UCM Test Review Problems

Problem 1

Your 950 kg convertible coup moves around a level 50 m radius jug-handle. The coefficient of static friction between the tires and the road is 0.8. Determine the maximum speed of the car so it does not skid off the road.

Problem 2

Sana is drawing force diagrams for people going through a roller coaster on Physics Day at Great Adventure. Her friend Tovi went on the ride earlier and described how he felt at different parts of the ride. Help Sana by drawing your own diagrams for each part so you can double check each other's work.

a) Tovi said they waited a long time at rest on a level piece of track for the other coaster ahead of them to move up the ramp
b) On the very top of the first drop as they moved over the circular hump, Tovi felt only about half as heavy as he did, getting butterflies in his stomach.
c) Entering a loop, Tovi said that he felt much heavier, four times as much as normal.
d) At the top of the loop, Tovi claimed he was just about to fall out of his seat, feeling weightless.

Problem 3

A situation involving circular motion is described mathematically below, take a look at the situation and answer the questions below.

$$900\ \text{N} + \ 50\ \text{kg} \quad -9.8\frac{\text{m}}{\text{s}^2} \ = \ 50\ \text{kg} \ \frac{v^2}{12\ \text{m}}$$

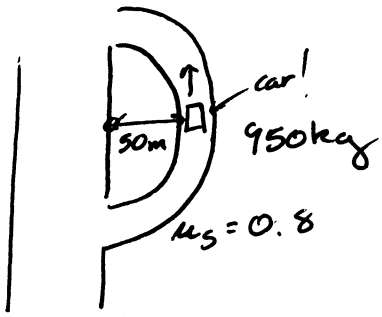
a) Sketch a possible situation for what this equation might describe.
b) Write in words a problem for which this equation is a solution to, be sure to identify what unknown a person would be trying to solve for.

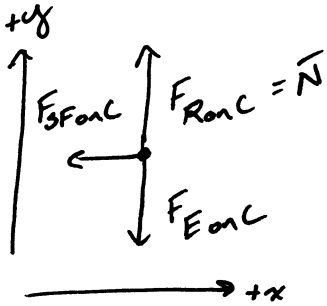
Problem 4

In another solar system, planet Vulcan is an average of 6.1×10^6 m away from the main star, it takes the planet only 30 Earth days to orbit around the star. (Be sure to show all diagrams and work for the bonus part)

a) If another planet, Tatooine takes 1225 days to orbit around the main star, how far away is it from that main star?
b) If the planet Tatooine has a mass of 8.9×10^{25} kg what is the mass of the main star? (+1.5 points)

Problem 1





F_{SFonC} is the unbalanced force keeping the car moving in a circle.

$$F_{SFonC} = \mu_s \bar{N}$$

$$F_{EonC} + F_{RonC} = 0 \Rightarrow -F_{EonC} = F_{RonC}$$

$$F_{RonC} = -gm$$

$$= -\left(-9.8 \tfrac{m}{s^2}\right)(950\,kg)$$

$$= 9310\,N$$

Negative, look @ force diagram

$$F_{SFonC} = (0.8)(9310\,N) = -7448\,N$$

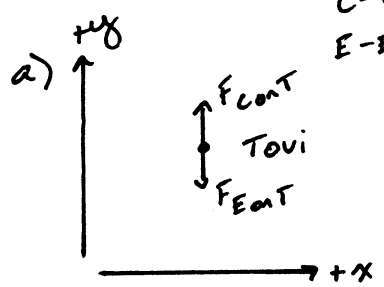
$$a_x = \frac{\Sigma F_x}{m} \Rightarrow a_x = \frac{v^2}{r} \Rightarrow \frac{v^2}{r} = \frac{\Sigma F_x}{m}$$ ← Just static friction

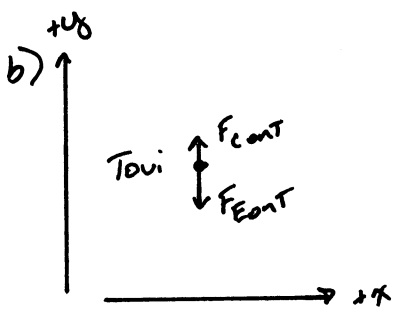
$$\frac{v^2}{r} = \frac{F_{SFonC}}{m} \qquad v = \sqrt{\frac{(F_{SFonC})\,r}{m}}$$

$$\boxed{v = 19.8\ m/s}$$

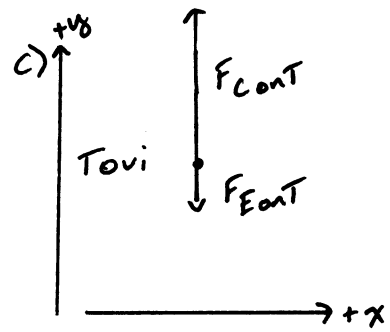
Problem 2

C- COASTER
E- EARTH





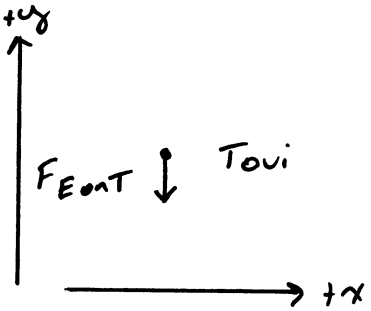
$$|F_{ConT}| = \tfrac{1}{2}|F_{EonT}|$$



$$4|F_{ConT}| = F_{EonT}$$

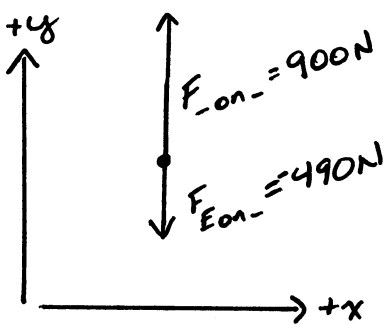
Problem 2 (continued)

d)



"Weightless" refers to no $F_{con T}$

Problem 3



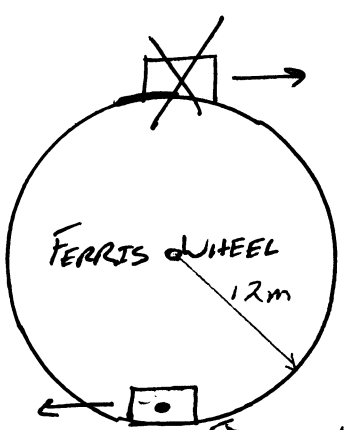
$$\underbrace{900N}_{F_{on-}} + \overbrace{\underbrace{(50kg)}_{\text{mass}}\underbrace{(-9.8\tfrac{m}{s^2})}_{g}}^{F_{E on-}} = \underbrace{(50kg)}_{m}\underbrace{\frac{v^2}{12m}}_{a}$$

(mass; velocity; radius)

ΣF = sum of forces

mass x acceleration

a)

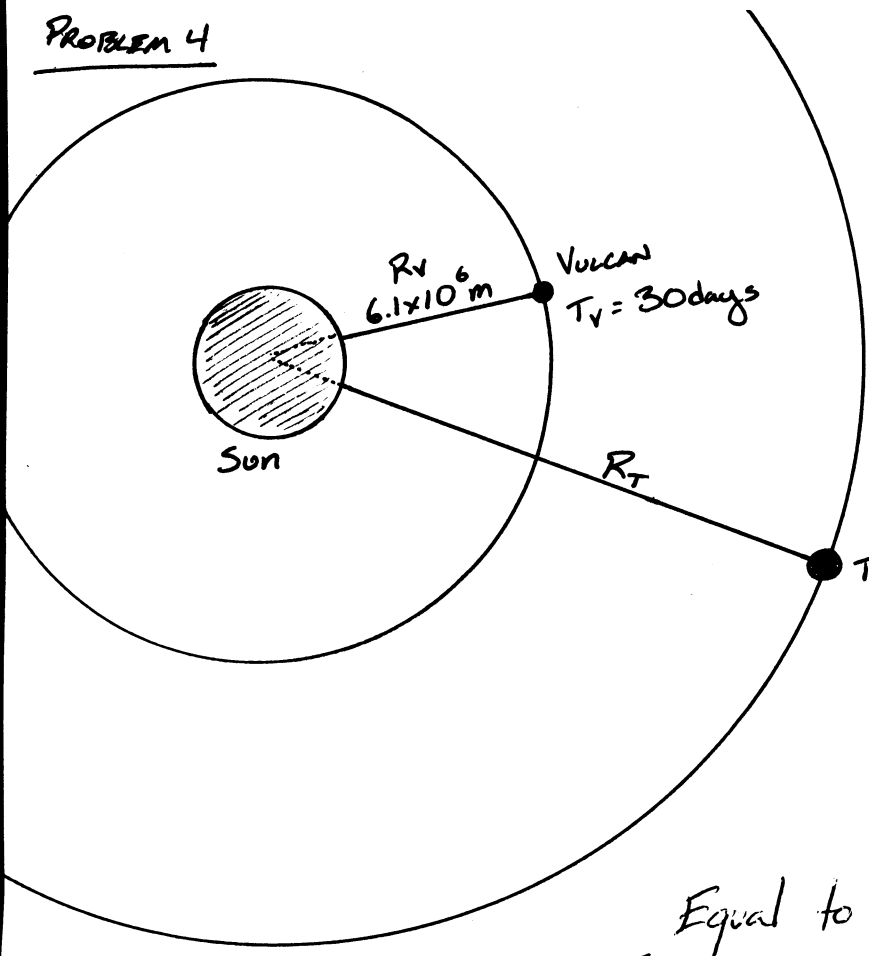


50 kg person is at the bottom of a ferris wheel with radius of 12 m

must be at the bottom because unbalanced force is upward

b) Janelle is on a ferris wheel, her mass is 50kg, at the bottom of the ride how quickly is she moving? The radius of the wheel is 12m.

PROBLEM 4



a) $\left(\frac{T_V}{T_R}\right)^2 = \left(\frac{R_V}{R_T}\right)^3$

$\left(\frac{30\text{ days}}{1225\text{ days}}\right)^2 = \left(\frac{6.1\times10^6\text{ m}}{R_T}\right)^3$

$R_T = \frac{6.1\times10^6\text{ m}}{\left(\frac{30\text{ days}}{1225\text{ days}}\right)^{\frac{2}{3}}}$

$\boxed{R_T = 7.23\times10^7\text{ m}}$

b) $a_T = \frac{v^2}{R_T}$ $\quad a_T = \frac{\Sigma F}{m_T}$ ← Equal to F_{Sun-T} $\quad F_{Sun-T} = G\frac{m_S m_T}{R_T^2}$

$\frac{v^2}{R_T} = \frac{\Sigma F}{m_T} \Rightarrow \frac{v^2}{R_T} = \frac{G\frac{m_S \cancel{m_T}}{R_T^2}}{\cancel{m_T}}$

$\frac{v^2}{\cancel{R_T}} = G\frac{m_S}{R_T^{\cancel{2}}} \Rightarrow \frac{v^2 R_T}{G} = m_S$ $\quad v = \frac{2\pi R_T}{T_T}$

$m_S = \frac{\left(\frac{2\pi R_T}{T_T}\right)^2 R_T}{G} = \frac{\frac{4\pi^2 R_T^2}{T_T^2} R_T}{G} = \frac{4\pi^2 R_T^3}{T_T^2 G}$

$\boxed{m_S = 1.997\times10^{19}\text{ kg} \leftarrow \text{ooops! too small to be a star!}}$