Quiz 8, Physics 2a, Nov 19 2010

Double check that you bubble in your code number correctly.

If there's a mistake, your score will be lowered –as a penalty.

In case you forgot to write these down in your formula sheet:

$$I = \begin{cases} \frac{1}{12}ML^2 & \text{rod through center} \\ \frac{1}{3}ML^2 & \text{rod through end} \\ \frac{1}{2}MR^2 & \text{solid cylinder} \\ \frac{2}{5}MR^2 & \text{solid sphere} \\ \frac{2}{3}MR^2 & \text{thin walled hollow sphere.} \end{cases}$$

VERSION A

1. A bowling ball rolls up a ramp, without slipping. Let $\widehat{i}$ be a unit vector pointing in the horizontal direction of the ball's motion. Let $\widehat{j}$ be a unit vector in the vertical direction, pointing up. As usual, $\widehat{k} = \widehat{i} \times \widehat{j}$. Define $\omega = |\vec{\omega}|$ and $\alpha = |\vec{\alpha}|$ (where, as usual, $|\vec{v}|$ denotes the magnitude of a vector $\vec{v}$). Which of the following is true?
   (a) $\vec{\omega} = \omega\widehat{k}$, $\vec{\alpha} = \alpha\widehat{k}$.
   (b) $\vec{\omega} = -\omega\widehat{k}$, $\vec{\alpha} = \alpha\widehat{k}$.
   (c) $\vec{\omega} = \omega\widehat{k}$, $\vec{\alpha} = -\alpha\widehat{k}$.
   (d) $\vec{\omega} = -\omega\widehat{k}$, $\vec{\alpha} = -\alpha\widehat{k}$.

2. Same setup. Which forces exert a **non-zero** torque on the ball while it is rolling up the ramp?
   (a) Friction only.
   (b) Friction and gravity.
   (c) Friction and gravity and the normal force.
   (d) Gravity and the normal force.

3. Same setup. Suppose that the bowling ball was initially rolling without slipping horizontally at $\vec{v} = v\widehat{i}$, with $v = 10m/s$, before it gets to the ramp. Approximately how high up the ramp (in the vertical direction) will the ball go, assuming that it continues to roll without slipping?
   (a) 7 meters
   (b) 5 meters
   (c) 10 meters
   (d) 3 meters

4. Same setup, again with a bowling ball initially rolling without slipping horizontally at $\vec{v} = 10m/s\widehat{i}$ before it gets to the ramp. But now suppose that the ramp is coated with a special material (BAM) making the ramp frictionless. Now approximately how high up the frictionless ramp does the ball go?
   (a) 7 meters
   (b) 5 meters
   (c) 10 meters
   (d) 3 meters

5. Same setup, but replace the bowling ball with a **thin-walled hollow** cylinder, and take the ramp to have friction, so the cylinder rolls up it **without slipping**. Now approximately how high up does the cylinder go?
   (a) 7 meters
   (b) 5 meters
   (c) 10 meters
   (d) 3 meters

6. A $4kg$ bunch of bananas is attached to an approximately massless string, which winds around a wheel of mass $5kg$ and radius $0.5m$. The wheel has a peculiar, non-uniform mass distribution, and its moment of inertia is 1.0 $kg\ m^2$. As the mass falls, the string turns the wheel, without slipping. What is the approximate downward acceleration of the bananas?
   (a) $5m/s^2$.
   (b) $3m/s^2$.
   (c) $7m/s^2$.
   (d) $9m/s^2$.

7. Same setup. What is the approximate tension in the string?
   (a) $28N$
   (b) $20N$
   (c) $4N$
   (d) $12N$.

8. A man, with his arms at his sides, is spinning on a light frictionless turntable. When he extends his arms:
   (a) his angular velocity increases.
   (b) his angular velocity remains the same.
   (c) his rotational kinetic energy increases.
   (d) his angular momentum remains the same.

9. A frictionless turntable, with moment of inertia $2kgm^2$, is initially spinning at 30 radians per second. A $4kg$ lump of clay is dropped from above, and it hits the turntable at a distance of $0.5m$ from the rotational axis, where it sticks. What is the final angular speed of the turntable and clay?
   (a) 30 radians per second.

(b) 15 radians per second.

(c) 12 radians per second

(d) 20 radians per second

10. Same setup. Let K_i be the initial rotational kinetic energy of the turntable, and let K_f be the final rotational kinetic energy of the turntable plus stuck clay. $K_i - K_f =$

(a) 0

(b) $300J$

(c) $900J$

(d) $500J$.

11. A force of $\vec{F} = (2\widehat{i} + 1\widehat{j})N$ is applied to the point $x = 3m$, $y = 4m$. The torque is

(a) $11\widehat{k}N\ m$

(b) $-11\widehat{k}N\ m$

(c) $5\widehat{k}N\ m$

(d) $-5\widehat{k}N\ m$

12. A grindstone in the shape of a solid disk has mass $80kg$ and radius $0.5m$. It is initially rotating at 20 radians per second. You press an ax against the rim with a normal force of $100N$ and the grindstone comes to rest in $5s$. What is the coefficient of friction between the ax and the grindstone (ignore friction in the bearings).

(a) 0.8

(b) 0.4

(c) 0.2

(d) 0.6.

13. How much energy was lost to heat, from the initial time to the final time when the wheel has stopped?

(a) $2000J$

(b) $1000J$

(c) $4000J$

(d) none of the above.

14. A solid uniform disk, a solid uniform sphere, and a hollow sphere start from rest at the same height and roll down a ramp. They reach the bottom in the order:

(a) disk, solid sphere, hollow sphere.

(b) solid sphere, hollow sphere, disk.

(c) solid sphere, disk, hollow sphere.

(d) hollow sphere, solid sphere, disk.