

Name: _____
140 points
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Test 1
Chemistry 261
March 3, 1999

**Answer the following multiple choice questions for 10 points each.
Must show complete work for full credit to be given:**

- For an ideal gas, $Z = 1$ always whereas for a real gas A at low to moderate pressure, $Z < 1$. If the molar volume of an ideal gas is 22.4 L/mol at 1.0 atm pressure and 273 K, do you expect the volume for the real gas A under the same pressure and temperature to
A) be the same B) be larger C) be smaller D) may not be calculated
- For an ideal gas, $C_v = 3 n R / 2$ and $C_p = 5 n R / 2$. What is the final volume if 2.00 L of an ideal gas at 500.0 K is adiabatically and reversibly cooled to 300.0 K?
A) 4.68 L B) 2.72 L C) 2.81 L D) 4.30 L E) none of the above
- Calculate the work done when 5.00 mol of an ideal gas is expanded isothermally at 300.0 K from 5.00 atm to 2.00 atm pressure.
A) -12.5 kJ B) 12.5 kJ C) -4.96 kJ D) 4.96 kJ E) none of the above

Choose one of the following two exercises for 20 points:

- A certain liquid has $\Delta_{\text{vap}} H^\circ = 32.0 \text{ kJ/mol}$. Calculate w , H , and U when 0.75 mol is vaporized at 260 K and 750 Torr.
- A sample of a liquid of mass 25 g is cooled from 290 K to 275 K at constant pressure by extraction of 2.3 kJ of energy as heat. Calculate q and H and estimate the heat capacity of the sample.

Choose two of the following three problems for 45 points each:

- A 0.2560 g sample of $\text{C}_7\text{H}_{15}\text{COOH}$ was burned in a constant volume oxygen bomb calorimeter. A total of 1132 J of energy was released to the water bath and bomb (observed by a temperature change). Calculate ΔH for the reaction. Assuming that all of the carbon and hydrogen were converted into gaseous CO_2 and liquid H_2O respectively, determine $\Delta_f H$ for $\text{C}_7\text{H}_{15}\text{COOH}$. ($\Delta_f H_{\text{CO}_2} = -393 \text{ kJ/mol}$, $\Delta_f H_{\text{H}_2\text{O}} = -285 \text{ kJ/mol}$)
- Assume that the heat capacity of a gas may be written as $C_p = A + B T + C T^2$ where $A = 28.0 \text{ J mol}^{-1} \text{ K}^{-1}$, $B = 0.021 \text{ J mol}^{-1} \text{ K}^{-2}$, $C = 0.00051 \text{ J mol}^{-1} \text{ K}^{-3}$. Calculate the ΔH when this gas is heated from 200 K to 400 K under constant pressure conditions.
- The thermodynamic equation of state $(dU/dV)_T = T (dp/dT)_V - p$ was quoted in the text of chapter 3. Derive its partner: $(dH/dp)_T = -T (dV/dT)_p + V$ using $(dU/dV)_T$ and other derivative relationships.