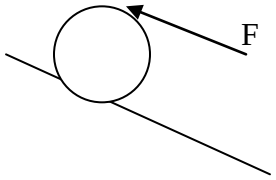
Physics 110

Practice Problems for Exam 3

Problems

1. A uniform cylinder of 0.5 kg mass and 5 cm radius lies on an inclined plane with a 30^o angle of inclination.

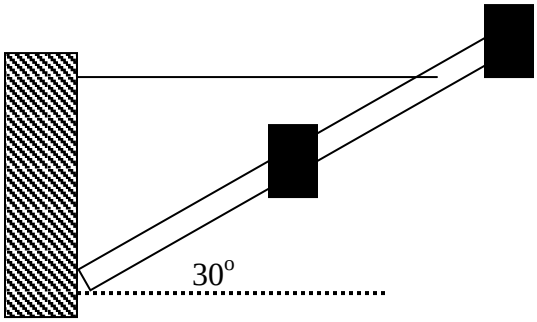
a) Draw a carefully labeled free-body diagram for the cylinder when at rest at its initial height of 1.5 m and calculate the external force F that must be applied to the cylinder as shown to keep it from rolling.



b) If this external force is now removed, use conservation of energy principles to find the speed of the cylinder's center at the bottom of the incline.

c) What is the cylinder's angular momentum at the instant that it reaches the bottom of the incline?

2. A light 4 m long rod is hinged (frictionless) at one end, has two weights attached (one of 2 kg fastened at its center and one of 4 kg fastened at its other end), and is held in place at a 30^o angle by a horizontal cable fixed at ¾ of the way along the rod from the hinge as shown.



a) Find the tension in the cable

b) If the cable is cut, find the initial angular acceleration of the rod.

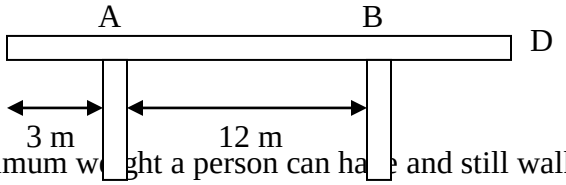
3. A bottle of saline solution (with a specific gravity of 1.02) is attached to a 1.2 m long piece of tubing with a 1.0 cm inner diameter.

a) If the tubing is held vertically, filled with saline, and clamped at the bottom, what is the gauge pressure at the bottom of the tube and what would be the initial efflux velocity of the saline if the clamp was released. (Take the height of the saline solution in the bottle to be 10 cm)

4. Water flows through a horizontal Venturi tube with a section with a large inner radius of 2.5 cm and a section with a smaller inner radius of 1 cm that is 4 cm long. If the flow rate into the larger diameter section of the tube is 30 cm^3/s, find the following (neglecting the viscosity of water):
a) the water speed in both the larger and smaller cross-sections of the tube
b) the water pressure difference between the two sections of the tube
c) What is the buoyant force on a spherical bubble of 0.1 mm radius trapped within the tube?

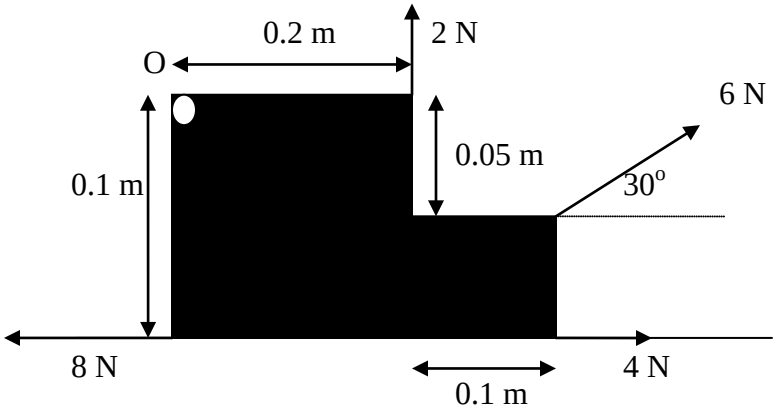
5. Water is being pumped through a horizontal pipe of 1 cm inner diameter by a gauge pressure equal to one tenth of atmospheric pressure so that the flow rate is equal to 1000 cm^3/min.
a) Find the velocity of the water (neglecting viscosity).
b) In a region where dirt has accumulated and the inner diameter is reduced by half, find the internal gauge pressure in the water

6. A 20m long uniform beam weighing 600 N is supported on two 3 m long concrete columns A and B each having a cross-sectional diameter of 10 cm as shown.



a) Find the maximum weight a person can have and still walk to the extreme end D without tipping the beam.
b) Find the forces that the columns A and B exert on the beam when the same person is standing at a point 2m to the right of B.

7. a) Three uniform spheres of radii R, 2R, and 3R lie in contact with each other from left to right in the order given with their centers along the x-axis. Remembering that the volume of a sphere is given by $4/3\ \pi r^3$, find the position of the center of mass of the three spheres as measured from the left edge of the smallest sphere.
b) Find the net torque on the object shown about the pivot point O. (Hint: Look at the two components of the 6N force separately.)



8, A 50 cm outer diameter tire on a bicycle has a 0.05 kg piece of chewing gum stuck to its edge.
a) If the bike starts from rest and attains a linear speed of 6 m/s in 30 s by a uniform acceleration, what was the angular acceleration of the gum?
b) How many revolutions did the wheel make in that time?
c) What were the tangential and radial components of the gum's acceleration at the end of the 30 s?
d) How large must the force from the tire on the gum have been for it to remain stuck on the tire during the entire acceleration?

9. A student sits on a freely rotating stool holding two weights, each of which has a mass of 3.00 kg. When his arms are extended horizontally, the weights are 1.00 m from the axis of rotation and he rotates with an angular speed of 0.750 rad/s. The moment of inertia of the student plus stool is 3.00 kgm^2 and is assumed to be constant. The student pulls the weights inward horizontally to a position 0.300 m from the rotation axis.
(a) Find the new angular speed of the student.
(b) Find the kinetic energy of the rotating system before and after he pulls the weights inward.

Link to answers