Chemistry 11: General Chemistry 1
Final Examination

Winter 2006

Answers are given at the end of the exam.

Name_____

Part 1

1. A 0.600 g pure sample of elemental iron **(Fe)** is dissolved in $H_2SO_{4\,(aq)}$ to give $Fe^{2+}{}_{(aq)}$ and $H_{2\,(g)}$.

a. Write the balanced equation that represents this reaction (showing the physical state of **each reactant and product**).

The resulting solution (from part a) reacts with 49.33 mL of a $KMnO_4$ solution by the reaction:
$Fe^{2+}{}_{(aq)} + MnO_4^-{}_{(aq)} \rightarrow Fe^{3+}{}_{(aq)} + Mn^{2+}{}_{(aq)}$.

b. What is the balanced oxidation-reduction reaction for this reaction in an acidic solution?

c. What is the molarity of the $KMnO_4$ solution?

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2. How many joules of heat are required to heat 38.5 g of copper (specific. heat = 0.385 J/g^{o}C) from 18.0^{o}C to 35.2^{o}C?

3. A small bubbles rises from the bottom of a lake, where the temperature and pressure are 10°C and 4.6 atm, to the water‘s surface. At the water's surface the tempetature is 23°C and the pressure is 1 atm. Calculate the final volume (in mL) of the bubble if the initial volume was 1.9 mL.

4. Automobile antifreeze consists of ethylene glycol, a nonvolatile nonelectrolyte. Calculate the boiling point and freezing point of a solution containing 651 g of this substance in 2500 g of water. The molar mass of ethylene glycol is 62.01 g/mol. For water, K_f=1.86°C·kg/mol and K_b = 0.51°C·kg/mol.

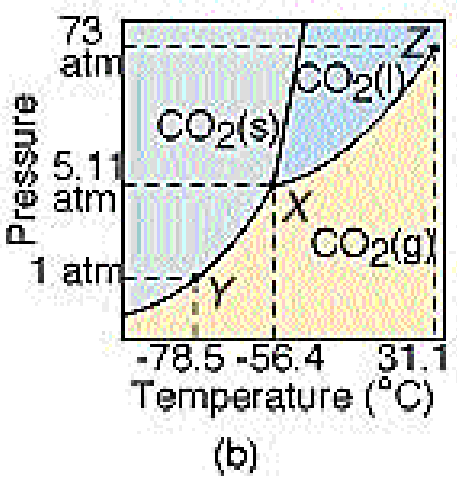
5) How does one explain (by physical and chemical methods) the differences between ionic compounds and covalent compounds?

6. Nitrogen dioxide is formed from the reaction between nitrogen monoxide and oxygen gas:

$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$

a) If 5.25 g of nitrogen monoxide and 4.75 g of oxygen gas are mixed how many moles of nitrogen dioxide will be formed? b) How many grams of nitrogen dioxide will be formed?

7. Answer the questions below that refer to the figure.



a. What is the temperature and pressure at the triple-point for carbon dioxide?

b. What state is carbon dioxide in at 6 atm and 30°C?

c. What does the graph show us about the existence of liquid carbon dioxide at room temperature and atmospheric pressure?

d. Suppose the temperature of carbon dioxide is 32°C at a pressure of 74 atm. What state is the carbon dioxide in?

8. The density of a gaseous organic compound is 3.38 g/L at 40°C and 1.97 atm. What is its molar mass?

9. Calculate the reaction enthalpy for the synthesis of hydrogen chloride gas, $H_{2\,(g)} + Cl_{2\,(g)} \rightarrow 2\,HCl_{(g)}$, from the following data:

$NH_{3\,(g)} + HCl_{(g)} \rightarrow NH_4Cl_{(s)}$	$\Delta H^0 = -176.0$ kJ
$N_{2\,(g)} + 3\,H_{2\,(g)} \rightarrow 2\,NH_{3\,(g)}$	$\Delta H^0 = -92.22$ kJ
$N_{2\,(g)} + 4\,H_{2\,(g)} + Cl_{2\,(g)} \rightarrow 2NH_4Cl_{(s)}$	$\Delta H^0 = -628.86$ kJ

End Part 1

Part 2
Choose the BEST answer for each question.

1. Which isotope of copper has 34 neutrons?
a. ^{63}Co b. ^{34}Co c. ^{63}Cu d. ^{34}Cu

2. There are three isotopes of oxygen having atomic masses of 15.99491u, 16.99913u, and 17.99916u. The average atomic mass of oxygen is 15.9994u. Which isotope has a greater natural abundance?
a. Percent abundance data are needed
b. The three isotopes are equally abundant
c. The isotope with mass of 16.99913u is more abundant
d. The isotope with mass of 15.99491u is more abundant
e. The isotope with a mass of 17.99916u is more abundant.

3. Which statement below is true about the spectrum of hydrogen obtained in gas discharge tubes experiments?
a. A photon is absorbed as the electron goes from a state with a ***higher*** energy to one with a ***lower*** energy.
b. A photon is absorbed as the electron goes from a state with a ***lower*** energy to one with a ***higher*** energy.

c. A photon is emitted as the electron goes from a state with a ***higher*** energy to one with a ***lower*** energy.
d. A photon is emitted as the electron goes from a state with a ***lower*** energy to one with a ***higher*** energy.
e. An electron is emitted as the photon goes from a state with a ***higher*** energy to one with a ***lower*** energy.

4. The spectroscopic notation (number + letter designation) for the subshell with $n = 4$ and $l = 2$ is
a. 4d subshell
b. 4p subshell
c. 4f subshell
d. 4s subshell
e. there is no subshell fitting this description

5. The statement that the ground state configuration of an atom is generated by filling in levels from the lowest (energy-wise) to the highest with electrons observing the maximum for each of these levels is the
a. Aufbau principle
b. Bustamente's principle
c. Hund's Rule
d. Murphy's rule
e. the Pauli Principle

6. How many unpaired electrons are there in a chromium atom in its ground state?
a. 1 b. 2 c. 3 d. 4 e. 5

7. How many coordinate covalent bonds are there in the product of the reaction between H^+ and NH_3 which gives NH_4^+ as the only product?
a. 0 b. 1 c. 2 d. 3 e. 4

8. Which name is named **incorrectly**?
a. $Ca_3(PO_4)_2$ calcium phosphate
b. KCl potassium chloride
c. Co_2O_3 cobalt(III) oxide
d. $CrCl_2$ chromium(I) chloride
e. N_2O_5 dinitrogen pentaoxide

9. Based on conclusions from application of the VSEPR theory, which one of the following molecules or ions has a regular tetrahedral geometry?
a. BF_3
b. CF_4
c. NH_3
d. SF_4
e. XeF_4

10. Which of the following molecules is linear?
a. H_2O
b. NH_3
c. NO_2
d. CO_2
e. H_2S

11. How many σ-bonds and π-bonds, respectively, are there in a CO_2 molecule?
7

a. 1 σ-bonds and 2 π-bonds
b. 2 σ-bonds and 0 π-bonds
c. 2 σ-bonds and 2 π-bonds
d. 2 σ-bonds and 4 π-bonds
e. 4 σ-bonds and 0 π-bonds

12. Which of the following chemical formulas CANNOT be an empirical formula?
a. CH_4 b. $C_2H_4O_2$ c. C_2H_6O d. NO_2

13. Which are the spectator ions in this reaction?
$CoCl_3$ (aq) + NaOH (aq) → $Co(OH)_3$ (s) + NaCl (aq)
a. Co^{+3} and Na^+ b. OH^- and Cl^- c. Co^{+3} and Cl^-
d. $Na^+$and OH^- e. Na^+ and Cl^-

14. A block of ice has a mass of 25.00 g. How many atoms of hydrogen are in the block of ice?
a. 1.388 b. 1.5×10^{25} c. 450 d. 8.33×10^{23} e. 1.67×10^{24}

15. Salt A and salt B were dissolved separately in 100-milliliter beakers of water. The water temperatures were measured and recorded as shown in the following table:

	Salt A	Salt B
Initial water temperature (^oC)	25.1	25.1
Final water temperature (^oC)	30.2	20.0

.Which statement is a correct interpretation of these data?
a. The dissolving of only Salt A was endothermic.
b. The dissolving of only Salt B was exothermic
c. The dissolving of both Salt A and salt B was endothermic
d. The dissolving of Salt A was exothermic and the dissolving of Salt B was endothermic.

16. What intermolecular forces exist between molecules of CH_3 Br?
a. London dispersion forces
b. hydrogen bonding and London dispersion forces
c. dipole-dipole and London dispersion forces
d. hydrogen bonding, dipole-dipole, and London dispersion forces

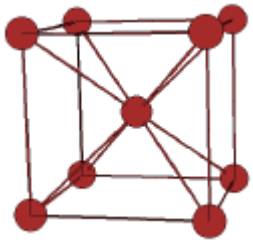
17. Under what conditions is the solubility of carbon dioxide in water lowest?
a. high temperature and low pressure
b. low temperature and low pressure
c. high temperature and high pressure
d. low temperature and high pressure

18. Arrange these elements in order of increasing atomic radius. **Ca, F, Li, N**

a. Li < N < F < Ca b. Ca < Li < N < F c. F < N < Li < Ca d. Ca < F < N < Li

19. Which unit cell is represented by the figure?

a. simple hexagonal
b. body-centered cubic
c. face-centered cubic
d. simple cubic



20. Which of the following statements is **NOT** a part of the kinetic molecular theory of gases?

a. Gas particles move randomly through space.
b. Collisions with the walls of the container results in pressure.
c. The number of moles of a gas determines the average kinetic energy of the gas.
d. The sizes are gas particles are small relative to the distances between them.
e. The average speed of the individual gas particles increases with increasing temperature.

End Part 2 of exam.

Constants

$N_A = 6.022 \times 10^{23}$/mol
$c = 2.997 \times 10^8$ m/s
$h = 6.626 \times 10^{-34}$ Js

Photons

$E = h\nu$
$c = \nu\lambda$

Metric prefixes

zepto	z	10^{-21}
atto	a	10^{-18}
femto	f	10^{-15}
pico	p	10^{-12}
nano	n	10^{-9}
micro	μ	10^{-6}
milli	m	10^{-3}
kilo	k	10^{3}
mega	M	10^{6}
giga	G	10^{19}
tera	T	10^{12}
peta	P	10^{15}
exa	E	10^{18}
zeta	Z	10^{21}

Gases

$PV = nRT$
$R = 0.0821$ Latm/Kmol
760 torr = 1 atm
1 mm Hg = 1 torr
1 Pa = 1 N/m^2
1.01 kPa = 1 atm
$P_T = P_A + P_B + ...P_N$
STP = 0°C and 1 atm

$$\frac{\text{rate}1}{\text{rate}2}\sqrt{\frac{M_2}{M_1}}$$

$$\ln VP = \frac{\Delta H_{VAP}}{R}\frac{1}{T} + C$$

$C_{gas} = k_H P_{gas}$
$MM = dRT/P$

Energy

$q = ms\Delta T$
$q = C\Delta T$
$E = q + w$
$\Delta H = q$ at constant P
$KE = 1/2mv^2$
$w = -P\Delta V$

Solutions

$\Delta T = K_F m$
$\Delta T = K_b m$
$P_{osmotic} = MRT$
$P_{solution} = X_{solvent}P°_{solvent}$

Conversions

$T_K = T_{°C} + 273$
$T_{°F} + 1.8T_{°C} + 32$
1 in = 2.54 cm

1 ft = 12 in

1 yd = 3 ft
1 cal = 4.184 J

$d = m/V$

ANSWERS:

Part 1

1a. $H_2SO_4(aq) + Fe(s) \rightarrow Fe^{+2}(aq) + H_2(g) + SO_4^{-2}(aq)$

1b. $8H^+(aq) + 5Fe^{+2}(aq) + MnO_4^-(aq) \rightarrow 5Fe^{+3}(aq) + 4H_2O(l) + Mn^{+2}(aq)$

1c. Molarity of $KMnO_4$ = 0.218 mol/L

2. Heat = 255 J

3. The volume of the bubble is 9.1 mL or 0.0091 L

4. The freezing point is 0°C - 7.8°C = -7.8°C. The boiling point is 0°C - 7.8°C = -7.8°C

5. There are two types of covalent compounds. Covalent compounds have relatively low melting points. Ionic compounds tend to have relatively large melting points. Ionic compounds do not conduct electricity well in the solid state but do in the liquid state. Molecular compounds do not conduct electricity well in either the solid or the liquid state. Ionic compounds are brittle. Ionic compounds have properties that are different from molecular compounds because of the nature of the ionic structure. Dislocation of an ionic crystal results in repulsions between layers of the crystal. Ionic compounds conduct electricity in the liquid state because the ions are free to move. But in the solid state the ions are locked into place and cannot move freely.

6a. 0.175 mol NO_2 are produced.

6b. 8.1 g of NO_2 are produced.

7a. The triple point occurs at a pressure of 5.11 atm and a temperature of -56.4°C.

7b. Carbon dioxide is in the gaseous state at 6 atm and 30°C.

7c. At room temperature (20°C) and atmospheric pressure (1 atm) carbon dioxide is stable in the gaseous state only. So liquid carbon dioxide is not stable at these values.

7d. At 32°C and 74 atm carbon dioxide exists as a supercritical fluid.

8. The molar (molecular) mass is 43.0 g/mol.

9.The heat of reaction is 2(+176.0 kJ) + 1(+92.22 kJ) + 1(-628.86 kJ) = -184.6 kJ

Part 2

1. c	**2. d**	**3. b**	**4. a**	**5. a**	**6. e**	**7. b**
8. d	**9. b**	**10. d**	**11. c**	**12. b**	**13. e**	**14. e**
15. d	**16. c**	**17. a**	**18. c**	**19. b**	**20. c**	