Rolling Wheel without Slip
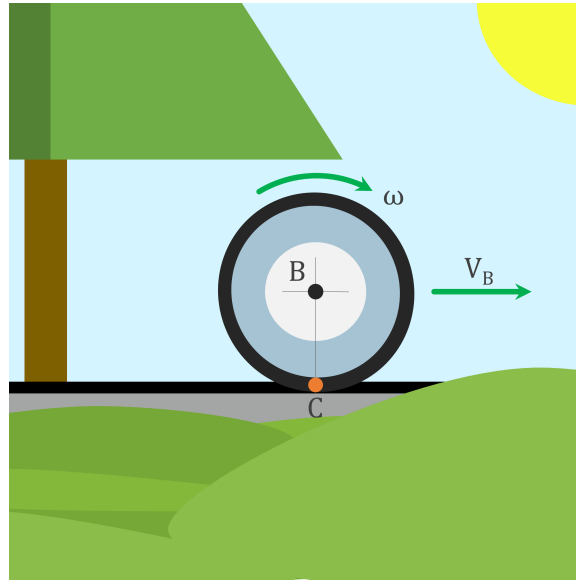

Find the velocity profile of a wheel that rotates without slipping.

Given:
Velocity at B: v_B
Angular velocity: ω

Since the rotating wheel does not slip, there is no horizontal movement of the wheel at the contact point C (with respect to the ground). This means that the contact point C also have a zero velocity (with respect to the ground). The resulting velocity profile is depicted in Figure 1.

If the wheel were to move either right or left, without any rotation, the wheel would skid along the ground. In this case, the contact point P has a velocity pointing towards the direction of the movement.

If the wheel were to purely slip across the surface, both bottom point C and top point have a velocity pointing in opposite directions. Resulting in a net zero movement of the middle point B, hence if the wheel would be purely slipping it would just rotate around its centre and does not move forward. The resulting velocity profile is depicted in Figure 2.
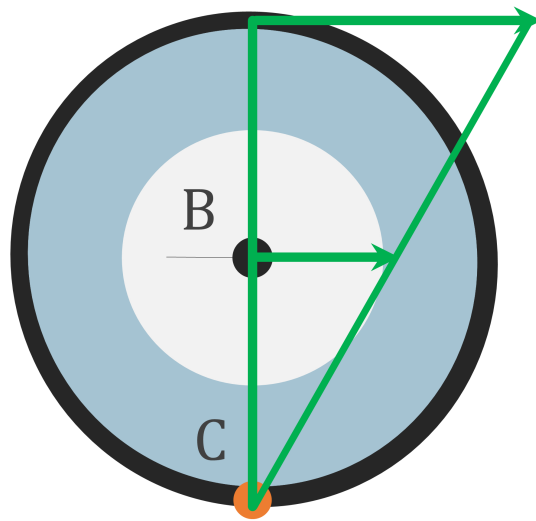
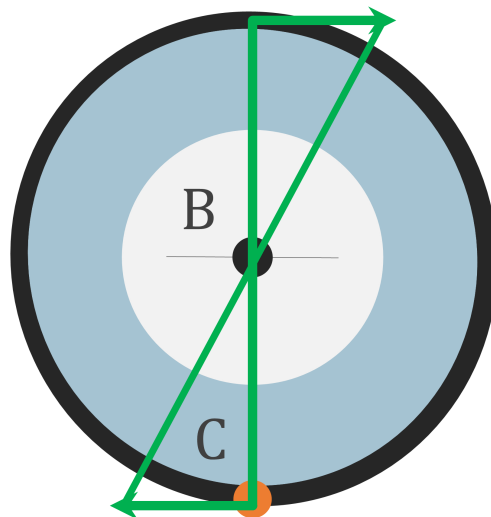Figure 1: Velocity profile of rolling wheel without slipping.

Figure 2: Velocity profile of rolling wheel in pure slip.