Practice Final Exam
Name (Last, First): SB

Chem 30A Merritt College Spring 2015

1. Convert 3.070×10^{-5} L to mL. $3.070 \times 10^{-5}\,L = 0.00003070\,L \left(\frac{1000\,mL}{L}\right)$
$= 0.03070\,mL = 3.070 \times 10^{-2}\,mL$

2. Convert 88.42 °C to K.
$88.42\,°C + 273.15 = 361.57\,K$

3. What is the charge on a single proton?
+1

both correct answers

4. Give the symbol and name for the element with 18 protons. How many neutrons and electrons?
#18 is Argon. Mass ≅ 40. $40 - 18 = 22$ neutrons.

5. A liquid has a volume of 2.4 mL and a mass of 3.602 g. Calculate its density. Is it more or less dense than pure water?
$\text{density} = \frac{\text{mass}}{\text{volume}} = \frac{3.602\,g}{2.4\,mL} = 1.5\,g/mL$ (2 s.f.)

6. Carbon has 2 naturally occurring isotopes: carbon-12 weighing 12.000 amu (98.90%), and carbon-13 weighing 13.034 amu (1.10%). Calculate the average atomic mass of carbon, to 3 decimals.

$\text{avg mass} = (0.9890)(12.000\,amu) + (0.0110)(13.034\,amu)$
$= 11.868\,amu + 0.143374\,amu = 12.011\,amu$

7. List 2 examples of pure substances.
pure water, pure gold, pure O_2 gas

8. List 2 examples of physical changes.
boiling, condensing, freezing, melting...

9. List 2 examples of a heterogeneous mixture.
↳ not uniform throughout
soil, cereal in milk, smoke particles in air

10. Carbon tetrachloride (CCl_4) has a melting point of -22.9 °C and a boiling point of 76.6 °C. What is the state of pure CCl_4 at 94.0 °C?
gas (above the b.p.)

11. Write the name and molecular formula for an ionic compound of the elements bromine and barium.
$BaBr_2$ Ba – +2 (group 2) Br – −1 (group 7) barium bromide

12. A piece of metal weighs 22.834 g. The metal is heated from 1.5 °C to 70.2 °C. How much energy is gained by the metal upon heating if it has a heat capacity c_p = 0.44 J/°C g?

$\Delta T = 70.2\,°C - 1.5\,°C = 68.7\,°C$

$\Delta H = m\,c_p\,\Delta T$

$\Delta H = m\,c_p\,\Delta T = (22.834\,g)\left(0.44\,\frac{J}{°C\,g}\right)(68.7\,°C)$

2 s.f.

$\approx 690\,J = \boxed{6.9 \times 10^2\,J}$

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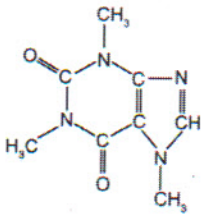
13. Give the chemical formula for:
    a. magnesium chloride $MgCl_2$
    b. iron (III) oxide Fe_2O_3
    c. silver chloride $AgCl$
    d. sodium hydroxide $NaOH$
    e. sulfuric acid H_2SO_4

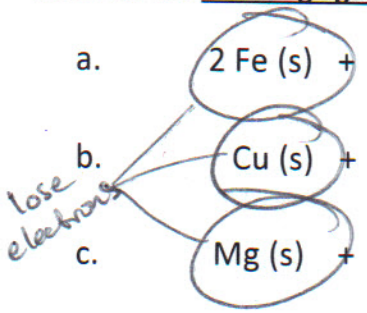
14. Name the following compounds:
    a. NaBr sodium bromide
    b. FeO iron (II) oxide
    c. $BaSO_4$ barium sulfate
    d. $Mg(OH)_2$ magnesium hydroxide
    e. HCl (aq) hydrochloric acid

15. Write the molecular formula for caffeine, shown to the right.



$C_8H_{10}N_4O_2$

16. Give 2 examples of diatomic molecules.
    Cl_2, O_2, N_2
17. Are diatomic molecules polar or nonpolar?
    non-polar
18. Circle the **reducing agent** in the following redox reactions:



a. $2\,Fe\,(s) + O_2\,(g) \rightarrow 2\,FeO\,(s)$

b. $Cu\,(s) + 2\,Ag^+\,(aq) \rightarrow Cu^{2+}\,(aq) + 2\,Ag\,(s)$

c. $Mg\,(s) + Cl_2\,(g) \rightarrow 2\,MgCl_2\,(s)$

19. Indicate whether the following reactions are precipitation, neutralization, or redox.

redox a. $Fe\,(s) + Cu^{2+}(aq) \rightarrow Fe^{2+}(aq) + Cu\,(s)$

precip b. $2\,NaOH\,(aq) + MgCl_2\,(aq) \rightarrow Mg(OH)_2\,(s) + 2NaCl\,(aq)$

neutralization c. $Mg(OH)_2\,(aq) + H_2SO_4\,(aq) \rightarrow MgSO_4\,(aq) + 2\,H_2O\,(l)$

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20. Give the oxidation number for carbon in the following:

key: O = −2, H = +1, alone = −1

other examples: CH_4 C = −4; CO^{-2} C = +2

a. C (s) — 0

b. H_2CO (l) — 0

c. H_2CO_3 (l) — +4

d. CO_3^{2-} (aq) — +4 ; C + −6 = −2 ; C = +4 ; total charge is −2 on this ion

e. CBr_4 (l) — +4

21. Predict whether the following covalent bonds are polar or non-polar using electronegativity difference:

a. H-Cl $\Delta E = 3.0 - 2.1 = 0.9$ polar — look at electronegativity difference < 0.5 for nonpolar

b. H-C $\Delta E = 2.5 - 2.1 = 0.4 < 0.5$ non polar

c. H-S nonpolar $\Delta E = 2.5 - 2.1 = 0.4 < 0.5$

d. H-H nonpolar $\Delta E = 0$

22. Determine the limiting reactant when 19.3 g propane (C_3H_8) is burned in the presence of 70.8 g oxygen gas using the balanced combustion equation below. What is the theoretical yield of CO_2 in grams? What is the percent yield if an experiment produced 99.6 g of CO_2? Show your work, and write your answers below.

a)

$$C_3H_8 + 5\,O_2 \rightarrow 3\,CO_2 + 4\,H_2O$$

b) yield $= (1.31 \text{ mol } CO_2)\left(\frac{44.009 \text{ g}}{1 \text{ mol}}\right) = 57.8 \text{ g}$

c) % yield $= \frac{\text{actual}}{\text{theoretical}} = \frac{99.6 \text{ g}}{57.8 \text{ g}} \times 100 = 172\%$

propane molar mass $= (3)(12.011 \text{ g/mol}) + (8)(1.008 \text{ g/mol}) = 44.097 \text{ g/mol}$

O_2 molar mass $= 2(15.999 \text{ g/mol}) = 31.998 \text{ g/mol}$

CO_2 " $= 2(15.999 \text{ g/mol}) + (1)(12.011 \text{ g/mol}) = 44.009 \text{ g/mol}$

$\#\text{mol propane} = (19.3 \text{ g})\left(\frac{\text{mol}}{44.097 \text{ g}}\right) = 0.438 \text{ mol}$

$\text{mol } O_2 = 70.8 \text{ g}\left(\frac{\text{mol}}{31.998 \text{ g}}\right) = 2.19 \text{ mol}$

Limiting reactant: propane

Theoretical yield: 57.8 g

Percent yield: 172%

yield from propane $= (0.438 \text{ mol propane})\left(\frac{3 \text{ mol } CO_2}{1 \text{ mol propane}}\right) = \boxed{1.31 \text{ mol } CO_2}$ limiting reactant

yield from O_2 $= (2.19 \text{ mol } O_2)\left(\frac{3 \text{ mol } CO_2}{5 \text{ mol } O_2}\right) = 1.33 \text{ mol } CO_2$

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23. Give the complete and net ionic equations.

Molecular equation: $AgNO_3\,(aq) + HCl\,(aq) \rightarrow AgCl\,(s) + HNO_3\,(aq)$

Complete Ionic equation:

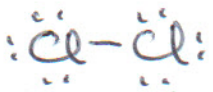
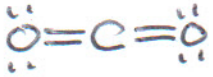
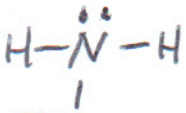
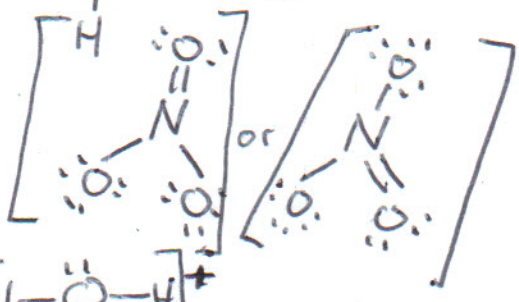
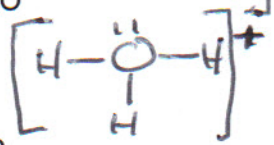
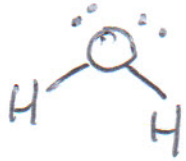
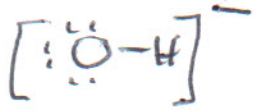
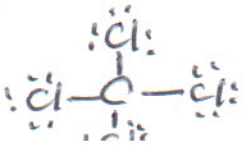
$Ag^+(aq) + NO_3^-(aq) + H^+(aq) + Cl^-(aq) \rightarrow AgCl(s) + H^+(aq) + NO_3^-(aq)$

solid does not dissociate

Net ionic equation:

$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$

24. Give Lewis structures, molecular geometry (shape), and indicate if resonance structures exist for the following:

	Lewis structure	shape	resonance?
a. Cl_2		linear	no
b. CO_2		linear	no
c. NH_3		trigonal pyrimidal	no
d. NO_3^-		trigonal planar	yes (3 Lewis structures)
e. H_3O^+		trigonal pyrimidal	
f. H_2O		bent (109.5°)	no
g. OH^-		linear	no
h. CCl_4		tetrahedral	no

253/ replace name #

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25. Use the below expression for Gibbs Free Energy ΔG to determine if carbon dioxide (CO_2) will spontaneously boil at 273 K. For CO_2, ΔH_{vap} = 15.326 kJ/mol and ΔS_{vap} = 70.8 J/mol·K. Show a calculation for ΔG.

$$\Delta G = \Delta H - T\Delta S$$

$\Delta G = \Delta H - T\Delta S$

$= 15{,}326 \frac{J}{mol} - (273\,\cancel{K})\left(70.8 \frac{J}{mol\,\cancel{K}}\right)$

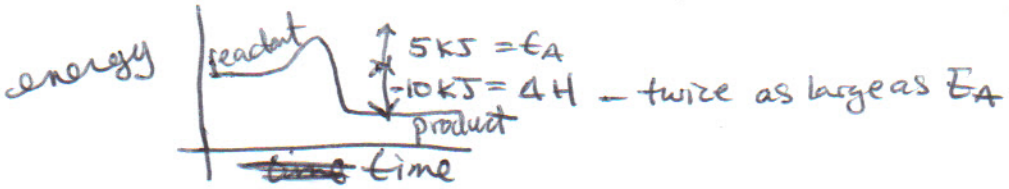
$= 15{,}326 \frac{J}{mol} - 19{,}328.4 \frac{J}{mol}$ (3 s.f.)

$= 4002.4 \frac{J}{mol} \Rightarrow 4000\ J/mol$ (3 s.f.)

or $\Delta G = \frac{-4.00\ kJ}{273?}$ or $\frac{-4.00 \times 10^3\ J}{273?}$

spontaneous ~~at 373K?~~ yes $\Delta G < 0$

26. 3. Draw a reaction diagram (energy vs. time) for an exothermic reaction that releases 10 kJ of energy and has an activation energy of 5 kJ. Label the reactants, products, activation energy, enthalpy change, and both axes.



27. Use the Le Chatlier principle to predict the effects on the below equilibrium.

$CO_2\,(g) + H_2O\,(l) \rightleftarrows H_2CO_3\,(aq) + heat$ (Exothermic)

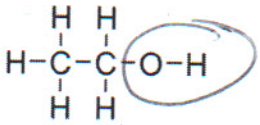
	shift: left/right/none?	**CO_2 increases/decreases/stays the same?**
a. increase H_2O	R	↓
b. decrease H_2O	L	↑
c. increase H_2CO_3	L	↑
d. increase temperature (Exothermic)	L	↑
e. increase pressure	R	↓

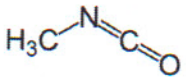
(CO_2 is only gas)

28. Indicate the strongest intermolecular force (IMF) for the following as pure liquids. Choices are dipole-dipole interactions, London dispersion forces, and hydrogen bonding.

a. hexadecane ($C_{16}H_{34}$) London

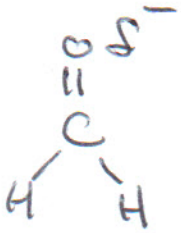
b. water (H_2O) hydrogen

c. ethanol (CH_3CH_2OH)  hydrogen

d. methyl isocyante (CH_3NCO)  dipole

e. diatomic chlorine (Cl_2) Cl-Cl London - nonpolar

f. ammonia (NH_3) dipole

g. formaldehyde (CH_2O)  dipole

29. Use the concept of IMFs to explain the low boiling point of helium, a noble gas, in 1-3 sentences.

Helium is a small, spherical atom and is therefore nonpolar. London forces are weak IMFs for nonpolar compounds. Thermal energy overcomes the London forces, allowing He to gassify at low T.

30. Convert the pressure of 550. mm Hg (3 s.f.) into atm.

$$P = (550.\ \text{mm Hg})\left(\frac{1\ \text{atm}}{760\ \text{mm Hg}}\right)$$ (3 s.f.)

$$= 0.724\ \text{atm}$$

Pressure = 0.724 atm

31. A sample of air has a pressure of 843 mm Hg. The oxygen mole percent is 21%. Calculate the partial pressure of oxygen in mm Hg.

$(843\ \text{mm Hg})\left(\frac{1\ \text{atm}}{760.\ \text{mm Hg}}\right)$

$(843\ \text{mm Hg})(0.21) = 180\ \text{mm Hg}$

2 s.f.

$P_{O_2} = 180\ \text{mm Hg}$

32. How much energy is gained/released when 15.2 g of ice melts to form water given ΔH_{fus} = 333 J/mol? Show the correct sign and number of significant figures.

molar mass $H_2O = (2)(1.008\ \text{g/mol}) + 15.999\ \text{g/mol} = 18.015\ \text{g/mol}$

$\#\text{mol } H_2O = (15.2\ \text{g})\left(\frac{1\ \text{mol}}{18.015\ \text{g}}\right) = 0.844\ \text{mol}$

3 s.f.

$\Delta H = (0.844\ \text{mol})\left(\frac{333\ \text{J}}{\text{mol}}\right) = 281\ \text{J}$

$\Delta H = 281\ \text{J}$

33. Use PV = nRT to calculate the number of moles of gas occupying a volume of 25.4 L at a pressure of 721 mm Hg and a temperature of 50. °C. Use R = 0.0821 L·atm/ mol·K.

$P = (721\ \text{mm Hg})\left(\frac{1\ \text{atm}}{760\ \text{mm Hg}}\right) = 0.949\ \text{atm}$

$V = 25.4\ \text{L}$

$T = 50. + 273.15 = 323.15\ \text{K}$

$PV = nRT$

$n = \frac{PV}{RT}$

$n = \frac{(0.949\ \text{atm})(25.4\ \text{L})}{\left(0.0821\ \frac{\text{L atm}}{\text{mol K}}\right)(323.15\ \text{K})}$

$n = 0.908\ \text{mol}$

34. What is the concentration in units of molarity (M) for 2.84 L of aqueous solution containing 10.3 g of dissolved HCl?

$M = \frac{\#\text{mol solute}}{\#\text{Liters solution}}$

molar mass HCl = 1.008 g/mol + 35.45 g/mol
= 36.46 g/mol

$\#\text{mol solute} = (10.3\ \text{g})\left(\frac{\text{mol}}{36.46\ \text{g}}\right) = 0.283\ \text{mol}$

3 s.f.

$M = \frac{0.283\ \text{mol}}{2.84\ \text{L}} = 0.0995\ \text{M}$

3 s.f.

or $= 9.95 \times 10^{-2}\ \text{M}$

35. Provide the equilibrium reaction between formic acid (HCOOH) and formate ion ($HCOO^-$) in water. Label the Lewis acid/base and conjugate base/acid.

$HCOOH + H_2O \rightleftharpoons HCOO^- + H_3O^+$
acid base conj. base conj. acid

5 s.f. ⇌ 1 digit after decimal

1 digit [H+]

36. What is the pH of a solution with $[H^+] = 3 \times 10^{-4}$ M?

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s.f. log

$pH = -\log(3\times10^{-4}) = -(-3.5) = 3.5$

1 digit after decimal

37. What is the $[H^+]$ of a solution with pH = 3.6?

1 digit after decimal

$[H^+] = 10^{-3.6} = 0.25 \times 10^{-4}\ M \rightarrow 3\times10^{-4}\ M$

38. A titration experiment uses 40.60 mL of 0.205 M of magnesium hydroxide $Mg(OH)_2$ to neutralize 50.00 mL of hydrochloric acid (HCl). What is the concentration of the acid?

$N_{acid}V_{acid} = N_{base}V_{base}$

Base dissociates twice! $Mg(OH)_2 \rightarrow 2\ OH^- + \ldots$

$N_b = 2 \cdot M_b = (2)(0.205\ M) = 0.410\ N$ (0.205 M: 3 s.f.)

$N_a V_a = N_b V_b$

$N_a = \frac{N_b V_b}{V_a} = \frac{(0.410\ N)(40.60\ mL)}{(50.00\ mL)} = 0.333\ N$ (0.410 N: 3 s.f.)

normality and molarity same for monoprotic HCl

$M_a = 0.333\ M$

2. Complete the following nuclear reactions for alpha emission:

$^{238}_{92}U \rightarrow ^{2}_{9}\ ?$

$\alpha = {}^4_2He$ ← I will give you this on exam.

Should read: $^{238}_{92}U \rightarrow {}^4_2He + ?$

$? = {}^{234}_{90}Th$