CIRCULAR MOTION 1

1) REMAINS THE SAME

2) $F \propto v^2$

3) INWARD

4) INWARD

5) d) s^{-1}

6) A) $v = \frac{2\pi r}{T} = \frac{2\pi(.93m)}{1.18s} = 4.95 m/s$

B) $a_c = \frac{v^2}{r} = \frac{(4.95m/s)^2}{.93m} = 26.4 m/s^2$

C) $F_c = ma_c = (.013kg)(26.4 m/s^2) = .34N$

7) A) $v, a, 2F$

B) $2v, 2a, 2F$

C) $2v, 4a, 4F$

8) A) $a = \frac{v^2}{r} = \frac{(8.8m/s)^2}{25m} = 3.1 m/s^2$

B) THE GROUND

9) A) $a_c = \frac{v^2}{r} = \frac{(32m/s)^2}{56m} = 18.3 m/s^2$

B) $f_{MAX} = F_c \quad \mu mg = \frac{mv^2}{r} \quad \mu = \frac{v^2}{rg} = \frac{(32m/s)^2}{(56m)(9.8m/s^2)} = 1.87$

10) A) $a = \frac{4\pi^2 r}{T^2} = \frac{4\pi^2(50m)}{(14.3s)^2} = 9.65 m/s^2$

B) $F_c = ma_c = (615kg)(9.65 m/s^2) = 5937N$

11) $a = 4\pi^2 r f^2 = 4\pi^2(1.3m)(1Hz)^2 = 51.3 m/s^2$

12) $F = m4\pi^2 r f^2 = (.2kg)4\pi^2(.8m)(1Hz)^2 = 6.32N$

13) A) INWARD

B) $a = 4\pi^2 r f^2$ 33 rev/min = .5555 Hz

$4\pi^2(.05)(.55Hz) = .609 m/s^2$

$4\pi^2(.10)(.55Hz) = 1.22 m/s^2$

$4\pi^2(.15)(.55Hz) = 1.83 m/s^2$

C) LARGEST RADIUS DUE TO GREATER TANGENTIAL VELOCITY

14) $v_{MAX} = \sqrt{\mu r g}$

$= \sqrt{(.3)(80m)(9.8m/s^2)}$

$= 15.3 m/s$

Circular Motion Problems II

1. The decrease in speed limit is a result of the acceleration of the curve giving less traction available for maneuvering on the curve. Therefore, the clover leaf must have a smaller radius giving the same acceleration by $a = \frac{v^2}{r}$

2. The clothes and water feel a centrifugal force to the outside of the barrel. For the clothes the wall of the barrel pushes back. For the water the holes in the barrel allow ~~the~~ it to pass through thus partially drying the clothes.

3. There is no centrifugal force. The people in the car, by the law of inertia, will move off tangent to the curve. If the car stays on the road, this would mean that right side of the car would appear to be accelerating toward the passangers in the diagram. Inside the car, this would give the passangers the illusion that there was a force pushing them to the right or away from the center of the curve.

4. When he is flying strain $F_N = mg$

a) At the bottom

$$F_{net} = \frac{mv^2}{r} = F_{NBot} - W$$

$$ff = \frac{F_{Nbot}}{F_N} = \frac{m\frac{v^2}{r} + mg}{mg}$$

$$ff = \frac{v^2}{rg} + 1$$

$$ff = \frac{(194.4\,m/s)^2}{(2{,}000\,m)(9.8\,m/s^2)} + 1$$

$$\boxed{ff = 2.93}$$

b) At the top

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

$$F_{Ntop} = m\left(\frac{v^2}{r} - g\right)$$

$$ff = \frac{F_{Ntop}}{F_N} = \frac{m\left(\frac{v^2}{r} - g\right)}{mg}$$

$$ff = \frac{v^2}{gr} - 1 = \frac{(194\,m/s)^2}{(9.8\,m/s^2)(2000\,m)} - 1 = \boxed{0.93}$$

5. $r = 1.50\,m$ $T = 1.20\,s$

a) $v = \frac{2\pi r}{T} = \frac{2\pi(1.50\,m)}{1.20\,s}$

$$\boxed{v = 7.85\,m/s}$$

b) $a = \frac{v^2}{r} = \frac{(7.85\,m/s)^2}{1.50\,m}$

$$\boxed{a = 41.12\,m/s^2}$$

c) No it must be at some angle to accomodate the force of gravity $(T\sin\theta = mg)$

6. $r = 1.25\,m$ $a = 1.25\,m/s^2$ $v = ?$

$a = \frac{v^2}{r}$ $1.25\,m/s^2 = \frac{v^2}{1.25\,m}$ $\boxed{v = 1.25\,m/s}$

7. $r = 1{,}000\,m$ $v = 120\,km/h = 33.3\,m/s$

$$a = \frac{v^2}{r} = \frac{(33.3\,m/s)^2}{1000} = \boxed{1.11\,m/s^2}$$

8. $T = \cancel{29.5\,days}$ 27.3 days (actually $27\frac{1}{3}$ days)

$r = 3.80 \times 10^{8}\,m$

$T = \cancel{2.55 \times 10^6\,s}$ $2.36 \times 10^6\,s$

$$a = \frac{4\pi^2 r}{T^2} = \frac{4\pi^2(3.80 \times 10^8\,m)}{(2.36 \times 10^6\,s)^2} = \boxed{\cancel{2.31 \times 10^{7}\,m/s^2}} \quad \boxed{\cancel{2.31 \times 10^{-3}\,m/s^2}} \quad \boxed{2.70 \times 10^{-3}\,m/s^2}$$

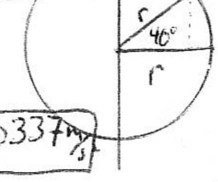
9. $r = 400\,m$ $v = 83.0\,km/h = 23.06\,m/s$

$a_{max\,tire} = 1.25\,m/s^2$ $a_c = \frac{v^2}{r} = \frac{(23.06\,m/s)^2}{400\,m} = 1.33\,m/s^2$

Since the max acceleration that can be supplied by the tires is smaller than the needed centripetal acceleration the car will not negotiate the curve smoothly

$\boxed{No}$

10. $r_e = 6.37 \times 10^6\,m$ $v = \frac{2\pi r}{T}$ $T = 24\,h = 8.64 \times 10^4\,s$



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

a) At equator

$$a = \frac{4\pi^2(6.37 \times 10^6\,m)}{(8.64 \times 10^4\,s)^2} = \boxed{0.0337\,m/s^2}$$

d) * a 70 kg person is 0.53 lbs lighter at Equator than at NY

b) At 40° Latitude

$$a = \frac{4\pi^2 r'}{T^2} = \frac{4\pi^2 r\cos 40°}{T^2} = a_{equator}\cos 40° = \boxed{0.0258\,m/s^2}$$

c) $\boxed{a = 0\,m/s^2}$

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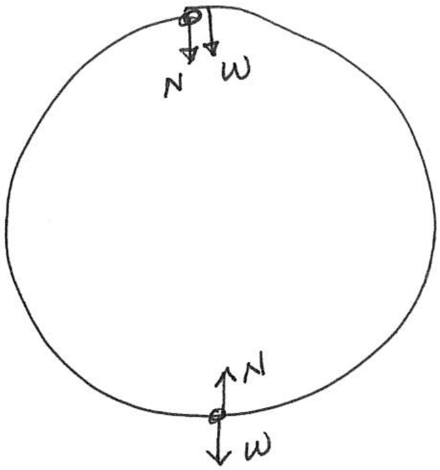
Top



Bottom

$$F_c = \Sigma F$$
$$F_c = N + W$$
$$\frac{mv^2}{r} = N + mg$$
$$N_{Top} = \frac{mv^2}{r} - mg$$

$$Ff_{Top} = \frac{N_{Top}}{N}$$
$$= \frac{\frac{mv^2}{r} - mg}{mg}$$
$$Ff_{Top} = \frac{v^2}{rg} - 1$$

$$F_c = \Sigma F$$
$$F_c = N - W$$
$$\frac{mv^2}{r} = N - mg$$
$$N_{Bottom} = \frac{mv^2}{r} + mg$$

$$Ff_{Bottom} = \frac{N_{Bot}}{N}$$
$$\frac{\frac{mv^2}{r} + mg}{mg}$$
$$Ff_{Bottom} = \frac{v^2}{rg} + 1$$

700 km/hr = 194.4 m/s
2 km = 2000 m

$$Ff_{Top} = \frac{v^2}{rg} - 1 = \frac{(194.4\,m/s)^2}{(2000\,m)(9.8\,m/s^2)} - 1 = .928$$
$$Ff_{Bottom} = \frac{v^2}{rg} + 1 = \frac{(194.4\,m/s)^2}{(2000\,m)(9.8\,m/s^2)} + 1 = 2.93$$