Answer #283

The answer is (b): The period of oscillation will be less with the wheel free, as seen by clicking your mouse on the photograph at the left below.

For comparison with the original case, click your mouse on the photograph at the right.

This experiment illustrates the "*Parallel Axis Theorem*," which states that the moment of inertia of a rigid body about an arbitrary axis I is equal to the moment of inertia of its center of mass about the arbitrary axis added to the moment of inertia of the object rotating about its center of mass.

Suppose that the mass of the wheel m is much greater than that of the pendulum, the length of the pendulum is L and the bicycle wheel radius is r.

When the wheel is tied down so that it cannot rotate, according to the parallel axis theorem its moment of inertia is equal to $mL^2 + mr^2$.

When the wheel is free to rotate, its moment of inertia, is equal to mL^2. Because the wheel does not rotate, this pendulum is equivalent to a pendulum consisting of the mass of the wheel at the radius L. The moment of inertia is therefore mL^2.

The former is greater than the latter, so the pendulum will oscillate more slowly when the wheel is tied down and cannot rotate.

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For questions and comments regarding the *Question of the Week* contact Dr. Richard E. Berg by e-mail or using phone number or regular mail address given on the Lecture-Demonstration Home Page.