

Answer on Question #46810, Physics, Mechanics | Kinematics | Dynamics

Question:

A force F acts tangentially at top of a solid sphere of mass M kept on rough horizontal plane. If sphere rolls without slipping, acceleration of its center is: ($10F/7M$ is answer. But dont know how. Please help.)

Answer:

If sphere rolls without slipping:

$$\beta = \frac{a}{R}$$

where β is angular acceleration, a is acceleration of center of the sphere.

Newton's laws of motion:

$$(F + F_{fr})R = I\beta$$

$$F - F_{fr} = ma$$

where F_{fr} is force of friction, I is moment of inertia (for solid sphere $I = \frac{2}{5}mR^2$)

Assuming $\beta = \frac{a}{R}$:

$$(F + F_{fr}) = \frac{I}{R^2}a$$

$$F - F_{fr} = ma$$

Therefore:

$$2F = \frac{I}{R^2}a + ma$$

$$a = \frac{2F}{\frac{I}{R^2} + m} = \frac{2F}{\frac{2}{5}m + m} = \frac{10F}{7m}$$

Answer: $\frac{10F}{7m}$

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