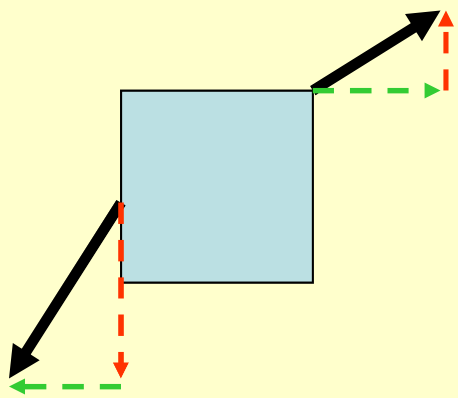
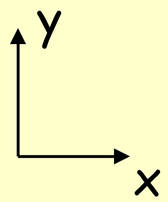
# PHYS 100 Midterm Exam Review Session





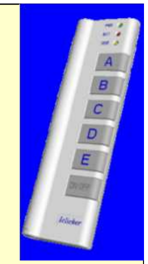

$$\vec{F}_{\text{net on }A} = m_A \vec{a}_A$$

$$v_x = v_{0x} + a_x t$$

$$x = x_0 + v_{0x} + \tfrac{1}{2} a_x t^2$$

$$v_x{}^2 = (v_{0x})^2 + 2a_x (x - x_0)$$

# Music



Who is the Artist?

A) Professor Longhair
B) John Cleary
C) Allen Toussaint
D) Fats Domino
E) Tuts Washington

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New Orleans Icon

MUST SEE DVD !!
"Piano Players Rarely Ever Play Together"


P.S. Traditional Jazz Orchestra was hot on Mardi Gras!

# Exam

- TUESDAY MARCH 15 7pm in 136 Loomis
  - Conflicts contact me NOW
- FORMAT
  - ScanTron (bubble sheet)… bring:
    - #2 pencils
    - a calculator
  - Multiple Choice (just like online quizzes and PHYS 211 exams)
    - Three Types
    - True/False (no possible partial credit)
    - Three choices (no possible partial credit)

      Five choices (~75% of the exam points)
      - Choose only the right answer = 6 points (full credit)
      - Choose two answers, one of which is right = 3 points
      - Choose three answers, one of which is right = 2 points
    - The partial credit is only really helpful if you're clueless on how to solve a problem but can definitely eliminate some choices on physical or conceptual grounds.

# What does the exam cover?

## Question Types

- ~30% Conceptual Questions
- ~70% Calculations
  - 3/5 Numerical
  - 2/5 Symbolic

## Topics (there's overlap)

- ~50% Kinematics
  - Graphs
  - 1-D kinematics
  - 2-D kinematics
  - Relative motion
- ~50% Newton's Laws
  - Applying Newton's Laws
  - Friction
  - UCM

# Major Ideas of PHYS 100

## KINEMATICS

- **Definitions**
  - Graphs
  - Vector Pictures
- **Constant Acceleration Eqns**
  - 1-D problems
  - 2-D problems
    - Projectile Motion

$$v_x = v_{0x} + a_x t$$

$$x = x_0 + v_{0x} t + \tfrac{1}{2} a_x t^2$$

$$v_x{}^2 = (v_{0x})^2 + 2a_x (x - x_0)$$

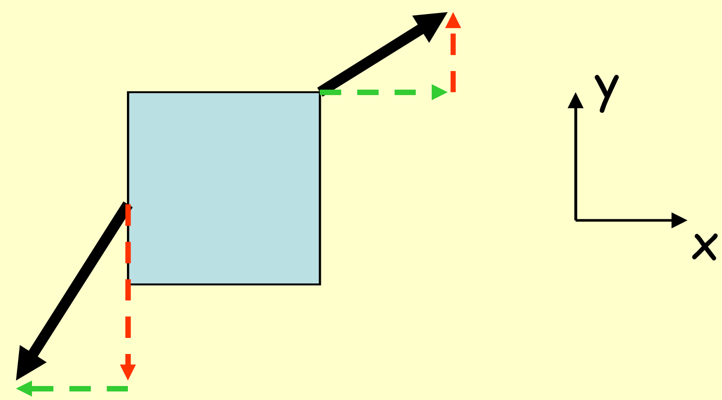
## DYNAMICS

Newton's Second Law

$$\vec{F}_{\text{net on } A} = m_A \vec{a}_A$$

$$F_{\text{net on } A,x} = m_A a_x \qquad F_{\text{net on } A,y} = m_A a_y$$

$$F_{1x} + F_{2x} + \ldots = m_A a_x \qquad F_{1y} + F_{2y} + \ldots = m_A a_y$$



# Newton's Second Law General Procedure

1. Draw a Free Body Diagram
2. Choose Convenient Coordinate Axes
   - Choose an axis along the acceleration, if known
   - Make the most forces possible parallel to the axes
3. Write Newton's Second Law for each object in the x- and y-directions
   - $F_{net\ on\ A,x} = m_A a_x$
   - $F_{net\ on\ A,y} = m_A a_y$
4. Solve the resulting equations simultaneously for unknown forces or accelerations

# Practice Problems

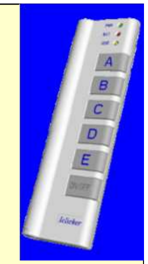
We'll do some here.

There are lots more in:

- ONLINE PRACTICE EXAMS
  - available from "Practice Exams" link on Homepage

- Preflights
- Online Quizzes
- Discussion Problems
- Worked examples

Sp06 #13) A box of mass *M* is pulled across a horizontal floor with constant velocity by a rope that makes an angle *θ* with the horizontal. The tension in the rope is *T* and the coefficient of kinetic friction between the box and the floor is *μ*. The magnitude of the normal force between the floor and the box is *N*.

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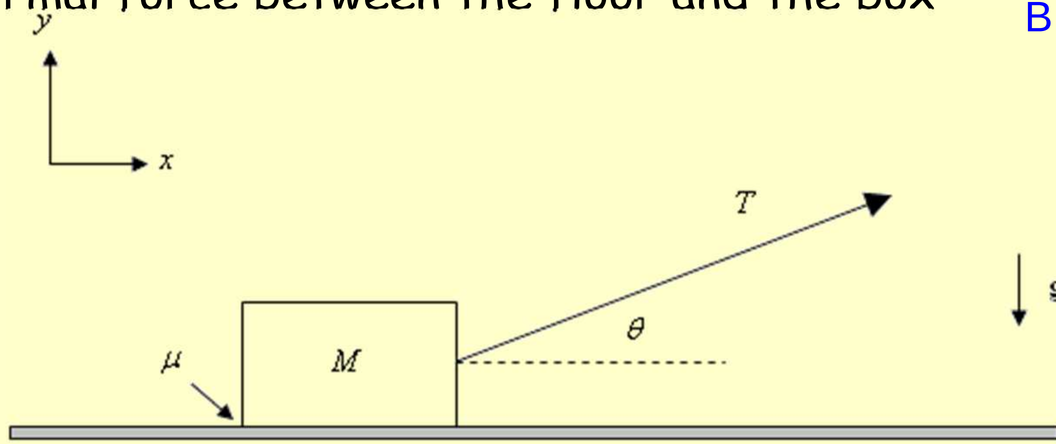



The net force on the box is

(a) in the +x direction.

(b) in the -x direction.

(c) zero.

$$\vec{a} = 0 \quad \Rightarrow \quad \vec{F}_{net} = 0$$

Sp06 #14) Which one of the following relationships is true?

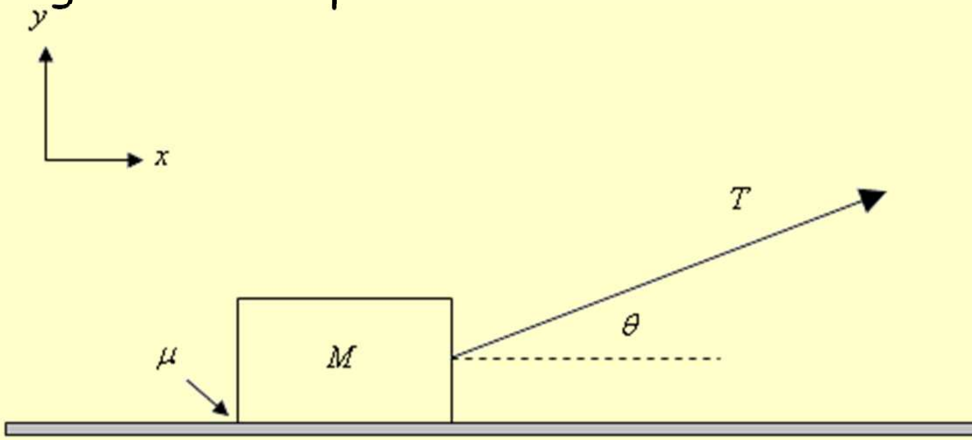
(a) $T\cos\theta - \mu N = 0$

(b) $N - Mg = 0$

(c) $T - Mg = 0$

(d) $T\sin\theta - N\cos\theta = 0$

(e) $T\cos\theta - \mu Mg = 0$

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**Strategy Poll: Which is the right STRATEGY to use to solve this problem?**

A) Draw a Free Body Diagram. Use $F_{net} = Ma$ in the x- and y-directions. Fill in the net force with the sum of the force components in the problem. The acceleration is $\mathbf{a_x=0}$ and $\mathbf{a_y=0}$.

B) Draw a Free Body Diagram. Use $F_{net} = Ma$ in the x- and y-directions, Fill in the net force with the sum of the force components in the problem. The acceleration is $\mathbf{a_x=0}$ and $\mathbf{a_y=-g}$.

C) Draw a Free Body Diagram. Use $F_{net} = Ma$. Fill in $F_{net}$ using the forces in the problem, then solve for the acceleration using both the y- and x-directions (2 eqns and 2 unknowns). Plug this acceleration back in to one of the equations to find an expression for the forces in the x- and y-directions.

## Sp06 #14) Which one of the following relationships is true?

(a) $T\cos\theta - \mu N = 0$

(b) $N - Mg = 0$

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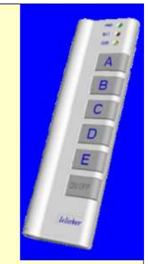
(d) $T\sin\theta - N\cos\theta = 0$

(e) $T\cos\theta - \mu Mg = 0$

Note: $N \neq Mg$



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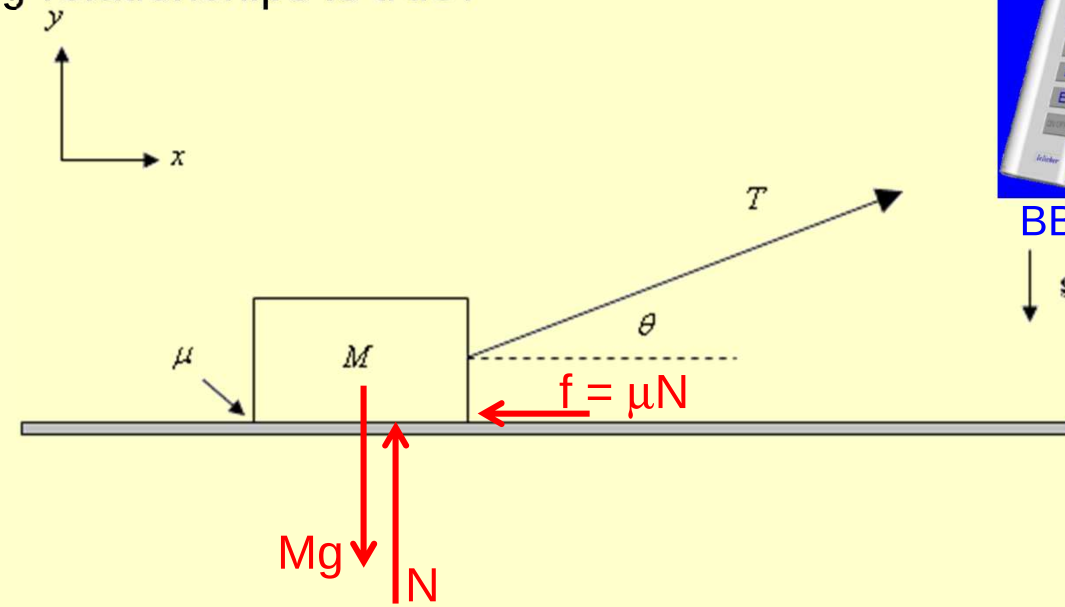
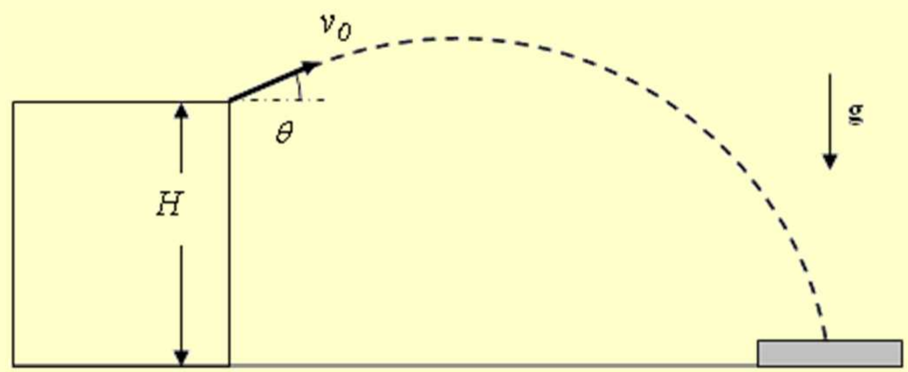


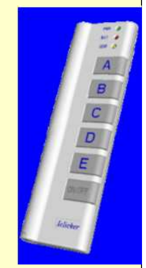

x: $T\cos\theta - \mu N = 0$

y: $T\sin\theta + N - Mg = 0$

Sp06 #8) A stuntwoman jumps from the rooftop of a building with an initial velocity $v_0$ = 6.0 m/s at an angle $\theta$ = 30° with respect to the ground. She lands on a mattress as shown. The height of the building is $H$ = 5.0 m. Ignore air resistance and the thickness of the mattress. For what length of time $t$ is she in the air?

(a) $t$ = 3.08 sec
(b) $t$ = 2.71 sec
(c) $t$ = 2.58 sec
(d) $t$ = 2.03 sec
(e) $t$ = 1.36 sec



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**Strategy Poll: Which strategy works and is the most efficient?**

A) Use the fact that the y-velocity at the top of the trajectory is zero to find the time to the top of the flight (using $v_y = v_{0y}+a_yt$). Next find the time it takes to go from this point to hitting the ground using $y = y_0+v_{0y}+1/2a_yt^2$. Add the two times to together to get the total time in the air.

B) Use the distance-time kinematic equation $y = y_0+v_{0y}t+1/2a_yt^2$ in the y-direction to find the time to go from the initial height to hitting the ground.

C) Use the velocity-distance equation $v_y^2=v_{0y}^2+2a_y(y-y_0)$ to find the woman's final y-velocity when she hits the ground. Use this and the initial velocity in the velocity-time equations $v_y = v_{0y}+a_yt$ to get the flight time.

Sp06 #8) A stuntwoman jumps from the rooftop of a building with an initial velocity $v_0$ = 6.0 m/s at an angle $\theta$ = 30° with respect to the ground. She lands on a mattress as shown. The height of the building is $H$ = 5.0 m. Ignore air resistance and the thickness of the mattress. For what length of time $t$ is she in the air?

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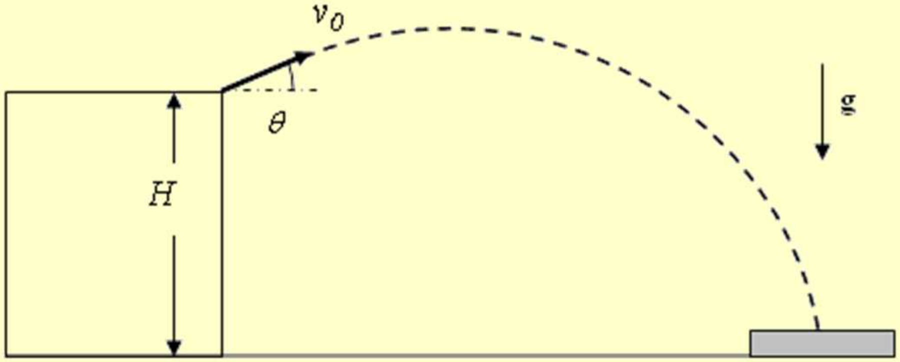



We'll do this one now !

$$v_y^2 = v_{oy}^2 + 2a(y - y_0) \Rightarrow v_y^2 = v_{oy}^2 - 2g(-H) \Rightarrow v_y = -\sqrt{v_{oy}^2 + 2gH}$$

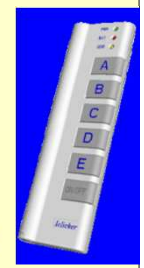
$$v_y = v_{0y} + at \Rightarrow v_y = v_{0y} - gt \Rightarrow t = \frac{v_y - v_{0y}}{-g}$$

$$t = \frac{-\sqrt{v_{oy}^2 + 2gH} - v_{0y}}{-g} \Rightarrow t = \frac{-10.34 - 3}{-9.8} = 1.36s$$

$$v_{0y} = v_0 \sin\theta$$

# FOLLOW-UP

Sp06 #8) A stuntwoman jumps from the rooftop of a building with an initial velocity $v_0$ = 6.0 m/s at an angle $\theta$ = 30° with respect to the ground. She lands on a mattress as shown. The height of the building is $H$ = 5.0 m. Ignore air resistance and the thickness of the mattress. She is in air for 1.36 s.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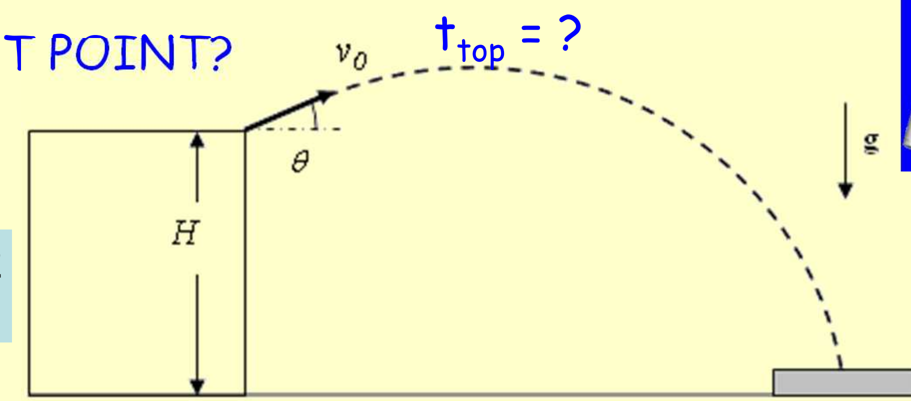
WHEN DID SHE REACH HER HIGHEST POINT?




(a) $t$ = 0.15 sec
(b) $t$ = 0.3 sec
(c) $t$ = 0.45 sec
(d) $t$ = 0.6 sec
(e) $t$ = 0.9 sec

$$v = v_o + at$$

$$x = x_o + v_o t + \frac{1}{2} a t^2$$

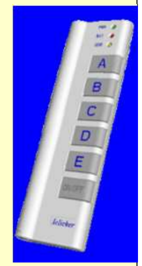
$$v_y = v_o \sin\theta - gt$$

$$v_y = 0$$

$$t_{top} = \frac{v_o \sin\theta}{g}$$

# FOLLOW-UP

Sp06 #8) A stuntwoman jumps from the rooftop of a building with an initial velocity $v_0$ = 6.0 m/s at an angle $\theta$ = 30° with respect to the ground. She lands on a mattress as shown. The height of the building is $H$ = 5.0 m. Ignore air resistance and the thickness of the mattress. She is in air for 1.36 s.



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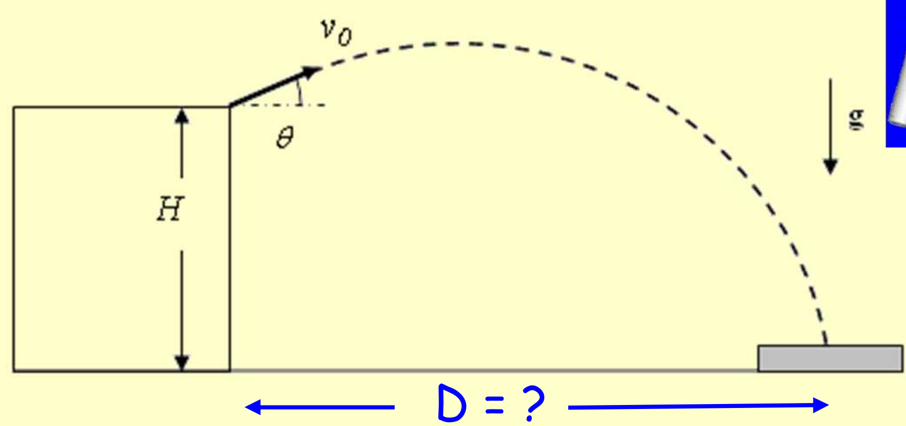
HOW FAR DID SHE GO?

(a) $D$ = 4.2 m
(b) $D$ = 5.2 m
(c) $D$ = 7.1 m
(d) $D$ = 8.4 m
(e) $D$ = 9.1 m

$$v = v_o + at$$

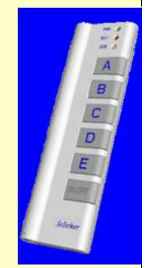
$$x = x_o + v_o t + \frac{1}{2} a t^2$$




$$a_x = 0 \quad \Rightarrow \quad D = (v_o \cos\theta) t$$

F07 #22) A student who can swim with a speed of 3 m/s in still water wants to get to the other side of a 400 m wide river whose waters flows downstream at 2 m/s. If she swims in such a way that her path as viewed by someone on the shore is straight across the river, how long does it take her to get to the other side?

(a) 179 s
(b) 112 s
(c) 208 s
(d) 92 s
(e) 156 s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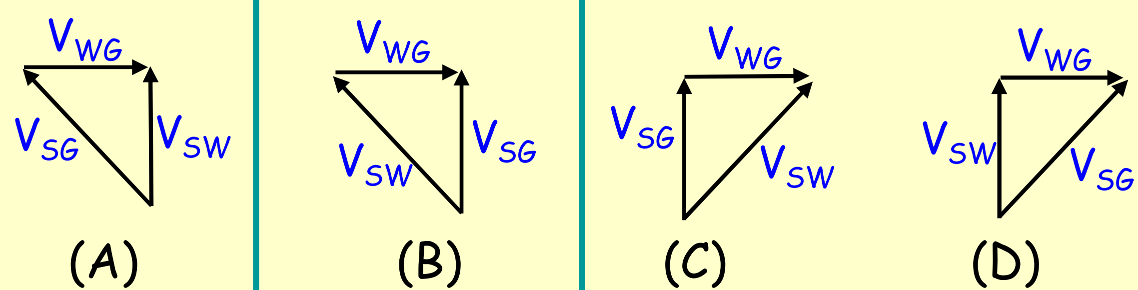
**WHICH OF THESE VECTOR DIAGRAMS WOULD YOU USE TO SOLVE THIS PROBLEM?**

$V_{SG}$ = V (swimmer wrt ground)

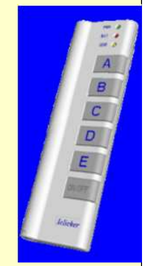
$V_{SW}$ = V (swimmer wrt water)

$V_{WG}$ = V (water wrt ground)




$$\vec{v}_{SG} = \vec{v}_{SW} + \vec{v}_{WG}$$

F07 #22) A student who can swim with a speed of 3 m/s in still water wants to get to the other side of a 400 m wide river whose waters flows downstream at 2 m/s. If she swims in such a way that her path as viewed by someone on the shore is straight across the river, how long does it take her to get to the other side?

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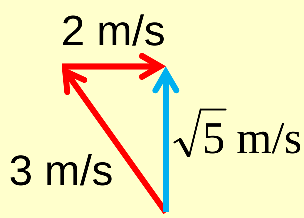
Solve and vote… we will then discuss




$$t = \frac{400\ \text{m}}{\sqrt{5}\ \text{m/s}} = 179\ \text{s}$$

A man holds a 10 kg mass suspended at rest above the ground by pushing it against a wall. If he pushes with a force of 90 N directed 60 degrees above the horizontal, what is the force of friction exerted by the wall on the mass? The coefficient of static friction between the block and the wall is 0.8 .

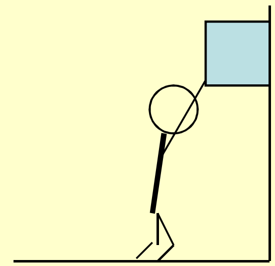
a) 20 N

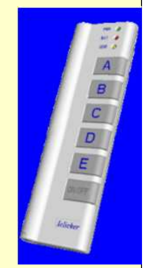
b) 30 N

c) 36 N

d) 40 N

e) 78.5 N





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**Which strategy can be used to solve this problem?**

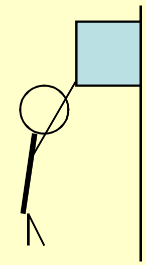
A) Use $f_s = \mu_s N$ to find the static friction force. Use $F_{net} = Ma$ in the x-direction to find the normal force to plug in. The accelerations are $a_x=0$ and $a_y=0$.

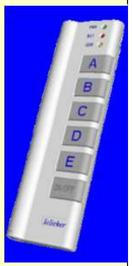
B) Use $f_s = \mu_s N$ to find the static friction force. Use $F_{net} = Ma$ in the x-direction to find the normal force to plug in. The accelerations are $a_x=0$ and $a_y=g$ downward.

C) Use $F_{net} = Ma$ in the y-direction to find the static friction force. The accelerations are $a_x=0$ and $a_y=0$.

D) Use $F_{net} = Ma$ in the y-direction to find the static friction force. The accelerations are $a_x=0$ and $a_y=g$ downward.

A man holds a 10 kg mass suspended at rest above the ground by pushing it against a wall. If he pushes with a force of 90 N directed 60 degrees above the horizontal, what is the force of friction exerted by the wall on the mass? The coefficient of static friction between the block and the wall is 0.8 .



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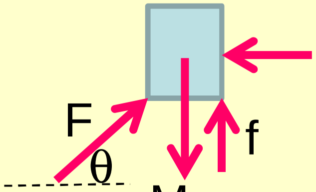
Solve and vote… we will then discuss




x: $F\cos\theta - N = 0$

y: $F\sin\theta + f - Mg = 0$

Know: F, θ, M

Unknowns: N, f

$f = Mg - F\sin\theta$