Half-Life Worksheet

1

$$CS_2 \longrightarrow C + Sr$$

$$r = 2.8 \times 10^{-7}\ s^{-1}\ [CS_2]$$

a) $$t_{1/2} = \frac{\ln 2}{k}$$

$$= \frac{\ln 2}{2.8 \times 10^{-7}\ s^{-1}}$$

$$t_{1/2} = 2.48 \times 10^6\ s$$

$$= 28.7\ days$$

b) $m_{CS_2\,0} = 2.00\ g$

$m_{CS_2\,t} = 0.75\ g$

$K = 2.8 \times 10^{-7}\ s^{-1}$

$$\ln\left(\frac{m_{CS_2\,0}}{m_{CS_2\,t}}\right) = kt$$

$$\ln\left(\frac{2.00}{0.75}\right) = (2.8 \times 10^{-7}\ s^{-1})\,t$$

$$t = 3.5 \times 10^6\ s$$

$$= 40.5\ days$$

c) $m = 0.75\ g$

d) $m_{CS_2\,0} = 2.00\ g$

$m_{CS_2\,t} = \_\_\_\_\ g$

$K = 2.8 \times 10^{-7}\ s^{-1}$

$t = 45\ days$

$= 3.89 \times 10^6\ s$

$$\ln\left(\frac{m_{CS_2\,0}}{m_{CS_2\,t}}\right) = Kt$$

$$\ln\left(\frac{2}{m}\right) = (2.8 \times 10^{-7})(3.89 \times 10^6)$$

$$\ln\frac{2}{m} = 1.08$$

$$\frac{2}{m} = e^{1.08}$$

$$m = \frac{2}{e^{1.08}}$$

$$\boxed{m = 0.67\ g}$$

2. $r = 87\,s^{-1}[C_4H_8]$

a) $t_{1/2} = \frac{\ln 2}{k}$

$= \frac{\ln 2}{87\,s^{-1}}$

$\boxed{t_{1/2} = 7.97 \times 10^{-3}\ s}$

b) $\ln\left(\frac{m_I}{m_t}\right) = kt$

$m_I = 2.00g$

$m_t = 1.50g$

$\ln\left(\frac{2.00}{1.50}\right) = (87\,s^{-1})t$

$\boxed{t = 3.31 \times 10^{-3}\ s}$

c) $\ln\left(\frac{m_I}{m_t}\right) = kt$

$m_I = 1.00$

$m_t = x$

$t = 1\,s$

$K = 87\,s^{-1}$

$\ln\left(\frac{1}{m_t}\right) = (87\,s^{-1})(1s)$

$\ln\left(\frac{1}{m_t}\right) = 87$

$\frac{1}{M_t} = e^{87}$

$\boxed{m_t = 1.6 \times 10^{-38}\ s}$

3. $r = 1.4 \times 10^{-10}\ s^{-1}\ [NO_2]$

a) $t_{1/2} = \frac{\ln 2}{k}$

$= \frac{\ln 2}{1.4 \times 10^{-10}\ s^{-1}}$

$t_{1/2} = 4.95 \times 10^6\ s$

$= 5.73 \times 10^4$ days

b) $[NO_2]_I = \frac{3\ mol}{2L} = 1.5\ mol/L$

$t = 115$ yrs

$= 3.63 \times 10^9\ s$

$\ln\left(\frac{[NO_2]_I}{[NO_2]_t}\right) = kt$

$\ln\left(\frac{1.5}{x}\right) = (1.4 \times 10^{-10})(3.63 \times 10^9)$

$\ln\left(\frac{1.5}{x}\right) = 0.508$

$\frac{3}{x} = e^{0.508}$

$x = \frac{1.5}{1.66} = 0.904\ \frac{mol}{L}$

$[NO_2] = 0.904\ \frac{mol}{L}$

b)

$m = [NO] \times V \times M$

$= 0.9\ \frac{mol}{L} \times 2.00L \times 46.01\ g/mol$

$m = 83.2g\ NO_2$

c) $n_{NO_2\ reacted} = n_{NO_2\ I} - n_{NO_2\ t}$

$= 3.00 - (0.904\ mol/L)(2L)$

$= 1.192\ mol\ NO_2$

$n_{NO} = n_{NO_2\ reacted} \times$ mol ratio

$= 1.192\ mol\ NO_2 \times \frac{2\ mol\ NO}{1\ mol\ NO_2}$

$= 2.38\ mol\ NO$

$[NO] = \frac{n}{V}$

$= \frac{2.38\ mol\ NO}{2L}$

$[NO] = 1.19\ mol\ NO/L$

(4.) $K = 0.0606\ day^{-1}$

$$t_{1/2} = \frac{\ln 2}{K}$$

$$= \frac{\ln 2}{0.0606\ day^{-1}}$$

$$\boxed{t_{1/2} = 11.4\ days}$$

(5.) $k = 2.74 \times 10^{-3}\ s^{-1}$

$[C_3H_6]_I = 0.290\ M$

if 99.0% disappears then 1% remains

$$[C_3H_6]_t = [C_3H_6]_I \times 1\%$$

$$= 2.9 \times 10^{-3}\ mol/L$$

$$\ln \frac{[C_3H_6]_I}{[C_3H_6]_t} = kt$$

$$\ln \left(\frac{0.290}{2.9 \times 10^{-3}}\right) = \left(2.74 \times 10^{-3}\right) t$$

$$\boxed{t = 2.00 \times 10^{3}\ s}$$

6. $k = 1.20 \times 10^{-2}\ s^{-1}$

$[N_2O_5]_I = 0.00500\ mol/L$

a) $[N_2O_5]_t = 0.00110\ mol/L$

$$\ln\left(\frac{[N_2O_5]_I}{[N_2O_5]_t}\right) = kt$$

$$\ln\left(\frac{0.00500}{0.00110}\right) = (1.2 \times 10^{-2})\, t$$

$$\boxed{t = 134\ s}$$

b) $[N_2O_5]_I = 0.00110\ mol/L$

$[N_2O_5]_t = 0.000900\ mol/L$

$$\ln\left(\frac{0.00110}{0.0009}\right) = (1.2 \times 10^{-2}\ s^{-1})\, t$$

$$\boxed{t = 16.7\ s}$$

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⑦ $t = 47\ min = 2820\ s$

$[A]_I = 0.75\ mol/L$

$[A]_t = 0.20\ mol/L$

$$\ln\left(\frac{[A]_0}{[A]_t}\right) = kt$$

$$\ln\left(\frac{0.75}{0.20}\right) = (2820\ s)\, k$$

$$\boxed{k = 4.69 \times 10^{-4}\ s^{-1}}$$