quizz 5, ME 240 Dynamics, Fall 2017

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0.1 Problems

Question 1 2.5 pts

Estimate the distance between the earth and the sun (don't google the answer. I changed some numbers). Assume that the Earth is on a circular orbit around the sun, which takes 364 days to complete one revolution. Additionally, assume that the sun's position is fixed.

According to Newton's universal gravitational law, the force between the Earth and the Sun is $F = \frac{G\, m_{sun} m_{earth}}{r^2}$

where the universal gravitational constant G = 6.674x10e-11 $\frac{m^3}{kg\ s^2}$, m_{sun} = 1.989x10e30 kg, m_{earth} = 5.972x10e24 kg, and r is the distance between the earth and the sun.

Calculate the distance r between the earth and sun, and enter your solution for **r in billions** of meters

Question 2 2.5 pts

A 2 kg toy car is driving over rolling hills defined by

y = 8.0sin(πx) meters (use radians for the sine function)

Assuming that the car begins to lose contact with the ground at the top of the hill, what is the velocity of the car at this point?

Calculate the velocity in meters per second and answer to 2 decimal places.

0.2 Problem 1 solution

Angular speed of earth around sun is

$$\dot{\theta} = \frac{2\pi}{(364)(24)(60)(60)}$$

Force on earth is therefore $mr\dot{\theta}^2$. Equating this to $F = G\frac{m_e m_s}{r^2}$ and solving for r gives

$$r\dot{\theta}^2 = G\frac{m_s}{r^2}$$

One equation with one unknown r. Solving gives (taking the positive root)

$$r = 149.26 \times 10^9 \text{ meter}$$

0.3 Problem 2 solution

$$y(x) = 8\sin(\pi x)$$

We want to solve for v in

$$\frac{v^2}{\rho} = g$$

But $\rho = \frac{\left(1+y'(x)^2\right)^{\frac{3}{2}}}{|y''(x)|}$. To find what x to use, since at top of hill, then we want $\sin(\pi x) = 1$ or $x = \frac{1}{2}$. Plugging this into ρ gives

$$\rho = 0.0126651$$

Hence

$$\frac{v^2}{0.0126651} = 9.81$$

Or

$$v = 0.3525 \text{ m/s}$$