Answers, Even-Numbered Problems, Chapter 6

6.2. **(a)** When the cable is horizontal, $W = 4.25\times 10^{6}\ \text{J}$. When the cable is $35.0°$ above the horizontal, $W = 3.48\times 10^{6}\ \text{J}$.

(b) $-4.26\times 10^{6}\ \text{J}$ and $-3.48\times 10^{6}\ \text{J}$.

(c) $W = 0$ in both cases.

6.4.

(a) $99.2\ \text{N}$

(b) $387\ \text{J}$

(c) $W_f = -387\ \text{J}$

(d) T $W_n = 0.\ W_w = 0$

(e) $W_{\text{tot}} = 0$

6.6. $2.62\times 10^{9}\ \text{J}$

6.8. $-150\ \text{J}$.

6.10. **(a)** $3.18\times 10^{5}\ \text{J}$

(b) $K_2 = K_1 / 4$. The change in kinetic energy is a decrease of $\frac{3}{4}K_1$.

(c) $46\ \text{mi/h} = 74\ \text{km/hr} = 20.6\ \text{m/sec}$.

6.12. **(a)** Walking: $K = 150\ \text{J}$. Running: $K = 1400\ \text{J}$.

(b) $2.2\times 10^{-18}\ \text{J}$.

(c) $16\ \text{J}$.

(d) $2.6\ \text{m/s}$. Yes, this is reasonable.

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6.14. .

(a) $W_{\text{grav}} = 1180\ \text{J}$

(b) $1180\ \text{J}; 22.2\ \text{m/s}$.

(c) The answer in (a) would be unchanged and both answers in (b) would decrease.

6.16.

(a) $30.3\ \text{m/s}$

(b). $46.8\ \text{m}$.

6.18. **(a)** $W_{||} = mgh$. $W_{\perp} = 0$, $W_{mg} = W_{||} + W_{\perp} = mgh$, same as falling height *h*.

(b) $W_{\text{tot}} = K_2 - K_1$ gives $mgh = \frac{1}{2}mv^2$ and $v = \sqrt{2gh}$, same as if had been dropped from height *h*. **(c)** $h = 15.0 \text{ m}$, so

(c) 17.1 sec

6.20. $W = -\frac{15}{16}K_1$

(b) No

6.22. 0.168 m

6.24.

(a) -28.4 J.

(b) 15.3 m/s.

(c) No;

6.26 2.97 m/s.

6.28. **(a)** $2.67 \times 10^4 \text{ N/m}$.

(b) 801 N.

(c) 21.4 J; 1070 N.

6.30. **(a)** 40 J.

(b) 20 J.

(c) 60 J.

6.32. -209 J.

6.34. **(a)** 800 N.

(b) 1600 N.

6.36. **(a)** 0.060 J.

(b) 0.18 m/s.

6.38. **(a)**, 2.00 m/s.

(b) 2.00 m/s.

(c) 1.73 m/s.

6.40. **(a)** $2k$.

(b) $k_{\text{seg}} = 3k$, where k_{seg} is the force constant of each segment.

6.42. 0.53 m.

6.44.

(a) $3.2 \times 10^{11} \text{ W}$.

(b) 1.1 kW/person.

(c) 800 km^2.

6.46. 157 W

6.48. $0.23 = 23\%$

6.50 28 passengers can ride.

6.52. $8.1 \times 10^6 \text{ N}$.

6.54. $P_{\text{av}} = 0.20 \text{ W}$.

6.56. **(a)**.. $3.55 \times 10^{18} \text{ J}$.

(b). 56.5 devices.

6.58. **(a** 3.92 J/kg.

(b) 5.6%.

(c) 2.8%.

(d) If both the man and the child can do work at the rate of 70 J/kg, and if the child only needs to use 1.96 J/kg instead of 3.92 J/kg, the child should be able to do more chin-ups.

6.60. **(a)**.20.0 N block: $W_{\text{tot}} = Ts = (7.50 \text{ N})(0.750 \text{ m}) = 5.62 \text{ J}$.

12.0 N block: $W_{\text{tot}} = (w_B - T)s = (12.0 \text{ N} - 7.50 \text{ N})(0.750 \text{ m}) = 3.38 \text{ J}$

(b)

20.0 N block: 2.58 J.

12.0 N block: 1.54 J.

6.62. **(a)** -22.3 J

(b) $15.3\ \text{J}$.
(c) The normal force does no work.
(d) $-7.0\ \text{J}$.
(e), $1.4\ \text{m}/\text{s}$.

6.64. **(a)** $\dfrac{1}{k_{\text{eff}}} = \dfrac{1}{k_1} + \dfrac{1}{k_2}$.

(b) $\dfrac{1}{k_{\text{eff}}} = \dfrac{1}{k_1} + \dfrac{1}{k_2} + \cdots + \dfrac{1}{k_N}$.

6.66. $11{,}000\ \text{m/s}$

6.68. **(a)** $W = \dfrac{k}{2}x_2^2 - \dfrac{b}{3}x_2^3 + \dfrac{c}{4}x_2^4$. When $x_2 = 0.050\ \text{m}$, $W = 0.12\ \text{J}$.

(b) When $x_2 = -0.050\ \text{m}$, $W = 0.17\ \text{J}$.

(c) It's easier to stretch the spring; the quadratic $-bx^2$ term is always in the $-x$-direction, and so the needed force, and hence the needed work, will be less when $x_2 > 0$.

6.70. (a) $2.41 \times 10^5\ \text{m/s}$.
(b) $2.82 \times 10^{-10}\ \text{m}$.
(c) $3.00 \times 10^5\ \text{m/s}$.

6.72. $0.01875\ \text{s}$. $\dfrac{\Delta W}{\Delta t} = \dfrac{7.84 \times 10^5\ \text{J}}{0.01875\ \text{s}} = 4.18 \times 10^7\ \text{W}$

6.74. **(a)** $W = \displaystyle\int_{x_0}^{\infty} \frac{b}{x^n}\,dx = \left.\frac{b}{(n-1))x^{n-1}}\right|_{x_0}^{\infty} = \frac{b}{(n-1)x_0^{n-1}}$. Note that for this part, for $n > 1$, $x^{1-n} \to 0$ as $x \to \infty$.

(b) When $0 < n < 1$, the improper integral must be used,
$W = \displaystyle\lim_{x_2 \to \infty}\left[\frac{b}{(n-1)}(x_2^{n-1} - x_0^{n-1})\right]$, and because the exponent on the x_2^{n-1} is positive, the limit does not exist, and the integral diverges. This is interpreted as the force *F* doing an infinite amount of work, even though $F \to 0$ as $x_2 \to \infty$.

6.76. **(a)** $6.93\ \text{m/s}$.
(b) $4.90\ \text{m/s}$.
(c). $0.0150\ \text{m}$; $5.20\ \text{m/s}$

6.78 $6.58\ \text{m/s}$.

6.80. $3.17\ \text{m/s}$.

6.82. $2.90\ \text{m/s}$.

6.84. $89\ \text{m/s}$.

6.86. $390\ \text{W}$.

6.88. $P = (0.96\ \text{N/s})t + (0.43\ \text{N/s}^2)t^2 + (0.043\ \text{N/s}^3)t^3$. At $t = 4.00\ \text{s}$, the power output is 13.5 W.

6.90. **(a)** $1.75\ \text{J/s}$. At 10 beats/s, the bird must expend between 0.07 J/beat and 0.175 J/beat.
(b) The steady output of the athlete is $(500\ \text{W})/(70\ \text{kg}) = 7\ \text{W/kg}$, which is below the 10 W/kg necessary to stay aloft. Though the athlete can expend $1400\ \text{W}/70\ \text{kg} = 20\ \text{W/kg}$ for short periods of time, no human-powered aircraft could stay aloft for very long.

6.92. **(a)** $v = \sqrt{\dfrac{2Pt}{m}}$.

(b) $a = \dfrac{dv}{dt} = \sqrt{\dfrac{P}{2mt}}$.

(c) $x - x_0 = \int v\ dt = \sqrt{\dfrac{8P}{9m}}t^{\frac{3}{2}}$.

6.94. **(a)** 177, rounding down to the nearest integer.

(d) The total number of cars is 36, rounding to the nearest integer.

6.96. **(a)**. $15.0\ \text{J}$

(b), no work is done moving in the *y*-direction.
(c) $10.0\ \text{J}$.

6.98. **(a)** $1.68 \times 10^3\ \text{N}$.

(b) $10.3\ \text{kW} = 13.8\ \text{hp}$.

(c) $114.8\ \text{kW} = 154\ \text{hp}$.

6.102. **(a)** $32.9\ \mathrm{m/s} = 118\ \mathrm{km/h}$.

(b) $25\ \mathrm{m/s} = 90\ \mathrm{km/h}$.

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