Honors Physics - Chapter 4 Practice Answers

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1)

$m = 3.10 \times 10^2$ kg
$g = 9.81$ m/s^2
$\theta_1 = 30.0°$
$\theta_2 = -30.0°$

$F_{x,net} = \Sigma F_x = F_{T,1}(\sin \theta_1) + F_{T,2}(\sin \theta_2) = 0$

$F_{y,net} = \Sigma F_y = F_{T,1}(\cos \theta_1) + F_{T,2}(\cos \theta_2) + \text{Fg} = 0$

$F_{T,1}(\sin 30.0°) = -F_{T,2}[\sin(-30.0°)]$

$F_{T,1} = F_{T,2}$

$F_{T,1}(\cos \theta_1) + F_{T,1}(\cos \theta_2) = -F_g = mg$

$F_{T,1}(\cos 30.0°) + F_{T,1}[\cos(-30.0°)] = (3.10 \times 10^2 \text{ kg})(9.81 \text{ m/s}^2)$

$$F_{T,1} = \frac{(3.10 \times 10^2 \text{ kg})(9.81 \text{ m/s}^2)}{(2)(\cos 30.0°)[\cos(-30.0°)]}$$

$F_{T,1} = F_{T,2} = \boxed{1.76 \times 10^3 \text{ N}}$

As the angles θ_1 and θ_2 become larger, cos θ_1 and cos θ_2 become smaller. Therefore, $F_{T,1}$ and $F_{T,2}$ must become larger in magnitude.

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2)

$v_i = 173$ km/h
$v_f = 0$ km/h
$\Delta x = 0.660$ m
$m = 70.0$ kg
$g = 9.81$ m/s^2

$$a = \frac{v_f^2 - v_i^2}{2\Delta x} = \frac{[(0 \text{ km/h})^2 - (173 \text{ km/h})^2](10^3 \text{ m/km})^2(1 \text{ h}/3600 \text{ s})^2}{(2)(0.660 \text{ m})}$$

$a = -1.75 \times 10^3$ m/s^2

$F = ma = (70.0 \text{ kg})(-1.75 \times 10^3 \text{ m/s}^2) = \boxed{-1.22° \times 10^5 \text{ N}}$

$F_g = mg = (70.0 \text{ kg})(9.81 \text{ m/s}^2) = \boxed{6.87 \times 10^2 \text{ N}}$

The force of deceleration is nearly 178 times as large as David Purley's weight.

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3)

$m = 2.65$ kg
$\theta_1 = \theta_2 = 45.0°$
$a_{net} = 2.55$ m/s^2
$g = 9.81$ m/s^2

$F_{x,net} = F_{T,1}(\cos \theta_1) - F_{T,2}(\cos \theta_2) = 0$

$F_{T,1}(\cos 45.0°) = F_{T,2}(\cos 45.0°)$

$F_{T,1} = F_{T,2}$

$F_{y,net} = ma_{net} = F_{T,1}(\sin \theta_1) + F_{T,2}(\sin \theta_2) - mg$

$F_T = F_{T,1} = F_{T,2}$

$\theta = \theta_1 = \theta_2$

$F_T(\sin \theta) + F_T(\sin \theta) = m(a_{net} + g)$

$2F_T(\sin \theta) = m(a_{net} + g)$

$$F_T = \frac{m(a_{net} + g)}{2(\sin \theta)} = \frac{(2.65 \text{ kg})(2.55 \text{ m/s}^2 = 9.81 \text{ m/s}^2)}{(2)(\sin 45.0°)}$$

$$F_T = \frac{(2.65 \text{ kg})(12.36 \text{ m/s}^2)}{(2)(\sin 45.0°)} = 23.2 \text{ N}$$

$F_{T,1} = 23.2$ N

$F_{T,2} = 23.2$ N

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4)

$m_{max} = 70.0$ kg

$m = 45.0$ kg

$g = 9.81$ m/s^2

$$F_{max} = m_{max}g = F_T$$

$$F_{max} = (70.0 \text{ kg})(9.81 \text{ m/s}^2) = 687 \text{ N}$$

$$F_{net} = ma_{net} = F_T - mg = F_{max} - mg$$

$$a_{net} = \frac{F_{max}}{m} - g = \frac{687 \text{ N}}{45.0 \text{ kg}} - 9.81 \text{ m/s}^2 = 15.3 \text{ m/s}^2 - 9.81 \text{ m/s}^2 = 5.5 \text{ m/s}^2$$

$$\mathbf{a_{net}} = \boxed{5.5 \text{ m/s}^2 \text{ upward}}$$

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5)

$m = 3.00 \times 10^3$ kg

$F_{applied} = 4.00 \times 10^3$ N

$\theta = 20.0°$

$F_{opposing} = (0.120)\ mg$

$g = 9.81$ m/s^2

$$F_{net} = ma_{net} = F_{applied}(\cos\theta) - F_{opposing}$$

$$a_{net} = \frac{F_{applied}(\cos\theta) - (0.120)\ mg}{m}$$

$$a_{net} = \frac{(4.00 \times 10^3 \text{ N})(\cos 20.0°) - (0.120)(3.00 \times 10^3 \text{ kg})(9.81 \text{ m/s}^2)}{3.00 \times 10^3 \text{ kg}}$$

$$a_{net} = \frac{3.76 \times 10^3 \text{ N} - 3.53 \times 10^3 \text{ N}}{3.00 \times 10^3 \text{ kg}} = \frac{2.3 \times 10^2 \text{ N}}{3.00 \times 10^3 \text{ kg}}$$

$$a_{net} = \boxed{7.7 \times 10^{-2} \text{ m/s}^2}$$

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6)

$m = 409$ kg

$d = 6.00$ m

$\theta = 30.0°$

$g = 9.81$ m/s^2

$F_{applied} = 2080$ N

$v_i = 0$ m/s

a. $F_{net} = F_{applied} - mg(\sin\theta) = 2080 \text{ N} - (409 \text{ kg})(9.81 \text{ m/s}^2)(\sin 30.0°)$

$F_{net} = 2080 \text{ N} - 2010 \text{ N} = 70 \text{ N}$

$\mathbf{F_{net}} = \boxed{70 \text{ N at } 30.0° \text{ above the horizontal}}$

b. $a_{net} = \dfrac{F_{net}}{m} = \dfrac{70 \text{ N}}{409 \text{ kg}} = 0.2 \text{ m/s}^2$

$\mathbf{a_{net}} = \boxed{0.2 \text{ m/s}^2 \text{ at } 30.0° \text{ above the horizontal}}$

c. $d = v_i\Delta t + \frac{1}{2}a_{net}\Delta t^2 = (0 \text{ m/s})\Delta t + \frac{1}{2}(0.2 \text{ m/s}^2)\Delta t^2$

$$\Delta t = \sqrt{\frac{(2)(6.00 \text{ m})}{(0.2 \text{ m/s}^2)}} = \boxed{8 \text{ s}}$$

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7)

$m = 25.0$ kg

$F_{applied} = 59.0$ N

$\theta = 38.0°$

$\mu_s = 0.599$

$g = 9.81$ m/s^2

$$F_{s,max} = \mu_s F_m$$

$$F_n = mg(\cos\theta) + F_{applied}$$

$$F_{s,max} = \mu_s[mg(\cos\theta) = F_{applied}] = (0.599)[(25.0 \text{ kg})(9.81 \text{ m/s}^2)(\cos 38.0° + 59.0 \text{ N}]$$

$$F_{s,max} = (0.599)(193 \text{ N} + 59 \text{ N}) = (0.599)(252 \text{ N}) = \boxed{151 \text{ N}}$$

Alternatively,

$$F_{net} = mg(\sin\theta) - F_{s,max} = 0$$

$$F_{s,max} = mg(\sin\theta) = (25.0 \text{ kg})(9.81 \text{ m/s}^2)(\sin 38.0°) = \boxed{151 \text{ N}}$$

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8) $\theta = 5.2°$

$g = 9.81\ \text{m/s}^2$

$$F_{net} = mg(\sin\theta) - F_k = 0$$
$$F_k = \mu_k F_n = \mu_k mg(\cos\theta)$$
$$\mu_k mg(\cos\theta) = mg(\sin\theta)$$
$$\mu_k = \frac{\sin\theta}{\cos\theta} = \tan\theta = \tan 5.2°$$
$$\mu_k = \boxed{0.091}$$

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9) $F_{applied} = 1.13 \times 10^8\ \text{N}$

$\mu_s = 0.741$

$$F_{net} = F_{applied} - F_{s,max} = 0$$
$$F_{s,max} = \mu_s F_n = \mu_s mg$$
$$m = \frac{F_{applied}}{\mu_s g} = \frac{1.13 \times 10^8\ \text{N}}{(0.741)(9.81\ \text{m/s}^2} = \boxed{1.55 \times 10^2\ \text{kg}}$$

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10) $F_{net} = 6.99 \times 10^3\ \text{N}$

$\theta = 45.0°$

$\mu_k = 0.597$

$$F_{net} = ma_{net} = mg(\sin\theta) - F_k$$
$$F_k = \mu_k F_n = \mu_k mg(\cos\theta)$$
$$m[g(\sin\theta) - \mu_k g(\cos\theta)] = F_{net}$$
$$m = \frac{F_{net}}{g[\sin\theta - \mu_k(\cos\theta)]} = \frac{6.99 \times 10^3\ \text{N}}{(9.81\ \text{m/s}^2)[(\sin 45.0°) - (0.597)(\cos 45.0°)]}$$
$$m = \frac{6.99 \times 10^3\ \text{N}}{(9.81\ \text{m/s}^2)(0.707 - 0.422)} = \frac{6.99 \times 10^3\ \text{N}}{(9.81\ \text{m/s}^2)(0.285)}$$
$$m = \boxed{2.50 \times 10^3\ \text{kg}}$$
$$F_n = mg(\cos\theta) = (2.50 \times 10^3\ \text{kg})(9.81\ \text{m/s}^2)(\cos 45.0°) = \boxed{1.73 \times 10^4\ \text{N}}$$

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11) $m = 1.89 \times 10^5\ \text{kg}$

$F_{applied} = 7.6 \times 10^5\ \text{N}$

$a_{net} = 0.11\ \text{m/s}^2$

$$F_{net} = ma_{net} = F_{applied} - F_k$$
$$F_k = F_{applied} - ma_{net} = 7.6 \times 10^5\ \text{N} - (1.89 \times 10^5)(0.11\ \text{m/s}^2) = 7.6 \times 10^5\ \text{N} - 2.1 \times 10^4\ \text{N}$$
$$F_k = \boxed{7.4 \times 10^5\ \text{N}}$$
