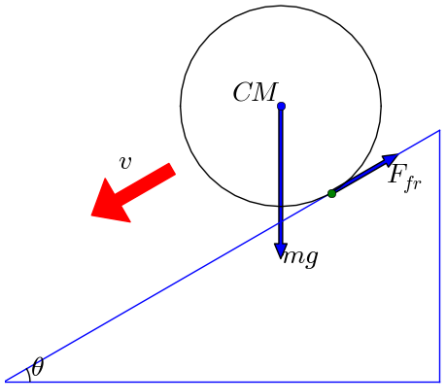
Part I

The direction of rolling friction w/o slippling

How to determine the direction of friction force acting on a rolling object? This is important and is ensential to solving the dynamics of rolling motions.

Case 1 *Round object freely rolling down the hill*

The only force that makes the object rotate is friction so friction has to go up the hill. This friction force is exerted on the wheel by the slope.



Case 2 *Object is forced to roll up the hill initially but external force is removed once the object is going upward. We are considering the later part of the motion when the external force is removed, so only gravitation is in place. The wheel is still rolling up the hill.*

The rotation of the object slows down as it climbs up the hill. Friction is the only force that produces a torque to slow down the rotation. So it needs to go against the rotating direction. So the friction force acting on the wheel is up the hill.

Case 3