

Exam 5 Chm 203 (Dr Mattson) 6 December 2017

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: _____

Chemistry Student Number: _____

One point bonus for correctly completing all three items: printed name, signature, and chemistry 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 periodic table" in the answer box — then write your name on the periodic table and turn it 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.

$$R = 0.0821 \text{ L atm mol}^{-1} \text{ K}^{-1} = 4.184 \text{ J g}^{-1} \text{ deg}^{-1}$$

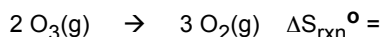
$$1 \text{ J} = \text{kg m}^2/\text{s}^2 \quad 1 \text{ Pa} = 1 \text{ N/m}^2 \quad 1 \text{ N} = \text{kg m/s}^2$$

$$1 \text{ atm} = 101.325 \text{ kPa} = 760 \text{ mmHg}$$

1. (5 pts) Calculate $\Delta S^\circ_{\text{rxn}}$ for the reaction shown in the workbox.

	S°
$\text{O}_2(\text{g})$	205.0 J/(mol K)
$\text{O}_3(\text{g})$	238.8 J/(mol K)

You must show work for credit. Mind the sign of your answer.

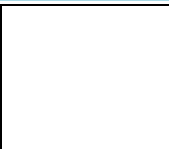


Answer with units: _____

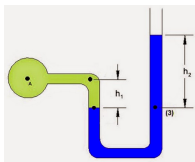
2. (7 pts) We discussed Hess's law and how it was used to estimate the lattice energy (in blue print), a value that cannot actually be measured. Predict the signs of ΔH for each step.

$\text{K}(\text{s}) \rightarrow \text{K}(\text{g})$	+ or -
$\text{K}(\text{g}) \rightarrow \text{K}^+(\text{g}) + \text{e}^-$	+ or -
$\text{Br}_2(\text{l}) \rightarrow \text{Br}_2(\text{g})$	+ or -
$\frac{1}{2} \text{Br}_2(\text{g}) \rightarrow \text{Br}(\text{g})$	+ or -
$\text{Br}(\text{g}) + \text{e}^- \rightarrow \text{Br}^-(\text{g})$	+ or -
$\text{K}^+(\text{g}) + \text{Br}^-(\text{g}) \rightarrow \text{KBr}(\text{s})$	+ or -
$\text{K}(\text{s}) + \frac{1}{2} \text{Br}_2(\text{l}) \rightarrow \text{KBr}(\text{s})$	+ or -

3. (3 pts) In Charles's law, one plots V on the y-axis and T on the x-axis, resulting in a straight line. What is the slope of the line in terms of some of all of the gas variables, P, V, n, R, and/or T?



- 4a. (3 pts) What is the pressure of the gas shown in green if the external pressure is 710 mmHg and h_2 is 23.4 cm? The blue liquid is mercury.



Show work for credit.

Answer with units: _____

- 4b. (3 pts) Convert this pressure to kPa.

Show work for credit.

Answer with units: _____

5. (5 pts) If 15.0 g $\text{CO}_2(\text{g})$ has a volume of 0.300 L at 300 K, what is its pressure in atm?

Show work for credit.

Answer with units: _____

6. (5 pts) What is the molar mass of an unknown gas if 2.97 g of the gas has a volume of 1160 mL at STP?

Show work for credit.

Answer with units: _____

7. (5 pts) A tank of compressed oxygen has a volume of 49 L and a pressure of 150 atm at 298 K. What is the volume of the gas at 720 mmHg and 40 °C?

Show work for credit.

Answer with units: _____

8. (5 pts) What is the partial pressure of neon in a mixture of 2.80 mol neon, 6.15 mol nitrogen, and 3.28 mol sulfur dioxide if the total pressure is 714 mmHg?

Show work for credit.

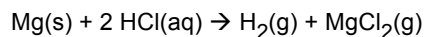
Answer with units of mmHg: _____

9. (5 pts) Suppose an unknown gas effuses/diffuses 2.92 times more slowly than $\text{H}_2(\text{g})$. What is the molar mass of the gas?

Show work for credit.

Answer with units: _____

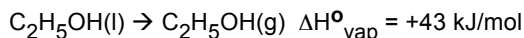
10. (6 pts) Magnesium reacts with $\text{HCl}(\text{aq})$ to produce $\text{H}_2(\text{g})$ at 1.0 atm and 293 K. What volume of $\text{H}_2(\text{g})$ is expected under these conditions from 15.2 g Mg and 50.5 mL 6.0 M HCl?



Show work for credit.

Answer with units: _____

11a. Given $\Delta H^\circ_{\text{vap}} = +43 \text{ kJ/mol}$ for ethanol:

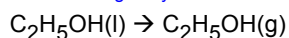


11a. (1 pt) What is the sign for $\Delta S^\circ_{\text{vap}}$?

11b. (1 pt) What is the value of $\Delta H^\circ_{\text{condensation}}$ for ethanol?

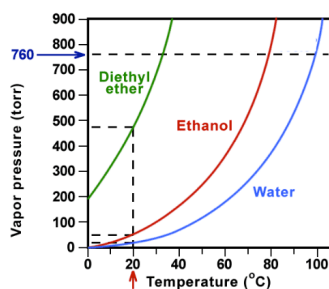
11c. (4 pts) How much heat is needed to vaporize 20.7 g ethanol?

Show work for credit. Mind the sign of your answer.



Answer with units:

12. Consider the vapor pressure diagram at right. A = diethyl ether, B = ethanol and C = water



12a. (2 pts) Which substance(s) is/are completely in the gas phase at 50 °C? Circle one or more: **A B C**

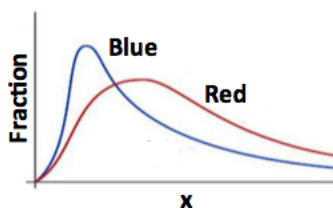
12b. (2 pts) What is the normal boiling point (at 1 atm) of ethanol?

12c. (2 pts) What is the vapor pressure of diethyl ether at 20 °C?

12d. (2 pts) At what temperature is the vapor pressure of water = 300 mmHg?

12e. (2pts) Which substance has the weakest intermolecular forces? Circle one: **A B C**

13a. (2 pts) Graphs like this one can represent different things. If x is molecular speed and Blue and Red are either NH_3 or CHCl_3 at the same temperature, which is NH_3 ? Circle: **Blue** or **Red**.



13b. (2 pts) If x is kinetic energy and Blue and Red are the same substance at two different temperatures, which is the higher temperature? Circle: **Blue** or **Red**.

14. (5 pts) Match these types of solids with examples A-E.

- | | |
|------------------------------|---|
| ___ metal | A. iodine |
| ___ covalent-molecular solid | B. silicon carbide |
| ___ ionic | C. sugar, $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ |
| ___ network covalent | D. gallium |
| ___ elemental non-metal | E. lithium sulfide |

15. (5 pts) Palladium forms a fcc lattice and has a density of 12.02 g/cm^3 . What is its atomic radius in pm?

Show work for credit.

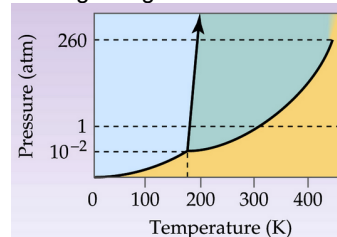
Answer with units of pm:

16. (2 pts each) Suppose an ionic substance features anions, A^{X-} in a fcc arrangement. What is the formula, C_xA_y , of the salt if the cations, C^{Y+} occupy the...

16a. all of the tetrahedral holes?

16b. all of the octahedral holes (all edge centers + body center positions)?

17. (4 pts) Consider this phase change diagram for a particular element. Draw a small circle (o) on the graph representing room temperature and pressure. Is the substance a **solid**, **liquid**, or **gas**? Draw an **x** to show where things would be if you placed



this element in the refrigerator at 4 °C. Be careful with placement of the **o** and **x**. In the refrigerator, is the substance a **solid**, **liquid**, or **gas**?

18. (10 pts) Circle the correct name. Skip if you are N. C.

CaCr_2O_7	(a) calcium(II) chromate (b) calcium dichromate (c) calcium chromate (d) calcium(II) dichromate
$\text{HBrO}_3(\text{aq})$	(a) hydrobromic acid (b) hydrobromous acid (c) bromous acid (d) bromic acid
PbS_2	(a) lead(IV) sulfide (b) lead(II) sulfide (c) lead(II) sulfite (d) lead sulfite
S_3N_2	(a) sulfur binitrogen (b) sulfur(III) nitride (c) sulfur dinitride (d) trisulfur dinitride
$\text{HNO}_2(\text{aq})$	(a) nitric acid (b) hydronitrous acid (c) hydrogen nitrate (d) nitrous acid

iron(II) bicarbonate: Circle the correct formula:
(a) FeCO_3 (b) FeHCO_3 (c) $\text{Fe}(\text{HCO}_3)_2$ (d) Fe_2HCO_3

cobalt(II) chlorate:
(a) CoClO_3 (b) Co_2ClO_4 (c) CoClO_2 (d) $\text{Co}(\text{ClO}_3)_2$

xenon tetrafluoride
(a) Xe_4F_4 (b) Xe_4F (c) XeF_4 (d) XeF_5

hydroiodic acid
(a) $\text{HIO}_3(\text{aq})$ (b) $\text{HIO}_2(\text{aq})$ (c) $\text{HIO}(\text{aq})$ (d) $\text{HI}(\text{aq})$

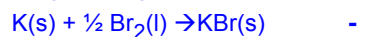
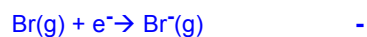
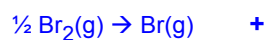
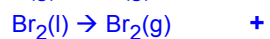
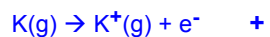
ammonium phosphate
 NH_3PO_3 $(\text{NH}_4)_3\text{PO}_4$ NH_4PO_4 $(\text{NH}_4)_2\text{PO}_4$

Total score (out of 100):

A+ ≥ 95% A ≥ 90% B+ ≥ 85% B ≥ 80% C+ ≥ 75% C ≥ 70% D ≥ 60%

Answers

1. $\Delta S_{\text{rxn}}^{\circ} = + 137 \text{ J/K}$



3. slope = nR/P

4a. 944 mmHg

4b. 126 kPa.

5. 28.0 atm

6. 57.4 g/mol

7. 8150 L

8. 163 mmHg

9. 17.2 g/mol

10. 3.64 L

11a. +

11b. -43 kJ/mol

11c. +19.3 kJ

12a. A

12b. ~80 °C

12c. ~470 mmHg

12d. ~75 °C

12e. A

13a. **Red**

13b. **Red**

14. D, C, E, B, A

15. 137 pm?

16a. C₂A, 16b. CA

17. The x and o should appear on the P = 1 atm line and in the liquid region, very near the liquid/gas phase line.

The x should be just to the left of the o, but should be very close. As for predicting the state of matter, I graded it so it matched your x and o, respectively.

18. b, d, a, d, d, c, d, c, d, (NH₄)₃PO₄