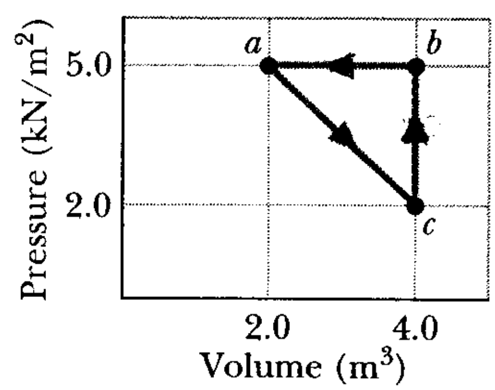
PHYSICS 215 - Thermodynamics and Modern Physics

Practice Midterm Exam 1

1. Calculate the rate of energy loss by conduction (in Watts) through all sides of a cubical box of side L = 25 cm if five of the faces are made of stainless steel (thermal conductivity = 14.0 W/m.K) and the sixth is made of copper (thermal conductivity = 401. W/m.K). The thickness of each of the six faces is 2.0 cm. The temperature inside the cube is 77 ^{o}C and the temperature outside is 27 ^{o}C.

2. One mole of an ideal gas is taken through the cyclic process acba as shown in the figure.



(a) What is the temperature at point a?

(b) What is the work done by the gas in the cycle?

(c) What is the change of internal energy in a cycle?

(d) What is the net amount of heat added to the gas during the cycle?

3. In each cycle a Carnot engine absorbs 52 kJ of heat from a high-temperature reservoir and exhausts 36 kJ to a low-temperature reservoir.

(a) What is the work done per cycle?

(b) What is the engine's efficiency?

(c) If the temperature of the cold reservoir is 15^{o}C, what is the temperature of the hot reservoir?

4. What is the root-mean-square speed, v_{rms}, of Helium atoms in a gas of P = 2.5 atm, V = 0.5 liter, T = 27^{o}C? (The molar mass of Helium is 4.0 gm.)

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Fall 2007

Useful Constants:

1 calorie = 4.186 J
1 atmosphere = 1.01E5 Pa
Universal Gas Constant, R = 8.31 J/mol.K
Boltzmann's constant, k = 1.38E-23 J/K
Stefan-Boltzmann constant, σ = 5.67E-8 W/m^2K^4
Avogadro's number, N_A = 6.02E23 mol^{-1}
Speed of light, c = 3.00E8 m/s
Charge of an electron, -e = -1.6E-19 C
Planck's constant, h = 6.63E-34 J.s

Useful Formulae:

$\Delta Q = mc\Delta T$ where m = mass, c = specific heat.

Heat conduction, $I = \Delta T/R$ in Watts where
R = thermal resistance = $\Delta x/kA$ and
Δx = thickness, A = area and k = thermal conductivity of the material.

$P_{RAD} = \sigma\varepsilon A T^4$ where ε = emissivity and A = area.

1st Law of Thermodynamics: $\Delta Q = \Delta W + \Delta U$

Ideal gas law: $PV = nRT$

Work done, $\Delta W = \int PdV$

$v_{rms} = \sqrt{(3RT/M)}$

Molar specific heats, $C_V = \Delta U/n\Delta T$, $C_P = C_V + R$, $\gamma = C_P/C_V$

Adiabatic ==> $\Delta Q = 0$, and PV^γ = constant.

Carnot engine efficiency, $\varepsilon_C = 1 - Q_C/Q_H = 1 - T_C/T_H$

Potential energy lost by a charge q in traversing a potential difference of V is $U = qV$

Wave relation: $v = \nu\lambda$
where v = velocity, ν = frequency, λ = wavelength.