Chapter **05** (Bueche & Jerde) ***Work and Energy***

P04 $m = 1250$ kg, $\mu = 0.7$ & $\Delta x = 36$ m. $f_r = -mg\mu = -8.58\times10^3$ N & $W_f = -(mg\mu)(\Delta x) = -3.09\times10^5$ J .

P12 $m = 50$ kg, $s = 2.5$ m & $\theta = 36°$. $f_k = mg\sin\theta$, $W_f = -f_k s = -mgs\sin\theta = -720$ J .

P14 $P = F_x x/t = (50.0)(20.0)/(5.00) = 200$ (W) .

P20 $\Delta U/\Delta t = (\Delta m/\Delta t)gh = (0.6/60)(9.8)(3.0) = 0.294$ (W) $= 3.94\times10^{-4}$ (hp) .

P27 $m = 800$ kg, $v_1 = 15$ m/s & $v_2 = 20$ m/s: $W_1 = (½)m(v_2^2 - v_1^2) = 70{,}000$ J; $v_1 = 20$m/s & $v_2 = 25$ m/s, $W_2 = (½)m(v_2^2 - v_1^2) = 90{,}000$ J; $W_1/W_2 = 0.777$.

P32 (a) $m = 1.5$ g, $v_0 = 40$ m/s & $\Delta x = 5$ cm. $W = \Delta K$ or $F_d\Delta x = -(½)mv_0^2$, $F_d = W/\Delta x = -120/0.05 = -2400$ (N); (b) $\Delta x = (½)(v_i+v_f)\, t$, $0.05 = (½)(0 + 400)\, t$ or $t = 2.5\times10^{-4}$ s .

P38 $m = 75$ kg & $h = 600$ m: (a) $W = \Delta U_g = mgh = 4.41\times10^5$ J; (b) No; (c) $t = 96$min $= 5{,}760$ s, $P = W/t = 76.6$ J $= 0.103$ hp .

P47 $v = 45$ km/h $= 12.5$ m/s, $m = 6.4\times10^5$ kg & $s = 2.4$ km: (a) $W = (½)mv_f^2 + mgs\sin\theta = 5.00\times10^7 + 78.8\times10^7 = 83.8\times10^7$ (J); (b) $r = \Delta U/W = 7.88/8.38 = 0.940$; (c) $\underline{v} = 6.25$ m/s, $t = s/\underline{v} = 384$ s. (d) $P = W/t = 2182$ kW $= 2925$ hp .

P49 (a) $mgh = (½)mv_0^2$, $h = v_0^2/(2g) = 14^2/(2\times9.8) = 10.0$ (m); (b) $0 - (½)mv_0^2 = -(mgh + fh)$, $f = [(½)mv_0^2 - mgh]/h$, $f = (0.240)(4^2)/(2\times6.5) - (0.240)(9.8) = 3.62 - 2.35 = 1.27$ (N); (c) $(½)mv_f^2 - 0 = mgh - fh = (0.240)(9.8)(6.5) - (1.27)(6.5) = 7.04$, $v_f = 7.66$ m/s .

P51 $U_i = mgh$ & $K_i = 0$; $U_f = 0$, where $h = 4.0$ m and $v_f = 6$ m/s. $(E_i - E_f)/E_i = [mgh - (½)mv_f^2]/mgh = 1 - v_f^2/(2gh) = 1 - 0.459 = 0.541$.

P55 $\Delta K = -\Delta U$, or $mg\ell(1-\cos\theta_i) = (½)mv_f^2$, $v_f^2 = 2g\ell(1-\cos\theta_i)$, where $\ell = 3.6$ m and $\theta_i = 60°$, so $v_f = 5.94$ m/s .

P60 (a) AMA $= (240)(9.80)/180 = 13.1$; (b) % efficiency = (AMA/IMA)×100, IMA $= 13.1/0.870 = 15.0$; (c) IMA is defined to be $s_i/s_o = 15.0$.

P65 (a) The power to do useful work is $P = (0.330)(55.0) = 18.2$ (W). The belt speed is (16.0 rev/60.0 s)[$2\pi(0.0320)$ m/rev] $= 0.0536$ m/s. Then, the force $F = P/v = 339$ N; (b) The velocity is increased by 10,000, so the force is reduced by this same amount, $F = 0.0339$ N.

P68 Let $m_1 = m$, $m_2 = 0.80m$ & $m_3 = 0.50m$. $M \equiv m_1+m_2+m_3 = 2.3m$, $h_1 = 0.72$ m. Up: $a_1 = (m_2+m_3-m_1)g/M$, $v_1^2 = 2ah_1$, $v_1 = 1.36$ (m/s); Down: $(½)(m_1+m_2)\, v_1^2 = (½)(m_1+m_2)v_2^2 + m_2gh - m_1gh$, $(m_1+m_2)(m_2+m_3-m_1)gh/M + (m_1-m_2)gh = (½)(m_1+m_2)v_2^2$, $v_2^2 = 3.41$ or $v_2 = 1.85$ m/s .

P69 $m = 2.4$ kg, $\ell = 1.8$ m & $\theta = 30°$. (a) $W_F = F_{||}\ell = F\ell\cos\theta = (45)(1.8)(\cos30°) = 70.2$ (J); (b) $W_g = (-mg)(\ell\sin\theta) = -(2.4)(9.8)(1.8)(\sin30°) = -21.2$ (J); (c) $F_N = mg\cos\theta + F\sin\theta$, $W_f = -\mu_k F_N\ell = -9.25$ J; (d) $W_F + W_g + W_f = \Delta K$, $\Delta K = 39.7$ J .

P71 $\Delta K+\Delta U_g = W_{air}$ & $m = 60$ kg: (a) Using $h_1 = 1000$ m & $v_1 = 60$ m/s, $W_{air} = (½)mv_1^2 - mgh_1 = W_{air} = -480$ kJ; (b) Using $h_2 = 800$ m, $W_{air} = -mgh_2 = -(60)(9.8)(800) = -470$ (kJ) .