TUTORIAL ANSWERS IDEAL GAS- 2

1) rms speed = $\sqrt{[(1^2 + 9^2) / 2]}$ = **$6.4\ kms^{-1}$**

2.) $p = (1/3)\rho<c^2>$

$(1 \times 10^5) = (1/3)\ (1.25)\ <c^2>$

$<c^2> = 240\ 000$; C_{rms} = **$490\ ms^{-1}$**

3.) $U = (3/2)nRT$

$U = (3/2)(1)(8.31)(300)$ = **3739.5 J**

4.) $(1/2)Nm<c^2> = (3/2)nRT$

$(1/2)(0.032)<c^2> = (3/2)(1)(8.31)(200)$

$<c^2>$ = **$395\ ms^{-1}$**

5.) $(1/2)Nm<c^2> = (3/2)nRT$

$(1/2)(0.044)<c^2> = (3/2)(1)(8.31)(303)$

$<c^2>$ = **$414\ ms^{-1}$**

6.) i.) $T \alpha$ K.E.

K.E. at $127^\circ C = [(127+273) / (27+273)]*375$

= **500 J**

ii.) value of M.

$(1/2)(0.004)<c^2> = (3/2)(1)(8.31)(400)$

$<c^2>$ = **$2493000\ m^2s^{-2}$**

$(1/2)(M)<c^2> = 500$ J

$M = (500*2) / (2493000)$ = **4.01×10^{-4} kg**

7.) mean K.E. = (3/2)kT

= (3/2)k(500) = **1.04×10^{-20} J** (same for both hydrogen & nitrogen)

Hydrogen will moves faster because the mass is smaller.
(1/2)Nm<c^2> = K.E.

8.) Total K.E. = (3/2)pV = (3/2)(1×10^5)(50×10^{-6}) = **7.5 J**

9.) <c^2> α T

$(c_{rms})^2 / (2c_{rms})^2 = (300) / (T)$

T = **1200 K**

10.) $P_1V_1 / T_1 = P_2V_2 / T_2$

$T_2 = (1.10 \times 10^5 * 1.20 \times 10^{-3})(273.16) / (1.00 \times 10^5 * 1.00 \times 10^{-3})$

T_2 = **360.57 K**

11.) a.) pV = nRT

(2.0×10^5)(1.0×10^{-3}) = n(8.31)(300)

n = 0.08 mol ; mass = 0.08 (4) = **0.32 g**

b.) (0.08)(6.023×10^{23}) = **4.82×10^{22} kg**

c.) (1/2)(0.00032)<c^2> = (3/2)(2.0×10^5)(1.0×10^{-3})

c_{rms} = **1369 ms^{-1}**

12.) a.) (i) pV = nRT

n = ($124.5 \times 10^3 * 1.0 \times 10^{-3}$) / (8.31*300) = **0.0499 mol**

(ii) 1 mol of helium = 4g ; 0.0499 mol = **0.2 g** b.) (i) 0.1g of helium = 0.025mol ; 0.1g of hyrogen = 0.05mol

$pV = nRT$

$p(1.0 \times 10^{-3}) = (0.05 + 0.025)(8.31)(300)$

p = **187 kPa**

(ii.) since pressure is now 187 kPa at 300 K, the gradient will increase by 1.5 times.

13.)(i) A gas molecule colliding with a wall experiences a change in velocity and in momentum. A force acts on the molecule, and a reaction acts on the wall. The force on the wall is equal to the rate of change of momentum of the molecule as it hits the wall again and again over a certain time interval. The total force on the wall is due to all the molecules that collide with the wall. Force per unit area is the pressure.

(ii) Let say intial velocity of molecule is c.
After collision with wall, velocity of molecule = -c (assuming elastic collision).
Change in momentum of molecule = -2mc.
After collision, molecules moves a distance of 2L before hitting same wall again, after $\Delta t = 2L / c$.
Force = $\Delta p / \Delta t = [(-2mc) / (2L / c)] = (-m/L)c^2$

Force on wall = $(m / L)c^2$; since m & L constant, thus $F \propto c^2$

14.) a) (i) $P_{atm} + h\rho g$

$1.01 \times 10^5 + (15)(1.03 \times 10^3)(9.81) =$ **2.53×10^5 Pa**

(ii) $p_1V_1 = p_2V_2$

$V_2 = (2.10 \times 10^7 * 9.00 \times 10^3) / (2.53 \times 10^5)$

$V_2 =$ **7.5×10^5 cm^3**

b) Pressure at 35.0 m = P_{atm} + (35)(1.03 x 10^3)(9.81)

= **4.54 x 10^5 Pa**

$V_2 = (p_1V_1 / T_1)(T_2 / p_2)$

= [(2.10 x 10^7*9.00 x 10^3) / 297](293/**4.54 x 10^5**)

= **410 x 10^3 cm^3**

Volume of 7.50 x 10^5 cm^3 lasted for 45 mins.

Thus, 410 x 10^3 cm^3 will last for = (4.10 x 10^5 / 7.50 x 10^5)(45)

= **24.6 mins**

15.) (i) straight line graph.

According to this equation for an ideal gas, **$p = (1/3)\rho<c^2>$** , at constant temperature, $<c^2>$ must also be constant.

Thus, p α ρ only. Since graph is a straight line, thus gas behave as ideal gas.

(ii) **$p = (1/3)\rho<c^2>$**

y = mx + c ; whereby gradient of graph, **$m = (1/3)<c^2>$**

Rearrange the equation: **$<c^2> = 3*m$; $c_{rms} = \sqrt{(3*m)}$**

c_{rms} = 512 ms^{-1} (approximately)

(iii) At 27°C, p = (1/3)(1.00)(512^2) = 0.88 x10^5 Pa.

At same density, p α $<c^2>$ α T.

At 57°C, new pressure =[(273+57) / (273 + 27)](0.88 x10^5)

= **0.97 x 10^5 Pa**