

Exam 5 Chm 203 (Dr Mattson) 5 December 2018

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: _____
(1 point bonus for completing 1. signature, 2. printed name and 3. your correct chemistry student number)

Instructions: Show all work whenever a calculation box is provided! Write legibly. The usual instructions apply.

1. (3 pts) Given that 2.54 cm is exactly 1 inch by definition, what is the pressure **in atm** on a day when the pressure is 29.79 inches of mercury?

See information in yellow box. Show your work for full credit.

Answer with units: _____

2. (3 pts) What is the pressure in kPa inside a manometer if the mercury is shifted 11.5 cm higher towards the side of the arm open to the atmosphere and given the atmospheric pressure is 704 mmHg?

See information in yellow box. Show your work for full credit.

Answer with units: _____

3. (4 pts) Proportional relationships. How does...

P change if **V** is raised at constant **T** and **n**? **Circle:** ↑ ↓

P change if **T** is raised at constant **V** and **n**? **Circle:** ↑ ↓

V change if **T** is lowered at constant **P** and **n**? **Circle:** ↑ ↓

density change if **P** is raised at constant **T**? **Circle:** ↑ ↓

4. (4 pts) How many liters are in a m³? Derive this using the relationships between m and cm and cm³, mL and L.

Show your work for full credit.

Answer with units: _____

- 5a. (4 pts) Our classroom has a volume of ~920 m³. How many moles of gas are present at 300 K and 735 mmHg?

See information in yellow box. Show your work for full credit.

Answer with units: _____

- 5b. (4 pts) Given that for air the mole fraction of oxygen is 0.21, what is the partial pressure of nitrogen in the room?

Show your work for full credit.

Answer with units: _____

- 5c. (4 pts) If the room is cooled to 17 °C and the pressure decreases to 705 mmHg. How many moles of gas are now in the room? **Gases can enter/leave under the door.**

Show your work for full credit.

Answer with units: _____

$$R = 0.0821 \text{ L atm mol}^{-1} \text{ K}^{-1} = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$$

$$1.000 \text{ atm} = 760 \text{ mmHg} = 101.325 \text{ kPa}$$

$$u_A/u_B = (MM_B/MM_A)^{1/2} \quad N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$$

6. An experiment often used in general chemistry labs (not ours) leads to an estimation of molar mass.

- 6a. (3 pts) Starting with the ideal gas law, derive a formula for MM, showing your work and in the format MM = _____

Show your work for full credit.

Answer: MM = _____

- 6b. (3 pts) Given 1.322 g of an unknown gas occupies 954 mL at 715 mmHg and 93 °C. What is its molar mass?

See information in yellow box. Show your work for full credit.

Answer with units: _____

7. (4 pts) If a gas has a density of 1.55 g/L at 300 K and 99.4 kPa. What is its density at 400 K and 107.0 kPa?

Show your work for full credit.

Answer with units: _____

8. (4 pts) What is the molar mass of a gas that effuses 27% faster than carbon dioxide under identical conditions?

Equation provided in yellow box. Show your work for full credit.

Answer with units: _____

9. (6 pts) Predict the signs of ΔH and ΔS for each of these processes pertaining to a holiday candle. Paraffin (candle wax) is a mixture of hydrocarbons, the smallest of which is C₁₆H₃₄. Circle either <0 or >0 for each box.

| | ΔS | ΔH |
|--------------------------------|------------|------------|
| a. Combustion of paraffin | <0 or >0 | <0 or >0 |
| b. Melting candle wax | <0 or >0 | <0 or >0 |
| c. Candle making (from liquid) | <0 or >0 | <0 or >0 |

9d. (3 pts) For which of these would ΔG always be spontaneous? Circle one or more: **9a 9b 9c None**

10. (4 pts) Which of these is entropy-favored? **Circle four!**

Yes No $\text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{O}(\text{s})$ **Yes No** $\text{N}_2(\text{l}) \rightarrow \text{N}_2(\text{g})$

Yes No $\text{SO}_2(\text{g}) + 2 \text{H}_2\text{S}(\text{g}) \rightarrow 3 \text{S}(\text{s}) + 2 \text{H}_2\text{O}(\text{g})$

Yes No $\text{C}_5\text{H}_{12}(\text{l}) + 8 \text{O}_2(\text{g}) \rightarrow 5 \text{CO}_2(\text{g}) + 6 \text{H}_2\text{O}(\text{g})$

11. (4 pts) Circle the member of each pair of liquids with the highest surface tension and viscosity.

11a. **C_6H_{14} or $\text{C}_5\text{H}_{11}\text{OH}$** 11b. **$\text{C}_5\text{H}_{12}$ or $\text{C}_{14}\text{H}_{30}$**

11c. **$\text{C}_2\text{H}_4(\text{OH})_2$ or $\text{C}_2\text{H}_5\text{OH}$** 11d. **$\text{C}_2\text{Cl}_6$ or CCl_4**

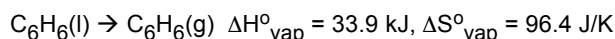
12. Benzene, C_6H_6 , is a liquid that freezes at $+5.5^\circ\text{C}$ and boils at $+80.1^\circ\text{C}$. A sample of C_6H_6 stored in an ice-water bath was placed in a large hot water bath at 60°C .

12a. (2 pts) **Circle** the final physical state of the benzene, and **draw a box** around the initial physical state of the benzene. **Answer: Solid Liquid Gas**

12b. (3 pts) In order to calculate the amount of heat adsorbed by the benzene, circle **all** the values needed. The molar heat capacity, C_m , has units of J/mol K .

$\Delta H^\circ_{\text{vap}}$ $\Delta H^\circ_{\text{fus}}$ $C_m(\text{s})$ $C_m(\text{l})$ $C_m(\text{g})$ $n_{\text{C}_6\text{H}_6}$ $MM_{\text{C}_6\text{H}_6}$

12c. (3 pts) For the vaporization of benzene, C_6H_6 :



Estimate the boiling point of benzene from the equation $\Delta G = \Delta H - T\Delta S$. (Recall the value of ΔG for a phase change.) Leave this value in kelvins, K.

Show your work for full credit.

Answer with units of K: _____

13. Consider this graph for which $n = \text{moles}$.

13a. (2 pts) Which line represents the lowest temperature? **Circle: Blue (tallest) Red or Green**

13b. (1 pt) The average molecular speed **increases** or **decreases** with an increase in temperature.

13c. (1 pt) Instead of moles, the y-axis could have been labeled any of these, except... **Circle the exception:**

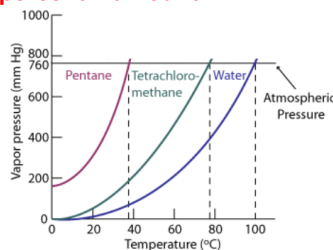
fraction number speed percent amount

14. (1 pt ea) The vapor pressures (in mmHg) for three liquids are shown in this diagram. The liquids are **pentane in red, CCl_4 in green and water is blue.**

14a. What liquid has the lowest vapor pressure?

Circle: Pentane CCl_4 or H_2O

14b. Estimate the vapor pressure of CCl_4 at 40°C ?



14c. At what approximate temperature does water have a vapor pressure of 200 mmHg?

14d. Estimate the normal boiling point (normal means $P = 1 \text{ atm}$) for **pentane**.

14e. What substance(s) is/are liquid(s) at 50°C ? **Circle one, two or all three: Pentane CCl_4 H_2O**

15. Pd has a unit cell dimension of 389 pm and is fcc.

15a. (4 pts) What is the atomic radius of palladium in pm?

Show your work for full credit.

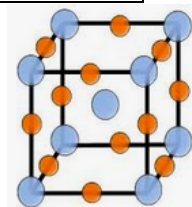
Answer with units of pm: _____

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

See information in yellow box. Show your work for full credit.

Answer with units of g/cm^3 : _____

16. (3 pts) An ionic salt crystallizes as shown here. The blue atoms form a bcc sublattice with the orange atoms at all of the edge-centers. What is the formula of the salt in the format $\text{Blue}_x\text{Orange}_y$? (How many net ions are **within** each unit cell?)



Your answer: Blue Orange

16. (1 pt ea) In the phase diagram:

16a. The green represents...

Circle: Solid Liquid or Gas

16b. The triple point is labeled...

Circle: B C D or O

16c. Crossing from green and purple represents...

Circle: fusion vaporization or sublimation

16d. What state exists under standard conditions? **Circle:**

Solid Liquid or Gas

16e. The critical temperature is: **-78.5°C -56.7°C 31.0°C**

17. (10 pts) Nomenclature. Cross out all misnamed compounds. **Skip this if you are nomenclature certified.**

Na_2O_2 sodium peroxide

H_2SO_4 sulfuric acid

V_2O_4 vanadium tetroxide

CS_2 carbon disulfide

Na_2SO_3 sodium sulfate

Fe_2S_3 iron(III) sulfite

$\text{Ca}_2(\text{PO}_4)_3$ calcium phosphate

NO_3 nitrate

PCl_3 potassium trichloride

LiClO_2 lithium chlorite

Total score (out of 100): _____

Answers:

1. 0.996 atm
2. 109.2 kPa
3. ↓ ↑ ↓ ↑
4. 1000 L
- 5a. 3.62×10^4 mol
- 5b. 581 mmHg (or 0.764 atm)
- 5c. 3.59×10^4 mol
6. An experiment often used in general chemistry labs (not ours) leads to an estimation of molar mass.
- 6a. $MM = mRT/PV$
- 6b. 44.3 g/mol
7. 1.25 g/L
8. 27.3 g/mol
- 9.

| | ΔS | ΔH |
|--------------------------------|------------|------------|
| a. Combustion of paraffin | > 0 | < 0 |
| b. Melting candle wax | > 0 | > 0 |
| c. Candle making (from liquid) | < 0 | < 0 |

9d. 9a

10.

- No $H_2O(l) \rightarrow H_2O(s)$ Yes $N_2(l) \rightarrow N_2(g)$
No $SO_2(g) + 2 H_2S(g) \rightarrow 3 S(s) + 2 H_2O(g)$
Yes $C_5H_{12}(l) + 8 O_2(g) \rightarrow 5 CO_2(g) + 6 H_2O(g)$

11.

- 11a. $C_5H_{11}OH$ 11b. $C_{14}H_{30}$
11c. $C_2H_4(OH)_2$ 11d. C_2Cl_6

12a. Box: Solid Circle Liquid

12b. ΔH_{fus}° $C_m(s)$ $C_m(l)$ $n_{C_6H_6}$

12c. 352 K

13a. Blue

13b. increases

13c. speed

14a. H_2O

14b. ~200 mmHg

14c. ~60 °C

14d. ~38 °C

14e. CCl_4 H_2O

15a. 137 pm

15b. 12.01 g/cm³

16. Blue₂Orange₃

16a. Solid

16b. O

16c. fusion

16d. Gas

16e. 31.0 °C

17. Misnamed compounds.

V_2O_4 vanadium tetroxide

Na_2SO_3 sodium sulfite

Fe_2S_3 iron(III) sulfide

NO_3 nitrate

PCl_3 phosphorus trichloride