Circular Motion Worksheet

① (a) $\bar{v} = \frac{d}{t} = \frac{2\pi r}{T} = \frac{2\pi(50)}{9.0} = \underline{34.9 \text{ m/s}}$

(b) $a = \frac{v^2}{r} = \frac{(34.9)^2}{50} = \underline{24 \text{ m/s}^2}$

② (a) $\bar{v} = \frac{d}{t} = \frac{2\pi r}{T} = 2\pi r f = 2\pi(1.5)\left(\frac{120}{60}\right) = \underline{18.8 \text{ m/s}}$

(b) $a = \frac{v^2}{r} = \frac{(18.8)^2}{1.5} = \underline{236 \text{ m/s}^2}$

③ $a = \frac{v^2}{r} = \frac{(20)^2}{50} = \underline{8 \text{ m/s}^2}$

④ $a = \frac{v^2}{r} \qquad v = \frac{2\pi r}{T}$

$a = \frac{4\pi^2 r}{T^2} = \frac{4\pi^2(4.0)}{(60)^2} = \underline{0.044 \text{ m/s}^2}$

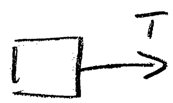
⑤ (a) $\bar{v} = \frac{d}{t} = \frac{2\pi r}{T} = \frac{2\pi(.15)}{1.8} = \underline{0.52 \text{ m/s}}$

(b) $a = \frac{v^2}{r} = \frac{(.52)^2}{.15} = \underline{1.80 \text{ m/s}^2}$

(6) (a) $a = \frac{v^2}{r}$ $\quad v = \frac{2\pi r}{T}$

$$a = \frac{4\pi^2 r}{T^2} = \frac{4\pi^2(.75)}{(.8)^2} = \underline{46.3 \text{ m/s}^2}$$

(b)

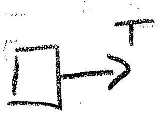


$$T = ma_c$$
$$= (.1)(46.3) = \underline{4.6 \text{ N}}$$

(7) (a) $a = \frac{v^2}{r}$ $\quad v = 2\pi r f$

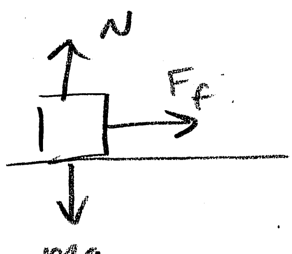
$$a = 4\pi^2 f^2 r = 4\pi^2\left(\frac{1}{.5}\right)^2(1) = \underline{9.86 \text{ m/s}^2}$$

(b)



$$T = ma_c$$
$$= .5(9.86) = \underline{4.93 \text{ N}}$$

(8)



$$F_f = ma_c = \frac{mv^2}{r} \quad v = \frac{2\pi r}{T}$$

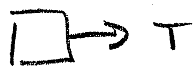
$$F_f = m\frac{4\pi^2 r}{T^2} = \frac{(900)4\pi^2(90)}{(12.3)^2}$$

$$= \underline{21\,100 \text{ N}}$$

The frictional force between the tires and the road provides the centripetal force.

(9) (a) $\bar{v} = \frac{d}{t} = \frac{2\pi r}{T} = 2\pi r f = 2\pi(4)\left(\frac{2}{6}\right) = \underline{8.4\ m/s}$

(b) $a = \frac{v^2}{r} = \frac{(8.4)^2}{4} = 17.6\ m/s^2$

(c) 

$T = ma_c$

$= 2(17.6) = \underline{35.2\ N}$

(d) The object flies off in a straight line tangent to the circle at the point the cord breaks with a speed of 8.4 m/s.

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

$v = \sqrt{ar} = \sqrt{(78)(2)} = \underline{12.5\ m/s}$

Centripetal Force Worksheet 2

① $F_c = \frac{mv^2}{r}$

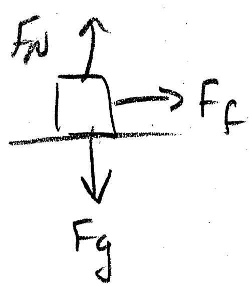
$v = \sqrt{\frac{F_c r}{m}} = \sqrt{\frac{(1850)(25)}{72}} = 642 \text{ m/s}$

② $F_c = \frac{mv^2}{r} = \frac{(.2)(5.6)^2}{.25} = 62.7 \text{ N}$

③ (a) $F_c = \frac{mv^2}{r}$ $\qquad$ $48 \text{ km/h} = 13.3 \text{ m/s}$

$= \frac{1250(13.3)^2}{35} = \underline{6318 \text{ N}}$

(b)



$F_f = \mu mg = .5(1250)(10)$

$= \underline{6250 \text{ N}}$

(c) The frictional force is not large enough to sustain the circular motion. The car will skid.

(4) $F_c = \frac{mv^2}{r}$ F_c is the gravitational force.

$$r = \frac{mv^2}{F} = \frac{(7.65 \times 10^{13})(0.173 \times 10^{-3})^2}{505} = \underline{4475\ m}$$

(5) $F_c = \frac{mv^2}{r}$ F_c is the force from the wall

$$m = \frac{F_c r}{v^2} = \frac{.158(.35)}{(2.21)^2} = \underline{0.011\ kg}$$

(6) $F_c = \frac{mv^2}{r}$

$$m = \frac{F_c r}{v^2} = \frac{(8 \times 10^2)(.4)}{(6)^2} = \underline{8.9\ kg}$$

Circular motion

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

② (a)  $T = \frac{mv^2}{r} = \frac{(1)(2)}{.4} = \underline{5.00\ N}$

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

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

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

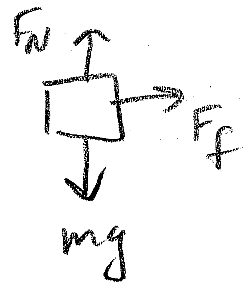
$r = \frac{mv^2}{T} = \frac{(1)(4)}{20} = \underline{0.20\ m}$

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

$a_c = 4\pi^2 r f$

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

④



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

$$\mu m g = \frac{m v^2}{r}$$

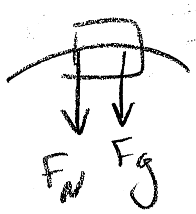
$$v = \sqrt{\mu g r} = \sqrt{(.65)(10)(130)}$$

$$\underline{v = 29.1 \text{ m/s}}$$

⑤ $$a = \frac{v^2}{r}$$

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

⑥

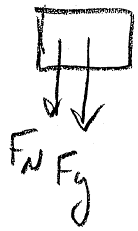


$$F_N + F_g = \frac{mv^2}{r}$$ for minimum speed $F_N = 0$

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

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

⑦ (a)

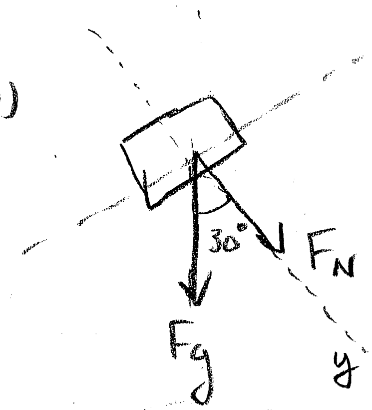


$$F_N + F_g = \frac{mv^2}{r}$$

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

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

(b)



F_c is in y-direction

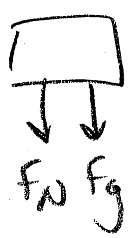
$$F_N + F_g \cos\theta = \frac{mv^2}{r}$$

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

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

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

(c)

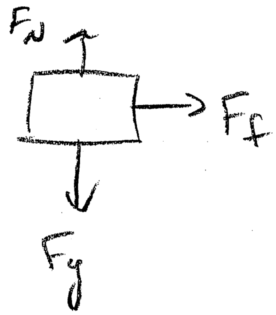


$$F_N + F_g = \frac{mv^2}{r}$$

for minimum speed $F_N = 0$

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

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

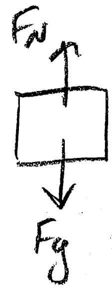
(8) 

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

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

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

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 $= 180\,N$

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