Today 6.2

$\boxed{L19}$

Today 6.2

L19

Kinetic energy & work

L19

Today 6.2

Friday 6.3, 6.4

Today 6.2

$\boxed{L19}$

Friday $\underbrace{6.3}$, 6.4

Work
with varying
forces

$\boxed{\text{L19}}$

Today 6.2

Friday 6.3, $\underbrace{6.4}_{\text{Power}}$

L19

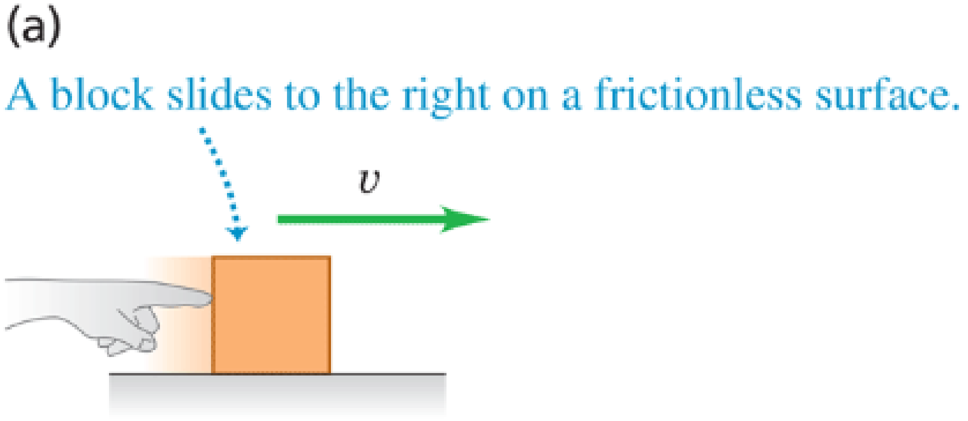
Today 6.2

Friday 6.3, 6.4

Monday Exam #2

Work & kinetic energy

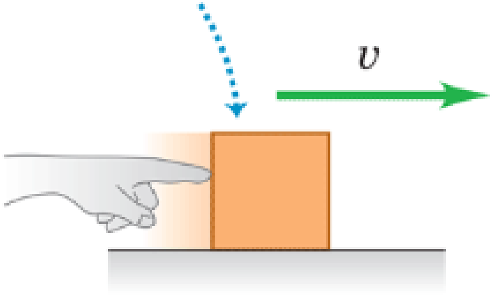
Work & kinetic energy



Work & Kinetic energy

(a)

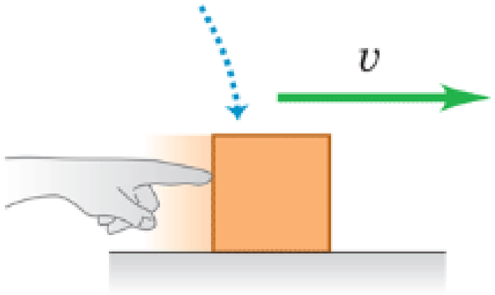
A block slides to the right on a frictionless surface.



If you push to the right on the block as it moves, the net force on the block is to the right.

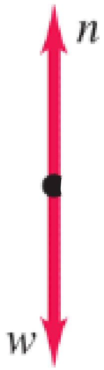
Work & Kinetic energy

(a)



A block slides to the right on a frictionless surface.

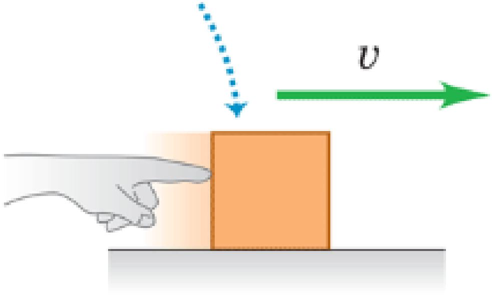
If you push to the right on the block as it moves, the net force on the block is to the right.



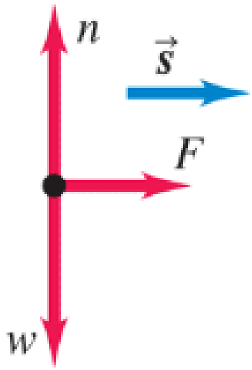
Work & kinetic energy

(a)

A block slides to the right on a frictionless surface.



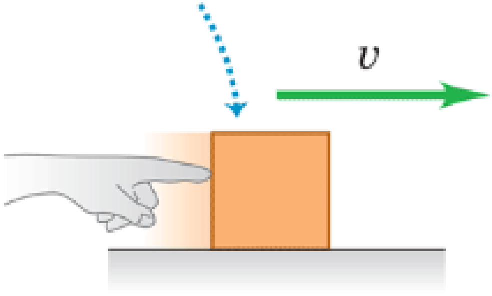
If you push to the right on the block as it moves, the net force on the block is to the right.



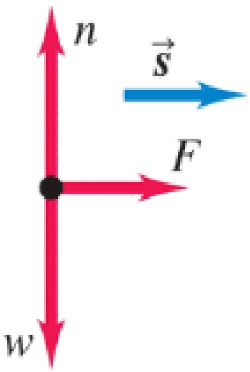
Work & kinetic energy

(a)

A block slides to the right on a frictionless surface.

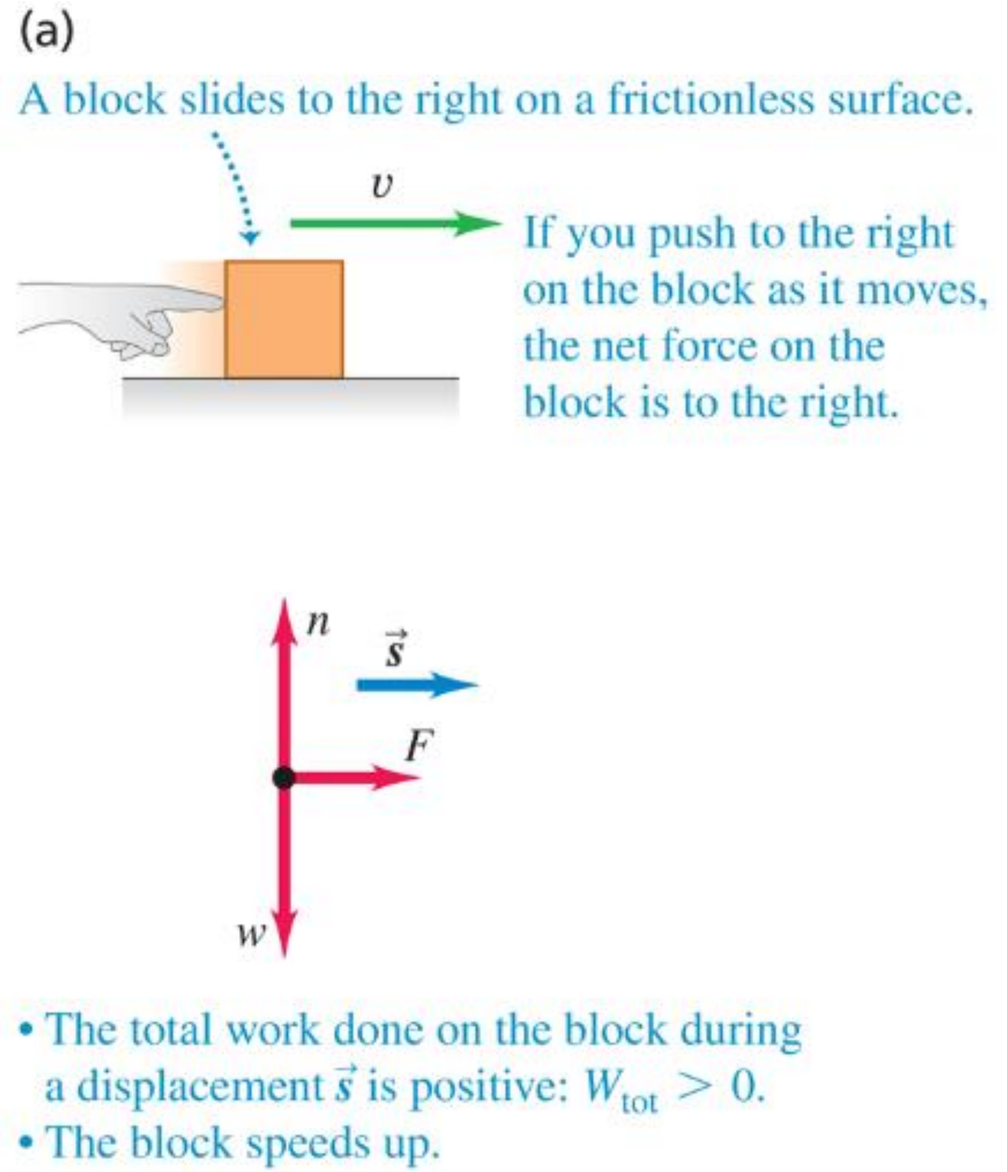


If you push to the right on the block as it moves, the net force on the block is to the right.



- The total work done on the block during a displacement $\vec{s}$ is positive: $W_{tot} > 0$.

Work & Kinetic energy



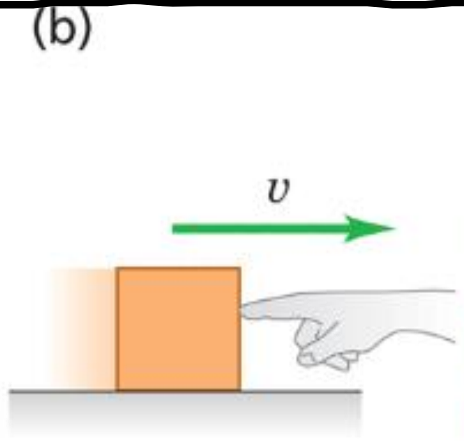
(a)

A block slides to the right on a frictionless surface.

If you push to the right on the block as it moves, the net force on the block is to the right.

- The total work done on the block during a displacement $\vec{s}$ is positive: $W_{tot} > 0$.
- The block speeds up.

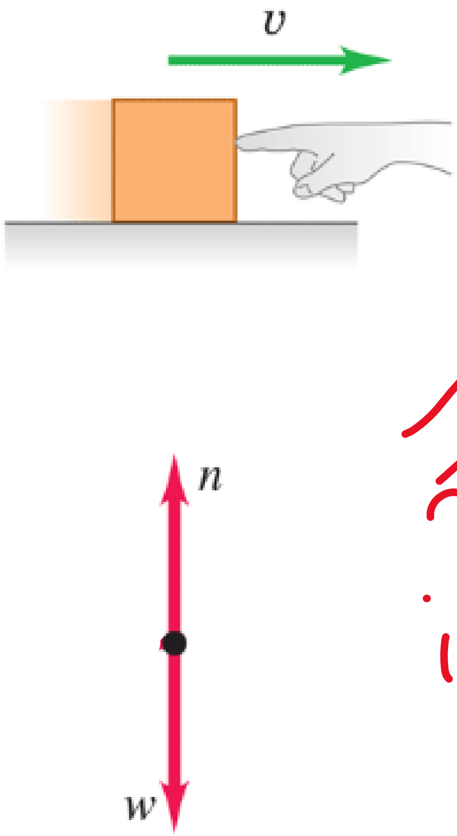
Work & kinetic energy



If you push to the left on the block as it moves, the net force on the block is to the left.

Work & kinetic energy

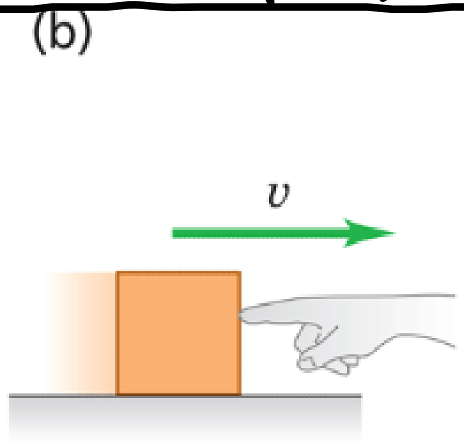
(b)



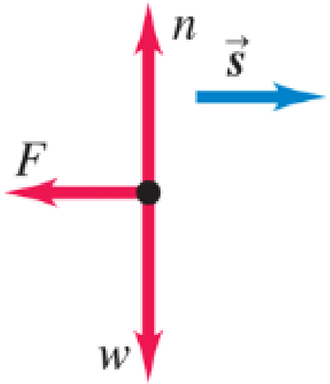
If you push to the left on the block as it moves, the net force on the block is to the left.

Forces in vertical are same as before

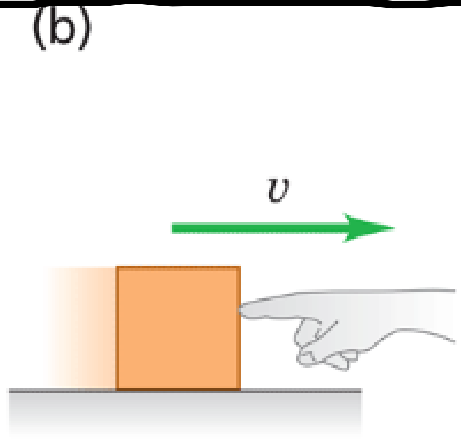
Work & kinetic energy



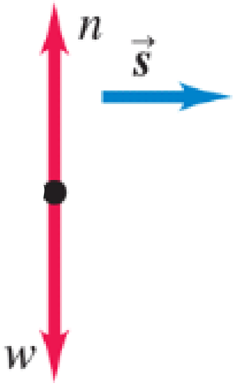
If you push to the left on the block as it moves, the net force on the block is to the left.



Work & kinetic energy



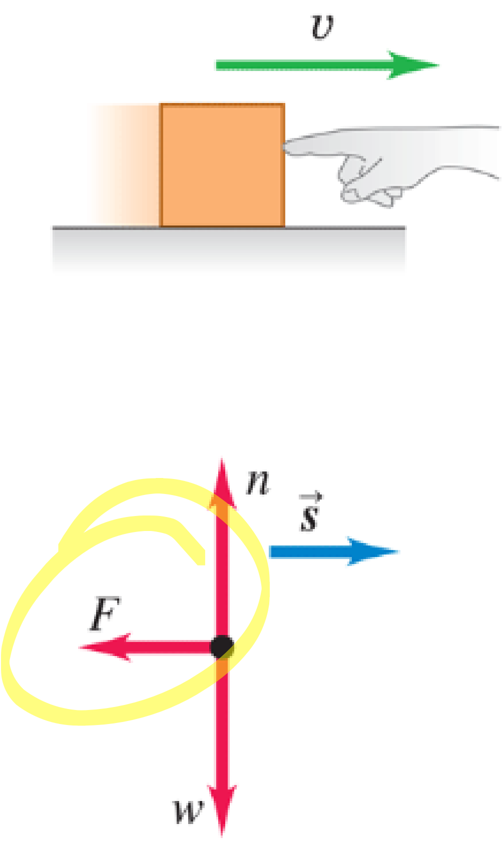
If you push to the left on the block as it moves, the net force on the block is to the left.



Displacement direction is same as before

Work & Kinetic energy

(b)

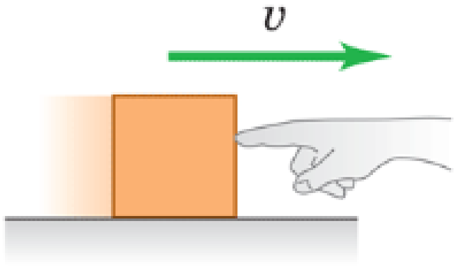


If you push to the left on the block as it moves, the net force on the block is to the left.

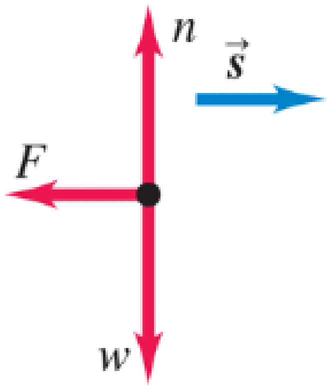
Horizontal force applied in opposite direction

Work & Kinetic energy

(b)



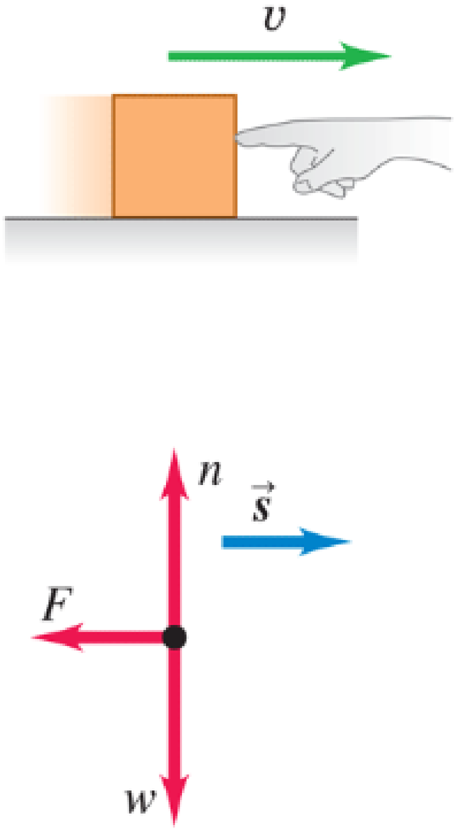
If you push to the left on the block as it moves, the net force on the block is to the left.



- The total work done on the block during a displacement $\vec{s}$ is negative: $W_{\text{tot}} < 0$.

Work & kinetic energy

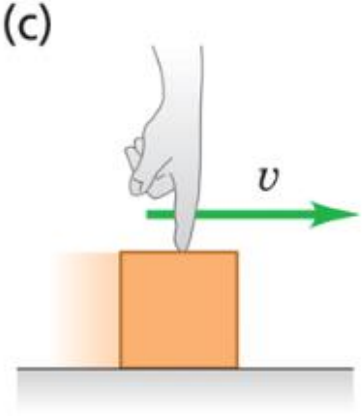
(b)



If you push to the left on the block as it moves, the net force on the block is to the left.

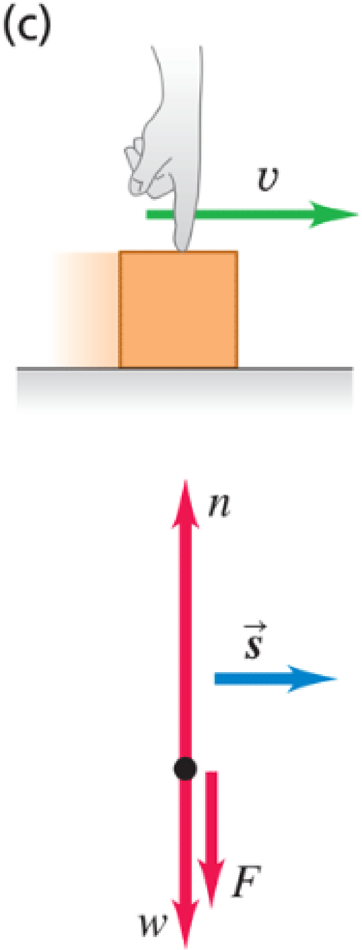
- The total work done on the block during a displacement $\vec{s}$ is negative: $W_{\text{tot}} < 0$.
- The block slows down.

Work & kinetic energy



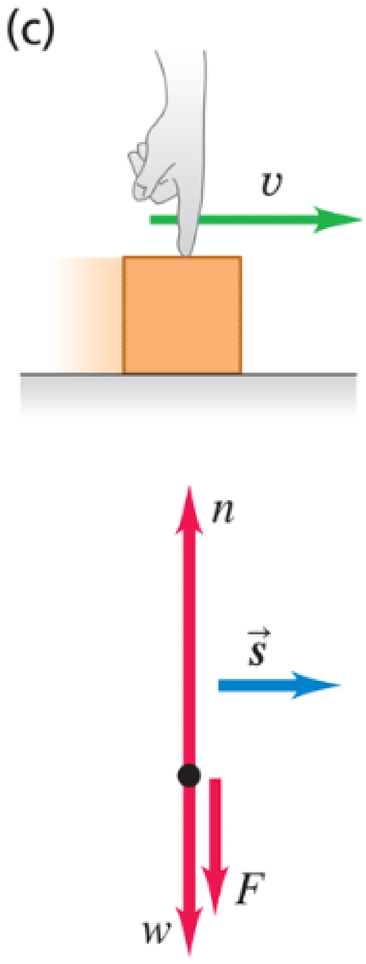
If you push straight down on the block as it moves, the net force on the block is zero.

Work & kinetic energy



If you push straight down on the block as it moves, the net force on the block is zero.

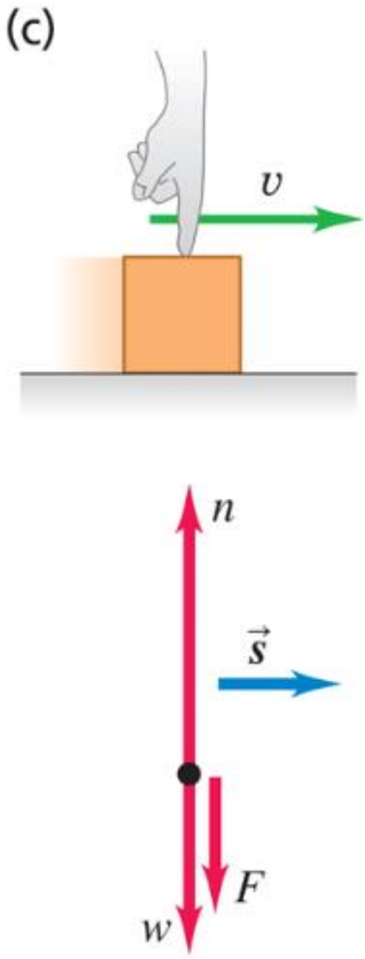
Work & kinetic energy



If you push straight down on the block as it moves, the net force on the block is zero.

- The total work done on the block during a displacement $\vec{s}$ is zero: $W_{tot} = 0$.

Work & kinetic energy



If you push straight down on the block as it moves, the net force on the block is zero.

- The total work done on the block during a displacement $\vec{s}$ is zero: $W_{tot} = 0$.
- The block's speed stays the same.

NOTE: No friction

Constant acceleration & displacement

Constant acceleration & displacement

Previosly we found $a = v\frac{dv}{dx}$

Constant acceleration & displacement

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Constant acceleration & displacement

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$\Rightarrow \int a\,dx = \frac{1}{2}V_2^2 - \frac{1}{2}V_1^2$

Constant acceleration & displacement

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so if $a =$ constant & $\int dx = s$

Constant acceleration & displacement

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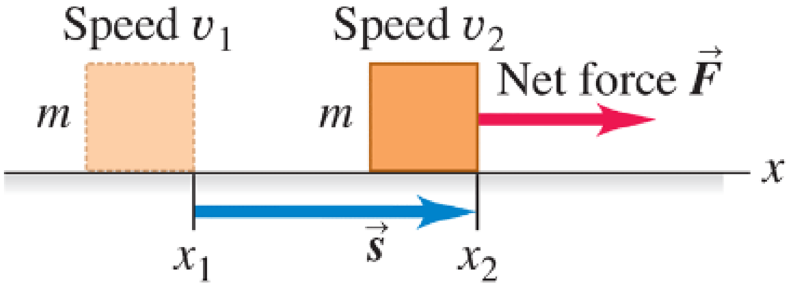
so if $a = \text{constant}$ & $\int dx = s$

then $a = \frac{v_2^2 - v_1^2}{2s}$



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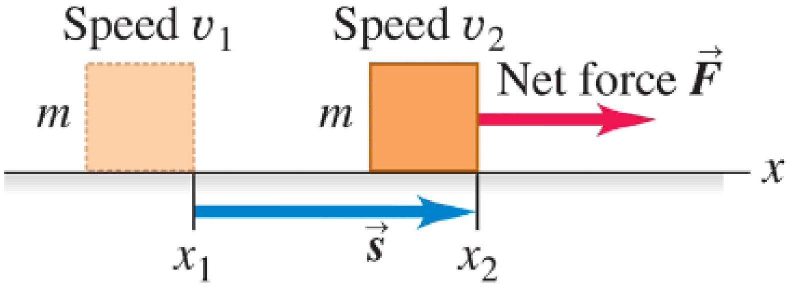

So

$W = Fs$

Constant acceleration & displacement

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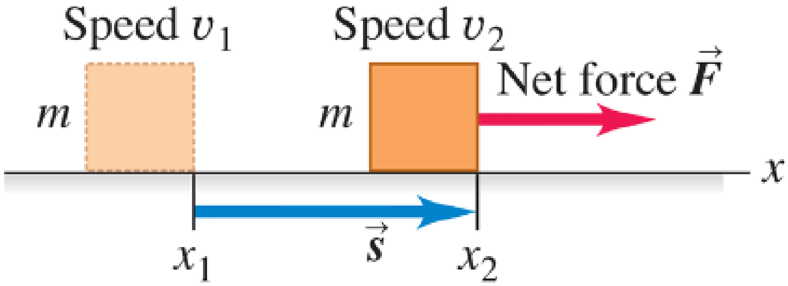

So

$W = Fs = mas$

Constant acceleration & displacement

Previosly we found $a = v\frac{dv}{dx} \Rightarrow \int a\,dx = \int v\,dv$

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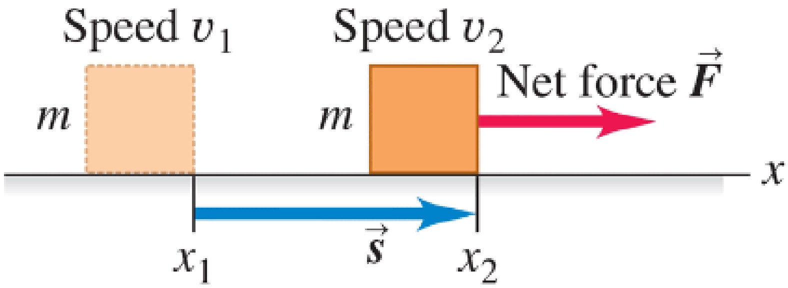
so if $a = \text{constant}$ & $\int dx = s$

then $a = \frac{v_2^2 - v_1^2}{2s}$



So

$W = Fs = mas = m\left(\frac{v_2^2 - v_1^2}{2s}\right)s$

Constant acceleration & displacement

Previosly we found $a = v\frac{dv}{dx} \Rightarrow \int a\,dx = \int v\,dv$

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so if $a =$ constant & $\int dx = s$

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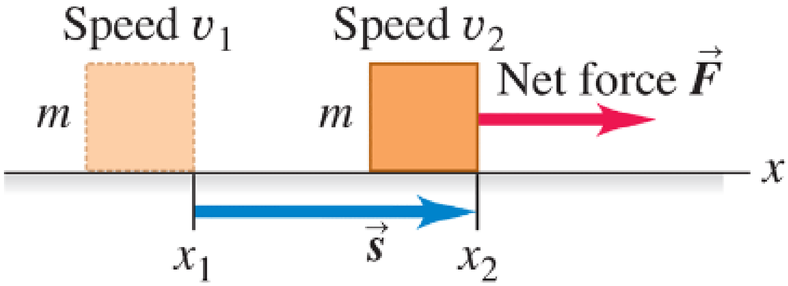

So

$$W = Fs = mas = m\left(\frac{v_2^2 - v_1^2}{2s}\right)s = \frac{1}{2}mv_2^2 - \frac{1}{2}mv_2^2$$

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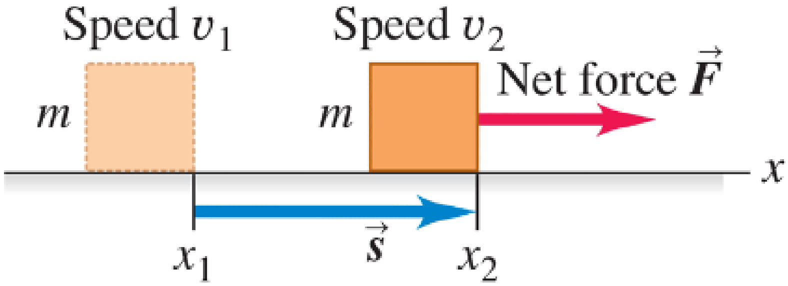
so if $a = \text{constant}$ & $\int dx = s$

then $$a = \frac{v_2^2 - v_1^2}{2s}$$



So

$$W = Fs = mas = m\left(\frac{v_2^2 - v_1^2}{2s}\right)s = \frac{1}{2}mv_2^2 - \frac{1}{2}mv_2^2$$

or $W = K_2 - K_1$

Constant acceleration & displacement

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so if $a = \text{constant}$ & $\int dx = s$

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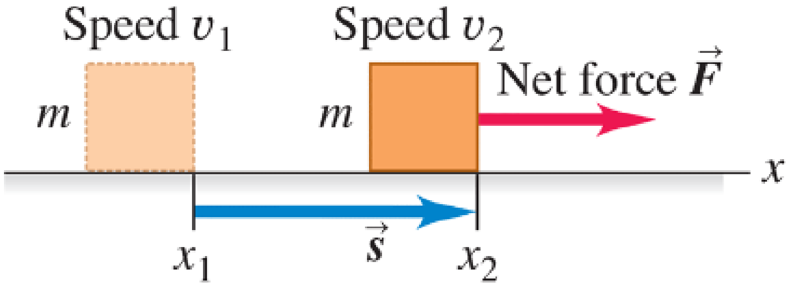


So

$$W = Fs = mas = m\left(\frac{V_2^2 - V_1^2}{2s}\right)s = \frac{1}{2}mV_2^2 - \frac{1}{2}mV_2^2$$

or $W = K_2 - K_1$, where $K \equiv$ kinetic energy

Constant acceleration & displacement

Previosly we found

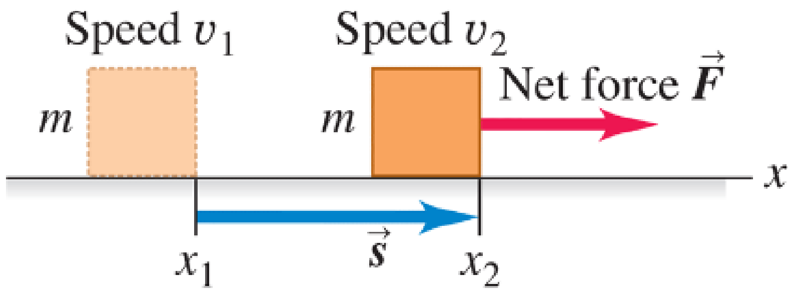
$$a = v\frac{dv}{dx} \Rightarrow \int a\,dx = \int v\,dv$$

$$\Rightarrow \int a\,dx = \tfrac{1}{2}v_2^2 - \tfrac{1}{2}v_1^2$$

so if $a = \text{constant}$ & $\int dx = s$

then

$$a = \frac{v_2^2 - v_1^2}{2s}$$



So

$$W = Fs = mas = m\left(\frac{v_2^2 - v_1^2}{2s}\right)s = \tfrac{1}{2}mv_2^2 - \tfrac{1}{2}mv_2^2$$

or $W = K_2 - K_1$, where $K \equiv$ kinetic energy & $K \equiv \tfrac{1}{2}mv^2$

Kinetic energy

Kinetic energy

$K = \frac{1}{2} m v^2$

Kinetic energy

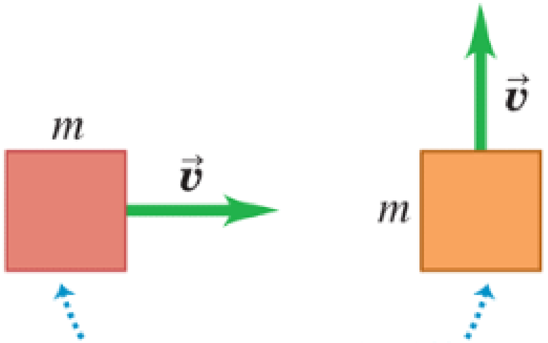
$K = \frac{1}{2}mv^2$ & K is scalar

Kinetic energy

$K = \frac{1}{2}mv^2$ & K is scalar

Don't confuse K [Kinetic energy] with K [spring constant]

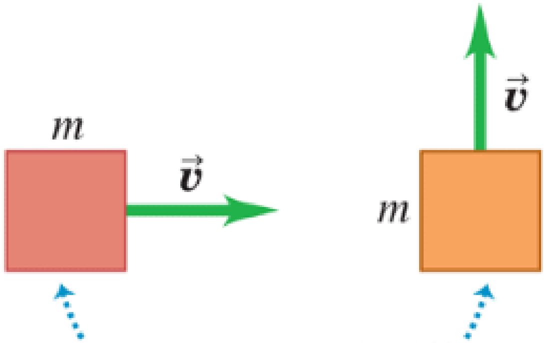
Kinetic energy



Same mass, same speed, different directions of motion

Kinetic energy

$K_1 = \frac{1}{2}mv^2$



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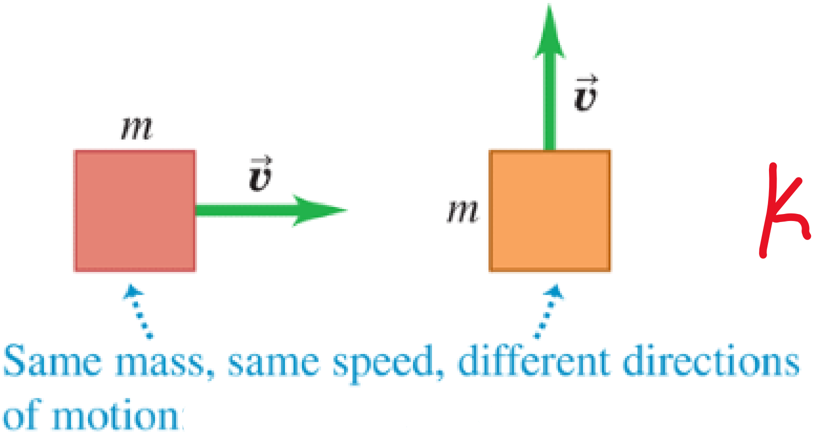
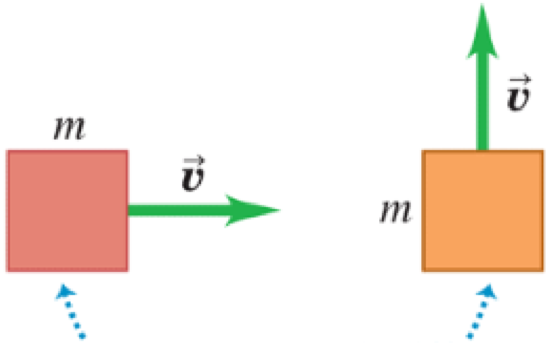


Same mass, same speed, different directions of motion

$K_2 = \frac{1}{2}mv^2$

Kinetic energy

$K_1 = \frac{1}{2}mv^2$

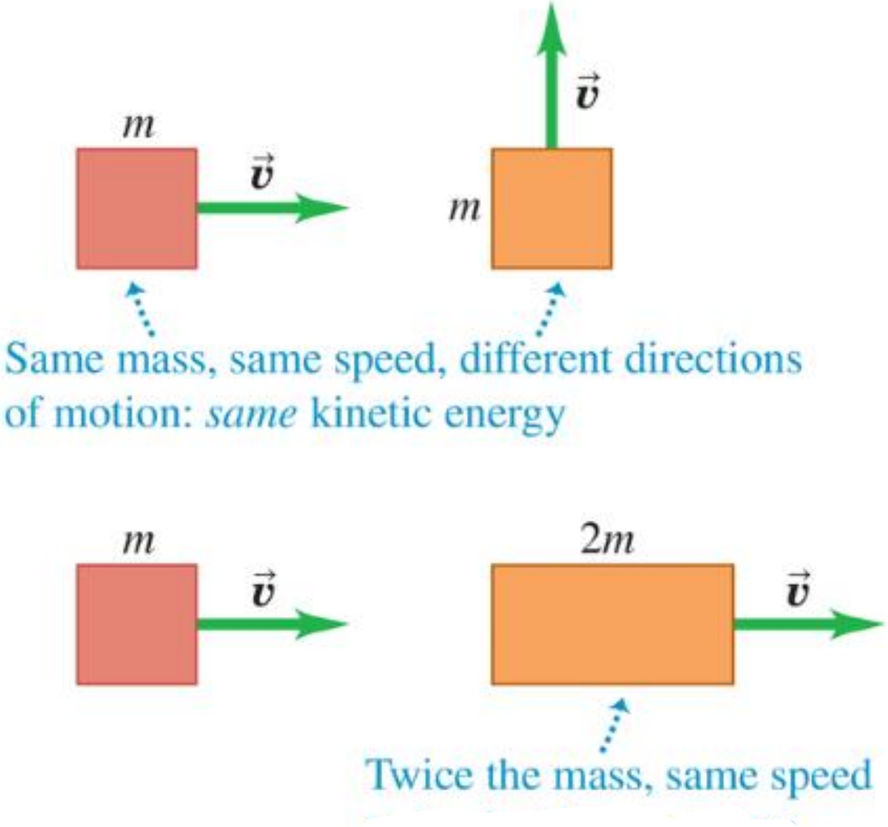


Same mass, same speed, different directions of motion: *same* kinetic energy

$K_2 = \frac{1}{2}mv^2$

$K_1 = K_2$

Kinetic energy

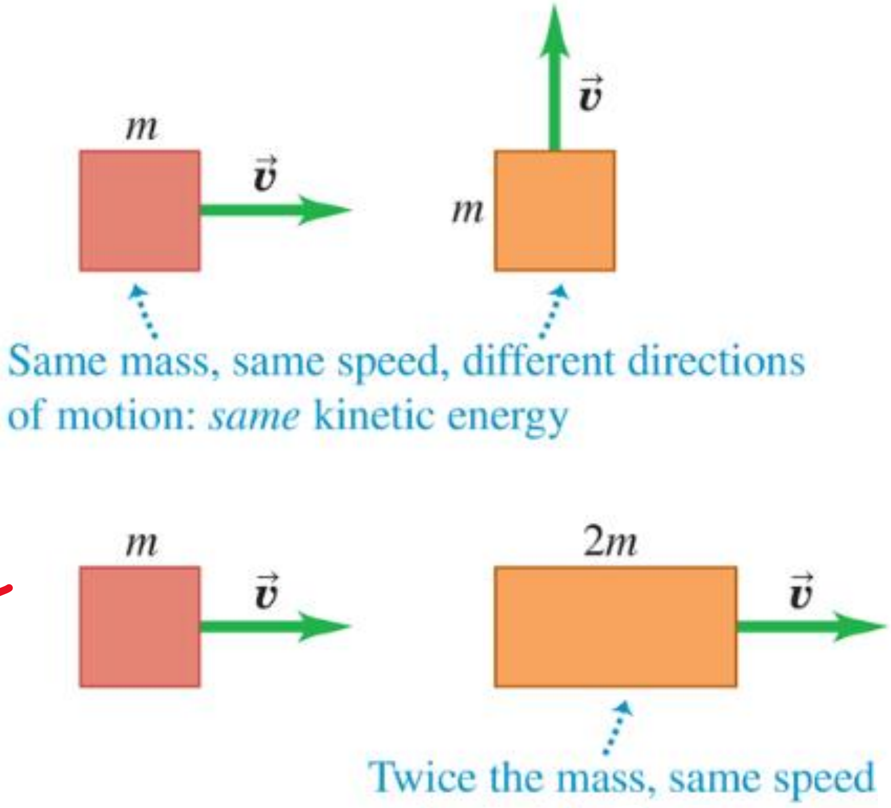


Same mass, same speed, different directions of motion: *same* kinetic energy

Twice the mass, same speed

Kinetic energy

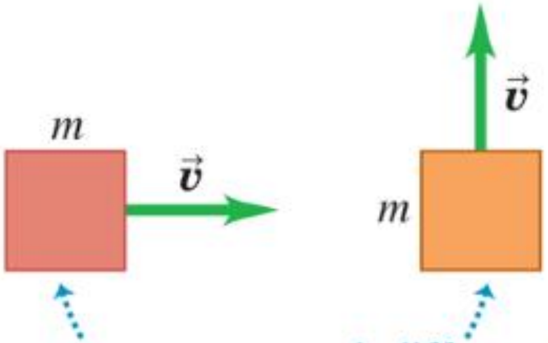
$K_1 = \frac{1}{2} m v^2$



Same mass, same speed, different directions of motion: *same* kinetic energy

Twice the mass, same speed

Kinetic energy



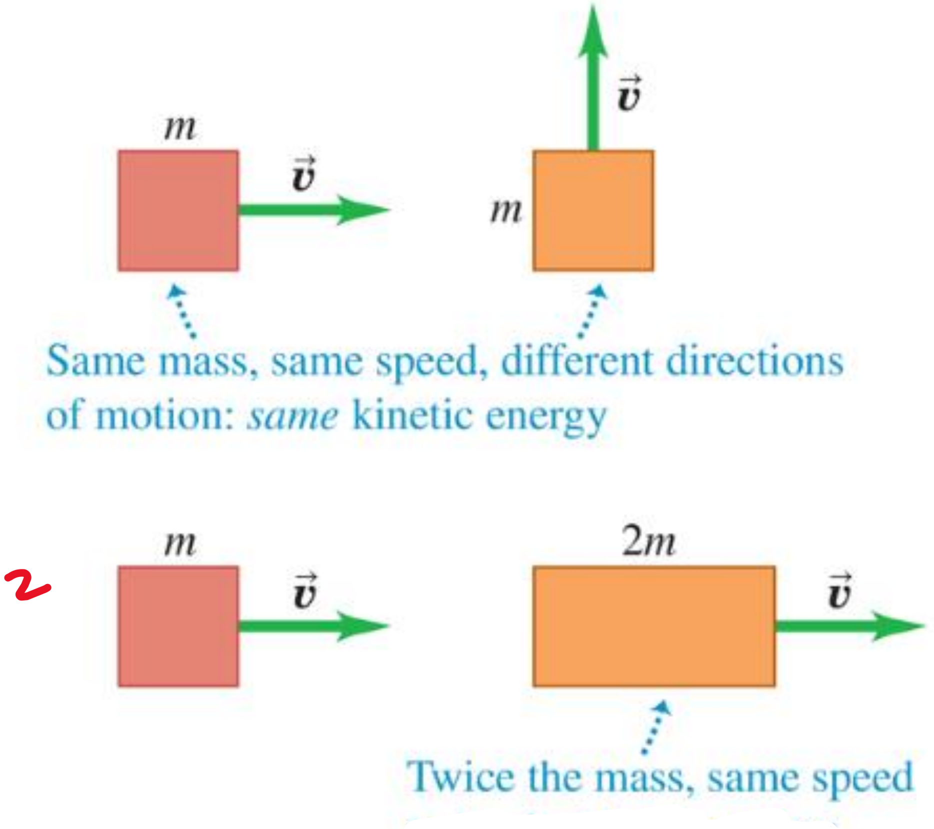
Same mass, same speed, different directions of motion: *same* kinetic energy

$K_1 = \frac{1}{2} m v^2$

$K_2 = \frac{1}{2}(2m) v^2$

Twice the mass, same speed

Kinetic energy



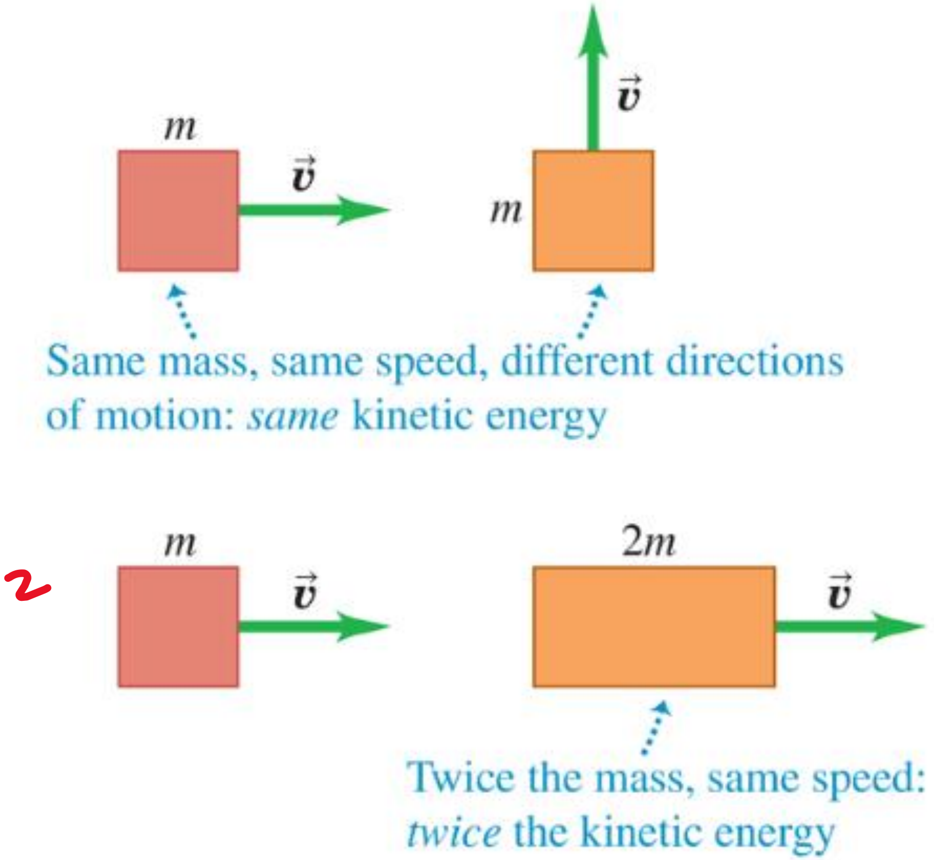
Same mass, same speed, different directions of motion: *same* kinetic energy

Twice the mass, same speed

$K_1 = \frac{1}{2} m v^2$

$K_2 = \frac{1}{2}(2m) v^2$
$= m v^2$

Kinetic energy



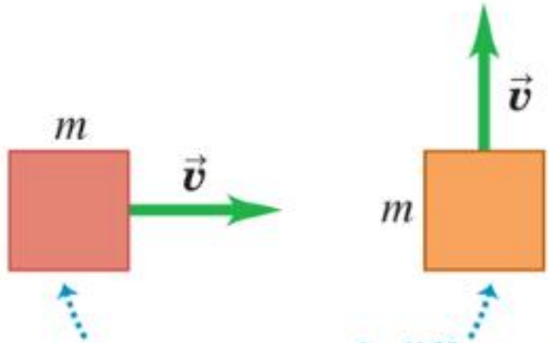
Same mass, same speed, different directions of motion: *same* kinetic energy

Twice the mass, same speed: *twice* the kinetic energy

$K_1 = \frac{1}{2} m v^2$

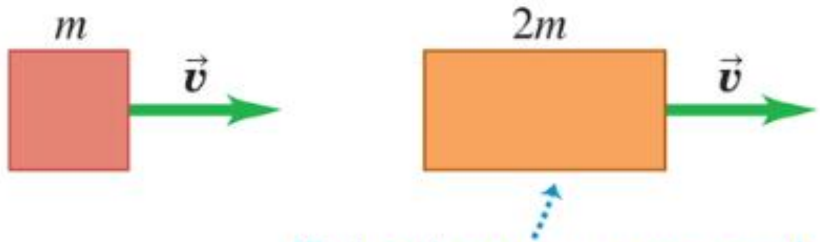
$K_2 = \frac{1}{2}(2m) v^2$
$= m v^2$

Kinetic energy



Same mass, same speed, different directions of motion: *same* kinetic energy

$K_1 = \frac{1}{2} m v^2$

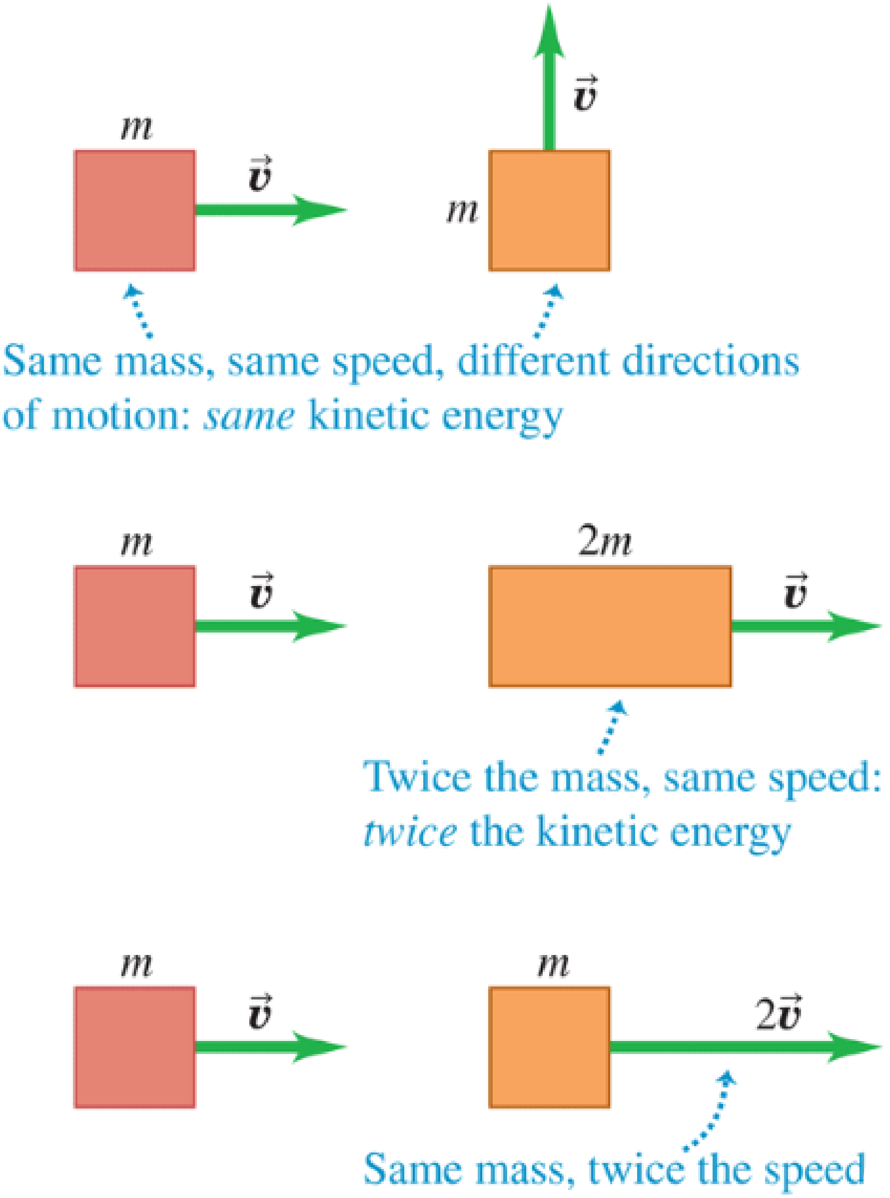


$K_2 = \frac{1}{2}(2m) v^2$
$= m v^2$

Twice the mass, same speed: *twice* the kinetic energy

$K_2 = 2K_1$

Kinetic energy

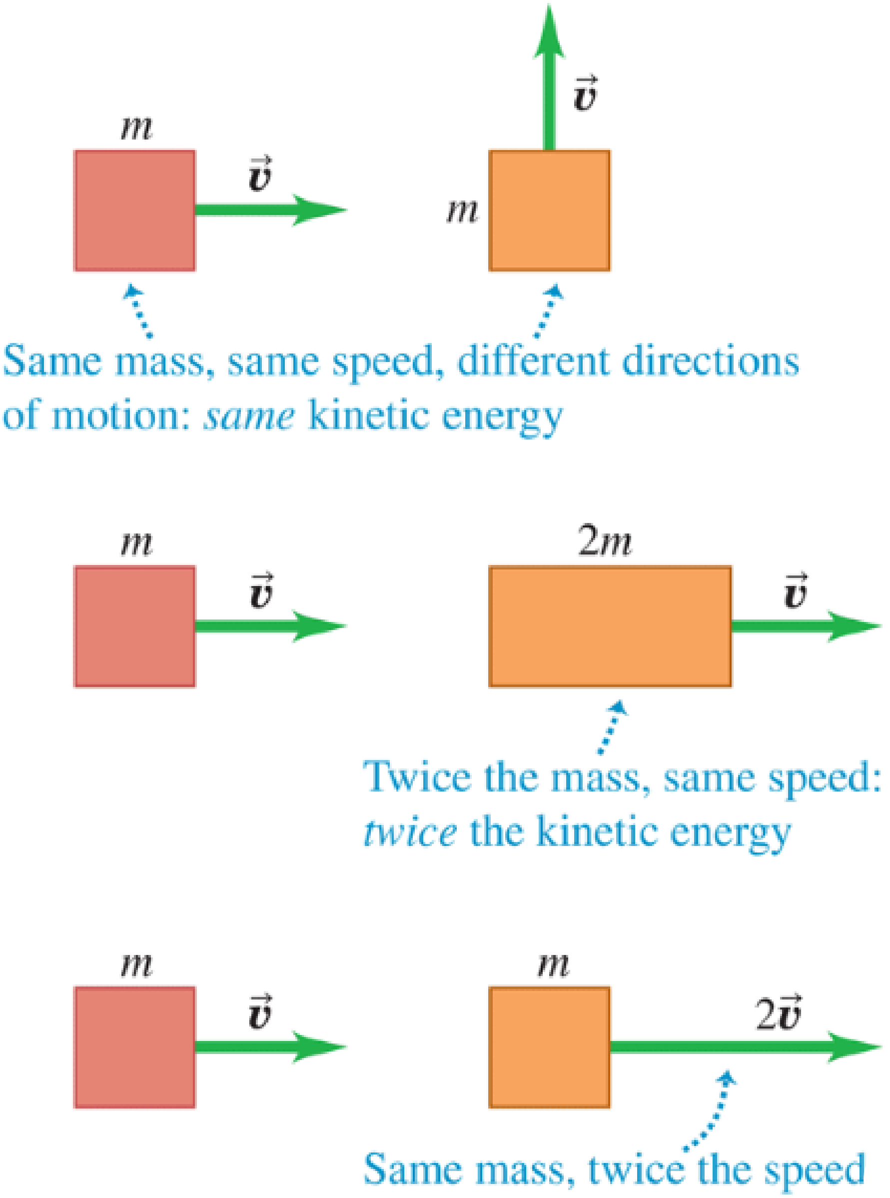


Same mass, same speed, different directions of motion: *same* kinetic energy

Twice the mass, same speed: *twice* the kinetic energy

Same mass, twice the speed

Kinetic energy



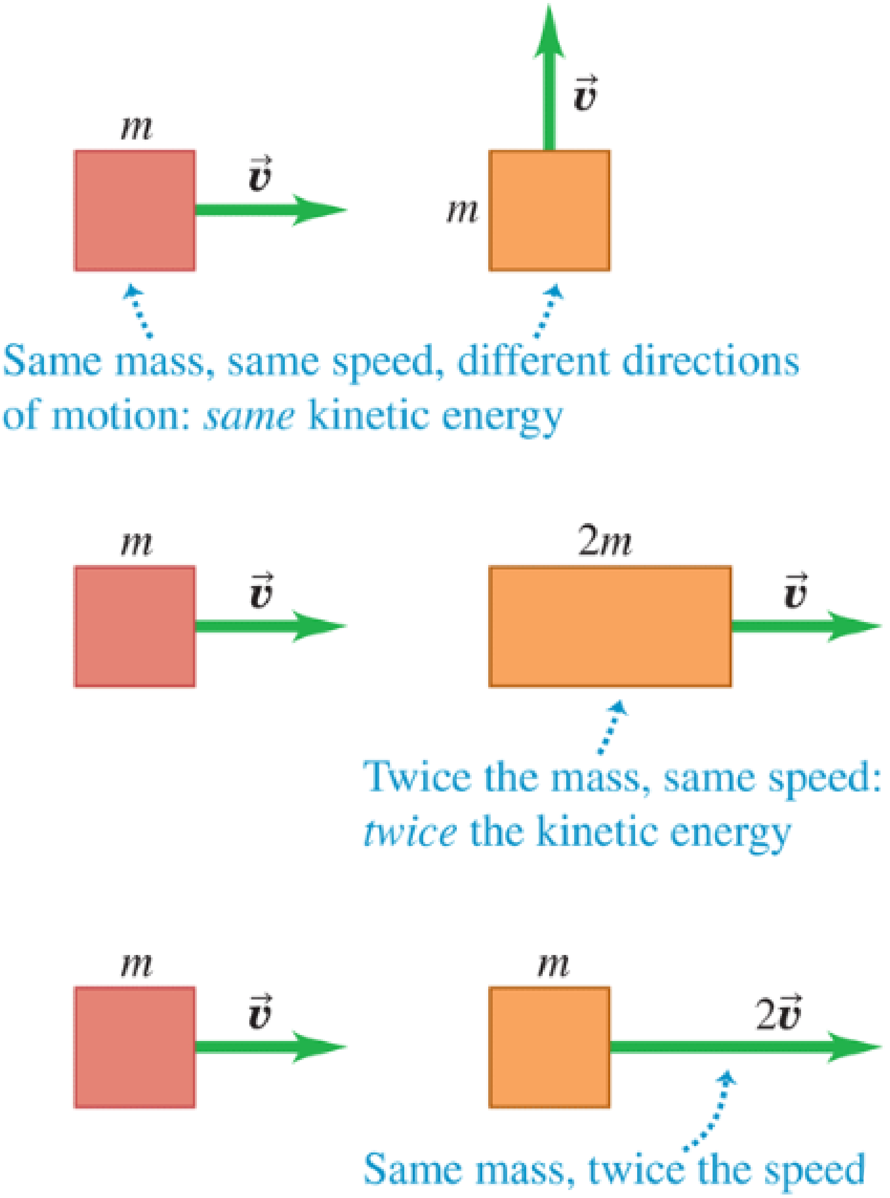
Same mass, same speed, different directions of motion: *same* kinetic energy

Twice the mass, same speed: *twice* the kinetic energy

Same mass, twice the speed

$K_1 = \frac{1}{2} m v^2$

Kinetic energy



Same mass, same speed, different directions of motion: *same* kinetic energy

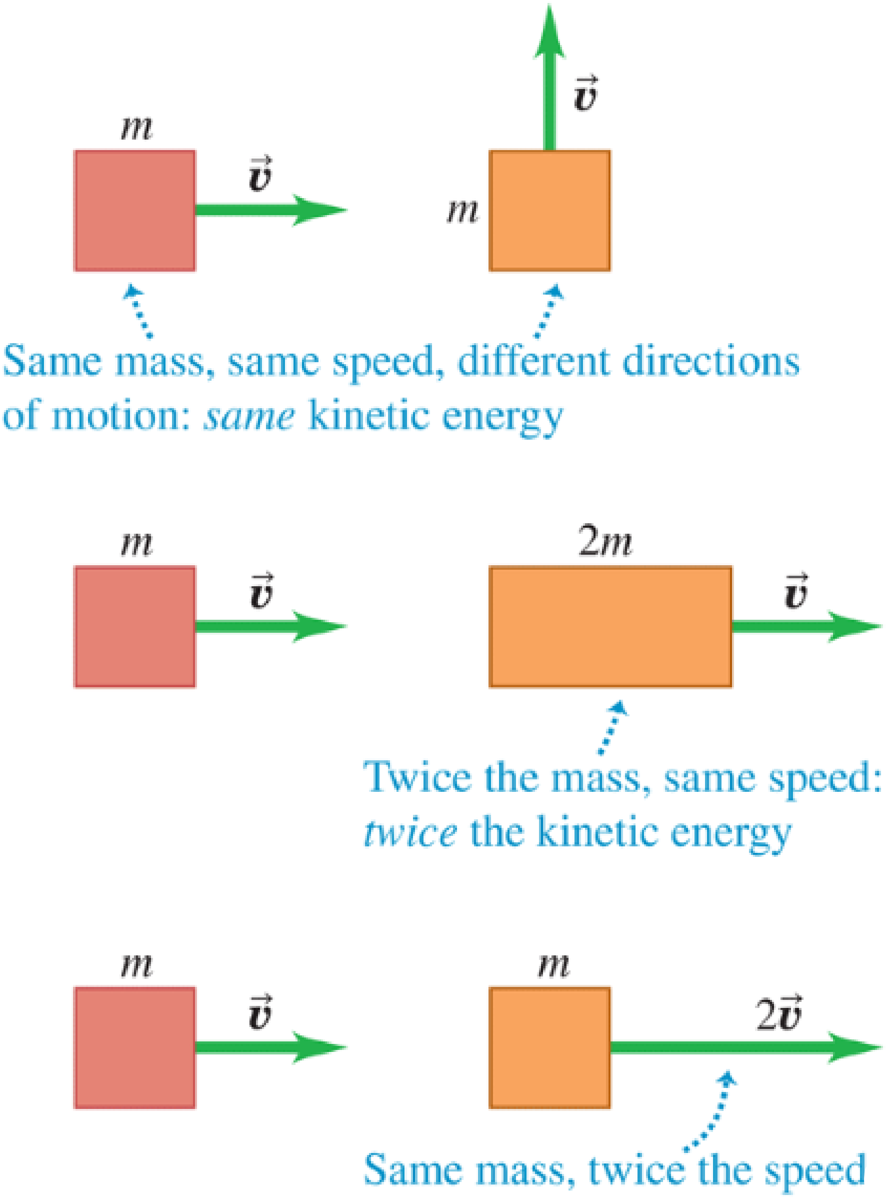
Twice the mass, same speed: *twice* the kinetic energy

Same mass, twice the speed

$K_1 = \frac{1}{2}mv^2$

$K_2 = \frac{1}{2}m(2v)^2$

Kinetic energy



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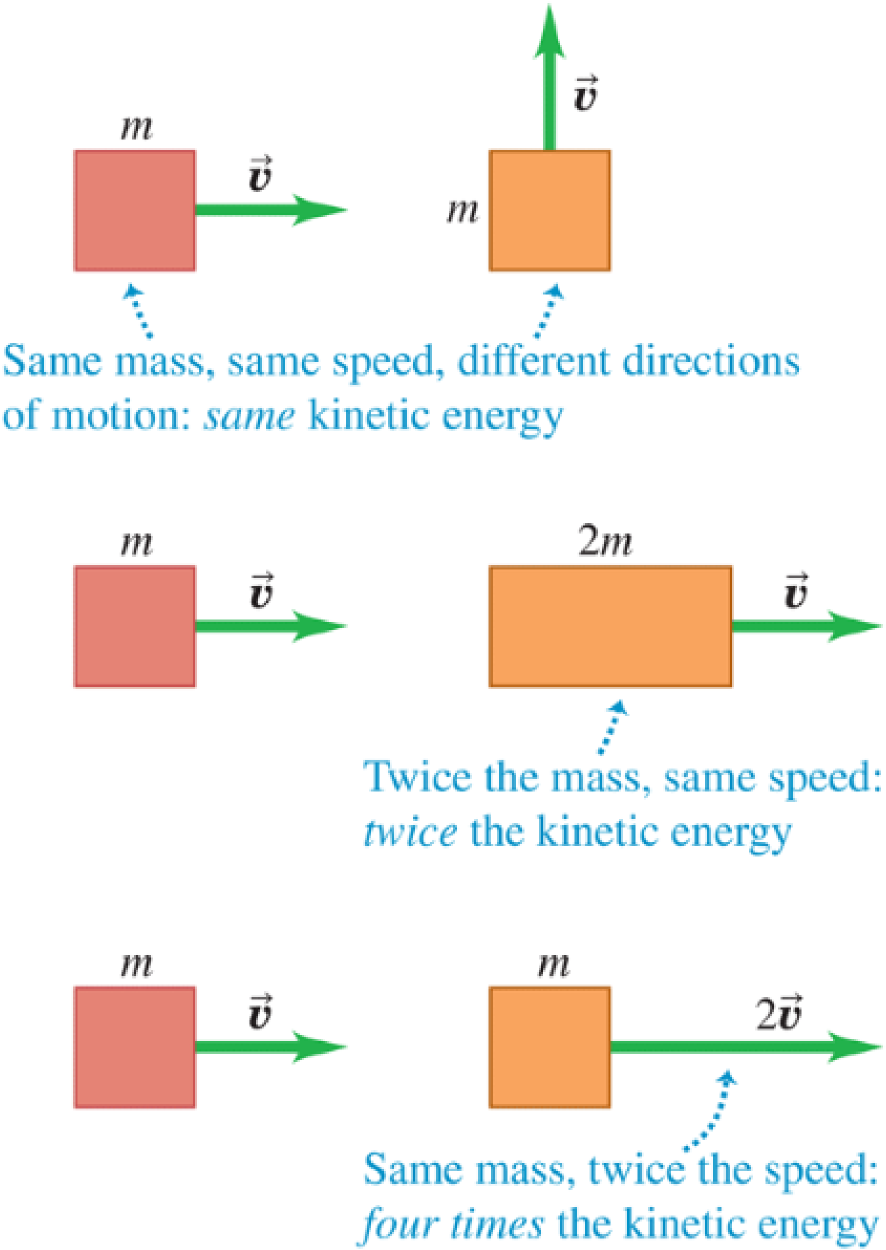

Same mass, same speed, different directions of motion: *same* kinetic energy

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Same mass, twice the speed: *four times* the kinetic energy

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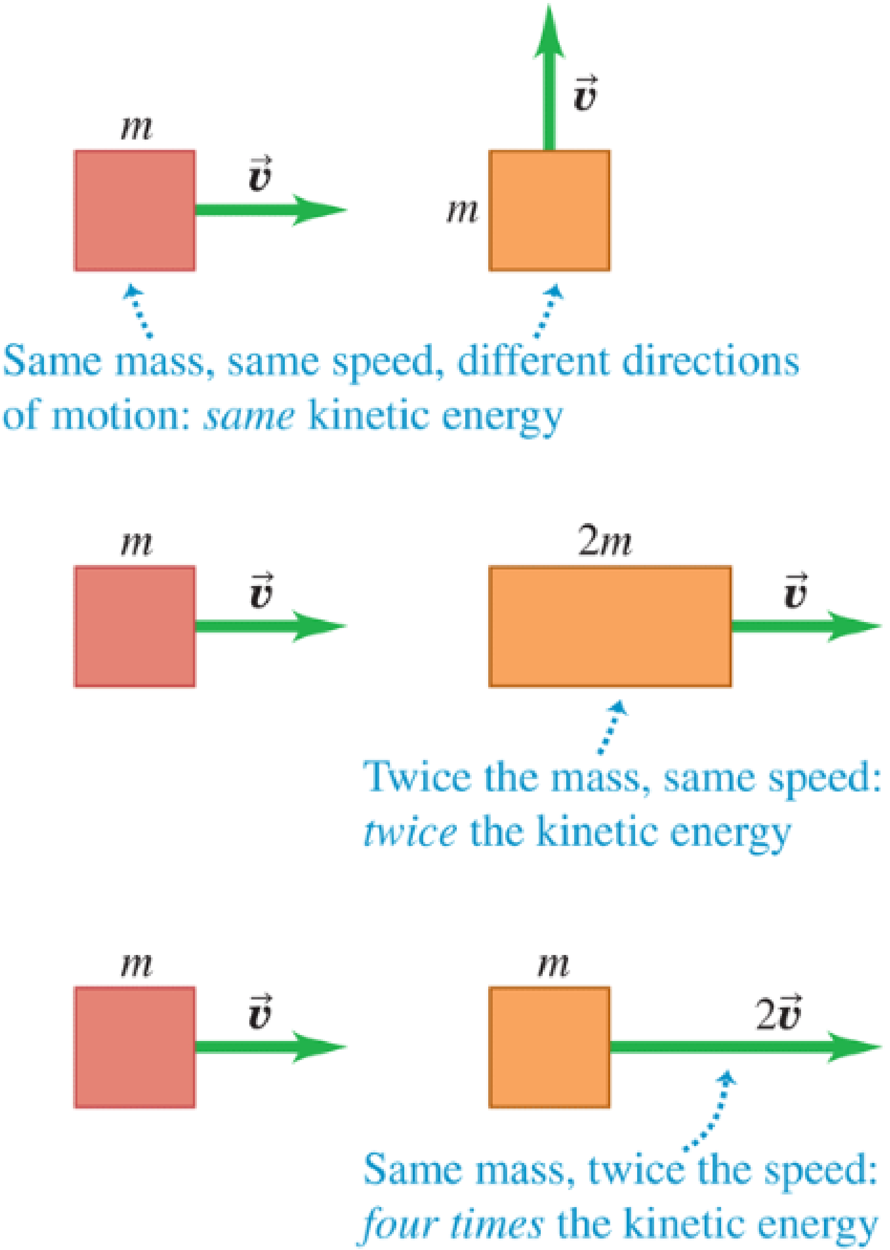

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$K_2 = 4 K_1$

Work–energy theorem: Work done by the net force on a particle equals the change in the particle's kinetic energy.

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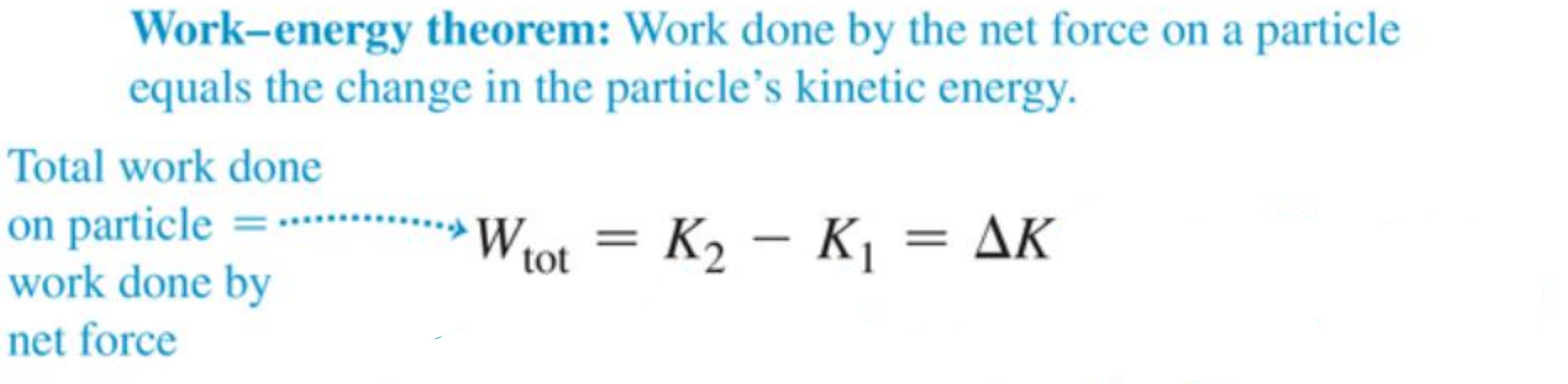
$$W_{\text{tot}} = K_2 - K_1 = \Delta K$$



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Total work done on particle = work done by net force

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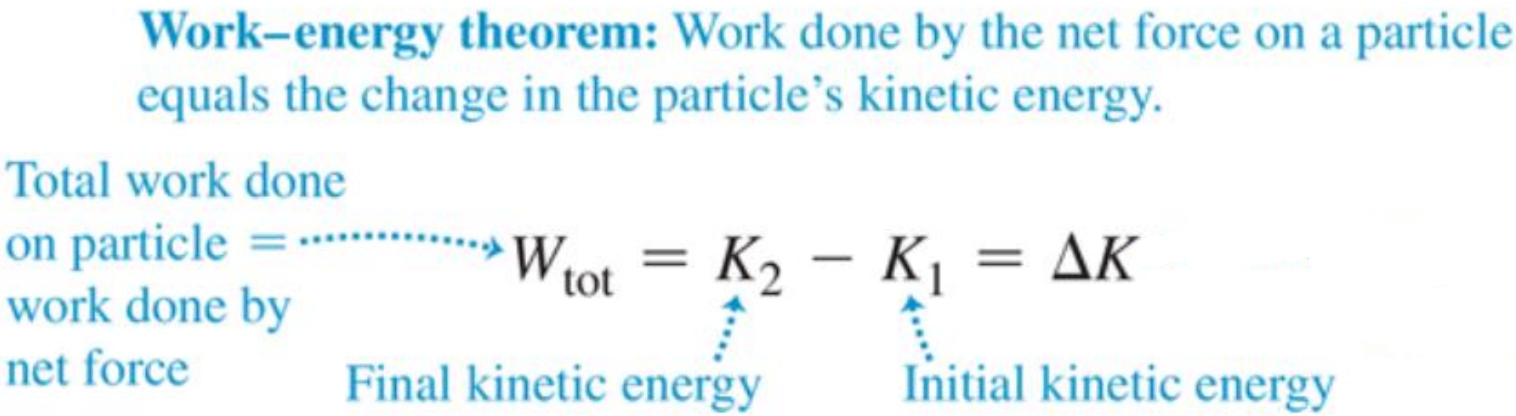
Final kinetic energy



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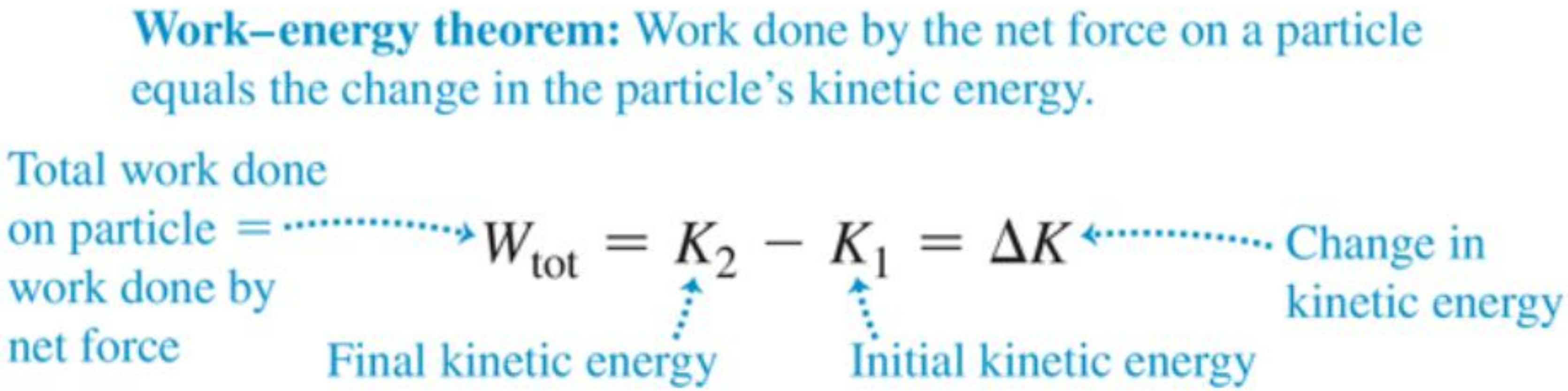
Final kinetic energy

Initial kinetic energy



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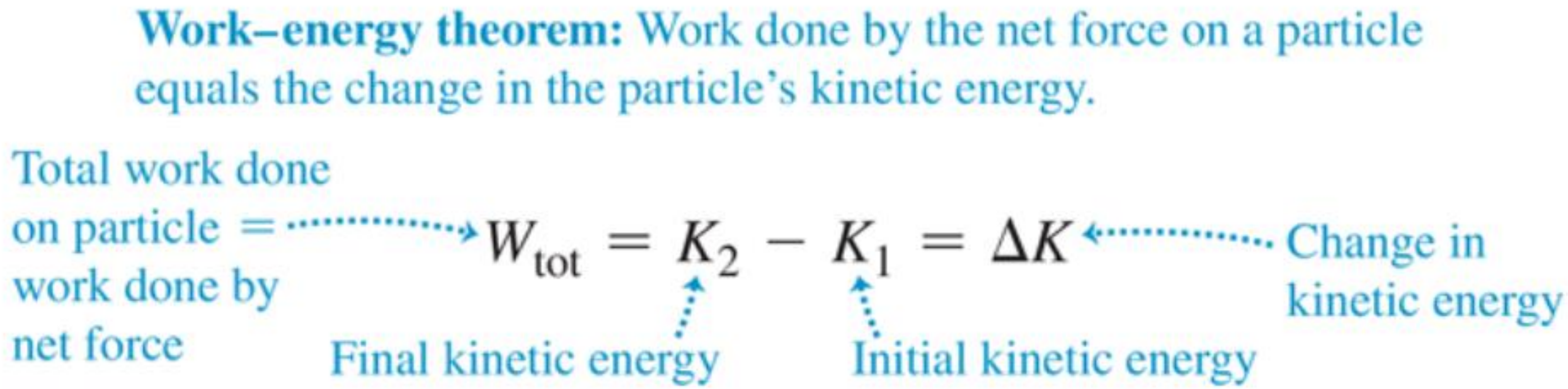
Change in kinetic energy

Final kinetic energy

Initial kinetic energy



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Change in kinetic energy

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Initial kinetic energy

* When $W_{TOT} > 0$

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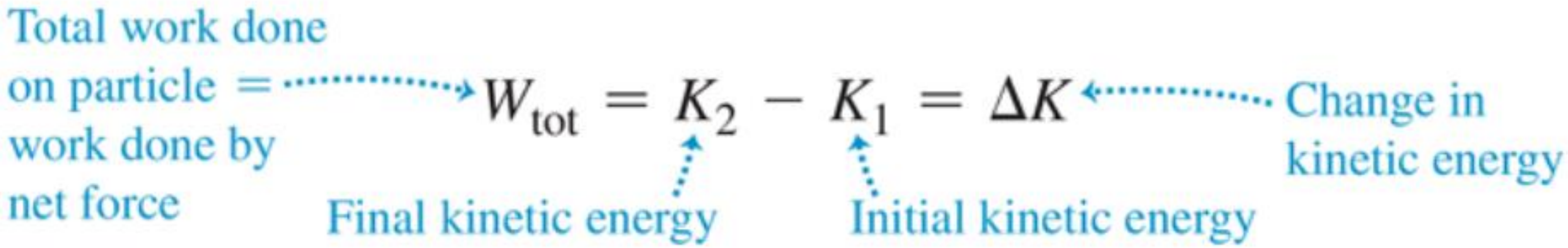

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Final kinetic energy

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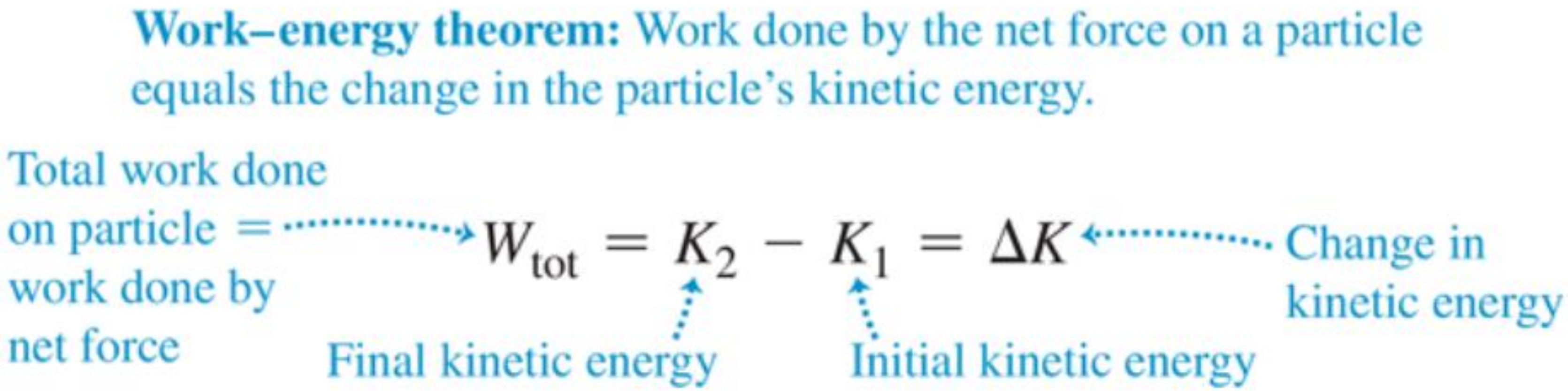
Change in kinetic energy

* When $W_{TOT} > 0$, Kinetic energy increases



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Change in kinetic energy

Final kinetic energy

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* When $W_{TOT} > 0$, Kinetic energy increases [object goes faster]

Work–energy theorem: Work done by the net force on a particle equals the change in the particle's kinetic energy.

Total work done on particle = work done by net force ⋯→ $W_{tot} = K_2 - K_1 = \Delta K$ ←⋯ Change in kinetic energy

K_2: Final kinetic energy

K_1: Initial kinetic energy

* When $W_{TOT} > 0$, Kinetic energy increases [object goes faster]

* When $W_{TOT} < 0$

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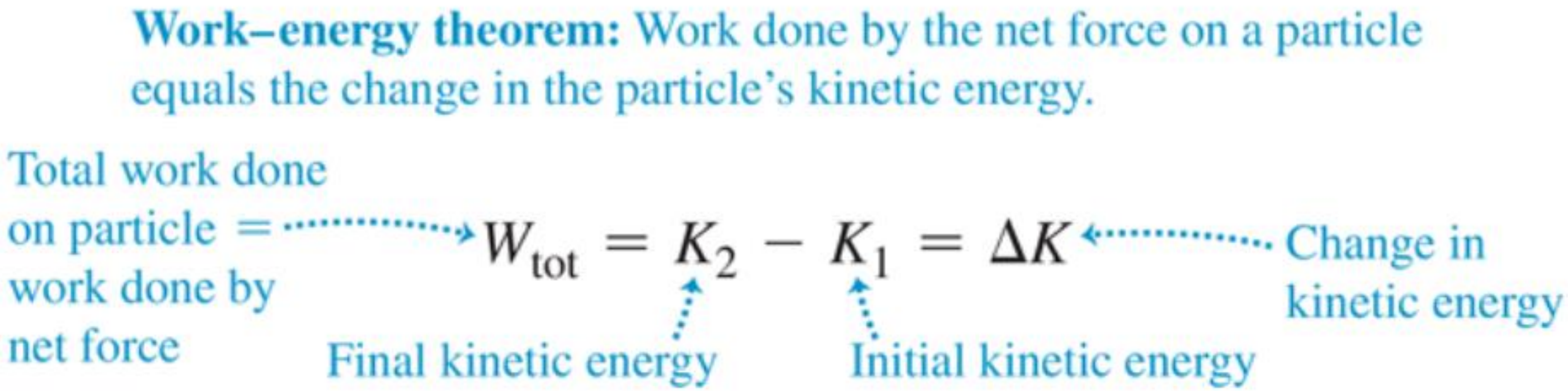

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K_2: Final kinetic energy

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* When $W_{TOT} > 0$, Kinetic energy increases [object goes faster]

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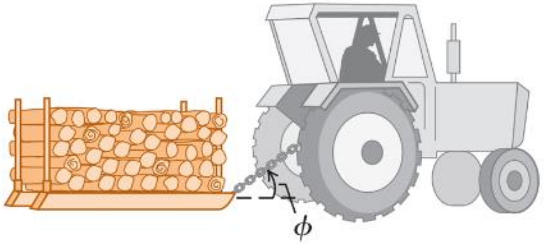
Let's look again at the sled in Fig. 6.7 and our results from Example 6.2. Suppose the sled's initial speed v_1 is 2.0 m/s. What is the speed of the sled after it moves 20 m?



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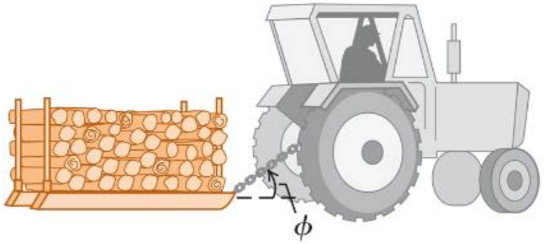

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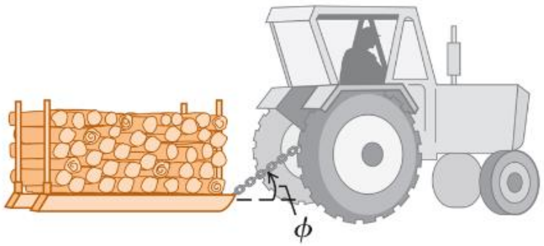

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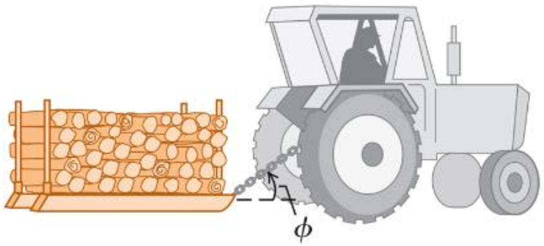

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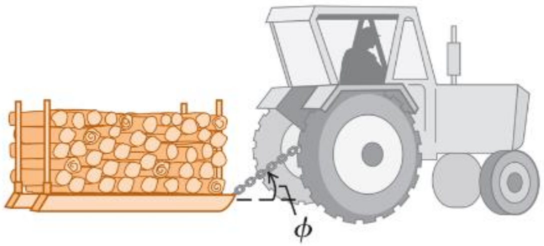

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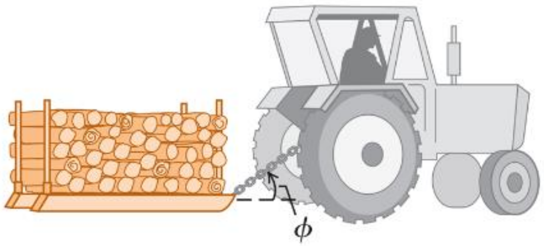

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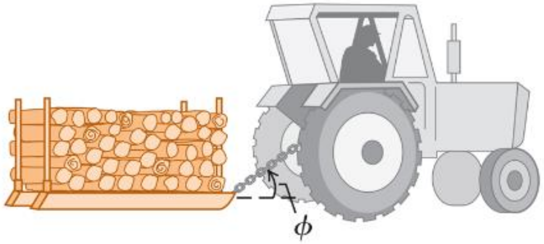

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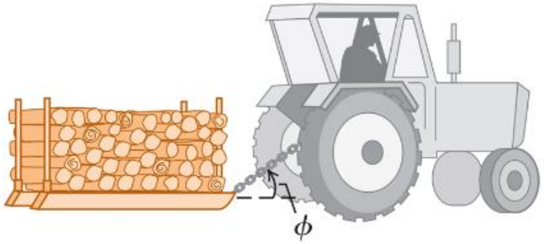

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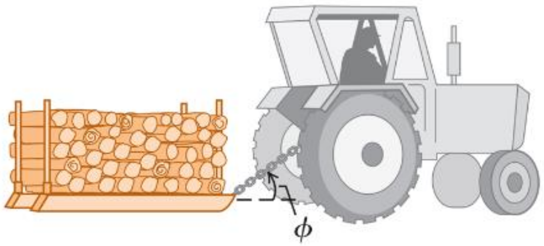

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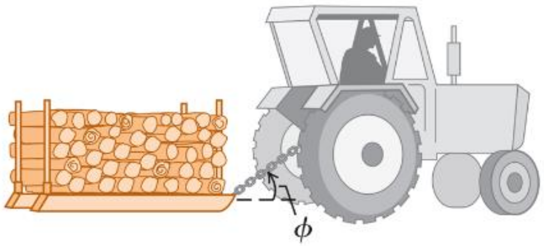

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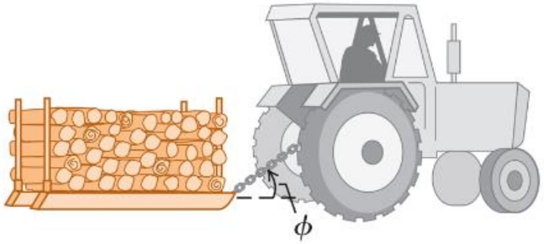

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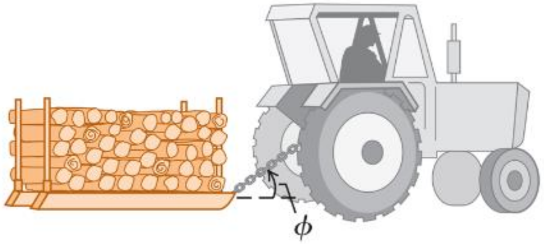

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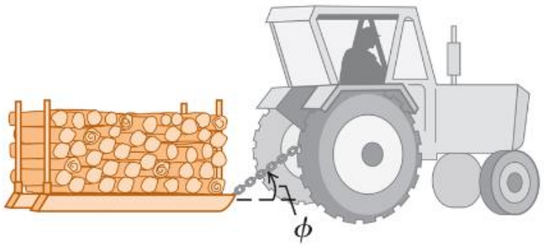

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Note: weight $= mg \Rightarrow m = \frac{w}{g}$

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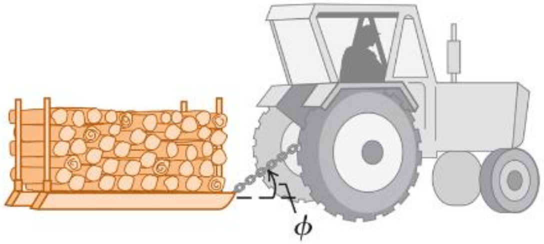

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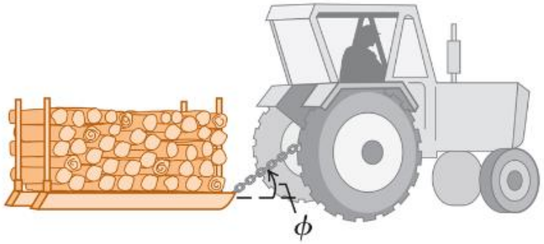

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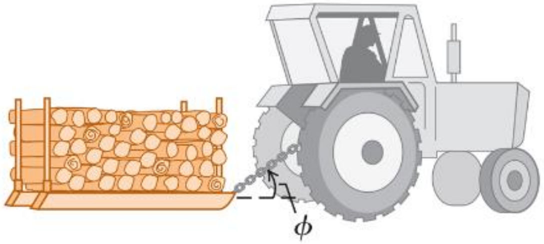

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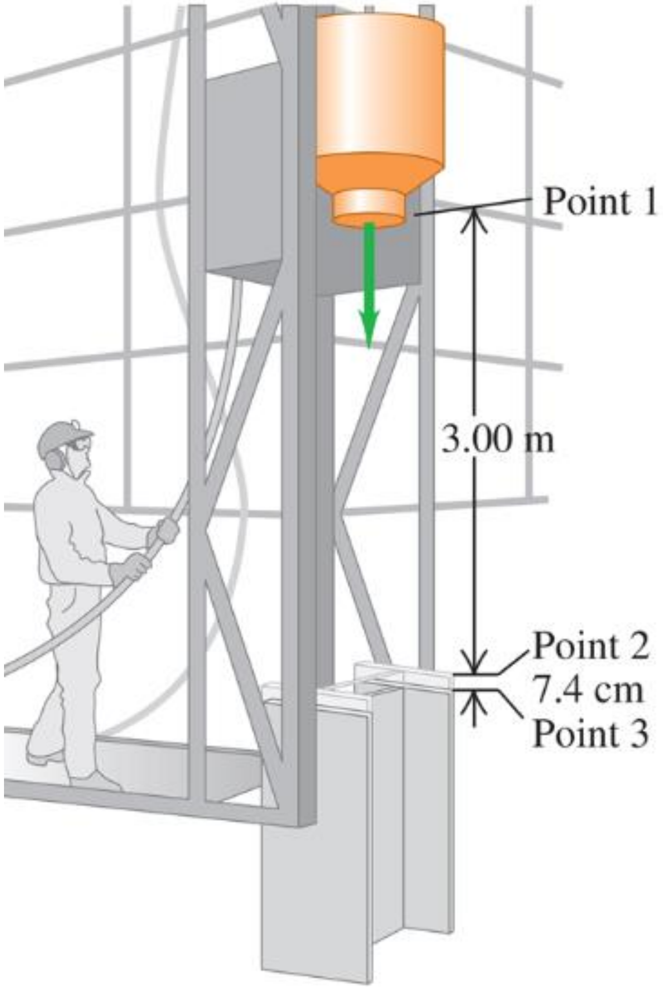
The 200 kg steel hammerhead of a pile driver is lifted 3.00 m above the top of a vertical I-beam being driven into the ground (Fig. 6.12a). The hammerhead is then dropped, driving the I-beam 7.4 cm deeper into the ground. The vertical guide rails exert a constant 60 N friction force on the hammerhead. Use the work–energy theorem to find (a) the speed of the hammerhead just as it hits the I-beam and (b) the average force the hammerhead exerts on the I-beam. Ignore the effects of the air.



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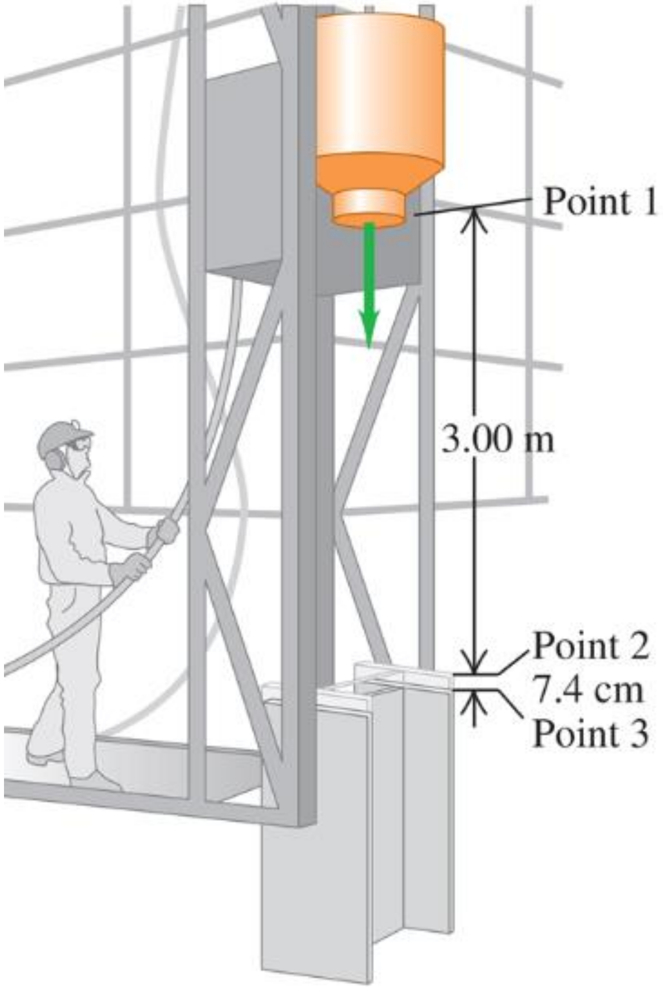
$M = 200\text{kg}$



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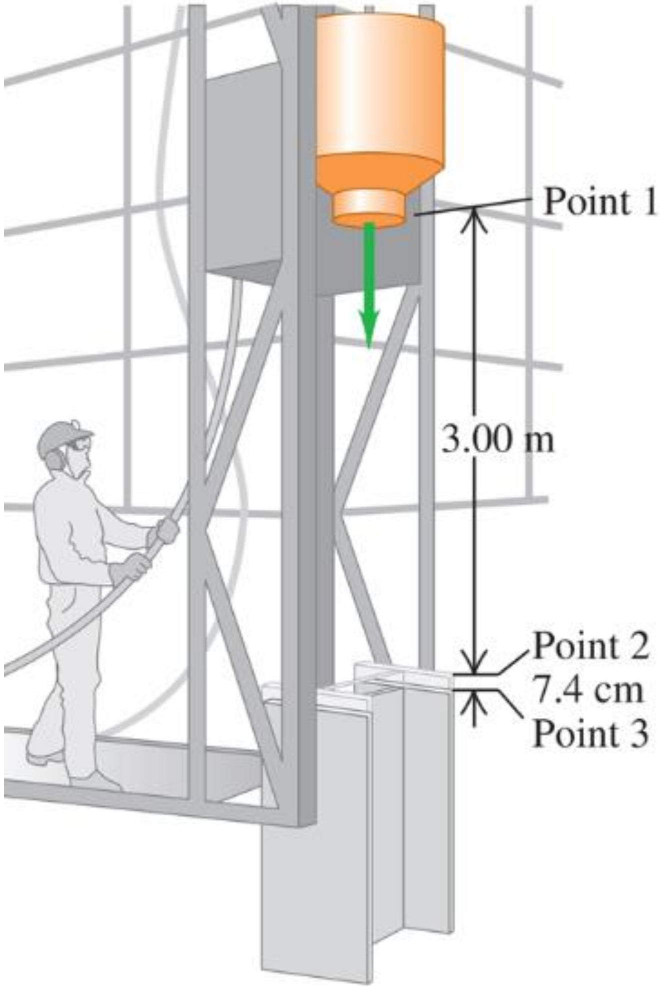
$m = 200\text{kg}$, $y_1 = 3\text{m}$



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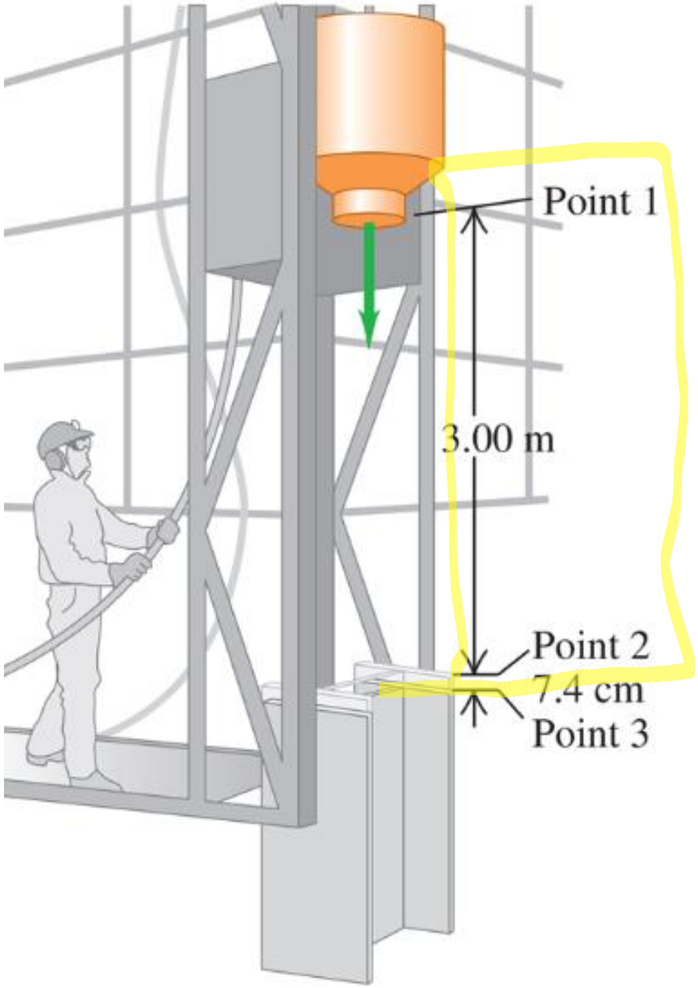
$m = 200\text{kg}$, $y_1 = 3\text{m}$, $y_2 = 0$



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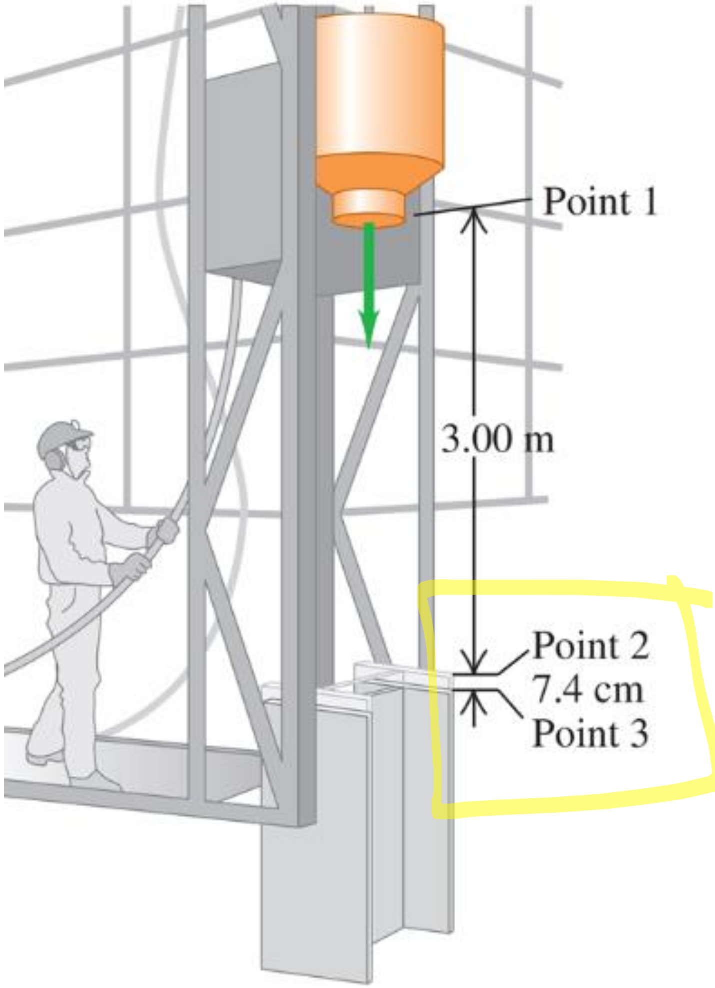
$m = 200kg$, $y_1 = 3m$, $y_2 = 0$

$y_3 = -0.074m$



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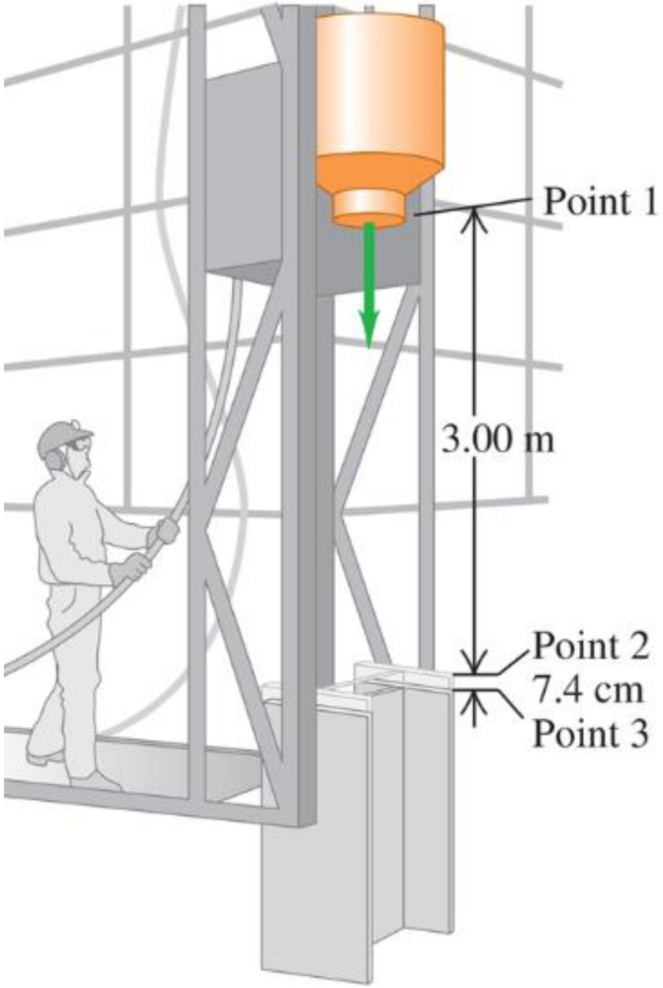
$m = 200kg$, $y_1 = 3m$, $y_2 = 0$

$y_3 = -0.074m$, $F = 60N$



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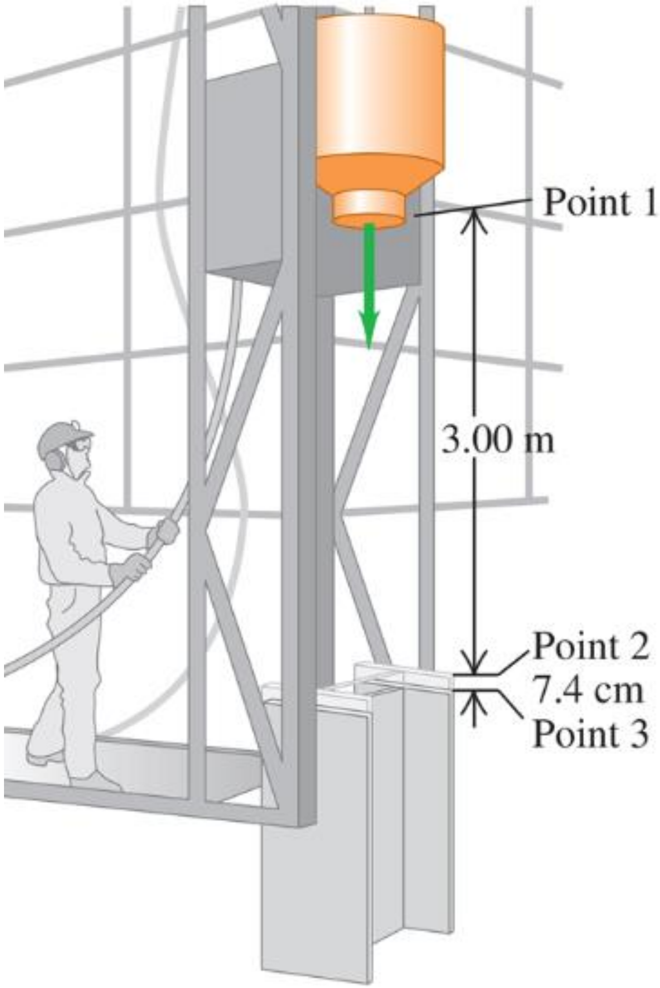
$m = 200kg$, $y_1 = 3m$, $y_2 = 0$

$y_3 = -0.074m$, $F = 60N$,

find V_2 :



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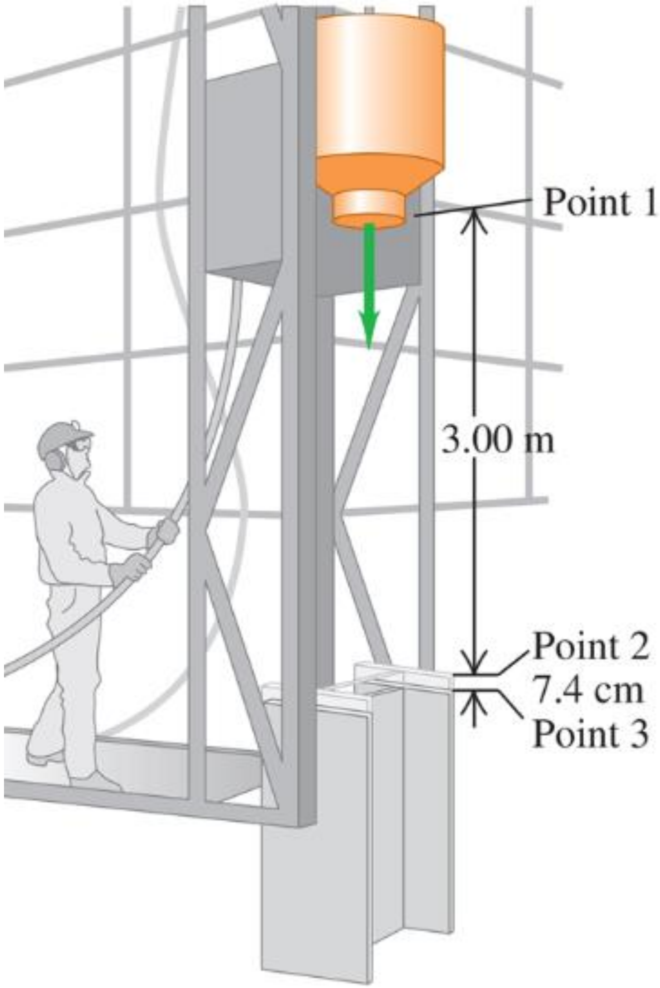
$m = 200kg$, $y_1 = 3m$, $y_2 = 0$

$y_3 = -0.074m$, $F = 60N$,

find V_2 : $W_{1\to2} = K_2 - K_1$



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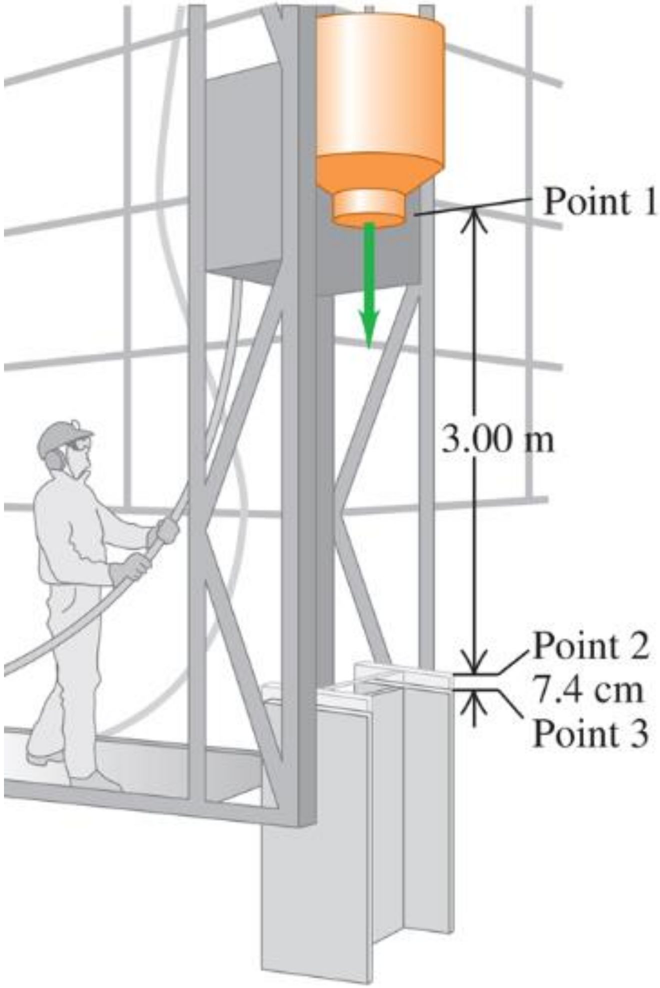
$m = 200kg$, $y_1 = 3m$, $y_2 = 0$

$y_3 = -0.074m$, $F = 60N$,

find V_2 : $W_{1\to 2} = K_2 - K_1$

$\Rightarrow K_2 = W_{1\to 2} + K_1$



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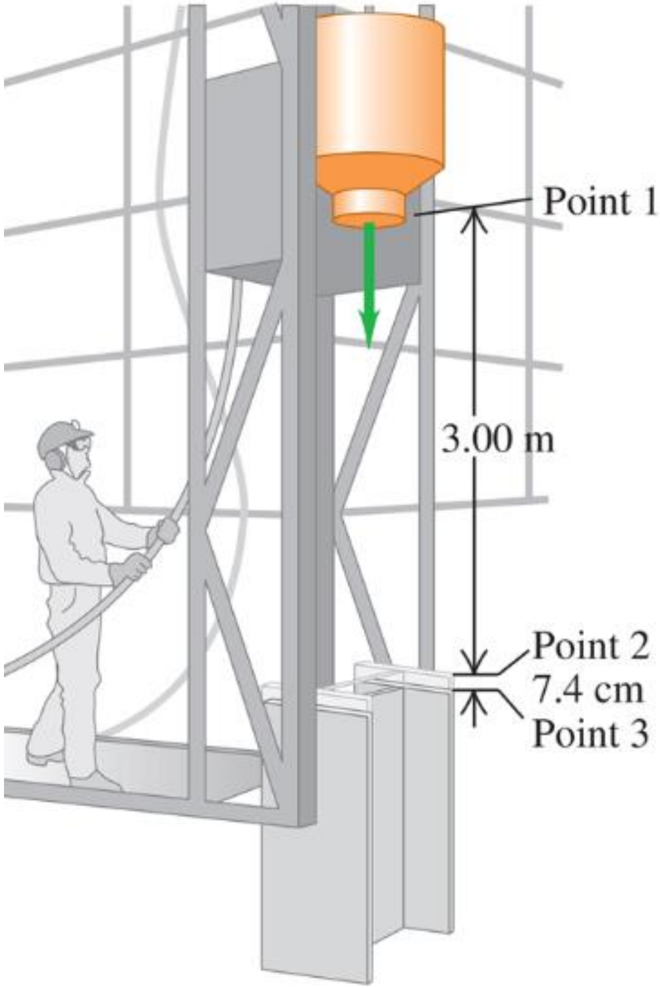
$m = 200kg$, $y_1 = 3m$, $y_2 = 0$

$y_3 = -0.074m$, $F = 60N$,

find V_2 : $W_{1\to2} = K_2 - K_1$

$\Rightarrow K_2 = W_{1\to2} + \cancelto{0}{K_1}$



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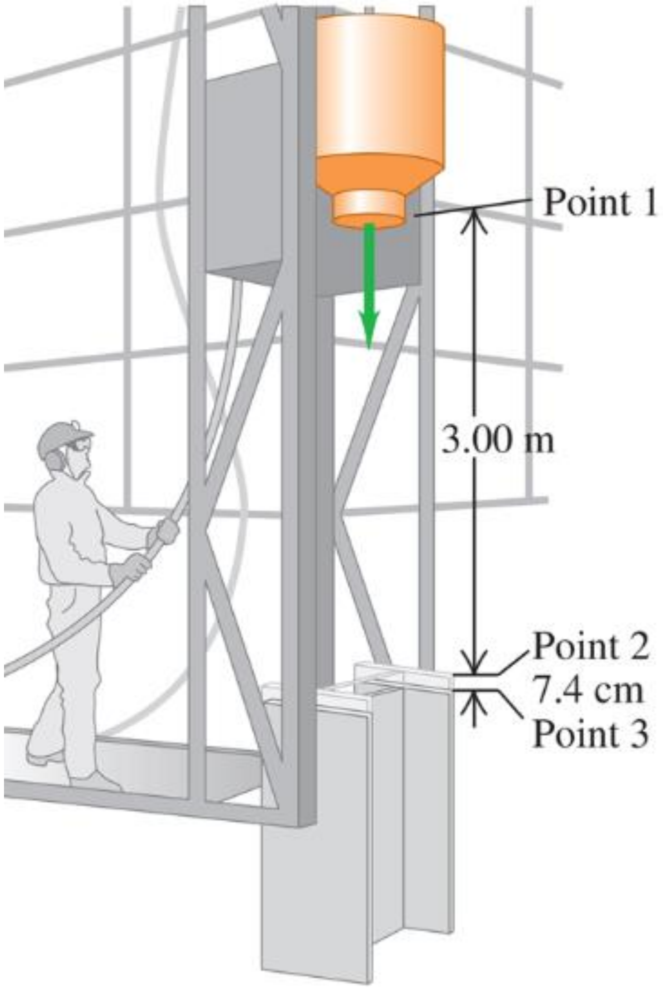
$M = 200kg$, $y_1 = 3m$, $y_2 = 0$

$y_3 = -0.074m$, $F = 60N$,

find V_2 : $W_{1\to2} = K_2 - K_1$

$\Rightarrow K_2 = W_{1\to2} + \overset{0}{\cancel{K_1}}$ &

$w_{1\to2} = (mg - F)(y_1 - y_2)$



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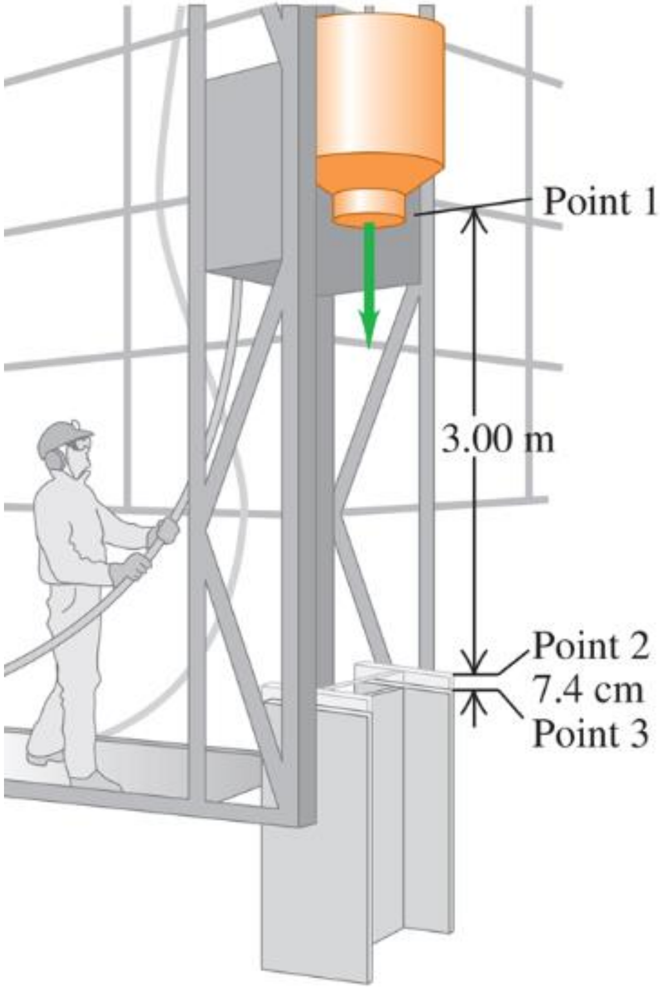


$m = 200kg$, $y_1 = 3m$, $y_2 = 0$

$y_3 = -0.074m$, $F = 60N$,

find V_2 : $W_{1\to2} = K_2 - K_1$

$\Rightarrow K_2 = W_{1\to2} + \overset{0}{\cancel{K_1}}$ &

$W_{1\to2} = (mg - F)(y_1 - y_2) \Rightarrow$

$\frac{1}{2}mv^2 = (mg - F)(y_1 - y_2)$

The 200 kg steel hammerhead of a pile driver is lifted 3.00 m above the top of a vertical I-beam being driven into the ground (Fig. 6.12a). The hammerhead is then dropped, driving the I-beam 7.4 cm deeper into the ground. The vertical guide rails exert a constant 60 N friction force on the hammerhead. Use the work–energy theorem to find (a) the speed of the hammerhead just as it hits the I-beam and (b) the average force the hammerhead exerts on the I-beam. Ignore the effects of the air.

$m = 200kg$, $y_1 = 3m$, $y_2 = 0$

$y_3 = -0.074m$, $F = 60N$,

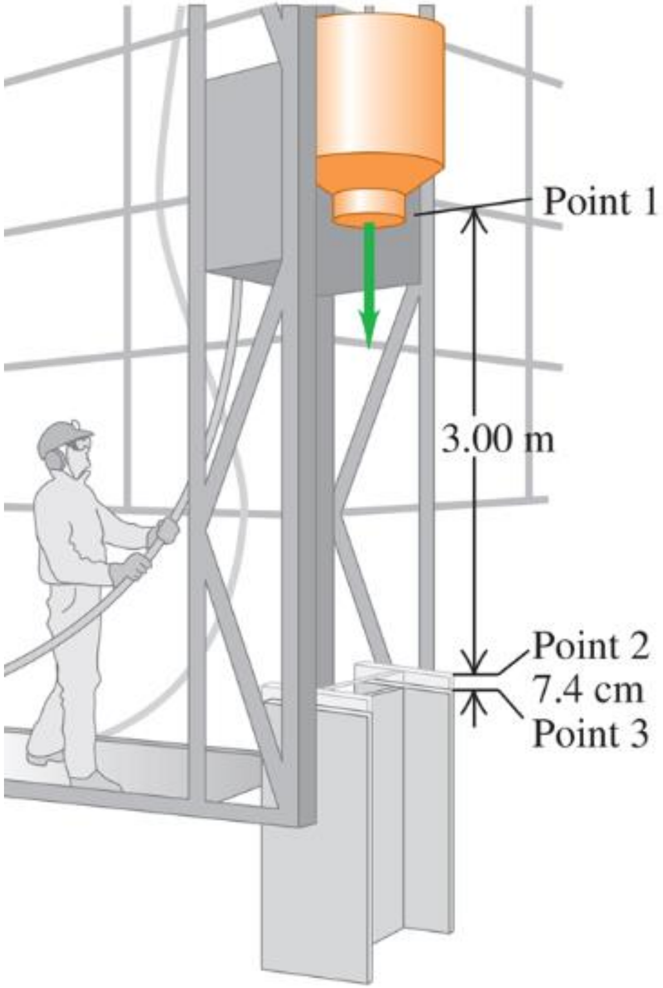
find V_2 : $W_{1\to 2} = K_2 - K_1$

$\Rightarrow K_2 = W_{1\to 2} + \cancelto{0}{K_1}$ &

$W_{1\to 2} = (mg - F)(y_1 - y_2) \Rightarrow$

$\frac{1}{2}mv^2 = (mg - F)(y_1 - y_2) \Rightarrow$

$v = \left[2\left(g - \frac{F}{m}\right)(y_1 - y_2)\right]^{1/2}$



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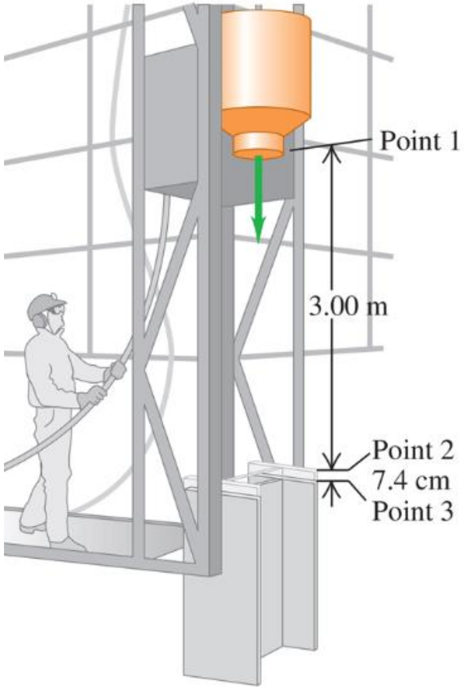


$m = 200 kg$, $y_1 = 3 m$, $y_2 = 0$

$y_3 = -0.074 m$, $F = 60 N$,

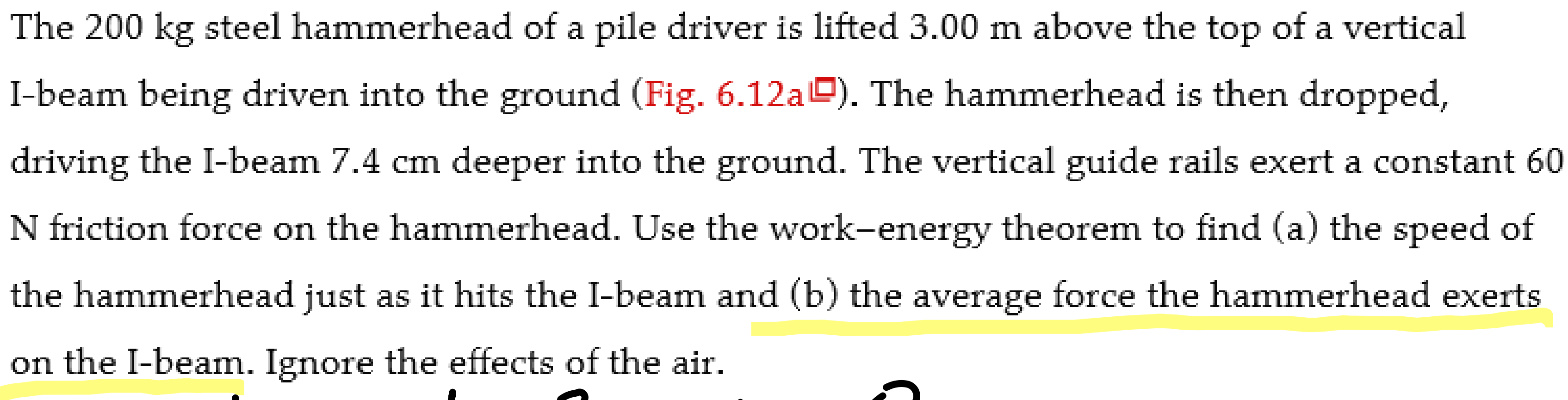
find V_2: $W_{1\to 2} = K_2 - K_1$

$\Rightarrow K_2 = W_{1\to 2} + \cancelto{0}{K_1}$ &

$W_{1\to 2} = (mg - F)(y_1 - y_2) \Rightarrow$

$\frac{1}{2} m v^2 = (mg - F)(y_1 - y_2) \Rightarrow$

$v = \left[2\left(g - \frac{F}{m}\right)(y_1 - y_2)\right]^{1/2} = \sqrt{2\left(9.8 - \frac{60}{200}\right)(3)}\ \frac{m}{s} = 7.55 \frac{m}{s}$



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$M = 200\text{kg}$, $y_1 = 3\text{m}$, $y_2 = 0$

$y_3 = -0.074\text{m}$, $F = 60\text{N}$, Find $(F_{h \to I})_{AVE}$

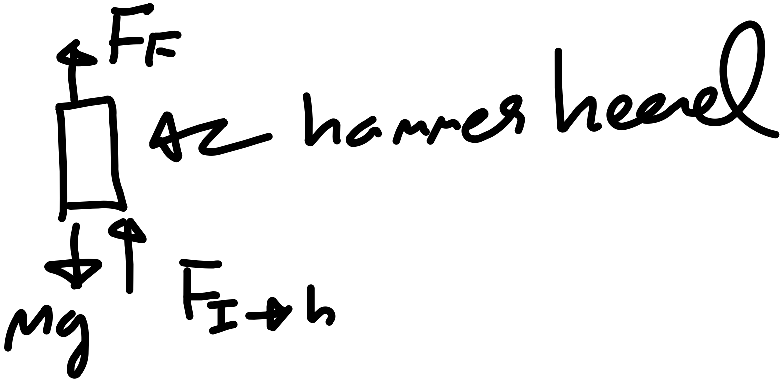
$$W_{2\to3} = K_3 - K_2$$

The 200 kg steel hammerhead of a pile driver is lifted 3.00 m above the top of a vertical I-beam being driven into the ground (Fig. 6.12a). The hammerhead is then dropped, driving the I-beam 7.4 cm deeper into the ground. The vertical guide rails exert a constant 60 N friction force on the hammerhead. Use the work–energy theorem to find (a) the speed of the hammerhead just as it hits the I-beam and (b) the average force the hammerhead exerts on the I-beam. Ignore the effects of the air.

$m = 200kg$, $y_1 = 3m$, $y_2 = 0$

$y_3 = -0.074m$, $F_F = 60N$, Find $(F_{h \to I})_{AVE}$

$W_{2 \to 3} = K_3 - K_2$



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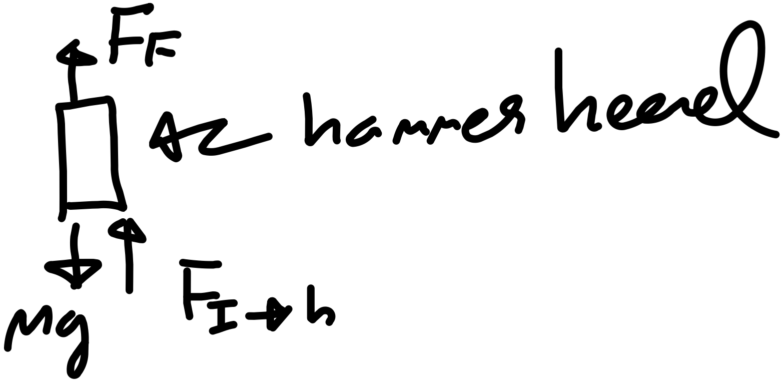
$m = 200kg$, $y_1 = 3m$, $y_2 = 0$

$y_3 = -0.074m$, $F_F = 60N$, Find $(F_{h\to I})_{AVE}$

$$W_{2\to3} = \overset{0}{\cancel{K_3}} - K_2$$



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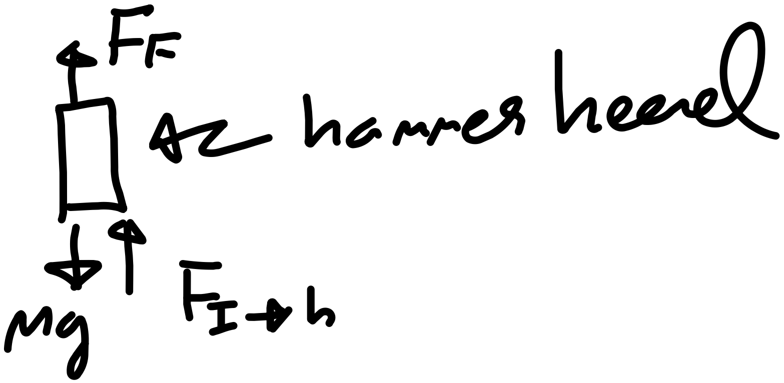
$m = 200kg$, $y_1 = 3m$, $y_2 = 0$

$y_3 = -0.074m$, $F_F = 60N$, Find $(F_{h\to I})_{AVE}$

$W_{2\to3} = \overset{0}{K_3} - K_2$, & $K_2 = \frac{1}{2}mv_2^2$

where $v_2 = 7.55$ m/s



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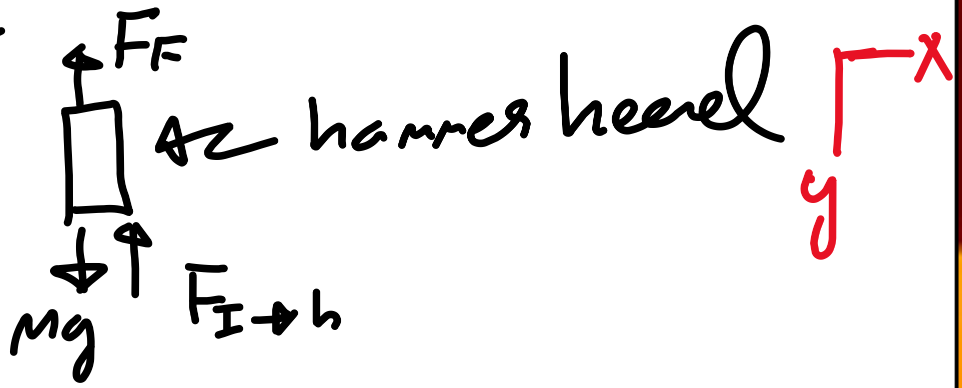
$m = 200kg$, $y_1 = 3m$, $y_2 = 0$

$y_3 = -0.074m$, $F_F = 60N$, Find $(F_{h \to I})_{ave}$

$W_{2\to3} = \overset{0}{\cancel{K_3}} - K_2$, & $K_2 = \frac{1}{2}mv_2^2$

where $v_2 = 7.55 \, m/s$

& $\Sigma F_y = (mg - F_F - F_{I\to h})$



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$m = 200\text{kg}$, $y_1 = 3\text{m}$, $y_2 = 0$

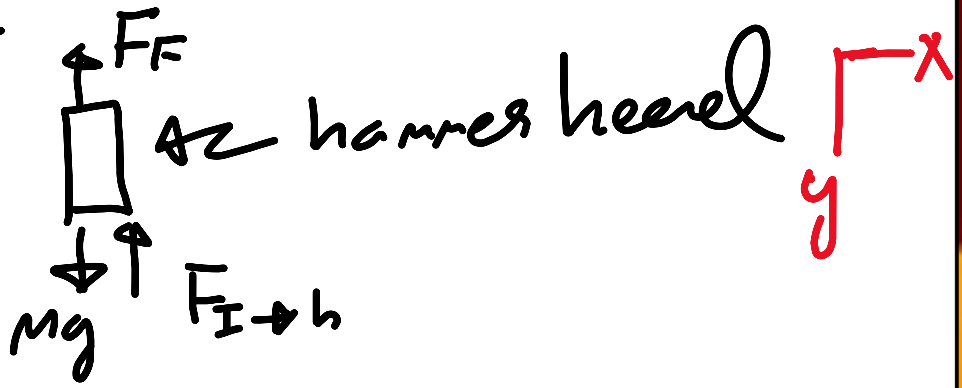
$y_3 = -0.074\text{m}$, $F_F = 60\text{N}$, Find $(F_{h\to I})_{ave}$

$W_{2\to3} = \overset{0}{\cancel{K_3}} - K_2$, & $K_2 = \frac{1}{2}mv_2^2$

where $v_2 = 7.55\,\text{m/s}$

& $\Sigma F_y = (mg - F_F - F_{I\to h})$

$\Rightarrow W_{2\to3} = (mg - F_F - F_{I\to h})|y_3|$



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$m = 200kg$, $y_1 = 3m$, $y_2 = 0$

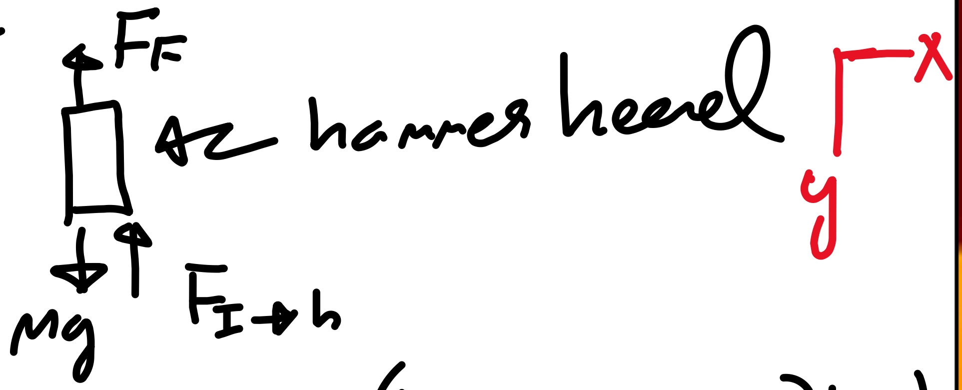
$y_3 = -0.074m$, $F_F = 60N$, Find $(F_{h\to I})_{AVE}$

$W_{2\to3} = \cancelto{0}{K_3} - K_2$, & $K_2 = \frac{1}{2}mv_2^2$

where $v_2 = 7.55 m/s$

& $\Sigma F_y = (mg - F_F - F_{I\to h})$

$\Rightarrow W_{2\to3} = (mg - F_F - F_{I\to h})|y_3| \Rightarrow K_2 = (F_F + F_{I\to h} - mg)|y_3|$



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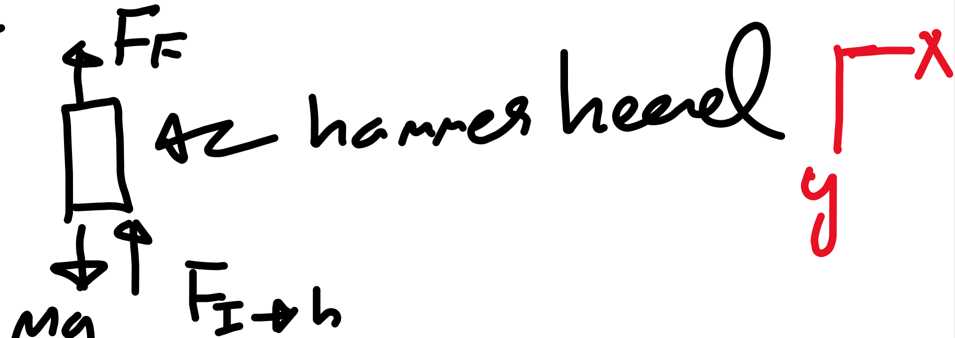
$m = 200\text{kg}, \quad y_1 = 3\text{m}, \quad y_2 = 0$

$y_3 = -0.074\text{m}, \quad F_F = 60\text{N}, \quad \text{Find } (F_{h \to I})_{AVE}$

$W_{2\to3} = \overset{0}{\cancel{K_3}} - K_2, \quad \& \quad K_2 = \frac{1}{2} m v_2^2$

where $v_2 = 7.55 \text{ m/s}$



$\& \quad \Sigma F_y = (mg - F_F - F_{I\to h})$

$\Rightarrow W_{2\to3} = (mg - F_F - F_{I\to h})|y_3| \Rightarrow K_2 = (F_F + F_{I\to h} - mg)|y_3|$

$\Rightarrow \quad F_{I\to h} = \frac{K_2}{|y_3|} + mg - F_F$

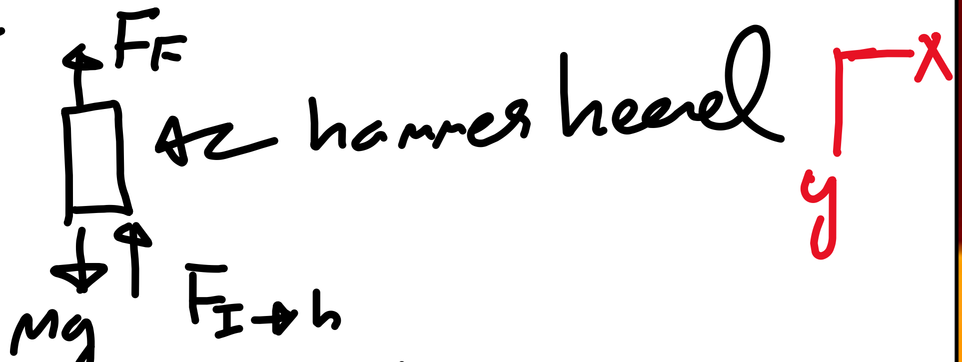
The 200 kg steel hammerhead of a pile driver is lifted 3.00 m above the top of a vertical I-beam being driven into the ground (Fig. 6.12a). The hammerhead is then dropped, driving the I-beam 7.4 cm deeper into the ground. The vertical guide rails exert a constant 60 N friction force on the hammerhead. Use the work–energy theorem to find (a) the speed of the hammerhead just as it hits the I-beam and (b) the average force the hammerhead exerts on the I-beam. Ignore the effects of the air.

$m = 200kg$, $y_1 = 3m$, $y_2 = 0$

$y_3 = -0.074m$, $F_F = 60N$, Find $(F_{h \to I})_{AVE}$

$W_{2\to3} = \cancelto{0}{K_3} - K_2$, & $K_2 = \frac{1}{2} m v_2^2$

where $v_2 = 7.55 \, m/s$



& $\Sigma F_y = (mg - F_F - F_{I\to h})$

$\Rightarrow W_{2\to3} = (mg - F_F - F_{I\to h})|y_3| \Rightarrow K_2 = (F_F + F_{I\to h} - mg)|y_3|$

$\Rightarrow F_{I\to h} = \frac{K_2}{|y_3|} + mg - F_F = \frac{\left(\frac{200}{2}\right)7.55^2}{0.074} + (9.8)200 - 60$

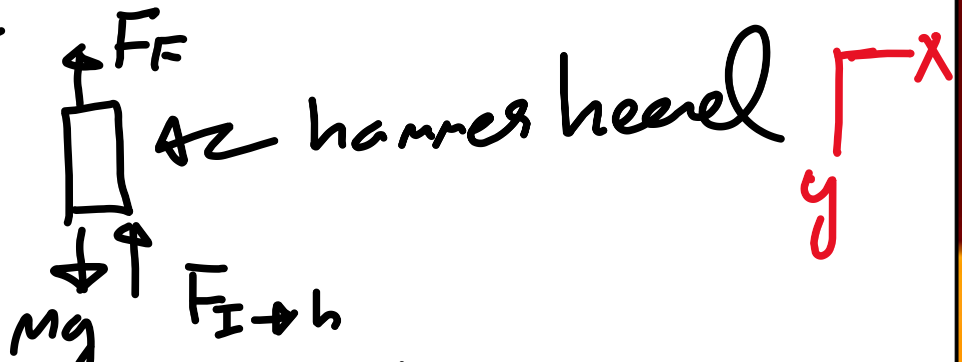
The 200 kg steel hammerhead of a pile driver is lifted 3.00 m above the top of a vertical I-beam being driven into the ground (Fig. 6.12a). The hammerhead is then dropped, driving the I-beam 7.4 cm deeper into the ground. The vertical guide rails exert a constant 60 N friction force on the hammerhead. Use the work–energy theorem to find (a) the speed of the hammerhead just as it hits the I-beam and (b) the average force the hammerhead exerts on the I-beam. Ignore the effects of the air.

$m = 200kg$, $y_1 = 3m$, $y_2 = 0$

$y_3 = -0.074m$, $F_F = 60N$, Find $(F_{h\to I})_{AVE}$

$W_{2\to3} = \overset{0}{\cancel{K_3}} - K_2$, & $K_2 = \frac{1}{2}mv_2^2$

where $v_2 = 7.55 \, m/s$



& $\Sigma F_y = (mg - F_F - F_{I\to h})$

$\Rightarrow W_{2\to3} = (mg - F_F - F_{I\to h})|y_3| \Rightarrow K_2 = (F_F + F_{I\to h} - mg)|y_3|$

$\Rightarrow F_{I\to h} = \frac{K_2}{|y_3|} + mg - F_F = \frac{\left(\frac{200}{2}\right)7.55^2}{0.074} + (9.8)200 - 60 = 79kN$

When a billiards player hits a cue ball at rest, the ball's kinetic energy after being hit is equal to the work that was done on it by the cue.

When a billiards player hits a cue ball at rest, the ball's kinetic energy after being hit is equal to the work that was done on it by the cue.

The greater the force exerted by the cue and the greater the distance the ball moves while in contact with it, the greater the ball's kinetic energy.

Trick question

Two iceboats like the one in Example 5.6 (Section 5.2) hold a race on a frictionless horizontal lake (Fig. 6.14). The two iceboats have masses m and $2m$. The iceboats have identical sails, so the wind exerts the same constant force $\vec{F}$ on each iceboat. They start from rest and cross the finish line a distance s away. Which iceboat crosses the finish line with greater kinetic energy?

Figure 6.14