CHEMISTRY 102B/C
Hour Exam II
October 26, 2016
T. Hummel

NAME _____

SIGNATURE _____

SECTION _____

FORM "A"

This exam is made up of an answer sheet, two cover sheets and 7 numbered pages. Below are instructions for coding the answer sheet. The last page of this exam contains some useful equations and constants, plus the periodic table.

On the answer sheet:

1. **Use #2 pencil. Erase cleanly**.
2. Print your **NAME** in the appropriate designated spaces, then blacken in the letter boxes below each printed letter, last name first, then your first name initial.
3. Fill in your university **ID** number under **STUDENT NUMBER**.
4. Under **SECTION** write the five digit number that corresponds to your section designation, and then blacken in the corresponding number of boxes. **For 102B students,** the numbers are: BQ1 = 00011, BQ2 = 00012, BQ3 = 00013, BQ4 = 00014, BQ5 = 00015, BQ6 = 00016, BQ7 = 00017, BQ8 = 00018, BQA = 00021, BQB = 00022, BQD = 00024, BQG = 00027, BQH = 00028, BQI = 00029. **For 102C students**, the numbers are: CQ1 = 00031, CQ2 = 00032, CQ3 = 00033, CQ4 = 00034, CQ5 = 00035, CQ6 = 00036, CQ7 = 00037, CQ8 = 00038, CQ9 = 00039, CQA = 00041, CQB = 00042, CQC = 00043, CQD = 00044, CQE = 00045
5. Under **NETWORK ID** print your University Network ID beginning on the left hand side with box #1, and then blacken in the corresponding letters, numbers and/or dashes under each character. Do not fill in a character for any unused boxes.
6. Under **TEST FORM** blacken the letter corresponding to the form designated on the upper left hand corner of the exam booklet.
7. Your TA's name should be printed for **INSTRUCTOR** and write your section number for **SECTION** in the lines provided.
8. **Sign** your name (do not print) on the line provided. Print your name underneath it.
9. **Mark** only one answer per question and do not use the answer sheet for scratch paper or make any stray marks on it. Erase cleanly if you wish to change an answer. The exam itself can be used for scratch paper.

Work carefully and efficiently. If your answer differs from one given in the last proper significant figure, mark that answer as correct and not the response "none of these". All questions are worth the same.

Solubility rules:

1. Most nitrate salts are soluble.
2. Most salts of alkali metals and ammonium cations are soluble.
3. Most chloride, bromide, and iodide salts are soluble.
   Exceptions: salts containing Ag^{+}, Pb^{2+}, and Hg_2^{2+} ions are insoluble.
4. Most sulfate salts are soluble.
   Exceptions: sulfates containing Ca^{2+}, Ba^{2+}, Pb^{2+}, and Hg_2^{2+} ions are insoluble.
5. Most hydroxide salts are insoluble.
   Exceptions: hydroxides containing alkali metals, Ba^{2+}, Sr^{2+}, and Ca^{2+} ions are soluble.
6. Most sulfide, carbonate, chromate, and phosphate salts are insoluble.
   Exceptions: salts of alkali metals and ammonium cations are soluble.

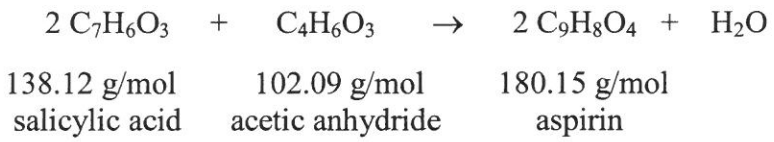
1. Consider a 1.0 L container of neon gas at STP. Which of the following (a-c) will change if the volume of the container is decreased to 0.50 L while the temperature is held constant?

   a) The frequency of collisions of the atoms with the walls of the container.
   b) The average speed of the atoms.
   c) The average kinetic energy of the atoms.
   d) All of the above (a-c) will change.
   e) None of the above (a-c) will change.

2. At some temperature, it took 3.0 minutes for 1.0 L of gas A to effuse through a porous barrier. Under identical conditions, it took 12.0 minutes for 1.0 L of gas B to effuse through the porous barrier. Which of the following could be the identities of gas A and gas B? Molar masses are given after each formula.

   a) Gas A = CH_4 (16 g/mol) and gas B = He (4 g/mol)
   b) Gas A = He (4 g/mol) and gas B = CH_4 (16 g/mol)
   c) Gas A = N_2 (28 g/mol) and gas B = BH_3 (14 g/mol)
   d) Gas A = O_2 (32 g/mol) and gas B = H_2 (2 g/mol)
   e) Gas A = H_2 (2 g/mol) and gas B = O_2 (32 g/mol)

3. Aspirin can be synthesized by the following reaction (the molar masses are below each formula):



   A 0.55 g-sample of acetic anhydride is reacted with an excess of salicylic acid. What is the percent yield if 1.26 g of aspirin are actually produced?

   a) less than 50% b) 65% c) 77% d) 85% e) greater than 95%

4. A 0.573 mol sample of hydrogen gas has a volume of 8.56 L at a pressure of 1140 torr. Calculate the temperature of this gas sample.

   a) 207°C b) −66°C c) 273°C d) 0°C e) 151°C

5. When 2.0 L of 0.10 *M* $AgNO_3$ reacts with 1.0 L of 0.10 *M* Na_3PO_4, calculate the moles of precipitate that can form assuming 100% percent yield.

   a) 0.033 mol b) 0.050 mol c) 0.067 mol d) 0.10 mol e) 0.20 mol

6. How many of the following four compounds (I-IV) is/are soluble in water?

I) iron(II) sulfate II) lead chloride

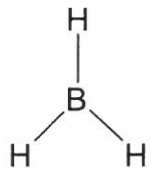
III) potassium chromate IV) nickel(II) hydroxide

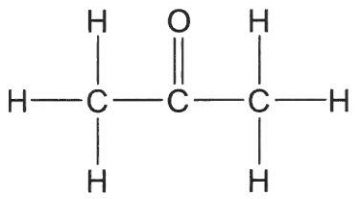
a) none b) 1 c) 2 d) 3 e) 4 (All are soluble.)

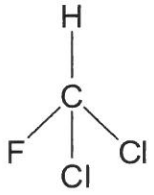
7. Which of the following statements regarding intermolecular forces is **false**?

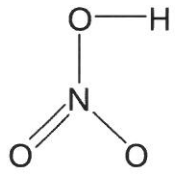
a) The intermolecular forces exhibited by ionic compounds are much stronger than hydrogen bonding intermolecular forces.
b) Polar covalent compounds always boil at higher temperatures than nonpolar covalent compounds.
c) As the strength of the intermolecular forces increase, the molar heat of vaporization (ΔH_{vap}) increases.
d) In general, as the molar mass of a compound increases, the strength of the London dispersion forces increase.
e) Hydrogen bonding is a special type of dipole-dipole force.

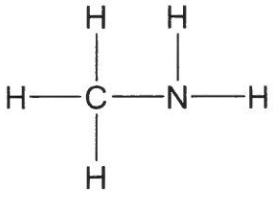
Consider the following five compounds for the next two questions:











8. How many of these five compounds can form hydrogen bonding forces with itself?

a) 1 b) 2 c) 3 d) 4

e) 5 (All can form H–bonding intermolecular forces.)

9. Which of these compounds would be expected to have the highest vapor pressure at −100°C?

a) BH_3 b) $(CH_3)_2CO$ c) $CFCl_2H$ d) HNO_3 e) CH_3NH_2

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10. Consider two different containers of gases, container A and container B, with both containers at the same temperature. It was determined that the gas in container A has an average velocity of 200 m/s while the gas in container B has an average velocity of 600 m/s. Which of the following is the best reason why the gas molecules in the two different containers have different average velocity values? Assume ideal gas behavior.

a) There are three times as many gas molecules in container B as compared to the number of gas molecules in container A.

b) The volumes of containers A and B are different.

c) The pressure of the gases in containers A and B are different.

d) The molar masses of the gas molecules in containers A and B are different.

e) The gas constant R for the gases in containers A and B are different.

11. O_2 gas is collected over water into a 2.00 L container at 30.°C and a total pressure of 783 torr. The vapor pressure of H_2O at 30.°C is 31.8 torr. What is the pressure of the dried oxygen gas at 25°C in the same 2.00 L container?

a) 752 torr b) 783 torr c) 770. torr d) 764 torr e) 739 torr

12. How many of the following five compounds (I-V) is/are strong electrolytes?

I) CH_4N_2O II) $(NH_4)_2SO_4$ III) $SeCl_4$ IV) $Cu(NO_3)_2$ V) HI

a) 1 b) 2 c) 3 d) 4 e) 5 (All are strong electrolytes.)

13. A 25.00 mL portion of 0.112 *M* $Pb(NO_3)_2$ is mixed with a 45.00 mL portion of 0.0840 *M* K_2CrO_4. A bright yellow precipitate forms. Assuming the reaction has gone to completion, what are the molarities of the NO_3^- ions and the Pb^{2+} ions in solution after the reaction?

	NO_3^-	Pb^{2+}
a)	0.0400 *M*	0
b)	0.0400 *M*	0.040 *M*
c)	0.0800 *M*	0.040 *M*
d)	0.0800 *M*	0
e)	0.224 *M*	0.112 *M*

14. A beaker containing 230. mL of a 0.275 *M* solution is left on a hotplate overnight; the following morning the solution is 1.10 *M*. What volume of solvent has **evaporated** from the 0.275 *M* solution?

a) 57.5 mL b) 63.3 mL c) 173 mL d) 230. mL e) 288 mL

15. Silver metal tarnishes when exposed to hydrogen sulfide and oxygen gas. We can see the tarnish (Ag_2S) as a dark coating on the silver. What mass of Ag_2S can be produced when a solid silver fork with a mass of 45.0 g reacts with 22.5 g H_2S and 36.0 g O_2? The molar mass of Ag_2S is 247.87 g/mol and the molar mass of Ag is 107.9 g/mol.

$$4\ Ag + 2\ H_2S + O_2 \rightarrow 2\ Ag_2S + 2\ H_2O$$

a) 280 g Ag_2S b) 164 g Ag_2S c) 104 g Ag_2S

d) 207 g Ag_2S e) 51.7 g Ag_2S

16. Vitamin A has a molar mass of 286.4 g/mol and a general molecular formula of C_xH_yE where E is an unknown element. If vitamin A is 83.86% C and 10.56% H by mass, what is the identity of element E?

a) nitrogen b) oxygen c) fluorine

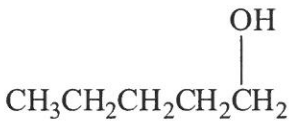
d) sulfur e) chlorine

17. A gaseous compound with the empirical formula CH_2 has a density of 1.88 g/L at 0°C and 760. torr. What is the molecular formula of the gas?

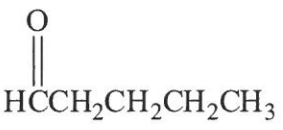
a) CH_2 b) C_2H_4 c) C_3H_6 d) C_4H_8 e) C_5H_{10}

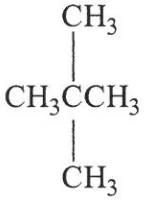
18. The five compounds in the answers below have boiling points of 9.5°C, 36°C, 69°C, 103°C, and 137°C. Which compound boils at 69°C?

a) $CH_3CH_2CH_2CH_2CH_3$

b) 

c) $CH_3CH_2CH_2CH_2CH_2CH_3$

d) 

e) 

19. Chlorisondiamine ($C_{14}H_{18}Cl_6N_2$) is a drug used in the treatment of hypertension. A 1.28-g sample of a medication containing some chlorisondiamine was treated to release all chlorine as the chloride ion. The resulting solution was then reacted with excess silver nitrate, $AgNO_3$, producing 0.104 g of AgCl. Calculate the mass percent of chlorisondiamine in the medication, assuming the drug is the only source of chloride. The molar mass of silver chloride is 143.35 g/mol and the molar mass of chlorisondiamine is 427.00 g/mol.

a) 62.9% b) 1.67% c) 12.4%

d) 24.8% e) 4.03%

20. Consider a theoretical quadprotic acid H_4X, i.e., H_4X has four acidic hydrogens. What volume of a 0.0200 *M* $Ba(OH)_2$ solution is needed to exactly react with 25.0 mL of a 0.0150 *M* H_4X solution?

a) 18.8 mL b) 9.38 mL c) 75.0 mL

d) 37.5 mL e) 4.69 mL

21. $H_2(g)$ reacts with $N_2(g)$ to form $NH_3(g)$. What volume of $NH_3(g)$ will form when 4.5 L of $H_2(g)$ reacts with 1.5 L of $N_2(g)$, with all gases measured at STP? Assume the reaction goes to completion.

a) 1.5 L b) 2.0 L c) 3.0 L d) 4.5 L e) 6.0 L

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22. Caffeine consists of carbon, hydrogen, oxygen, and nitrogen. When 0.1920 g of caffeine is burned in an excess of oxygen, 0.3481 g of carbon dioxide and 0.0891 g of water are formed, along with some nitrogen gas. Caffeine is 28.86% nitrogen by mass. What is the mass percent of hydrogen in caffeine? Assume all the hydrogen in caffeine ended up as hydrogen in the H_2O produced.

a) 2.60% H b) 5.19% H c) 10.4% H d) 23.2% H e) 46.4% H

23. Caffeine consists of carbon, hydrogen, oxygen, and nitrogen. When 0.1920 g of caffeine is burned in an excess of oxygen, 0.3481 g of carbon dioxide and 0.0891 g of water are formed, along with some nitrogen gas. Caffeine is 28.86% nitrogen by mass. What is the empirical formula of caffeine?

a) $C_4H_5N_2O$ b) $C_3H_2N_2O_2$ c) $C_2H_2N_2O$ d) $C_5H_6N_3O_2$ e) $C_5H_6N_3O_3$

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24. A solution contains the ions Ag^+, Pb^{2+}, and Ni^{2+}. Solutions of NaCl, Na_2SO_4, and Na_2S are available to separate the positive ions from each other through the formation of precipitates. In order to effect separation, in which order should the solutions be added? **Note:** To effectively separate the cations from each other, only one precipitate should form at a time. Assume that after each solution is added, all of the precipitate is removed before the next solution is added to the remaining liquid.

a) Na_2SO_4 added first; NaCl added second; Na_2S added last

b) Na_2SO_4 added first; Na_2S added second; NaCl added last

c) Na_2S added first; NaCl added second; Na_2SO_4 added last

d) NaCl added first; Na_2S added second; Na_2SO_4 added last

e) NaCl added first; Na_2SO_4 added second; Na_2S added last

25. When the equation $NH_3 + O_2 \rightarrow NO + H_2O$ is balanced with the smallest set of whole number integers, the sum of the coefficients is:

a) 4 b) 12 c) 14 d) 19 e) 24

26. Air bags are activated when a severe impact causes a steel ball to compress a spring and electrically ignite a detonator cap. This causes sodium azide (NaN_3) to decompose explosively according to the following reaction:

$$2\ NaN_3(s) \rightarrow 2\ Na(s) + 3\ N_2(g)$$

What mass of $NaN_3(s)$ must be reacted to inflate an air bag with nitrogen gas to 70.0 L at 25°C and 1.00 atm?

a) 241 g NaN_3 b) 80.2 g NaN_3 c) 186 g NaN_3

d) 62.1 g NaN_3 e) 124 g NaN_3

27. Which of the following (a-d) is the net ionic equation for the reaction between $Zn(NO_3)_2(aq)$ and $Na_2CO_3(aq)$?

a) $Zn^{2+}(aq) + 2\ Na^+(aq) \rightarrow Zn^{2+}(aq) + 2\ Na^+(aq)$

b) $Zn^{2+}(aq) + 2\ NO_3^-(aq) \rightarrow Zn(NO_3)_2(aq)$

c) $Zn^{2+}(aq) + 2\ NO_3^-(aq) + 2\ Na^+(aq) + CO_3^{2-}(aq) \rightarrow Na^+(aq) + NO_3^-(aq) + ZnCO_3(s)$

d) $2\ Na^+(aq) + 2\ NO_3^-(aq) \rightarrow 2\ NaNO_3(aq)$

e) None of the above (a-d) are the correct net ionic equation.

28. Consider the van der Waals equation for gases given on the constant/equation page of this exam. Which of the following gases would be expected to behave most ideally at P = 10 atm, T = 300 K and V = 2.0 L?

a) H_2 b) N_2 c) O_2 d) F_2 e) Cl_2

29. Two containers of gases are at the same temperature and pressure. One holds 1.0 mol of hydrogen gas and the other holds 1.0 mol of oxygen gas. Which of the following statements (a-c) is/are **false**?

a) The density of the hydrogen sample is the same as the density of the oxygen sample.

b) The number of molecules in the hydrogen container is the same as the number of molecules in the oxygen container.

c) The volume of the hydrogen container is the same as the volume of the oxygen container.

d) All of these statements (a-c) are false.

e) None of these statements (a-c) are false.

30. Sucralose is the sugar sucrose with some of the hydroxyl groups replaced by chlorine atoms. It is composed of C, H, O, and Cl atoms. It is shown that sucralose is 36.24% C, 4.82% H, and 32.19% O. What is the empirical formula for sucralose?

a) $C_8H_{12}ClO_5$ b) $C_{12}H_{19}Cl_3O_8$ c) $C_{24}H_{38}Cl_6O_{16}$

d) $C_{16}H_{24}Cl_2O_{10}$ e) $C_5H_{12}Cl_3O_6$

31. Calcium carbonate is the active ingredient in some antacids. Calcium nitrate is the "active ingredient" in some fireworks. Both are found as white powders. If calcium carbonate and calcium nitrate were inadvertently mixed together, would pouring the mixture in water help in separating them? Why or why not?

a) No, both powders will dissolve.

b) No, neither powder will dissolve.

c) Yes, the calcium carbonate will dissolve while the calcium nitrate will not dissolve.

d) Yes, the calcium nitrate will dissolve while the calcium carbonate will not dissolve.

e) No, no one would survive the resulting explosion.

32. My answers for this Chemistry 102 exam should be graded with the answer sheet associated with:

a) Form A b) Form B c) Form C d) Form D e) Form E

USEFUL CONSTANTS/EQUATIONS

$K = °C + 273$

$PV = nRT$

1 kg = 1000 g

R = 0.08206 L atm/K mol

1 L = 1000 mL

Avogadro's number, $N = 6.022 \times 10^{23}$

1 atm = 760 torr = 760 mm Hg

$$\text{Mass \% of A} = \frac{\text{mass of A}(100)}{\text{total mass}}$$

$$\frac{\text{rate 1}}{\text{rate 2}} = \sqrt{\frac{M_2}{M_1}} \quad (M = \text{molar mass})$$

$KE_{AVE} = (3/2)\,RT$, R = 8.3145 J/K•mol

$$M = \text{Molarity} = \frac{\text{mol solute}}{\text{L solution}}$$

$$\text{\% yield} = \frac{\text{actual}}{\text{theoretical}}\,(100)$$

$P_{total} = P_1 + P_2 + P_3 + \ldots$

STP = 1.00 atm, 273 K

d = density = mass/volume

P•M = dRT, M = molar mass

$$\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$$

Kinetic Energy = $(1/2)\,mv^2$

$$\left(P_{measured} + \frac{an^2}{V^2}\right)(V_{measured} - nb) = nRT$$

PERIODIC TABLE OF THE ELEMENTS

1 IA												13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1 H 1.008	2 2A																2 He 4.003
3 Li 6.941	4 Be 9.012					26 Fe 55.85	←Atomic number / ←Atomic mass					5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31	3	4	5	6	7	8	9	10	11	12	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.70	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc 98	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La* 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po 209	85 At 210	86 Rn 222
87 Fr 223	88 Ra 226	89 Ac† 227	104 Rf 261	105 Db 262	106 Sg 266	107 Bh 262	108 Hs 265	109 Mt 266	110 Ds 271	111	112						

*Lanthanides	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm 145	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
†Actinides	90 Th 232.0	91 Pa 231	92 U 238	93 Np 244	94 Pu 242	95 Am 243	96 Cm 247	97 Bk 247	98 Cf 251	99 Es 252	100 Fm 257	101 Md 258	102 No 259	103 Lr 260