Exam 6 Chm 203 (Dr Mattson) 9 December 2015

Name:*

Chemistry Student Number:* _____

*1 pt for signing name, printing name, student number

Instructions: Show all work whenever a calculation box is provided! Write legibly. Include units whenever appropriate. 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 the periodic table provided — Write: "See PT" in the answer box and then hand the periodic table in with your exam. On your desk you are allowed only pencils (but no pencil pouch), an eraser, and a non-programmable calculator without a slipcover. Backpacks, bags, and purse-like items must be stored in the rear section of the room. Cell phones must be silent and placed in your backpack/bag/purse – not in your pocket.

$R = 8.314$ J mol^{-1} K^{-1} = 0.0821 L atm mol^{-1} K^{-1}
1 atm = 760 mmHg = 101.325 kPa
$N_A = 6.022 \times 10^{23}$ mol^{-1}

1a. (4 pts) Given that pressure is a force over an area and that force = mass x acceleration and that acceleration has units of distance/s^2, what are the SI units for pressure (m, kg, s)? Box your answer.

> Show work for credit!

1b. (1 pt) What is the name of the pressure unit that we use for the SI units for pressure derived above?

A. torr   B. bar   C. Pa   D. atm   E. None of these

2. (4 pts) Circle the larger pressure for each pair.

A. **50 atm** OR **50,000 Pa**   B. **10 atm** OR **5000 mmHg**

C. **760 mmHg** OR **1 MPa**   D. **500 mmHg** OR **500 kPa**

3. (2 pts) Gallium is a liquid above 29.7 °C. The densities of gallium and mercury are 5.91 and 13.32 g/cm^3, respectively. Suppose the external pressure was known to be 790 mmHg and the temperature is such that gallium is a liquid, what is the pressure in mmGa?

A.   790 x 13.32 / 5.91

B.   790 x 5.91 / 13.32

C.   13.32 x 5.91 / 790

D.   790 / (13.32 x 5.91)

4. (3 pts) A manometer exhibits a difference in mercury levels of 24 mm with the column being lower on the arm open to the atmosphere.   If P_{ext} = 755 mmHg, what is the pressure of the gas inside the bulb?

> Answer with units: _____

5. (4 pts) Given that 1 inch = 2.54 cm, convert 760 mmHg into inches of mercury, inHg.

> Show work for credit!
>
> Answer with units: _____

6a. (5 pts) A rigid gas cylinder holds 49 L of neon at 95 atm pressure and 25 °C. What is its volume at STP?

> Show work for credit!
>
> Answer with units: _____

6b. (5 pts) How many moles of neon are present in the cylinder as described in 6a (49 L, 95 atm, 25 °C)?

> Show work for credit!
>
> Answer with units: _____

6c & d. (7 pts) What is the density of neon present in the cylinder? Express answer **in g/L**. 6c. 3 pts for deriving formula and 6d. 4 pts for correct answer.

> 6c. Show derivation of the formula here – not on periodic table!

> 6d. Show work for answer to the question, 'What is the density of neon…"
>
> Answer with units: _____

7. (5 pts) The composition of "natural gas" varies with location. A typical composition consists of 94 mole% methane and 6 mole% ethane. In the lab, the natural gas supply has a pressure of about 950 mmHg. What is the partial pressure of ethane in mmHg?

> Show work for credit!
>
> Answer with units: _____

8a. (4 pts) True/False regarding a mixture of methane (CH_4) and ethane (C_2H_6) in the same vessel.

T F CH_4 has a greater average kinetic energy.

T F The C_2H_6 has greater average molecular speed.

T F The average molecular speed for both gases would increase as the temperature is increased.

T F Individual CH_4 and C_2H_6 molecules experience the same number of collisions per second.

8b. (5 pts) What is the relative rate of effusion/diffusion of methane and ethane, $u_{methane}/u_{ethane}$?

Answer (ratios have no units): _____

9. (5 pts) "Carbon tet" is the common name for a substance that is a gas above 77 ^oC. A flask with a known volume of 1084 mL contains 4.92 g of gaseous carbon tet at 97.0 ^oC and 719 mmHg. What is the molar mass of carbon tet?

Show work for credit!

Answer with units: _____

10. (6 pts) Mercury has mp = -38.8 ^oC (234.2 K) and bp = 356.6 ^oC (629.6 K). What, if any, phase changes take place under the following conditions at 1.0 atm pressure? The temperature of the sample goes from…

A. -30 ^oC to 365 ^oC: **Start: s l g   End: s l g**

B. 291 K to 238 K: **Start: s l g   End: s l g**

C. 638 K to 231 K: **Start: s l g   End: s l g**

11. (5 pts) Suppose you were to calculate the amount of energy needed to heat 15.0 g ice at -14.0 ^oC to 40 ^oC? Which of these values would you need? **Circle all.**

ΔH_{fus} ΔH_{vap} $C_{m, H2O(s)}$ $C_{m, H2O(l)}$ $C_{m, H2O(g)}$

12. (8 pts) The vapor pressure of ether is higher than that of ethanol. Evaluate these as True/False/Uncertain.

T F U Ethanol has a higher boiling point at 1 atm.

T F U Ethanol has stronger intermolecular forces.

T F U ΔH_{vap} is larger for ethanol.

T F U Ethanol has stronger covalent bonds.

13. (6 points) Circle all substances that are solid due to metallic forces.

**MgO   Mg   KClO$_4$ Fe   Hg$_2$Br$_2$ CuSO$_4$**
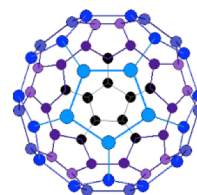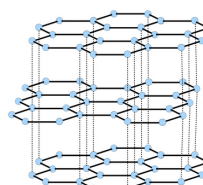
14. (4 pts) Graphite consists of sheets of carbon atoms in a network covalent arrangement and buckminster-fullerene (buckyball) has formula C_{60} with a soccer ball-like structure of pentagons and hexagons of carbon rings. The latter sublimes at about 600 ^oC.

T F Graphite has a higher sublimation temperature.

T F C_{60} molecules are held to one another by London dispersion forces.

T F Within graphite sheets, the carbon atoms are held together by covalent bonds.

T F Within the C_{60} molecule, the carbon atoms are held together by covalent bonds.

15. (1 pt) Identify the unit cell shown here.

A. Simple cubic

B. Body-centered cubic

C. Face-centered cubic
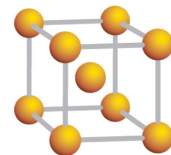
16. (4 pts) The yellow spheres in this figure are oxygen ions, the small blue ones are sodium ions, and the large purple one is an ion of atom X. (a) What is the formula of the substance in format $Na_?X_?O_?$? (b) What is the charge on X?
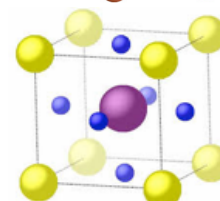
17. (5 pts) Titanium has a face-centered unit cell with a density of 4.506 g/cm^3. What is the atomic radius of Ti?

Show work for credit! **Express your answer in nm**

Answer in nm: _____

18. (6 pts) Bromine has a triple point at 5.8 kPa and 266 K and a normal melting point of 266 K. Bromine's critical point is 588 K and 10.34 MPa. What is the primary phase present under each of these conditions?

A. 1 atm and 298 K   Circle: **SOLID** or **LIQUID** or **GAS**

B. 5.8 kPa and 298 K   Circle: **SOLID** or **LIQUID** or **GAS**

C. 3.0 kPa and 266 K   Circle: **SOLID** or **LIQUID** or **GAS**

D. 5.8 kPa and 250 K   Circle: **SOLID** or **LIQUID** or **GAS**

E. 1 atm and 250 K   Circle: **SOLID** or **LIQUID** or **GAS**

F. 11 MPa and 500 K   Circle: **SOLID** or **LIQUID** or **GAS**

Total score (out of 100):   _____

A+ $\geq$ 95% A $\geq$ 90% B+ $\geq$ 85% B $\geq$ 80% C+ $\geq$ 75% C $\geq$ 70% D $\geq$ 60%

Answers:

1a. $kg\ s^{-2}\ m^{-1}$

1b. C

2. (4 pts) Circle the larger pressure for each pair.

   A. **50 atm**   B. **10 atm**

   C. **1 MPa**   D. **500 kPa**

3. A

4. 731 mmHg

5. 29.9 inHg

6a. 4300 L

6b. 190 mol

6c. $d = P \times MM\ R^{-1}\ T^{-1}$

6d. 78 g/L

7. 57 mmHg?

8a. F F T F

8b. 1.37

9. 145.7 g/mol

10. A. liquid to gas; B. liquid stays liquid; C. gas to solid

11. ΔH_{fus}, $C_{m,\ H2O(s)}$, $C_{m,\ H2O(l}$

12. T T T U

13. Mg and Fe

14. T T T T

15. B

16. (a) $Na_3X_1O_1$ (b) -1

17. 146 nm

18.
   A. I accepted either **LIQUID** or **GAS**
   B. **GAS**
   C. **GAS**
   D. **SOLID**
   E. **SOLID**
   F. **LIQUID**