Name _____ **Student #** _____

Chemistry 301 - MIDTERM EXAM #1

Friday, October 7, 2011, 9:00 am
Only the standard UBC Science calculator (Sharp 510B) is permitted.
Worth 31 points (20% of course)

PART I (multiple choice – 15 points)
One point for each correct answer, no penalty for wrong answers - if you don't know, then guess. There is only one best answer for each question.

1. What is the classification used when a body of water is very high in nutrients and clogged with plant life?

   A. Eutrophic
   B. Autotrophic
   C. Dystrophic
   D. Oligotrophic
   E. Heterotrophic

2. Residence time is defined as:

   A. inputs / outputs
   B. (input or output) / inventory
   C. inventory / (input or output)
   D. inventory * (input or output)
   E. outputs / inputs

3. Why is water's boiling point so high compared to its molecular weight?

   A. Hydrogen bonding
   B. Large amount of dissolved ions
   C. pH
   D. Polarity
   E. Specific heat

4. Which of the following water conditions would offer the highest gas solubility in water?

   A. high salinity, high temperature, high pressure
   B. high salinity, low temperature, high pressure
   C. low salinity, low temperature, high pressure
   D. low salinity, high temperature, low pressure
   E. high salinity, low temperature, low pressure

5. In a high pH environment, compared to a low pH environment, assuming equilibrium with $Al(OH)_3$, $[Al^{3+}]$ is:

   A. more likely to precipitate
   B. less likely to precipitate
   C. equally likely to precipitate

6. When can you ignore [CO_3^{2-}] in the total CO_2 equation?

A. when the pH is high
B. when the pH is low
C. when the water is in equilibrium with the atmosphere
D. in an anoxic environment
E. in the marine environment

7. Why does soap scum form?

A. Soap complexes with calcium ions.
B. Soap kills bacteria and forms a complex.
C. Soap complexes with dissolved CO_2 in the water.
D. Soap complexes with phosphate.
E. Soap complexes with hydroxide in water.

8. Compared to other ligands, why do chelates hold metals more strongly?

A. Chelating ligands have less steric hindrance.
B. Chelating functional groups are much stronger.
C. Chelating ligands have stronger interactions with d-orbitals.
D. Chelating ligand attach at multiple sites.
E. Chelating ligands aren't as affected by pH.

9. What makes a contaminant different than a pollutant?

A. A contaminant is only a radioactive species released into the environment.
B. A contaminant is at a comparatively low concentration in the environment.
C. A contaminant is a one-time occurrence in the environment.
D. A contaminant is not known to be a problem in the environment.
E. A contaminant is a species that never existed in nature before human input.

10. Given the following pKa's for H_3NTA:
pKa1 = 1.66
pKa2 = 2.95
pKa3 = 10.28
At what pH do you expect $HNTA^{2-}$ to be dominant?

A. pH < 1.66
B. 1.66 < pH < 2.95
C. 2.95 < pH < 10.28
D. pH > 10.28

11. For Fe^{2+}, when you change from high pH (pH = 10) to low pH (pH = 3), what hydrolysis reaction do you expect?

A. aqua to hydroxo
B. hydroxo to aqua
C. oxo to hydroxo
D. hydroxo to oxo
E. aqua to oxo

12. Humic substances are divided into three groups. What are the three groups based on?

A. ionic strength
B. weight
C. solubility
D. functional groups present (N vs. O)
E. electronegativity

Name _____ **Student #** _____

13. If pH = pKa - 1, what is the ratio of the two dominant species in solution?

A. 100:1
B. 2:1
C. 3:2
D. 1:1
E. 10:1

14. Water hardness is a measure of:

A. the carbonate in solution
B. solids in solution
C. cations in solution
D. basicity of a solution
E. the soap scum in a solution

15. Total CO_2 is:

A. All of the CO_2 gas dissolved in water
B. The CO_2 gas plus the HCO_3^- dissolved in water
C. The CO_2 gas plus the CO_3^{2-} dissolved in water
D. The CO_2 gas plus the HCO_3^- and the CO_3^{2-} dissolved in water
E. All of the carbon in all forms dissolved in water

PART II (short answer – 10 pts)

16. (3 pts)

a) Define carbonate alkalinity in an equation and in words.

b) What makes CO_3^{2-} different compared to other contributors to this equation? Why?

c) What determines the alkalinity of natural waters?

17. (4 pts)

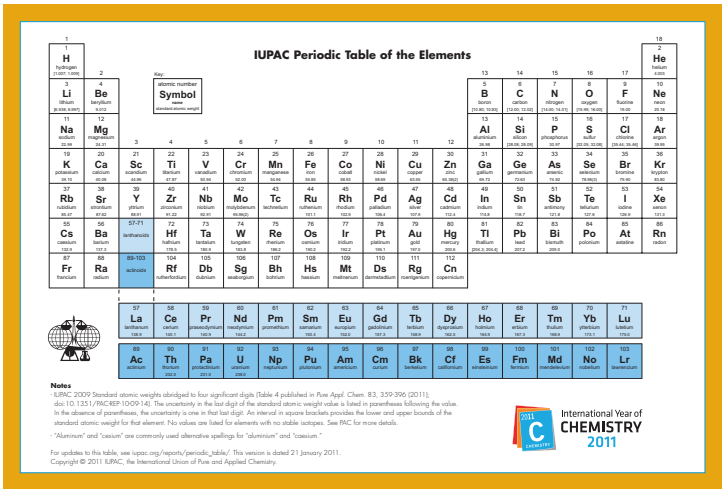
a) Explain the three major factors which contribute to the occurrence of limnic eruptions.

b) Which of these factors ensures that Canadian lakes are at a low risk for limnic eruptions?

18. (2 pts) On the periodic table below, circle and label:

a) the primary region where you find A-type metals.

b) the region where you find the ligand atoms A-type metals prefer to bind with.



19. (1pt) Why can we ignore the concentration of $PbNTA^-$ in a total NTA equation when NTA >>> Pb^{2+}?

Name _____ **Student #** _____

PART III (calculations – 6 pts)

4) For a lake where pH = 8 and the carbonate concentration is determined to be 0.1 mM, answer the following questions. *(If you are doing this without a calculator, you may round off all pK's to the nearest whole number, and round off other numbers as needed.)*

(a) (2 points) Calculate the expected $[Pb^{2+}]$ based on equilibrium with $Pb(OH)_2(s)$.

(b) (2 points) Calculate the expected $[Pb^{2+}]$ based on equilibrium with $Pb(CO_3)(s)$.

(c) (2 points) If the measured concentration of dissolved Pb in this lake is 10^{-10}M, do you expect that Pb will be precipitating in this lake? Why? If yes, what precipitate will be forming?

Extra Page – use as needed.