$$V_{new} = 1.1499 - \left[\frac{-0.00188518}{23.31519633}\right] = 1.1499 liters$$

5. $V_c = 0.1113L$ (?), $P_c = 113.688 bar \cong 11.67 MPa$ and $T_c \cong 405.85K^\circ$

6. 153.8 grams/mole, probably CCl_4

7. 0.024235 moles

8. $\sqrt{(0.833333\%)^2 + (0.132275\%)^2 + (0.102337\%)^2} = 0.849949\%$

9. $V = \frac{4}{3}\pi\left[2.54\left(\frac{9.39}{2}\right)\right]^3 = 7103.9ml = 7.1039 liters$

10. let $n = 1$, $\alpha = \left(\frac{1}{V}\right)\left(\frac{R}{P}\right) = \left(\frac{1}{T}\right)$ and $\beta = \left(\frac{-1}{V}\right)\left(\frac{-RT}{P^2}\right) = \left(\frac{1}{P}\right)\left(\frac{RT}{PV}\right) = \left(\frac{1}{P}\right)$

Chapter 2
Answers to Problems

1. $\left(V/t\right) = 63.05$ gallons/min with constant pressure; 3.15 gallons/min with a duty cycle of 0.05

2. $\eta_x = \eta_{H_2O}\left(\frac{t_x}{t_{H_2O}}\right) = (0.010038)\left(\frac{19}{17}\right) = 0.011219 poise$

3. $\left(V/t\right) = \dfrac{\pi\left(\frac{100-14.7}{14.7}\right)(1.01325x10^6)(2.54)^4(60)}{8(12)(2.54)(0.01)(4)(946)} = 5.00x10^6 gallons/\min$ (wow!)

4. $\eta = \dfrac{\pi\left(\frac{18-14.7}{14.7}\right)atm\left(1.01325x10^6\left(gramcm/\sec^2\right)/cm^2atm\right)(2.54cm/2)^4(60\sec/\min)}{8(6inch)(2.54cm/inch)(5gal/\min)(4qt/gal)(946cm^3/qt)}$

$= 48.354 gram/cm\sec = 48.354 poise = 4.8354 Pascal \sec$ (molasses?)

5. $R = \left[\left(\frac{V}{t}\right)\frac{8l\eta}{\pi Pf}\right]^{\left(\frac{1}{4}\right)}$ where $f = 0.05$ is a "pulse duty cycle"

$$R = \left[\frac{(9)(4)(946)(8)(7)(2.54)(0.02)}{(0.05)(60)(2.54)^4\pi\left(\frac{140-60}{760}\right)(1.01325x10^6)}\right]^{\left(\frac{1}{4}\right)} = 0.2194" = \text{Radius}$$

Diameter = 2(Radius) =0.4388", seems large but he is an athelete!

Teacher notes for Polymer Example

$[\eta]=KM^a$, $\ln([\eta])=\ln K+a\ln M$, $\ln M=\dfrac{\ln([\eta])-\ln K}{a}=\left(\dfrac{1}{a}\right)\ln\left(\dfrac{[\eta]}{K}\right)=\ln\left(\dfrac{[\eta]}{K}\right)^{\left(\frac{1}{a}\right)}$

so that $M=\left(\dfrac{[\eta]}{K}\right)^{\left(\frac{1}{a}\right)}$, now set up tables of $[\eta]=\left[\dfrac{\eta_{sp}}{c}\right]$ and $[\eta]=\left(\dfrac{\ln\eta_r}{c}\right)_{c\to 0}$ for

$\left[C\left(kg/m^3\right),\eta\left(mPa\sec\right)\right]$: (21.4, 1.35), (10.7, 0.932) and (5.35, 0.757).

Use $\eta_r\equiv\left(\dfrac{\eta}{\eta_0}\right)$ and $\eta_{sp}\equiv\eta_r-1$ to set up tables versus the concentration. Use $\eta_0=0.606$

C	η	η_r	η_{sp}	(η_{sp}/c)	$(\ln\eta_r/c)$
21.4	1.35	2.228	1.228	0.05737	0.03743
10.7	0.932	1.538	0.538	0.05028	0.04023
5.35	0.757	1.249	0.249	0.04657	0.04156

m = slope for (η_{sp}/c) = (0.05737-0.04657)/(21.4-5.35) = 6.7290E-4

m = slope for = $(\ln\eta_r/c)$ = (0.03743-0.04156)/(21.4-5.35) = -2.5732E-4

Without doing the graph we can ask "what is y when x=21.4", within the sig. fig. of the data.

For (η_{sp}/c) we have: 0.05737 = (21.4)(6.7290E-4) + b so b = 0.04297

For $(\ln\eta_r/c)$ we have: 0.03743 = (21.4)(-2.5732E-4)+ b so b = 0.04294

The average of these two intercepts is 0.042955 or 0.04286 with four significant figures.

$[\eta]\cong 0.04296$ On the graph one line slopes up, the other slopes down but both have the same limiting intercept.

$$M=\left(\frac{[\eta]}{K}\right)^{\left(\frac{1}{a}\right)}=\left(\frac{0.04296}{1.71x10^{-3}m^3/kg}\right)^{(1.351)}=77.8919\cong 78kg/m^3$$

This seemingly strange molecular weight tells us that the limiting case represents a tangled web of polymer that may be hopelessly knotted with itself and/or actually cross linked chemically. In the case of synthetic rubber tires, cross linking may be so great that one can say the whole tire is one molecule! Even so the intrinsic viscosity is used by polymer scientists to compare different polymers as a measureable property.

Chapter 3

Answers to Problems

1. M = 39.9481 grams/mole