

CHEMISTRY 101
Hour Exam II
October 29, 2019
Leveritt/McCarren

Name _____

Signature _____

Section _____

Q: What do mummies like listening to on halloween?



A: Wrap!

This exam contains 17 questions on 9 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).

$PV = nRT$ $R = 0.08206 \text{ L} \cdot \text{atm}/\text{mol} \cdot \text{K}$

$K = ^\circ\text{C} + 273$ $N_A = 6.022 \times 10^{23} = 1 \text{ mole}$

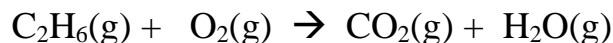
Standard temperature and pressure (STP) is 1.0 atm and 273 K.

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.

Part 1: Multiple Choice

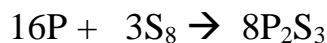
1. Ethane (C₂H₆) reacts with oxygen gas to produce carbon dioxide and water according to the unbalanced equation below.



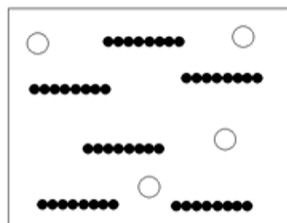
What is the sum of coefficients in this equation when it has been balanced in standard form?

- a. 4 b. 8 c. 9 d. 9.5 e. 19

Consider the balanced equation below where an atom of phosphorus reacts with a molecule of sulfur (S₈) to form a compound of P₂S₃.



2. A container holds some of both of the reactants as shown below where the particles represent molecules of sulfur and atoms of phosphorus.



Notation:
 = 1 molecule S₈
 = 1 atom P

How many atoms of phosphorus need to be **added** to this container so that both of the reactants are completely consumed when the reaction occurs? (This would mean that there is no limiting reactant.)

- a. 4 atoms
 b. 8 atoms
 c. 16 atoms
 d. 28 atoms
 e. 32 atoms
3. Now that we have added phosphorus such that both sulfur and phosphorus are totally used up, how many P₂S₃ molecules could be formed as a result of this reaction?
- a. 1 molecule
 b. 2 molecules
 c. 8 molecules
 d. 16 molecules
 e. 32 molecules

Ammonia (NH₃) is able to react with oxygen gas to form nitrogen dioxide gas and water vapor according to the balanced equation below. Use this equation to answer the next several questions.

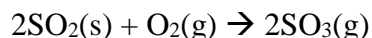


4. If eight moles of nitrogen monoxide gas were formed in this reaction, how many moles of water were also formed?
 - a. 4.00 moles
 - b. 6.00 moles
 - c. 8.00 moles
 - d. 12.00 moles
 - e. 16.00 moles

5. 14.00 moles of ammonia and 15.00 moles of oxygen were reacted. How many moles of excess reactant were left over after the reaction?
 - a. 1.00 moles
 - b. 2.00 moles
 - c. 3.00 moles
 - d. 4.00 moles
 - e. 6.00 moles

6. If 100.0 grams of ammonia reacted with excess oxygen, what mass of water formed?
 - a. 5.89 grams
 - b. 8.82 grams
 - c. 159 grams
 - d. 257 grams
 - e. 953 grams

7. The generation of sulfur trioxide is a key reaction needed to produce sulfuric acid in large quantities. One potential reaction is shown below.



If the reaction consumed 3.90 moles of oxygen gas, what would be the volume of the sulfur trioxide produced at STP? (Hint: the value of STP is the front page!)

- a. 1.00 L
- b. 5.74 L
- c. 22.4 L
- d. 87.4 L
- e. 174.7 L

The table below which represents the results when aqueous solutions are mixed with an unknown substance. This is similar to those which you observed in the precipitation reactions video. Use this table and information about solubility rules to answer the next three questions.

	Sodium chloride	Sodium sulfate	Sodium sulfide
Unknown solution	No reaction	Precipitate	Precipitate

8. The table above shows which substances formed precipitates when combined with an unknown solution. What is the identity of the unknown solution? (Hint: check the solubility rules on the cover page!)
- Lead(II) nitrate
 - Barium nitrate
 - Potassium nitrate
 - Copper(II) nitrate
 - Sodium phosphate
9. According to the “Precipitation Reactions” activity, the reaction between silver nitrate and sodium sulfide formed a precipitate. Give the net ionic equation that results when these two react.
- $2\text{Ag}^+(\text{aq}) + \text{S}^{2-}(\text{aq}) \rightarrow \text{Ag}_2\text{S}(\text{s})$
 - $\text{Ag}_2^+(\text{aq}) + \text{S}^{2-}(\text{aq}) \rightarrow \text{Ag}_2\text{S}(\text{s})$
 - $\text{Na}^+(\text{aq}) + \text{NO}_3^-(\text{aq}) \rightarrow \text{NaNO}_3(\text{s})$
 - $2\text{Na}^+(\text{aq}) + \text{NO}_3^-(\text{aq}) \rightarrow \text{Na}_2\text{NO}_3(\text{s})$
 - $2\text{Ag}^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{Ag}_2\text{SO}_4(\text{s})$
10. Consider the reaction between silver nitrate and sodium sulfide. If 250.0 mL of 2.00 M silver nitrate react with 500.0 mL of 2.00 M sodium sulfide, which ion has a concentration of zero after the reaction?
- Sodium ion
 - Silver ion
 - Nitrate ion
 - Sulfide ion
 - There is more than one ion after the reaction that has a concentration of zero.

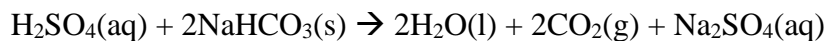
Use the following combinations of reactants to answer the next two questions.

Combination 1	$\text{H}_2\text{SO}_4(\text{aq}) + \text{NH}_4\text{OH}(\text{aq}) \rightarrow$
Combination 2	$\text{Ca}(\text{OH})_2(\text{aq}) + \text{NaCl}(\text{aq}) \rightarrow$
Combination 3	$\text{K}_2\text{CO}_3(\text{aq}) + \text{Fe}(\text{NO}_3)_3(\text{aq}) \rightarrow$
Combination 4	$\text{Na}_3\text{PO}_4(\text{aq}) + \text{Ca}(\text{OH})_2(\text{aq}) \rightarrow$
Combination 5	$\text{NH}_4\text{OH}(\text{aq}) + \text{K}_2\text{CO}_3(\text{aq}) \rightarrow$

11. For how many of the combinations above does a precipitate form?
- 1
 - 2
 - 3
 - 4
 - 5 (Precipitates form in all cases.)
12. For which of the combinations does a reaction occur, but **no precipitate** forms?
- Combination 1
 - Combination 2
 - Combination 3
 - Combination 4
 - Combination 5
-
13. The products of an acid-base reaction are sodium nitrate and water. What were the reactants? Assume that both reactants are in the aqueous phase.
- NaNO_3 and Na_2O
 - HNO_3 and NaOH
 - HNO_3 and NaH
 - HNO_2 and NaOH
 - HNO_3 and Na_2O

Please go on to the next page.

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):



The sulfuric acid and baking soda react to produce a balloon full of carbon dioxide that has volume 2.20 L at a temperature of 23.0°C and a pressure of 1.10 atm.

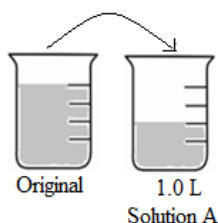
14. What mass of baking soda was required to produce this much carbon dioxide? Assume that sufficient sulfuric acid was present for the baking soda to be able to react.
- 0.100 g
 - 0.200 g
 - 4.20 g
 - 8.40 g
 - 16.80 g
15. If the mass of baking soda you determined in question #14 was used to react with sulfuric acid, which solution of sulfuric acid could **not** be used to completely react with this amount of baking soda?
- 25.0 mL of 1.00 M H_2SO_4
 - 25.0 mL of 2.00 M H_2SO_4
 - 50.0 mL of 1.00 M H_2SO_4
 - 50.0 mL of 2.00 M H_2SO_4
 - All of these can be used to make that amount of carbon dioxide.

Please go on to the next page.

Part 2: Free Response

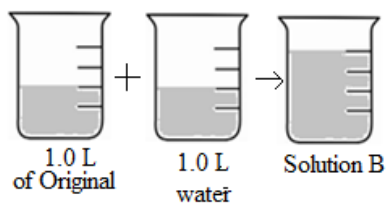
16. Recall the demonstration from lecture in which we created solutions of varying concentrations. Use your knowledge of these solutions to answer the questions below.
- a. You place 234 grams of sodium chloride into a very large beaker and add water until the total volume of the solution is 2,000. mL. What is the concentration of this solution?
(Note: The molar mass of sodium chloride is 58.45 g/mol.)

- b. You pour one liter of this solution into a second beaker. This new solution is solution A.
- i. Give the concentration of solution A. Explain your answer.



- ii. Give the number of moles of solute within solution A. Show work.

- c. You take the remaining 1.00 liter sodium chloride solution and add an additional 1.00 liters of water. This new solution is solution B.
- i. Give the concentration of solution B in the beaker after the water has been added.
Show work.



- ii. Give the number of moles of solute in solution B. Show your work and explain how you got your answer.

- d. You combine solutions A and B together into one container to form solution C. Compare the moles of solute in solution C, the volume of solution C, and the concentration of solution C to that of both solutions A and B by filling in the table below. Show numerical support in each case.

<p><u>i. Moles of solute in solutions</u> Fill in each box below with <, >, or =.</p> <p>Solution C <input type="checkbox"/> Solution A</p> <p>Solution C <input type="checkbox"/> Solution B</p>	<p>Numerical support for part i:</p>
<p><u>ii. Volume of solutions</u></p> <p>Solution C <input type="checkbox"/> Solution A</p> <p>Solution C <input type="checkbox"/> Solution B</p>	<p>Numerical support for part ii:</p>
<p><u>iii. Concentration of solutions</u></p> <p>Solution C <input type="checkbox"/> Solution A</p> <p>Solution C <input type="checkbox"/> Solution B</p>	<p>Numerical support for part iii:</p>

Please go on to the next page.

17. Recall the demonstration from lecture in which solid magnesium reacted with solid carbon dioxide to produce solid magnesium oxide and solid carbon.



- **Before** the reaction, some magnesium and 10.14 grams carbon dioxide were placed in a closed container.
- **After** this reaction, the container held 1.20 grams of carbon, some magnesium oxide and potentially some leftover reactant.

a. Give the balanced equation for this reaction. Include phases.

b. Determine the masses of magnesium, carbon dioxide, magnesium oxide, and carbon present both before and after the reaction by completely filling in the table below. Show all work in the space below the table. (Hint: A BCA table may be helpful in this situation!)

	Mass Magnesium	Mass carbon dioxide	Mass magnesium oxide	Mass carbon
Before Reaction		10.14 g	0	0
After Reaction				1.20 g

c. Explain how your table above demonstrates that mass has been conserved in this process.



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

Chem 101 Scratch Paper

NOTHING WRITTEN ON THIS PAGE WILL BE GRADED

Periodic Table of the Elements

1A	1 H Hydrogen 1.008	2A	3A	4A	5A	6A	7A	8A										
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										
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										
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
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
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 Platinum 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)
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 - -	112 - -	114 - -	116 - -	116 - -	116 - -	116 - -	116 - -

Key

Atomic number	67	Symbol
Name	Holmium	Atomic mass

HO

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 Gadolinium 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
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)

Lanthanides

Actinides