Northern Arizona University **Exam #2**
CHM 151, General Chemistry I Dr. Brandon Cruickshank
Section 4, Fall 2004 October 28, 2004

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. What is your favorite band or solo artist? You will receive 1 bonus pt.
- There are **84** points on this exam.

GOOD LUCK! ENJOY!!

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

1. A weak acid or a weak base partially ionizes in water.

2. There are **4** unpaired electrons in a Cr atom.

3. In an exothermic reaction, heat flows from the surroundings to the system.

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

PART II: Multiple Choice (3 points each)

5. What is the **molarity** of a solution prepared by dissolving 5.65 grams of NaCl in 250 mL of solution?

[a] 3.87×10^{-4} *M* [b] 58.4 *M* [c] 0.0967 *M* [d] 0.387 *M* [e] 0.0226

6. What **volume** of 1.1 *M* Li_2SO_4 is needed to prepare 200 mL of a 0.20 *M* Li_2SO_4 solution?

[a] 1.1×10^{-3} mL [b] 36 mL [c] 64 mL [d] 1.1×10^{3} mL [e] none of these

7. Consider the reaction of potassium hydroxide, KOH, with sulfuric acid, H_2SO_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 $Pb(NO_3)_2$ and NH_4Cl are mixed?

[a] $Pb(NO_3)_2\,(aq) + 2\,NH_4Cl\,(aq) \rightarrow 2\,NH_4NO_3\,(aq) + PbCl_2\,(s)$
[b] $Pb^{2+}\,(aq) + 2\,Cl^-\,(aq) \rightarrow PbCl_2\,(s)$
[c] $Pb^{2+}\,(aq) + 2\,NO_3^-\,(aq) + 2\,NH_4^+\,(aq) + 2\,Cl^-\,(aq) \rightarrow 2\,NH_4^+\,(aq) + 2\,NO_3^-\,(aq) + PbCl_2\,(s)$
[d] $2\,NH_4^+\,(aq) + 2\,NO_3^-\,(aq) \rightarrow 2\,NH_4NO_3\,(aq)$
[e] There is no reaction when the solutions are mixed.

9. Which one of the following reactions occurring at 25°C does the symbol ΔH_f° for $HNO_3(l)$ refer to?

[a] $H(g) + N(g) + O_2(g) \rightarrow HNO_3(l)$
[b] $HNO_3(l) \rightarrow \frac{1}{2}\,H_2(g) + \frac{1}{2}\,N_2(g) + \frac{3}{2}\,O_2(g)$
[c] $HNO_3(l) \rightarrow H_2(g) + N_2(g) + O_2(g)$
[d] $HNO_3(l) \rightarrow H(g) + N(g) + O_2(g)$
[e] $\frac{1}{2}\,H_2(g) + \frac{1}{2}\,N_2(g) + \frac{3}{2}\,O_2(g) \rightarrow HNO_3(l)$

10. Given the balanced equation below, what is the $\boldsymbol{\Delta H}$ for the combustion of 19.0 grams of $CO(g)$ in an excess of oxygen?

$$2\,CO\,(g) + O_2\,(g) \rightarrow 2\,CO_2\,(g) \qquad \Delta H_{rxn}^\circ = -566\ kJ$$

[a] –29.8 kJ [b] –283 kJ [c] +283 kJ [d] –192 kJ [e] –384 kJ

11. Ethanol, C_2H_5OH, undergoes combustion according to the equation

$$C_2H_5OH\,(l) + 3\,O_2\,(g) \rightarrow 2\,CO_2\,(g) + 3\,H_2O\,(l) \qquad \Delta H_{rxn}^\circ = -1366.8\ kJ$$

Given that: $\Delta H_f^\circ\,[CO_2(g)] = -393.5$ kJ/mol $\Delta H_f^\circ\,[H_2O(l)] = -285.8$ kJ/mol

What is the **standard enthalpy of formation** of ethanol ($\Delta H_f^\circ\,[C_2H_5OH(l)]$)?

[a] 3,010 kJ [b] –687.6 kJ [c] –277.6 kJ [d] 687.6 kJ [e] 1,367 kJ

12. Calculate the enthalpy change, $\boldsymbol{\Delta H}$, for the reaction

$$C\ (graphite) + 2\,H_2\,(g) + \tfrac{1}{2}\,O_2\,(g) \rightarrow CH_3OH\,(l)$$

using the following information:

$C\ (graphite) + O_2\,(g) \rightarrow CO_2\,(g)$ $\Delta H = -393.5$ kJ
$H_2\,(g) + \frac{1}{2}\,O_2\,(g) \rightarrow H_2O\,(l)$ $\Delta H = -285.8$ kJ
$CH_3OH\,(l) + \frac{3}{2}\,O_2\,(g) \rightarrow CO_2\,(g) + 2\,H_2O\,(l)$ $\Delta H = -726.4$ kJ

[a] –1691.5 kJ [b] –47.1 kJ [c] 1691.5 kJ [d] 47.1 kJ [e] –238.7 kJ

13. How much **heat** needs to be added to an 8.77 gram piece of nickel to raise its temperature from 22.0°C to 27.0°C? [$s_{Ni} = 0.444$ J/g·°C]

[a] 19.5 J [b] 22.8 J [c] 6.88 J [d] 15.2 J [e] none of these

14. Which of the following regions of the electromagnetic spectrum has the **highest energy**?

[a] Ultra-violet light [b] Visible light [c] Infrared light
[d] Light with the longest wavelength [e] Light with the lowest frequency

15. Calculate the **wavelength** (in nm) of a photon that has a frequency of 5.49×10^{14} Hz.

[a] 6.07×10^{3} nm [b] 546 nm [c] 0.126 nm [d] 1.83×10^{6} nm [e] 1.65×10^{14} nm

16. Of the following transitions in the hydrogen atom, which transition results in the *emission* of a photon with the *lowest* frequency.

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

17. What is the **wavelength** (in nm) of light emitted by a hydrogen atom during the transition of its electron from the $n = 3$ to the $n = 1$ energy level?

[a] 102.6 nm [b] 136.9 nm [c] 365.0 nm [d] 1.45×10^{-9} nm [e] 1.94×10^{-18} nm

18. What is the **velocity** (in m/s) of an electron if it has a wavelength of 6.4×10^{-12} m?
[mass electron = 9.109×10^{-31} kg]

[a] 1.14×10^{8} m/s [b] 8.79×10^{-9} m/s [c] 2.15×10^{14} m/s
[d] 6.87×10^{10} m/s [e] none of these

19. Which of the following is ***TRUE***?

[a] An orbital is a region of space where an electron is most likely to reside.
[b] In the usual order of filling electrons in orbitals of atoms, the $(n + 1)s$ orbital is filled before the nd orbital.
[c] There are two possible spins for an electron, +1/2 or –1/2.
[d] An orbital can hold at most two electrons.
[e] All of the above are true.

20. Three sets of quantum numbers are listed below. Pick the best answer.

I. $n = 3, l = 3, m_l = 2$ II. $n = 4, l = 2, m_l = 0$ III. $n = 1, l = 0, m_l = 0$

[a] I and II are allowed sets, III is not
[b] only III is an allowed set
[c] II and III are allowed sets, I is not
[d] all three sets are allowed
[e] only II is an allowed set

21. Which of the following is the general electron configuration for the outermost electrons for elements in the *alkaline earth metal* family?

[a] ns^1 [b] ns^2 [c] ns^2np^4 [d] ns^2np^5 [e] $ns^2np^6(n-1)d^6$

22. An atom of vanadium (V) has _____ unpaired electrons and is _____ .

[a] 0, diamagnetic [b] 2, diamagnetic [c] 3, paramagnetic [d] 5, paramagnetic [e] 7 paramagnetic

PART III: Problems

23. A piece of copper metal weighing 104.4 grams was heated to 100°C and then dropped into 180 grams of water at 25°C. The copper metal cooled down and the water became warmer until both were at a temperature of 28.8°C. Calculate the ***specific heat*** of copper. [$s_{H_2O} = 4.184\ J/g \cdot °C$] [4 pts]

24. A sample containing sodium bicarbonate ($NaHCO_3$) was titrated with a NaOH standard solution.

$$NaHCO_3 + NaOH \rightarrow Na_2CO_3 + H_2O$$

It took 23.07 mL of 0.1576 *M* NaOH to reach the equivalence point of the titration. Calculate the number of **grams** of $NaHCO_3$ in the sample. [5 pts]

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

[a] P

[b] Rh

[c] Ba

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 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