Exam 5 Chm 203 (Dr Mattson) 6 December 2013

Academic Integrity Pledge: *In keeping with Creighton University's ideals and with the Academic Integrity Code, I pledge that this work is my own and that I have neither given nor received inappropriate assistance in preparing it.*

Signature:

Name:

Circle your Folder group:

H He Li Be B C N O F Ne Na Mg Al Si

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 and purses must be closed and stored on the floor under the table. Cell phones must be OFF and placed in your backpack/purse – not in your pocket.

R = 0.0821 L atm/mol K; R = 8.314 J/mol K
$N_A = 6.02 \times 10^{23}$; 1 atm = 760 mmHg = 101.325 kPa

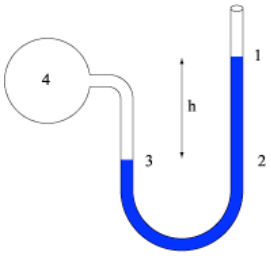
1. (4 pt) What pressure (in atm) is exerted by 0.12 mol carbon dioxide in a 2.0 L bottle at 25 ^{o}C?

Answer with units:_____

2. (3 pts) Convert a pressure of 725 mmHg into units of kPa.

Answer with units:_____

3. (1 pt) The manometer pictured here is open to the atmosphere above the surface labeled 1 and the external pressure is 713 mmHg. The manometer is filled with mercury, and the difference between levels 3 and 1, h = 31.1 cm. What is the pressure (in mmHg) inside the portion of the vessel labeled 4?



A. $P_4 = 713 + 31.2$ B. $P_4 = 713 - 31.2$

C. $P_4 = 713 - 31.2/10$ D. $P_4 = 713 + 31.2 \times 10$

4. (3 pts) A sample of gas in a rigid vessel exerts a pressure of 488 kPa at 25 ^{o}C. What is its pressure at 200 ^{o}C?

Answer with units:_____

5A. (4 pts) Suppose 15.8 g of a noble gas occupies 4.22 L at STP. What is its molar mass?

Answer with units:_____

5B (1 pt) Which gas might this be? **He Ne Ar Kr Xe Rn**

6. (4 pts) Starting with the ideal gas law, derive an expression for density. Answer in the form: d =

7. (4 pts) Use your derived formula in Question 6 to calculate the density of gaseous carbon tetrachloride at 200 ^{o}C and 690 mmHg.

Answer with units:_____

8 - 11. Suppose 5.00 g of helium and 5.00 g argon are mixed in a 10.0 L rigid vessel at 298 K.

8. (4 pts) What is the mole fraction of argon?

Answer with units:_____

9. (4 pts) What is the partial pressure of helium?

Answer with units:_____

10. (4 pts) True/False regarding the helium and argon in the same vessel.

T F The helium has a greater average kinetic energy.
T F The helium has a greater average molecular speed.
T F The average molecular speed for both gases would increase as the temperature is increased.
T F Individual helium and argon atoms experience the same number of collisions per second.

11. (4 pts) What is the relative rate of effusion/diffusion of helium and argon? Express ratio as fast over slow.

Answer (no units):_____

12. (6 pts) Which of these molecules are polar? Circle all that apply.

A. PCl_3 B. OCl_2 C. SO_2

D SO_3 E. SiH_4 F. BF_3

13. (3 pts) Circle the member of each group with the largest London dispersion forces. Circle 3 answers.

A. PF_3 PCl_3 PCl_5
B. C_2H_6 C_3H_8 C_4H_{10}
C. F_2 Cl_2 Br_2

14. (3 pts) Circle the one member of each group that exhibits hydrogen bonding. Circle 3 answers.

A. PH_3 NH_3 CH_4
B. C_2H_6 $N(CH_3)_3$ CH_3OH
C. $HC_2H_3O_2$ HCl CH_2O

15. (3 pts) Circle the one member of each group that exhibits only London dispersion forces. Circle 3 answers

A. PCl_3 $SiCl_4$ CH_3OH
B. C_2H_6 $N(CH_3)_3$ CH_2Cl_2
C. I_2 HI HIO_3

16. (3 pts) We studied three essential unit cells, the simple cube, face-centered cube and body-centered cube. All metallic elements exhibit one of these. How many net metal atoms are completely within the boundaries of each of these unit cells? Circle your choice.

Unit cell	**Atoms/unit cell**
Simple cube	**1 2 3 4 5 6 >6**
Face-centered cube, **fcc**	**1 2 3 4 5 6 >6**
Body-centered cube, **bcc**	**1 2 3 4 5 6 >6**

17. (3 pts) With the simple cube unit cell, the atoms touch along the edges so that the edge length, e = 2 x r, where r is the radius of the atom. Sketch one face of the face-centered unit cell, carefully showing how the atoms are in contact with one another. Give the relationship between e and r. Show your work.

18. (5 pts) The density of a large sample of a metal is the same as the density of one unit cell of the same metal. Aluminum exhibits an fcc lattice and has a density of 2.70 g/cm^3. What is the volume of one unit cell and what is the length of an edge? Use answer to Q16.

(If you could not answer Q16, use a value of 5 as your answer)

Volume with units:_____

Edge length with units:_____

19. (3 pts) Using your answer to Q17 and Q18, what is the radius of an aluminum atom in units of nm?

(If you could not answer Q17, use e = 3r. If you could not answer Q18, use V = 7.0 x 10^{-23} cm^3.)

Answer with units:_____

20. (5 pts) T/F. Most of the alkali metal oxides consist of the large ions in a fcc lattice. How do these structures compare to metals that exhibit the fcc structure?

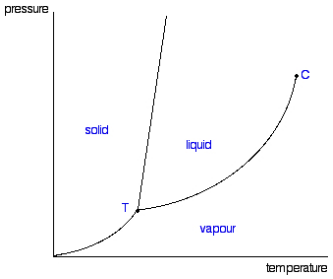
T F The large ions occupy the same positions as metals do in an fcc lattice.
T F The cations and anions together occupy the same positions as metals do in the fcc, lattice.
T F There is less empty space in an ionic substance compared to a metal, both with fcc structures.
T F The small ions occupy the empty voids left when the large ions form the fcc lattice.
T F Cations and anions occupy alternating fcc unit cells.

21. (3 pts) What values would you need to calculate the amount of heat needed to warm a solid to its melting point, melt it and warm it half-way to its boiling point? Circle all that apply. Note: SH = specific heat

A. ΔH_{fus} B. ΔH_{vap} C. mass or moles of substance

D SH_{solid} E. SH_{liquid} F. SH_{gas}

22. (3 pts) The phase diagram at right is not for any particular substance.



A. Draw a line on the diagram representing P = 1 atm for a substance known to sublime at 1 atm.

B. If the triple point is at 3.2 atm and 15 ^oC, what is the phase of the substance at room temperature and pressure? **Solid** **Liquid** **Gas**

C. Could this be the phase diagram for water, given that ice melts under high pressure? **Yes** **No**

Subtotal from exam: _____

Folder work: (20 max) _____

Total:

Answers

1. 1.47 atm

2. 96.7 kPa.

3. D

4. 775 kPa

5A. 84 g/mol

5B. Kr

6. d = P x MM/RT

7. 3.60 g/L

8. 0.091

9. 3.05 atm

10. F T T F

11. 3.16

12. A, B, and C

13. A. PCl_5; B. C_4H_{10}; C. Br_2

14. A. NH_3; B. CH_3OH; C. $HC_2H_3O_2$

15. A. $SiCl_4$

B. C_2H_6

C. I_2

16. Simple cube has **1;** face-centered cube, **fcc**, **4,** and body-centered cube, **bcc 2.**

17. $e = 4r/2^{½}$

18. $V = 6.63 \times 10^{-23}$ cm^3; $e = 4.06 \times 10^{-8}$ cm

19. e = 0.143 nm

20. T F T T F

21. A C D E

22. A. The line should be horizontal and below the triple point.

B. **Gas**
C. **No**