p 130 1-7, 11, 13-17, 19, 24

(1) (a) $a = \frac{v^2}{r} = \frac{(1.25\ m s^{-1})^2}{1.1\ m} = \underline{1.42\ m s^{-2}}$

(b) $F = ma = (25.0\ kg)(1.42\ m s^{-2}) = \underline{35.5\ N}$

(2) $a = \frac{v^2}{r} = \frac{(525\ m s^{-1})^2}{(6000\ m)} = 45.9\ m s^{-2} = \underline{4.68\ g}$

(3) $a = \frac{4\pi^2 r}{T^2} = \frac{4\pi^2 (1.5 \times 10^{11}\ m)}{(3.156 \times 10^7\ s)^2} = \underline{5.95 \times 10^{-3}\ m s^{-2}}$

$F = ma = (5.98 \times 10^{24}\ kg)(5.95 \times 10^{-3}\ m s^{-2}) = \underline{3.56 \times 10^{22}\ N}$

The gravitational attraction of the sun exerts the force.

(4) $F = \frac{mv^2}{r}$

$v = \sqrt{\frac{Fr}{m}} = \sqrt{\frac{(210\ N)(0.90\ m)}{2.0\ kg}} = \underline{9.7\ m s^{-1}}$

(5) $r = 400\ km + 6.38 \times 10^3\ km = 6.78 \times 10^3\ km = 6.78 \times 10^6\ m$

$T = 90\ min = 5400\ s$

$a = \frac{4\pi^2 r}{T^2} = \frac{4\pi^2 (6.78 \times 10^6\ m)}{(5400\ s)^2} = 9.18\ m s^{-2} = \underline{0.9\ g}$

(6) $f = 45\ rpm = 0.75\ Hz$

$T = \frac{1}{f} = \frac{1}{.75} = 1.33\ s$

$a = \frac{4\pi^2 r}{T^2} = \frac{4\pi^2 (0.16\ m)}{(1.33\ s)^2} = \underline{3.57\ m s^{-2}}$

(7) (a)

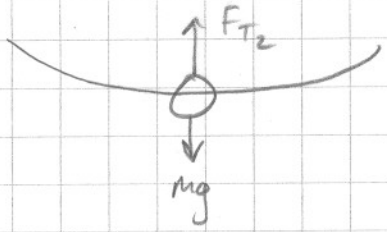
$$\Sigma F = \frac{mv^2}{r}$$

$$mg + F_{T_1} = \frac{mv^2}{r}$$

$$F_{T_1} = \frac{mv^2}{r} - mg = m\left(\frac{v^2}{r} - g\right) = 0.3\,kg\left(\frac{(4\,ms^{-1})^2}{0.72m} - 9.81\,ms^{-2}\right)$$

$$\underline{F_{T_1} = 3.72\,N}$$

(b)



$$\Sigma F = \frac{mv^2}{r}$$

$$F_{T_2} - mg = \frac{mv^2}{r}$$

$$F_{T_2} = \frac{mv^2}{r} + mg = m\left(\frac{v^2}{r} + g\right) = 0.3\,kg\left(\frac{(4\,ms^{-1})^2}{0.72m} + 9.81\,ms^{-2}\right)$$

$$\underline{F_{T_2} = 9.61\,N}$$

(11) $$F_{back} = \frac{mv^2}{r}$$

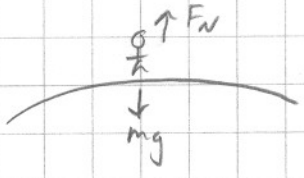
$$7.85\,mg = \frac{mv^2}{r}$$

$$v = \sqrt{7.85gr} = \sqrt{7.85(9.81\,ms^{-2})(12\,m)} = \underline{30.4\,ms^{-1}}$$

$$v = \frac{2\pi r}{T} \qquad T = \frac{2\pi r}{v} = \frac{2\pi(12m)}{30.4\,ms^{-1}} = 2.48\,s$$

$$f = \frac{1}{T} = \frac{1}{2.48s} = \underline{0.403\,Hz}$$

14(c)



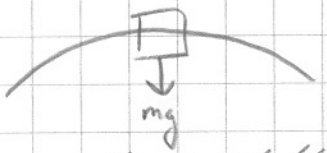
$F_N = 0$

$$\Sigma F = \frac{mv^2}{r}$$

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

$$v = \sqrt{gr} = \sqrt{(9.81\ ms^{-2})(95\ m)} = \underline{31\ ms^{-1}}$$

15



"weightless" - only force is gravitational
diameter = 15 m

$$mg = \frac{m\,4\pi^2 r}{T^2}$$

$$T = \sqrt{\frac{4\pi^2 r}{g}} = \sqrt{\frac{4\pi^2 (7.5\ m)}{9.81\ ms^{-2}}} = 5.49\ s$$

$$f = \frac{1}{T} = \frac{1}{5.49\ s} = 0.182\ Hz = \underline{11\ rpm}$$

16 (a)

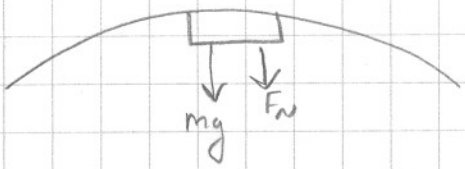
$$\Sigma F = \frac{mv^2}{r}$$

$$F_T - mg = \frac{mv^2}{r}$$

$$v = \sqrt{\frac{r}{m}\left(F_T - mg\right)} = \sqrt{\frac{1.1\ m}{2\ kg}\left(25\ N - 2\ kg(9.81\ ms^{-2})\right)}$$

$$v = \underline{1.72\ ms^{-1}}$$

(13)



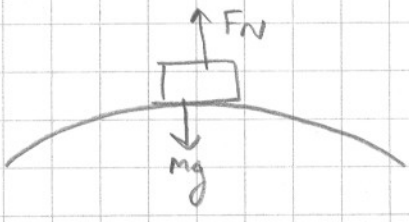
minimum speed $F_N = 0$

$$\Sigma F = \frac{mv^2}{r}$$

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

$$v = \sqrt{gr} = \sqrt{(9.81\,ms^{-2})(7.4m)} = \underline{8.5\,ms^{-1}}$$

(14) (a)



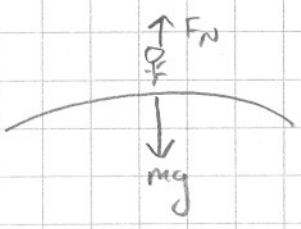
$$\Sigma F = \frac{mv^2}{r}$$

$$mg - F_N = \frac{mv^2}{r}$$

$$F_N = mg - \frac{mv^2}{r} = m\left(g - \frac{v^2}{r}\right) = 950kg\left(9.81ms^{-2} - \frac{(22ms^{-1})^2}{95m}\right)$$

$$F_N = \underline{4500\,N}$$

(b)



$$\Sigma F = \frac{mv^2}{r}$$

$$mg - F_N = \frac{mv^2}{r}$$

$$F_N = mg - \frac{mv^2}{r} = m\left(g - \frac{v^2}{r}\right) = 72kg\left(9.81ms^{-2} - \frac{(22ms^{-1})^2}{95m}\right)$$

$$\underline{F_N = 340\,N}$$

16 (b)

$F_T = 0$

$$\Sigma F = \frac{mv^2}{r}$$

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

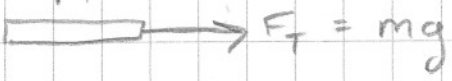
$$v = \sqrt{gr} = \sqrt{(9.81\,ms^{-2})(1.10\,m)} = \underline{3.28\,ms^{-1}}$$

(17) $$a = \frac{4\pi^2 r}{T^2}$$

$$T = \sqrt{\frac{4\pi^2 r}{a}} = \sqrt{\frac{4\pi^2(0.09\,m)}{115000\,(9.81\,ms^{-2})}} = 1.77 \times 10^{-3}\,s$$

$$f = \frac{1}{T} = \frac{1}{1.77 \times 10^{-3}\,s} = 563.5\,Hz = \underline{33\,800\,rpm}$$

(19)



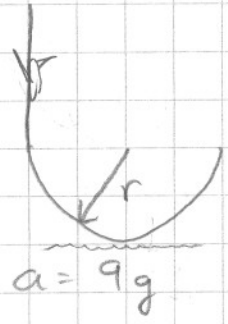
$$\Sigma F = \frac{mv^2}{r}$$

$$F_T = \frac{Mv^2}{R}$$

$$mg = \frac{Mv^2}{R}$$

$$v = \sqrt{\frac{mgR}{M}}$$

(24)



$$a = \frac{v^2}{r}$$

$$r = \frac{v^2}{a} = \frac{(310\,ms^{-1})^2}{9(9.81\,ms^{-2})} = \underline{1100\,m}$$