

Tutorial #6 – Dynamics of Circular Motion

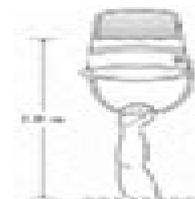
- (K4 Ex8.10mod)
 - What is the maximum speed (in km/h) with which a 1500 kg car can successfully take a highway exit ramp of radius 50 m on a level (unbanked) road in dry conditions without sliding? ($\mu_s = 1.0$)
 - How does the maximum speed from Part A. change if the roads are wet? ($\mu_s = 0.3$)
 - What is the correct banking angle if a car, traveling at 50 km/h, can take this curve without assistance from friction? (Hint: Use the trigonometric identity $\tan \theta = \frac{\sin \theta}{\cos \theta}$)
 - What direction (not magnitude!) is the friction force on a car if it takes the curve at a speed of 70 km/h?

- (K4 Ex8.13mod) Mass $m_1 = 1.0 \text{ kg}$ on a frictionless table is connected by a string through a hole in the table to a hanging mass $m_2 = 2.0 \text{ kg}$. With what angular velocity must m_1 rotate in a circle of radius $r = 50 \text{ cm}$ if m_2 is to remain hanging at rest?

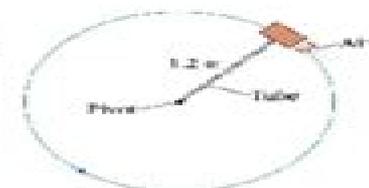


- (K4 Ex8.17) Communications satellites are placed in circular orbits where they stay directly over a fixed point on the equator as the earth rotates. These are called *geosynchronous orbits*. The altitude of a geosynchronous orbit is $3.58 \times 10^7 \text{ m}$.
 - What is the period of a satellite in a geosynchronous orbit? (Use common sense!)
 - Find the value of g at this altitude. (Full derivation required. Do not use Newton's law of universal gravitation.)
 - What is the weight of a 2000 kg satellite in a geosynchronous orbit?

- (K4 Ex8.22) A student has 65-cm-long arms. What is the minimum angular velocity (in rpm) for swinging a bucket of water in a vertical circle without spilling any? The distance from the handle to the bottom of the bucket is 35 cm. (Hint: This is similar to the minimum speed of a roller coaster.)



- (K4 P8.70) A 500 g steel block rotates on a steel table while attached to a 1.2-m-long hollow tube as shown. Compressed air fed through the tube and ejected from a nozzle on the back of the block exerts a thrust force of 4.0 N perpendicular to the tube. The maximum tension the tube can withstand without breaking is 50 N. If the block starts from rest, how many revolutions does it make before the tube breaks? ($\mu_k = 0.60$)



Answers: 1) a. 80 km/h, b. 44 km/h, c. 21° , d. Down the ramp. 2) 6.3 rad/s. 3) a. 86,400 s, b. 0.223 m/s^2 , c. 0 N. 4) 30 rpm. 5) 3.8 rev.

Challenge Problem Solutions Circular Motion Dynamics

M Walker



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