2017 F=ma Exam: Problem 19

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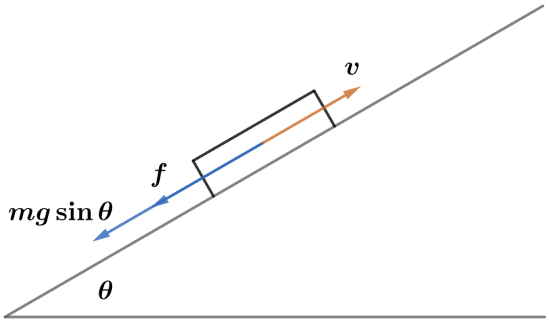
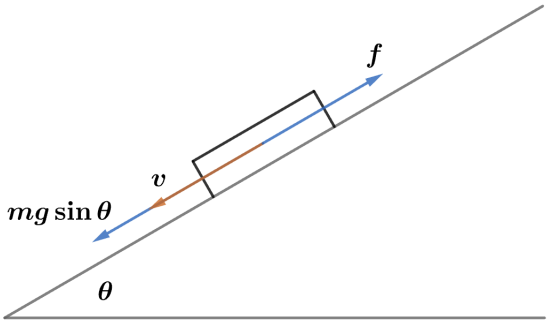


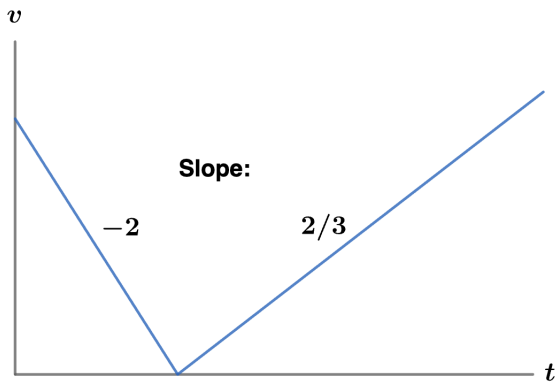
Going up the ramp, we have

$$F = -mg\sin\theta - f = -mg(\sin\theta + \mu\cos\theta)$$
$$a_{\text{up}} = -g(\sin\theta + \mu\cos\theta)$$



Going down the ramp, we have

$$F = mg\sin\theta - f = mg(\sin\theta - \mu\cos\theta)$$
$$a_{\text{down}} = g(\sin\theta - \mu\cos\theta)$$



From the v-t plot, we see that going up is associated with a slope of -2 while going down is associated with a slope of $2/3$. Since the slope of a v-t plot corresponds to the acceleration,

$$\frac{a_{\text{up}}}{a_{\text{down}}} = \frac{-2}{2/3}$$

where we took the ratio of accelerations (slopes) to produce a dimensionless quantity as we don't know the units of v and t in the plot. Then

$$\frac{-g(\sin\theta + \mu\cos\theta)}{g(\sin\theta - \mu\cos\theta)} = -3$$
$$\sin\theta + \mu\cos\theta = 3\sin\theta - 3\mu\cos\theta$$
$$4\mu\cos\theta = 2\sin\theta$$

Since $\theta = \pi/6$,

$$\mu = \frac{\tan\theta}{2} = \frac{1}{2\sqrt{3}} = 0.29$$

so the answer is $\boxed{\text{D}}$.