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"I agree to neither give nor receive aid during this quiz."

Quiz 2 for Physics 176

Professor Greenside
Friday, January 30, 2009

This quiz is closed book. Please answer all questions on this quiz. The T/F questions do not need to be justified. If you need extra paper, let me know.

The following data and formulas may be useful:

$$k \approx 1.4 \times 10^{-23} \, \text{J/K}, \qquad 1 \, \text{atm} = 1.0 \times 10^5 \, \text{N/m}^2, \qquad \text{T}_{\text{absolute}} = -273°\text{C}, \qquad 1 \, \text{cal} = 4.2 \, \text{J}.$$

$$PV = NkT, \qquad \Delta U = Q + W, \qquad U = Nf \, (kT/2), \qquad v_{\text{rms}} = \sqrt{3kT/m}, \qquad v_{\text{escape}} = \sqrt{2GM/R}.$$

$$PV^{\gamma} = \text{const}, \qquad VT^{f/2} = \text{const}, \qquad \gamma = (f+2)/f.$$

$$C = Q/\Delta T, \qquad L = Q/m, \qquad C_V = (\partial U/\partial T)_V, \qquad C_P = (\partial U/\partial T)_P + P(\partial V/\partial T)_P.$$

True or False Questions (2 points each)

For each of the following statements, please circle **T** or **F** to indicate respectively whether a given statement is true or false.

1. **T** / **F**   An isobaric (constant pressure) compression of an ideal gas will increase its temperature.

2. **T** / **F**   An isothermal (constant temperature) compression of an ideal gas requires that some object that is cold compared to the gas be placed in contact with the gas during the compression.

3. **T** / **F**   An isochoric (constant volume) process that changes the pressure of an ideal gas will not change the gas's thermal energy.

4. **T** / **F**   An adiabatic compression of a gas requires more work than an isothermal compression of the same gas to achieve the same change in volume.

5. **T** / **F**   An adiabatic compression of a gas requires that the gas not be ideal since $PV^{\gamma} = \text{const}$ for an adiabatic compression while $PV = \text{const}$ for an ideal gas.

6. **T** / **F**   If a series of physical processes applied to an ideal gas trace out a continuous closed loop in the PV-plane of the gas, the total work done on the gas and the total heat that flows into the gas after traversing the loop once are each equal to zero.

7. **T** / **F**   A quasistatic expansion is an isothermal expansion.

8. **T / F**   If a person were placed in a small room with plenty of food, water, and air such that the walls of the room were essentially perfect thermal insulators, that person's body temperature would eventually increase to a fatal level.

9. **T / F**   The heat capacity C_V of 2 moles of ammonia gas, NH_3, is less than the heat capacity of a gaseous mixture consisting of one mole of N_2 and three moles of H_2. (Note: all gases are ideal and the temperature is so high that no degrees of freedom are frozen out.)

10. **T / F**   It is possible for an object to have a solid angle Ω of 12.

11. **T / F**   If the radius of a planet were somehow to double with all other properties unchanged (its mass, the temperature of its exosphere), then atomic hydrogen will escape more rapidly from that planet's atmosphere.

Something to Calculate

Microscopic analysis of an iron meteorite found in Antarctica showed that it completely liquefied upon entering the atmosphere.

1. (3 points) Was the iron meteorite melted by heat or by work? (Justify your answer briefly.)

2. (5 points) If the temperature of the meteorite before entering the atmosphere was -125°C, estimate to one significant digit the minimum speed v of the meteorite when it entered the Earth's atmosphere.

   Some thermodynamic data for iron: the melting point is 1808°C, the latent heat of fusion is 2.9×10^5 J/kg, the boiling point is 3023°C, the latent heat of vaporization is 6.3×10^6 J/kg, and the specific heat is $450 \, \text{J}/(\text{kg} \cdot \text{C}°)$.