## RESOLUTION of FORCES into COMPONENTS (p. 33)

| | |
|---|---|
| $W = \text{weight} = mg$ | $F_G = \dfrac{Gm_1m_2}{r^2}$ |
| $F_x = F\cos\theta$ | $F_y = F\sin\theta$ |

1.

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

3.

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

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

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.

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

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

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

11.

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

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

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

## 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) $M_A = F_C \cos\theta(0.20) = -200(\cos 20^O)(0.20) = -35.6 \text{ N.m}$
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)

| | |
|---|---|
| $\Sigma F_x = 0$ | $\underline{M} = \underline{r} \times \underline{F} = (r_x F_y - r_y F_x)\underline{k}$ |
| $\Sigma F_y = 0$ | $\Sigma \underline{F} = \underline{0}$ |
| $\Sigma M_A = 0$ | $\Sigma \underline{M} = \Sigma(\underline{r} \times \underline{F}) = \underline{0}$ |

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.

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

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

17. (a)

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

(b)

throwing a dart, kicking, jumping

21.

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

$$F_{1_x} = F_{2_x}$$

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

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

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

23.

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

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

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

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

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