2, 5, 9, 10, 13, 16

$\boxed{\#7.2}$

(a) $t_{1/2} = \dfrac{2^{n-1}-1}{(n-1)k A_0^{n-1}}$ $\quad V = kA^n \quad (7.26)$

$$\frac{t_{1/2}}{t'_{1/2}} = \left(\frac{A_0'}{A_0}\right)^{n-1} \Rightarrow \boxed{n=2}$$

(b) $$k = \frac{\cancel{2^{n-1}}\ 1}{t_{1/2} \cdot A_0} = \frac{1}{0.01 \cdot 1000} = \frac{1}{0.005 \cdot 2000} = \frac{1}{10}$$

$$k = 0.1 \frac{1}{s \cdot M}$$

(c) $\boxed{t = 2000s}$ ← exp 1

$t = 1000 + 2000 = \boxed{3000s}$ ← exp 2

(d) $V = kA^2$
$V = kAB$
$V = kB^2$

(e) use different values of A_0 and B_0

~~#2.5~~ $\boxed{\#7.5}$

(a) $V = KA^nB^m$ (b) $\boxed{m = 0}$

$\boxed{n = 2}$

(c) $\boxed{\dot{C} = KA^2}$

(d) $K = \frac{V}{A^2} = \frac{1\times10^{-3}\ \frac{m}{s}}{(1\ m)^2} = \boxed{1\times10^{-3}\ \frac{1}{m\cdot s}}$

(e) "Slow" or Rate-Limiting Step is collisional association of A w/ itself: $\boxed{2A \rightarrow A_2}$

$\boxed{\#7.9}$ (a) $k = Ae^{-E_a/RT} \Rightarrow \ln K = \ln A - E_a/RT$

Plot $\left[\ln K \text{ vs } \frac{1}{T}\right]$

$1/T$	$\ln(K_1)$	$\ln(K_{-1})$
$3.28\times10^{-31}\ \frac{1}{K}$	-0.223	0
3.23	0.833	1.16
3.18	1.25	2.73
3.13	1.79	4.47

Results: forward

Slope $= -12.9\times10^3$; $E_a = 107\ \frac{kJ}{mol}$

intercept $= 42.3$; $A = 2.35\times10^{23}\ \frac{1}{m\cdot s}$

reverse

Slope $= -30.0\times10^3$; $E_a = 249\ kJ/mol$

intercept $= 98.1$; $A = 4.02\times10^{42}\ \frac{1}{m\cdot s}$

forward $RT \approx 2.6\ kJ/mol$

$\boxed{\Delta H^\ddagger} = E_a - RT = \boxed{104\ kJ/mol}$

$\boxed{\Delta S^\ddagger} = R\ln\left(\frac{Ah}{K_BT}\right) = \boxed{202\ \frac{J}{K\,mol}}$

Reverse

$\boxed{\Delta H^\ddagger = 246\ kJ/mol}$ $\boxed{\Delta S^\ddagger = 570\ \frac{J}{K\,mol}}$

(b) $K_{eq} = \frac{K_1}{K_{-1}} = \frac{2.3e^5}{3.2} = 0.719\times10^5 = \boxed{7.2\times10^4}$

$\Delta H = \Delta H_f^\ddagger - \Delta H_r^\ddagger = \boxed{-142\ \frac{kJ}{mol}}$

$\Delta S = \Delta S_f^\ddagger - \Delta S_r^\ddagger = \boxed{-368\ \frac{J}{mol\cdot K}}$

(c) It will stabilize the products.

$\boxed{\#7.10}$ $A+B \rightarrow C \Rightarrow \dot{A} = \dot{B}$

Since $A(0) = B(0)$ and $\dot{A}(t) = \dot{B}(t) \Rightarrow A(t) = B(t)$

(a) $\dot{A} = kA \Rightarrow A = A_0 e^{-kT} \Rightarrow k = \frac{-1}{t} \ln\left(\frac{A}{A_0}\right) = \frac{-1}{1h} \ln(0.1)$

$= 2.3 \frac{1}{h}$

$$\frac{A(2h)}{A(0)} = e^{-2.3\frac{1}{h} \cdot 2h} = \boxed{0.01}$$

Alternatively: $\frac{1}{10} \cdot \frac{1}{10} = \frac{1}{100} = 0.01$

Since it decreases 90.1% per hour.

(b) $\dot{A} = kA^2 \Rightarrow \frac{1}{A} - \frac{1}{A_0} = kt \Rightarrow \frac{A}{A_0} = \frac{1}{1+ktA_0}$

$k = ?$: $k = \left(\frac{A_0}{A} - 1\right)\frac{1}{tA_0} = \left(\frac{10}{1} - 1\right)\frac{1}{1h} \cdot \frac{1}{A_0} = \boxed{\frac{9}{A_0}\frac{1}{h} = k}$

$$\boxed{\frac{A}{A_0} =} \frac{1}{1+kTA_0} = \frac{1}{1+\frac{9}{A_0}\frac{1}{h} \cdot T \cdot A_0} = \boxed{\frac{1}{1+9T/h}}$$

$$\boxed{\frac{A(2h)}{A(0)} = \frac{1}{19}}$$

(c) $\dot{A} = -k$ iff $A(t) > 0$

$\dot{A} = 0$ iff $A(t) = 0$

$\Rightarrow A = -kt + A_0$

$= A_0 - kt$

$\Rightarrow \boxed{A(2h) = 0}$

(d) $\dot{A} = -kA^{3/2} \Rightarrow \frac{1}{A^{1/2}} - \frac{1}{A_0^{1/2}} = \frac{k}{2}t$

$$\Rightarrow \frac{A}{A_0} = \frac{1}{\left(1+\frac{kt}{2}\sqrt{A_0}\right)^2}$$

$k = ?$: $k = \frac{2}{t}\left(\sqrt{\frac{A_0}{A}} - 1\right)\frac{1}{\sqrt{A_0}} = \frac{2}{1h}\left(\sqrt{\frac{10}{1}} - 1\right)\frac{1}{\sqrt{A_0}}$

$$\boxed{k = \frac{4.32}{\sqrt{A_0}} \cdot \frac{1}{h}}$$

$$\frac{A}{A_0} = \frac{1}{\left(1+\frac{kt}{2}\sqrt{A_0}\right)^2} = \frac{1}{\left(1+\frac{4.32}{\sqrt{A_0}}\cdot\frac{1}{h}\cdot\frac{t}{2}\cdot\sqrt{A_0}\right)^2}$$

$$\boxed{\frac{A}{A_0} = \frac{1}{\left(1+2.16\frac{1}{h}\cdot t\right)^2}} \Rightarrow \boxed{\frac{A(24)}{A(0)} = \frac{1}{28.4} = 0.035}$$

$\boxed{\#7.13}$ $\frac{A}{A_0} = e^{-kt}$ $\quad t_{1/2} = \frac{\ln 2}{k}$ $\quad t = -\frac{1}{k}\ln\frac{A}{A_0} = -\frac{t_{1/2}}{\ln 2}\ln\frac{A}{A_0}$

$$t = \frac{-12.5y}{\ln 2}\cdot\ln(0.2) = \boxed{29.0y}$$

$\boxed{\#7.16}$

(a) $\dot{u} = k_0 - k_1 \cdot u$

(b) Solve

Change of Variables $\boxed{u = w + \frac{k_0}{k_1}}$

(a) $\Rightarrow \frac{d}{dt}\left(w + \frac{k_0}{k_1}\right) = k_0 - k_1\left(w + \frac{k_0}{k_1}\right)$

$\Rightarrow \dot{w} = \cancel{k_0} - k_1 w - \frac{\cancel{k_1 k_0}}{\cancel{k_1}} = -k_1 w$

$\Rightarrow \boxed{w(t) = w(0)\, e^{-k_1 t}}$

but $w(t) = u(t) - \frac{k_0}{k_1}$

$\Rightarrow u(t) - \frac{k_0}{k_1} = \left(u(0) - \frac{k_0}{k_1}\right) e^{-k_1 t}$

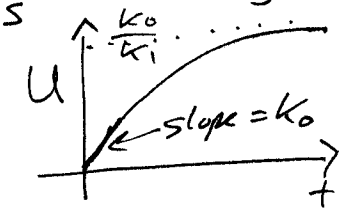
$u(t) = \frac{k_0}{k_1} + u(0)\, e^{-k_1 t} - \frac{k_0}{k_1} e^{-k_1 t}$

$$\boxed{u(t) = u(0)\, e^{-k_1 t} + \frac{k_0}{k_1}\left(1 - e^{-k_1 t}\right)}$$

Now set $u(0) = 0$

✓✓

(c) $K_0 = 1\times10^{-9}\,\frac{m}{s}$ $\quad K_1 = \frac{\ln 2}{t_{1/2}} = \frac{\ln 2}{1800\,s} = 3.85\times10^{-4}\,\frac{1}{s}$



$$\frac{K_0}{K_1} = \frac{1\times10^{-9}\,\frac{m}{s}}{3.85\times10^{-4}\,\frac{1}{s}} = 2.6\times10^{-6}\,m$$

$$= \boxed{2.6\,\mu m} \text{ @ } t=\infty$$

(d) $u = \frac{K_0}{K_1}\left[1-e^{-K_1 t}\right] \Rightarrow t = \frac{-1}{K_1}\ln\left(1-\frac{K_1}{K_0}u\right)$

$$t = \frac{-1}{3.85\times10^{-4}\,\frac{1}{s}}\cdot\ln\left[1-(2.6\times10^{-6}\,m)^{-1}\cdot 1\times10^{-6}\,m\right]$$

$$= 1261\,s = 0.35\,h$$

(e) now $K_0 = 0.5\times10^{-9}\,\frac{m}{s}$

$$t = \frac{-1}{3.85\times10^{-4}\,\frac{1}{s}}\cdot\ln\left[1-\frac{3.85\times10^{-4}\,\frac{1}{s}}{0.5\times10^{-9}\,\frac{m}{s}}\cdot 1\times10^{-6}\,m\right]$$

$$= 3817\,s = 1.1\,h$$

(f) $u_{max} = \frac{K_0}{K_1}$ $\quad$ If $K_1 = 3.85\times10^{-4}\,\frac{1}{s}$ what is K_0 such that $u_{max} = 1\times10^{-6}\,m$

$$K_0 = u_{max}\cdot K_1$$

$$= 1\times10^{-6}\,m\cdot 3.85\times10^{-4}\,\frac{1}{s} = \boxed{3.85\times10^{-10}\,\frac{m}{s}}$$