Complete solutions to Exercise 1(d)

1. Obtain the dimensions of each quantity in the brackets from TABLE 1 and then use the rules of indices.
2. Use TABLE 1 and simplify by using indices.
3. Using TABLE 1:

(a) Incorrect because from TABLE 1 we have

$$[F] = MLT^{-2}$$

$$[m \times g \times l] = M \times LT^{-2} \times L = ML^2T^{-2}$$

Hence the dimensions of F do not equal the dimensions of mgl.

(b) Correct

$$[s] = L, \quad \left[ut + \frac{1}{2}gt^2\right] = LT^{-1}T + LT^{-2}T^2 \underbrace{=}_{\text{by (1.5)}} L + L$$

(c) Correct

$$\left[v^2\right] = \left(LT^{-1}\right)^2 = L^2T^{-2}, \quad \left[u^2 + 2gs\right] = \left(LT^{-1}\right)^2 + LT^{-2}L = \underbrace{L^2T^{-2}}_{\text{by (1.7)}} + \underbrace{L^2T^{-2}}_{\text{by (1.5)}}$$

(d) Incorrect

$$[W] = ML^2T^{-2}, \quad [F \times v] = MLT^{-2} \times LT^{-1} = ML^2T^{-3}$$

(e) Incorrect

$$[P] = ML^2T^{-3}, \quad [F \times l] = MLT^{-2} \times L = ML^2T^{-2}$$

4. Transposing to make μ the subject gives $\mu = \frac{Fd}{Av}$. Using TABLE 1

$$[\mu] = \left[\frac{F \times d}{A \times v}\right]$$

$$= \frac{MLT^{-2} \times L}{L^2 \times LT^{-1}} = \frac{ML^2T^{-2}}{L^2 \times LT^{-1}} = ML^{-1}T^{-2-(-1)} = ML^{-1}T^{-1}$$

5. We show (a) and (e). The others (b), (c) and (d) are similar.

(a)

$$[\text{Re Number}] = \left[\frac{\rho \times v \times l}{\mu}\right]$$

$$= \frac{\left(ML^{-3}\right) \times \left(LT^{-1}\right) \times L}{ML^{-1}T^{-1}}$$

$$= \frac{ML^{-3+1+1}T^{-1}}{ML^{-1}T^{-1}} = \frac{ML^{-1}T^{-1}}{ML^{-1}T^{-1}} = 1$$

(e)

$$[\text{Weber Number}] = \frac{\left(LT^{-1}\right)^2 \times L \times \left(ML^{-3}\right)}{MLT^{-2}/L}$$

$$= \frac{\left(L^2T^{-2}\right) \times L \times \left(ML^{-3}\right)}{MLT^{-2}/L} = \frac{MT^{-2}}{MT^{-2}} = 1$$

(1.5) $a^m a^n = a^{m+n}$

(1.7) $\left(a^m\right)^n = a^{m \times n}$