

$$68.2\% = \frac{1223 \text{ J}}{\text{Work in}} \times 100\%$$

$$\text{Work in} = 1793 \text{ J}$$

$$\begin{aligned} \text{Work required to overcome friction} \\ &= \text{work in} - \text{work out} \\ &= 1793 \text{ J} - 1223 \text{ J} \\ &= 570.3 \text{ J} \end{aligned}$$

$$\text{Work} = F_f d$$

$$\begin{aligned} F_f &= \frac{\text{Work}}{d} \\ &= \frac{570.3 \text{ J}}{5.00 \text{ m}} \\ &= 114 \text{ N} \end{aligned}$$

6. Although we define efficiency in terms of work, we can express it in terms of power.

$$\text{Efficiency} = \frac{\text{Power out}}{\text{Power in}} \times 100\%$$

$$\begin{aligned} \text{Power out} &= \frac{\text{Power out}}{t} = \frac{mgh}{t} \\ &= \frac{(1.30 \times 10^3 \text{ kg})(9.80 \text{ m/s}^2)(25.0 \text{ m})}{60.0 \text{ s}} \\ &= 5.31 \times 10^3 \text{ W} \end{aligned}$$

$$\begin{aligned} \text{Efficiency} &= \frac{5.31 \times 10^3 \text{ W}}{1.00 \times 10^4 \text{ W}} \times 100\% \\ &= 53.1\% \end{aligned}$$

### Additional Exercises

1.  $\text{Work} = mgh$   
 $= (12.0 \text{ N})(2.30 \text{ m})$   
 $= 27.6 \text{ J}$

2.

$v_0$	$v_f$	$a$	$d$	$t$
15.0 m/s	20.0 m/s	?	?	4.30 s

$$\begin{aligned} a &= \frac{v_f - v_0}{t} \\ &= \frac{20.0 \text{ m/s} - 15.0 \text{ m/s}}{4.30 \text{ s}} \\ &= 1.16 \text{ m/s}^2 \end{aligned}$$

$$\begin{aligned} F_{\text{net}} &= ma \\ &= (11.0 \text{ kg})(1.16 \text{ m/s}^2) \\ &= 12.8 \text{ N} \end{aligned}$$

$v_0$	$v_f$	$a$	$d$	$t$
15.0 m/s	20.0 m/s	1.16 m/s <sup>2</sup>	?	4.30 s

$$\begin{aligned} d &= \left( \frac{v_f - v_0}{2} \right) t \\ &= \left( \frac{20.0 \text{ m/s} + 15.0 \text{ m/s}}{2} \right) (4.30 \text{ s}) \\ &= 75.3 \text{ m} \end{aligned}$$

$$\begin{aligned} \text{Work} &= F_{\text{net}} d \\ &= (12.8 \text{ N})(75.3 \text{ m}) \\ &= 963 \text{ J} \end{aligned}$$

3.  $\text{Work} = F_f d$   
 $= (2.0 \text{ N})(6.0 \text{ m})$   
 $= 12 \text{ J}$

4.  $E_p = mgh$   
 $= (20.0 \text{ N})(2.0 \text{ m})$   
 $= 4.0 \times 10^1 \text{ J}$

5. Convert km/h to m/s  
 $\frac{(40.0 \text{ km/h})(1000 \text{ m/km})}{3600 \text{ s/h}} = 11.1 \text{ m/s}$

$$\begin{aligned} E_k &= \frac{1}{2} mv^2 \\ &= \frac{1}{2} (1250 \text{ kg})(11.1 \text{ m/s})^2 \\ &= 7.72 \times 10^4 \text{ J} \end{aligned}$$

6.  $v = \frac{d}{t}$

$$\begin{aligned} d &= vt \\ &= (1.2 \text{ m/s})(2.5 \text{ s}) \\ &= 3.0 \text{ m} \end{aligned}$$

$$\Delta E_k + \Delta E_p = 0$$

$$\frac{1}{2} m(v_f^2 - v_0^2) + mg\Delta h = 0$$

$$\frac{1}{2} (v_f^2 - v_0^2) + g\Delta h = 0$$

$$\frac{1}{2} (v_f^2 - 0) + (9.80 \text{ m/s}^2)(-3.0 \text{ m}) = 0$$

$$\begin{aligned} v_f &= \sqrt{2(-9.80 \text{ m/s}^2)(-3.0 \text{ m})} \\ &= 7.7 \text{ m/s} \end{aligned}$$