February 17, 2016
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4A QUIZZ #3

This Quizz is closed book.

PROBLEM 1 (20 points).

A conservative force acts on an object in one dimension (the particle moves along the x-axis). The force is generated by a potential given by $U(x) = 2Ax^2 - 6Bx\,\mathrm{J}$ where A and B are constants equal to $1\,\mathrm{J/m^2}$ and $1\,\mathrm{J/m}$ respectively. Assume that a particle of mass $m = 6\,\mathrm{kg}$ is moving on the x-axis in this potential and that it has a total mechanical energy $E = 20\,\mathrm{J}$. No other forces act on the particle.

a. Calculate the acceleration of the particle at $x = 0$.

b. Calculate the velocity of the particle at $x = 0$.

c. Calculate the allowed range of motion of the particle along the x-axis.

d. Make a graph that shows $U(x)$ and the total mechanical energy E as function of x. Indicate in the graph how your answer in c) can be made visible.

PROBLEM 2 (20 points).

In the picture shown below two masses m_1 and m_2 are tied by a massless string that is suspended over a frictionless pulley. Assume $m_1 > m_2$ and that the masses are held stationary and then let go.

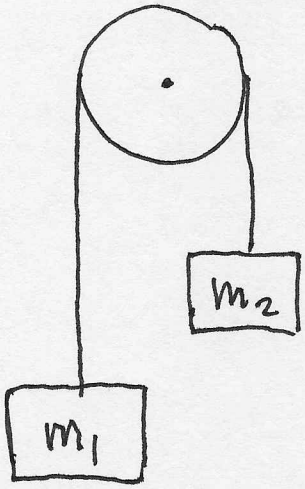
a. Calculate the acceleration of the second mass.

b. What kind of motion do the masses execute?

c. At the point when m_1 has dropped $h\,\mathrm{m}$, what is the velocity of the second mass?

d. Calculate the tension in the string.

e. Do a sanity check on your answers in a) and c) for example by considering the limiting cases $m_1 = 0$ and $m_2 = 0$.



PROBLEM 3 (20 points).

A catapult is made by loading a 0.5 kg ball onto a spring with spring constant $k = 10,000\,\mathrm{N/m}$ which is compressed by 50 cm. The ball is released so that the force of the spring launches the ball at an angle of 30° from the horizontal. Assume the ball is launched from ground level and neglect air resistance.

a. What is the velocity of the ball immediately after launch?

b. What is the velocity of the ball when it has reached its maximum height in terms of its initial speed v?

c. What is the maximum height the ball reaches?

PROBLEM 4 (10 points).

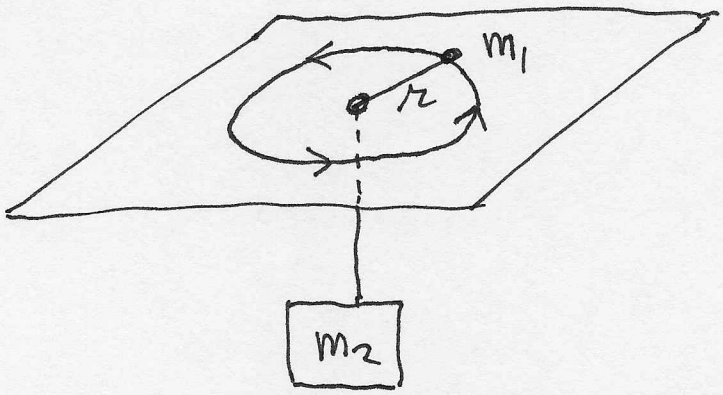
A woman is in the process of moving to a different house and has a bunch of heavy boxes resting on her floor. She tries to move one by pushing it with a horizontal force. The box weighs 100 N. She finds that if she pushes with 1, 5, 10, or 15 N of force that she cannot move the box. However if she pushes with a force of 20 N the box does move.

a. Based upon this information calculate what values the static coefficient of friction can have.

b. Based upon this information calculate what values the kinetic coefficient of friction can have.

PROBLEM 5 (15 points).

Below is an image showing a puck of mass m_1 on a frictionless table. The puck is attached to a hanging mass of mass m_2 by a massless string which is threaded through a hole in the center of the table. There is no friction between the string and the hole in the table. The puck is spun at a constant speed v in a circle of radius r about the hole such that the hanging mass does not move up or down. What is the tension in the string?



PROBLEM 6 (15 points)

A rider of mass m is in a seat on a Ferris wheel of radius R that moves at a constant speed. He is always upright. What is the speed of the Ferris wheel if the magnitude of the normal force from the seat upon him is three times his weight when the seat is at its lowest point?