Assignment 5: CHM221A
Topic: Material properties

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To students: These assignments are designed to strengthen your understanding in the lessons taught in class as well as develop your problem solving skills. If you copy from other sources without understanding, those purposes will be defeated and you will receive no benefits. **If you cannot solve them, *try* and bring your problems to the instructor. He will definitely help. Also, there may be some typo - discuss with me if you think there are any.**

1. Show that for a monoatomic ideal gas
$$\alpha = \frac{1}{T}; \kappa_T = \frac{1}{P}; c_p - c_v = R$$

2. For a van der Waals gas, show that
$$\alpha \to 0 \text{ if } P \to 0.$$

3. For a vdW gas find out the κ_T

4. For adiabatic compression, show that
$$dT = \frac{Tv\alpha}{c_p} dP$$

5. Show that for a monoatomic ideal gas,
$$c_v = \frac{3}{2} R$$
starting from entropy.

6. A balloon of volume V was kept inside a vacuum chamber $5V$. The balloon suddenly popped. Show that the drop of temperature
$$dT = \left(\frac{P}{Nc_v} - \frac{T\alpha}{Nc_v\kappa_T} \right) dV$$

(a) Is the process reversible?

(b) If the gas (consider ideal gas) inside the balloon was kept at $V = 0.2$ L, $P = 10^5$ Pa and $T = 300K$, find out the temperature drop.

7. For a non-ideal gas, the equation of state is generally represented as

$$\frac{P}{T} = \frac{R}{v}\left(1 + \frac{B_1(T)}{v} + \frac{B_2(T)}{v^2} + \frac{B_3(T)}{v^3} + \dots\right).$$

The generally temperature dependent (not necessarily) coefficients $B_i(T)$ are known as i^{th} ***virial coefficients***. Compute $B_1(T)$ and $B_2(T)$ for a van der Waals gas in terms of a and b.