the center of the Earth, and the Equator. For Example, the Equator is 0°, and the South Pole is 90° S.

2. $P(t)=P\ (t_o)e^{rt}$
population at time t related to original population at t_o and the growth rate constant - r

3. speed of light = $c = \lambda \upsilon = 3 \times 10^8$ m/s
where λ = wavelength and υ = frequency

4. energy of a photon = $E = h\upsilon = hc/\lambda$
where h = Planck's constant = 6.63×10^{-34} Js

5. S = radiant flux at a distance r from a point source = $S_o\ [r_o/r]^2$

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 effective temperature T_{eff} (in K) has its maximum
    radiant flux

$$\lambda_{max} = \frac{2898\,\mu mK}{Teff}$$

8. S = radiant flux leaving the surface of a blackbody at temperature T (in K)
    $S = \sigma\ T_{eff}{}^4$
    where σ = Stefan-Boltzman constant = 5.67×10^{-8} W/(m^2 K^4)

9. T_{eff} = planet's effective temperature

$$T_{eff} = \left(\frac{S^*(1-A)}{4\sigma}\right)^{1/4}$$

    where (S*) is the radiant flux impinging on the planet from its "sun"
    and A is albedo. For the Earth/Sun system S=1370 W/m^2

10. K_a of carbonic acid (H_2CO_3) = 2×10^{-7}

11. The expression for an acid equilibrium constant for a generic acid (HX) is $K_a = \frac{[H^+][X^-]}{[HX]}$

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

13. 1 ft = .305 m