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 = 10 kg
Problem 1:

We have three freeze frame picture of the following physical situation without friction. In frame 1, we have a spring with $k=16\text{N/m}$ compressed by 1m. $M=10\text{ kg}$ and $m=4\text{ kg}$. 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. [5 pts]
(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? [5 pts]
Problem 2

Object is sliding around with a constant speed along a ramped circular track as depicted below. \( R = 30 \text{ m} \) and \( \theta = 45^\circ \).

(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 \( \theta, v, \) and \( R \). [4 pts]
(c) Calculate velocity, \( v \). [6 pts]
(d) Calculate normal force exerted by the track on the block [6 pts]

\[ \text{Normal Force} \]
Problem 3

Two small cannon balls each with $m=1\text{kg}$ and velocity $v=10\text{m/s}$ are being successively shot into a massive blob, with $M=9\text{kg}$, 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. $m = 1 \text{ kg}$, $M = 4 \text{ kg}$, and $h = 1 \text{ m}$. Length of the rope to the top is $10 \text{ m}$. Assume no air resistance and all collisions are elastic.

(a) What are the conserved quantities? [4 pts]
(b) What is the velocity of the little mass $m$ at the bottom when it is about to collide with the big mass $M$? [4 pts]
(c) After the collision how high will $M$ rise from bottom? [6 pts]
(d) How high will $m$ rise from bottom? [6 pts]