WORK-ENERGY THEOREM (p. 162)

$$\text{work} = W = \Delta E = E_f - E_i$$
$$\text{energy} = E = mgy + \tfrac{1}{2}mv^2 + \tfrac{1}{2}I\omega^2$$

1.

$$E = mgy + \tfrac{1}{2}mv^2 = 70(9.81)1.150 + \tfrac{1}{2}(70)12.00^2$$
$$= 789.7 + 5040 = 5830 \text{ joules} = 5.83 \text{ kJ}$$

3.

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

5.

$$E = \tfrac{1}{2}\text{Iw}^2 = \tfrac{1}{2}(2.00)\left(300\frac{r}{\min} \times \frac{2\pi}{1r} \times \frac{1\min}{60s}\right)^2$$
$$= \tfrac{1}{2}(2.00)31.416^2 = 987 \text{ J}$$

7.

$$y = v \sin 20^\circ t = 6.00 \sin 20^\circ (60.0 \text{ s}) = 123.1 \text{ m}$$
$$W = Ef - Ei = mgy_f - mgy_i$$
$$= 50(9.81)123.1 - 0 = 490.5(123.1) = 60.4 \text{ kJ}$$

9.

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

11. (a)

$$a = \frac{vf - vi}{t} = \frac{0-3}{4} = -0.750$$
$$s_f = s_i + \frac{v_f^2 - v_i^2}{2a} = \frac{0-3^2}{2(-0.75)} = \frac{-9.0}{-1.50} = 6.00 \text{ m}$$

(b)

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

(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)
$$W = F_x s_x + F_y s_y$$
$$= 25.3\times 1.325 + 63.2\times 2.92$$
$$= 218\text{ J}$$

3.
$$W_{force} = Fs\cos\phi$$
$$= 35.0\,(23.0)\cos 30^\circ = 697\text{ J}$$

5.
$$F_{normal} = mg = 25.0(9.81)$$
$$= 245.25\text{ N}$$
$$F_{kinetic} = F_{normal}\mu_{kinetic}$$
$$= 245.25\times 0.800 = 196.2\text{ N}$$
$$W_{\mu=0.8} = F_{kinetic}s = 196.2\times 10.00$$
$$= 1962\text{ J}$$
$$W_{\mu=0.2} = 245.25\times 0.2\times 10.00$$
$$= 491\text{ J}$$

7.
$$W = Fs = (Lg)s$$
$$= 20(9.81)10(6.00)$$
$$= 196.2(60.0) = 11772\text{ J}$$
$$= 11.77\text{ kJ}$$

9.
$$W = Fs = (Lg)s$$
$$= 3.50(9.81)4000$$
$$= 137\,340\text{ J} = 137.3\text{ kJ}$$

11.
$$W = mgy = 60(9.81)0.350$$
$$= 206\text{ J}$$

13. (a)
$$W_{total} = mgy = 300(9.81)0.1500$$
$$= 441\text{ J}$$

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

(c)
$$n = W_{total}/W_{moment}$$
$$= \frac{441}{54} = 8\text{ and }1/6 = 8.17\text{ cycles}$$

15. (a)
$$W = E_f - E_i = 0 - \tfrac{1}{2} I\omega^2$$
$$= -\tfrac{1}{2}(0.450)\,20.0^2 = -90.0\text{ J}$$

(b)
$$F_{friction} = F_{normal}\mu_{kinetic}$$
$$= -12.50(0.800) = -10.00\text{ N}$$
$$\alpha = \frac{M}{I} = \frac{Fd}{I} = \frac{10.00\times 0.300}{0.450}$$
$$= -6.667\text{ rad/s}^2$$
$$t = \frac{\omega_f - \omega_i}{\alpha} = \frac{0-20.0}{-6.667} = 3.00\text{ s}$$

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 <u>mechanical</u> work.

7.

$$\omega = 200\frac{\text{deg}}{s}\times\frac{2\pi \text{ rad}}{360 \text{ deg}} = 3.49$$
$$P = M\omega = 50.0\times 3.39 = 174.5 \text{ W}$$

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)

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

1.

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

$$½mv^2 = mgy$$

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

3.

$$E_f = E_i$$

$$½mv_f^2 + mgy_f = ½mv_i^2 + mgy_i$$

$$½mv_f^2 + 0 = ½(65.0)4.15^2 + 65.0(9.81)10.00$$

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

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

5.

$$mgy = ½\, mv^2$$

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

7.

$$W = mgy_{top} = ½\, mv_{takeoff}^2$$

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

$$½\, mv_{takeoff}^2 = 266\ \text{J}$$

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

9.

$$mgy = ½\, mv^2$$

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

$$½\, mv^2 = 51.85\ \text{J}$$

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