

Exam 5 Chm 203 (Dr Mattson) 4 December 2019

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: _____

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. On your desk you may have pencils (but no pencil pouch), an eraser, and a non-programmable calculator without a slipcover. Backpacks, bags, and similar items must be stored on the tables in the back of the room. Cell phones must be silent and placed in your backpack/bag – not in your pocket.

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

$$N_A = 6.022 \times 10^{23} \text{ mol}^{-1} \quad R = 0.0821 \text{ L atm mol}^{-1} \text{ K}^{-1}$$

1a. (7 pts) The following are the steps of the Hess's law approach to determining the lattice energy for $\text{CaH}_2(\text{s})$.

Circle whether each step is exothermic or endothermic.

- A. $\text{Ca}(\text{s}) \rightarrow \text{Ca}(\text{g})$ **exo** **endo**
 B. $\text{Ca}(\text{g}) \rightarrow \text{Ca}^+(\text{g}) + \text{e}^-$ **exo** **endo**
 C. $\text{Ca}^+(\text{g}) \rightarrow \text{Ca}^{2+}(\text{g}) + \text{e}^-$ **exo** **endo**
 D. $\text{H}_2(\text{g}) \rightarrow 2 \text{H}(\text{g})$ **exo** **endo**
 E. $\text{H}(\text{g}) + \text{e}^- \rightarrow \text{H}^-(\text{g})$ **exo** **endo**
 F. $\text{Ca}^{2+}(\text{g}) + 2 \text{H}^-(\text{g}) \rightarrow \text{CaH}_2(\text{s})$ **exo** **endo**
 G. $\text{Ca}(\text{s}) + \text{H}_2(\text{g}) \rightarrow \text{CaH}_2(\text{s})$ **exo** **endo**

1b. (1 pt) Which step is the definition of lattice energy?

A B C D E F G

1c. (1 pt) Which step is the definition of ΔH_f for CaH_2 ?

A B C D E F G

1d. (1 pt) Which step is the definition of bond energy?

A B C D E F G

1e. (2 pt) Which two of these steps are entropy-favored?

Circle two: A D F G

2. (4 pts) Convert 800 mmHg into units of kPa

Show all work for credit.

Answer with units: _____

3. (4 pts) An open-end manometer contains a gas of unknown pressure. The level of mercury in the trap is 17.3 cm higher on the gas-bulb side than on the open-to-atmosphere side. If the external pressure is 744 mmHg, what is the pressure inside the gas bulb?

Show all work for credit.

Answer with units: _____

4. (4 pts) At what temperature would 35 g argon occupy 50.0 L at 700 mmHg?

Show all work for credit.

Answer with units: _____

5. (4 pts) A sample of gas in a rigid vessel has a pressure of 247.0 kPa at 22 °C. What is its pressure at 0 °C?

Show all work for credit.

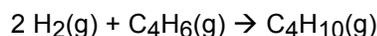
Answer with units: _____

6. (4 pts) What is the molar mass of a gas if 0.4478 g of the gas occupies a volume of 500.00 mL at 95 °C and 735 mmHg?

Show all work for credit.

Answer with units: _____

7a. (4 pts) Consider the following reaction. What volume of $\text{C}_4\text{H}_6(\text{g})$ at constant temperature and pressure would you need to react stoichiometrically with 40.0 mL $\text{H}_2(\text{g})$?
 7b. What volume of $\text{C}_4\text{H}_{10}(\text{g})$ is the theoretical yield?



7a. Answer with units: _____

7b. Answer with units: _____

8a. (4 pts) Suppose you prepared a three-gas mixture consisting of 2.0 mol $\text{H}_2(\text{g})$, 4.0 mol $\text{O}_2(\text{g})$ and 3.0 mol $\text{N}_2(\text{g})$. What is the mole fraction of $\text{O}_2(\text{g})$?

Show all work for credit.

Answer with units: _____

8b. (4 pts) If the total pressure is 755 mmHg, what is the partial pressure of $\text{O}_2(\text{g})$?

Show all work for credit.

Answer with units: _____

9. (2 pts) Real gases such as CO_2 are most likely to behave as ideal gases under (**low or high**) temperature and (**low or high**) pressures. **Circle your two choices.**

10. Water's heating curve has five different regions, I – V as given below. Water's normal melting point is 0 °C and its normal boiling point is 100 °C.
- Warming ice: q_I uses $C_{m, H_2O(s)} = 36.7 \text{ J/mol deg}$
 - Melting ice: q_{II} uses $\Delta H_{fus} = 6.01 \text{ kJ/mol}$
 - Warming water: q_{III} uses $C_{m, H_2O(l)} = 75.4 \text{ J/mol deg}$
 - Vaporizing water: q_{IV} uses $\Delta H_{vap} = 40.67 \text{ kJ/mol}$
 - Warming steam: q_V uses $C_{m, H_2O(g)} = 33.6 \text{ J/mol deg}$

What regions (I, II, III, IV, V) would you need to calculate the heat transferred when the temperature is...

- 10a. (2 pts) raised from -10 °C to +50 °C
Circle the regions: I II III IV V
- 10b. (2 pts) lowered from 90 °C to 30 °C
Circle the regions: I II III IV V
- 10c. (2 pts) raised from +10 °C to +110 °C
Circle the regions: I II III IV V
- 10d. (4 pts) How much heat is required to melt 200.0 g $H_2O(s)$ at 0 °C?

Show all work for credit.

Answer with units: _____

- 10e. (4 pts) How much heat is required to warm 200.0 g $H_2O(l)$ from 0 °C to 65 °C? ($c = 75.4 \text{ J/mol deg}$)

Show all work for credit.

Answer with units: _____

11. (4 pts) Circle the member of each pair that would have at higher vapor pressure at the same temperature.

C_2H_5OH or CH_3OH $NaBr$ or C_6H_{14}

C_2H_5OH or C_3H_8 C_5H_{12} or C_6H_{14}

12. (1 pt) Increasing which of the following would increase the vapor pressure of a liquid? **Circle:** Increasing the **temperature, pressure, volume**

13. (6 pts) Classify each of these as ionic (I), covalent-molecular (CM), metallic (M), or network covalent (NC).

$C_{12}H_{22}O_{11}$ I **CM** **M** **NC**

Hg I **CM** **M** **NC**

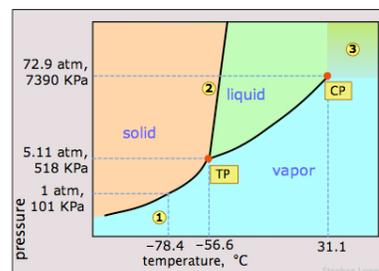
C(graphite) I **CM** **M** **NC**

K_2SO_4 I **CM** **M** **NC**

SiH_4 I **CM** **M** **NC**

Cu I **CM** **M** **NC**

14. The phase diagram for CO_2 is given here:



- 14a. (2 pts) What phase transition occurs if a sample of CO_2 at 70 atm and 0 °C and the pressure is decreased to 1 atm?

- 14b. (2 pts) At what temperature does CO_2 sublime under standard pressure?

- 14c. (2 pts) Is CO_2 a permanent gas or a condensable gas?

- 14d. (2 pts) What phase exists at -60 °C and 6.0 atm?

- 15a. (4 pts) Iridium, Ir, crystallizes in a fcc unit cell with an edge distance, e , equal to 383.3 pm. Direct contact between atoms occurs across the face diagonal for fcc. What is the atomic radius of iridium in pm?

Show all work for credit.

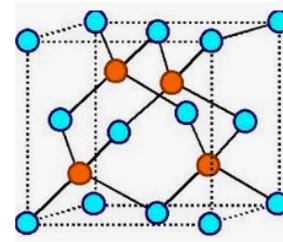
Answer with units: _____

- 15b. (4 pts) What is the density of iridium in g/cm^3 ?

Show all work for credit.

Answer with units: _____

16. (3 pts) In the following unit cell, the blue spheres are sulfide ions and the red spheres are metal ions. What is the formula of this ionic substance?



List cation first: _____

17. (10 pts) **Nomenclature.**

Check all correctly paired name-formula matches.

Completely color in the circle. **Nom Certified? Skip this.**

- calcium bicarbonate, $CaHCO_3$ iron(II) sulfide, Fe_2S
- perbromic acid, $HBrO_4$ carbon (IV) chloride, CCl_4
- vanadium (V) nitrate, $V(NO_3)_5$ sulfur dihydride, SH_2
- sodium sulfite, Na_2SO_4 zinc dichloride, $ZnCl_2$
- bromine pentafluoride, BrF_5 chlorous acid, $HClO_2$

Answers

1a. endo, endo, endo, endo, exo, exo, exo,

1b. F

1c. G

1d. D

1e. A, D

2. 106.7 kPa

3. 571 mmHg

4. 640 K

5. 229 kPa

6. 28.0 g/mol

7a. 20 mL, 7b. 20 mL

8a. 0.444

8b. 332 mmHg

9. **high** temperature and **low** pressures

10a. I II III

10b. III

10c. III IV V

10d. 66.7 kJ

10e. 54.4 kJ

11. CH₃OH C₆H₁₄

 C₃H₈ C₅H₁₂

12. temperature

13. CM, M, NC, I, CM, M

14a. liquid → gas (vaporization)

14b. -78.4 °C

14c. condensation

14d. solid

15a. 136 pm

15b. 22.5 g/cm³

16. Red₁Blue₁ (or RedBlue or RB)

17. perbromic acid, HBrO₄; vanadium (V) nitrate, V(NO₃)₅; sulfur dihydride, SH₂; bromine pentafluoride, BrF₅; chlorous acid, HClO₂

General Chemistry with Dr. Mattson

Course website: <http://mattson.creighton.edu>

1 H 1.0079																	2 He 4.003																														
3 Li 6.941	4 Be 9.012											5 B 10.811	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180																														
11 Na 22.990	12 Mg 24.305											13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.065	17 Cl 35.453	18 Ar 39.948																														
19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.867	23 V 50.941	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.693	29 Cu 63.546	30 Zn 65.409	31 Ga 69.723	32 Ge 72.64	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.80																														
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29																														
55 Cs 132.91	56 Ba 137.33	71 Lu 174.97	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.06	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)																														
87 Fr (223)	88 Ra (226)	103 Lr (262)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (264)	108 Hs (265)	109 Mt (268)	110 Ds (269)	111 Rg (272)	112 Cn (277)	113 Nh (unknown)	114 Fl (289)	115 Mc (unknown)	116 Lv (289)	117 Ts (unknown)	118 Og (293)																														
<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tbody> <tr> <td>57 La 138.91</td> <td>58 Ce 140.12</td> <td>59 Pr 140.91</td> <td>60 Nd 144.24</td> <td>61 Pm (145)</td> <td>62 Sm 150.36</td> <td>63 Eu 151.96</td> <td>64 Gd 157.25</td> <td>65 Tb 158.93</td> <td>66 Dy 162.50</td> <td>67 Ho 164.93</td> <td>68 Er 167.26</td> <td>69 Tm 168.93</td> <td>70 Yb 173.04</td> <td>71 Lu 174.97</td> </tr> <tr> <td>89 Ac (227)</td> <td>90 Th 232.04</td> <td>91 Pa 231.04</td> <td>92 U 238.03</td> <td>93 Np 237.0</td> <td>94 Pu (244)</td> <td>95 Am (243)</td> <td>96 Cm (247)</td> <td>97 Bk (247)</td> <td>98 Cf (251)</td> <td>99 Es (252)</td> <td>100 Fm (257)</td> <td>101 Md (258)</td> <td>102 No (259)</td> <td>103 Lr (260)</td> </tr> </tbody> </table>																		57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97	89 Ac (227)	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np 237.0	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)
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