2048 H   Exam #2

Name:

There are 5 questions: Please check first.

Please write out your solutions and your thought process if you want to receive partial credits

☆ PROBLEM #2   MASS OF BLOCK = 10kg

Problem 1:

We have three freeze frame picture of the following physical situation without friction. In frame 1, we have a spring with k=16N/m compressed by 1m. M=10 kg and m=4 kg. All surfaces are frictionless. At some point, the spring is released and it launches the mass: this is depicted in frame 2.

(a) Find the initial mechanical energy of the system. [5 pts]
(b) What are the conserved quantities between frame 1 (with the compressed spring) and frame 2? Write your conservation statement in mathematics. [5 pts]
(c) In frame 2, what are the velocities of the ball and the platform? Please indicate directions. [5pts]
(d) In frame 3, the ball is caught by a pocket curved into the platform. What is the conserved quantities between frame 2 and 3? What is the velocity of the platform now? [5pts]
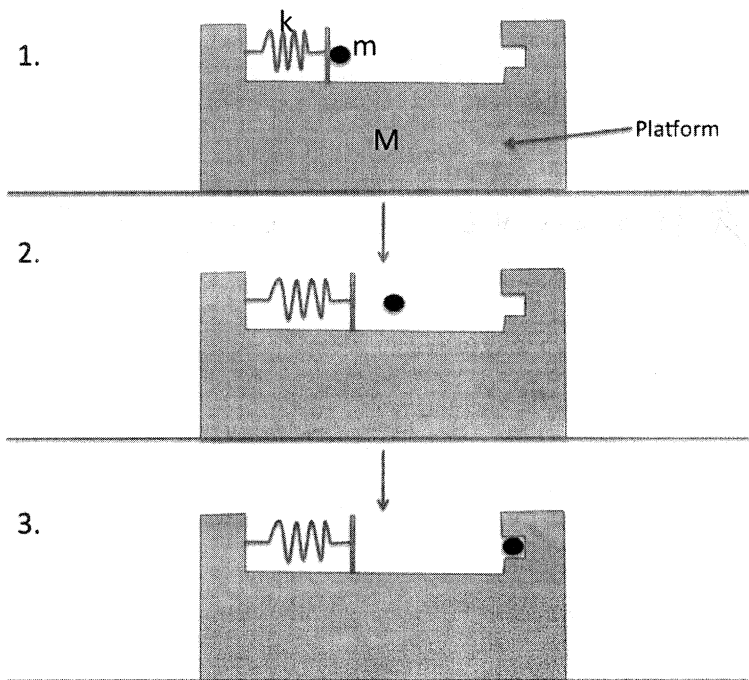
Problem 2

Object is sliding around with a constant speed along a ramped circular track as depicted below. R = 30 m and θ = 45°.
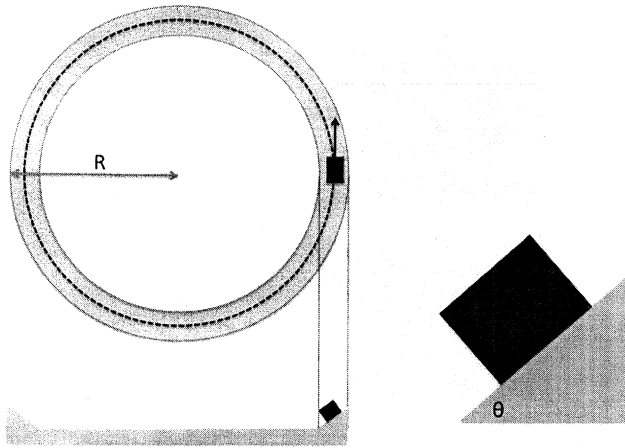

(a) Draw Force Diagram for this situation. Please note that I am grading and I like big pictures. [4 pts]

(b) Write down the mathematical expression for the force acting on this block in terms of θ,v, and R. [4 pts]

(c) Calculate velocity, v. [6 pts]

(d) Calculate normal force exerted by the track on the block [6 pts]

Whoops Supply 10kg = m

Problem 3

Two small cannon balls each with m=1kg and velocity v=10m/s are being successively shot into a massive blob, with M=9kg, which totally absorb the balls. The surface is frictionless and the blob starts at rest. Only consider motion in 1-D.
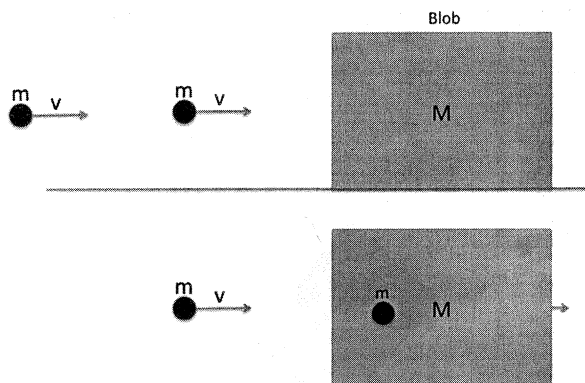
(a) How would you classify this collision: elastic or inelastic? What are the conserved quantities? [4 pts]
(b) Calculate the velocity of the blob after it absorbs the first cannon ball [8 pts]
(c) Calculate the velocity of the blob after it absorbs the second cannon ball [8 pts]

Problem 4: A particle is under influence of potential $U(x) = -x^3 + x + 2$.
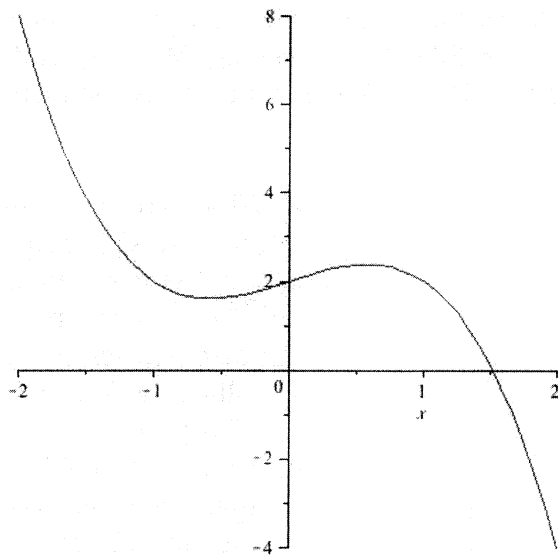
(a) Calculate exact positions for equilibrium positions for this potential [4 pts]
(b) State and classify these positions into state or unstable equilibrium [4 pts]
(c) Calculate force due to this potential at x=1 [6 pts]
(d) If the particle starts moving to −x direction under this potential at x=4 with initial total energy of 4 J, what is its velocity at x=0? Assuming that the mass of the particle is 2 kg [6 pts]

Problem 5: Modified Executive Toy

As shown in the figure here, Masa has decided to modify the executive toy simply to torment the students in 2048H. m = 1 kg, M=4 kg, and h =1m. Length of the rope to the top is 10m. Assume no air resistance and all collisions are elastic.
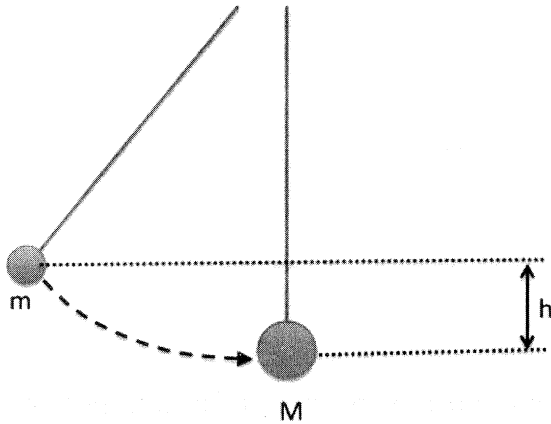
(a) What are the conserved quantities? [4pts]
(b) What is the velocity of the little mass m at the bottom when it is about to collide with the big mass M? [4pts]
(c) After the collision how high will M rise from bottom? [6 pts]
(d) How high will m rise from bottom? [6 pts]