Integrated Rate Law

① $C_{12}H_{22}O_{11} + H_2O \rightarrow C_6H_{12}O_6$

$r = k[C_{12}H_{22}O_{11}]$ 1st order

$t = 2.57h$ → $[C_{12}H_{22}O_{11}]_0 = 6.00\,g/L$ (initial)

$[C_{12}H_{22}O_{11}]_t = 5.40\,g/L$ (at time t)

$t = 2.57h$

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

$$\ln\left(\frac{[C_{12}H_{22}O_{11}]_0}{[C_{12}H_{22}O_{11}]_t}\right) = +kt$$

$$\ln\left(\frac{6.00}{5.40}\right) = +k(2.57hr)$$

$$k = 4.10 \times 10^{-2}\ s^{-1}$$

2. cyclobutane $\rightarrow$ 2 ethene.

$r = 87\ s^{-1}[\text{cyclobutane}]^1$

$k = 87\ s^{-1}$

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

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

$t_{1/2} = 8.0 \times 10^{-3}\ s$

b) $[\text{cyclobutane}]_0 = 2.00\ g$

$[\text{cyclobutane}]_t = 1.50\ g$

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

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

$t = \frac{0.287}{87\ s^{-1}}$

$= 3.3 \times 10^{-3}\ s$

c) $[\text{cyclobutane}]_0 = 1.00\ g$

$[\text{cyclobutane}]_t = x\ g$

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

$\ln\left(\frac{1.00}{x}\right) = 87\ s^{-1}(1\ s)$

$\ln\left(\frac{1.00}{x}\right) = 87$

$\frac{1.00}{x} = e^{87}$

$x = \frac{1.00}{e^{87}}$

$x = 1.6 \times 10^{-38}\ g$

3. $r = 0.0606\ d^{-1}\ [Ra\text{-}223]$

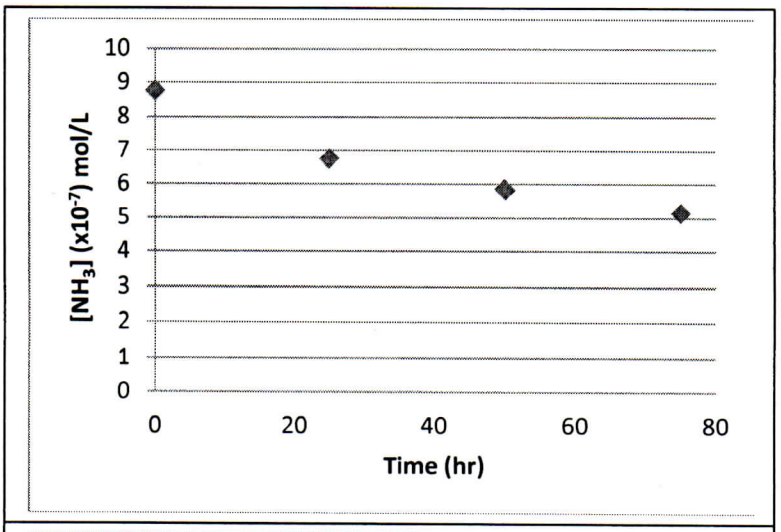
$$t_{1/2} = \frac{\ln 2}{k}$$

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

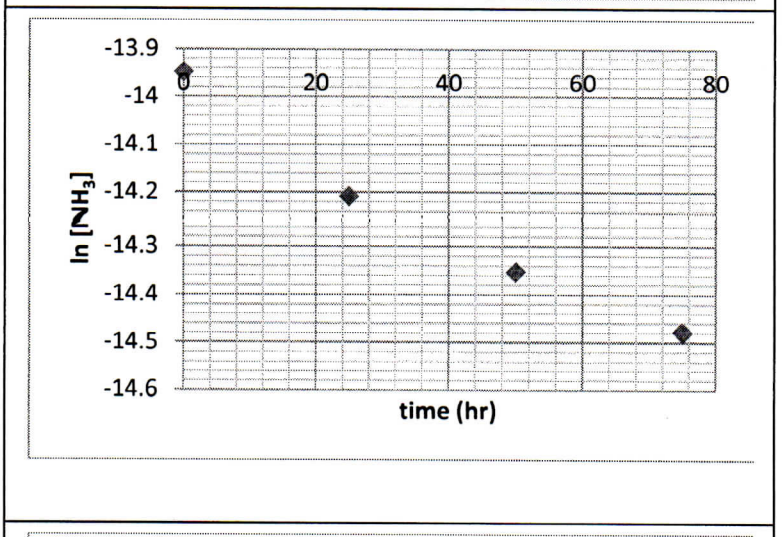
$$t_{1/2} = 11.4 \text{ days}$$

4.

curved line, therefore not zero order



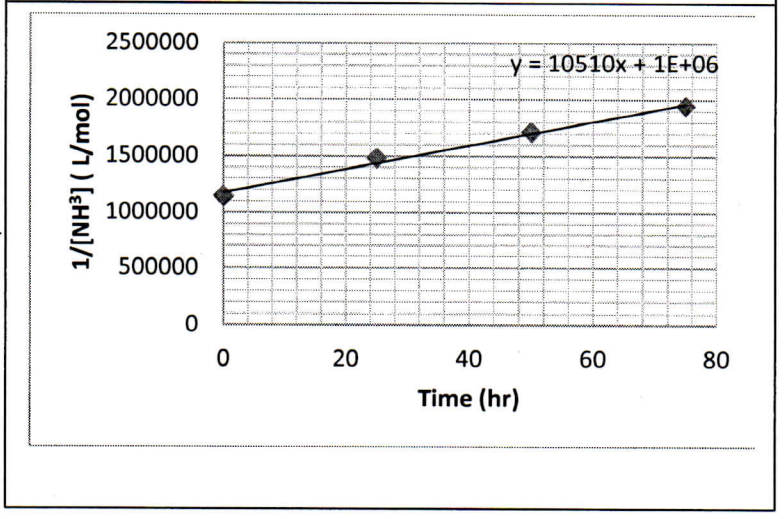
curved line, therefore not first order



Straight line, slope = +k

$k = 1.05 \times 10^4\ L\ mol^{-1}\ s^{-1}$

$r = 1.05 \times 10^4\ L\ mol^{-1}\ s^{-1}\ [NH_3]^2$



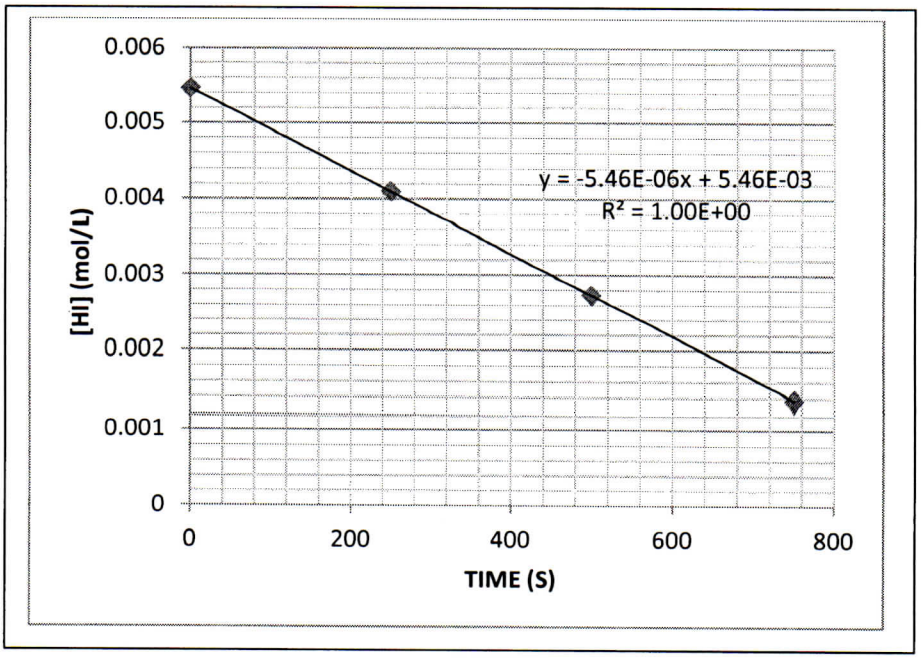
5.

straight line in a concentration vs time therefore it is zero order

m = o

k = -slope

$k = 5.46 \times 10^{-6}$



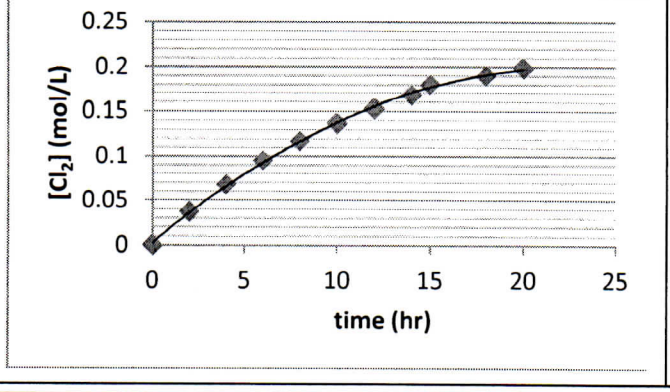
graph

$$[HI]_t = -5.46 \times 10^{-6} t + 5.46 \times 10^{-3}$$

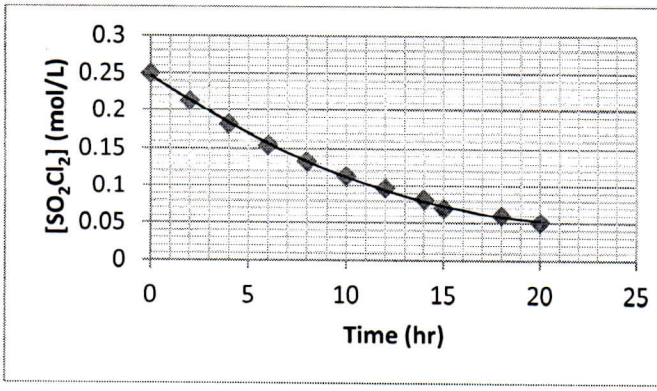
$$= -5.46 \times 10^{-6}(600s) + 5.46 \times 10^{-3}$$

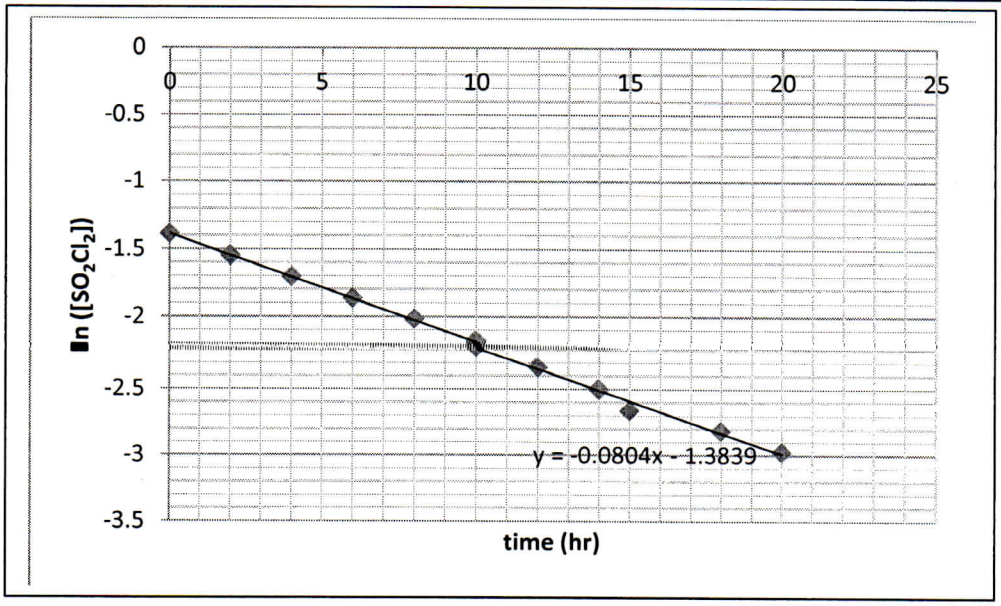
$$[HI]_t = 2.18 \times 10^{-3} \text{ mol/L}$$

6. (a)



(b)





↑ to determine $[SO_2Cl_2]$ at each time use mol ratio from $[SO_2Cl_2]_I$ and $[Cl_2]$ at each time.

(c) $r = 8.04 \times 10^{-2}\ s^{-1}[SO_2Cl_2]$.

(d) $K = 8.04 \times 10^{-2}\ s^{-1}$

(e) $[SO_2Cl_2]_0 = x$

$[SO_2Cl_2]_t = 0.05x$ ← if 95% react 5% left

$K = 8.04 \times 10^{-2}\ s^{-1}$

$$\ln\left(\frac{[SO_2Cl_2]_0}{[SO_2Cl_2]_t}\right) = kt$$

$$\ln\left(\frac{x}{0.05x}\right) = \left(8.04 \times 10^{-2}\ s^{-1}\right) t$$

$$\ln 20 = \left(8.04 \times 10^{-2}\ s^{-1}\right) t$$

$$t = 37.3\ s$$

7.a) $2HI_{(g)} \rightarrow H_{2(g)} + I_{2(g)}$

$k = 0.080 \frac{L}{mol\ s}$

bcz of k units the overall order of rxn is 2

$\therefore m = 2$

$r = k[HI]^m$

$r = 0.080 \frac{L}{mol \cdot s}[HI]^2$

(b) I would not ask you this question but to answer use eq'n from straight line graph and solve for t

$\frac{1}{[HI]_t} = \frac{1}{[HI]_0} + kt$

$[HI]_0 = 1.50 mol/L$

$[HI]_t = 0.30 mol/L$

$k = 0.080 \frac{L}{mol \cdot s}$

$kt = \frac{1}{[HI]_t} - \frac{1}{[HI]_0}$

$kt = \frac{1}{0.30} - \frac{1}{1.50}$

$kt = 3.33 - 0.666$

$kt = 2.666. \frac{L}{mol.}$

$t = \frac{2.66 \frac{L}{mol}}{0.080 \frac{L}{mol\ s}}$

$t = 33\ s$