Problem 4.2
Since this is an aqueous system, the volume is assumed to be constant.
$A + 2B \rightarrow R + S$
From the stoichiometry, for every mole of A reacted, 2 moles of B are reacted.
Therefore,

$$XB = 2*XA*Cao/Cbo$$

Since Ca and Cao are given, XA = 1-Ca/Cao = 1-20/100 = 0.80.
Therefore, XB = 2*0.80*100/100 = 1.60.
Clearly, this is not possible, since the maximum value of XB is 1.0.
Therefore, **the problem setup is in error and CB cannot be determined**.
The point of this problem is for the students to recognize that the numerical answer obtained by applying the equations is not physically possible and therefore the setup/assumptions must be in error.

Problem 5.4
For an MFR $\tau = (Co - C)/(-r)$
If $r = -k\,C^{1.5}$, then $\tau = (Co - C)/\,k\,C^{1.5}$
Given 70% conversion, C = Co (1-X) = 10 (1-0.7) = 3.0
So, $\tau = (Co - C)/\,k\,C^{1.5} = 1.34715/k$
If new reactor has twice the volume, $\tau_2 = 2\,\tau_1 = 2.6943/k = (Co - C)/\,k\,C^{1.5}$
$\tau_2 = 2.6943/k = (Co - C)/\,k\,C^{1.5}$
$2.6943 = (Co - C)/\,C^{1.5}$
Given answer: Solving for C = 2.83 so **X = 0.717**
(I used excel solver to get Ca = 2.056 X=0.79)

Problem 5.8
For an MFR in which a reversible reaction occurs,

$$k_1\tau = Xa\,Xe/(Xe - Xa)$$

Since we know from the reaction model , -ra = 0.04 Ca – 0.01 Cr .
At equilibrium, ra = 0, so Caeq/Creq = 0.01/0.04 = 0.25 or Creq = 4 Caeq.
Since by mass balance, Ca+Cr=Cao=100, Caeq=20 and Creq=80 mmol/L.

Xe = (Cao-Ca)/Cao = 100-20/100 = 0.80
Plugging this into the above equation, with $k_1 = 0.04$, $\tau = 20$
0.04*20 = Xa(0.8)/(0.80-Xa)
Solving for **Xa = 0.40.**

Problem 5.9
Integrating the M-M equation gives,
. $\tau = Km/Vm \ln(1/1-X) + 1/Vm\,(Co\,X)$
Plugging in X = 0.95, Vm = 0.2, Km = 2.0 gives
$\tau = 39.46 = V/q$ **V = 986.43 L**

Problem 5.11

For an MFR in which a M-M reaction occurs,

$\tau = (Co - C)/-r$

Substituting in the M-M equation and re-arranging,

$C^2 + \{Km + \tau\, Vm - Co\}C - Km\, Co = 0$

For 95% conversion, C = 0.05 Co.

Substituting this in with Co, Km and Vm values gives

τ = 199.5 min = V/q so V = 199.5*25 = 4987.5 L

Problem 5.21

For this one, you need to plot 1/r vs. C and integrate under the data curve to get the space-time parameter. Integrating 1/r vs. C between 0.3 and 1.3 gives t = 12.75 min.