July 3, Week 5

Today: Finish Chapter 9, Begin Chapter 10,Work

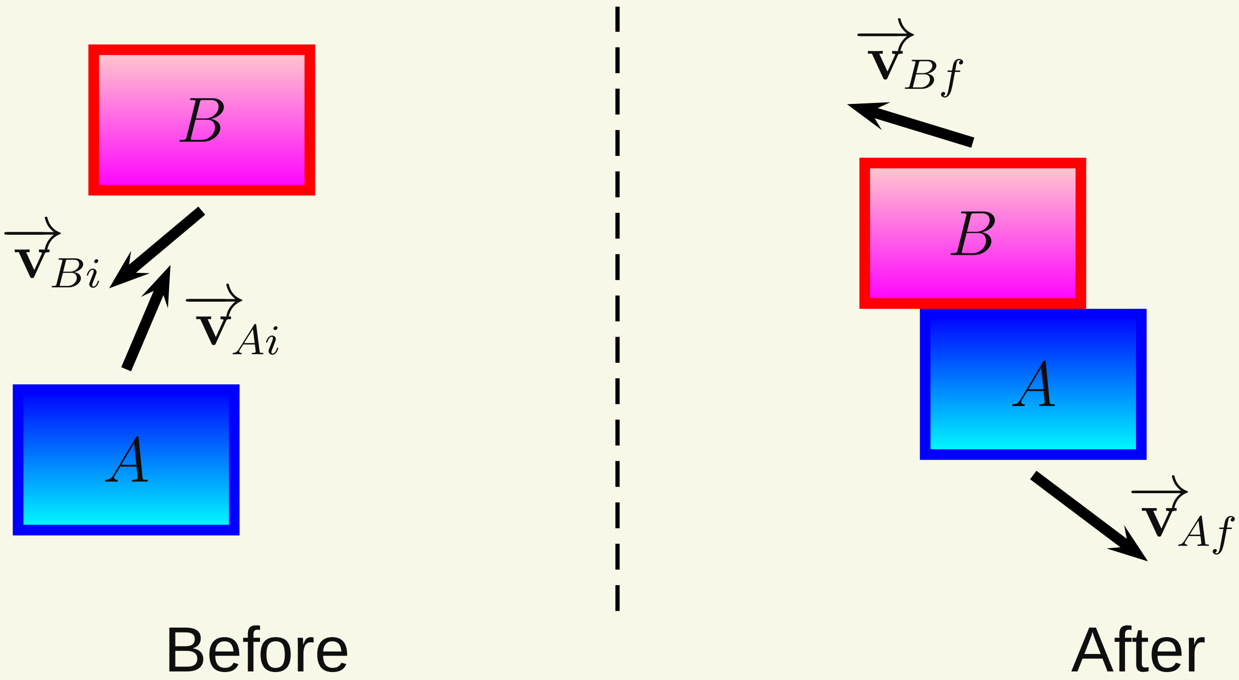
No Office Hours on Friday.

Homework Assignment #5 - Due Monday, July 7. (Homework assignment #6 will be due Friday, July 11)

Test #5 on Tuesday, July 8

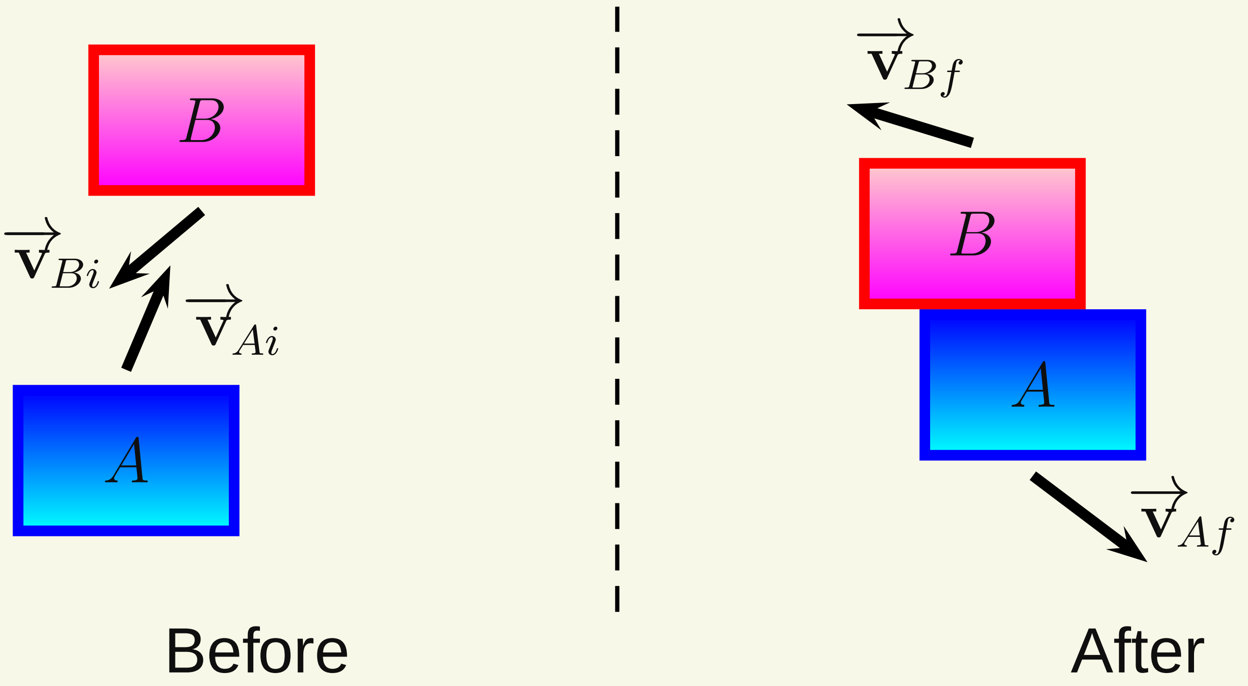
There will be a reading quiz due Monday.

Using Conservation of Momentum II



$$m_A \vec{\mathbf{v}}_{Ai} + m_B \vec{\mathbf{v}}_{Bi} = m_A \vec{\mathbf{v}}_{Af} + m_B \vec{\mathbf{v}}_{Bf}$$

Using Conservation of Momentum II



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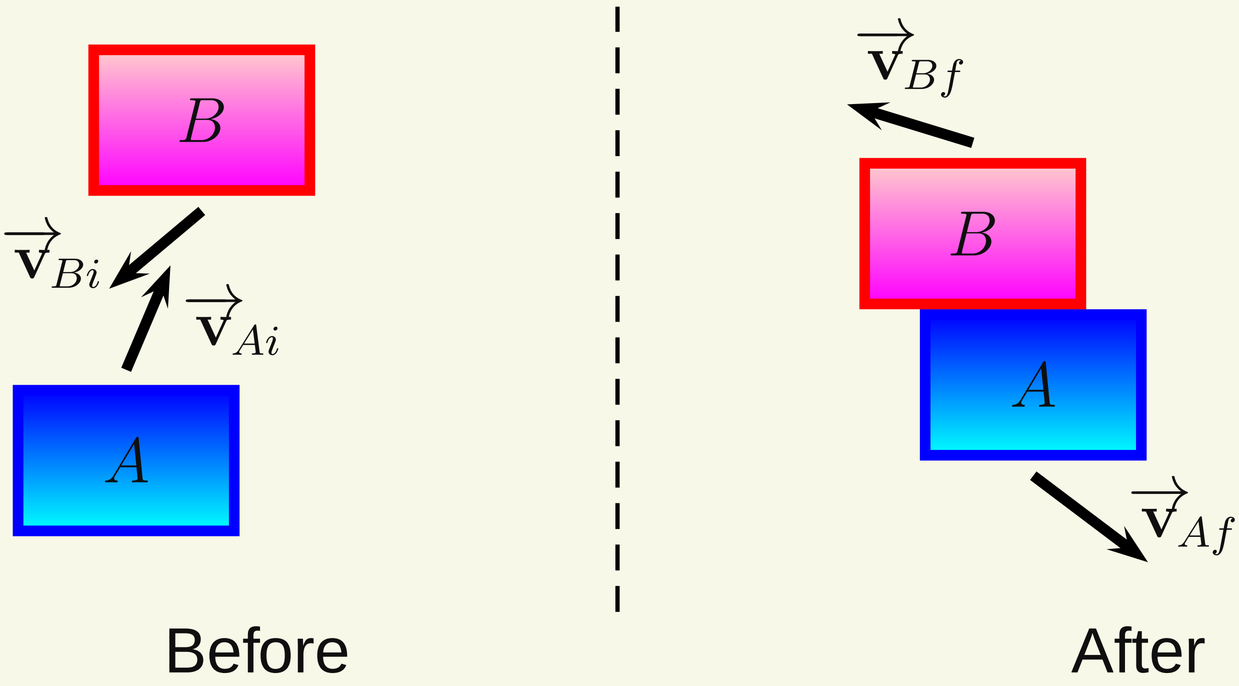
Component Form:

Using Conservation of Momentum II



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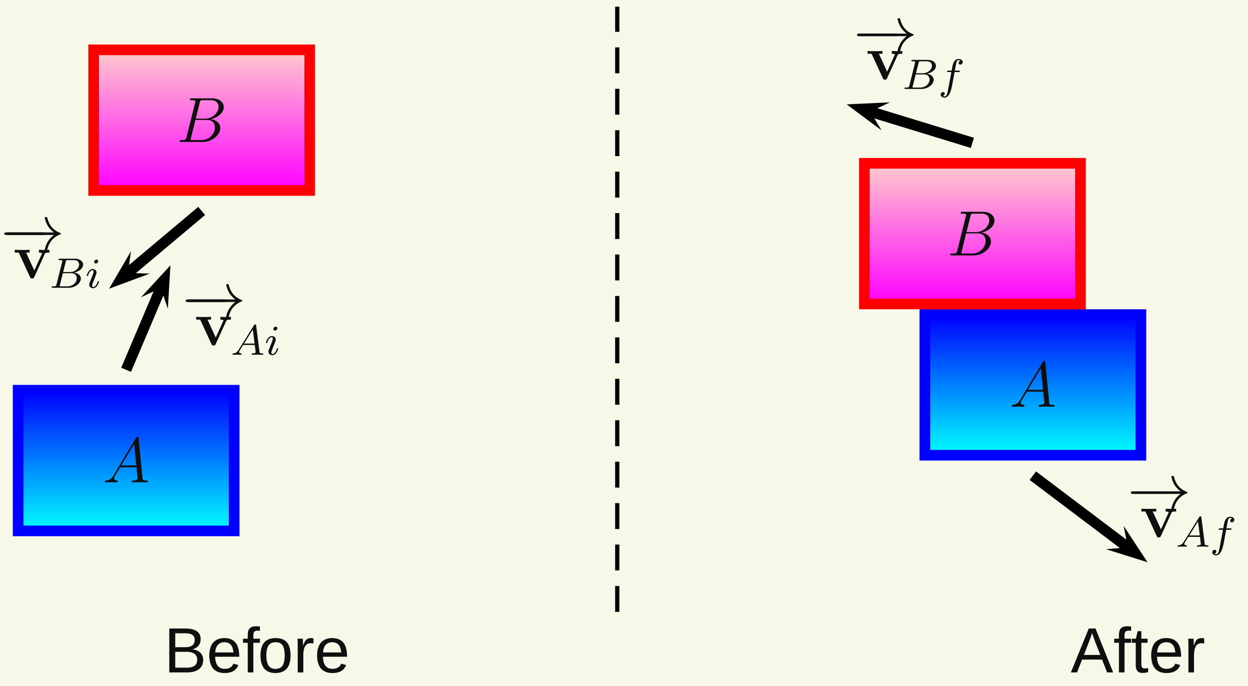
Component Form:

$$m_A \left(v_{Ax}\right)_i + m_B \left(v_{Bx}\right)_i = m_A \left(v_{Ax}\right)_f + m_B \left(v_{Bx}\right)_f$$

Using Conservation of Momentum II



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$$m_A \left(v_{Ax}\right)_i + m_B \left(v_{Bx}\right)_i = m_A \left(v_{Ax}\right)_f + m_B \left(v_{Bx}\right)_f$$

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Completely-Inelastic Collisions

When the colliding objects stick together, the collision is called completely inelastic.

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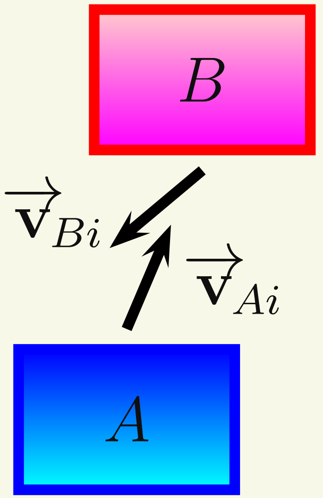

Before

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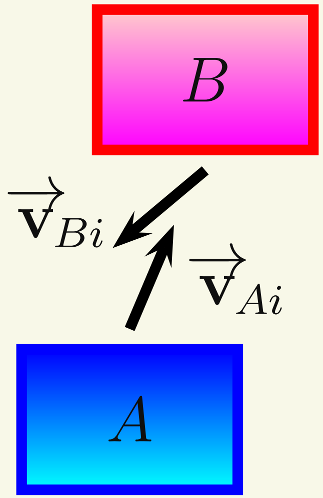

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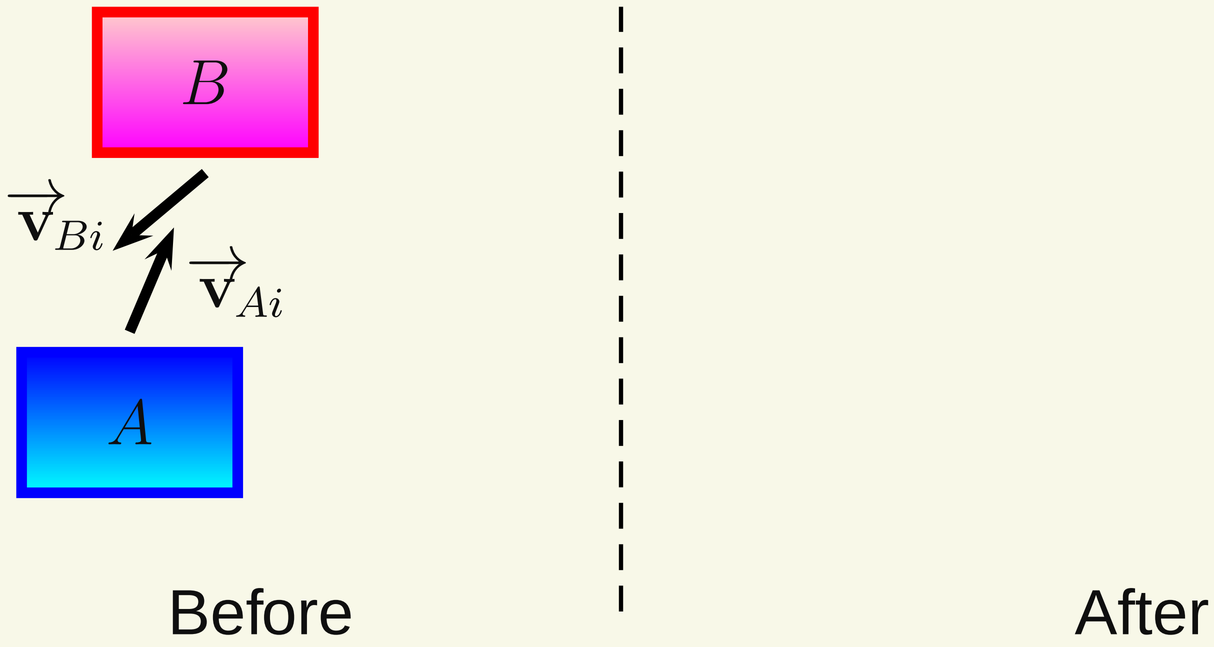

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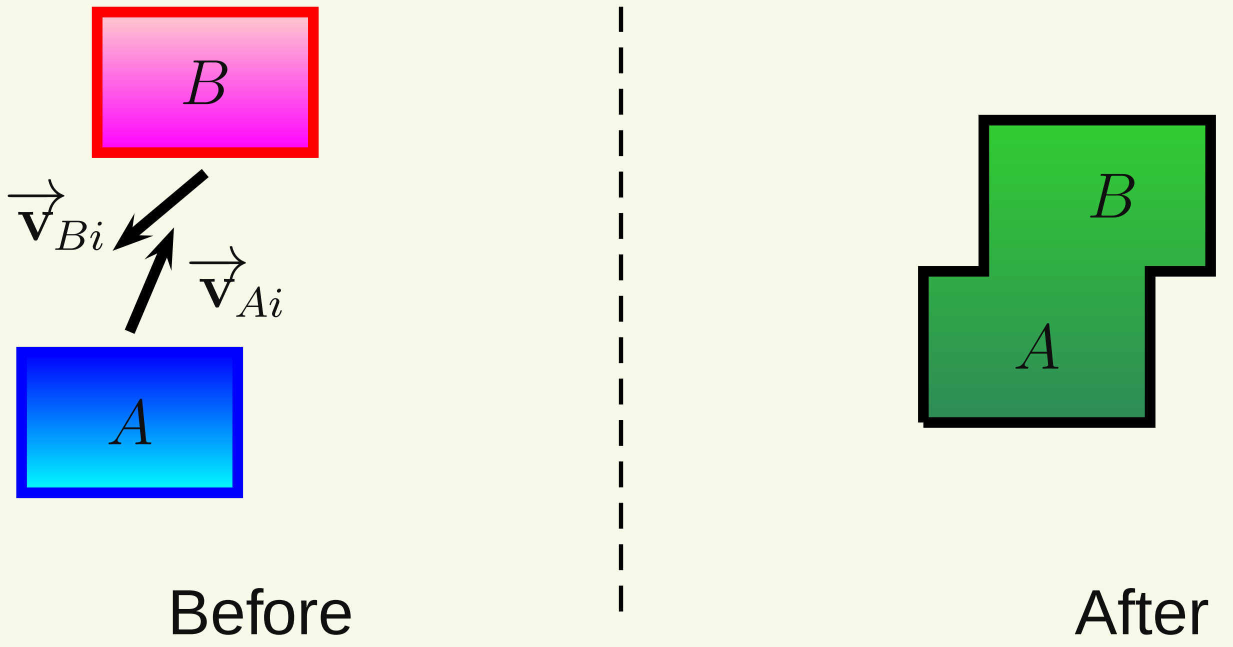

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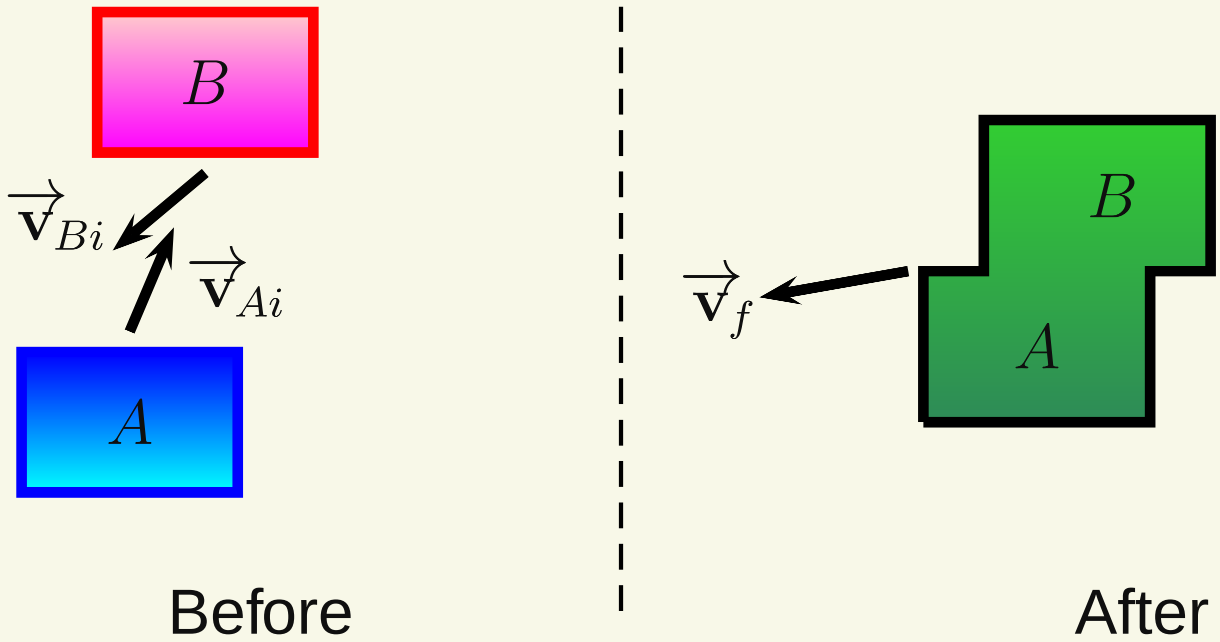

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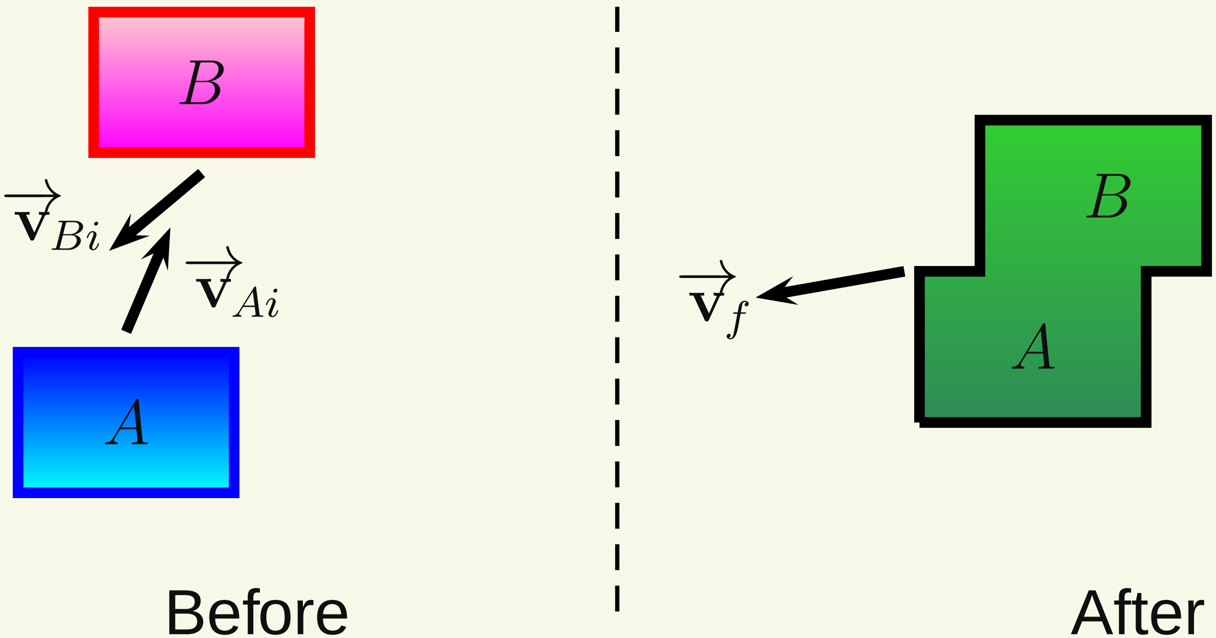

$$m_A \vec{\mathbf{v}}_{Ai} + m_B \vec{\mathbf{v}}_{Bi} \qquad (m_A + m_B)\,\vec{\mathbf{v}}_f$$

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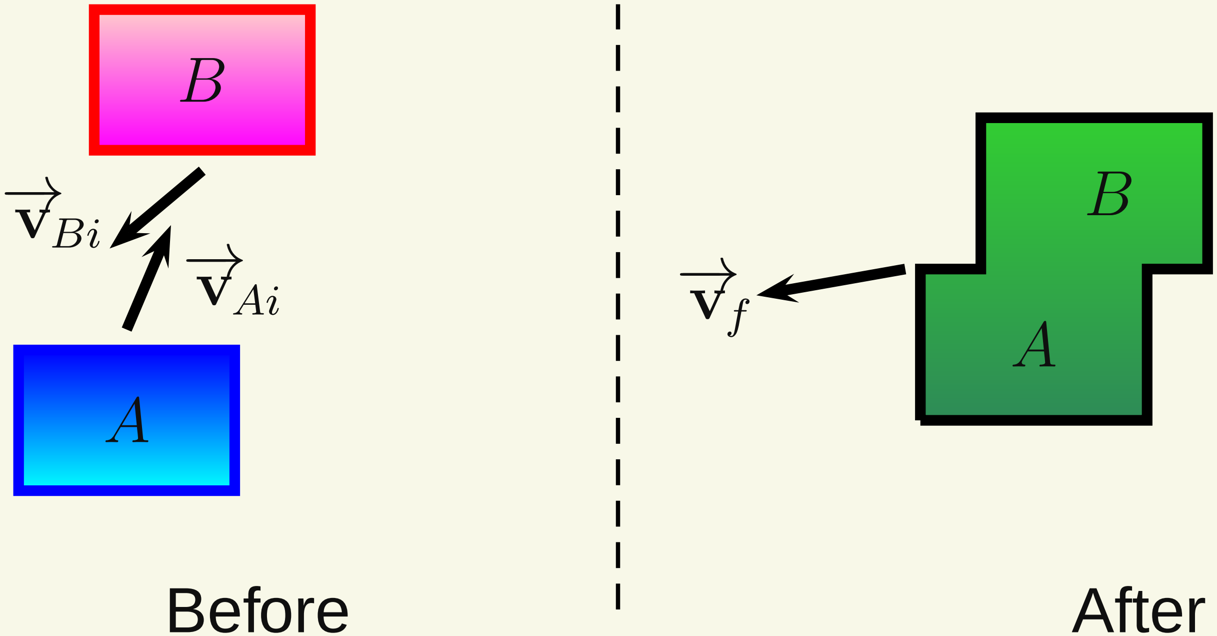

$$m_A \vec{\mathbf{v}}_{Ai} + m_B \vec{\mathbf{v}}_{Bi} = (m_A + m_B)\, \vec{\mathbf{v}}_f$$

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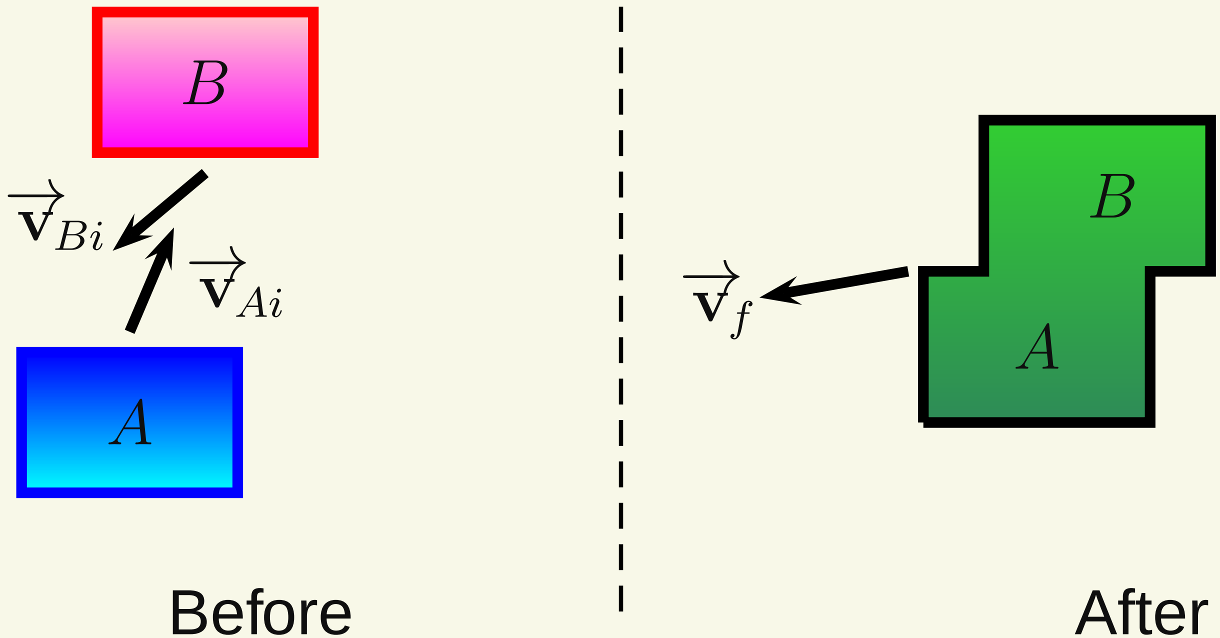


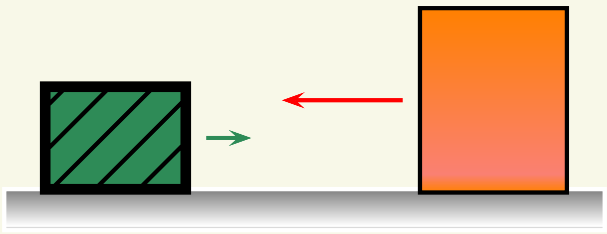
$$m_A \vec{\mathbf{v}}_{Ai} + m_B \vec{\mathbf{v}}_{Bi} = (m_A + m_B)\, \vec{\mathbf{v}}_f$$

Component Form: $m_A (v_{Ax})_i + m_B (v_{Bx})_i = (m_A + m_B)(v_x)_f$

$$m_A (v_{Ay})_i + m_B (v_{By})_i = (m_A + m_B)(v_y)_f$$

Conservation Exercise IV

A 1-kg mass sliding to the right with speed $1\,m/s$ on a frictionless floor collides with a 2-kg mass going to the left at $2\,m/s$. If the masses stick to each other, how fast is the combo going after?



BEFORE

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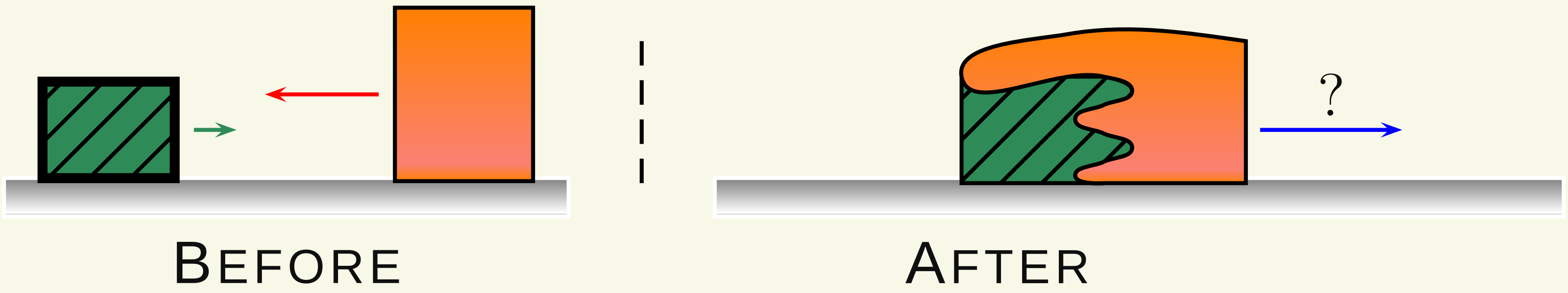

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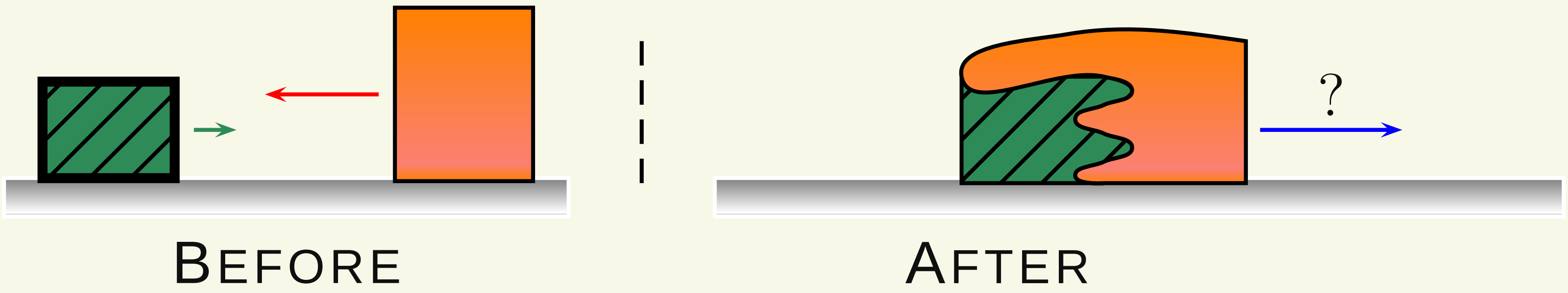

(a) $(5/3)\ m/s$

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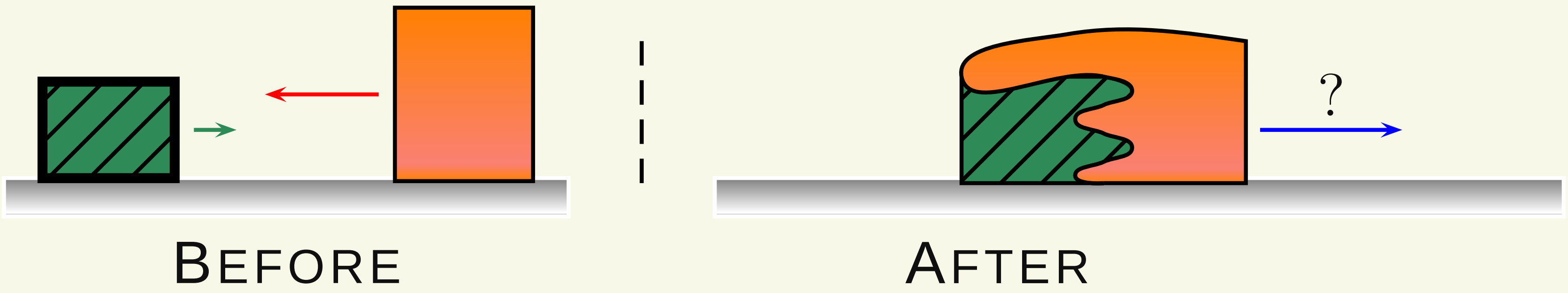

(a) $(5/3)\ m/s$ (b) $-(5/3)\ m/s$

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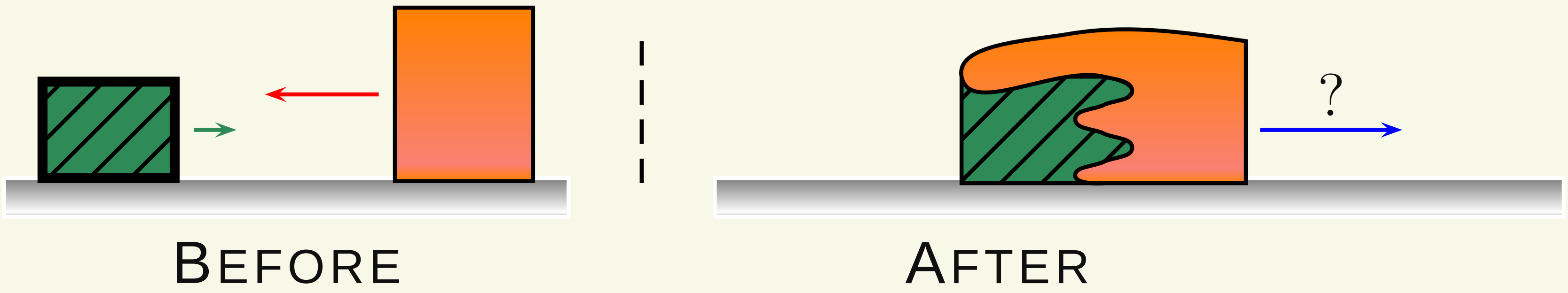

(a) $(5/3)\ m/s$ (b) $-(5/3)\ m/s$ (c) $-1\,m/s$

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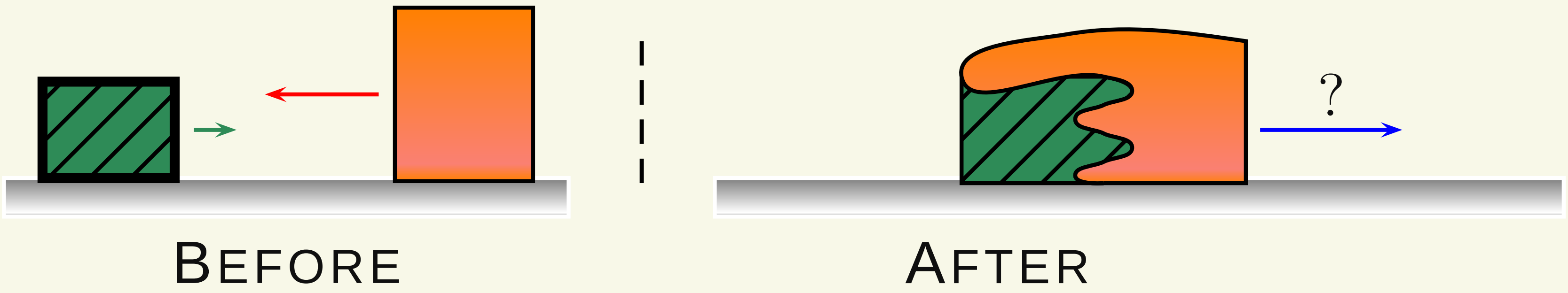

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(d) $3\,m/s$

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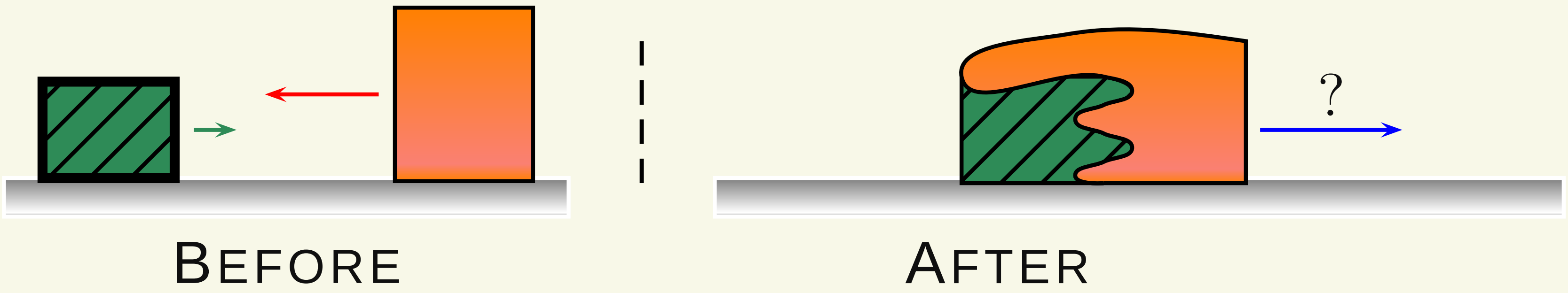

(a) $(5/3)\ m/s$ (b) $-(5/3)\ m/s$ (c) $-1\,m/s$

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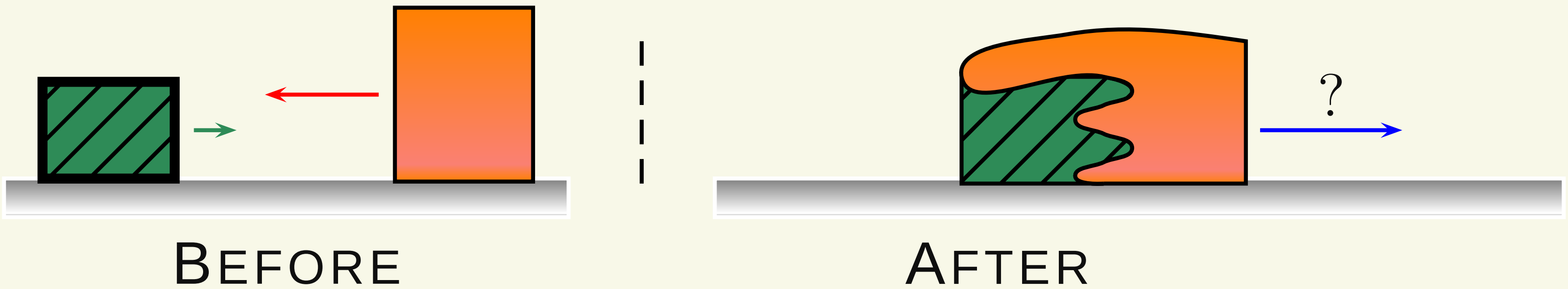

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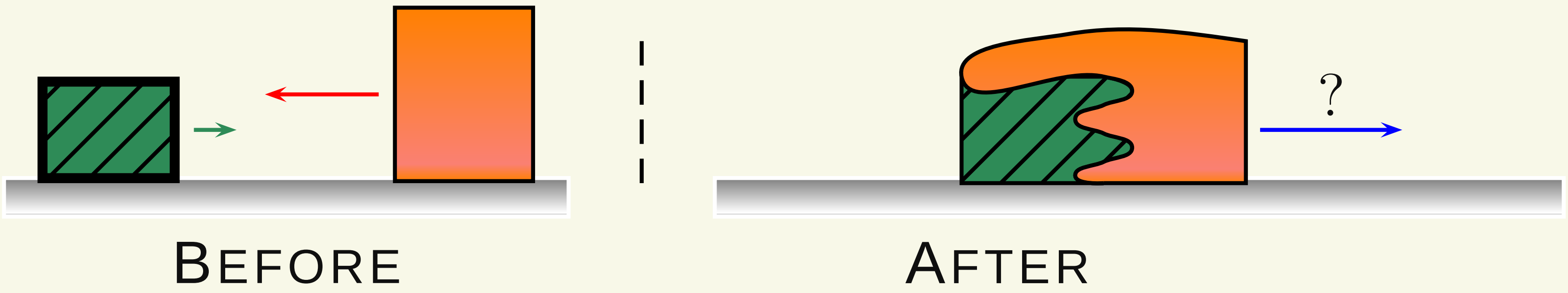
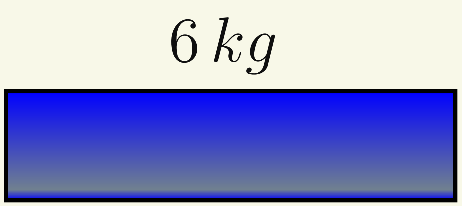


(c) $-1\,m/s$

Conservation: $(1\,kg)(1\,m/s) + (2\,kg)(-2\,m/s) = (1\,kg + 2\,kg)(v_x)_f$
$(1\,kg \cdot m/s) - (4\,kg \cdot m/s) = (3\,kg)(v_x)_f \Rightarrow -(3\,kg \cdot m/s) = (3\,kg)(v_x)_f$

2D-Conservation Exercise

A $6\,kg$ box-shaped firecracker explodes into two unequal pieces. If the first piece of mass $2\,kg$ has velocity $20\,m/s$ at $45°$, what speed and direction must the other piece have?



BEFORE

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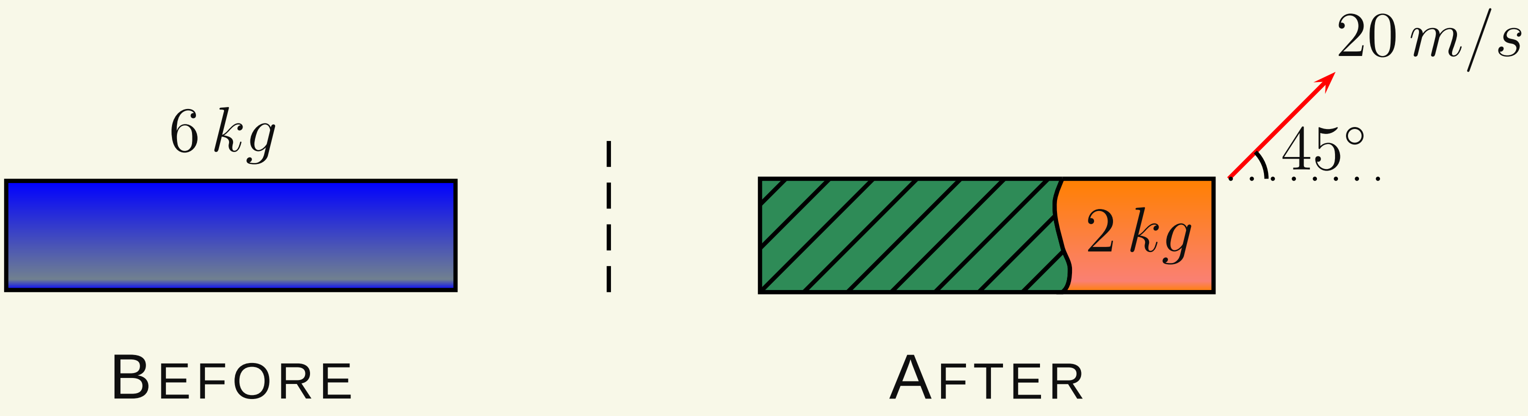

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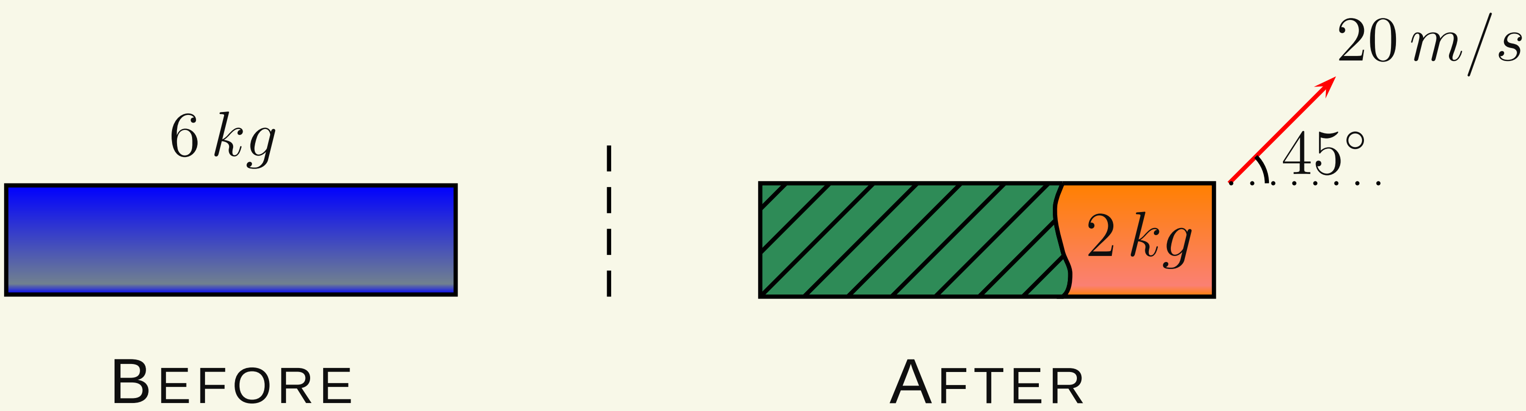

(a) $10\,m/s$ at $225°$

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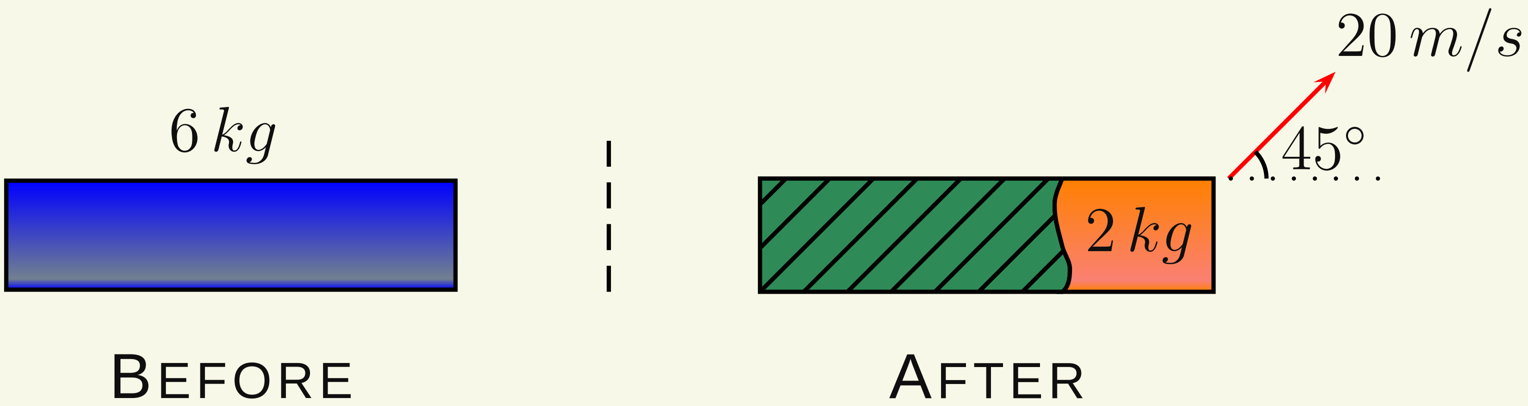

(a) $10\,m/s$ at $225°$ (b) $20\,m/s$ at $225°$

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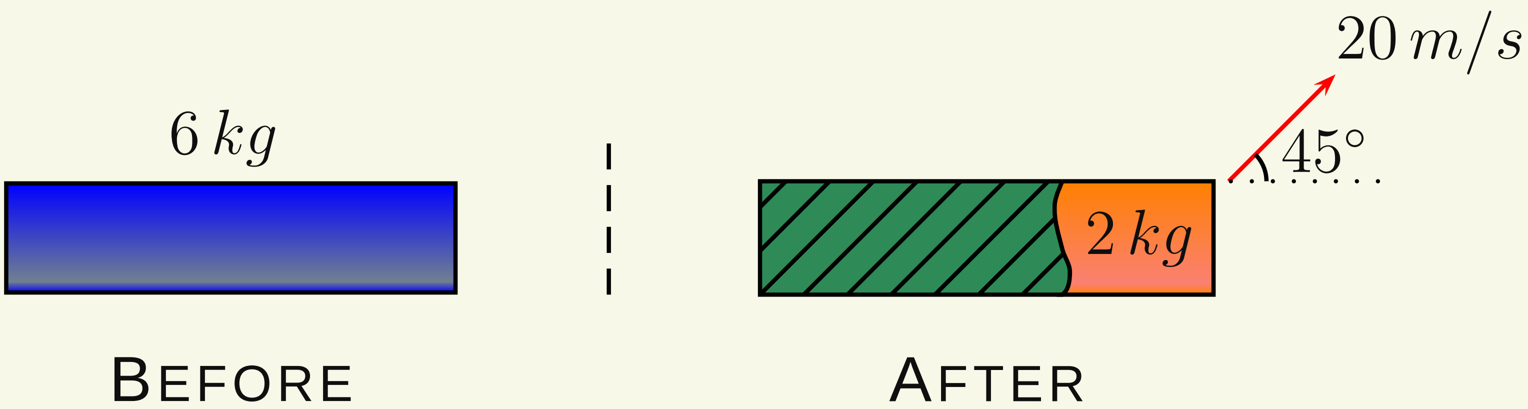

(a) $10\,m/s$ at $225°$ (b) $20\,m/s$ at $225°$ (c) $40\,m/s$ at $225°$

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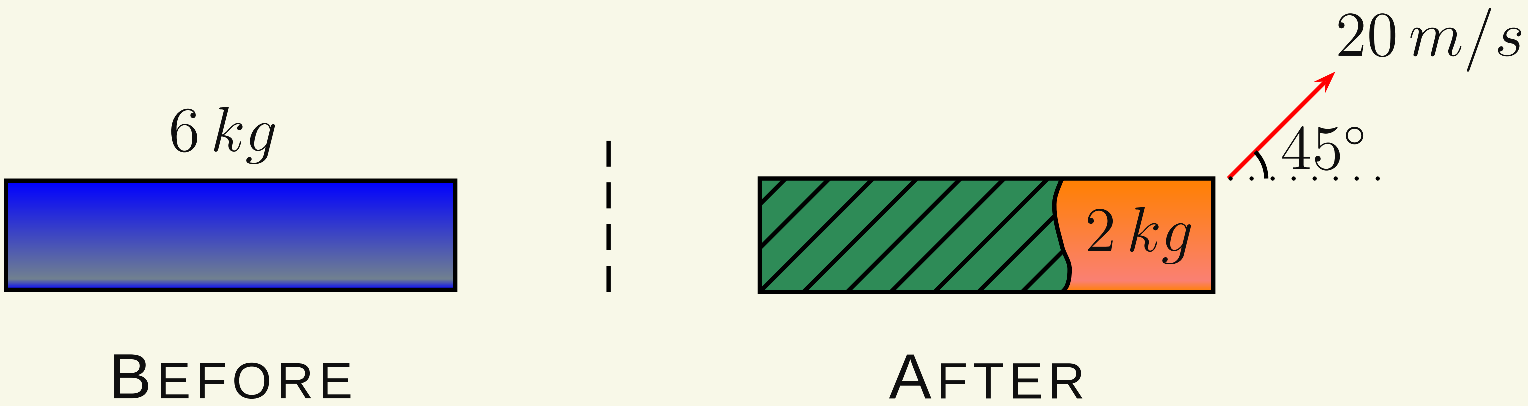

(a) $10\,m/s$ at $225°$

(b) $20\,m/s$ at $225°$

(c) $40\,m/s$ at $225°$

(d) $10\,m/s$ at $135°$

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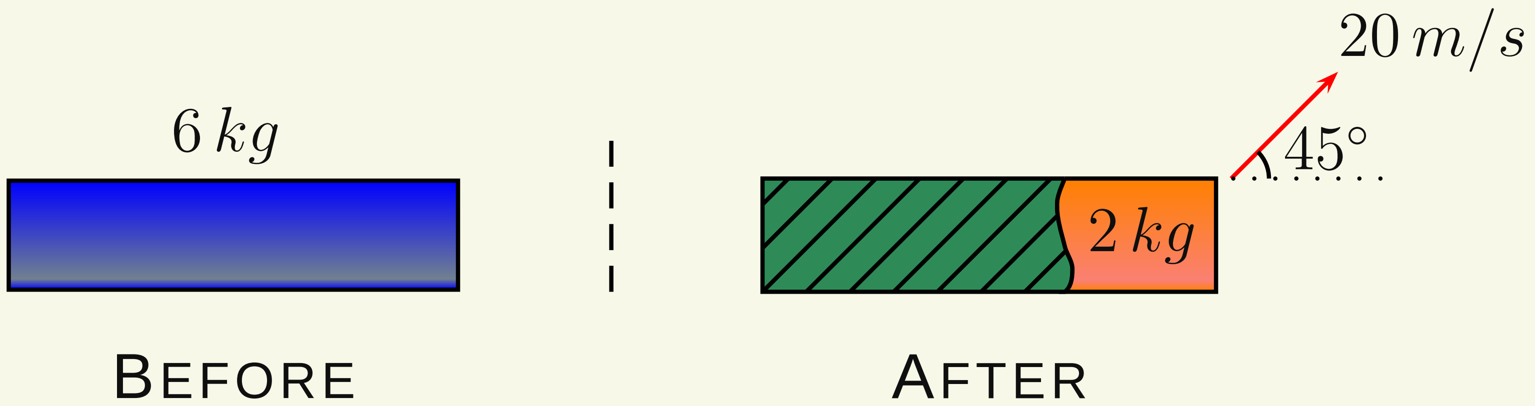

(a) $10\,m/s$ at $225°$ (b) $20\,m/s$ at $225°$ (c) $40\,m/s$ at $225°$

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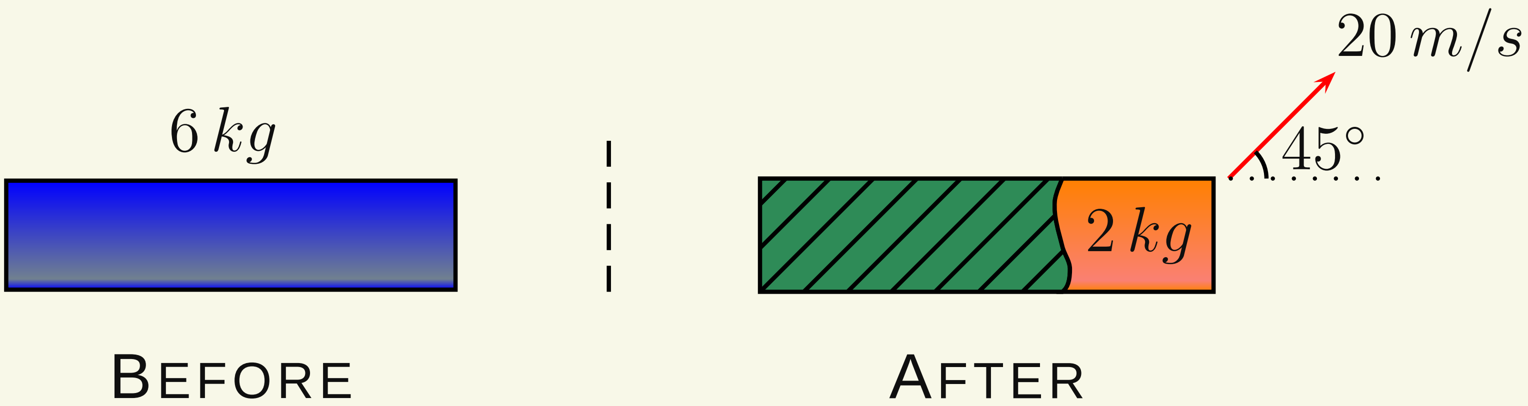

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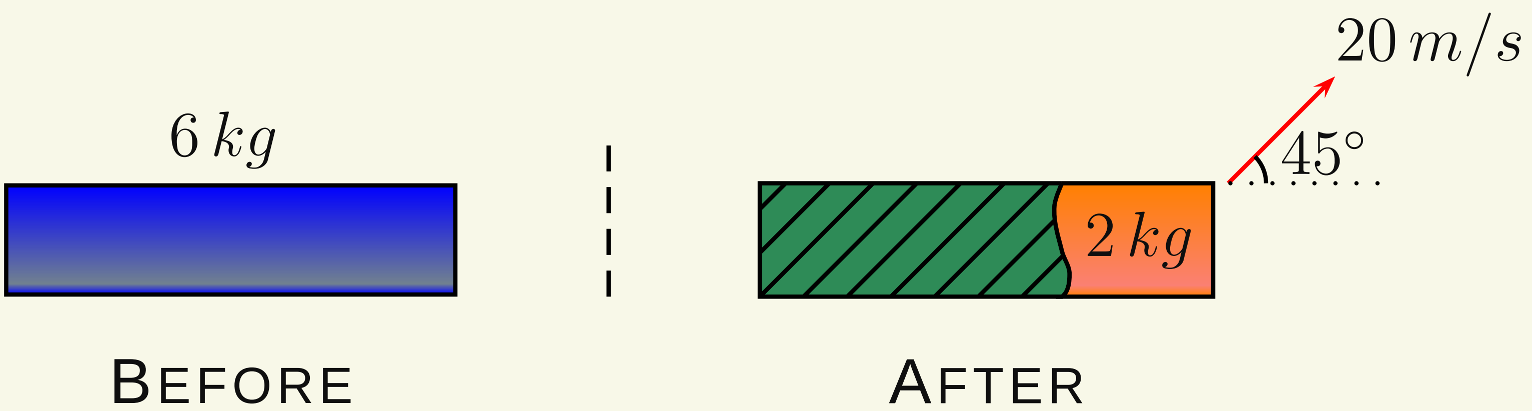
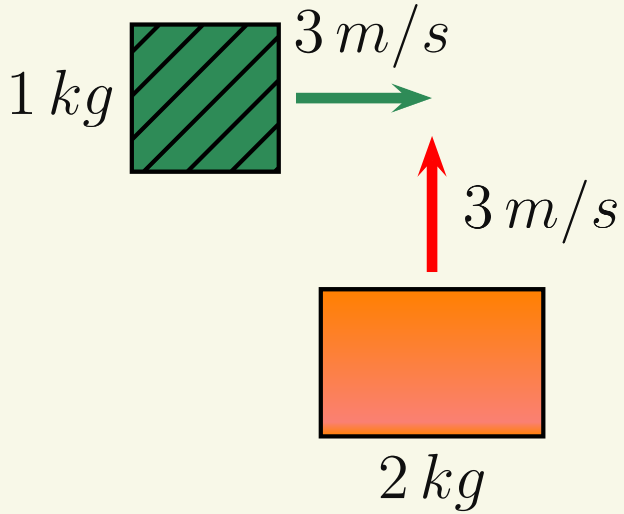


(a) $10\,m/s$ at $225°$

$$0 = m_A \vec{\mathbf{v}}_{Af} + m_B \vec{\mathbf{v}}_{Bf} \Rightarrow \vec{\mathbf{v}}_{Bf} = -\left(\frac{m_A}{m_B}\right)\vec{\mathbf{v}}_{Af} = -\left(\frac{2}{4}\right)\vec{\mathbf{v}}_{Af}$$

2D Exercise II

A block with $M_A = 1\,kg$ and velocity $3\,m/s$ to the right has a perfectly inelastic collision with $M_B = 2\,kg$ that has velocity $3\,m/s$ up. How fast must the masses be going the instant after their collision?



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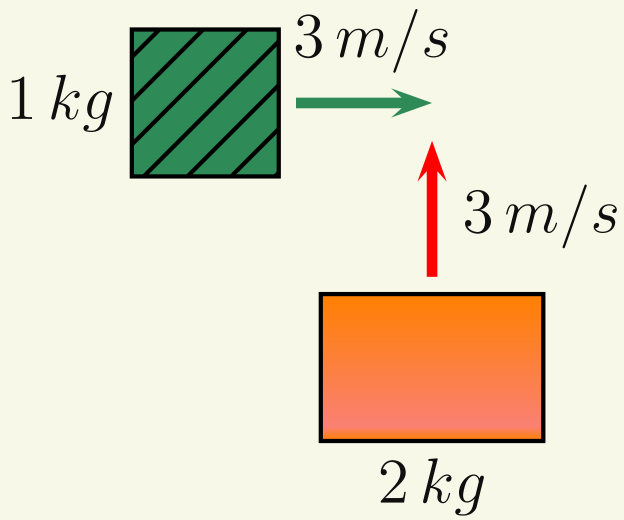

(a) $9\,m/s$

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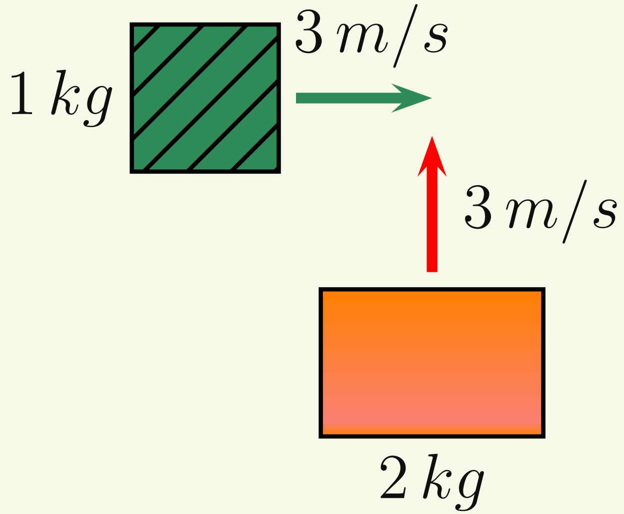

(a) $9\,m/s$

(b) $\sqrt{45}\,m/s = 6.7\,m/s$

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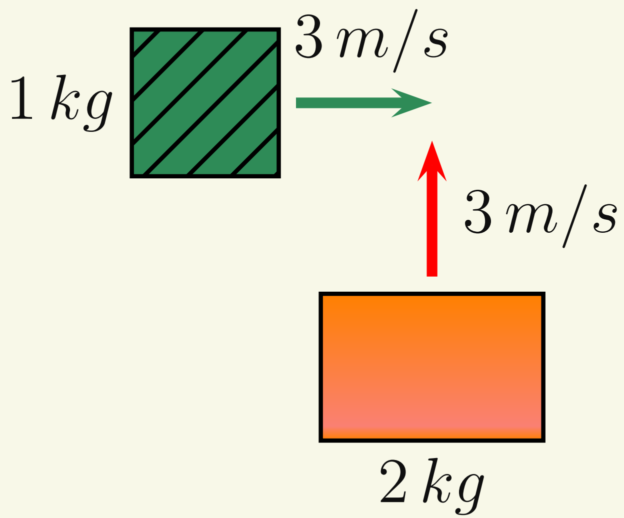

(a) $9\,m/s$

(b) $\sqrt{45}\,m/s = 6.7\,m/s$

(c) $3\,m/s$

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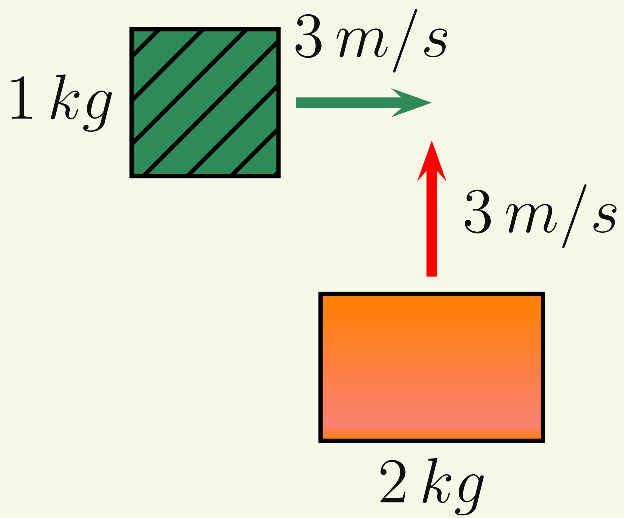

(a) $9\,m/s$

(b) $\sqrt{45}\,m/s = 6.7\,m/s$

(c) $3\,m/s$

(d) $\sqrt{5}\,m/s = 2.236\,m/s$

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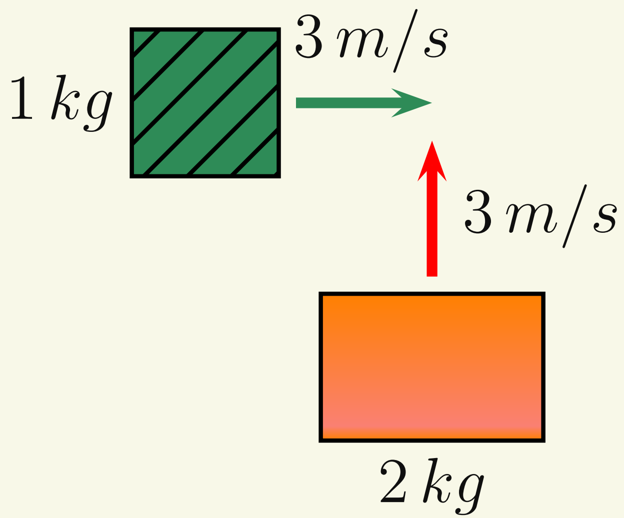

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(e) $1\,m/s$

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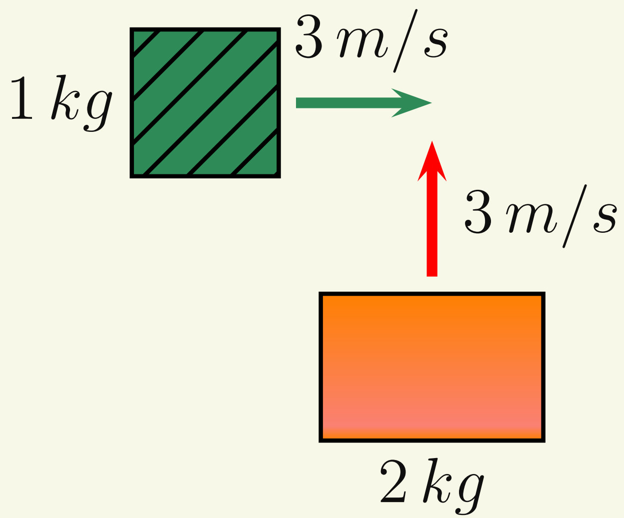

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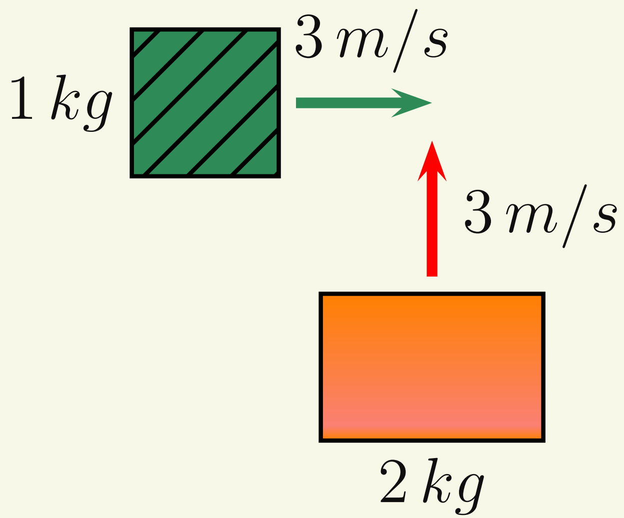

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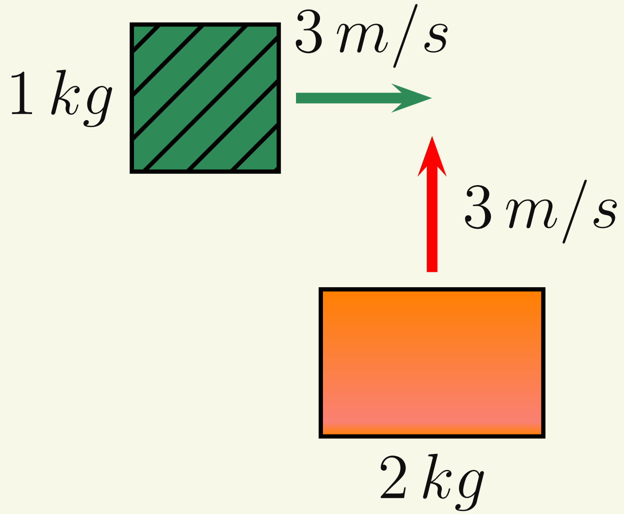

(d) $\sqrt{5}\,m/s = 2.236\,m/s$

$$(v_{Ax})_i = 3\,m/s \qquad (v_{Ay})_i = 0$$

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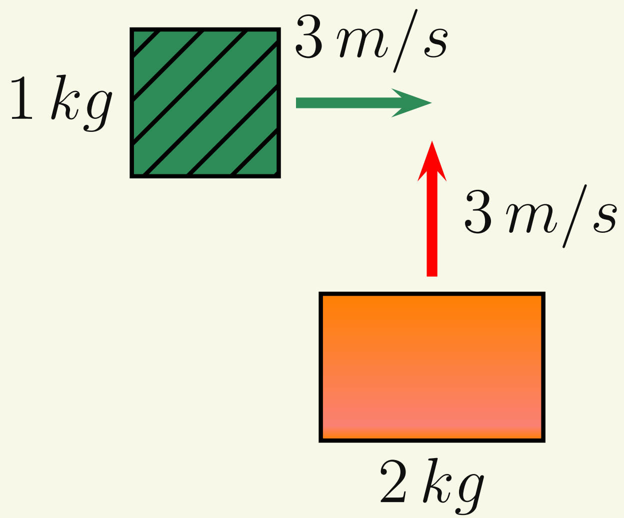

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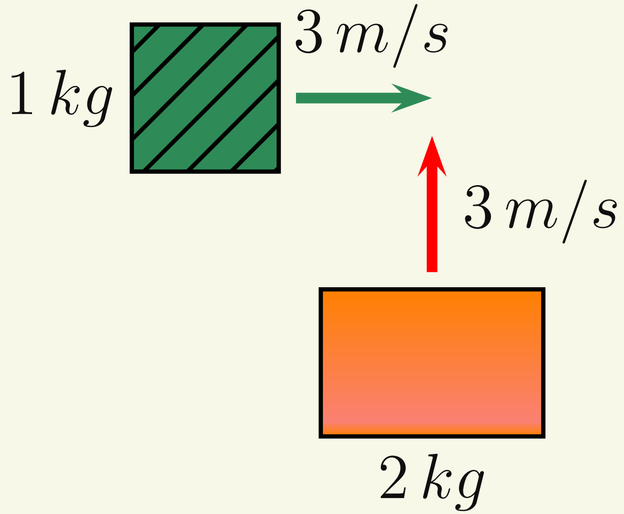

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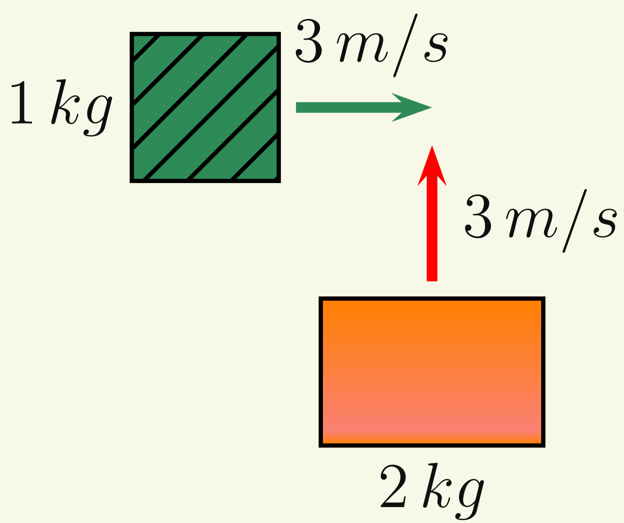

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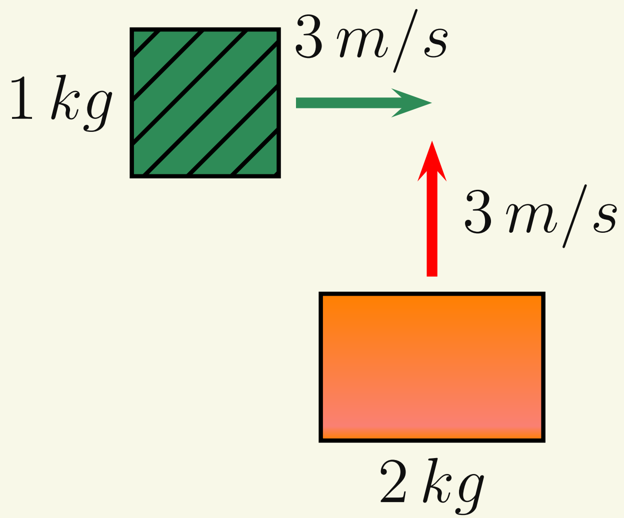

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$$v_f = \sqrt{(v_x)_f^2 + (v_y)_f^2} = \sqrt{1\,m^2/s^2 + 4\,m^2/s^2}$$

Work and Energy

Energy - The ability to do work or results from work being done to something.

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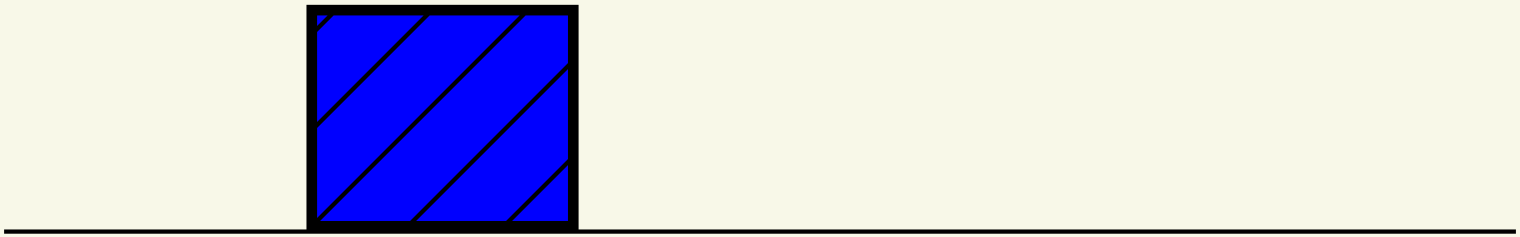

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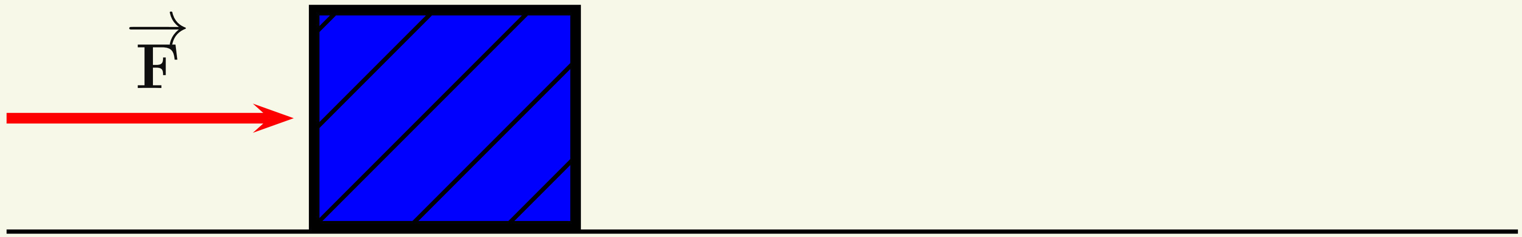

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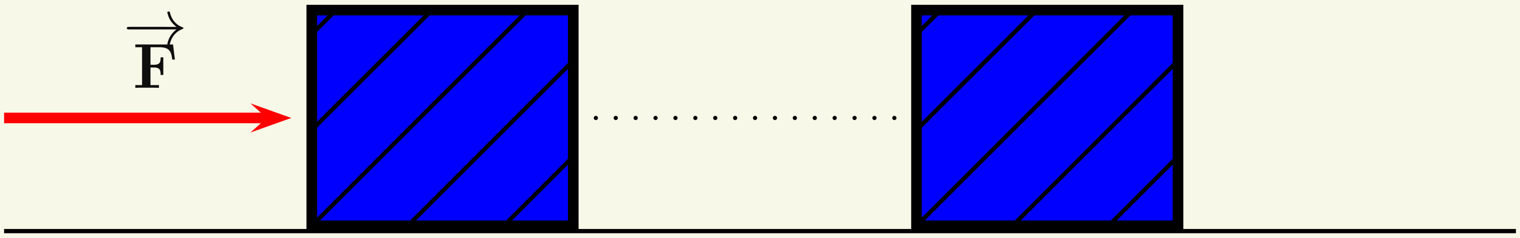

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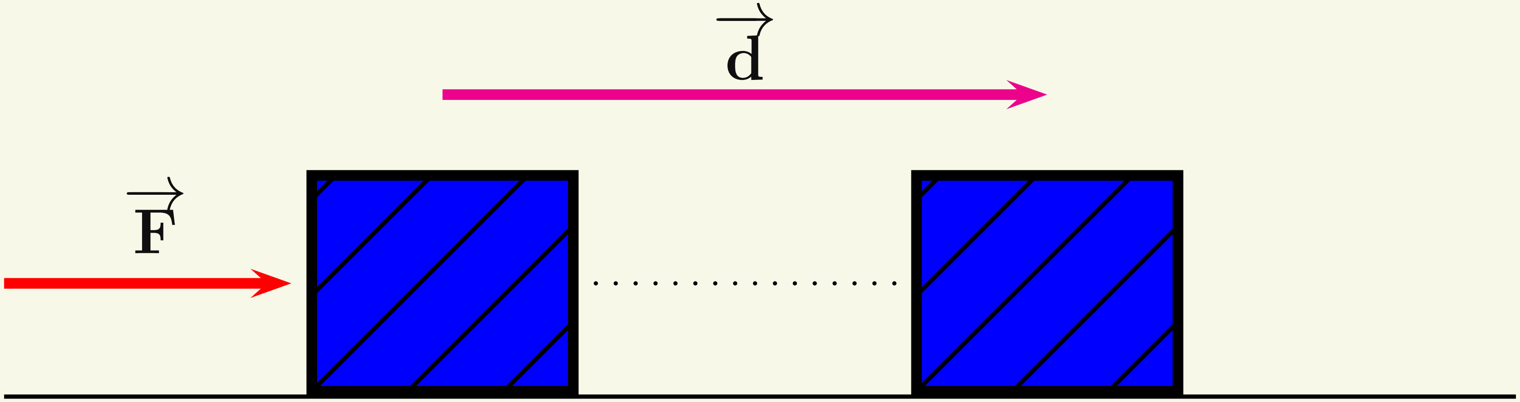

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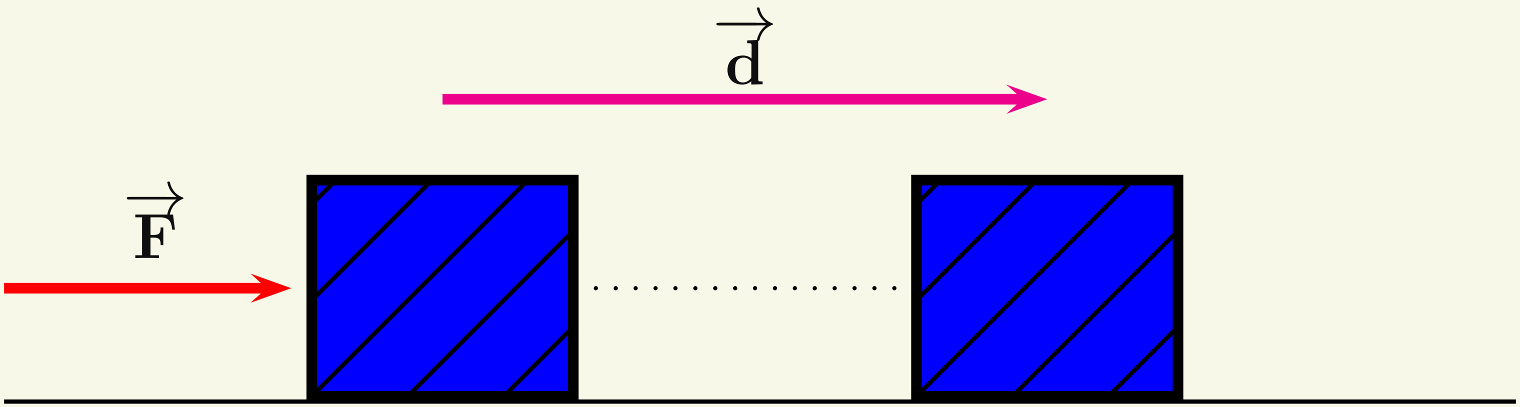

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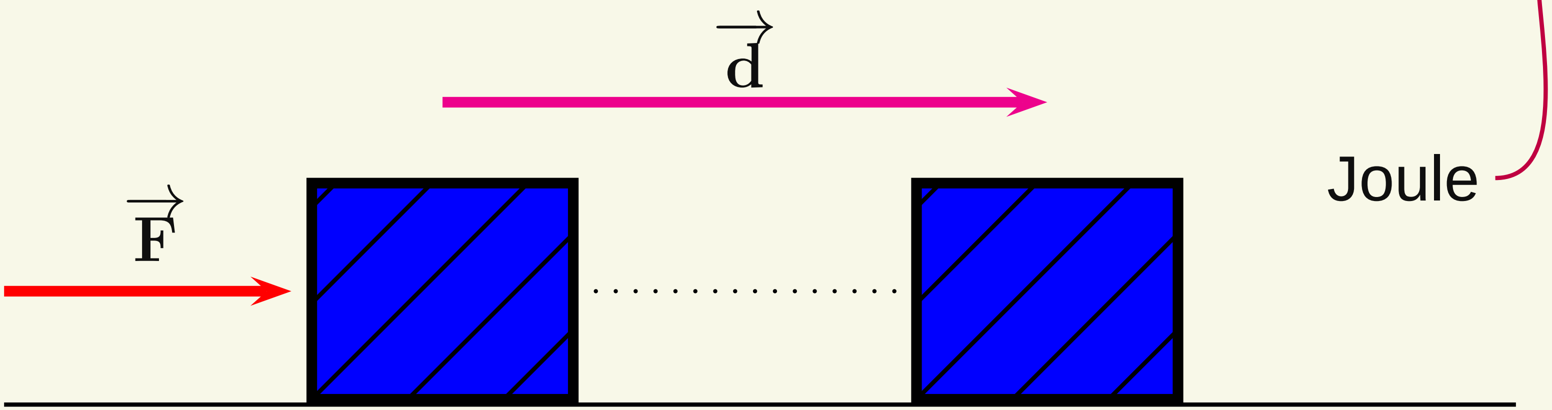
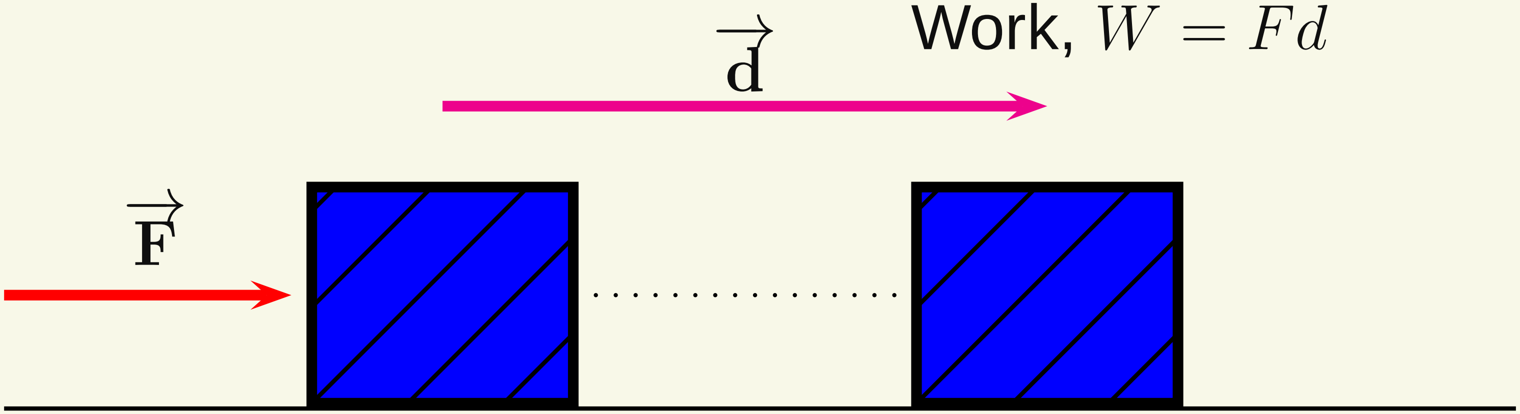
Unit: $N \cdot m = kg \cdot m^2/s^2 = J$



Restrictions



This equation is correct only in the situation that:

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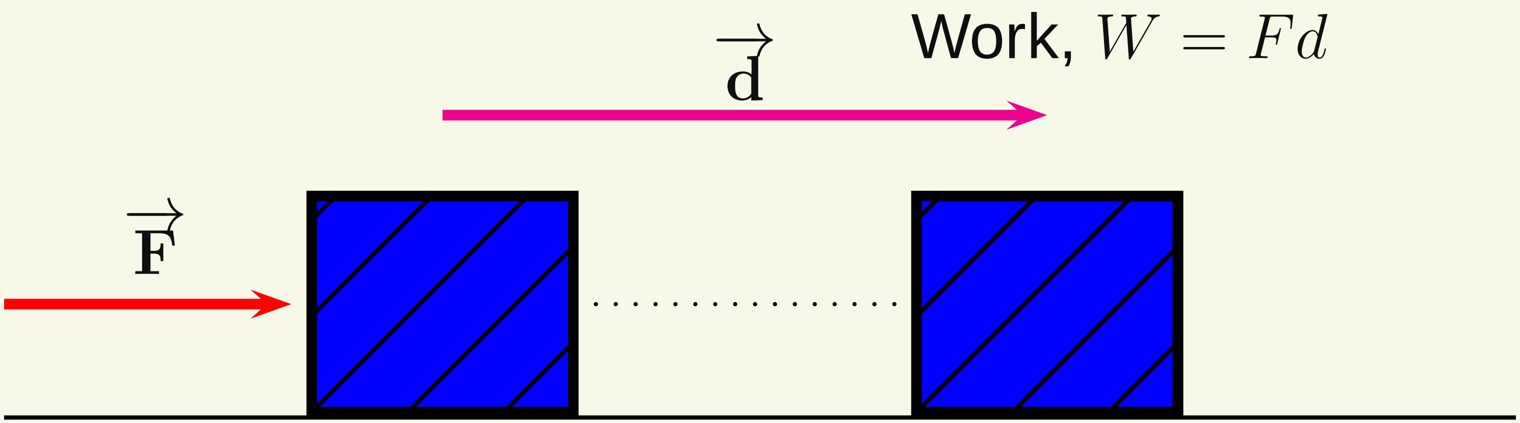

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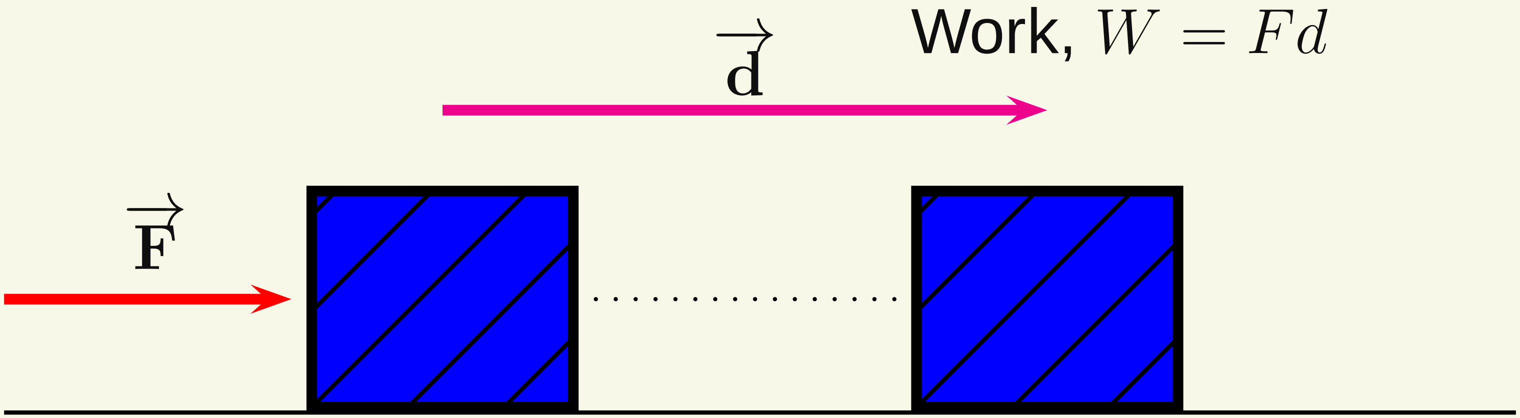

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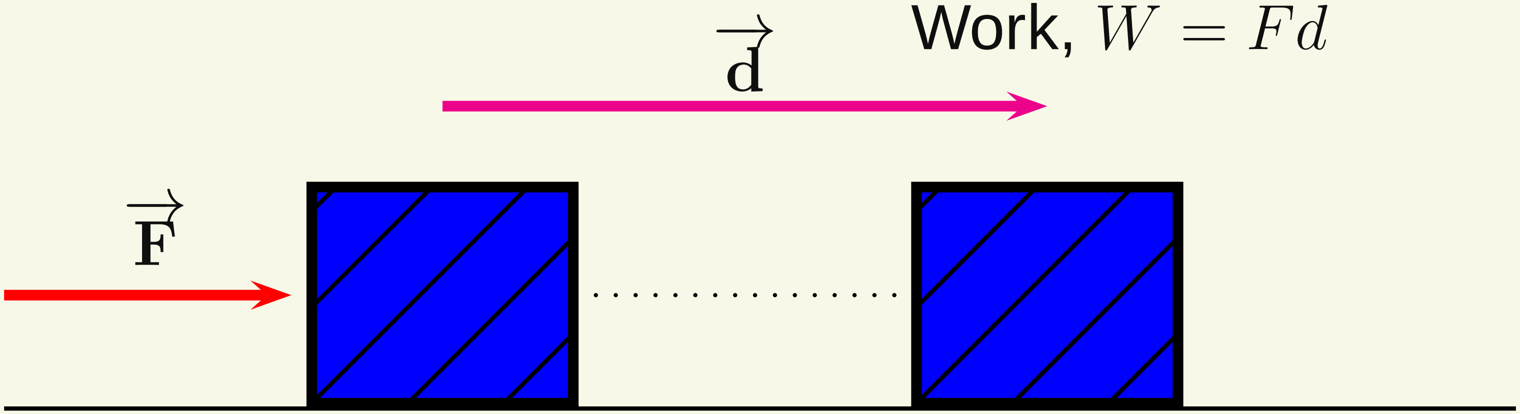

Work, $W = Fd$

This equation is correct only in the situation that:

$\overrightarrow{\mathbf{F}}$ is constant

$\overrightarrow{\mathbf{d}}$ is a straight line

$\overrightarrow{\mathbf{F}}$ and $\overrightarrow{\mathbf{d}}$ are in the same direction.

Work Exercise I

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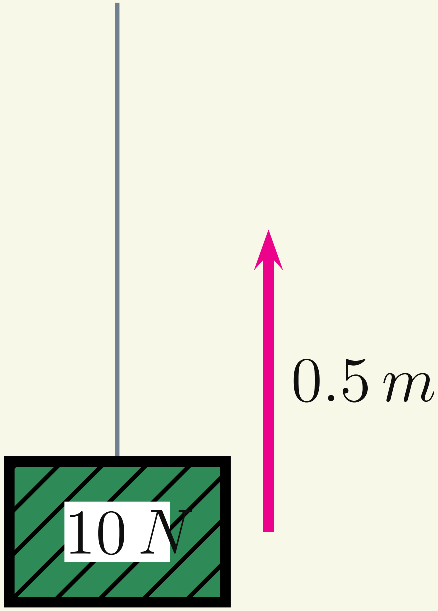

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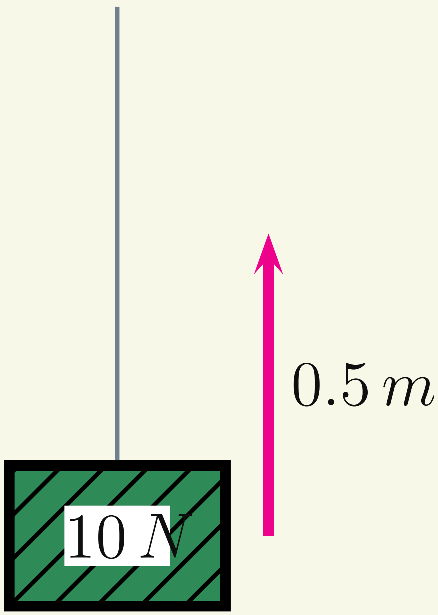

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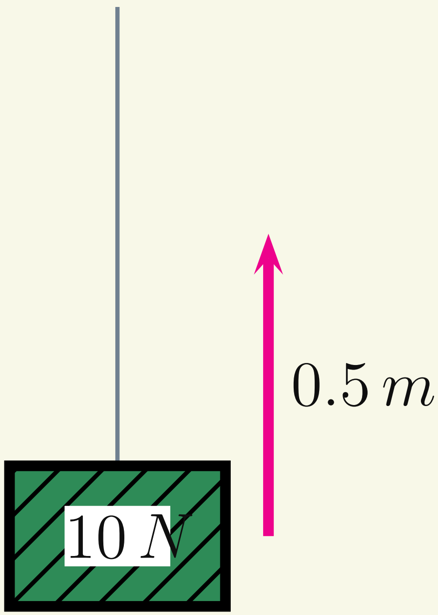

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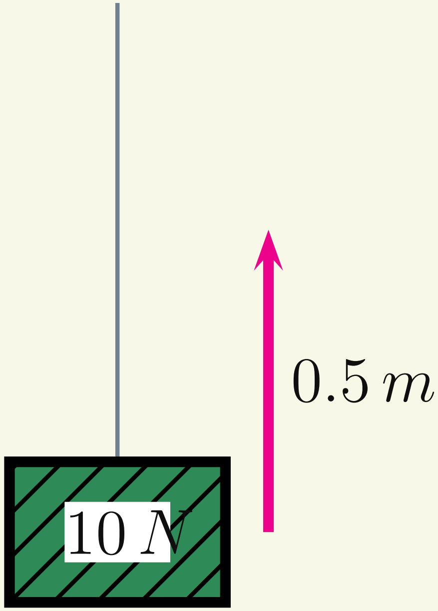

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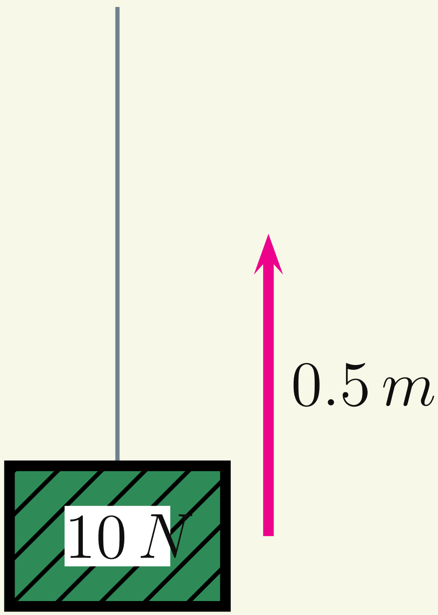

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(d) $10\,J$

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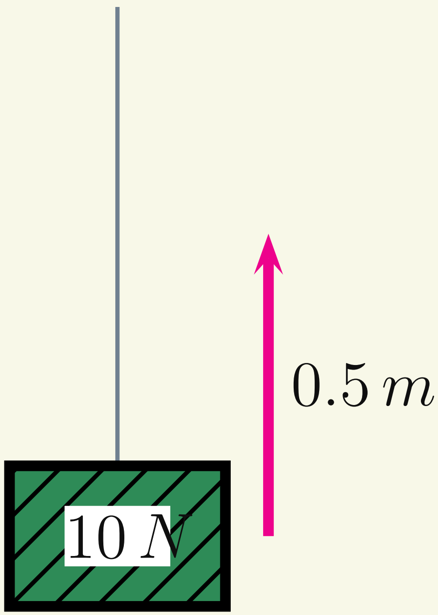

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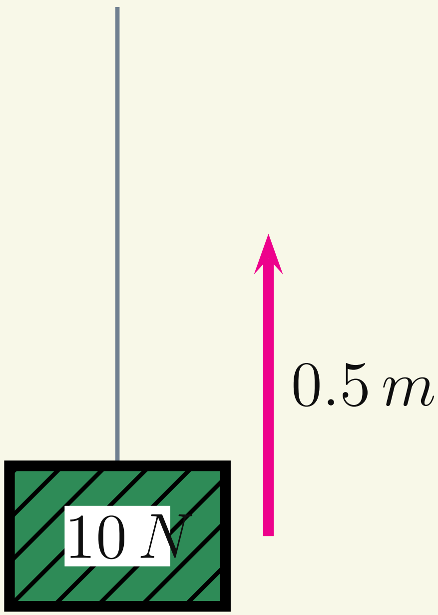

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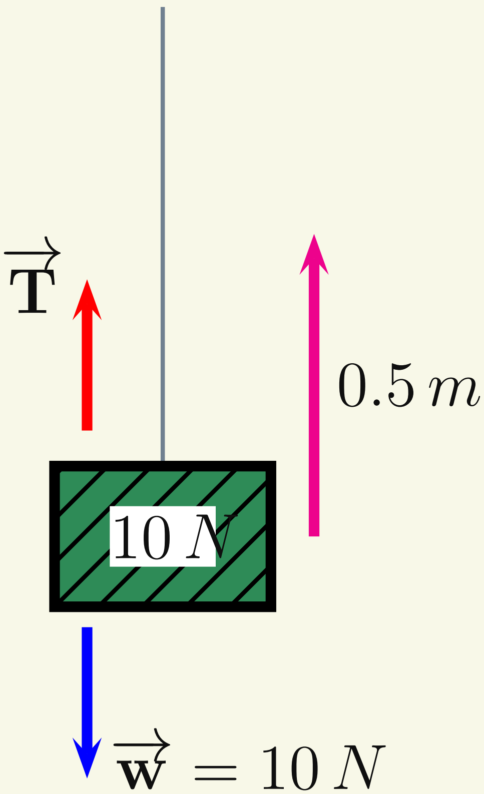

$$\sum F_y = ma_y \Rightarrow$$

$$T - 10\,N = 0 \Rightarrow T = 10\,N$$

$$W = Td = (10\,N)(0.5\,m)$$

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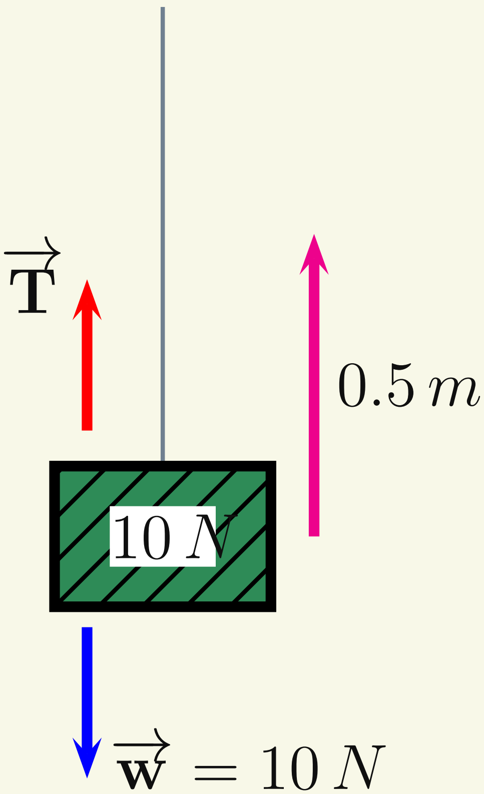

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Note: W = work and w = weight

Perpendicular Force

A force perpendicular to the displacement does no work.

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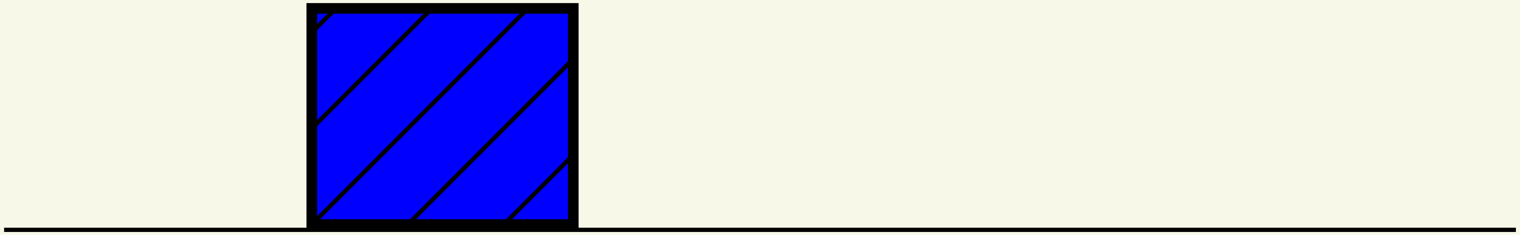

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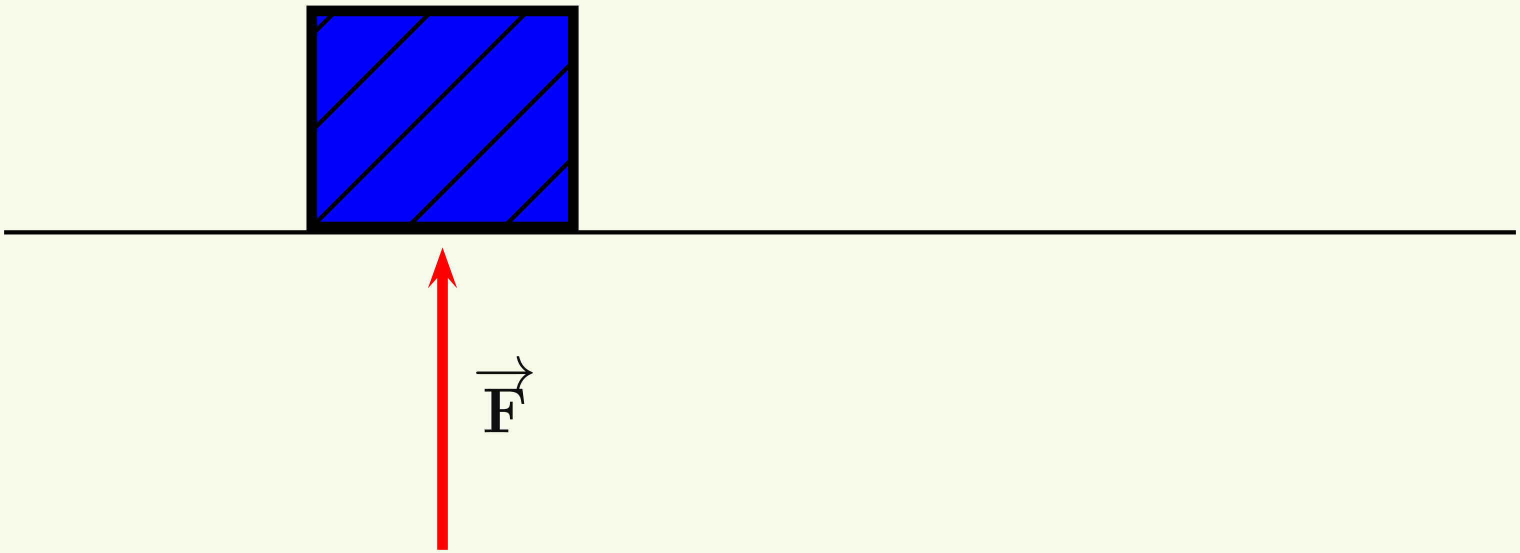

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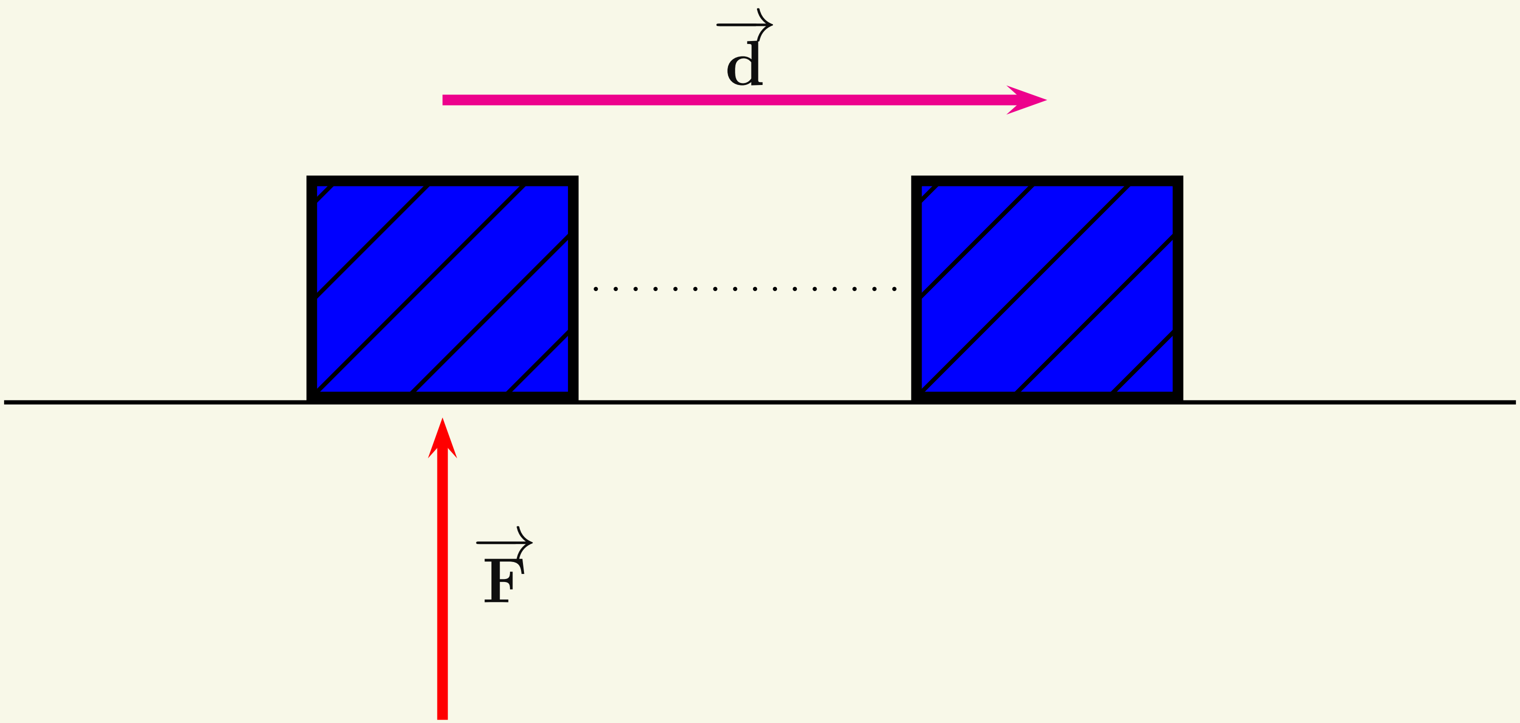

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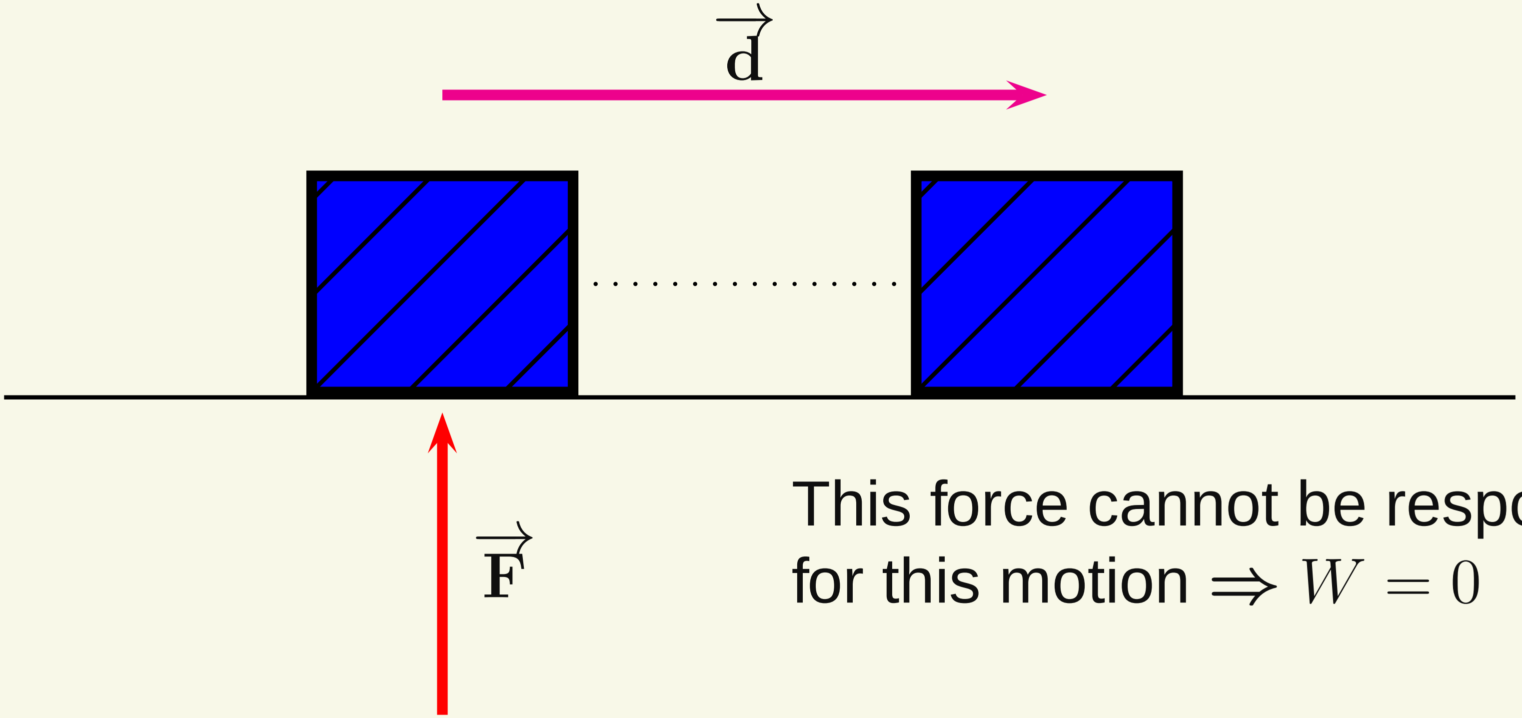

This force cannot be responsible for this motion $\Rightarrow W = 0$

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Only the component of the force parallel to the displacement does work.

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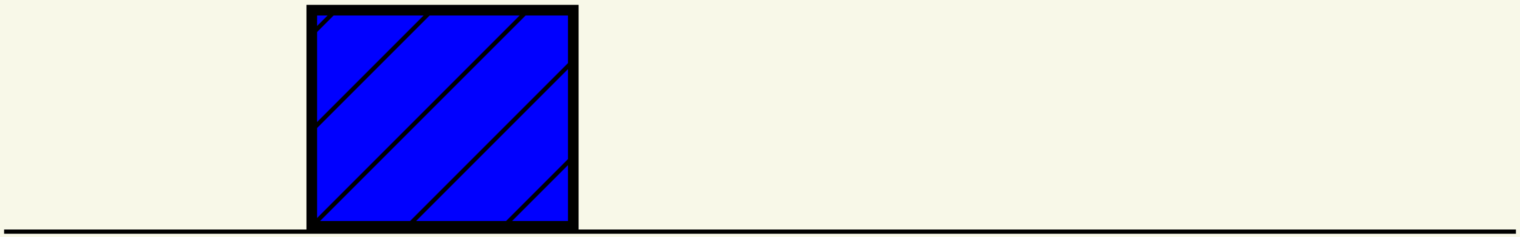

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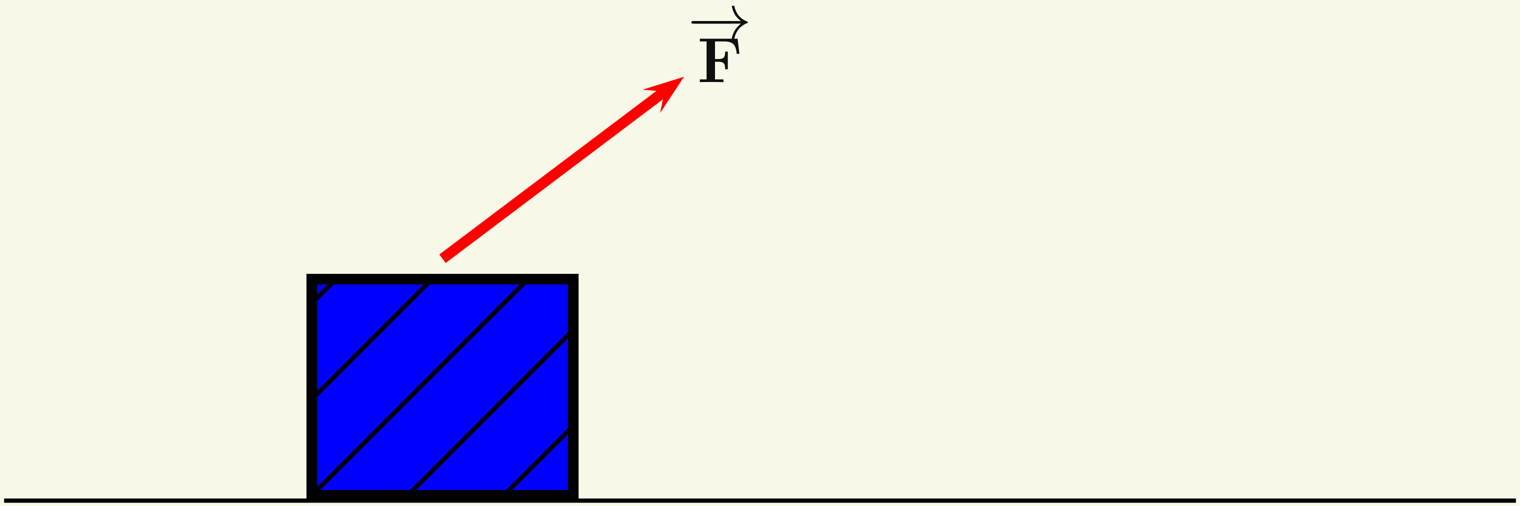

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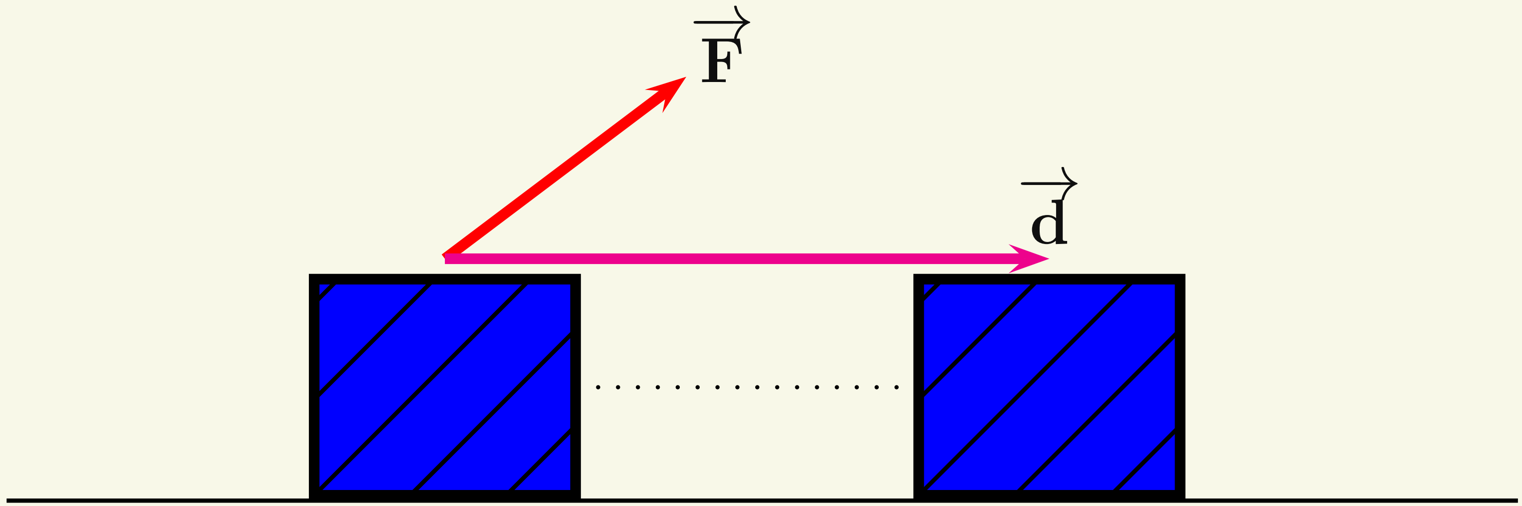

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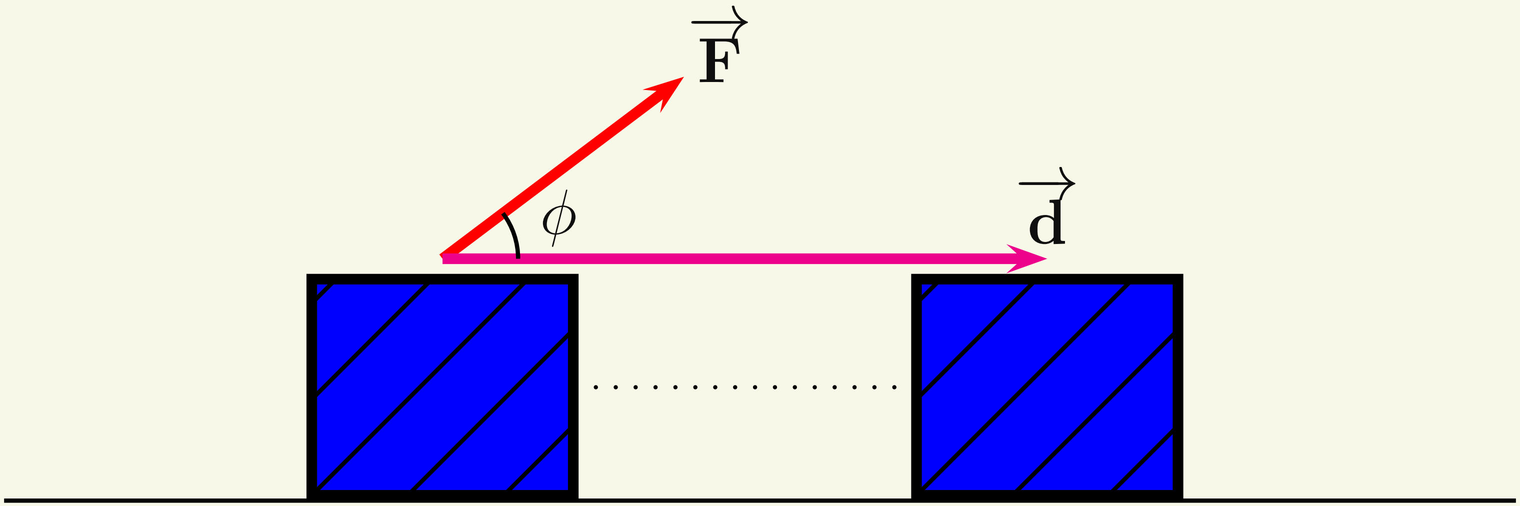

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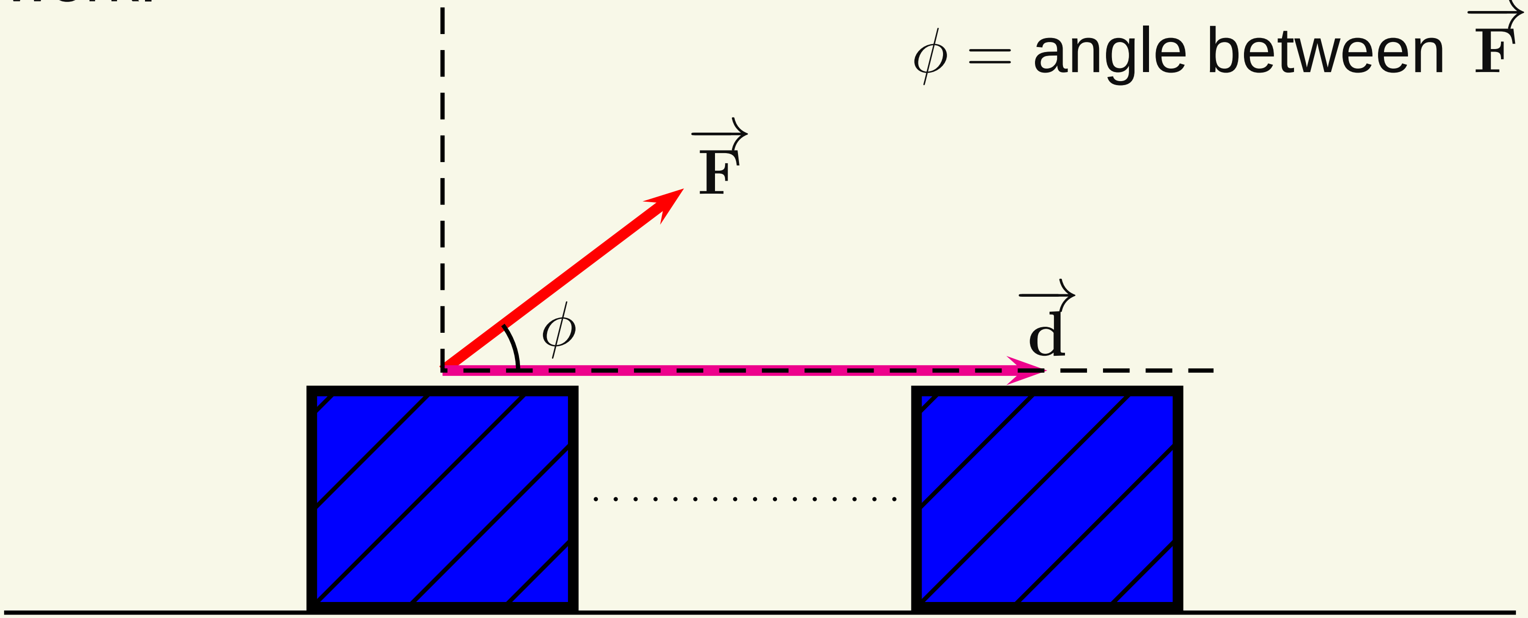

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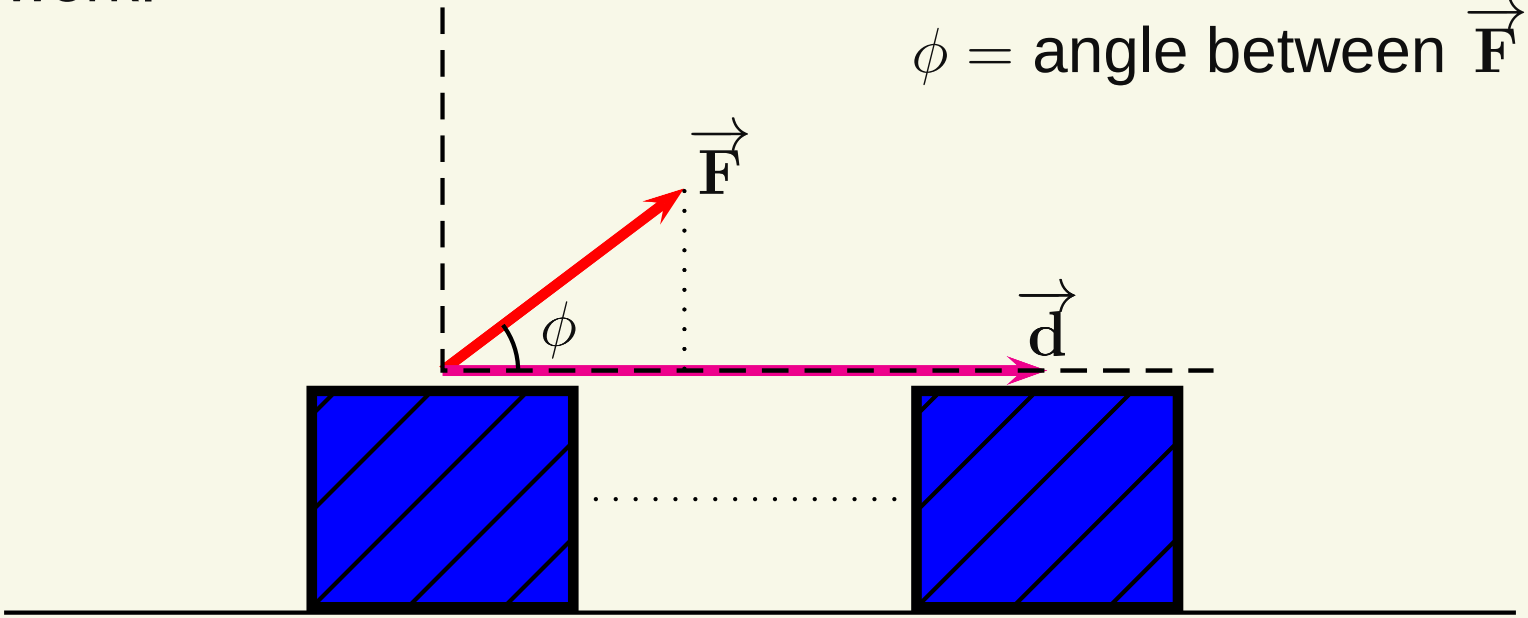

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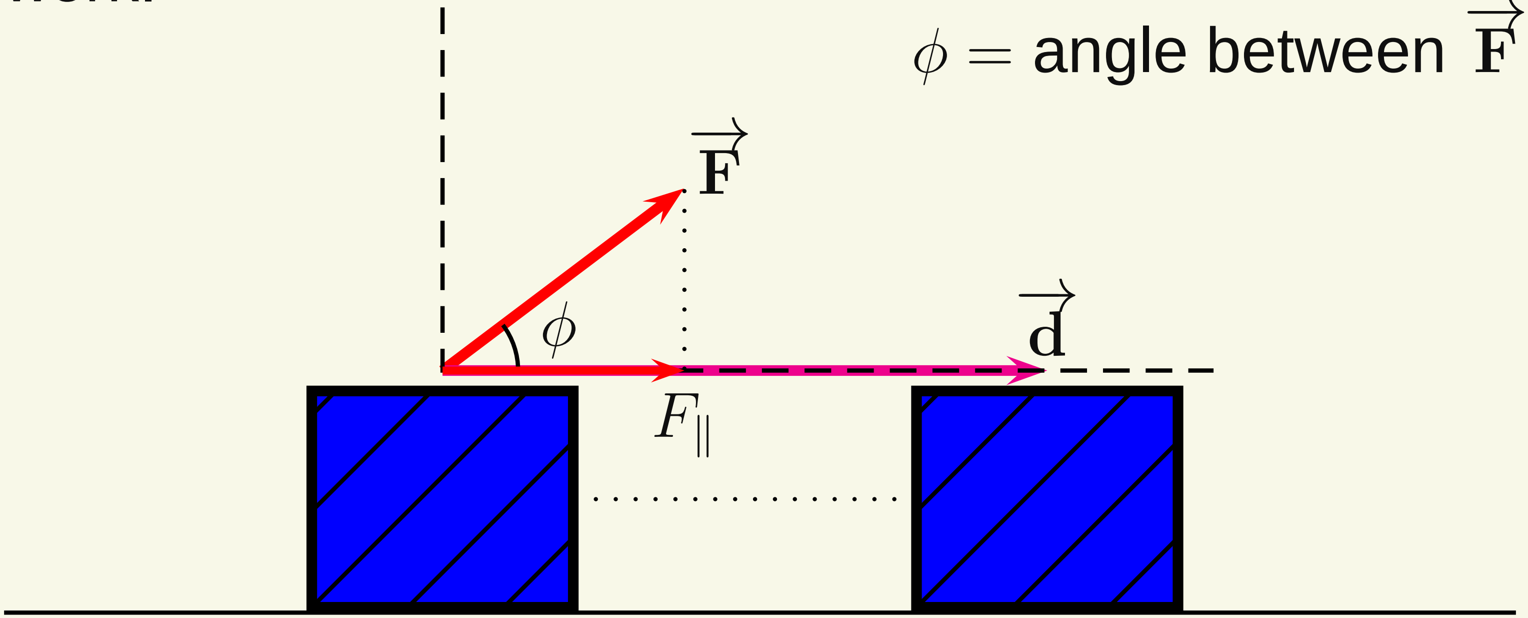

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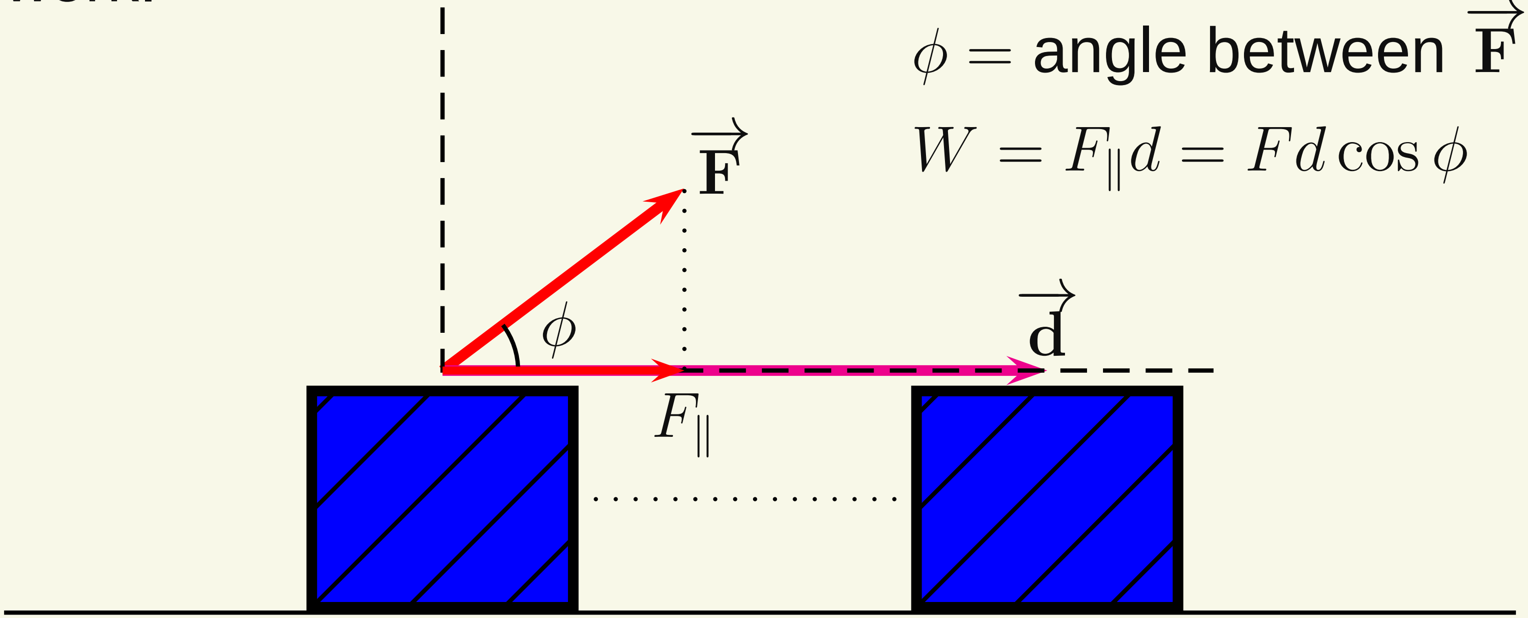

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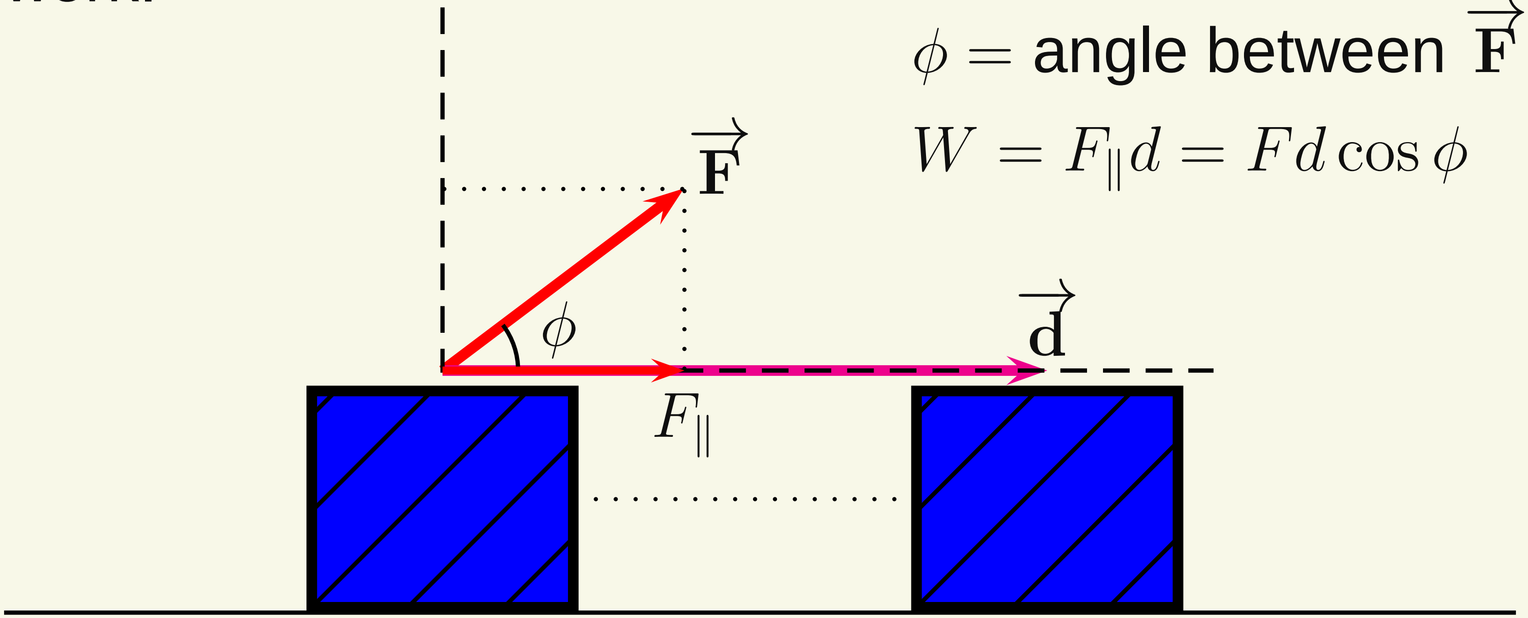

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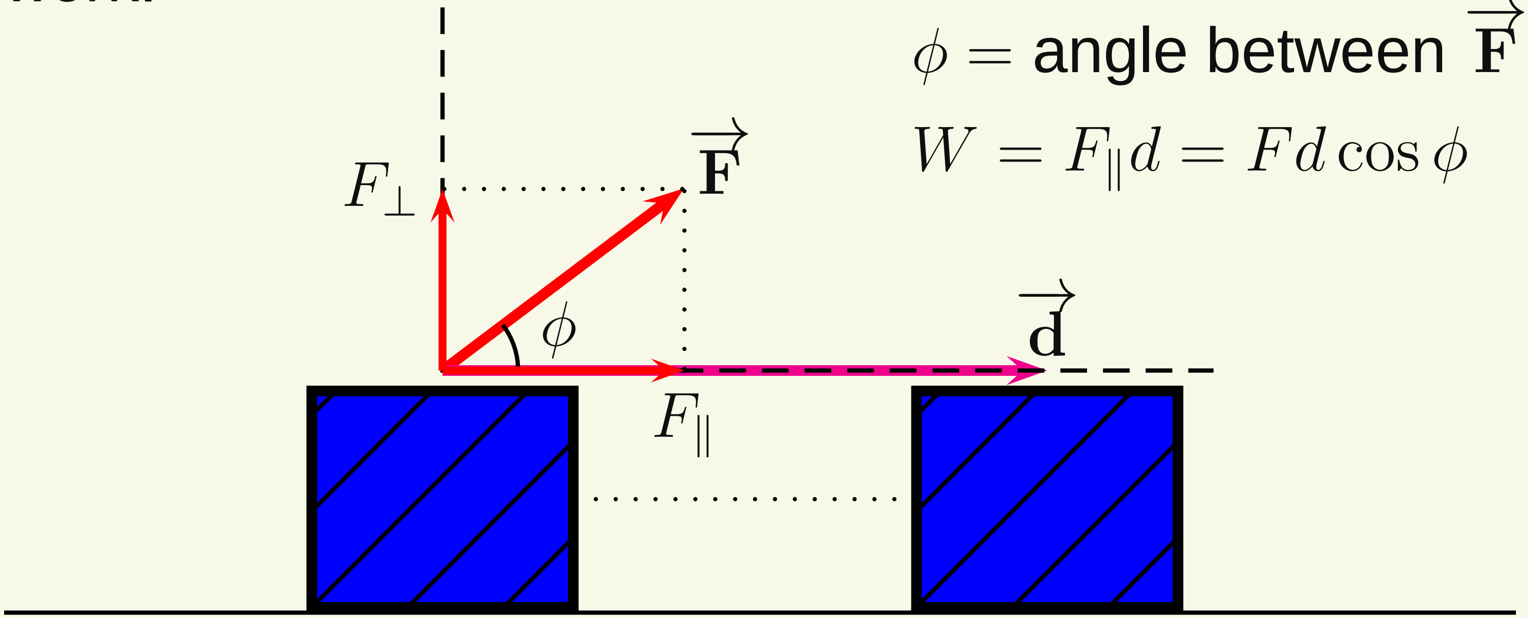

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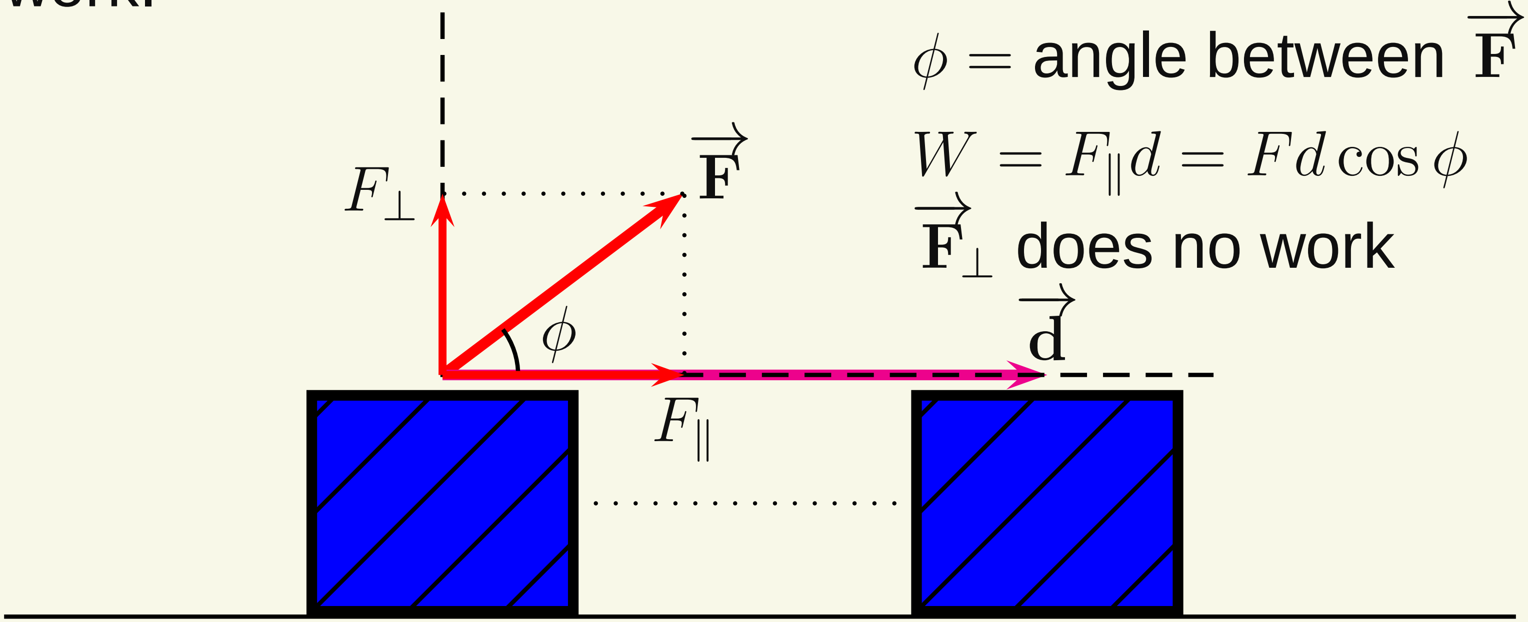

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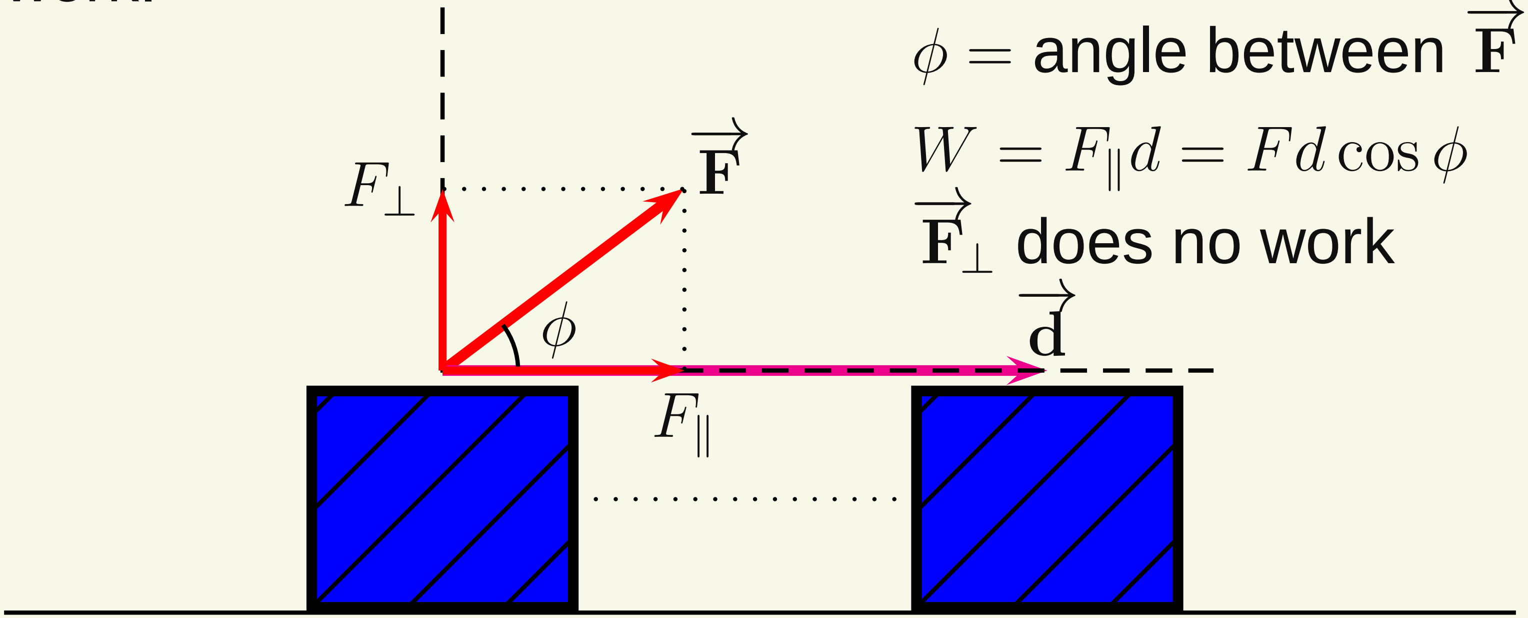

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$$\boxed{W = Fd\cos\phi}$$

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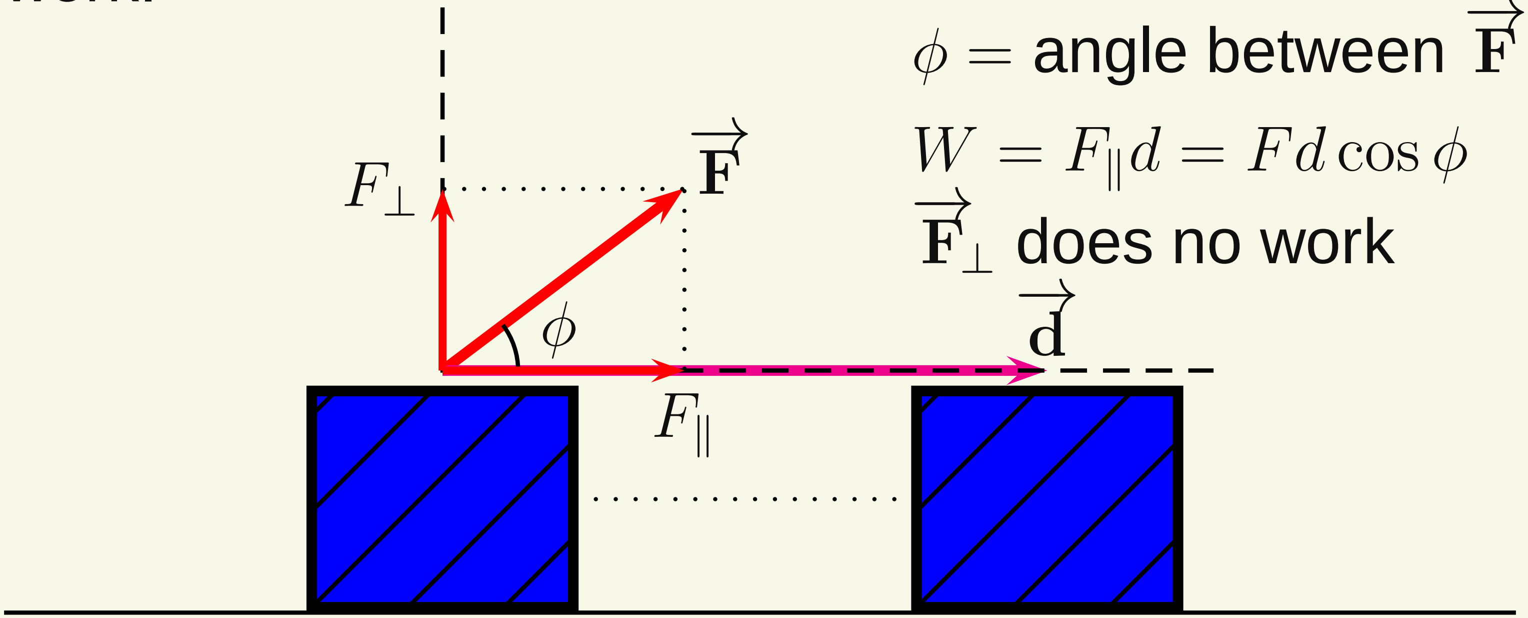

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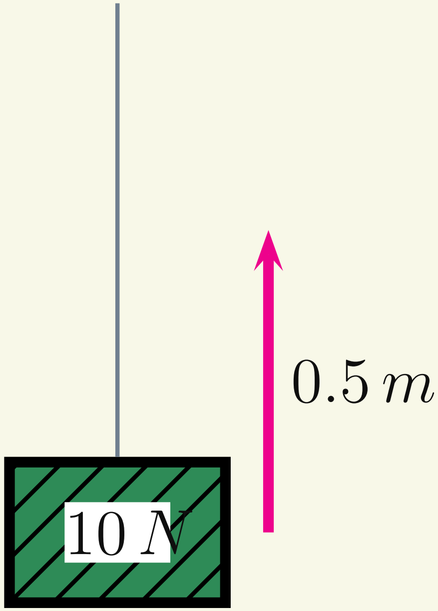
$$W = F d \cos\phi$$

Only correct for Constant force & Straight-line displacement

Work Exercise II

A $10\,N$ block is pulled $0.5\,m$ upwards with constant speed by a massless rope. How much work is done by gravity?



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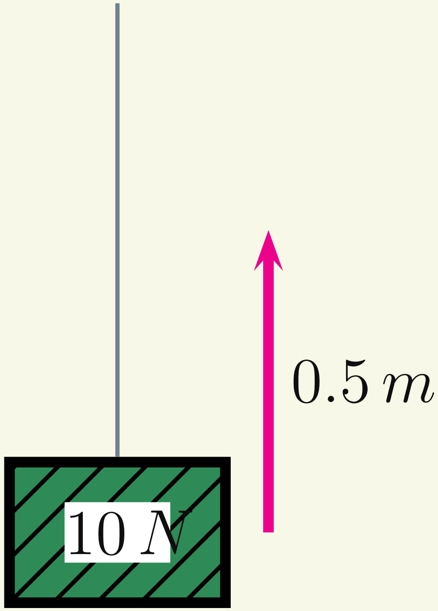

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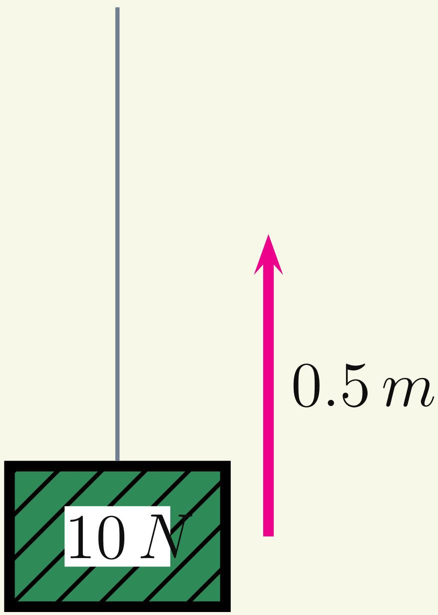

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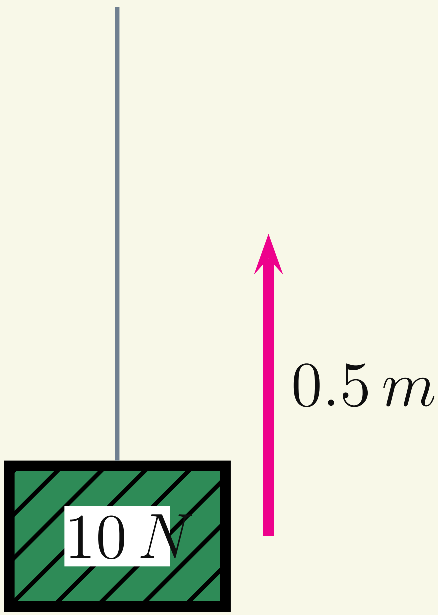

(a) $0\,J$

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(c) $5\,J\cos 180° = -5\,J$

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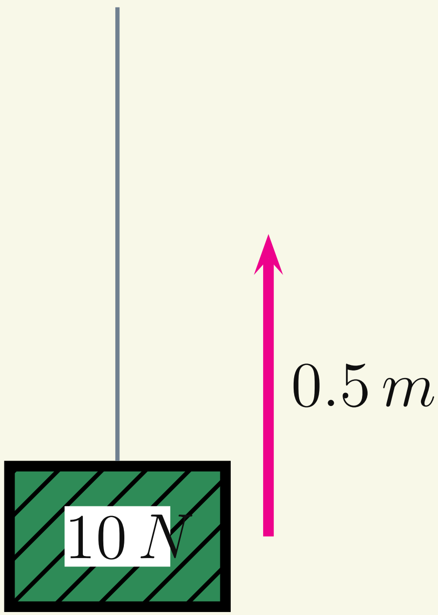
A $10\,N$ block is pulled $0.5\,m$ upwards with constant speed by a massless rope. How much work is done by gravity?



(a) $0\,J$

(b) $5\,J$

(c) $5\,J\cos 180° = -5\,J$

(d) $10\,J\cos 180° = -10\,J$

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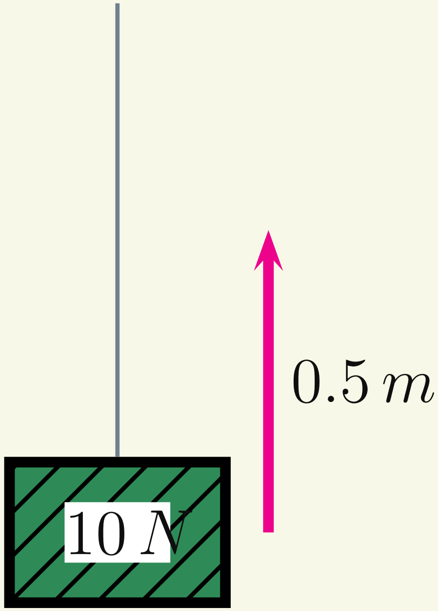

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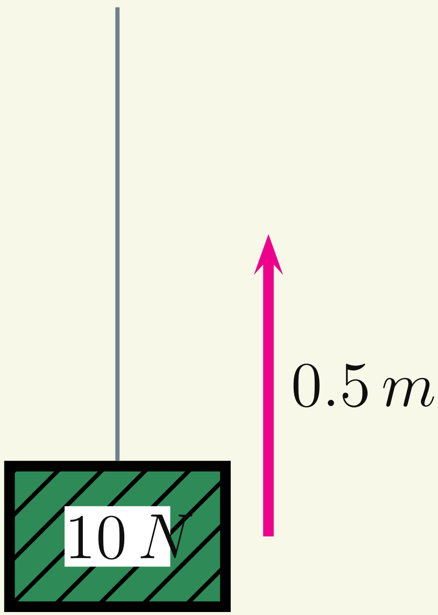

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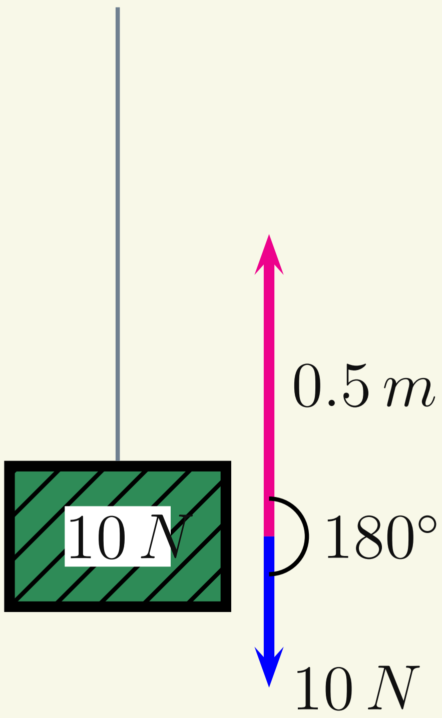

$$W = Fd\cos\phi$$

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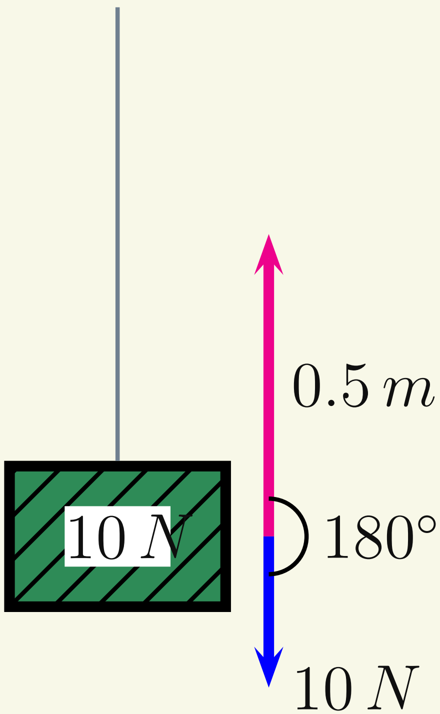

$$W = Fd\cos\phi$$

$$\Rightarrow W = (10\,N)(0.5\,m)\cos 180°$$

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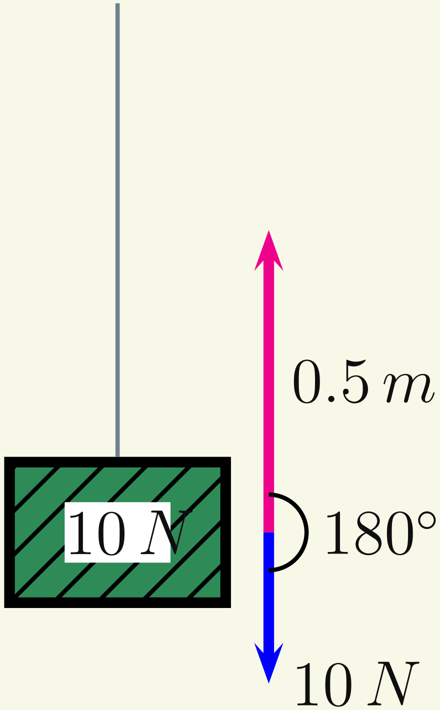

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Negative work slows an object down