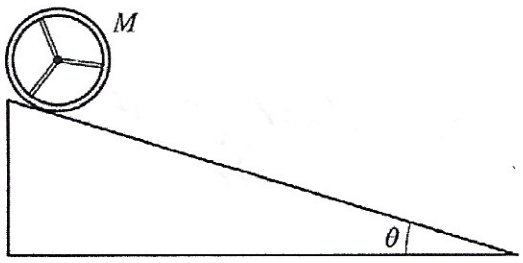
Name _____ Date _____

AP Physics AP Review #

Period _____ Mrs. Nadworny

AP Review # 21

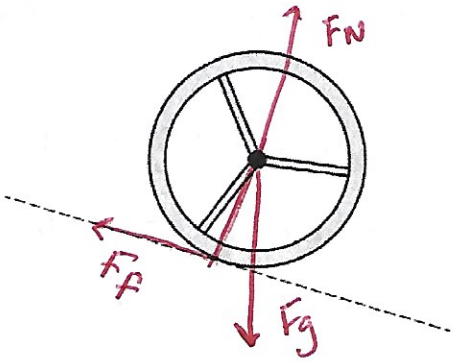


1. (7 points, suggested time 13 minutes)

A wooden wheel of mass M, consisting of a rim with spokes, rolls down a ramp that makes an angle θ with the horizontal, as shown above. The ramp exerts a force of static friction on the wheel so that the wheel rolls without slipping.

(a)

i. On the diagram below, draw and label the forces (not components) that act on the wheel as it rolls down the ramp, which is indicated by the dashed line. To clearly indicate at which point on the wheel each force is exerted, draw each force as a distinct arrow starting on, and pointing away from, the point at which the force is exerted. The lengths of the arrows need not indicate the relative magnitudes of the forces.



(1) F_g down

(1) F_f @ wheel
F_N diagonal

ii. As the wheel rolls down the ramp, which force causes a change in the angular velocity of the wheel with respect to its center of mass?

The force of static friction acts as a torque, causing a net angular acceleration

Briefly explain your reasoning.

(1) F_f is torque

(b) For this ramp angle, the force of friction exerted on the wheel is less than the maximum possible static friction force. Instead, the magnitude of the force of static friction exerted on the wheel is 40 percent of the magnitude of the force or force component directed opposite to the force of friction. Derive an expression for the linear acceleration of the wheel's center of mass in terms of M, θ, and physical constants, as appropriate.

(c) In a second experiment on the same ramp, a block of ice, also with mass M, is released from rest at the same instant the wheel is released from rest, and from the same height. The block slides down the ramp with negligible friction.

i. Which object, if either, reaches the bottom of the ramp with the greatest speed?

____ Wheel ____ Block ____ Neither; both reach the bottom with the same speed.

Briefly explain your answer, reasoning in terms of forces.

ii. Briefly explain your answer again, now reasoning in terms of energy.

b) $F_f = .4\,F_{g\parallel}$

(1) ΣF
(1) use $F_f = .4F_{g\parallel}$

$$a = \frac{F_{net}}{m} = \frac{F_f - F_{g\parallel}}{m} = \frac{.4F_{g\parallel} - F_{g\parallel}}{m}$$

$$= \frac{-.6\,m g \sin\theta}{m}$$

$$a = .6\,g\sin\theta$$

c) i) The block reaches the bottom with greater speed. Since the F_f is negligible, the acceleration is larger

(1)

ii) The block + wheel have the same gravitational potential energy at the top of the incline. for the block all of the U_g converts to K at the bottom of the ramp. for the wheel, some of the energy is used for rotational kinetic energy. This decreases the regular K, leading to a lower speed than the block.

(1)