Week 8 Quiz

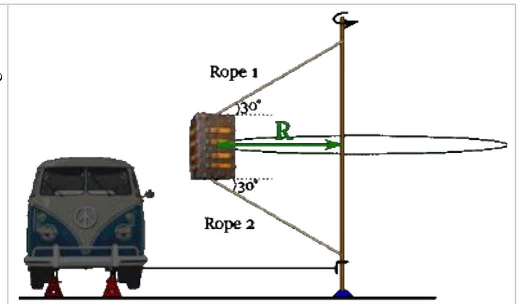
Friday, November 20, 2020 10:18 AM

After a 2 week trip home in their newly purchased VW van, the owners drafted up plans for a device that can spin a 70.0-kg box around a 3.00 meter radius circular path at a constant speed of 7.67 m/s. The box is attached to a vertical rod via two separate pieces of rope as shown in the figure below. Both ropes make the same angle with respect to the horizontal at all times during the circular motion.

(a) A useful unit of acceleration is the "g". For example, if a car has an acceleration of 2.00 m/s², the cars acceleration in units of "g" is: (2.00/9.8)g, which is approximately 0.22 g. What is the approximate acceleration of the box in units of g?

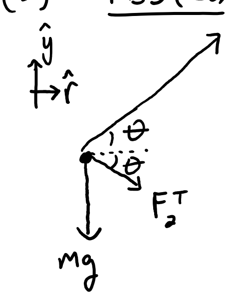
(b) How does the tension in rope 1 compare to the tension in rope 2: greater than, less than, or equal to? Briefly explain your reasoning in words, phrases, diagrams, etc...

(c) Find the magnitude of tension in each rope.



(a) UCM $\Rightarrow \vec{a} = \langle \frac{v^2}{r}, 0, 0 \rangle = \langle 19.6, 0, 0 \rangle \, m/s^2 = \boxed{\langle 2g, 0, 0 \rangle}$

(b) FBD (Box)



For UCM $\Sigma \vec{F}$ points radially inward.

For $\Sigma F_y = 0$, $F_{1y}^T > F_{2y}^T$ b/c of gravity

So $\boxed{|F_1^T| > |F_2^T|}$

(c) $\Sigma F_y = m \cancel{a_y}^{0} \Rightarrow F_1^T \sin\theta - F_2^T \sin\theta - mg = 0$ eq(i)

$\Sigma F_r = m a_r \Rightarrow F_1^T \cos\theta + F_2^T \cos\theta = m\frac{v^2}{r}$ eq(ii)

2 eqs, 2 unknowns

from (i) $F_1^T = F_2^T + \frac{mg}{\sin\theta}$ → plug into (ii) → $\left(F_2^T + \frac{mg}{\sin\theta}\right)\cos\theta + F_2^T \cos\theta = \frac{mv^2}{r}$

$F_2^T = \frac{m}{2}\left[\frac{v^2}{r\cos\theta} - \frac{g}{\sin\theta}\right] = \boxed{106.51\,N}$

(eq i) → $F_1^T = F_2^T + \frac{mg}{\sin\theta} = \boxed{1479\,N}$

Rubric

~~ part (a) ~~	~~ part (b) ~~	~~ part (c) ~~
1 pt - UCM acceleration equation 0.5 pt - Finding correct acceleration value 0.5 pt - Finding acceleration in units of "g"	1 pt - reasoning 0.5 pts - correct answer	1.5 pts - FBD 1.5 pts - 2nd law application in vertical direction 1.5 pts - 2nd law application in the radial direction 0.5 pts - vertical acceleration = 0 1 pt - Algebra 0.5 pts - correct answer and units