Final Exam
CHEM 101, Winter 07 (200 points)

General Instructions.
- Please make sure to write your name on every page.
- There are two parts on the exam: a multiple choice and problem-solving/short-answer part. Please follow directions as indicated in each section.
- Good luck!

Part 1. Multiple Choice Questions (Circle Your Choice).

1. (5 pts) What is the pH of a solution with $[\text{H}_2\text{O}^+] = 1 \times 10^{-9}$ M?
   a. $1.0 \times 10^{-5}$ M.
   b. $-9.0$
   c. $5.0$
   d. $-5.0$
   e. $9.0$
   \[ \text{pH} = -\log [\text{H}_2\text{O}^+] = -\log (1 \times 10^{-9}) = 9 \]

2. (5 pts) Which of the following is the strongest acid? (You should know them!)
   a. $\text{H}_3\text{PO}_4$
   b. $\text{NH}_4^+$
   c. $\text{NaOH}$
   d. $\text{H}_2\text{CO}_3$
   e. $\text{HCl}$

3. (5 pts) How many milliliters of 0.400 M NaOH are required to completely neutralize 20.00 mL of 0.200 M HCl?
   a. 50.0 mL
   b. 40.0 mL
   c. 0.100 mL
   d. 20.0 mL
   e. 10.0 mL
   \[ v_2 = \frac{v_1 \cdot M_1}{M_2} = \frac{(20.0 \text{ mL})(0.20 \text{ M})}{0.40 \text{ M}} = 10.0 \text{ mL} \]

4. (5 pts) A researcher needed three samples of sodium chloride solution, each with a volume of 0.003510 mL. The total volume needed should be reported as
   a. 0.105 mL
   b. 0.0105 mL
   c. 0.10 mL
   d. 0.1053 mL
   e. 0.1100 mL
   \[ 3 \times 0.003510 \text{ mL} = 0.01053 \]
   \[ \text{Note this is missing a zero.} \]
5. (5 pts) Carrots are $0.79 per pound. What is the cost of 1.2 kg of carrots?
   a. $2.10
   b. $0.43
   c. $1.45
   d. $0.79
   e. $0.95

   \[
   1.2 \text{ kg} \times \frac{2.20 \text{ kg}}{1 \text{ kg}} \times \frac{\$0.79}{1 \text{ kg}} = \$2.08 \approx \$2.10
   \]

6. (5 pts) In the following reaction, what is the effect of adding more NO₂ to the starting reaction mixture?
   \[2\text{NO}_2 \rightarrow \text{N}_2\text{O}_4\]
   a. It would make the reaction more endothermic
   b. It would make the reaction more exothermic
   c. It would slow down the reaction
   d. It would decrease the final quantities of products
   e. It would increase the final quantities of products

7. (5 pts) In the following reaction, what is the effect on the direction of the reaction if more SO₃ is added to the reaction mixture?
   \[2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3\]
   a. Equilibrium shifts to produce more products
   b. Equilibrium position remains unchanged
   c. Rate of product formation increases
   d. Equilibrium shifts to produce more reactants
   e. The catalyst for the reaction is used up.

8. For the following reaction, the equilibrium constant \(K_c\) is 2.0 at a certain temperature. If the concentration of both products is 0.10 M at equilibrium, what is the concentration of the starring material, NOBr?
   \[2\text{NOBr} \rightarrow 2\text{NO} + \text{Br}_2\]
   a. \(5 \times 10^4\) M
   b. \(2.2 \times 10^{-4}\) M
   c. \(5 \times 10^{-2}\) M
   d. \(2.2 \times 10^{-2}\) M
   e. 2.2 M

   \[K_c = \frac{[\text{NO}]^2 [\text{Br}_2]}{[\text{NOBr}]^2}\]
   \[\frac{[\text{NOBr}]^2}{K_c} = \frac{[\text{NO}]^2 [\text{Br}_2]}{1}\]
   \[2 \times \frac{K_c}{0.10} = \frac{(0.10)^2 (0.10)}{2.0}\]
   \[2 \times \frac{1}{0.10} = \frac{(0.10)^2 (0.10)}{2.0}\]
   \[\sqrt{5 \times 10^{-4}} = 2.2 \times 10^{-2} \text{ M}\]
9. What is the correct form for the equilibrium constant for this reaction?

$$H_2 + F_2 \rightarrow 2HF$$

\[ K = \frac{(\frac{[HF]}{[H_2][F_2]})^2}{[HF]^2} \]

a. \( \frac{[HF]}{[H_2][F_2]} \)

b. \( \frac{[HF]^2}{[H_2][F_2]} \)

c. \( \frac{[H_2][F_2]}{[HF]} \)

d. \( \frac{[H_2][F_2]}{[HF]^2} \)

e. \( \frac{[H_2][F_2]}{2[HF]} \)

10. (5 pts) The rate of any chemical reaction can be determined by observing
   a. The amount of product formed in a unit of time
   b. The ratio of product concentration to reactant concentration
   c. The percent composition of the final product
   d. The theoretical yield of the product
   e. The number of chemical bonds broken and remade

11. (5 pts) What is the nuclear symbol for a radioactive isotope of copper with a mass number of 60?

   a. \(^{60}\text{Cu}\)
   b. \(^{60}\text{Cu}\)
   c. \(^{60}\text{Cu}\)
   d. \(^{61}\text{Cu}\)
   e. \(^{61}\text{Cu}\)

12. (5 pts) The product from the alpha decay of \(^{235}\text{U}\) is

   a. \(^{235}\text{Np}\)
   b. \(^{239}\text{Pu}\)
   c. \(^{231}\text{Th}\)
   d. \(^{233}\text{Ra}\)
   e. \(^{236}\text{U}\)

\[ ^{235}\text{U} \rightarrow ^{231}\text{Th} + ^{4}\text{He} \]
Name ________________

13. (5 pts) The symbol $^0_1 e$ is a symbol used for a(n)
   
   a. Proton
   b. Positron
   c. Gamma ray
   d. β particle
   e. α particle

14. (5 pts) The nuclear reaction shown below is an example of what type of process?

   $^{224}_{90} \text{Th} \rightarrow ^{220}_{88} \text{Rn} + ^4_2 \text{He}$

   a. Fusion
   b. Fission
   c. Translation
   d. Alpha emission
   e. Beta emission

15. (5 pts) Au is the symbol for

   a. Gold
   b. Silver
   c. Argon
   d. Aluminum
   e. Sodium

16. (5 pts) The Group 8A elements

   - Are unreactive and rarely found in combination with other elements
   - Are good conductors of electricity
   - Melt at high temperature
   - Are liquid at room temperature
   - React vigorously with water

17. (5 pts) An ionic compound

   a. Has a net positive charge
   b. Has a net negative charge
   c. Contains only cations
   d. Contains only anions
   e. Has a net charge of zero
18. (5 pts) The ability of an atom to attract the shared electrons in a covalent bond is its ____________
   a. Electron negativity
   b. Polarity
   c. Bonding ability
   d. Ionic character
   e. Non-polarity

19. (5 pts) The reaction of carbon with oxygen to produce carbon monoxide is an example of which class of reactions?
   a. Single replacement
   b. Double replacement
   c. Combination
   d. Catalytic
   e. Endothermic

\[ 2C + O_2 \rightarrow 2CO \]

20. (5 pts) In Gay-Lussac’s law, the pressure of a gas increases due to increases in temperature because
   a. The molecules strike the walls of the container less often
   b. The molecules strike the walls of the container more often
   c. The molecules get bigger
   d. There is decrease in the volume of the container
   e. There is an increase in the number of gas particles

**Part 2: Short Answer/Problem-Solving Questions.**

21. (10 pts) Name the following compounds.

   a. Al₂(SO₄)₃ ____________
   b. SF ____________
   c. Li₃N ____________
   d. Na₂CO₃ ____________
   e. CuI₂ ____________

22. (10 pts) Write formulas for the following compounds.

   a. Diphosphorus pentaoxide ____________
   b. Lead (II) oxide ____________
   c. Potassium cyanide ____________
   d. Copper (II) nitrate ____________
   e. Zinc sulfide ____________
23. (10 pts) The heat of fusion for water is 80. cal/g and the heat of vaporization is 540 cal/g. How many calories are required to convert 10.0 g of ice at 0°C to steam at 100°C?

\[
\frac{10.0 \text{ g} \times 80 \text{ cal}}{1 \text{ g}} = 800 \text{ cal}
\]
\[
\frac{10.0 \text{ g} \times 100 \text{ cal}}{1 \text{ °C}} = 1000 \text{ cal}
\]
\[
\frac{10.0 \text{ g} \times 540 \text{ cal}}{1 \text{ °C}} = 5400 \text{ cal} \text{ or } 7.2 \text{ kcal}
\]

24. (10 pts) How many calories are required to increase the temperature of 13g of alcohol from 11 °C to 23 °C? The specific heat of alcohol is 0.58 cal/g °C.

\[
\text{Heat} = 13 \text{ g} \times 12 \text{ °C} \times 0.58 \text{ cal} = 90.5 \text{ cal}
\]

25. (10 pts) Write the balanced chemical equation for the reaction, if any, that occurs when solid iron and aqueous hydrochloric acid are mixed. Indicate what type of reaction is involved.

\[
\text{Fe(s)} + \text{HCl(aq)} \rightarrow \text{FeCl}_2(aq) + \text{H}_2 \text{ gas}
\]

No Reaction

26. (10 pts) Predict the molecular structure of carbon dioxide molecule. Is this molecule expected to have dipole moment? (Hint, draw dot-structures).

\[
\text{CO}_2 \quad \overset{\text{o}}{\text{C}} = \overset{\text{O}}{\text{C}} \quad \text{linear}
\]

27. (10 pts) Give the electron configuration for sulfur.

\[
1s^2 2s^2 2p^6 3s^2 3p^4
\]

28. (10 pts) Express the following in a scientific notation and indicate how many significant figures there is in each number.

<table>
<thead>
<tr>
<th>Scientific Notation</th>
<th>Number of Significant Figures</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. (3.408 \times 10^{-3})</td>
<td>4</td>
</tr>
<tr>
<td>b. (3.51 \times 10^6)</td>
<td>3</td>
</tr>
<tr>
<td>c. (5.8542 \times 10^3)</td>
<td>5</td>
</tr>
<tr>
<td>d. (2.35 \times 10^5)</td>
<td>5</td>
</tr>
<tr>
<td>e. (8.60 \times 10^3)</td>
<td>3</td>
</tr>
</tbody>
</table>
Name ______________________

29. (10 pts) Calculate the molar mass of sucrose, C_{12}H_{22}O_{11}, and the percentage of each element of this compound.

\[C: 12 \times 12 = 144\]
\[H: 12 \times 1 = 12\]
\[O: 11 \times 16 = 176\]
\[
\frac{144 + 12 + 176}{232} \times 100 = 43.4\% \\
7\% H = 3.6\% \\
53\% O
\]

30. (10 pts) Hooray, hooray, the last question! The half-life of bromine-74 is 25 minutes. How much of 4.0 mg sample is still active after 75 minutes?

\[t_{1/2} = 25\text{ minutes}\]
\[75 \text{ minutes} = 3 \text{ half-lives} \left(\frac{75}{25} = 3\right)\]
\[4.0 \text{ mg } \times \left(\frac{1}{2}\right)^3 = 0.5 \text{ mg}\]

And finally: It was nice having you all in this class, I have enjoyed your company. Good luck to you all in your future academic endeavors.