

**Exam Four**  
**CHM 203 (Dr. Mattson)**  
**7 December 2011**

**Print your name:**

**Signature:**

**Circle your section:**

**8:30 9:30**

**Instructions:** Show all work whenever a calculation is required! You will receive credit for how you worked each problem as well as for the correct answer. If you need more space, you may use the back of your periodic table — Write: "See PT" in box and then attach the periodic table. **BOX YOUR ANSWERS!** Write legibly.

1. (4 pts) In the US, barometric pressures are frequently expressed in inches of mercury (inHg), which is basically like mmHg, but only in inches instead of mm. Given 1 inch = 2.54 cm, convert 29.5 inches of mercury in kPa. [Given: 1 atm = 101.325 kPa]

- 2a. (1 pt) Suppose you constructed a manometer like those sketched in the book problems (a globe containing gas connected to a U-tube filled with mercury.) Once the internal pressure has been determined, it never changes providing:

- A. the temperature is held constant.
- B. the external pressure does not change.
- C. the pressure is reported in mmHg.

- 2b. (4 pts) Suppose your manometer has an internal pressure of 722.2 mmHg at 25 °C. Your manometer can be used to determine the external pressure. On a particular day, suppose the column of mercury in the U-tube is 1.04 cm higher on the side connected to the globe. What is the external pressure?

3. (4 pts) A sample of sulfur trioxide occupies a volume of 1388 mL at 27 °C and 750.5 mmHg. What is the mass of the sulfur trioxide in grams?

- 4a. (4 pts) Starting with the ideal gas law, derive the formula you would use to determine the density of an ideal gas, given temperature and pressure.

- 4b. (4 pts) What is the density of carbon dioxide, in g/L, at 710.5 mmHg and 23.7 °C?

5. (4 pts) The pressure of a gas sample in a rigid container is 810.0 mmHg at 22 °C. What is the pressure, in mmHg, at 50 °C?

- 6a. (2 pts) Argon exists in three isotopic forms,  $^{36}\text{Ar}$ ,  $^{38}\text{Ar}$ , and  $^{40}\text{Ar}$ , with the latter being the most abundant. What isotope has the fastest relative rate of effusion/diffusion?

Circle one:  $^{36}\text{Ar}$   $^{38}\text{Ar}$   $^{40}\text{Ar}$

What isotope is the slowest of the three?

Circle one:  $^{36}\text{Ar}$   $^{38}\text{Ar}$   $^{40}\text{Ar}$

- 6b. (3 pts) What is the relative rate of effusion of the fastest to slowest,  $u_{\text{fast}}/u_{\text{slow}}$ ? Calculate a number; do not leave as a fraction.

7. (4 pts) Suppose a mixture consisting of 4.2 mol  $\text{Cl}_2(\text{g})$  and 3.7 mol  $\text{H}_2(\text{g})$  exhibited a total pressure of 801.1 mmHg. What is the partial pressure of  $\text{Cl}_2(\text{g})$  in the mixture?

8. (1 pt) For which of the following choices will the ideal gas law give the best estimation of pressure?

- A. 5 mol  $\text{CO}_2$  in a 10 L container at 100 K
- B. 5 mol  $\text{CO}_2$  in a 100 L container at 100 K
- C. 5 mol  $\text{CO}_2$  in a 10 L container at 300 K
- D. 5 mol  $\text{CO}_2$  in a 100 L container at 300 K

9a. (8 pts) Which of the following gaseous molecules have dipoles? Show your work for credit. Circle Dipole or No Dipole

|                     |                     |
|---------------------|---------------------|
| (a) $\text{CO}_2$   | (b) $\text{SO}_2$   |
| Dipole or No dipole | Dipole or No dipole |
| (c) $\text{SO}_3$   | (d) $\text{O}_2$    |
| Dipole or No dipole | Dipole or No dipole |

9b. (1 pt) Which of the above molecules would have the largest London dispersion forces?

- A.  $\text{CO}_2$    B.  $\text{SO}_2$    C.  $\text{SO}_3$    D.  $\text{O}_2$

10. (3 pts) Sketch hydrogen bonding intermolecular forces that are present in liquid methanol,  $\text{CH}_3\text{OH}$ .

11. (4 pts) When liquid methanol,  $\text{CH}_3\text{OH}$ , undergoes the phase change to  $\text{CH}_3\text{OH}(\text{g})$ , what forces are broken? Circle all that apply.

- A. intermolecular hydrogen bonding
- B. C-H covalent bonds
- C. London dispersion forces
- D. ion dipole forces

12. (4 pts) Methanol has a  $\Delta H_{\text{vap}} = 35.3 \text{ kJ/mol}$   $\text{CH}_3\text{OH}$ . Calculate the change in heat,  $q$ , when 50.0 g methanol condenses? Caution! Is  $q$  + or -?

13. Copper crystallizes in a face-centered cubic unit cell with an edge length of 362 pm.

13a. (4 pts) What is the radius of a Cu atom in pm?

13. (5 pts) What is the density of copper in  $\text{g/cm}^3$ ?

14. (1 pt) Cesium chloride crystallizes with the chlorides forming a simple cubic unit cell. How many cesium cations are present in each unit cell?

- A. one   B. two   C. three   D. four   E. eight

15. (5 pt) Refer to the phase diagram for water on the data sheet, where pressure is in mmHg.

|   |
|---|
| 15a. Below what pressure will solid water sublime?  |
| 15b. What is the state of water at $-1^\circ\text{C}$ and 1 atm?                            |
| 15c. What happens to the water in 15b if the pressure is increased at constant temperature? |
| 15d. What phase change is represented by line OA?   |
| 15e. Is the critical temperature higher than the boiling point?                             |

16. (10 pts) Circle all substances incorrectly named. (Skip this question if you are nomenclature certified.)

|   |                                   |
|---|-----------------------------------|
| $\text{N}_2\text{O}_5$ nitrogen pentoxide | SiC silicon carbide               |
| $\text{CaSO}_4$ calcium sulfite           | $\text{OH}_2$ oxygen dihydride    |
| ClF chlorine fluoride                     | $\text{NH}_3$ ammonium            |
| $\text{NiCl}_2$ nickel dichloride         | $\text{NaN}_3$ sodium trinitride  |
| Au silver                                 | $\text{LiClO}_3$ lithium chlorate |



## Answers:

1. 99.9 kPa

2a. A

2b. 732.6 mmHg

3. 4.46 g

4a.

$$PV = nRT$$

$$n = \frac{m}{MM}$$

$$PV = \frac{m}{MM}RT$$

$$d = \frac{m}{V}$$

$$d = \frac{PM}{RT}$$

4b. 1.69 g/L

5. 887 mmHg

6a. fastest:  $^{36}\text{Ar}$  slowest:  $^{40}\text{Ar}$

6b.  $u_{\text{fast}}/u_{\text{slow}} = 1.05$

7. 425.9 mmHg

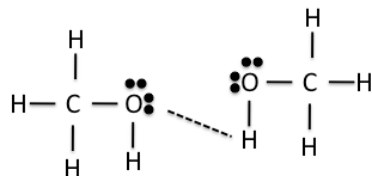
8. D

9a. Lewis dot structures that obeyed the octet rule were required for credit.

|   |  |
|---|--|
| (a) $\text{CO}_2$<br>$\text{AB}_2$<br>No dipole | (b) $\text{SO}_2$<br>$\text{AB}_2\text{E}$<br>Dipole |
| (c) $\text{SO}_3$<br>$\text{AB}_3$<br>No dipole | (d) $\text{O}_2$<br>symmetric diatomic<br>No dipole  |

9b. C

10. dashed line is hydrogen bonding intermolecular forces



11. A and C

12.  $q = -55.1 \text{ kJ}$

13a. 128 pm

13.  $8.90 \text{ g/cm}^3$

14. one

15a. 4.579 mmHg

15b. solid

15c. solid  $\rightarrow$  liquid

15d. liquid/gas

15e. Yes

16. Incorrectly named:

|                             |                           |
|-----------------------------|---------------------------|
| $N_2O_5$ nitrogen pentoxide | Ok                        |
| $CaSO_4$ calcium sulfite    | Ok                        |
| $ClF$ chlorine fluoride     | $NH_3$ ammonium           |
| $NiCl_2$ nickel dichloride  | $NaN_3$ sodium trinitride |
| Au silver                   | Ok                        |