Quiz #4 Ch.#19 T122 Phys101.28-30-v1

Q#1:An ideal gas expands at constant pressure of 120 kPa from (a) to (b) as shown in the figure. It is then compressed isothermally to point (c) where the volume is 40 L. Find the net work done during these two processes

$W_{net} = W_{ab} + W_{bc}$

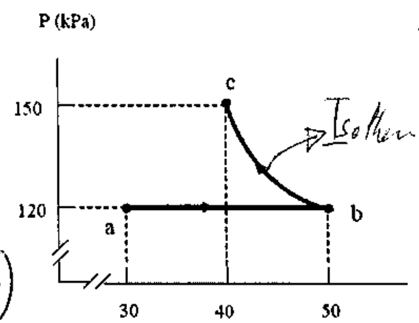
$= P\Delta V + nRT \ln\left(\frac{V_f}{V_i}\right)$

$= P\Delta V + P_b V_b \ln\left(\frac{V_f}{V_i}\right)$

$= 120\times10^3 \times (50-30)\times10^{-3}$

$+ 120\times10^3 \times 50\times10^{-3} \ln\left(\frac{40}{50}\right)$

$= 2400 - 1339 = 1061\ J$



Q#2: A diatomic ideal gas undergoes a constant pressure process in which its internal energy increases by 540 J. Find the heat added to the gas and the work done by the gas.

$\Delta E_{int} = n C_V \Delta T = 540\ J$

$n\Delta T = \frac{\Delta E_{int}}{C_V} = \frac{540}{\frac{5}{2}\times 8.31} = 25.99$

$\Delta Q = n C_p \Delta T = C_p \cdot n\Delta T$

$= \frac{7}{2}\times R \times n\Delta T = \frac{7}{2}\times 8.31\times 25.99 = 756\ J$

$W = \Delta Q - \Delta E_{int} = 756 - 540 = 216\ J$

Q#3: The air in an automobile engine at 20 degree-C is compressed adiabatically from an initial pressure of 1 atm and a volume of 200 cm**3 to a final volume of 20 cm**3. Find the final temperature if the air behaves like an ideal gas. [Take gamma = 1.4]

$T_f = T_i \left(\frac{V_i}{V_f}\right)^{\gamma-1}$

$= 293\left(\frac{200}{20}\right)^{1.4-1} = 293(10)^{0.4} = 736\ K$

$= 463^{\circ}C$

Quiz #4 Ch.#19 T122 Phys101.28-30-v2

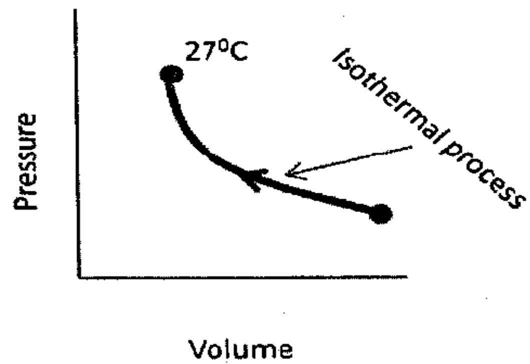
Q#1:In the isothermal process shown in Figure 2 the work done on 5.000 mole of monatomic ideal gas is 2275 J. Find the ratio of final to initial volumes.

$$W = nRT\ln\left(\frac{V_f}{V_i}\right)$$

$$\frac{W}{nRT} = \ln\left(\frac{V_f}{V_i}\right)$$

$$e^{(W/nRT)} = \frac{V_f}{V_i}$$

$$e^{-0.1825} = \frac{V_f}{V_i} = 0.8332$$



Q#2: The temperature of two moles of helium gas is raised from zero degrees Celsius to 100 degrees Celsius at constant pressure. Calculate the work done by the gas.

$$W = nR\Delta T = 2\times 8.31\times 100 = 1.66\ kJ$$

Q#3: Four moles of a monatomic ideal gas, initially at 300 K, expand adiabatically to double the initial volume. Calculate the change in the internal energy of the gas .

$$\Delta E_{int} = nC_v\Delta T = 4\times\frac{3}{2}R\times\Delta T \qquad 1.667 - 1.0 = 0.667$$

$$T_i = 300\,K,\ T_f = T_i\left(\frac{V_i}{V_f}\right)^{\gamma-1} = 300\left(\frac{1}{2}\right) = 300\times(1/2)$$

$$T_f = 188.9\ K$$

$$\Delta E_{int} = 4\times\frac{3}{2}\times 8.31\times(188.9 - 300)$$

$$= -5539.5\ J$$

Quiz #4 Ch.#19 T122 Phys101.28-30-v3

Q#1 Five moles of an ideal gas are kept at a constant temperature of 53.0 degrees Celsius while the pressure of the gas is increased from 1.00 atm to 3.00 atm. Find the work done in the process.

$$W = nRT \ln\left(\frac{V_f}{V_i}\right) = nRT \ln\left(\frac{P_i}{P_f}\right)$$
$$= 5 \times 8.31 \times 326 \times \ln\left(\frac{1}{3}\right)$$
$$= -14896\,J = -14.9\,kJ$$

Q#2: 500 g of water at 100 °C is converted to steam at 100 °C by heating at constant pressure of 1.01×10^5 Pa. The volume of the water is 0.5×10^{-3} m^3 and the volume of steam is 0.83 m^3. Calculate the change in the internal energy of the system.

$$\Delta E_{in} = Q - W = nC_p\Delta T - P\Delta V = mL_V - P\Delta V$$
$$= 0.5 \times 22256 \times 10^3 - 1.01 \times 10^5 \times (0.83 - 0.5\times10^{-3})$$
$$= 1044.17\,kJ$$

Q#3: One mole of a monatomic ideal gas is initially at a temperature of 300 K and with a volume of 0.080 m**3. The gas is compressed adiabatically to a volume of 0.040 m**3. What is the final temperature?

$$T_f = T_i\left(\frac{V_i}{V_f}\right)^{\gamma-1}$$
$$= 300(2)^{1.667-1} = 300 \times (2)^{0.667}$$
$$= 300 \times 1.583$$
$$T_f = 476\,K$$

Quiz #4 Ch.#19 T122 Phys101.28-30-v4

Q#1: Calculate the heat lost by one mole of an ideal gas during an isothermal compression from a volume of 22.4 L at 1.00 atm to a volume of 16.8 L.

$$\Delta Q = nRT \ln\left(\frac{V_f}{V_i}\right) = P_i V_i \ln\left(\frac{V_f}{V_i}\right) = 1.01\times10^{5} \times 22.4\times10^{-3} \ln\left(\frac{16.8}{22.4}\right)$$

$$= -650.9 \text{ J}$$

Q#2: 500 g of water at 100 °C is converted to steam at 100 °C by boiling it at a constant pressure of 1.01×10^5 Pa. The change in volume of the water-vapor system is 0.83 m^3. Calculate the change in internal energy of the water during this process.

$$\Delta E_{in} = Q_p - W = m_w L_V - P\Delta V$$

$$= 0.5\times2256\times10^{3} - 1.01\times10^{5}\times0.83$$

$$= 1044.2\times10^{3} \text{ J} = 1.04\times10^{6} \text{ J}$$

Q#3: A monatomic ideal gas is compressed adiabatically from an initial pressure of 1 atm and volume of 800 cm^3 to a volume of 400 cm^3. If the initial temperature of the gas is 20 ^{o}C, what is the final temperature of the gas? (Take γ=1.67) .

$$T_f = T_i \left(\frac{V_i}{V_f}\right)^{\gamma-1}$$

$$= 293 \times (2)^{1.667-1} = 293\times(2)^{0.667}$$

$$= 466 \text{ K}$$

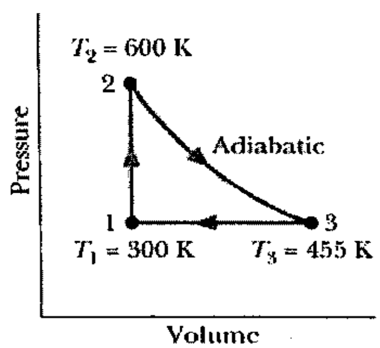
Quiz #4 Ch.#19 T122 Phys101.28-30-v5

Q#1: 6 moles of an ideal gas are kept at a constant temperature of 60 .0 °C while the pressure of the gas is increased from 1.00 atm to 4.00 atm. Find the heat involved during this process.

$$\Delta Q = nRT \ln\left(\frac{V_f}{V_i}\right) = nRT \ln\left(\frac{P_i}{P_f}\right)$$
$$= 6 \times 8.31 \times 333 \times \ln\left(\frac{1}{4}\right) = -23017.2 \text{ J}$$
$$= -23 \text{ kJ}$$

Q#2: Fig. 3. shows a cycle undergone by 1.0 mol of a monatomic ideal gas. What is the heat added to the gas during the whole cycle?

$$\Delta Q = \Delta Q_{31-P} + \Delta Q_{12-V} + \Delta Q_{23\text{-adiabatic}} (=0)$$
$$= n C_P \Delta T + n C_V \Delta T$$
$$= 1 \times \tfrac{5}{2} \times 8.31 \times (300 - 455)$$
$$+ 1 \times \tfrac{3}{2} \times 8.31 (600 - 300)$$
$$= 517.5 \text{ J}$$
$$= 520 \text{ J}$$



Q#3: One mole of a diatomic ideal gas is initially at a temperature of 127 °C and has a volume of 0.090 m³. The gas is compressed adiabatically to a volume of 0.045 m³. What is the final temperature?

$$T_f = T_i \left(\frac{V_i}{V_f}\right)^{\gamma-1} = 400 (2)^{\frac{7}{5}-1} = 400 \times (2)^{0.4}$$
$$T_f = 527.8 \text{ K}$$

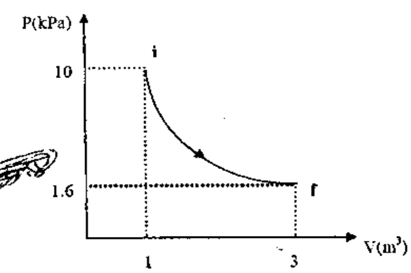
Quiz #4 Ch.#19 T122 Phys101.28-30-v6

Q#1: One mole of a monatomic ideal gas absorbs heat at constant pressure and its temperature rises from 40 °C to 90 °C. The heat absorbed in the process is :

$\Delta Q_p = n C_p \Delta T$

$= 1 \times \frac{5}{2} \times 8.31 \times 50 = 1039\ J$

Q#2: One mole of an ideal monatomic gas is taken through an adiabatic process, as shown in the figure. Calculate the work done in this process.



$W = -\Delta E_{int} = -n C_V \Delta T$

$T_i = \frac{P_i V_i}{nR} = \frac{10 \times 10^3 \times 1}{1 \times 8.31} = 1203.4\ K$

$T_f = \frac{P_f V_f}{nR} = \frac{1.6 \times 10^3 \times 3}{1 \times 8.31} = 577.6\ K$

$W = -1 \times \frac{3}{2} \times 8.31 \times (577.4 - 1203.4)$

$= -1 \times \frac{3}{2} \times 8.31 \times (-625.8) = 7.8\ kJ$

Q#3: One mole of an ideal monatomic gas, initially at 300 K, expands adiabatically to twice of its initial volume. The work done in this process is:

$T_i = 300\ K$

$T_f = T_i \left(\frac{V_i}{V_f}\right)^{\gamma - 1} = 300 \times \left(\frac{1}{2}\right)^{0.667} = 189\ K$

$W = -n C_V \Delta T = -1 \times \frac{3}{2} \times 8.31 \times (189 - 300)$

$= 1384.3\ J$

$= 1.4\ kJ$