Circular Motion

① $a = \frac{v^2}{r} = \frac{(4)^2}{2} = \underline{8.0\ m/s^2}$

② (a) $\square \rightarrow T$ $\quad T = \frac{mv^2}{r} = \frac{(1)(2)^2}{.4} = \underline{10.0\ N}$

(b) $T = \frac{mv^2}{r}$

$v = \sqrt{\frac{rT}{m}} = \sqrt{\frac{(.4)(20)}{1}} = \underline{2.82\ m/s}$

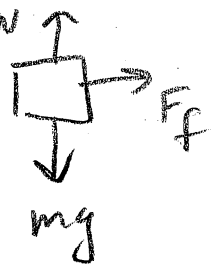
(c) $T = \frac{mv^2}{r}$

$r = \frac{mv^2}{T} = \frac{(1)(4)^2}{20} = \underline{0.80\ m}$

③ $a_c = \frac{v^2}{r} \quad v = 2\pi r f$

$a_c = 4\pi^2 r f$

$f = \frac{a_c}{4\pi^2 r} = \frac{4(10)}{4\pi^2(25)} = 0.0405/s \times 60 = \underline{2.43\ rpm}$

(4) 

$F_f = \frac{mv^2}{r}$ $\quad F_f = \mu F_N = \mu mg$

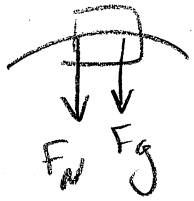
$\mu mg = \frac{mv^2}{r}$

$v = \sqrt{\mu g r} = \sqrt{(.65)(10)(130)}$

$v = 29.1$ m/s

(5) $a = \frac{v^2}{r}$

$v = \sqrt{ar} = \sqrt{1.5(10)(15)} = 15$ m/s

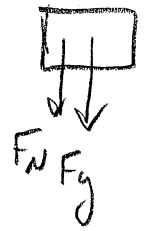
(6) 

$F_N + F_g = \frac{mv^2}{r}$ for minimum speed $F_N = 0$

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

$v = \sqrt{gr} = \sqrt{10(18)} = 13.4$ m/s

(7) (a)

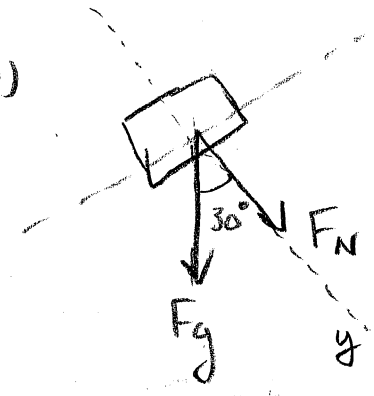


$$F_N + F_g = \frac{mv^2}{r}$$

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

$$= \frac{40(10)^2}{7} - 40(10) = \underline{171\ N}$$

(b)



F_c is in y-direction

$$F_N + F_g \cos\theta = \frac{mv^2}{r}$$

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

$$= \frac{40(10.5)^2}{7} - 40(10)\cos 30$$

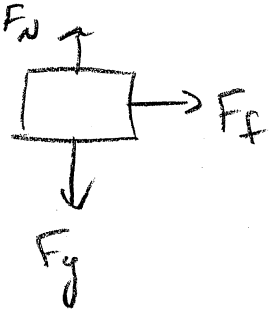
$$= \underline{283\ N}$$

(c)

$$F_N + F_g = \frac{mv^2}{r}$$ for minimum speed $F_N = 0$

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

$$v = \sqrt{gr} = \sqrt{(10)(7)} = \underline{8.37\ m/s}$$

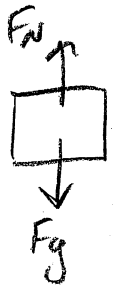
(8) 

$F_f = \frac{mv^2}{r}$ $\quad f_f = \mu F_N = \mu mg$

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

$\mu = \frac{v^2}{gr} = \frac{(30)^2}{10(50)} = 1.8$

The coefficient of friction cannot be greater than 1. (Normal values are 0.6 - 0.85)

(9)(a) 

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

$F_N = \frac{mv^2}{r} + F_g = \frac{60(23.4)^2}{28} + 60(10) = \underline{1773\,N}$

person's weight = $60(10) = \underline{600\,N}$

(b) It seems reasonable that the force be approximately 3 times the person's weight. (This is not too much force)

(10) (a) 

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

$F_N = \frac{mv^2}{r} + F_g = \frac{18(9)^2}{2} + 18(10) = \underline{909\,N}$

Child's weight = 180N

(b) The force exerted is just over 5 times the child's weight. This is an excessive amount of force.