PHYSICS 2C QUIZ 1 WINTER QUARTER 2018
PROF. HIRSCH

Formulas:

$T_3 = 273.16K = 0.01^oC$; water freezes/boils at $T = 0^oC = 32^oF / T = 100^oC = 212^oF$

$1cal = 4.1868J$; $N_A = 6.02 \times 10^{23}$

Thermal expansion: $\Delta L = L\alpha\Delta T$; $\Delta V = V\beta\Delta T$; $\beta = 3\alpha$

Heat capacity and specific heat: $Q = C\Delta T$; $Q = cm\Delta T$

Heat of vaporization, fusion: $Q = L_V m$; $Q = L_F m$

First law of thermodynamics: $\Delta E_{\text{int}} = Q - W$; $dE_{\text{int}} = dQ - dW$; $W = \int_{V_i}^{V_f} p\,dV$ work

Conduction: $P_{cond} = \frac{Q}{t} = kA\frac{T_H - T_L}{L}$; $R = \frac{L}{k}$ k,R=thermal conductivity, resistance

Radiation: $P_{rad} = \sigma\varepsilon AT^4$; $\sigma = 5.67 \times 10^{-8} W/m^2K^4$ $\varepsilon = 1$ for black body

Ideal gas: $PV = nRT = NkT = nN_A kT$; R=8.31J/molK ; $k = 1.38 \times 10^{-23} J/K$

Pressure: $P = \frac{Nm}{3V}(v^2)_{avg}$ Kinetic energy: $K_{avg} = \frac{1}{2}m(v^2)_{avg} = \frac{3}{2}kT$

Internal energy: $E_{\text{int}} = NK_{avg}$; $C_V = \frac{3}{2}R$ for monoatomic gas; $C_P = C_V + R$

C_V, C_P = molar heat capacity at constant volume, pressure

$C_V = \frac{f}{2}R$ for polyatomic gases with f degrees of freedom per molecule

Adiabatic expansion of ideal gas: $PV^\gamma = const$, $TV^{\gamma-1} = const$; $\gamma = C_P / C_V$

Problem 1

At 30ºC, a cube has edge length 20cm. At 45ºC, its edge lenth has increased by 0.0075cm. By how much does the volume increase when the cube is heated from 30ºC to 80ºC?

A: 20cm^3; B: 30cm^3; C: 40cm^3; D: 50cm^3; E: 60cm^3

Problem 2

10g of steam at 100ºC is added to 100g of a mixture of water and ice in equal proportions in thermal equilibrium in a thermally insulated container. Find the final temperature.

A: 22ºC; B: 32ºC; C: 42ºC; D: 52ºC; E: 62ºC

heat of vaporization of water: 539 cal/g, heat of fusion of ice: 79.7 cal/g;
specific heat of water: 1cal/g ºC

Problem 3

Assuming air is an ideal gas, if the rms speed of oxygen molecules at temperature 20ºC and pressure 1atm is 477m/s, what is the rms speed of nitrogen molecules at temperature 40ºC and pressure 2atm? Atomic weight of O is 16, of N 14. $v_{rms}^2 = (v^2)_{avg}$

A: 487m/s; B: 497m/s; C: 507m/s; D: 517m/s; E: 527m/s

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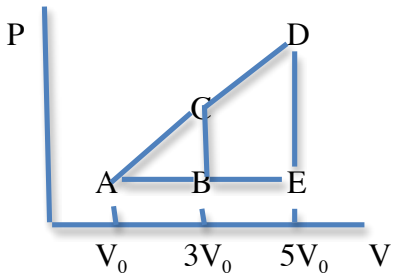
Problem 4

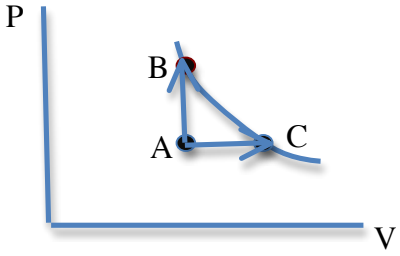
A cylindrical glass bottle of radius 2cm and height much larger than the radius is filled with water at 10ºC. The glass has thickness 0.3cm, and its thermal conductivity is 10^{-4}cal/(s cm ºC). The environment temperature is 30ºC. Estimate how long it will take for the water in the bottle to increase its temperature by 1ºC.
Specific heat of water: 1cal/g ºC. Density of water: 1g/cm^3
A: 1.5 minutes; B: 2 minutes; C: 2.5 minutes; D: 3 minutes; E: 3.5 minutes

Problem 5



In the cycle ABCA, 20J of heat are either added to or removed from the system. How much heat is added to or removed from the system in the cycle ABCDEBA?
A: 60J added; B: 40J removed; C: 40J added; D: 60J removed; E: 80J added

Problem 6



A monoatomic ideal gas absorbs 15J of heat in going from point A to point B at constant volume (see diagram). Points B and C are on an isoterm. How much work does the gas do in going from point A to point C at constant pressure?
A: 20J; B: 15J; C: 10J; D: 25J; E: 5J

Problem 7 (for extra credit)

In an adiabatic expansion, a monatomic ideal gas does 10J of work in expanding from volume V to volume 2V. Then it keeps expanding adiabatically to volume 3V. What is the total work done in the expansion from volume V to volume 3V?
A: 20J; B: 18J; C: 15J; D: 14J; E: 12J

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