Homework #3

№1.

Volume of the container does not change. $\Delta W = 0$. =>
all heat released in reaction goes into internal energy of the gas mixture.

$\Delta U_t = \Delta Q = 40.1\ kJ$

CO is an axial molecule => $U_c = \frac{f}{2} RT$ (for 1 mole)
with $f = 5$

H_2O is not axial $f = 6$ (3 translational + 3 rotational d. of f.)

$U_H = \frac{6}{2} RT$

$\Delta U_t = \Delta U_H + \Delta U_c = 3R\Delta T + \frac{5}{2}\Delta T \cdot R = \frac{11}{2} R \Delta T$

Number of molecules in the container did not change in reaction.

2 moles (1 mole of CO_2 and 1 mole of H_2)

initial pressure $P_i = 2RT_i/V$

2 moles 1 mole of H_2O and 1 mole of CO

final pressure $P_f = P_i + \Delta P = P_i + \frac{2R}{V}\Delta T =$

$= P_i + \frac{2R}{V} \cdot \frac{2\Delta U_t}{11R}$

$$\frac{P_f}{P_i} = 1 + \frac{4\Delta U_t}{11V} \cdot \frac{V}{2RT_i} = 1 + \frac{2}{11}\frac{\Delta Q}{RT_i}$$

assuming that $T_i = 300K$. $\frac{P_f}{P_i} \approx 3.9$

Problem # 3-2

Let's assume that mass of the cold water is m.
then the heat needed to heat it up from $10°C$ to $100°C$ is $\Delta Q = C_p \cdot m \cdot 90$ with $C_p = 4.2\ J/g\ °C$

$\Delta Q = 378 \cdot m\ (J)$

The power supplied to the container is

$$P = \frac{\Delta Q}{t} = \frac{378 \cdot m\ (J)}{600\ \ (sec)} = 0.63 \cdot m\ (Watt)$$

In the next step the same power is applied to evaporate m gramms of water. Needed heat is

$\Delta Q_{ev} = L \cdot m$

$L = 2260\ J/g$ is latent heat of evaporation

Time needed is

$$t_2 = \frac{\Delta Q_{ev}}{P} = \frac{L \cdot m}{0.63 \cdot m} = \frac{2260}{0.63} = 3587\ sec = 60\ minutes.$$

3-3

(A) With a method of symbolic multiplication we may generate all arrangments taking the product

$$(R_1+R_2+R_3)(B_1+B_2+B_3)(Y_1+Y_2+Y_3)(G_1+G_2+G_3)(O_1+O_2+O_3) =$$

In this product for example B_2 means blue ball in the second basket.

a particular arrangment (configuration) may for example be $R_2 B_3 Y_1 G_3 O_2$

Total number of possible arrangments is obviously 3^5

The probability of the particular distribution is $1/3^5$

(B) $$(R_1+R_2+R_3)(B_1+B_2+B_3)(Y_1'+Y_2'+Y_3')(Y_1''+Y_2''+Y_3'')$$

total number of arrangments is 3^4.

The configuration of interest

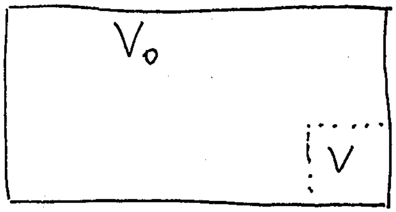
$R_1 B_2 Y_2 Y_3$ can be obtained in two ways

$R_1 B_2 Y_2' Y_3''$ and $R_1 B_1 Y_3' Y_2''$, so the probability of

$R_1 B_2 Y_2 Y_3$ is $2/3^4 \cong 0.025$

3-4.

V is part of V_0



a) • Let's assume first that we have just 1 molecule in volume V_0. The probability of this molecule to be in volume V is $\left(\frac{V}{V_0}\right)$ the probability of this molecule not to be in volume V is $\left(1-\frac{V}{V_0}\right)$

• N molecules move independently. The probability. That there is no molecules in V is

$$\left(1-\frac{V}{V_0}\right)^N$$

b)

$$0.01 = \left(1-\frac{V}{V_0}\right)^N \qquad V = V_0 \cdot \left(1-(0.01)^{1/N}\right)$$