PHYS 2311 Ch. 5 HW

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Problem 1.

$$\mu_k = 0.30$$

$$m = 26\,\text{kg}$$

$$F_N = (26)(9.8) = 254.8\,\text{N}$$

$$f_s = \mu_k F_N = (0.30)(254.8) = \boxed{76\,\text{N}}$$

$$\mu_k = 0, f_s = (0)(254.8) = \boxed{0\,\text{N}}$$

Problem 2.

(a)

$$F_{fr} = 35.0\,\text{N}$$

$$m = 4.0\,\text{kg}$$

$$F_N = (4.0)(9.8) = 39.2\,\text{N}$$

$$F_{fr} = \mu_s F_N$$

$$35.0 = \mu_s(39.2)$$

$$\mu_s = \boxed{0.89}$$

(b)

$$f_k = \mu_k F_N$$

$$F_{net} = F_{app} - f_k$$

$$ma - F_{app} = -f_k$$

$$ma - F_{app} = -\mu_k F_N$$

$$\frac{ma - F_{app}}{-F_N} = \mu_k$$

$$\mu_k = \frac{(4.0)(0.60) - 35.0}{-39.2}$$

$$\mu_k = \boxed{0.83}$$

Problem 3.

$$a = 0.20g$$

$$F_{fr} \leq \mu_s F_N$$
$$\frac{F_{fr}}{F_N} \leq \mu_s$$
$$\frac{ma}{mg} \leq \mu_s$$
$$\frac{a}{g} \leq \mu_s$$
$$\mu_s \geq \boxed{0.20}$$

Problem 6.

a_{nf} meaning "no friction" or frictionless acceleration.

$$m = 25.0\,\text{kg}$$

$$a = 0.36\,\text{m/s}^2$$

$$a_{nf} = g\sin\theta$$

$$\vec{F}_{net} = f_k + F_1$$
$$ma = f_k + ma_{nf}$$
$$f_k = ma_{nf} - ma$$
$$f_k = (25.0)((9.8)\sin(27)) - (25.0)(0.36) = \boxed{102\,\text{N}}$$

$$F_N = mg\cos\theta$$

$$f_k = \mu_k F_N$$
$$\mu_k = \frac{f_k}{F_N} = \frac{f_k}{mg\cos\theta} = \frac{102}{(25.0)(9.8)\cos(27)} = \boxed{0.47}$$

Problem 7.

$$a_x = -3.80\,\text{m/s}^2, \quad \theta = 9.3^\circ$$

$$F_N = mg$$

$$f_s = \mu_s F_N$$

$$ma_x = \mu_s mg$$

$$a_x = \mu_s g$$

$$\mu_s = \frac{a_x}{g} = \left|\frac{(-3.80)}{9.8}\right| = 0.388$$

$$F_N = mg\cos\theta$$

$$\Sigma F = F_g - f_k$$

$$\Sigma F = mg\sin\theta + \mu_s mg\cos\theta$$

$$a = \frac{\Sigma F}{m}$$

$$a = g\sin\theta + \mu_s g\cos\theta$$

$$a = (9.8)\sin(9.3) + (0.388)(9.8)\cos(9.3) = \boxed{5.3\,\mathrm{m/s^2}}$$

Problem 19.

(a)

$$\mu_k = 0.18, \quad m_1 = 65\,\mathrm{kg}, \quad m_2 = 125\,\mathrm{kg}$$

$$f_k = \mu_k F_N$$

$$\Sigma F = F_{app} - f_k$$

$$ma = F_{app} - \mu_k F_N$$

$$a = \frac{F_{app} - \mu_k mg}{m} = \frac{650 - (0.18)(190)(9.8)}{190} = \boxed{1.7\,\mathrm{m/s^2}}$$

(b)

$$F_{12} = f_{k2} + m_2 a$$

$$F_{12} = \mu_k mg + m_2 a = (0.18)(125)(9.8) + (125)(1.7) = \boxed{430\,\mathrm{N}}$$

(c)

$$\mu_k = 0.18, \quad m_1 = 125\,\mathrm{kg}, \quad m_2 = 65\,\mathrm{kg}$$

$$f_k = \mu_k F_N$$

$$\Sigma F = F_{app} - f_k$$

$$ma = F_{app} - \mu_k F_N$$

$$a = \frac{F_{app} - \mu_k mg}{m} = \frac{650 - (0.18)(190)(9.8)}{190} = \boxed{1.7\,\mathrm{m/s^2}}$$

$$F_{12} = f_{k2} + m_2 a$$

$$F_{12} = \mu_k mg + m_2 a = (0.18)(65)(9.8) + (65)(1.7) = \boxed{220\,\mathrm{N}}$$

Problem 23.

$$\mu_s = 0.40, \quad \mu_k = 0.30$$

(a)

$$f_s = \mu_s F_N$$
$$f_s = \mu_s m_A g$$
$$F_B = m_b g$$
$$\mu_s m_A g = m_B g$$
$$m_A = \frac{m_B}{\mu_s} = \frac{2.0}{0.40} = \boxed{5.0\,\text{kg}}$$

(b)

$$a = 0, \quad \Sigma F = 0$$
$$\Sigma F = F_A + F_B = 0$$
$$\mu_k m_A g - m_B g = 0$$
$$m_A = \frac{m_B}{\mu_k} = \frac{2.0}{0.30} = \boxed{6.7\,\text{kg}}$$

Problem 35.

$$m = 1200\,\text{kg}, \quad r = 90.0\,\text{m}, \quad \mu_s = 0.65$$
$$\vec{a} = \frac{v^2}{r}$$
$$v^2 = \mu_s g r$$
$$v = \sqrt{\mu_s g r} = \sqrt{(0.65)(9.8)(90.0)} = \boxed{24\,\text{m/s}}$$

We know that this value is independent of the mass as the mass gets canceled out in the equation for centripetal force.

Problem 36.

$$r = 1.40\,\text{m}, \quad v = 1.30\,\text{m/s}$$

(a)

$$a = \frac{v^2}{r} = \frac{(1.30)^2}{1.40} = \boxed{1.21\,\text{m/s}^2}$$

(b)

$$F_c = ma = (22.5)(1.21) = \boxed{27.2\,\text{N}}$$

Problem 38.

$$v = 525\,\text{m/s}, \quad r = 4800\,\text{m}$$

$$a = \frac{v^2}{r} = \frac{(525)^2}{4800} = 57.4\,\text{m/s}^2$$

$$a = \frac{57.4}{9.8} = \boxed{5.86\,\text{g's}}$$

Problem 45.

$$v = 50\,\text{km/h} \times \frac{1000\,\text{m}}{3600\,\text{s}} = 13.9\,\text{m/s}$$

From Table 5-1, coefficient of static friction for rubber on wet concrete:

$$\mu_s = 0.7$$

$$F_c = f_s$$

$$f_s = \mu_s F_N$$

$$F_c = \frac{mv^2}{r}$$

$$\frac{mv^2}{r} = \mu_s mg$$

$$\frac{v^2}{r} = \mu_s g$$

$$v^2 = \mu_s g r$$

$$r = \frac{v^2}{\mu_s g} = \frac{(13.9)^2}{(0.7)(9.8)} = \boxed{30\,\text{m}}$$

Problem 65.

$$v = 12\,\text{m/s}, \quad m = 950\,\text{kg}, \quad r = 250\,\text{m}, \quad a_{\tan} = 3.2\,\text{m/s}^2$$

$$F_{\tan} = ma_{\tan} = (950)(3.2) = \boxed{3.0 \times 10^3\,\text{N}}$$

$$a_R = \frac{v^2}{r} = \frac{(12)^2}{250} = 0.58\,\text{m/s}^2$$

$$F_R = ma_R = (950)(0.58) = \boxed{550\,\text{N}}$$