Exam 2 Name:_____

Chem 1A, Fall 2019

Fossum

Note: there are 5 points of extra credit "built in" to this exam.

1. (5) When a piece of manganese metal is placed in a solution of zinc sulfate, a dark coating forms on the surface of the manganese.

$Mn_{(s)} + Zn(NO_3)_{2\,(aq)} \rightarrow Mn(NO_3)_{2\,(aq)} + Zn_{(s)}$

a. Which is the more active metal, Zn or Mn? Explain how you can tell.

b. Find the oxidation number of each atom in the reaction above.

c. What is being oxidized and what is being reduced in this reaction? How can you tell?

2. (3) a. Which has higher energy, ultraviolet light or radio waves?

b. Which has the longer wavelength, yellow light or blue light?

c. Which has the higher frequency, red light or infrared light?

3. (2) Given the following diagram, determine the pressure of the gas in the container. The atmospheric pressure is 765 mmHg and the height of the mercury column is 118 mm.

4. (4) a. Calculate the deBroglie wavelength for a softball with a mass of 192 g traveling at 31 m/sec.

b. Comment on the size of this wavelength.

5. (10) Calculate ΔH of this reaction from ΔH_f values.

$4\ NH_{3\,(g)} + O_{2\,(g)} \rightarrow 2\ N_2H_{4\,(g)} + 2\ H_2O_{(l)}$

b. Is this reaction exothermic or endothermic?

c. Which is more stable in this reaction, reactants or products?

d. If you combine 50.0 kg of NH_3 with excess oxygen and allow them to react, what amount of energy will be absorbed or given off? (Specify whether heat will be absorbed or given off.)

e. What is the sign of work for the above reaction? How can you tell? (No calculation needed.)

6. a. (1) Which will have the higher average speed, $Ne_{(g)}$ atoms at 37°C or $Ar_{(g)}$ atoms at 37°C? Explain briefly how you can tell.

b. (1) The root-mean-square speed of O_2 gas molecules at 25°C is 482 meters per second. Are all of the O_2 molecules in this sample traveling at this speed? Explain briefly.

c. (1) Which will have a higher average kinetic energy: $Xe_{(g)}$ at 25°C or $Ne_{(g)}$ at 45°C? Explain briefly how you can tell.

7. (4) If you increase the temperature of a gas sample in a rigid container, what will happen to the pressure of the gas? More importantly, explain <u>why</u> this happens, according to kinetic-molecular theory. (Explain at the molecular level.)

8. (3) Which of the following gases is more likely to behave *nonideally*? Explain the underlying reason(s).
   a. $H_2O_{(g)}$ at 105°C and 1.00 atm
   b. $Ne_{(g)}$ at 25°C and 1.00 atm

9. (5) a. Starting with the ideal gas law (PV = nRT), show how to derive an equation that relates the volume and temperature of the gas when the pressure and number of moles is constant.

b. Using the equation that you derived, if a gas has a volume of 37.8 mL at a temperature of 65°C, what will the volume be at -25°C?

c. Explain why your answer makes sense.

10. (2) Are these sets of quantum numbers allowed or not allowed? If the set is allowed, state the type of orbital (for example: 1s). If the set is not allowed, state why it's not allowed.

a. $n = 5$, $l = 3$, $m_l = -1$, $m_s = -1/2$

b. $n = 4$, $l = 2$, $m_l = 3$, $m_s = +1/2$

11. (2) Can a 2d orbital exist? Explain why or why not.

12. (3) What are the **possible values** and the **physical meaning** of each of the following quantum numbers?

n

l

m_l

13. (4) Sketch the shape of a 5d orbital. Show radial nodes and nodal planes as dotted lines. Draw a graph of ψ^2 vs radius for this orbital.

14. (5) If you want to make 250.0 mL of 0.150 M $K_3PO_{4\ (aq)}$ starting with solid potassium phosphate, calculate amounts and describe how you would make this solution.

15. (7) A solution of $Ba(OH)_{2\ (aq)}$ is titrated with a solution of $HNO_{3\ (aq)}$.
a. Write the balanced overall (molecular) equation for this reaction.

b. If 20.00 mL of 0.1566 M HNO_3 requires 24.60 mL of $Ba(OH)_2$ solution to reach the endpoint, what was the molarity of the barium hydroxide solution?

16. (10 points) When an electron makes a transition from the n=3 level to the n=1 energy level in a hydrogen atom,

a. Is a photon absorbed or emitted? Explain how you can tell.

b. Calculate the frequency and wavelength (in nanometers) of light involved.

c. Calculate the energy of these photons in units of kJ/mol.

17. (6) A mixture of gases contains 0.0357 moles of O_2, 0.00254 moles of N_2, and 0.124 moles of Ar in a volume of 24.0 liters at 27°C. Calculate the partial pressure of O_2 in this mixture.

18. (9) 25.0 mL of 0.300 M $Ba(NO_3)_{2\,(aq)}$ and 35.0 mL of 0.100 M $K_3PO_{4\,(aq)}$ were mixed, and a precipitate of $Ba_3(PO_4)_2$ formed.
Calculate the concentrations (in molarity) of each of the ions still in the solution after the reaction is complete. (Hint: first write the balanced net ionic equation.)

19. (9) 15.4 grams of ice at -25.0°C was added to some water in a calorimeter that was initially at 23.7 °C. The final temperature of the water after the ice had melted was 10.2°C. Calculate the mass of water that was in the calorimeter initially.
[Hint: (total q for all endothermic processes) = - (total q for all exothermic processes)]
[It might be helpful to sketch a heating diagram to figure out how many processes there are.]

20. (9) a. In a bomb calorimeter, 2.072 g of gasoline is burned in an excess of oxygen. The balanced equation for the reaction is: $2\ C_8H_{18\,(l)} + 25\ O_{2\,(g)} \rightarrow 16\ CO_{2\,(g)} + 18\ H_2O_{(l)}$ The temperature of the calorimeter and its contents increases from 21.74 °C to 34.77 °C. The heat capacity of the calorimeter and its contents is 7.185 kJ/°C. Calculate w_p, ΔE, and ΔH for the above reaction as written.

b. Look at the signs of w, ΔE, and ΔH. Explain the physical meaning of each of the signs.