Racing Cylinders Module: Testing

This little document contains some ideas for testing for understanding of the concepts your students have dealt with in the *Racing Cylinders* Practical. They are just ideas, and will need some "fleshing out" depending on how you choose to organise your tests.

The Module emphasises how the moment of inertia, kinetic energy, etc. relates to the mass distribution and dimensions of the object. This is, of course, conceptually difficult for many students and we recommend testing their understanding with at least some non-numeric questions.

There are many scaling ideas that can be easily tested, such as:

- The dimension characterising the size of the object about its axis of rotation is **d**. If **d** is [doubled, halved], what effect does this have on the moment of inertia?
- Two [cylinders, spheres, cubes] are rotating about axes through their center of masses with equal angular speeds. They have the same dimensions and masses, but one is hollow and the other is solid. Which object has the [higher,lower] kinetic energy of rotation?
- Two [cylinders, spheres] are rolling with equal linear speeds. They have the same dimensions and masses, but one is hollow and the other is solid. Which has the [higher,lower] angular momentum?
- Two identical [cylinders, spheres, cubes] are rotating with equal angular speeds. One is rotating about an axis through its center of mass; the other is rotating about an axis parallel to the first one but a distance **d** away from it. Which has the greatest kinetic energy of rotation? [This question can be made harder by asking for an answer like: $\mathbf{I} + \mathbf{Md^2}$.]

The Module also discusses the fact that when a object is rolling the point in contact with the surface is stationary. Here is a possible question extending this discussion:

Wheels on a train or streetcar have a *flange* of a radius **R'** greater than the radius of the wheel **R**, which keeps the wheel on the track, as shown. If the wheel has a linear speed **v** to the right as shown, what is the speed of the point at the bottom of the flange?

[Answer: $-\mathbf{v}\,(\mathbf{R'} - \mathbf{R}) / \mathbf{R}$]

[You could also just ask for the direction of motion of that point. It is negative.]