Indonesian Physics Olympiad Selection Test 2019 District Stage

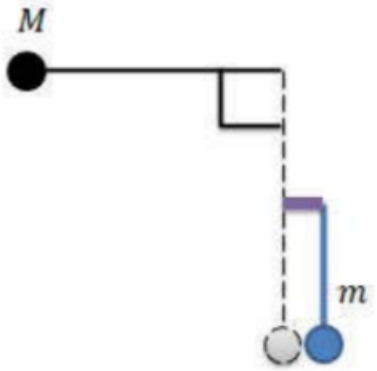
Translated by Sayed Aulia

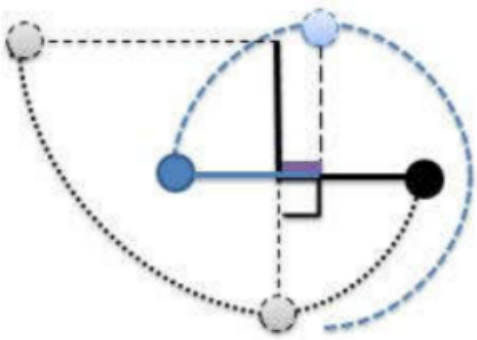
1. (10 Points)

Analyze the system that consists of two pendulums. The first pendulum has mass M and length $2L$, and the second pendulum has mass m and length L, as seen in the figure below. The first pendulum is released from angle 90° and collides with the second pendulum. After collision, the first pendulum reaches 90°, whereas the second pendulum managed to rotate in a full circle. Determines:

a. The coefficient restitution e and

b. The ratio of the two masses, M/m





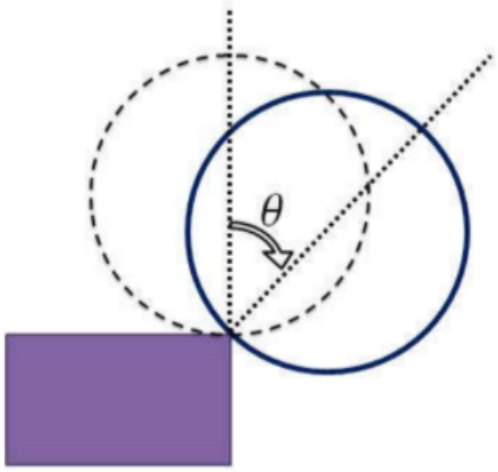
2. (10 Points)

A hollow cylinder with radius r and mass m is located at the edge of a table. If the cylinder rolled down from rest then loses contact with the table at angle θ. Determine:

a. The following θ

b. The velocity of center of mass at that point

The acceleration of gravity g is known.



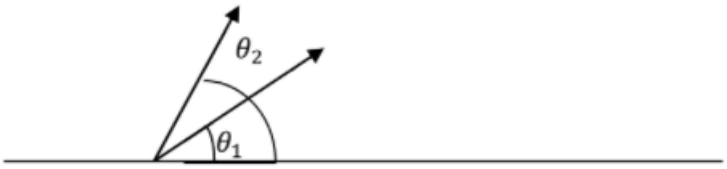
3. (15 Points)

Four cars A, B, C, D respectively are driving in a two-way direction highway (East-West) with a constant velocity. car A, car B, and Car C are driving toward the east, while car D is driving toward the west. It is known:
· Car A passes through car B at 10.00.
· Car A passes through car C at 11.00.
· Car A is in the same position as car D at 12.00.
· Car B is in the same position as car D at 14.00.
· Car C is in the same position as car D at 16.00.
a. Determine the time when car B passes through car C.
b. At a certain time interval analysed from east to west, the order of the cars are A-D-B-C, determine when car B is located exactly in the middle of car D and car C

4. (15 Points)

Two objects initially are located above a surface at the same position (Assume the objects as particle). At time $t = 0$ the two objects are given velocity v_1 and v_2 respectively. The velocity of the first object makes an angle θ_1 with respect to the horizontal and the velocity of the second object makes an angle θ_2 with respect to the horizontal as seen in the figure.
a. Determine the requirement for the magnitude and the angle of released of the two objects for the velocity of the two objects perpendicular at least once!
b. If the velocity of the two objects becomes perpendicular to each other happened twice, determine the time interval!

c. Determine the displacement of the first object from the first occurrence to the second occurrence!
d. Determine the displacement of the second object from the first occurrence to the second occurrence!

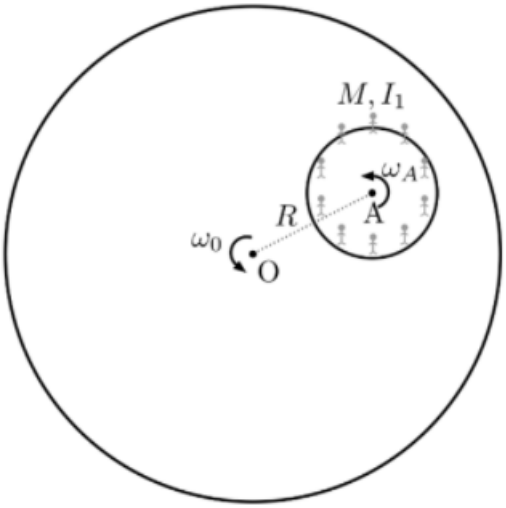


5. (13 Points)

In a reference frame (earth) that rotates about O with angular velocity ω_0, there exist a platform A which is located at distance R from the center of reference O. Assume that the platform rotate without friction from it axis. Above platform A, there exist some people which spread across the edge of the platform, so that it has total mass of M (Assume the center of mass is located exactly above the axis) and the moment inertia I_1. Initially, the platform moves together with the reference frame (earth), so that $w_{A,O} = 0$ (There is no relative motion between platform A in respect to the reference frame O). But, if analyzed from a non-inertial reference frame (For example from space), the platform rotates with angular velocity $\omega'_{A,NI} =_0$ and also revolves about the center of reference O.

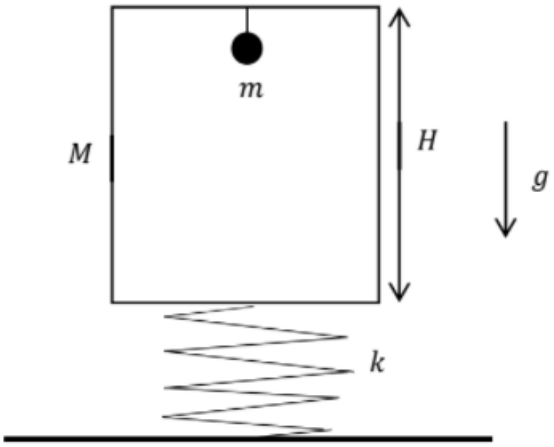
Like the particles of tornado that rotate and move toward their center (where pressure is lower) the people move toward the center of platform A, so that the moment inertia of platform A decreased to I_2. Assume the center of mass does not change along the motion, Determine:

a. Final angular velocity A($w_{A,O}$) relative to the reference frame (earth)! Declare your answer in M, R, I_1, I_2, and ω_0. Is the rotation clockwise or anti-clockwise?
b. Energy that must be released by those people to change the moment inertia of platform A from I_1 to I_2? Declare your answer in M, R, I_1, I_2, and ω_0.



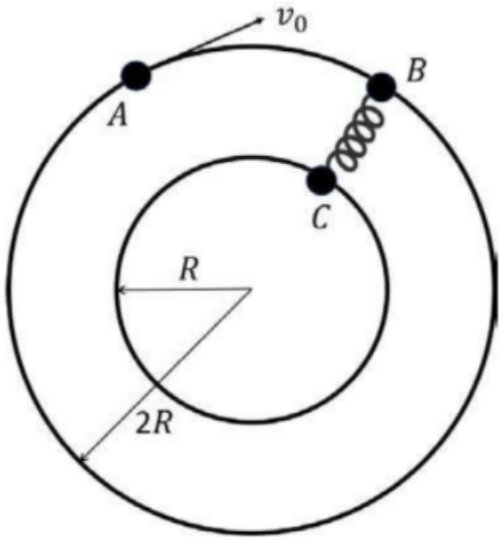
6. (12 Points)

A small object of mass m is tied to a ceiling of a room with a rope which length is negligible. The room has mass M and has height H and located above a spring with spring constant k. The system is in equilibrium. at $t = 0$ the rope is cut so that mass m fall with acceleration g relative to ground. Assume the value of M is very large. Determine the time it takes for mass m to hit the surface of the room. (Hint: for a small value of x, $\cos x \approx 1 - x^2/2$),



7. (12 Points)

Three particles A, B, and C that have the same mass m can slide along the Circular smooth path in a horizontal platform as seen from the figure below. Particle B and C are connected with a spring with spring constant k and natural length R. Initially the B and C system is in equilibrium along the radial line and particle A moved with velocity v_0. If the coefficient restitution between A and B is e, determine the maximum extension of the spring throughout the motion.

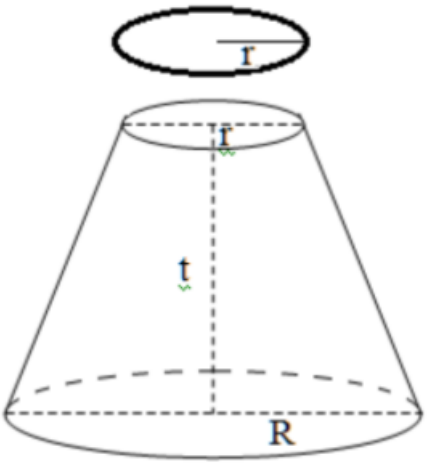


8. (13 Points)

A homogeneous rubber has mass m and can be thought as a spring which has spring constant k. When the rubber is in its unstretched condition, the rubber shape looks like a ring with radius r (Ignore the size of the cross section of the rubber), And then the rubber is placed horizontally at the smooth surface of a cut cone with the top radius of r, and the bottom radius of $R > r$ and with height t, Acceleration of g directed to the bottom. Determine:

a. The extension of the radius of the rubber declared in $m, g, k, r, R, andt.$

b. The height of the rubber from the bottom of the cone.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