

Physics 1215 – Spring 2008 - Exam #1
February 8, 2008

Name (Print): Key

My signature below is a statement that all work contained in this exam is my own work. I have not copied work from any other source, or used any material other than one 3 by 5 card and my calculator.

Name (Signature): _____

DO NOT TURN THIS PAGE OVER UNTIL YOU ARE INSTRUCTED TO DO SO.

STOP WORKING ON THIS EXAM AS SOON AS YOU ARE INSTRUCTED TO DO SO.

You will have approximately 1 hour to do this exam

- The following exam consists of 4 multiple-choice questions and 3 worked problems.
 - Point values are assigned to each problem in the exam.
- It is a good idea to first skim through the entire test and begin with the problems that seem most familiar. If you get stuck on a problem, skip to another.
- For the computational problems, please show all problem solving steps and all your work.
 - All work must be done on the pages provided.
 - Please write neatly and put a **BOX** around your final answer.
 - Use significant figures in your answers.
- Calculators may be used only to do arithmetic. You cannot use your calculator for solving algebraic equations, for graphing, for vectors, etc.
- One 3 by 5 card with written notes may be used. No books or other notes are allowed.

| Problem # | Max Points | Score | Problem # | Max Points | Score |
|-----------|------------|-------|-----------|------------|-------|
| 1 | 5 | | 5 | 25 | |
| 2 | 5 | | 6 | 25 | |
| 3 | 5 | | 7 | 30 | |
| 4 | 5 | | Total | 100 | |

Constants

$$R = 8.315 \text{ J/(mol}\cdot\text{K)}$$

$$k = 1.381 \times 10^{-23} \text{ J/K}$$

For Water: $L_f = 3.335 \times 10^5 \text{ J/kg}$
 $c = 4186 \text{ J/(kg}\cdot\text{K)}$

$$L_v = 2.256 \times 10^6 \text{ J/kg}$$

1. If 1.00 kg of ice at 273 K comes to equilibrium with 1 kg of steam at 373 K, the combination comes to thermal equilibrium as

- a mixture of ice and water at 273 K
 water at 323 K
 a mixture of water and steam at 373 K
 water at 503 K
 none of the above

$$Q_1 = Q(\text{melt ice}) = (1 \text{ kg}) \left(3.335 \times 10^5 \frac{\text{J}}{\text{kg}} \right) = 3.3 \times 10^5 \text{ J}$$

$$Q_2 = Q(\text{condense vapor}) = (1 \text{ kg}) \left(2.26 \times 10^6 \frac{\text{J}}{\text{kg}} \right) = 2.2 \times 10^6 \text{ J}$$

$$Q_3 = Q(\text{warm ice to } 373) = (1 \text{ kg}) \left(4186 \frac{\text{J}}{\text{kg K}} \right) (100 \text{ K}) = 4.2 \times 10^5 \text{ J}$$

Since $Q_1 + Q_3 < Q_2$

2. Ideal monatomic gas A is composed of molecules with mass m while ideal monatomic gas B is composed of molecules with mass $4m$. The average molecular kinetic energies are the same if the ratio of temperatures T_A/T_B is:

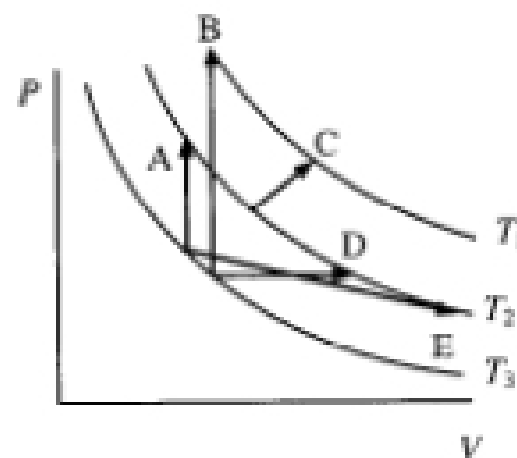
- 1/4 1/2 1
 2 4

$$K = \frac{1}{2} M \bar{v}^2 = kT$$

3. The diagram shows five processes carried out for an ideal gas. For which of these processes is the change in the internal energy of the gas greatest?

- A
 B
 C
 D
 E

$$\Delta U \propto \Delta T$$



4. You have been asked to choose the most efficient engine available. Four proposals are presented all working between 600°C and 300°C. Which engine should you choose?

| | Q_{in} | Q_{out} | W | 1st | 2nd |
|---|----------|-----------|-------|-----|-----|
| <input type="checkbox"/> Engine A | 1000 J | -700 J | 400 J | No | |
| <input type="checkbox"/> Engine B | 1000 J | -600 J | 400 J | OK | No |
| <input checked="" type="checkbox"/> Engine C | 1000 J | -700 J | 300 J | OK | OK |
| <input type="checkbox"/> Engine D | 1000 J | -400 J | 600 J | OK | No |
| <input type="checkbox"/> None of these engines will work | | | | | |
| <input type="checkbox"/> More than one of these engines will work | | | | | |

1st LAW $Q_{in} + Q_{out} = W$

2nd LAW $\frac{Q_{out} - |W_{out}|}{Q_{in}} < 1 - \frac{T_c}{T_h}$
 < 0.34

5. An ordinary glass is filled to the brim with 350.0 mL of water at a temperature of 100° C. If the temperature is decreased to 20° C, how much additional water can be added to the glass? The coefficient of linear expansion for glass is $9 \times 10^{-6} \text{ (C}^\circ\text{)}^{-1}$ and the coefficient of volume expansion for water is $500 \times 10^{-6} \text{ (C}^\circ\text{)}^{-1}$. (1 L = 10^{-3} m^3)

Find new volume of glass

$$V'_g = V_g + \Delta V_g = V_g (1 + 3\alpha_g (T_f - T_i)) = 350 \text{ mL} (1 + 3(9 \times 10^{-6})(-80^\circ \text{C}))$$
$$= 349.2 \text{ mL}$$

Find new volume of water

$$V'_w = V_w + \Delta V_w = V_w (1 + \beta_w (T_f - T_i)) = 350 \text{ mL} (1 + (500 \times 10^{-6} \text{ C}^{-1})(-80^\circ \text{C}))$$
$$= 336.0 \text{ mL}$$

$$\Delta V = V'_g - V'_w = 349.2 - 336.0 = \boxed{13.2 \text{ mL}}$$