

*You may use any calculator. You may NOT use cell phone or tablet.*

**CHEM 1101 C MIDTERM PRACTICE FOR 2019 – 70 MINUTES**

- **PRINT** YOUR NAME AND STUDENT NUMBER ON YOUR BOOKLET. **Underline your last name.**
  - **SPACE OUT YOUR ANSWERS** – we will mark answers on the lined side of the page only – you can use the other side for rough work if you wish
1. a) Draw and label a band diagram for potassium (*use at least  $\frac{1}{2}$  of a page*)  
b) Draw and label a band diagram for silicon (*use at least  $\frac{1}{2}$  of a page*)  
c) List an element that could be doped into silicon in order to make a p-type extrinsic semiconductor. Explain your choice briefly.  
d) Draw and label a band diagram for the p-type semiconductor from part c. (*use at least  $\frac{1}{2}$  of a page*)
  2. You have 125.0 kilograms of fluorine gas in a 225 L cylinder at 19°C.  
a) Determine its pressure if it is behaving ideally  
b) Determine its real pressure given that for fluorine gas,  $a=0.944 \text{ L}^2\text{atm/mol}^2$ ;  $b=0.0290 \text{ L/mol}$   
c) Determine the percent error (high or low) that arises if you use the ideal gas equation instead of the van der Waals equation to determine the pressure of nitrogen at these conditions.  
d) State the two false assumptions that are part of the ideal gas equation. Indicate which of the two assumptions is most responsible for the results in parts a and b; explain your choice briefly
  3. Heavy water ( ${}^2\text{H-O-}{}^2\text{H}$ , or  $\text{D}_2\text{O}$ : molar mass = 19.999 g/mol) has slightly different properties than regular water. Its vapour pressure at 25 °C is 0.0292 atm, and it has a standard heat of vaporization of 42.84 kJ/mol.  
a) Determine its normal boiling point, **in °C**.  
b) If you put  $\text{D}_2\text{O}$  in a closed container, with head space of 2.3 L above the liquid, at 25 °C, determine what mass will evaporate.
  4. a) Draw and label a Born-Haber diagram for lead oxide. (*Use at least half a page!*)  
b) Given the data on the data page, determine the crystal lattice energy of lead oxide.
  5. Given the phase diagram for carbon dioxide (**USE THE ONE ON THE SLIDES FOR THE PRACTICE MIDTERM. ONE WAS GIVEN FOR THE REAL MIDTERM**)  
a) Label the regions A, B, and C, the lines 1, 2, and 3 and the points a and b  
b) Describe what happens when the pressure of carbon dioxide is increased from 0.5 atm to 70 atm at  $-50^\circ\text{C}$ . MAKE REASONABLE ESTIMATES FOR PRESSURE AND TEMPERATURE AS NEEDED.

### Data and Equations:

$$PV = nRT$$

$$\ln \left( \frac{P_2}{P_1} \right) = \frac{\Delta H_{\text{vap}}^0}{R} \left( \frac{1}{T_1} - \frac{1}{T_2} \right) \quad R = 8.314 \text{ J/K}\cdot\text{mol}$$

$$\left[ P + \frac{an^2}{V^2} \right] [V - nb] = nRT$$

$$T(\text{K}) = T(^{\circ}\text{C}) + 273$$

$$R = 0.08206 \text{ L}\cdot\text{atm/K}\cdot\text{mol}$$

$$\text{I.E.}_1(\text{Pb}) = 715.6 \text{ kJ/mol}$$

$$\text{E.A.}_1(\text{O}) = -142 \text{ kJ/mol}$$

$$\text{I.E.}_2(\text{Pb}) = 1450.5 \text{ kJ/mol}$$

$$\text{E.A.}_2(\text{O}) = 247 \text{ kJ/mol}$$

$$\text{I.E.}_3(\text{Pb}) = 3081.5 \text{ kJ/mol}$$

$$\text{B.D.E.}(\text{O}_2) = 495 \text{ kJ/mol}$$

$$\text{I.E.}_4(\text{Pb}) = 4083.0 \text{ kJ/mol}$$

$$\Delta H_f^{\circ}(\text{PbO}_2) = -277.74 \text{ kJ/mol}$$

$$\text{I.E.}_5(\text{Pb}) = 6640. \text{ kJ/mol}$$

$$\Delta H_{\text{sub}}^{\circ}(\text{Pb}) = 373 \text{ kJ/mol}$$

**A PERIODIC TABLE AND A PHASE DIAGRAM FOR CO<sub>2</sub> WERE GIVEN**