

MECH230 - Fall 2024

Recommended Problems - Set 14

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Rolling

Consider a circular object in contact with a surface. The circular object is said to be rolling without slipping with respect to the surface if the velocity of the contact points P of the sphere matches the velocity of the surface. The acceleration of point P is not O because the material point P is moving in time.

In this case, static friction would be acting at this point of contact.

You can understand this process geometrically by imagining a disk whose edge is coated with paint. As the edge of the disk touches a surface, paint is deposited from the disk on the surface. If the disk is rolling without slipping on a surface, then the length of the paint deposited on the surface is equal to the length of paint lost by the disk.

Sliding

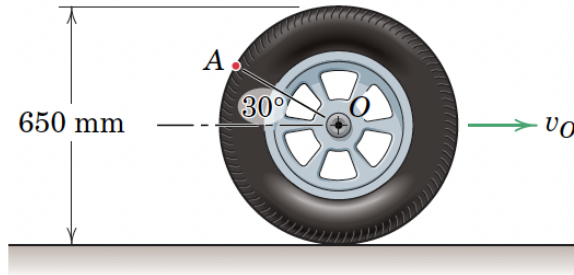
If a circular object is sliding with respect to a surface at their point of contact, then the different between their velocities at the contact point is called the slip velocity.

A kinetic friction force is being applied at this point.

These problems are taken from J. L. Meriam, L. G. Kraige, and J. N. Bolton (MKB), Engineering Mechanics: Dynamics, Ninth Edition, Wiley, New York, 2018.

1. [MKB 05-055]

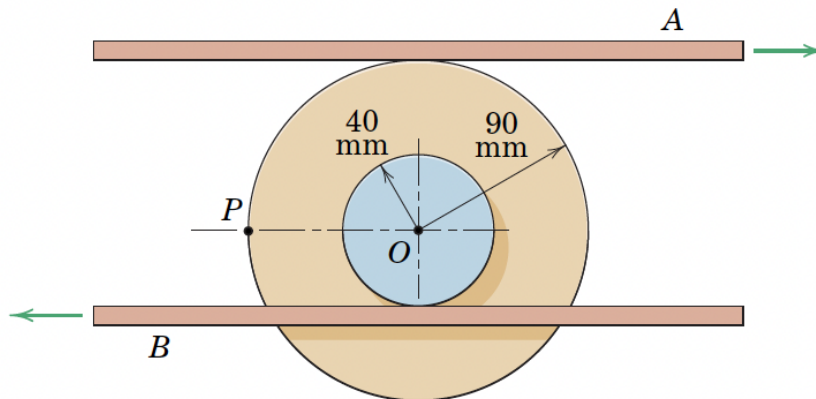
5/55 The magnitude of the absolute velocity of point A on the automobile tire is 12 m/s when A is in the position shown. What are the corresponding velocity v_O of the car and the angular velocity ω of the wheel? (The wheel rolls without slipping.)



PROBLEM 5/55

2. [MKB 05-087]

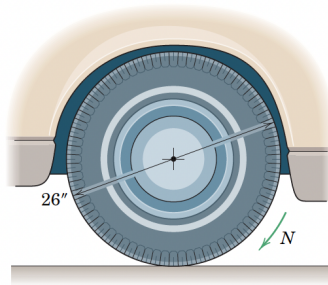
5/87 The attached wheels roll without slipping on the plates A and B , which are moving in opposite directions as shown. If $v_A = 60$ mm/s to the right and $v_B = 200$ mm/s to the left, determine the speeds of the center O and the point P for the position shown.



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3. [05-091]

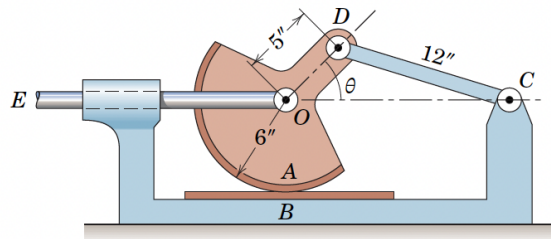
5/91 The rear driving wheel of a car has a diameter of 26 in. and has an angular speed N of 200 rev/min on an icy road. If the instantaneous center of zero velocity is 4 in. above the point of contact of the tire with the road, determine the velocity v of the car and the slipping velocity v_s of the tire on the ice.



PROBLEM 5/91

4. [05-093]

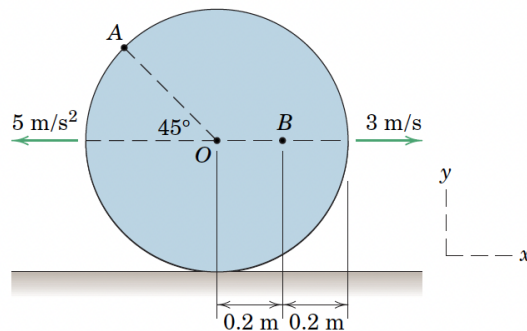
5/93 A device which tests the resistance to wear of two materials A and B is shown. If the link EO has a velocity of 4 ft/sec to the right when $\theta = 45^\circ$, determine the rubbing velocity v_A .



PROBLEM 5/93

5. [05-100]

5/100 The center O of the disk has the velocity and acceleration shown in the figure. If the disk rolls without slipping on the horizontal surface, determine the velocity of A and the acceleration of B for the instant represented.



PROBLEM 5/100