MID-TERM EXAM

Question 1 (3 + 3+ 3 pts)

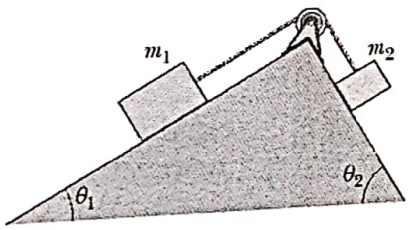
Here are three vectors in meters:

$$\vec{d}_1 = -3.0\hat{i} + 3.0\hat{j} + 2.0\hat{k}$$
$$\vec{d}_2 = -2.0\hat{i} - 4.0\hat{j} + 2.0\hat{k}$$
$$\vec{d}_3 = 2.0\hat{i} + 3.0\hat{j} + 1.0\hat{k}.$$

What results from (a) $\vec{d}_1 \cdot (\vec{d}_2 + \vec{d}_3)$, (b) $\vec{d}_1 \cdot (\vec{d}_2 \times \vec{d}_3)$, and (c) $\vec{d}_1 \times (\vec{d}_2 + \vec{d}_3)$?

Question 2 (14 pts)

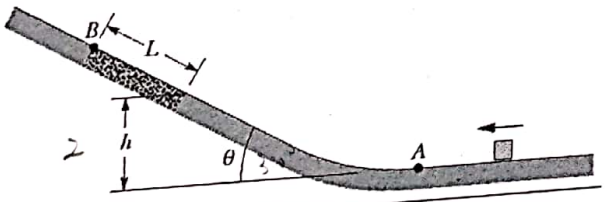
Figure shows a box of dirty money (mass $m_1 = 3.0$ kg) on a frictionless plane inclined at angle $\theta_1 = 30°$. The box is connected via a cord of negligible mass to a box of laundered money (mass $m_2 = 2.0$ kg) on a frictionless plane inclined at angle $\theta_2 = 60°$. The pulley is frictionless and has negligible mass. What is the tension in the cord?



Question 3 (15 pts)

In Fig., a block slides along a path that is without friction until the block reaches the section of length L= 0.75 m, which begins at height h = 2.0 m on a ramp of angle θ = 30°. In that section, the coefficient of kinetic friction is 0.40. The block passes through point A with a speed of 8.0 m/s. If the block can reach point B (where the friction ends), what is its speed there, and if it cannot, what is its greatest height above A?

$f_k = 0.4$



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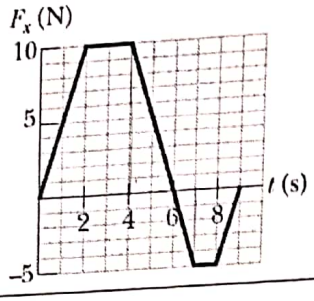
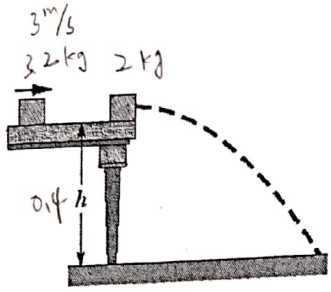
Question 4 (4 + 2 + 4 pts)

A 5.0 kg toy car can move along an x axis; Fig. gives F_x of the force acting on the car, which begins at rest at time $t = 0$. In unit-vector notation, what is $\vec{p}$ at (a) t = 4.0 s and (b) t = 7.0 s, and (c) what is $\vec{F}$ at t = 9.0 s?



Question 5 (12 pts)

In Fig. , a 3.2 kg box of running shoes slides on a horizontal frictionless table and collides with a 2.0 kg box of ballet slippers initially at rest on the edge of the table, at height h = 0.40 m. The speed of the 3.2 kg box is 3.0 m/s just before the collision. If the two boxes stick together because of packing tape on their sides, what is their kinetic energy just before they strike the floor?



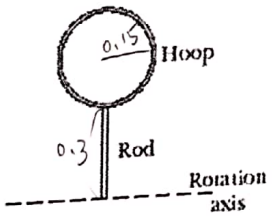
Question 6 (8+ 12 pts)

a)Prove that $I_{com} = mL^2/12$ for rod and $I_{com} = mR^2/2$ for hoop

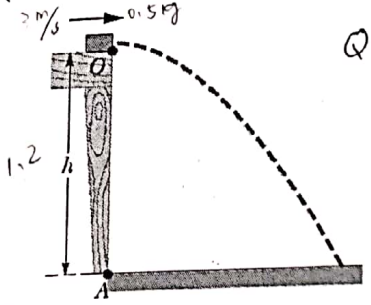
b) Use results for part (a) for the question below:

Figure shows a rigid assembly of a thin hoop (of mass m and radius R = 0.150 m) and a thin radial rod (of mass m and length L = 2.00R). The assembly is upright, but if we give it a slight nudge, it will rotate around a horizontal axis in the plane of the rod and hoop, through the lower end of the rod. Assuming that the energy given to the assembly in such a nudge is negligible, what would be the assembly's angular speed about the rotation axis when it passes through the upside-down (inverted) orientation?

Question 6



Question 7



Question 7 (5+ 5 + 5 + 5 pts)

In Fig., a small 0.50 kg block has a horizontal velocity $\vec{v}_0$ of magnitude 3.0 m/s when it slides off a table of height h = 1.2 m. Answer the following in unit-vector notation for a coordinate system in which the origin is at the edge of the table (at point O), the positive x direction is horizontally away from the table, and the positive y direction is up. What are the angular momenta of the block about point A (a) just after the block leaves the table and (b) just before the block strikes the floor? What are the torques on the block about point A (c) just after the block leaves the table and (d) just before the block strikes the floor?

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