

# PHYS 122 Midterm Exam

Time: 50 minutes

Total Points: 100

Full Name: \_\_\_\_\_

## Instructions

- Show all work clearly. Answers with no justification may receive little or no credit.
- Diagrams (including  $PV$  diagrams) must be drawn by the student when appropriate.

## Useful Equations

- $PV = nRT$
- $W_{\text{env}} = - \int P dV$
- $\Delta E_{\text{th}} = Q + W_{\text{env}}$
- $\Delta E_{\text{th}} = 3/2 nR \Delta T$
- $v_{\text{rms}} = \sqrt{\frac{3K_B T}{m}}$
- $\Delta L = \alpha L \Delta T$
- $\Delta V = \beta V \Delta T$

**Question 1****[60 points]**

One mole of an ideal gas undergoes a thermodynamic process. It starts with a Volume of  $0.1 \text{ m}^3$  and a pressure of  $1.0 \text{ kPa}$  and then both of its volume and pressure get doubled. Assume  $R \simeq 8 \frac{\text{J}}{\text{mol.K}}$ .

- (a) Draw a P-V diagram, with labels and units.
- (b) Calculate the work of the environment during the process.
- (c) Find the initial and final temperature of the gas.
- (d) Determine the change in thermal energy of the gas.
- (e) How much heat was transferred to or from the gas?
- (f) What is the ratio of final to initial root mean square velocities of the gas?

**Question 2****[20 points]**

An 100 m aluminum rod is cooled down from 220 C to 120 C. The linear thermal expansion of the aluminum is  $2.3 \times 10^{-5} C^{-1}$  and the volume expansion coefficient is  $6.9 \times 10^{-5} C^{-1}$ .

- (a) What is the new length of the rod?
- (b) Explain why the length of rod changes.

**Question 3****[20 points]**

You have a container and put some ice and hot water in it. You close its door and cover it with an insulator and wait for 1 hour. Then you open it and see there is more ice and some hot steam in the container. Will you get surprized or you think it's possible? Explain.