

**WORK-ENERGY THEOREM (p. 162)**

$$\text{work} = W = \Delta E = E_f - E_i$$

$$\text{energy} = E = mgy + \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$

1.

$$E = mgy + \frac{1}{2}mv^2 = 70(9.81)1.150 + \frac{1}{2}(70)12.00^2$$

$$= 789.7 + 5040 = 5830 \text{ joules} = 5.83 \text{ kJ}$$

3.

$$E = \frac{1}{2}mv^2 = \frac{1}{2}(60.0)2.00^2 = 120.0 \text{ J}$$

5.

$$E = \frac{1}{2}I\omega^2 = \frac{1}{2}(2.00) \left( 300 \frac{r}{\text{min}} \times \frac{2\pi}{1r} \times \frac{1 \text{ min}}{60s} \right)^2$$

$$= \frac{1}{2}(2.00)31.416^2 = 987 \text{ J}$$

7.

$$y = v \sin 20^\circ t = 6.00 \sin 20^\circ (60.0 \text{ s}) = 123.1 \text{ m}$$

$$W = E_f - E_i = mgy_f - mgy_i$$

$$= 50(9.81)123.1 - 0 = 490.5(123.1) = 60.4 \text{ kJ}$$

9.

$$W = E_f - E_i = 0 - E_i = 0 - \frac{1}{2}mv^2 = -\frac{1}{2}(25.0)5^2 = -313 \text{ J}$$

11. (a)

$$a = \frac{v_f - v_i}{t} = \frac{0 - 3}{4} = -0.750$$

$$s_f = s_i + \frac{v_f^2 - v_i^2}{2a} = \frac{0 - 3^2}{2(-0.75)} = \frac{-9.0}{-1.50} = 6.00 \text{ m}$$

(b)

$$\bar{F} = m\bar{a} = 20.0(-0.75) = -15.00 \text{ N}$$

(c)

$$W = Fs = -15.00(6.00) = -90.0 \text{ J}$$

## WORK of a FORCE or MOMENT of FORCE (p. 168-9)

$$W_{force} = Fs \cos \phi$$

$$W_{force} = \underline{F} \cdot \underline{s} = F_x s_x + F_y s_y$$

$$W_{moment} = M \theta = (Fr \sin \phi) \theta$$

1. (a)

$$W = Fs = 358 \times 0.517 = 185.1 \text{ J}$$

(b)

$$\begin{aligned} W &= F_x s_x + F_y s_y \\ &= 25.3 \times 1.325 + 63.2 \times 2.92 \\ &= 218 \text{ J} \end{aligned}$$

3.

$$\begin{aligned} W_{force} &= Fs \cos \phi \\ &= 35.0 (23.0) \cos 30^\circ = 697 \text{ J} \end{aligned}$$

5.

$$\begin{aligned} F_{normal} &= mg = 25.0(9.81) \\ &= 245.25 \text{ N} \\ F_{kinetic} &= F_{normal} \mu_{kinetic} \\ &= 245.25 \times 0.800 = 196.2 \text{ N} \\ W_{\mu=0.8} &= F_{kinetic} s = 196.2 \times 10.00 \\ &= 1962 \text{ J} \\ W_{\mu=0.2} &= 245.25 \times 0.2 \times 10.00 \\ &= 491 \text{ J} \end{aligned}$$

7.

$$\begin{aligned} W &= Fs = (Lg)s \\ &= 20(9.81)10(6.00) \\ &= 196.2(60.0) = 11772 \text{ J} \\ &= 11.77 \text{ kJ} \end{aligned}$$

9.

$$\begin{aligned} W &= Fs = (Lg)s \\ &= 3.50(9.81)4000 \\ &= 137340 \text{ J} = 137.3 \text{ kJ} \end{aligned}$$

11.

$$\begin{aligned} W &= mgy = 60(9.81)0.350 \\ &= 206 \text{ J} \end{aligned}$$

13. (a)

$$\begin{aligned} W_{total} &= mgy = 300(9.81)0.1500 \\ &= 441 \text{ J} \end{aligned}$$

(b)

$$\begin{aligned} W_{moment} &= M\theta = (Fd)\theta \\ &= (90.0 \times 0.600)(1 \text{ rad}) = 54.0 \text{ J} \end{aligned}$$

(c)

$$\begin{aligned} n &= W_{total} / W_{moment} \\ &= \frac{441}{54} = 8 \text{ and } 1/6 = 8.17 \text{ cycles} \end{aligned}$$

15. (a)

$$\begin{aligned} W &= E_f - E_i = 0 - \frac{1}{2} I \omega^2 \\ &= -\frac{1}{2} (0.450) 20.0^2 = -90.0 \text{ J} \end{aligned}$$

(b)

$$\begin{aligned} F_{friction} &= F_{normal} \mu_{kinetic} \\ &= -12.50(0.800) = -10.00 \text{ N} \\ \alpha &= \frac{M}{I} = \frac{Fd}{I} = \frac{10.00 \times 0.300}{0.450} \\ &= -6.667 \text{ rad/s}^2 \end{aligned}$$

$$t = \frac{\omega_f - \omega_i}{\alpha} = \frac{0 - 20.0}{-6.667} = 3.00 \text{ s}$$

**POWER (p. 173)**

$$P = W / t = \Delta E / t$$

$$P_{force} = Fv \cos\phi$$

$$P_{force} = \underline{F} \cdot \underline{v} = F_x v_x + F_y v_y$$

$$P_{moment} = M\omega$$

1.

$$s = 2 \times 70.0 \times 6.00 = 840 \text{ metres}$$

$$W_L = 10.00 \times 9.81 = 98.1 \text{ joules}$$

$$P = W_L s / t = 98.1(840) / (2 \times 60) \\ = 687 \text{ W}$$

3.

$$P = (W_L g) s / t = (3.5 \times 9.81) \times 4000 / (6 \times 60) = 382 \text{ W}$$

5.

$$P = 0$$

An isometric contraction does no mechanical work.

7.

$$\omega = 200 \frac{\text{deg}}{\text{s}} \times \frac{2\pi \text{ rad}}{360 \text{ deg}} = 3.49$$

$$P = M\omega = 50.0 \times 3.39 = 174.5 \text{ W}$$

9.

$$\omega = 3 \frac{r}{s} \times \frac{2\pi \text{ rad}}{1r} = 18.85 \text{ rad/s}$$

$$P = M\omega = 55.0 \times 18.85 = 1037 \text{ W}$$

11.

$$P = Fv = 225 \times 0.555 = 124.9 \text{ W}$$

$$W = Pt = 124.9 \times 3.50 = 437 \text{ J}$$

## CONSERVATION of MECHANICAL ENERGY (p. 178)

$$E_f = E_i = \text{constant}$$

1.

$$W_G = mgy = 75.0 \times 9.81 \times 3.00 = 2210 \text{ J}$$

$$\frac{1}{2}mv^2 = mgy$$

$$v = \sqrt{2gy} = \sqrt{2(9.81)3} = 7.67 \text{ m/s}$$

3.

$$E_f = E_i$$

$$\frac{1}{2}mv_f^2 + mgy_f = \frac{1}{2}mv_i^2 + mgy_i$$

$$\frac{1}{2}mv_f^2 + 0 = \frac{1}{2}(65.0)4.15^2 + 65.0(9.81)10.00$$

$$= 559.7 + 6376.5 = 6936 \text{ J}$$

$$v_f = \sqrt{\frac{2 \times 6936}{65.0}} = \sqrt{213.4} = 14.61 \text{ m/s}$$

5.

$$mgy = \frac{1}{2}mv^2$$

$$y = \frac{v^2}{2g} = \frac{5.50^2}{2(9.81)} = \frac{30.25}{19.62} = 1.542 \text{ m}$$

7.

$$W = mgy_{\text{top}} = \frac{1}{2}mv_{\text{takeoff}}^2$$

$$W = 60.0(9.81)0.452 = 266 \text{ J}$$

$$\frac{1}{2}mv_{\text{takeoff}}^2 = 266 \text{ J}$$

$$v_{\text{takeoff}} = \sqrt{\frac{2 \times 266}{60.0}} = \sqrt{8.868} = 2.98 \text{ m/s}$$

9.

$$mgy = \frac{1}{2}mv^2$$

$$mgy = (15.00 + 0.100)(9.81)(0.35) = 51.85 \text{ J}$$

$$\frac{1}{2}mv^2 = 51.85 \text{ J}$$

$$v = \sqrt{\frac{2 \times 51.85}{0.100}} = \sqrt{1036.9} = 32.2 \text{ m/s}$$