CHEMISTRY 101
Hour Exam II
October 30, 2018
McCarren

Name ______________________________

Signature ___________________________

Section _____________________________

Q: What is the most important subject a witch learns in school?

A: Spelling.

This exam contains 17 questions on 10 numbered pages. Check now to make sure you have a complete exam. You have one hour and thirty minutes to complete the exam. Determine the best answer to the first 15 questions and enter these on the special answer sheet. Also, circle your responses in this exam booklet. Show all of your work and provide complete answers to questions 16 and 17. A periodic table and one sheet of scratch paper are provided after the exam. Anything written on the periodic table and scratch paper will not be graded.

1-15	(30 pts.)	_________
16	(15 pts.)	_________
17	(15 pts.)	_________
Total	(60 pts.)	_________

Useful Information:

1 L = 1000 mL (exactly)

Always assume ideal behavior for gases (unless explicitly told otherwise).

PV = nRT

R = 0.08206 L·atm/mol·K ≈ 0.0821 L·atm/mol·K

K = °C + 273

$N_A = 6.022 \times 10^{23}$ = 1 mole

Solubility Rules:

1. Most nitrate salts are soluble.
2. Most salts of sodium, potassium, and ammonium cations are soluble.
3. Most chloride salts are soluble. Exceptions: silver(I), lead(II), and mercury(I) chloride.
4. Most sulfate salts are soluble. Exceptions: calcium, barium, and lead(II) sulfate.
5. Most hydroxide salts can be considered insoluble. Soluble ones: sodium, potassium, ammonium, and calcium hydroxide.
6. Consider sulfide, carbonate, and phosphate salts to be insoluble. Soluble ones: sodium, potassium, and ammonium.

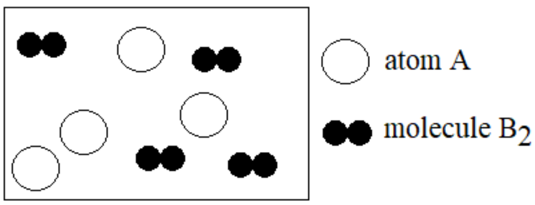
Write the balanced equation for the reaction below and use it to answer the next two questions.

Elemental boron is produced in one industrial process through the heating of diboron trioxide with magnesium metal. Magnesium oxide is also produced in this reaction.

1. What is the sum of the coefficients for this balanced equation when balanced in standard form (with the lowest possible whole numbers)?
   a. 4
   b. 6
   c. 7
   d. 8
   e. 9

2. If 2.50 moles of diboron trioxide react with sufficient magnesium, what is the **total mass** of both of the products produced in this reaction?
   a. 356 g
   b. 302 g
   c. 54.1 g
   d. 12.5 g
   e. 2.5 g

Use the diagram below to answer question 3.



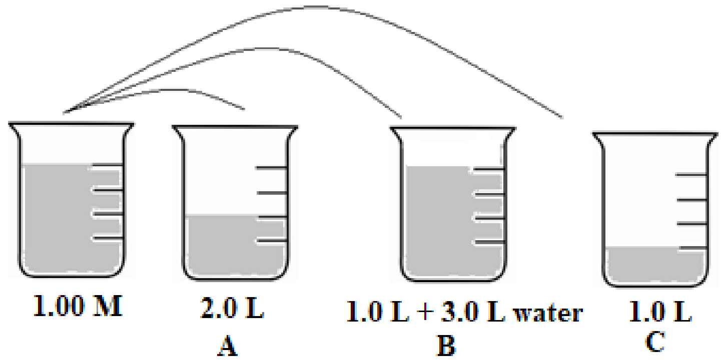
Unbalanced reaction: $A + B_2 \rightarrow A_xB_y$

3. Consider the container above holding four atoms of hypothetical element A and four diatomic molecules consisting of hypothetical element B. These react together to form some compound A_xB_y, where x and y represent integers, as shown in the **unbalanced** equation above. What is **true** about the limiting reactant when these react?
   a. Both atom A and molecule B_2 must be limiting reactants because there are same number of particles of each are present which will therefore be used up at the same time.
   b. Molecule B_2 must be the limiting reactant because two atoms of element B are used every time only one atom of element A is used.
   c. Molecule B_2 must be the limiting reactant if the coefficient of A is greater than the coefficient of B_2 in the balanced equation.
   d. Atom A must be the limiting reactant if the product formed in this reaction is AB.
   e. Atom A must be limiting reactant if the product formed in this reaction is AB_4.

Use the information given below to answer the next three questions:

Consider a 1.00 M glucose solution with volume of 4.0 liters.

- 2.0 L of this solution is poured into a container that is labeled solution A.
- 1.0 L of this solution is poured into another container and 3.00 liters of water are added. This is labeled solution B.
- 1.0 L of this solution is left and is labeled solution C.



4. Select the option which correctly ranks the solutions from highest to lowest concentration. It is possible that two or more of the solutions may have equal concentrations.
   a. A = C > B
   b. B > A > C
   c. B > A = C
   d. C > A > B
   e. A = B > C

5. Select the option which correctly ranks the solutions from greatest to least number of moles of solute. It is possible that two or more of the solutions may have equal moles of solute.
   a. A = C > B
   b. A > B = C
   c. A = B = C
   d. B > A > C
   e. B = C > A

6. Determine the mass of glucose (MM = 180. g/mol) that would need to be added to solution B to give it the same concentration as solution C. Assume the volume of the solution remains the same regardless of the amount of solute added.
   a. 180. g
   b. 360. g
   c. 540. g
   d. 720. g
   e. This is not possible because solution B already has a greater concentration than solution C.

For the next two questions, refer to the table below which represents combinations of aqueous solutions similar to those which you observed in the precipitation reactions video. Determine whether or not a precipitate has formed for each combination, and if it has, give the formula. An example has been done for you for one of the combinations below.

	Sodium chloride	Sodium sulfate	Sodium carbonate
Barium nitrate			
Lead(II) nitrate			$PbCO_3$

7. Determine the number of combinations (out of 6) which can be expected to form precipitates:
   a. 2
   b. 3
   c. 4
   d. 5
   e. 6

8. How many of the following formulas represent precipitates formed in this series of reactions?
   - $BaCl_2$
   - $BaSO_4$
   - $BaCO_3$
   - $PbCl_2$
   - $Pb(NO_3)_2$

   a. 1
   b. 2
   c. 3
   d. 4
   e. 5 (All represent formulas of precipitates formed.)

In mining iron from iron oxide ores, one of the reactions involves purifying elemental iron from iron oxide using carbon monoxide according to the equation shown below. Use this reaction to answer the next two questions.

$$Fe_3O_4(s) + 4CO(g) \rightarrow 3Fe(s) + 4CO_2(g)$$

9. If 3.00 moles of Fe_3O_4 react, how many moles of carbon monoxide are also needed to react?
   a. 0.750 moles
   b. 1.00 moles
   c. 4.00 moles
   d. 9.00 moles
   e. 12.0 moles

10. If 20.0 moles of Fe_3O_4 react with 20.0 moles of CO, how many moles of excess reactant are left over after the reaction?
    a. 5.00 moles
    b. 10.0 moles
    c. 15.0 moles
    d. 20.0 moles
    e. 35.0 moles

Consider the reaction between sulfuric acid (H_2SO_4) and sodium hydroxide to answer the next two questions.

11. What is the **molecular equation** for this reaction?
    a. $H_2SO_4(aq) + 2NaOH(aq) \rightarrow 2H_2O(l) + 2NaSO_4(aq)$
    b. $H_2SO_4(aq) + 2NaOH(aq) \rightarrow 2H_2O(l) + Na_2SO_4(aq)$
    c. $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$
    d. $2Na^+(aq) + SO_4^{2-} \rightarrow Na_2SO_4(s)$
    e. $2H^+(aq) + OH^-(aq) \rightarrow 2H_2O(l)$

12. It is necessary to use 100.0 mL of NaOH to completely react with (neutralize) 200.0 mL of 2.00 M H_2SO_4. What is the concentration of the sodium hydroxide solution?
    a. 1.00 M
    b. 2.00 M
    c. 4.00 M
    d. 8.00 M
    e. 16.0 M

Aqueous potassium carbonate and aqueous tin(IV) chloride react according to the following molecular equation:

$$2K_2CO_3(aq) + SnCl_4(aq) \rightarrow Sn(CO_3)_2(s) + 4KCl(aq)$$

In this situation, 1.00 L of 3.00 M potassium carbonate reacts with 2.00 L of 2.00 M tin(IV) choride to form the solid product. Use this information to answer questions 13 through 15.

13. What is the **complete ionic** equation for this reaction?
    a. $2K_2^{+}(aq) + 2CO_3^{2-}(aq) + Sn^{+4}(aq) + Cl_4^{-}(aq) \rightarrow Sn(CO_3)_2(s) + 4K^{+}(aq) + 4Cl^{-}(aq)$
    b. $4K^{+}(aq) + 2CO_3^{-}(aq) + Sn^{+2}(aq) + 4Cl^{-}(aq) \rightarrow Sn(CO_3)_2(s) + 4K^{+}(aq) + 4Cl^{-}(aq)$
    c. $4K^{+}(aq) + 2CO_3^{2-}(aq) + Sn^{+4}(aq) + 4Cl^{-}(aq) \rightarrow Sn(CO_3)_2(s) + 4K^{+}(aq) + 4Cl^{-}(aq)$
    d. $4K^{+}(aq) + 2CO_3^{2-}(aq) + Sn^{+4}(aq) + 4Cl^{-}(aq) \rightarrow Sn^{+4}(aq) + 2CO_3^{-2}(aq) + 4KCl(s)$
    e. $2CO_3^{-}(aq) + Sn^{+4}(aq) \rightarrow Sn(CO_3)_2(s)$

14. What is the concentration of **potassium ions** in the solution after the reaction?
    a. 6.0 M
    b. 3.0 M
    c. 2.0 M
    d. 1.0 M
    e. 0.50 M

15. Which best describes the concentration of **carbonate ions** in the solution after the reaction?
    a. 0 M, because the carbonate ion is the limiting reactant and is completely consumed in forming the precipitate.
    b. Between 0 M and 3.00 M, because some of the carbonate ion is used in forming the precipitate, but there is still some leftover.
    c. Between 0 M and 3.00 M, because the carbonate is not used in forming the precipitate but the solution has a greater volume after mixing, which decreases the carbonate ion concentration.
    d. 3.00 M, because the number of moles of carbonate ions present in the container stays the same throughout the entire reaction.
    e. Greater than 3.00 M, because the concentration of carbonate ions present increases as the precipitate forms.

Free Response: Please write your answers in the spaces below.

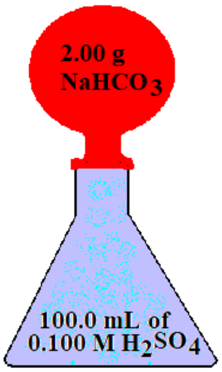
16. Recall the lab experiment in which you observed several balloons inflating after reacting two different acids with sodium bicarbonate (baking soda). One of the reactions you saw took place below between the baking soda and sulfuric acid (H_2SO_4).

$$H_2SO_4(aq) + 2NaHCO_3(s) \rightarrow 2H_2O(l) + 2CO_2(g) + Na_2SO_4(aq)$$

a. A balloon holding 1.68 grams of baking soda (MM=84.0 g/mol) is positioned on top of a flask holding sufficient sulfuric acid to react. If this reaction takes place at an external pressure of 1.0 atm and a temperature of 22°C, what is the volume of the balloon formed after the reaction takes place? <u>Assume the balloon is full of carbon dioxide.</u>

b. After the reaction took place, the flask held some water and aqueous sodium sulfate. It is possible to boil off the water until just solid sodium sulfate remains. How many grams of sodium sulfate would have been present if 1.68 grams baking soda reacted with sufficient sulfuric acid?

c. In a second scenario, 100. mL of 0.100 M sulfuric acid is placed in a flask. A balloon containing 2.00 grams of baking soda is positioned on top of this flask. The contents of the balloon and flask are mixed and the balloon inflates. Is this balloon the same size, smaller than, or larger than the balloon inflated in part a? Explain.



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17. Nitrogen and hydrogen gases are present in a rigid steel container which react to form ammonia gas (NH_3). Use the information below to answer the following questions.

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$$

- **Before** this chemical reaction took place, about 98.0 grams of nitrogen gas were present along with some mass of hydrogen gas.
- **After** the chemical reaction has occurred, 51.0 g ammonia plus 56.0 grams of excess reactant (either nitrogen or hydrogen) are present in a rigid container.

a. Identify the limiting reactant, or state that neither reactant is limiting. Circle your selection below and then justify your answer.

Limiting: Nitrogen Hydrogen Neither

b. Determine the mass of hydrogen that was present in the container before the reaction. Show work which clearly displays all steps.

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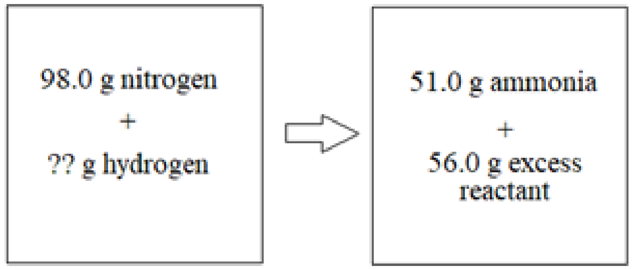
c. This reaction took place in a closed, rigid container with constant temperature and volume. Is the pressure in the container after the reactant greater than, less than, or equal to the pressure in the container before the reaction?



Fill in the blank below with your answer (less than/equal to/greater than) and then explain. Your explanation should include complete mathematical support showing all substances in the container both before and after the reaction.

The pressure in the container after the reaction is __________________ the pressure before the reaction.

STOP **This is the end of the exam. Nothing written after this page will be graded.**

Periodic Table of the Elements

Key

Atomic number →	67	
	Ho	← Symbol
Name →	Holmium	
	164.93	← Atomic mass

	1A	2A	3B	4B	5B	6B	7B	8B	8B	8B	1B	2B	3A	4A	5A	6A	7A	8A	
1	1 H Hydrogen 1.008																	2 He Helium 4.003	1
2	3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18	2
3	11 Na Sodium 22.99	12 Mg Magnesium 24.31											13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl Chlorine 35.45	18 Ar Argon 39.95	3
4	19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.88	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.38	31 Ga Gallium 69.72	32 Ge Germanium 72.59	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80	4
5	37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.1	45 Rh Rhodium 102.9	46 Pd Palladium 106.4	47 Ag Silver 107.9	48 Cd Cadmium 112.4	49 In Indium 114.8	50 Sn Tin 118.7	51 Sb Antimony 121.8	52 Te Tellurium 127.6	53 I Iodine 126.9	54 Xe Xenon 131.3	5
6	55 Cs Cesium 132.90	56 Ba Barium 137.3	57 La Lanthanum 138.9	72 Hf Hafnium 178.5	73 Ta Tantalum 180.9	74 W Tungsten 183.9	75 Re Rhenium 186.2	76 Os Osmium 190.2	77 Ir Iridium 192.2	78 Pt Platinium 195.1	79 Au Gold 197.0	80 Hg Mercury 200.6	81 Tl Thallium 204.4	82 Pb Lead 207.2	83 Bi Bismuth 209.0	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)	6
7	87 Fr Francium (223)	88 Ra Radium 226	89 Ac Actinium (227)	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (263)	107 Bh Bohrium (262)	108 Hs Hassium (265)	109 Mt Meitnerium (266)	110 Ds Darmstadtium (269)	111 — – (272)	112 — – (277)		114 — – (285)		116 — – (289)			7

Lanthanides 6	58 Ce Cerium 140.115	59 Pr Praseodymium 140.9076	60 Nd Neodymium 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.965	64 Gd Gadolium 157.25	65 Tb Terbium 158.9253	66 Dy Dysprosium 162.50	67 Ho Holmium 164.9303	68 Er Erbium 167.26	69 Tm Thulium 168.9342	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967	6
Actinides 7	90 Th Thorium 232.0381	91 Pa Protactinium 231.0359	92 U Uranium 238.0289	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (260)	7

Chem 101 Scratch Paper

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