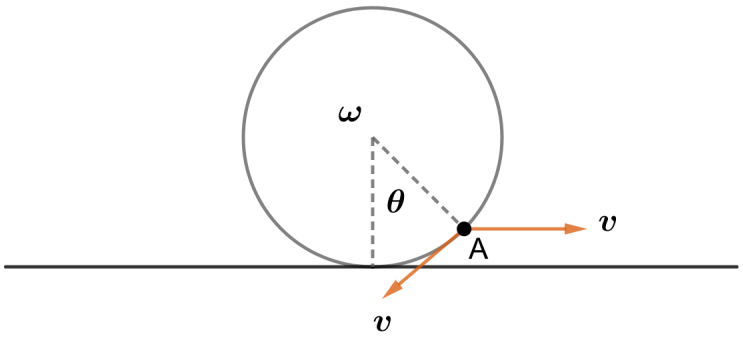
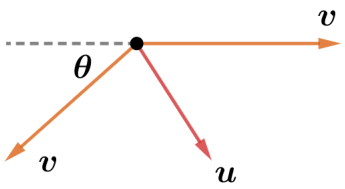
2019A F=ma Exam: Problem 9

Kevin S. Huang



Recall that rolling without slipping is the superposition of rotational motion with angular velocity ω and translational motion with velocity $v = \omega R$.



We have

$$u_x = v - v\cos\theta$$
$$u_y = v\sin\theta$$

so

$$u = \sqrt{u_x^2 + u_y^2} = v\sqrt{(1-\cos\theta)^2 + \sin^2\theta} = v\sqrt{2 - 2\cos\theta}$$
$$= 2v\sqrt{\frac{1-\cos\theta}{2}} = 2v\sin\frac{|\theta|}{2} = 2\omega R\sin\frac{|\theta|}{2}$$

and the answer is $\boxed{\text{E}}$.