Northern Arizona University **Exam #2**
CHM 151, General Chemistry I Dr. Brandon Cruickshank
Section 4, Fall 2005 October 27, 2005

Name _____

ID # _____

INSTRUCTIONS:

- PRINT your name and ID# above.
- Code the answers to the True-False and Multiple-Choice questions on the scantron form. Mark **A** for true and **B** for false. There is only ***one*** correct answer for each multiple choice question. There is no partial credit given for this section.
- Show all work on the problems section because partial credit is awarded for this section.
- On the scantron form, write the color of your exam above your name.
- Below your ID# above, answer the following question. In one word, attempt to describe your feelings about chemistry. Try to keep it clean. You will receive 1 bonus pt.
- There are **86** points on this exam.

GOOD LUCK! ENJOY!!

PART I: True-false statements (3 points each)

1. A weak acid or a weak base does not ionize in water.

2. There are **6** unpaired electrons in a Cr atom.

3. Consider the following reaction: $Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$. In this reaction, $Cu^{2+}(aq)$ is reduced.

4. When ice melts to form liquid water, the process is exothermic.

PART II: Multiple Choice (3 points each)

5. What is the **molarity** of a solution prepared by dissolving 3.65 grams of $NaNO_3$ in 250 mL of solution?

[a] 0.0932 *M* [b] 0.0429 *M* [c] 0.172 *M* [d] 14.6 *M* [e] 1.72×10^{-4} *M*

6. What **volume** of 1.10 *M* K_2CO_3 is needed to prepare 400 mL of a 0.200 *M* K_2CO_3 solution?

[a] 36 mL [b] 72.7 mL [c] 128 mL [d] 144 mL [e] 2.20×10^{3} mL

7. Consider the reaction of potassium hydroxide, KOH, with sulfuric acid, H_3PO_4. Balance the equation with the smallest whole number coefficients. What is the **balancing coefficient** for water?

[a] 0 [b] 1 [c] 2 [d] 3 [e] 4

8. Which of the following is the correct **net ionic** equation for the reaction that occurs when solutions of $Ba(NO_3)_2$ and NaOH are mixed?

[a] $Ba(NO_3)_2\,(aq) + 2\,NaOH\,(aq) \rightarrow 2\,NaNO_3\,(aq) + Ba(OH)_2\,(s)$
[b] $Ba^{2+}\,(aq) + 2\,OH^-\,(aq) \rightarrow Ba(OH)_2\,(s)$
[c] $Ba^{2+}\,(aq) + 2\,NO_3^-\,(aq) + 2\,Na^+\,(aq) + 2\,OH^-\,(aq) \rightarrow 2\,Na^+\,(aq) + 2\,NO_3^-\,(aq) + Ba(OH)_2\,(s)$
[d] $2\,Na^+\,(aq) + 2\,NO_3^-\,(aq) \rightarrow 2\,NaNO_3\,(aq)$
[e] There is no reaction when the solutions are mixed.

9. Given the three statements below, which answer is **correct**? [3 pts]

(1) In an endothermic reaction, heat is transferred from the surroundings to the system.
(2) The sign of ΔH for an endothermic reaction is positive.
(3) An exothermic reaction releases heat.

[a] 2 and 3 are true, 1 is false
[b] 1 and 3 are true, 2 is false
[c] 1 and 2 are false, 3 is true
[d] 1, 2, and 3 are false
[e] 1, 2, and 3 are true

10. Which one of the following reactions occurring at 25°C does the symbol ΔH_f° for $H_2SO_4(l)$ refer to?

[a] $2\,H(g) + S(s) + 4\,O(g) \rightarrow H_2SO_4(l)$
[b] $H_2SO_4(l) \rightarrow H_2(g) + S(s) + 2\,O_2(g)$
[c] $H_2(g) + S(s) + 2\,O_2(g) \rightarrow H_2SO_4(l)$
[d] $H_2SO_4(l) \rightarrow 2\,H(g) + S(s) + 4\,O_2(g)$
[e] $H_2(g) + S(s) + O_4(g) \rightarrow H_2SO_4(l)$

11. Given the following standard heats of formation, calculate the enthalpy change, ΔH, for the following reaction:

$$2\,H_2O\,(g) + 2\,SO_2\,(g) \rightarrow 2\,H_2S\,(g) + 3\,O_2\,(g) \qquad \Delta H_{rxn}^\circ = ?$$

$\Delta H_f^\circ[H_2S(g)] = -20.15$ kJ/mol
$\Delta H_f^\circ[H_2O(g)] = -241.8$ kJ/mol
$\Delta H_f^\circ[H_2O(l)] = -285.8$ kJ/mol
$\Delta H_f^\circ[SO_2(g)] = -296.1$ kJ/mol

[a] +1124 kJ/mol
[b] +517.8 kJ/mol
[c] +561.7 kJ/mol
[d] –1036 kJ/mol
[e] none of these

12. Calculate the enthalpy change, ΔH, for the reaction

$$2\,C_8H_{18}\,(g) + 17\,O_2\,(g) \rightarrow 16\,CO\,(g) + 18\,H_2O\,(l)$$

using the following information:

$2\,C_8H_{18}\,(g) + 25\,O_2\,(g) \rightarrow 16\,CO_2\,(g) + 18\,H_2O\,(l)$ $\Delta H = -11020$ kJ
$2\,CO\,(g) + O_2\,(g) \rightarrow 2\,CO_2\,(g)$ $\Delta H = -566$ kJ

[a] –6492 kJ
[b] –10454 kJ
[c] 15548 kJ
[d] +6492 kJ
[e] –15548 kJ

13. Given the balanced equation below, what is the ΔH for the combustion of 24.04 grams of SO(*g*) in an excess of oxygen?

$$2\,SO\,(g) + O_2\,(g) \rightarrow 2\,SO_2\,(g) \qquad \Delta H_{rxn}^\circ = -592.8\text{ kJ}$$

[a] –18.5 kJ
[b] –296.4 kJ
[c] +296.4 kJ
[d] –148.2 kJ
[e] –384 kJ

14. The **energy** of a photon of light is _____ proportional to its frequency and _____ proportional to its wavelength.

[a] directly, directly [b] inversely, inversely [c] directly, inversely
[d] inversely, directly [e] indirectly, not

15. Microwaves have *longer* wavelengths than ultraviolet-rays. Which of the following statements is **true**?

[a] Microwaves have lower frequencies than UV-rays.
[b] Microwaves travel slower than UV-rays.
[c] Microwaves are higher energy than UV-rays.
[d] Microwaves have a larger amplitude than UV-rays.
[e] none of the above statements is true.

16. Calculate the **wavelength** (in nm) of a photon that has a frequency of 6.912×10^{14} Hz.

[a] 4.823×10^{-24} nm [b] 434 nm [c] 2.304×10^{6} nm
[d] 2.074×10^{23} nm [e] 4.34×10^{-7} nm

17. Of the following transitions in the hydrogen atom, which transition is caused by *absorption* of a photon with the *lowest* frequency.

[a] $n = 1 \rightarrow n = 2$ [b] $n = 1 \rightarrow n = 6$ [c] $n = 5 \rightarrow n = 1$
[d] $n = 6 \rightarrow n = 5$ [e] $n = 1 \rightarrow n = 8$

18. What is the **wavelength** (in m) of light emitted by a hydrogen atom during the transition of its electron from the $n = 7$ to the $n = 4$ energy level?

[a] 4.45×10^{-20} m [b] 2.17×10^{-6} m [c] 9.18×10^{-20} m
[d] 1.38×10^{14} m [e] none of these

19. In an electron microscope, electrons are accelerated to great velocities. Calculate the **wavelength** of an electron traveling with a velocity of 7.0×10^{3} kilometers per second. The mass of an electron is 9.1×10^{-31} kg.

[a] 1.0×10^{-13} m [b] 1.0×10^{-7} m [c] 1.0 m [d] 1.0×10^{-10} m [e] 1.0×10^{-4} m

20. Which of the following sets of quantum numbers could apply to the *eleventh* electron of any atom? (n, l, m_l, m_s)

[a] 3, 2, –1, –1/2 [b] 2, 1, –1, +1/2 [c] 2, 0, 0, –1/2 [d] 3, 1, +1, –1/2 [e] 3, 0, 0, +1/2

21. An atom with the following electron configuration would belong to what **family** of the periodic table?

$$[Ne]3s^2 3p^5$$

[a] alkali metals [b] halogens [c] noble gases [d] coinage metals [e] alkaline earth metals

22. The ground state of which atom below has the **most** unpaired electrons.

[a] P [b] O [c] Se [d] Fe [e] N

PART III: Problems

23. A feverish student weighing 75 kilograms was immersed in 400 kg of water at 4.0°C to try to reduce the fever. The student's temperature dropped from 40°C to 37°C. Assuming the specific heat of the student to be 3.77 J/g·°C, what was the final temperature of the water? [s_{H_2O} = 4.184 J/g·°C] [5 pts]

24. An acid-base titration was used to analyze an impure sample of sodium bisulfate ($NaHSO_4$) using NaOH as the standard solution.

$$NaHSO_4 + NaOH \rightarrow Na_2SO_4 + H_2O$$

A 0.3456 g impure sample of $NaHSO_4$ required 17.08 mL of 0.1376 *M* NaOH to reach the end point of the titration. What is the **percent purity** of the $NaHSO_4$ sample? [**Hint:** $\text{percent purity} = \frac{\text{mass of substance in the sample}}{\text{mass of sample}} \times 100\%$]

[6 pts]

25. Write both an **electron configuration** and an **orbital diagram** for each of the following. You may use shorthand notation. [9 pts]

[a] Se

[b] Nb

[c] Sr

Potentially Useful Information

$q = ms\Delta t$

$\Delta t = t_f - t_i$

$c = \lambda\nu$

$\Delta H^\circ_{rxn} = \sum n\Delta H^\circ_f(\text{products}) - \sum n\Delta H^\circ_f(\text{reactants})$

$c = 3.00 \times 10^8$ m/s

$1\text{ g} = 6.022 \times 10^{23}$ amu

$E = h\nu$

Avogadro's number $= 6.022 \times 10^{23}$ particles/mole

$h = 6.626 \times 10^{-34}$ J·s

$E = \dfrac{hc}{\lambda}$

$1\text{ J} = \dfrac{1\text{ kg}\cdot\text{m}^2}{\text{s}^2}$

$\lambda = \dfrac{h}{mu}$

$\Delta E = -R_H\left(\dfrac{1}{n_f^2} - \dfrac{1}{n_i^2}\right)$

$E_n = -R_H\left(\dfrac{1}{n^2}\right)$

$R_H = 2.18 \times 10^{-18}$ J

$\Delta E = E_f - E_i$

$\text{Molarity} = \dfrac{\text{moles solute}}{\text{L of solution}}$

$1\text{ Mm} = 1 \times 10^6$ m

$M_1V_1 = M_2V_2$

SOLUBLE COMPOUNDS	EXCEPTIONS
Compounds containing alkali metal ions (Li^+, Na^+, K^+, Rb^+, Cs^+) and the ammonium ion (NH_4^+)	
Nitrates (NO_3^-), bicarbonates (HCO_3^-), and chlorates (ClO_3^-)	
Halides (Cl^-, Br^-, I^-)	Halides of Ag^+, Hg_2^{2+}, and Pb^{2+}
Sulfates (SO_4^{2-})	Sulfates of Ag^+, Ca^{2+}, Sr^{2+}, Ba^{2+}, and Pb^{2+}
INSOLUBLE COMPOUNDS	**EXCEPTIONS**
Carbonates (CO_3^{2-}), phosphates (PO_4^{3-}), chromates (CrO_4^-), and sulfides (S^{2-})	Compounds containing alkali metal ions and the ammonium ion
Hydroxides (OH^-)	Compounds containing alkali metal ions and the Ba^{2+} ion