$$\text{Least-squares of } \ln(\mu) \text{ versus } \frac{1}{T}: \quad \boldsymbol{\mu \approx 3.31E\text{–}9\ \frac{kg}{m{\cdot}s}\ \exp\left(\frac{5476\ K}{T°K}\right)} \quad \textit{Ans. (\#2)}$$

The accuracy is somewhat better, but not great, as follows:

T, °C:	0	20	40	60	80	100
μSAE30, kg/m·s:	2.00	0.40	0.11	0.042	0.017	0.0095
Curve-fit #1:	2.00	0.42	0.108	0.033	0.011	0.0044
Curve-fit #2:	1.68	0.43	0.13	0.046	0.018	0.0078

Neither fit is worth writing home about. Andrade's equation is not accurate for SAE 30 oil.

1.45 A block of weight W slides down an inclined plane on a thin film of oil, as in Fig. P1.45 at right. The film contact area is A and its thickness h. Assuming a linear velocity distribution in the film, derive an analytic expression for the terminal velocity V of the block.

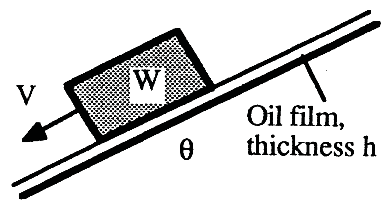

Fig. P1.45

Solution: Let "x" be down the incline, in the direction of V. By "terminal" velocity we mean that there is no acceleration. Assume a linear viscous velocity distribution in the film below the block. Then a force balance in the x direction gives:

$$\sum F_x = W \sin\theta - \tau A = W \sin\theta - \left(\mu \frac{V}{h}\right) A = ma_x = 0,$$

$$\text{or:} \quad V_{terminal} = \boldsymbol{\frac{hW \sin\theta}{\mu A}} \quad \textit{Ans.}$$

P1.46 A simple and popular model for two non-newtonian fluids in Fig. 1.9*a* is the *power-law*:

$$\tau \approx C\left(\frac{du}{dy}\right)^n$$

where *C* and *n* are constants fit to the fluid [15]. From Fig. 1.9*a*, deduce the values of the exponent *n* for which the fluid is (*a*) newtonian; (*b*) dilatant; and (*c*) pseudoplastic. (*d*) Consider the specific model constant $C = 0.4\ N\text{-}s^n/m^2$, with the fluid being sheared between two parallel plates as in Fig. 1.8. If the shear stress in the fluid is 1200 Pa, find the velocity *V* of the upper plate for the cases (*d*) $n = 1.0$; (*e*) $n = 1.2$; and (*f*) $n = 0.8$.