

CHEMISTRY 101
Hour Exam I
September 23, 2014
Adams/Esbenshade

Name _____

Signature _____

Section _____

“We cannot become what we need to be by remaining what we are.”

--Max DePree--

This exam contains 17 questions on 7 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.

1-15 (30 pts.) _____

16 (14 pts.) _____

17 (16 pts.) _____

Total (60 pts) _____

Useful Information:

$$PV = nRT$$

$$K = ^\circ\text{C} + 273$$

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

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

$$1 \text{ L} = 1 \text{ dm}^3$$

$$1 \text{ m} = 10 \text{ dm} = 100 \text{ cm} = 1000 \text{ mm}$$

$$1 \text{ mL} = 1 \text{ cm}^3$$

STP = standard temperature and pressure = 0°C and 1.00 atm

Assume atmospheric pressure is 1.00 atm (unless explicitly told otherwise).

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

1. A sample of a gas at 0.780 atm occupies a volume of 0.501 L. If the temperature remains constant, what will be the new pressure if the volume increases to 0.794 L?
- a) 0.391 atm
 - b) 0.492 atm
 - c) 0.510 atm
 - d) 0.780 atm
 - e) 1.24 atm

2. How many of the following compounds are named incorrectly?

- I. Al_2S_3 ; dialuminum trisulfide
- II. KClO_3 ; potassium chlorate
- III. Rb_2O ; rubidium oxide
- IV. CrPO_4 ; chromium(III) phosphate

- a) 0 b) 1 c) 2 d) 3 e) 4

3. Evaluate the following expression and determine the number of significant figures the final answer should be reported to.

$$2.3 \times 10^1 + 1.0124 \times 10^2$$

- a) 1 b) 2 c) 3 d) 4 e) 5

4. Which of the following **best** describes the air around you on a typical day? (Assume the air is made up of ~80% nitrogen and ~20% oxygen. Ignore other gases like water vapor and carbon dioxide.)

- a) Air is a **homogeneous mixture** of gases because it generally contains the same ratio of gaseous substances from one region to another.
- b) Air is a **heterogeneous mixture** of gases because it contains different gaseous substances in unequal amounts.
- c) Air is a **pure substance** because it always has the same composition.
- d) Air is a **compound** because it is made up of nitrogen and oxygen, which are different elements.
- e) Air is an **element** because it contains nitrogen and oxygen, which are found on the periodic table.

5. How many mole(s) are in a 50.0 g sample of ammonium carbonate?

- a) 0.438 mol b) 0.520 mol c) 0.531 mol d) 0.641 mol e) 3.13×10^{23} mol

6. The percent by mass of nitrogen is 46.7% for a species containing only nitrogen and oxygen. Which of the following could be this species?

a) N_2O_5 b) N_2O c) NO_2 d) NO e) NO_3

7. Which of the following correctly describes $^{17}_8\text{O}^{2-}$?

	<u># protons</u>	<u># electrons</u>	<u># neutrons</u>
a)	8	6	9
b)	8	9	10
c)	8	10	9
d)	17	2	8
e)	10	8	17

8. How many of the following is(are) classified as a physical change or property?

- I. If you spill some nail polish remover on your skin, it will evaporate quickly.
- II. Mothballs pass directly into the gaseous state in your closet without first melting.
- III. Your windshield fogs up on a hot day when the air conditioner is running.
- IV. A sample of gallium metal melts in your hand.

a) 0 b) 1 c) 2 d) 3 e) 4

9. How many grams of carbon are contained in a 13.25-g sample of carbon suboxide (C_3O_2)?

a) 0.1948 g b) 0.5843 g c) 0.7797 g d) 2.339 g e) 7.017 g

10. Which of the following statements is(are) **true**?

- a) At constant temperature, the lighter the gas molecules, the faster the average velocity of the gas molecules.
- b) At constant temperature, the heavier the gas molecules, the larger the average kinetic energy of the gas molecules.
- c) A real gas behaves most ideally when the temperature is low and the pressure of the gas is high.
- d) At least two of the above (a-c) are true.
- e) None of the above are true.

11. A rectangular solid measures 1.0 m by 2.4 mm by 3.9 dm. What is the volume in liters?

a) 940 L b) 94 L c) 9.4 L d) 0.94 L e) 0.094 L

12. Suppose two separate 100.0-L tanks are to be filled, one with helium and one with hydrogen. What mass of each gas is needed to produce a pressure of 2.70 atm in its respective tank at 24°C?

	<u>helium</u>	<u>hydrogen</u>
a)	11.1 g	11.1 g
b)	44.3 g	11.2 g
c)	44.3 g	22.3 g
d)	2.77 g	5.50 g
e)	549 g	276 g

13. A compound containing only sulfur and nitrogen is 69.6% S by mass. The molar mass is 184 g/mol. What is the correct name for this compound?

- a) tetrasulfur dinitride
- b) trisulfur hexanitride
- c) sulfur mononitride
- d) tetrasulfur tetranitride
- e) disulfur hexanitride

14. You have 1 mole of an ideal gas in a balloon. How must the volume change so that the pressure in the balloon doubles and the temperature in °C is halved (assume the temperature is a positive value)?

- a) The volume must *decrease by more than half* the original volume.
- b) The volume must *decrease to exactly half* the original volume.
- c) The volume must *not change* since pressure and temperature “balance” out.
- d) The volume must *increase to exactly twice* the original volume.
- e) The volume must *increase by more than twice* the original volume.

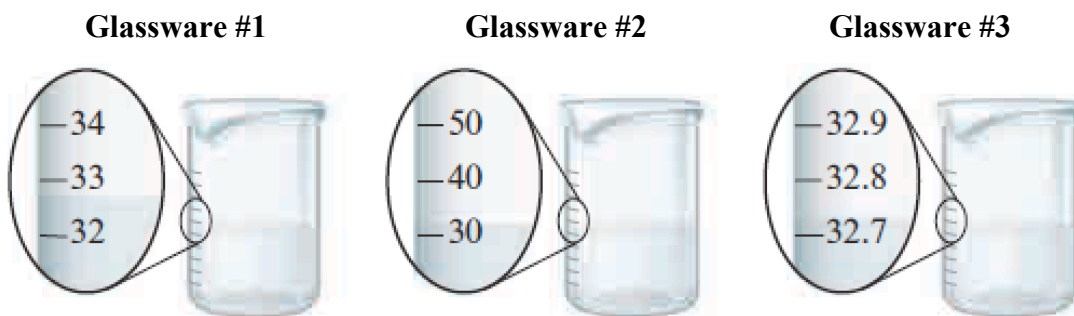
15. How many atoms of nitrogen are present in a 5.00-g sample of magnesium nitride?

- a) 1.49×10^{22} atoms
- b) 2.98×10^{22} atoms
- c) 4.06×10^{22} atoms
- d) 5.18×10^{22} atoms
- e) 5.97×10^{22} atoms

Answer the questions below. Show all work! Only complete and coherent explanations will receive full credit. **Please limit your answers to the space provided.**

16. a) Recalling from lab, you had a plastic bottle filled with water and a “diver”.
Provide an explanation as to why the “diver” sank when the bottle was squeezed.
Include *microscopic* sketches (before and after squeezing) with your explanation.

- b) You have the following three pieces of glassware available to you, each with a different level of precision.



(Source: Zumdahl S., Chemistry 9th edition, Cengage Learning, 2014, p. 35)

You are asked to measure 32.7 mL of a liquid (to exactly 3 significant figures as written). Which piece of glassware should you use? Justify your answer. What volume of liquid would you record for the other two pieces of glassware?

- c) If needed, correct each of the following statements regarding Dalton's atomic theory so that they are true to our current scientific understanding. For full credit, provide a thorough explanation for each correction. If no corrections are needed, write NO CORRECTIONS.

(i) Elements are made of tiny particles called molecules.

(ii) A chemical reaction may involve the gain or loss of atoms as it takes place.

(iii) All atoms of a given element are the same.

(iv) A given compound always has the same relative numbers and types of atoms.

17. A 2.50-L container at 1.00 atm and -48°C is filled with 5.41 g of a monatomic gas.

a) Determine the identity of the gas. Show all work.

b) Assuming the 2.50-L container is a large elastic balloon, predict what will happen when 10.0 g of oxygen gas is added to the balloon (which already contains 5.41 g of the monatomic gas).

Provide values for each of the variables listed below. Show all work. In addition, explain what is happening for each variable, incorporating the kinetic molecular theory into your explanation.

Temperature of gas mixture: _____ K

Total moles of gas mixture: _____ mol

Total pressure of gas mixture: _____ atm

Volume of balloon: _____ L

- c) Now assuming the 2.50-L container is rigid (like a steel container), predict what will happen when 10.0 g of oxygen gas is added to the container (which again already contains 5.41 g of the monatomic gas).

Provide values for each of the variables listed below. Show all work. In addition, explain what is happening for each variable, incorporating the kinetic molecular theory into your explanation.

Temperature of gas mixture: _____ K

Total moles of gas mixture: _____ mol

Total pressure of gas mixture: _____ atm

Volume of rigid container: _____ L