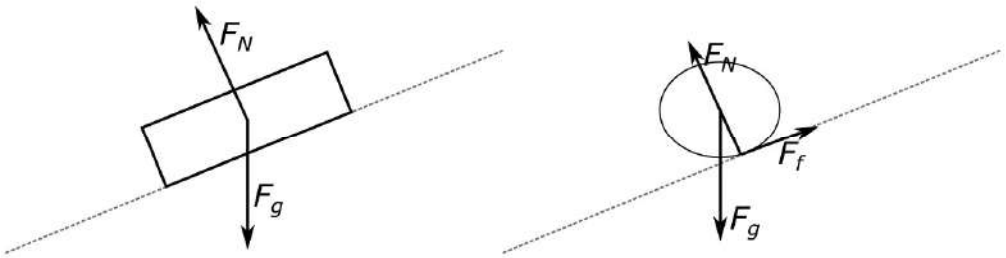
NAME _____ DATE _____

Scenario

A cart of mass M that slides across a surface with negligible friction, with initial speed v encounters an incline with an angle θ to the horizontal. At the same time, a wheel of mass M and radius R rolls with speed v without slipping and encounters an identical incline. Both the cart and the wheel reach the bottom of their respective inclines at the same time. The wheel does not slip as it rolls up the incline. Assume no energy is dissipated in the bearings in the cart.

Argumentation

PART A: The forces acting on the cart (shown as a rectangle) and the wheel (shown as a circle) are shown below while both objects are on their respective inclines. The incline is shown as a dotted line for reference.



i. Is the friction force acting on the wheel static or kinetic? Explain your reasoning.

ii. Explain why the friction force on the wheel points up the incline even though this is not the direction opposite to the wheel's translational motion.

PART B: Both the cart and the wheel will eventually come momentarily to rest at some point on their respective inclines. However, the wheel takes a longer time and travels a longer distance up its incline to come momentarily to rest than the cart does.

i. Explain why this happens in terms of the forces on the above diagrams.

ii. Explain why this happens in terms of conservation of energy principles.

PART C: While on the incline not including friction, the cart and wheel have identical forces $F_{||}$ acting on them directed down the incline. If it were determined that the frictional force on the wheel is 75% of the strength of $F_{||}$, and the cart travels a distance L up the incline before coming momentarily to rest, how far does the wheel travel in terms of L before coming momentarily to rest? Explain your method.