Note that 1 rev = 2π rad = 360°.

P05 $\omega = 2\pi/60 = 0.105$ (rad/s) .

P11 (**a**) $\alpha = (\omega_f - \omega_i)/t = [(3.75/60 - 0)]/22.0 = 2.84\times10^{-3}$ (rev/s^2); (**b**) $\theta = (\frac{1}{2})(\omega_i + \omega_f)\, t = 0.5(0+3.75/60)(22) = 0.688$ (rev) .

P13 $\theta = (\frac{1}{2})(\omega_i + \omega_f)\, t$, $9.5 = 0.5(\omega_i)(18.5)$, $\omega_i = 1.03$ rev/s .

P21 (a) $\omega = 2\pi/86400$; $v = r\omega = (6.37\times10^6)\omega = 463$ (m/s); (b) $r = 0$, $v = 0$.

P22 (a) $v = r\omega = (1.50\times10^{11})[2\pi/(365.25\times86400)] = 2.99\times10^4$ (m/s) .

P27 (a) $x = \underline{v}\, t = (6.6)(38)/2 = 125$ (m); (b) $\theta = x/r = 125/(0.625/2) = 401$ (rad) = 63.9 (rev).

P29 $\omega_0 = 1660$ rev/min = 174 rad/s, $\omega_f = 0$ & $t = 16$ s: (a) $\alpha = (\omega_f - \omega_0)/t = 109$ (rad/s^2), $\theta = (\omega_0/2)\, t = 221$ (rev); (b) $x = r\theta = (0.0625)(221)(2\pi) = 87.0$ (m) .

P31 $\omega = v/r$, $\omega_f - \omega_i = \alpha\, t$, $\alpha = v_f/(rt) = 17.5/(0.40\times23.6) = 1.85$ (rad/s^2); $\theta = (\frac{1}{2})\alpha\, t^2 = 0.5(1.85)(23.6^2) = 515$ (rad) = 82.0 (rev) .

P36 $f = mv^2/r \le \mu mg$, $\mu \ge v^2/(gr) = r\omega^2/g = (0.30)[(33.3)(2\pi/60)]^2/9.80$, $\mu \ge 0.372$.

P37 $a_c = r\omega^2 = 5.3g$, $(5.3)(9.80) = (11.3)(\omega^2)$, $\omega^2 = 4.596$, $\omega = 2.144$ rad/s = 0.340 rev/s .

P38 Let F be the force of the pail acting on the water. $F + mg = mv^2/r$, $v^2 \ge gr$, $v_{min} = \sqrt{gr} = \sqrt{(9.8)(0.72)} = 2.66$ (m/s) .

P41 $F_c = mr\omega^2$, $(12{,}000)(9.80) = (0.085)\omega^2$, $\omega = 1176$ rad/s= 187 rev/s .

P42 $F_N = mg$ & $F_c = F_s \le \mu_s F_N \Rightarrow mv^2/r \le \mu_s(mg)$, $v \le \sqrt{\mu_s gr} = \sqrt{0.85\times9.8\times31.5} = 16.2$ (m/s) .

P47 $M_m = 4\pi\rho R_m^3/3$, $M_e = 4\pi\rho R_e^3/3$, $g_m = GM_m/R_m^2$ & $g_e = GM_e/R_e^2$: $g_e/g_m = (M_e/M_m)(R_m^2/R_e^2) = R_e/R_m$, $R_m = Re(g_m/g_e) = R_e/6$.

P48 $T = 87$ min & $r = 6500$ km. $GmM/r^2 = mv^2/r$ & $T = 2\pi r/v \Rightarrow M = 4\pi^2 r^3/(GT^2) = 5.96\times10^{24}$ (kg) .

P51 Let the tension in the string be T. F_x: $T\sin\theta = mr\omega^2$ & F_y: $T\cos\theta = mg$; $\tan\theta = r\omega^2/g = (6.8)[0.045(2\pi)]^2/9.80 = 0.0555$, giving $\theta = 3.18°$.

P52 $mg\cos\theta - F_N = mv^2/R$. Constant of E gives $v^2 = 2gh = 2gR(1-\cos\theta)$. $3mg\cos\theta - F_N = 2mg$, $3mg\cos\theta \ge 2mg$, $\cos\theta \ge 2/3 \Rightarrow \cos\theta_c = 2/3$.

P54 $F_N\sin\theta = mg$ & $F_N\cos\theta = mv^2/r$. $\tan\theta = gr/v^2$, or $v = \sqrt{gr/\tan\theta}$.

P56 Let $m/M = r$. $MgR(1+\cos 60°) = mv_b^2/2$, $v_b^2 = 3gR$ …①; $v_{2f} = 2Mv_b/(m+M) = 2v_b/(1+r)$ …②; $v_{top}^2 = v_{2f}^2 - 2g(2R)$ …③,. $v_{top}^2 = 12gR/(1+r)^2 - 4gR \ge gR$, $(1+r)^2 \le 12/5$, $r \le 0.549$.

P59 Let T_i and T_o be the tensions in the inner and outer strings, respectively. (a) $T_o = m\omega^2(2L)$ and $T_i - T_o = m\omega^2 L$, giving $T_i = 3m\omega^2 L$. $T_i > T_o$. The inner string will break first. (b) $\omega^2 = T_i/(3mL) = 235/[(3)(0.500)(0.6)] = 261.1$, $\omega = 16.2$ rad/s = 2.57 rev/s .