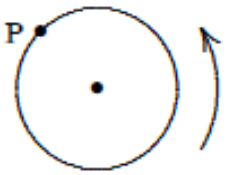
Physics I

Set no. 7

Please assume that g = 10 m/s^2 (magnitude the acceleration due to gravity) unless otherwise stated

1. A wheel (with radius R = 20 cm) turns at a constant rate completes n = 100 revolutions in t = 10 s. Please find its angular speed and normal acceleration of points on the edge of the wheel.

2. The figure shows a cylinder of radius 0.7m rotating about its axis at 10 rad/s. Please find the speed of the point P.



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E 3. A wheel starts from rest and spins with a constant angular acceleration. As time goes on the acceleration vector for a point on the rim (please choose):

   A) decreases in magnitude and becomes more nearly tangent to the rim

   B) decreases in magnitude and becomes more nearly radial

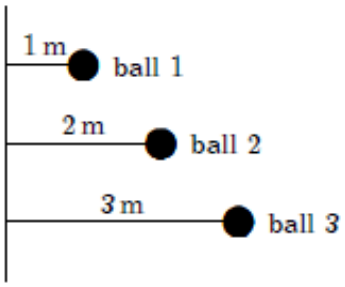
   C) increases in magnitude and becomes more nearly tangent to the rim

   D) increases in magnitude and becomes more nearly radial

   E) increases in magnitude but retains the same angle with the tangent to the rim

E 4. A wheel (radius R = 40 cm) starts from rest and spins with a constant angular acceleration ε = 2 rad/s^2. Please find the time after which the normal acceleration will be twice the tangent acceleration.

E 5. Three identical balls are tied by light strings to the same rod and rotate around it, as shown below. Please rank the balls according to their rotational inertia, least to greatest.



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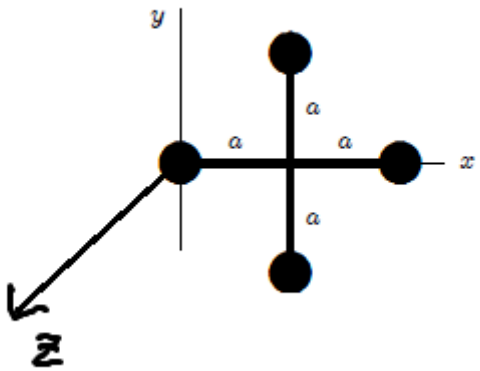
6. Four identical particles, each with mass m, are arranged in the x, y plane as shown (m = 2 kg and a = 1 m). They are connected by light sticks to form a rigid body. Please calculate:



a) the rotational inertia of this array about the x axis,
b) the rotational inertia of this array about the y axis,
c) the rotational inertia of this array about the z axis,
d) the tensor of inertia at this position.

7. The rotational inertia of a disk about its axis is I = 0.7 kg $\cdot m^2$. Please find the rotational inertia of the ring when a m = 2-kg weight is added to its rim, r = 0.40m from the axis.

8. When a thin uniform stick of mass M and length L is pivoted about its midpoint, its rotational inertia is $I_0 = ML^2/12$. Please determine the rotational inertia when this mass is pivoted about a parallel axis through one end. Use Steiner's theorem.

9. The rotational inertia of a solid uniform sphere about a diameter is $I_0 = (2/5)MR^2$, where M is its mass and R is its radius. Please find the rotational inertia if the sphere is pivoted about an axis that is tangent to its surface. Use Steiner's theorem.

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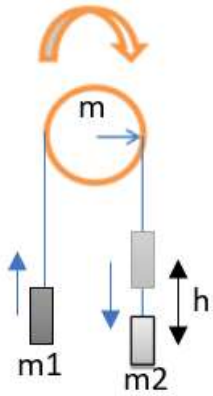
10. A weightless thread is thrown over a disc of mass m with a horizontal axis of rotation. At its ends hang two bodies of masses m_1 and m_2. Please calculate the acceleration of both bodies and the speed they will have after a distance h.



11. The full cylinder is rolling down a slope of length S and height H.

a) What is the moment of inertia of a cylinder with radius R = 0.25 cm and mass m = 70 kg?

b) Please calculate the acceleration and velocity of the cylinder at the bottom of the slope.

E 12. A sphere and a cylinder of equal mass and radius are simultaneously released from rest on the same inclined plane sliding down the incline. Then (please choose):

A) the sphere reaches the bottom first because it has the greater inertia

B) the cylinder reaches the bottom first because it picks up more rotational energy

C) the sphere reaches the bottom first because it picks up more rotational energy

D) they reach the bottom together

E) none of the above is true

E 13. A hoop, a uniform disk, and a uniform sphere, all with the same mass and outer radius, start with the same speed and roll without sliding up identical inclines. Please rank the objects according to how high they go, least to greatest.

E 14. The tortoise with a mass of m was in the center of the disc rotating at an angular velocity of ω_1. Please calculate the angular velocity of the disc when the turtle reached its edge. Assume that the moment of inertia of the turtle relative to the axis passing through center of the disc is $I_t = mr^2$ (the turtle can be treated as a single mass point). The radius of the shield is R, its mass - M.