TUTORIAL ANSWERS IDEAL GASES

9702 / 4 J/02

3.) a.)

i) The equation shows the mean kinetic energy of our molecules.

ii.) At absolute zero, molecules has no kinetic energy.

b.) i.) pV = nRT

$n = (1.2 \times 10^5 * 2.0 \times 10^{-2}) / (8.31 * 310.15) =$ **0.93 mol**

ii.) pV = nRT

$p = (0.93+1.2)(8.31)(310.15) / (4.0 \times 10^{-2}) =$ **1.37×10^5 Pa**

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5.) a.) the sum of the potential energies and kinetic energies of all the molecules of a body

b.) (i) molecules moves faster, thus internal energy increases.

(ii) No change in K.E of molecules because of no change in temperature. Potential energy of molecules of ideal gas is zero. Thus internal energy remain same.

(iii) If the gas as a whole is moving, the kinetic energy is not part of its internal energy. Thus, no change to internal energy.

c.) (i) pV = nRT

$T = (6.0 \times 10^5 * 5.0 \times 10^{-5}) / (5.2 \times 10^{-3} * 8.31) =$ **695 K**

(ii) 1) Molar heat capacity = C / mol = Q / (T*mol)

$= (85) / (800 * 5.2 \times 10^{-3}) =$ **20.4 $Jmol^{-1}K^{-1}$**

2.) $p = (5.2 \times 10^{-3} * 8.31 * (800+695)) / (5.0 \times 10^{-5})$

p = **1.29×10^6 Pa (or use $p_1 / T_1 = p_2 / T_2$)**

(iii) 1) The increase in the internal energy is equal to the heat supplied to the system and the work done on the system.

2.) $\Delta U = Q + W$

$\Delta U = 0 + (-62\ J) =$ **-62 J (internal energy decreased by 62 J)**

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b.) (i) A gas which obeys the equation of $pV = nRT$, and is subjected to the assumptions made in the kinetic theory of gases.

(ii) 1.) mean square speed

2.) $p = (1/3)\ (Nm/V)\langle c^2\rangle$; $\rho = Nm / V$

$pV = (1/3)(Nm)\langle c^2\rangle = nRT$

$(Nm)\langle c^2\rangle = 3nRT$

$(1/2)\ (Nm)\langle c^2\rangle = (3/2)nRT$

$(1/2)m\langle c^2\rangle = (3/2)(n/N)RT$; $n = (N / N_A)$; $(n / N) = (1 / N_A)$

$(1/2)m\langle c^2\rangle = (3/2)(1/N_A)RT$; $k = R / N_A$

$(1/2)m\langle c^2\rangle = (3/2)(kT)$

D 94 P3 Q5

5.) (a) i.) 273.15 + 6 = **279.15 K**

ii.) $pV = nRT$

$n = (1.8 \times 10^5 * 0.037) / (8.31 * 279.15)$ = **2.87 mol**

iii.) $p = (p_1 / T_1) * T_2$

$p = (1.8 \times 10^5 / 279.15) * (291.15)$ = **1.88×10^5 Pa**

(b) In accident when driver gets thrown forward towards the steering wheel due to a head on collision, the bag inflates to cushion the impact. It achieves this by lengthening the collision time such that the force of collision is lowered for the same change in momentum of the driver.

(c) i.) momentum before collision, p = **mu**

ii.) change in momentum, Δp = **-2mu / 2mu**

iii.) time taken between collision, t = **2L / u**

iv.) total number of collisions per unit time by all molecules, $n = N / (2L / u)$ = **Nu / 2L**

v.) rate of change of momentum, $F = (2mu)*(Nu/2L)$ = **(Nmu^2 / L)**

(d) $p = F / A = Nmu^2 / AL = Nmu^2 / V$; $M = Nm$ (total mass of all molecules)

p = **Mu^2 / V**

(e) Velocity of gas molecule is c, such that $c^2 = u^2 + v^2 + w^2$. Collisions also take place at other two walls perpendicular to wall A.

Since molecules are travellign at different speeds, mean square speed of the gas molecules should be used in the final expression of the pressure in the cubical box. $\langle u^2\rangle = \langle v^2\rangle = \langle w^2\rangle$

Thus, $\langle c^2\rangle = \langle u^2\rangle + \langle v^2\rangle + \langle w^2\rangle$

$\langle c^2\rangle = 3\langle u^2\rangle$; $\langle u^2\rangle = (1/3)\langle c^2\rangle$

$p = Mu^2 / V = (1/3)(M/V)\langle c^2\rangle = (1/3)(\rho)\langle c^2\rangle$

p = **$(1/3)(\rho)\langle c^2\rangle$**

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4.) (a) (i) **Force per unit area**

(ii) **Nm^{-2}**

(b) (i) pV = nRT

$n = (1.01 \times 10^5 * 0.5) / (8.31*290.15) =$ **20.9 mol**

(ii) number of molecules = $(20.9)(6.023 \times 10^{23}) =$ **1.26×10^{25}**

(c) (i) volume = $(4/3)*\pi*(1.2 \times 10^{-10})^3 =$ **$7.24 \times 10^{-30}\ m^3$**

(ii) $(7.24 \times 10^{-30})(1.26 \times 10^{25}) =$ **$9.12 \times 10^{-5}\ m^3$**

(d) (i) Volume of the molecules is negligible compared with volume of the containing vessel.

(ii) $9.12 \times 10^{-5}\ m^3 \ll 0.5\ m^3$. So assumption is justified.

5.) a.) (i) Smoke particles seen as small points of light which twist and turn continuously / haphazard motion.

(ii) random motion.

b.) Less movement of the smoke particles because larger particle has greater inertia / heavier.