Spring 2014

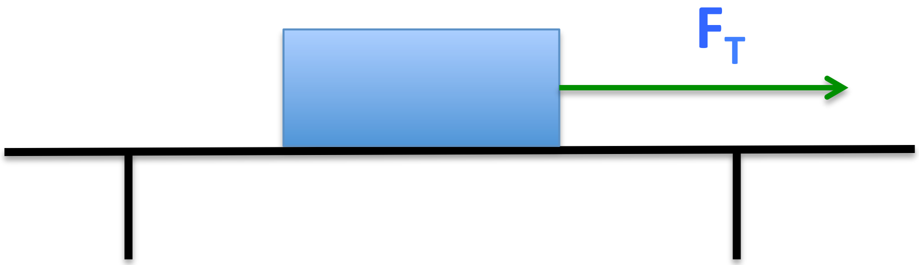
PHYS-2010

Lecture 19

Clicker Question

Room Frequency BA

A block of mass m on a rough table is pulled on by a string which exerts a horizontal force of magnitude F_T . The block does not move. The coefficient of static friction between block and table is μ_S.



What can you say about the size of the force of friction F_{fric} ?

A) $F_{fric} = \mu_s mg$

B) $F_{fric} = \mu_s mg + F_T$

C) $F_{fric} = F_T$

D) More than one of these is correct

E) None of these is correct

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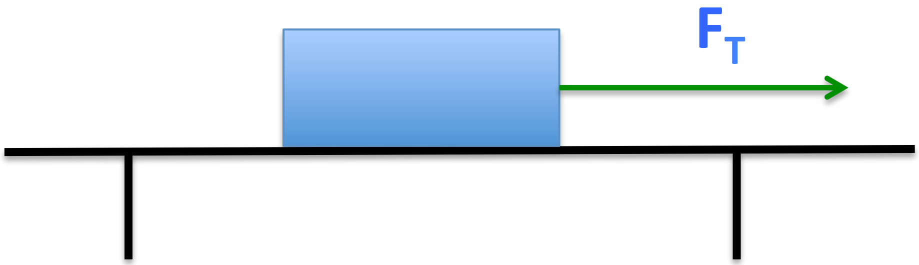

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Announcements

- Read Giancoli Chapter 5.
- **CAPA # 7** due next Tuesday at 11 pm.
- **Written homework # 5** due Friday at 4 pm.
- Prof. Pollock is out of town this Friday, **no office hours**.
- **Midterm II** will be on Thursday, March 6, at 7:30 pm.
- **Review session** will be held by Prof. Pollock and Rosemary Wulf on Tue. March 4, 5-6 pm, Duane G125.
- **Exam seating:**
  - if your TA is Rosemary Wulf or Andrew Hess, your exam is here, G1B30.
  - if your TA is Jake Fish or Clarissa Briner, your exam is next door, G1B20.
- More details about the exam are on the course website:

http://www.colorado.edu/physics/phys2010/phys2010_sp14/exams.html

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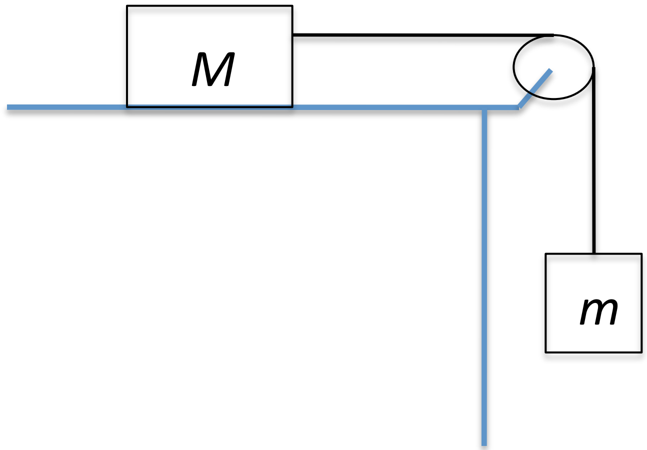

An object with mass *M* is resting on a rough table with coefficients of static and kinetic friction μ_S and μ_K, respectively.

Which of the following is a necessary condition to start the object in motion?

A) $M > m$

B) $M < m$

C) $mg > \mu_K Mg$

D) $Mg > \mu_S mg$

E) $mg > \mu_s Mg$

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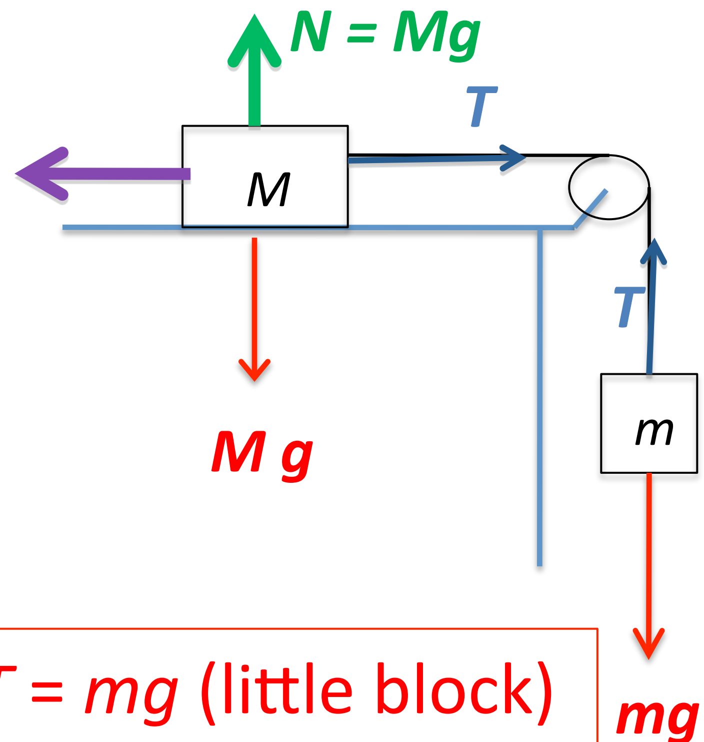
Room Frequency BA

$|f_{max}| = \mu_S N = \mu_S Mg$



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C) $mg > \mu_K Mg$

D) $Mg > \mu_S mg$

E) $mg > \mu_s Mg$

$T = mg$ (little block)

$T > \mu_s N$ (large block)

For motion to begin:

$mg > \mu_S Mg$

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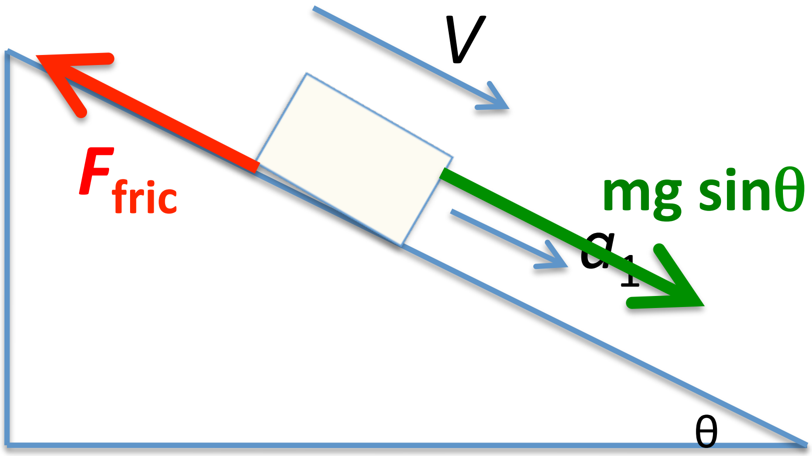
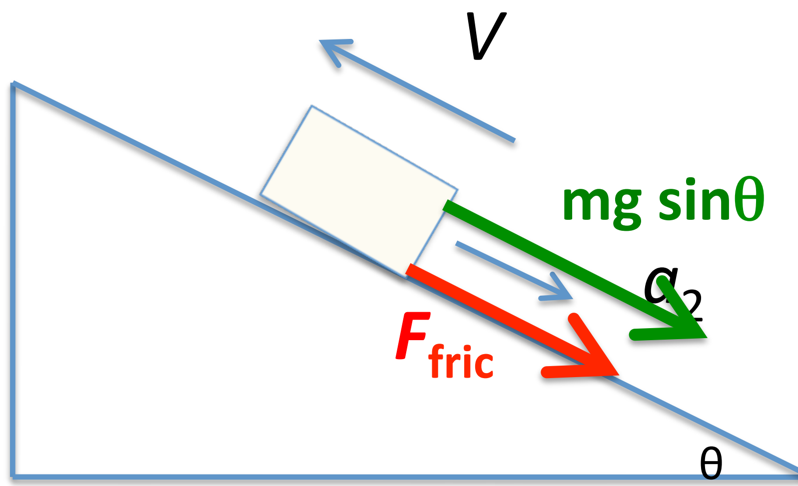
A mass slides down a **rough** (with friction) inclined plane with some non-zero acceleration a_1. Next, the same mass is shoved up the same incline with a large, brief initial push. As the mass moves up the incline, its acceleration is a_2. How do a_1 and a_2 compare?





A) $a_1 > a_2$

B) $a_1 = a_2$

C) $a_1 < a_2$

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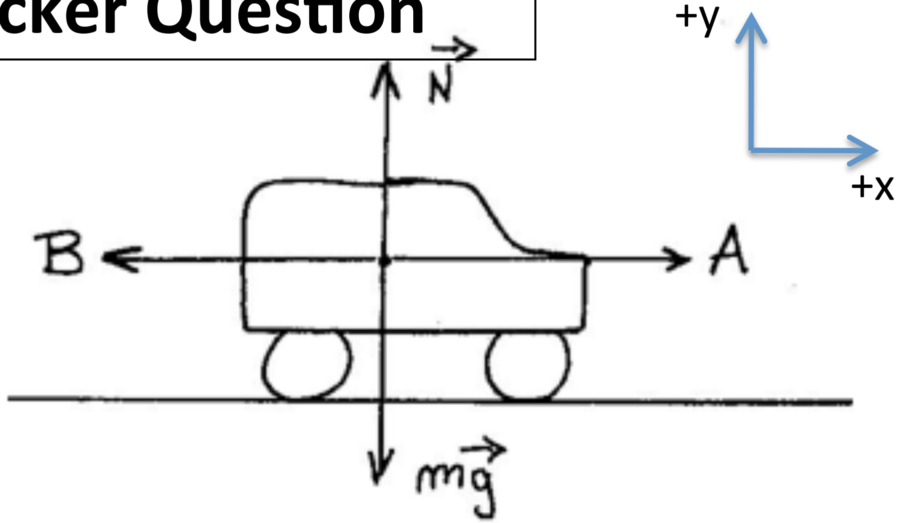


A car of mass *m* is moving in the positive x-direction. The driver slams on the brakes and the tires skid on the ground. The direction of the frictional force between the tires and the road is backwards. Its magnitude is $f = \mu_k N$ where μ_k is the kinetic friction coefficient.

The magnitude of the car's **acceleration** is given by

A) μA

B) $\mu_K mg$

C) $\mu_K g$

D) $\mu_S mg$

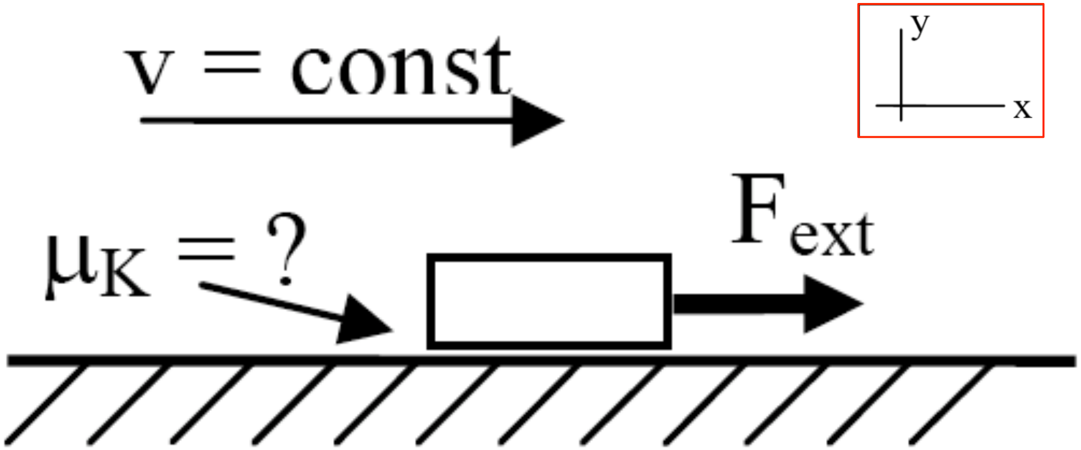
E) $\mu_S g$

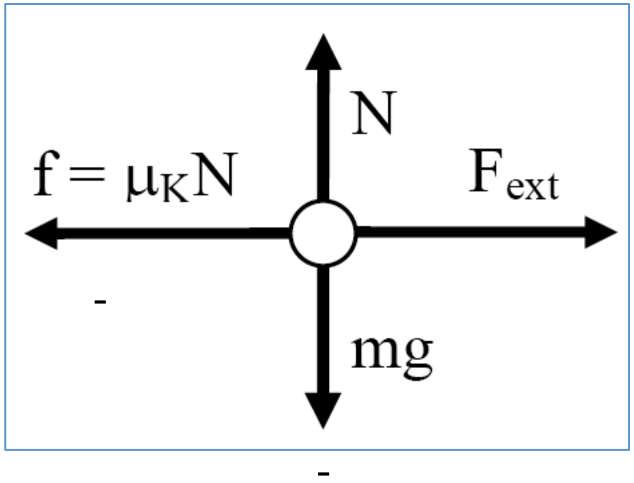
$$F_{net} = ma = f = -\mu_K mg$$

$$a = -\mu_K g$$

$$|a| = \mu_K g$$

A block of mass ***m*** is being pushed across a rough horizontal table. A constant velocity ***v*** is maintained with an external force $\boldsymbol{F}_{\mathbf{ext}}$. What is $\boldsymbol{\mu}_{\mathbf{K}}$?





$$F_{net,y} = ma_y = N - mg = 0 \quad \Rightarrow \quad N = mg$$

$$F_{net,x} = ma_x = F_{ext} - \mu_k N = F_{ext} - \mu_k mg = 0$$

$$\Rightarrow \quad \mu_k = \frac{F_{ext}}{mg}$$

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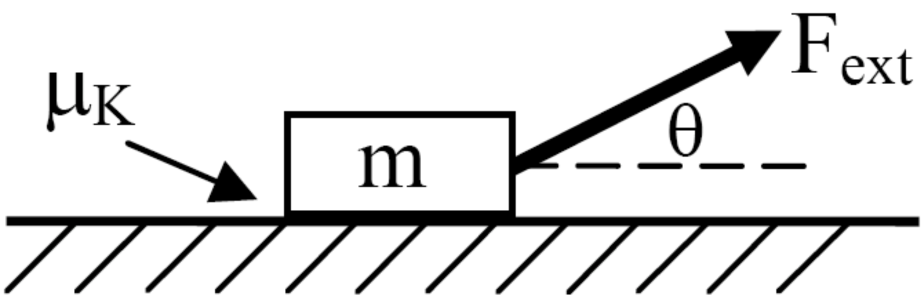
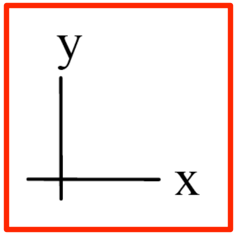
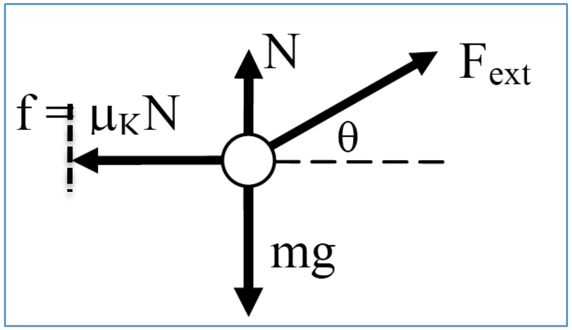
A block of mass *m* is pulled across a rough (μ_K) flat table with a constant force F_{ext} at an angle θ.







What is the correct expression for the magnitude of the Normal force to use for calculating the friction force?

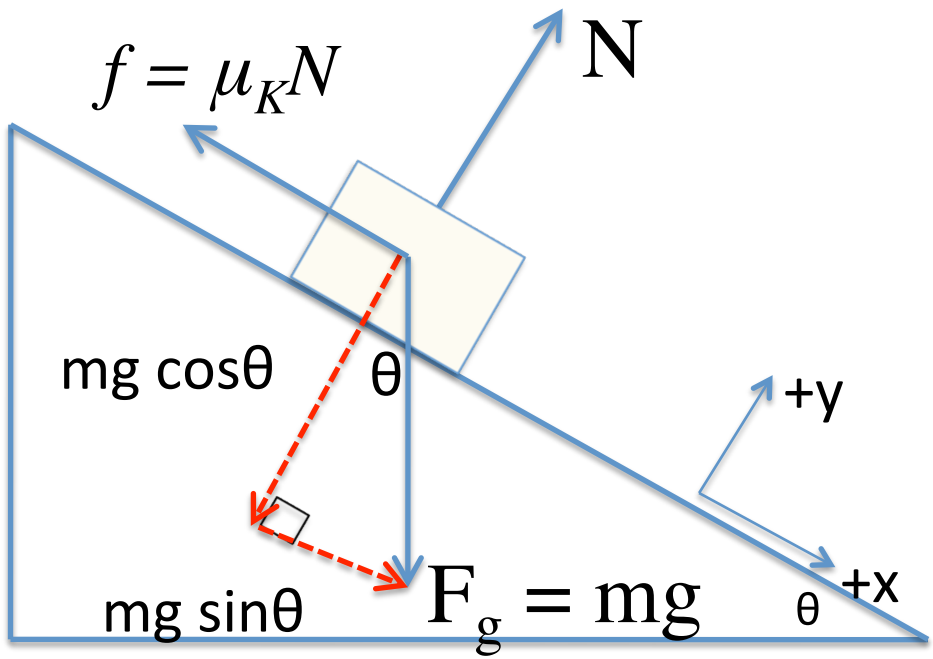
A) $N=mg$
B) $N=mg\sin\theta$
C) $N=mg\sin\theta-F_{ext}\sin\theta$
D) $N=mg-F_{ext}\cos\theta$
E) None of the above

$$F_{net,y} = ma_y = 0$$

$$0 = N - mg + F_{ext}\sin\theta$$

$$N = mg - F_{ext}\sin\theta$$

A block of mass *m* slides down a rough (μ_K) incline tilted at an angle θ from the horizontal.



$$F_{net,y} = ma_y = N - mg\cos\theta = 0 \Rightarrow N = mg\cos\theta$$

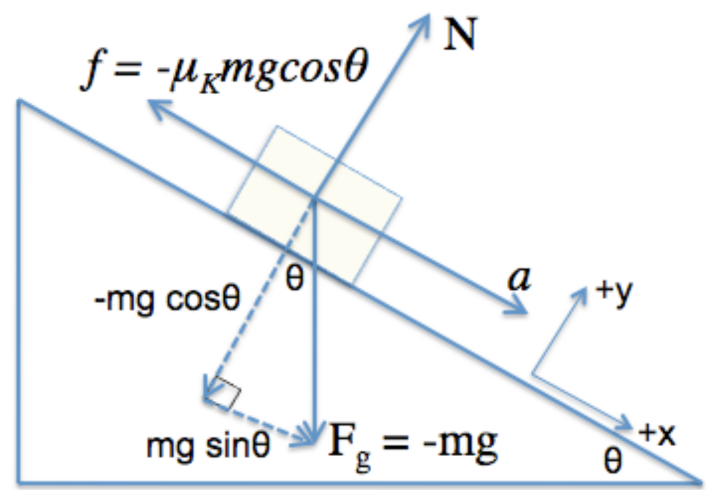
$$F_{net,x} = ma_x = mg\sin\theta - \mu_k N$$

$$ma_x = mg\sin\theta - \mu_k mg\cos\theta$$

A block of mass *m* slides down a rough (μ_K) incline tilted at an angle θ from the horizontal. What's the magnitude of *a*?

$$a = g(\sin\theta - \mu_K \cos\theta)$$

For the mass to have positive acceleration while sliding, what condition needs to be satisfied:



$\underline{a > 0}$: $$\sin\theta > \mu_K \cos\theta$$

$$\tan\theta = \frac{\sin\theta}{\cos\theta} > \mu_K$$

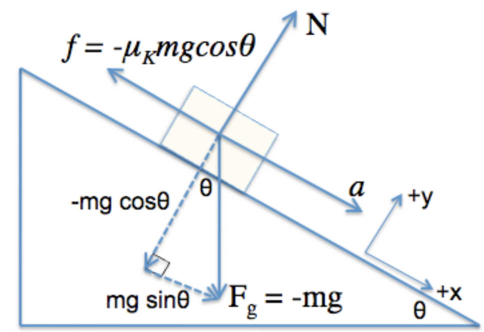
$$\theta > \tan^{-1}(\mu_K)$$

Condition to speed up while sliding.

A block of mass *m* slides down a rough (μ_K) incline tilted at an angle θ from the horizontal. What's the magnitude of *a*?

$$a = g(\sin\theta - \mu_K \cos\theta)$$

$\theta > \tan^{-1}(\mu_K)$ Condition to speed up while sliding.



Summary:

(1) If $a > 0$, a sliding object will speed up.

(2) If $a < 0$, a sliding object will slow to a stop.

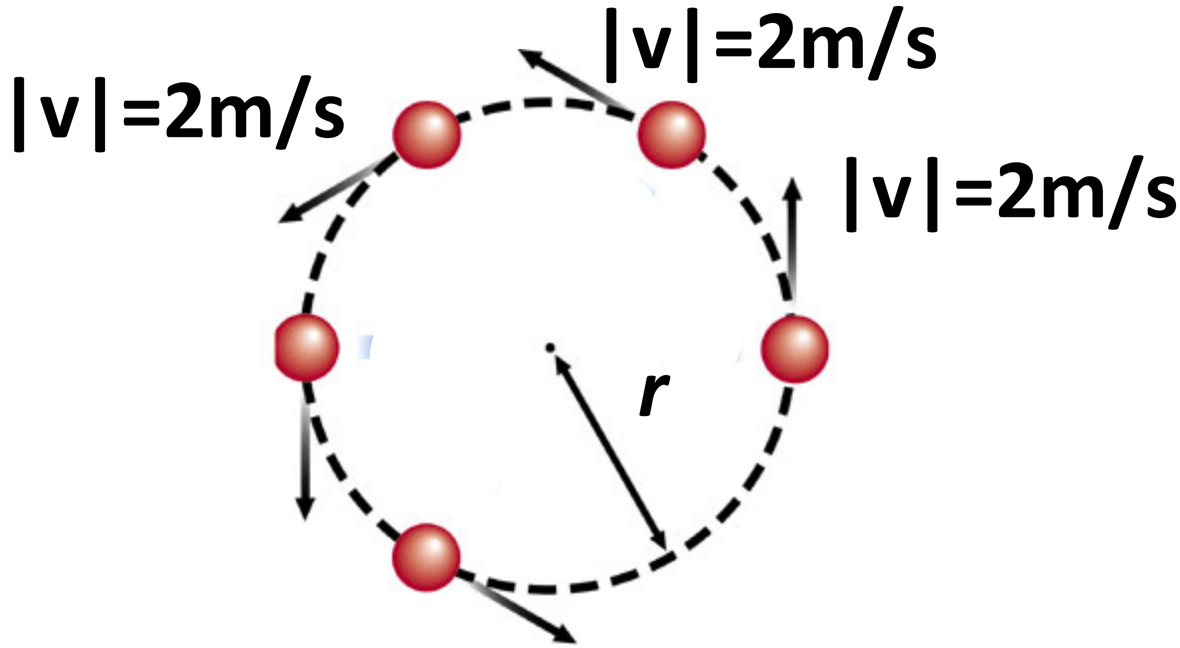
(3) If $a = 0$, the object will slide with a constant speed.

(4) For the object to accelerate from rest, the coefficient of kinetic friction, μ_K, should be replaced by the coefficient of static friction, μ_S. To start sliding: $\theta > \tan^{-1}(\mu_S)$.

Circular Motion

Kinematics of Circular Motion

Circular Motion: Object moving in a circle of radius *r* with a constant speed (meters/second).



T = period = time for one revolution (one cycle)

$$\text{speed} = |\vec{v}| = \frac{\text{distance}}{\text{time}} = \frac{\text{circumference}}{\text{period}} = \frac{2\pi\,\text{r}}{\text{T}}$$

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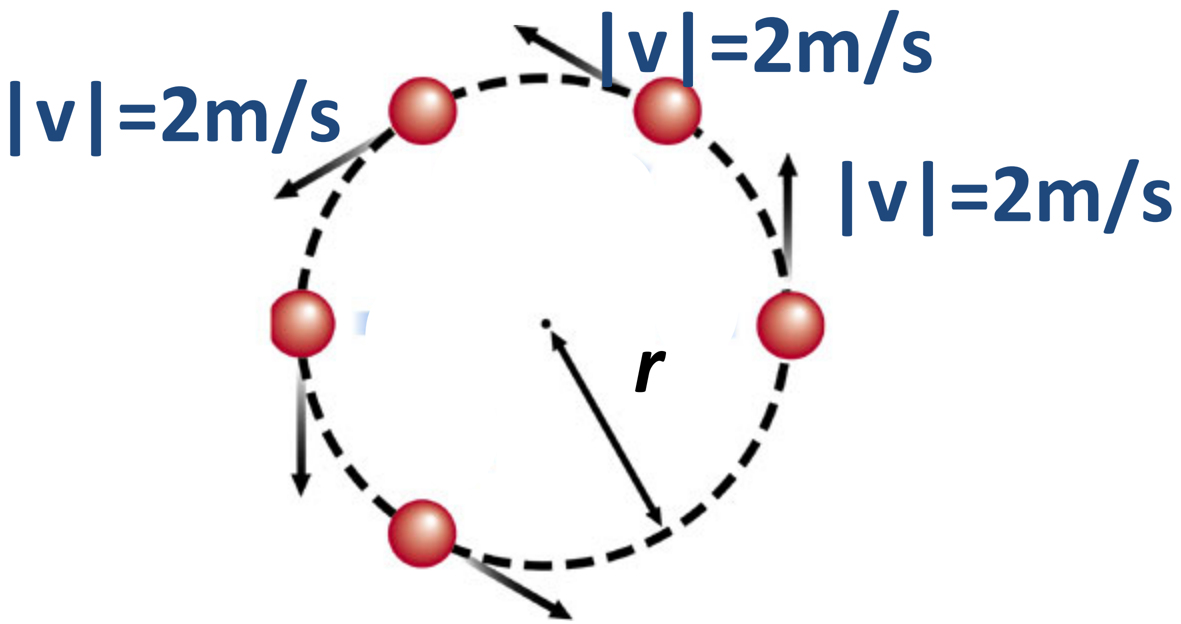

Is the object accelerating?

A) Yes

B) No