

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

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

Question 1**[60 points]**

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

- (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 surprised or you think it's possible? Explain.