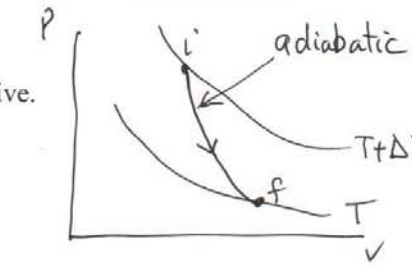
KING FAHD UNIVERSITY OF PERTOLEUM & MINERALS

PHYSICS DEPARTMENT

QUIZ #4- CHAPTER 19

NAME: Key ID# SECTION#

1. Which one of the following statements is correct?



a) In an isothermal process, the work done on the gas is always positive.
(b) In an adiabatic expansion the temperature of the gas decreases.
c) All real gases approach the ideal gas state at low temperatures.
d) In an isobaric process, the volume of the gas is constant.
e) In an adiabatic process, the work is always zero.

2. A diatomic ideal gas undergoes a constant pressure process in which its internal energy increases by 540 J. Calculate:

(a) The heat added to the gas

$$Q = n\, C_p\, \Delta T \qquad \Delta E_{int} = n\, C_v\, \Delta T$$

$$\Rightarrow Q = C_p \frac{\Delta E_{int}}{C_v} = \frac{7}{2} R \times \frac{\Delta E_{int}}{\frac{5}{2} R} \qquad \Rightarrow n\, \Delta T = \frac{\Delta E_{int}}{C_v}$$

$$= \frac{7}{5} \Delta E_{int} = \frac{7}{5} \times 540 = \boxed{756\,J}$$

(b) The work done by the gas.

$$\Delta E_{int} = Q - W$$

$$W = Q - \Delta E_{int}$$

$$= 756 - 540 = \boxed{216\,J}$$

(c) Is work done on the gas or by the gas?

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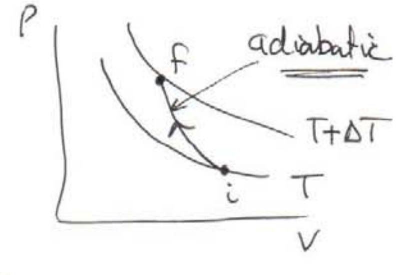
1. Which one of the following statements is correct?



a) In an isobaric process, the heat energy is always constant.
b) In an isothermal process, the work done on the gas is always positive.
c) All real gases approach the ideal gas state at low temperatures.
(d) In an adiabatic compression the temperature of the gas increases.
e) In an adiabatic process, the work done is always zero.

2. Two moles of nitrogen are in a 3 L container at a pressure of 5.0×10^{6} Pa.
(a) Calculate the internal energy of a molecule.

N_2 diatomic molecule.

$$E_{int} = \frac{5}{2} kT$$
$$= \frac{5}{2} k \frac{PV}{nR} = \frac{5}{2} \times \frac{1.38\times10^{-23} \times 5\times10^{6} \times 3\times10^{-3}}{2\times 8.31}$$
$$= \boxed{3.1\times10^{-20}\ J}$$

(b) Calculate the internal energy of the gas.

$$E_{int} = n C_v T = n \frac{5}{2} R T = n \frac{5}{2} R \frac{PV}{nR}$$
$$= \frac{5}{2} PV = \frac{5}{2} \times 6\times10^{5} \times 3\times10^{-3}$$
$$= \boxed{3.8\times10^{4}\ J}$$

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1. Which one of the following statements is correct?

a) In an isobaric process, the energy is always constant.
b) In an isothermal process, the work done on the gas is always positive.
c) All real gases approach the ideal gas state at low temperatures.
(d) Two different ideal gas molecules of different mass will have the same average translational kinetic energy if they are at the same temperature.
e) In an adiabatic process, the work is always zero.

$K = \frac{3}{2} kT$ ← depends on T only!

2. The air in an automobile engine at 20 ^{0}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. Consider air to be diatomic molecule and behaves like an ideal gas.

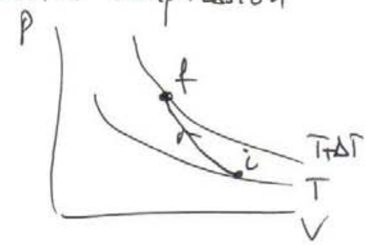
(a) Calculate the final temperature.

$$T_i V_i^{\gamma-1} = T_f V_f^{\gamma-1} \qquad \gamma = \frac{C_p}{C_v} = \frac{7}{5} = 1.4$$

$$T_f = T_i \left(\frac{V_i}{V_f}\right)^{\gamma-1} = 293 \left(\frac{200}{20}\right)^{0.4} = \boxed{736 K}$$

Temperature increases!

adiabatic compression



(b) Calculate the final pressure.

$$P_i V_i^{\gamma} = P_f V_f^{\gamma}$$

$$P_f = P_i \left(\frac{V_i}{V_f}\right)^{\gamma}$$

$$= 1 \left(\frac{200}{20}\right)^{1.4} = \boxed{25 \text{ atm}}$$

$$= \boxed{2.5 \times 10^6 \text{ Pa}}$$

Pressure increases!