

RESOLUTION of FORCES into COMPONENTS (p. 33)

$$W = \text{weight} = mg \qquad F_G = \frac{Gm_1m_2}{r^2}$$

$$F_x = F \cos \theta \qquad F_y = F \sin \theta$$

1.

$$W = mg = 50.5 \times 9.81 = 495 \text{ N}$$

3.

$$150 \text{ lbs.} \times \frac{1 \text{ kg}}{2.2045 \text{ lbs}} = 68.2 \text{ kg}$$

$$W = mg = 68.2 \times 9.81 = 669 \text{ N}$$

5.

$$m = \frac{W}{g} = \frac{625}{9.81} = 63.7 \text{ kg}$$

7.

$$(a) \quad \underline{R} = (25 + 10 + 4.53, 30 + 12 - 1.56) = (39.5, 40.4)$$

$$(b) \quad \underline{R} = (3 \times 4.53 - 1.25, 3 \times -1.56 - 5) = (12.34, -9.68)$$

$$(c) \quad \underline{R} = (0 - 10 - 1.25, 10 - 12 - 5) = (-11.25, -7.00)$$

$$(d) \quad \underline{R} = (4.53 + 2(-1.25) - 0, -1.56 + 2(-5) - 10) = (2.03, -21.6)$$

$$(e) \quad \underline{R} = \left[\frac{1}{2}(4.53) + 5.6, \frac{1}{2}(-1.56 - 2) \right] = (7.87, -2.78)$$

$$(f) \quad \underline{R} = \left[\frac{1}{4}(2.53 + 10), \frac{1}{4}(30 + 12) \right] = (8.75, 10.50)$$

$$(g) \quad \underline{R} = (-1.25 - 10 + 0, -5 - 12 + 10) = (-11.25, -7.00)$$

$$(h) \quad \underline{R} = -[(10 - 25), (12 - 30)] = (15.00, 18.00)$$

9.

$$F_{\text{moon}} = \frac{1}{6}(9.81)60.0 = 98.1 \text{ N}$$

$$m_{\text{space}} = 60.0 \text{ kg}$$

$$F_{\text{space}} = 0.00 \text{ N}$$

11.

$$g = \frac{G \times m_{\text{mars}}}{r_{\text{mars}}^2}$$

$$= 6.673 \times 10^{-11} \times \frac{6.419 \times 10^{23}}{(3.396 \times 10^6)^2}$$

$$= 3.71 \text{ m/s}^2$$

MOMENT of FORCE (p. 42-3)

$$M = Fd$$

$$M = rF \sin \theta$$

1.

$$F = \frac{M}{d} = \frac{500}{1.650} = 303 \text{ N}$$

3. (a)

$$R = \Sigma F = -50.0 - 25.0 + 125.0 - 50.0 = 0.00 \text{ N}$$

(b)

$$M_R = \Sigma F_i d_i = 50.0(0.0) - 25.0(0.05) + 125.0(0.15) - 50.0(0.25)$$

$$= 0 - 1.25 + 18.75 - 12.50 = 5.00 \text{ N.m}$$

(c)

$$\Sigma M_A = 0$$

$$\therefore 125.0(d_C) - 50.0(0.0) - 25.0(0.05) - 50.0(0.25) = 0$$

$$125.0(d_C) = 0.0 + 25.0(0.05) + 50.0(0.25)$$

$$d_C = (1.25 + 12.50)/125.0 = 0.1100$$

The force at C should be moved 11.00 cm to the right of A.

5. (a)

$$\Sigma M = 200(2.50) - 250(2.20) = -50.0$$

Therefore, Cathy will go up.

(b) Jill must move 20.0 cm towards Cathy so the two moments are equal.

(c)

$$\Sigma M = 0$$

$$\therefore 200(2.50) - 250(2.20) - 150.0(d) = 0$$

$$d = \frac{-50.0}{-150.0} = 0.333$$

Therefore, Ian must sit 33.3 cm from fulcrum on Cathy's side.

7. (a) $M_A = Fd = -300(0.25) = -75.0 \text{ N.m}$ (b) $M_A = F_C \cos \theta (0.20) = -200(\cos 20^\circ)(0.20) = -35.6 \text{ N.m}$

Note, vertical component at C cancels vertical component at D and horizontal component at D has no moment about axis at A.

9. $M = Fd = 56.5(0.650) = 36.7 \text{ N.m}$

LAWS of STATICS (p. 58-60)

$$\begin{array}{ll} \Sigma F_x = 0 & \underline{M} = \underline{r} \times \underline{F} = (r_x F_y - r_y F_x) \underline{k} \\ \Sigma F_y = 0 & \Sigma \underline{F} = \underline{0} \\ \Sigma M_A = 0 & \Sigma \underline{M} = \Sigma(\underline{r} \times \underline{F}) = \underline{0} \end{array}$$

1. (a)

$$\underline{M} = (0.35 \times 80.0 - 0.20 \times 50.0) = 18.00 \underline{k} \text{ N.m}$$

(b)

$$\underline{M} = (0.35 \times 20.0 - 0.20 \times -30.0) = 13.00 \underline{k} \text{ N.m}$$

(c)

$$\underline{M} = [-0.10 \times (80.0 + 20.0) - 0.30 \times (50.0 - 30.0)] = -16.00 \underline{k} \text{ N.m}$$

(d)

$$M = (-0.10 \times 20.0 - 0.30 \times 20.0) = 7.00 \text{ N.m}$$

(e)

$$M = (1.250 \times -50.0 - 2.50 \times 85.0) = -275 \text{ N.m}$$

(f)

$$\underline{M} = (-0.10 \times -50.0 - 0.30 \times 85.0) = -20.5 \underline{k} \text{ N.m}$$

3.

$$\underline{F} = (F \cos \theta, F \sin \theta) = (56.3 \cos 34.3^\circ, 56.3 \sin 34.3^\circ) = (46.51, 31.73)$$

$$\underline{M} = (0.1366 \times 31.73 - 0.205 \times 46.51) = -5.20 \underline{k} \text{ N.m}$$

5. (a)

$$M = (4.00 \times 35.0 - 8.00 \times 25.0) = -60.0 \text{ N.cm} = -0.600 \text{ N.m}$$

(b)

$$M = (-4.00 \times 35.0 - 8.00 \times 25.0) = -340 \text{ N.cm} = -3.40 \text{ N.m}$$

(c)

$$M = (4.00 \times 35.0 - (-8.00) \times 25.0) = 340 \text{ N.cm} = -3.40 \text{ N.m}$$

(d)

$$M = (-4.00 \times 35.0 - (-8.00) \times 25.0) = 60.0 \text{ N.cm} = 0.600 \text{ N.m}$$

7.

$$C = \frac{L \times F_A}{mg} = \frac{2.00 \times 300}{60.0(9.81)} = 1.019 \text{ m} = 101.9 \text{ cm}$$

9.

$$\Sigma F_x = F_{g_x} + F_{knee_x} = 0$$

$$\Sigma F_y = F_{g_y} + F_{knee_y} - mg = 0$$

$$\Sigma M_{cg} = M_{knee} + (\underline{r}_{knee} \times \underline{F}_{knee}) + (\underline{r}_g \times \underline{F}_g) = 0$$

15.

$$\Sigma F_y = 0: 2F_{cable} - mg = 0$$

$$F_{cable} = \frac{80.0(9.81)}{2} = 392 \text{ N per cable}$$

17. (a)

jacking up a car, prying with a bottle opener, shoveling

(b)

throwing a dart, kicking, jumping

21.

$$\Sigma F_x = 0: -F_{1x} + F_{2x} = 0$$

$$F_{1x} = F_{2x}$$

$$F_{2x} = 200 \cos 30^\circ = 173.2 \text{ N}$$

$$\Sigma F_y = 0: F_{1y} + F_{2y} - W = 0$$

$$F_{1x} = F_{2x} + mg = -200 \sin 30^\circ + 400 = 300 \text{ N}$$

23.

$$\Sigma F_x = 0: F_{knee_x} - F_{load_x} = 0$$

$$F_{knee_x} = F_{load_x}$$

$$F_{knee_x} = 250 \cos 30^\circ = 217 \text{ N}$$

$$\Sigma F_y = 0: F_{knee_y} - F_{load_y} - W = 0$$

$$F_{knee_x} = F_{load_x} + mg = 250 \sin 30^\circ + 40.0 = 165 \text{ N}$$