2.26 (a) $\underline{\underline{70.5\ \text{lb}_m/\text{ft}^3}}$; $\underline{\underline{8.27\times10^{-7}\ \text{in}^2/\text{lb}_f}}$

(b) $$\rho = (70.5\ \text{lb}_m/\text{ft}^3)\exp\left[\frac{8.27\times10^{-7}\ \text{in}^2}{\text{lb}_f}\cdot\frac{9\times10^6\ \text{N}}{\text{m}^2}\cdot\frac{14.696\ \text{lb}_f/\text{in}^2}{1.01325\times10^6\ \text{N}/\text{m}^2}\right]$$

$$= \frac{70.57\ \text{lb}_m}{\text{ft}^3}\cdot\frac{35.3145\ \text{ft}^3}{\text{m}^3}\cdot\frac{1\ \ \text{m}^3}{10^6\ \text{cm}^3}\cdot\frac{1000\ \text{g}}{2.20462\ \text{lb}_m} = \underline{1.13\ \text{g}/\text{cm}^3}$$

(c) $$\rho\left(\frac{\text{lb}_m}{\text{ft}^3}\right) = \rho'\frac{\text{g}}{\text{cm}^3}\cdot\frac{1\ \text{lb}_m}{453.593\ \text{g}}\cdot\frac{28{,}317\ \text{cm}^3}{1\ \text{ft}^3} = 62.43\rho'$$

$$P\left(\frac{\text{lb}_f}{\text{in}^2}\right) = P'\frac{\text{N}}{\text{m}^2}\cdot\frac{0.2248\ \text{lb}_f}{1\ \text{N}}\cdot\frac{1^2\ \ \text{m}^2}{39.37^2\ \text{in}^2} = 1.45\times10^{-4}\,P'$$

$$\Rightarrow 62.43\rho' = 70.5\exp\left[\left(8.27\times10^{-7}\right)\left(1.45\times10^{-4}\,P'\right)\right] \Rightarrow \underline{\rho' = 1.13\exp\left(1.20\times10^{-10}\,P'\right)}$$

$$P' = 9.00\times10^6\ \text{N}/\text{m}^2 \Rightarrow \rho' = 1.13\exp[(1.20\times10^{-10})(9.00\times10^6)] = \underline{1.13\ \text{g}/\text{cm}^3}$$

2.30 (b) $\ln y = \ln a + bx \Rightarrow y = ae^{bx}$

$$b = (\ln y_2 - \ln y_1)/(x_2 - x_1) = (\ln 2 - \ln 1)/(1-2) = -0.693$$

$$\ln a = \ln y - bx = \ln 2 + 0.63(1) \Rightarrow a = 4.00 \Rightarrow \underline{y = 4.00e^{-0.693x}}$$

(c) $\ln y = \ln a + b\ln x \Rightarrow y = ax^b$

$$b = (\ln y_2 - \ln y_1)/(\ln x_2 - \ln x_1) = (\ln 2 - \ln 1)/(\ln 1 - \ln 2) = -1$$

$$\ln a = \ln y - b\ln x = \ln 2 - (-1)\ln(1) \Rightarrow a = 2 \Rightarrow \underline{y = 2/x}$$

(d) $\ln(xy) = \ln a + b(y/x) \Rightarrow xy = ae^{by/x} \Rightarrow y = (a/x)e^{by/x}$ [can't get $y = f(x)$]

$$b = [\ln(xy)_2 - \ln(xy)_1]/[(y/x)_2 - (y/x)_1] = (\ln 807.0 - \ln 40.2)/(2.0 - 1.0) = 3$$

$$\ln a = \ln(xy) - b(y/x) = \ln 807.0 - 3\ln(2.0) \Rightarrow a = 2 \Rightarrow xy = 2e^{3y/x} \Rightarrow \underline{\underline{y = (2/x)e^{3y/x}}}$$

(e) $\ln(y^2/x) = \ln a + b\ln(x-2) \Rightarrow y^2/x = a(x-2)^b \Rightarrow y = [ax(x-2)^b]^{1/2}$

$$b = [\ln(y^2/x)_2 - \ln(y^2/x)_1]/[\ln(x-2)_2 - \ln(x-2)_1]$$

$$= (\ln 807.0 - \ln 40.2)/(\ln 2.0 - \ln 1.0) = 4.33$$

$$\ln a = \ln(y^2/x) - b(x-2) = \ln 807.0 - 4.33\ln(2.0) \Rightarrow a = 40.2$$

$$\Rightarrow y^2/x = 40.2(x-2)^{4.33} \Rightarrow \underline{\underline{y = 6.34x^{1/2}(x-2)^{2.165}}}$$

2.31 **(b)** Plot y^2 vs. x^3 on rectangular axes. Slope $= m$, Intcpt $= -n$

(c) $\frac{1}{\ln(y-3)} = \frac{1}{b} + \frac{a}{b}\sqrt{x} \Rightarrow$ Plot $\frac{1}{\ln(y-3)}$ vs. $\sqrt{x}$ [rect. axes], slope $= \frac{1}{b}$, intercept $= \frac{a}{b}$

(d) $\frac{1}{(y+1)^2} = a(x-3)^3 \Rightarrow$ Plot $\frac{1}{(y+1)^2}$ vs. $(x-3)^3$ [rect. axes], slope $= a$, intercept $= 0$

OR

$2\ln(y+1) = -\ln a - 3\ln(x-3)$

Plot $\ln(y+1)$ vs. $\ln(x-3)$ [rect.] or $(y+1)$ vs. $(x-3)$ [log]

$\Rightarrow$ slope $= -\frac{3}{2}$, intercept $= -\frac{\ln a}{2}$

(e) $\ln y = a\sqrt{x} + b$

Plot $\ln y$ vs. $\sqrt{x}$ [rect.] or y vs. $\sqrt{x}$ [semilog], slope = a, intercept = b

(f) $\log_{10}(xy) = a(x^2 + y^2) + b$

Plot $\log_{10}(xy)$ vs. $(x^2 + y^2)$ [rect.] $\Rightarrow$ slope = a, intercept = b

(g) $\frac{1}{y} = ax + \frac{b}{x} \Rightarrow \frac{x}{y} = ax^2 + b \Rightarrow$ Plot $\frac{x}{y}$ vs. x^2 [rect.], slope $= a$, intercept $= b$

OR $\frac{1}{y} = ax + \frac{b}{x} \Rightarrow \frac{1}{xy} = a + \frac{b}{x^2} \Rightarrow$ Plot $\frac{1}{xy}$ vs. $\frac{1}{x^2}$ [rect.], slope $= b$, intercept $= a$

Q.4 (a) $C_A = C_{Ae} + (C_{A0} - C_{Ae}) e^{-kt}$

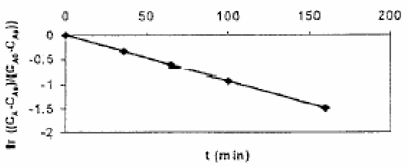
$C_A - C_{A0} = (C_{A0} - C_{Ae}) e^{-kt}$

$\ln(C_A - C_{A0}) = \ln(C_{A0} - C_{Ae}) + \ln e^{-kt}$

$\ln(C_A - C_{A0}) - \ln(C_{A0} - C_{Ae}) = -kt \ln e$ (= 1)

$\ln \frac{C_A - C_{A0}}{C_{A0} - C_{Ae}} = -kt$

Yes, because when $\ln[(C_A - C_{Ae})/(C_{A0} - C_{Ae})]$ is plotted vs. t in rectangular coordinates, the plot is a straight line.



one plot either in rectangular coordinates or in semi-log cordinates is enough

Slope = -0.0093 ⇒ $k = 9.3 \times 10^{-3}$ min^{-1}

(b) slope $= -k = \frac{\sum x_i y_i}{\sum x_i^2} = \frac{S_{xy}}{S_{xx}}$

t (min.)	0	10	50	100	150	200
$\ln\left[\frac{C_A - C_{Ae}}{C_{A0} - C_{Ae}}\right]$	0	-0.101	-0.499	-1.000	-1.500	-1.995
$x_i y_i$	0	-1.01	-24.95	-100.0	-225	-399.0
x_i^2	0	100	2500	10,000	22500	40,000

$\sum x_i y_i = 0 - 1.01 - 24.95 - 100 - 225 - 399$

$= -749.96$

$\sum x_i^2 = 100 + 2500 + 10,000 + 22,500 + 40,000$

$= 75,100$

$\Rightarrow -k = \text{slope} = -\frac{749.96}{75100} = -0.01$ min^{-1}

$\Rightarrow$ **$k = 0.01$ min^{-1}** (Same as above) Ans

(c) at $t = 1$ hr $= 60$ min

$C_A = 0.1 + (1 - 0.1) e^{-0.01 \times 60} = 0.594$ mol/L

mass concentration of A $= 0.594 \frac{\text{mol}}{\text{L}} \cdot \frac{20\text{ g}}{\text{mol}}$

$=$ **11.88 g/L** Ans.

Q.5

$$Q = c\,\frac{\Delta P \cdot r^4}{\mu \cdot L}$$

(a) Dimensions: l: length, t: time, m: mass

Q : $\frac{\text{Volume}}{\text{time}} : \frac{l^3}{t}$

c : dimensionless

ΔP : $\frac{\text{force}}{\text{area}} : \frac{\text{mass} \times \text{acceleration}}{\text{area}} : \frac{m \cdot l/t^2}{l^2} : \frac{m}{l \cdot t^2}$

r : l

L : l

$$\Rightarrow \frac{l^3}{t} = \frac{\frac{m}{l \cdot t^2} \times l^4}{\mu \times l} \Rightarrow \mu = \frac{\frac{m}{l \cdot t^2} \cdot l^4 \cdot t}{l \cdot l^3}$$

$$= \frac{m}{l \cdot t} : \frac{\text{mass}}{\text{length} \times \text{time}}$$

(b) Units:

	mass	length	time
SI :	kg	m	s
CGS :	g	cm	s
American :	lb_m	ft	s

$\Rightarrow \mu$: $\frac{kg}{m \cdot s}$ in SI units

$\frac{g}{cm \cdot s}$ in CGS units

$\frac{lb_m}{ft \cdot s}$ in American units