



Work

Kinetic Energy: A Scalar

vector:	$\vec{v} = v_x \hat{i} + v_y \hat{j}$	velocity
scalar:	$ \vec{v} = \sqrt{v_x^2 + v_y^2}$	speed
scalar:	$K = \frac{1}{2} m \vec{v} ^2 = \frac{1}{2} m (v_x^2 + v_y^2)$	kinetic energy

we can say:

- The velocity is upward
- The change in velocity is to the right
- The kinetic energy will decrease

we **never** say:

- ~~The kinetic energy is upward~~
- ~~The change in kinetic energy is to the right~~
- ~~The velocity will decrease~~

Change in Kinetic Energy

A 4 kg ball travels only in the x direction.

Its **speed** increases by 2 m/s.

Its kinetic energy changes by

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

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- B $\Delta K = 0 \text{ J}$
- C $\Delta K = +8 \text{ J}$
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from rest ($v_i=0$): $v_f=2 \text{ m/s}$

$$\begin{aligned} \Delta K &= 0.5 (4 \text{ kg}) (2^2 - 0^2) \\ &= +8 \text{ J} \end{aligned}$$

$$\Delta K = \frac{1}{2} m (v_f^2 - v_i^2)$$

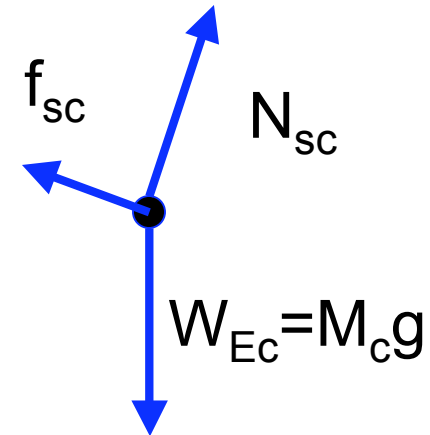
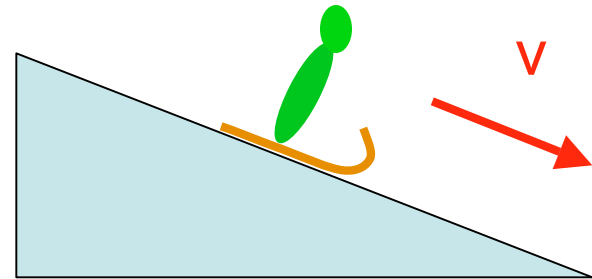
from $v_i=4 \text{ m/s}$: $v_f=6 \text{ m/s}$

$$\begin{aligned} \Delta K &= 0.5 (4 \text{ kg}) (6^2 - 4^2) \\ &= +40 \text{ J} \end{aligned}$$

~~$$\Delta K \neq \frac{1}{2} m (v_f - v_i)^2$$~~

Carl slides down Peet's hill.
Which of the following forces
**does positive work on the
Carl+sled system** over the
initial 3 meters?

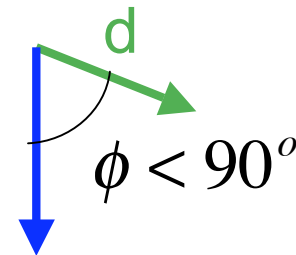
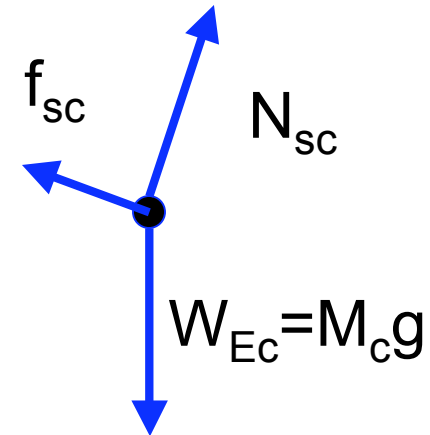
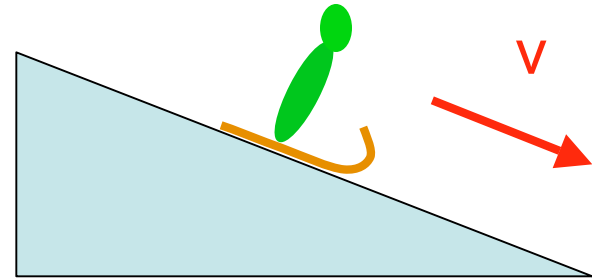
- A Friction
- B Gravity (weight force)
- C Normal force
- D A & B
- E B & C



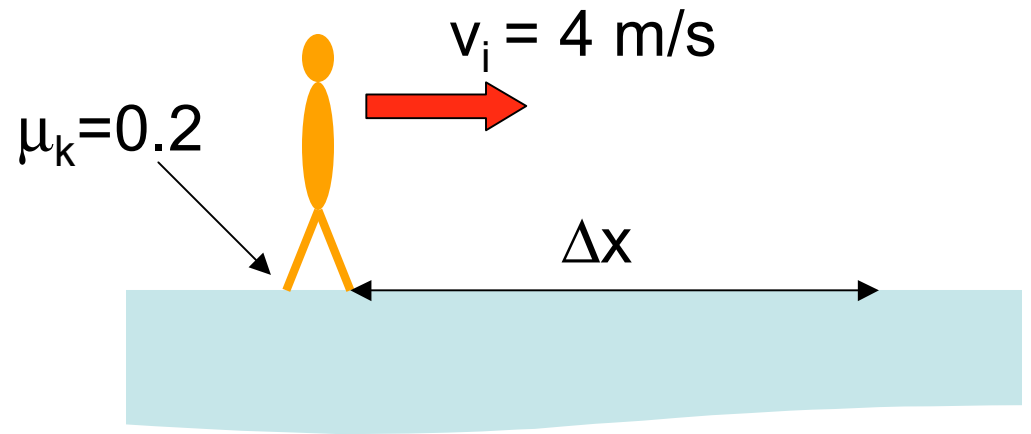
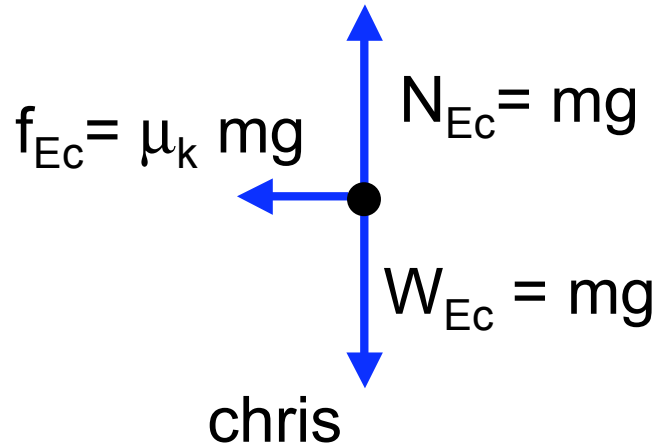
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$$W = \vec{F} \cdot \vec{d} = |\vec{F}| |\vec{d}| \cos \phi$$



Chris (64 kg) jumps onto an ice patch with an initial speed of 4 m/s. He slides with $\mu_k=0.2$. How far?

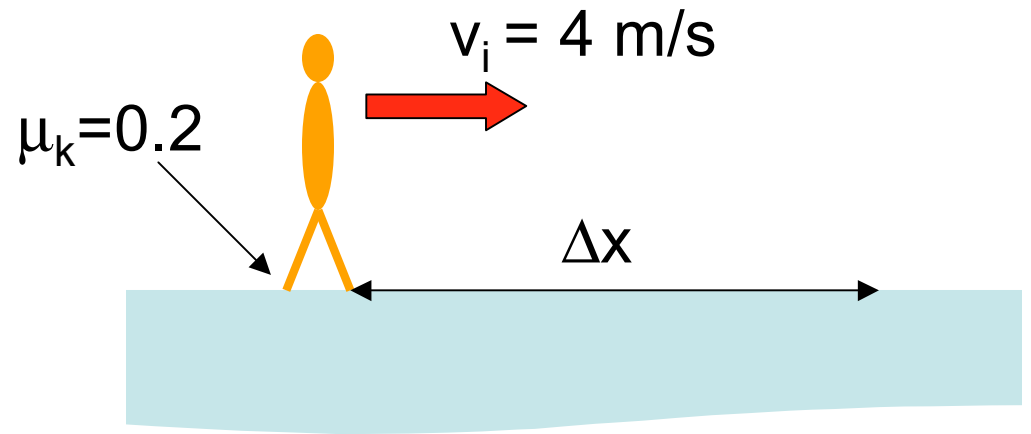
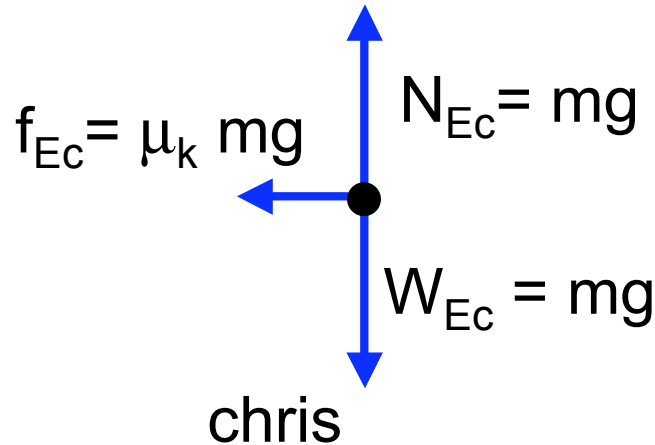


To begin:

The work **done by friction on Chris** during his slide is

- A -512 J
- B -128 J
- C 0 J
- D +128 J
- E +512 J

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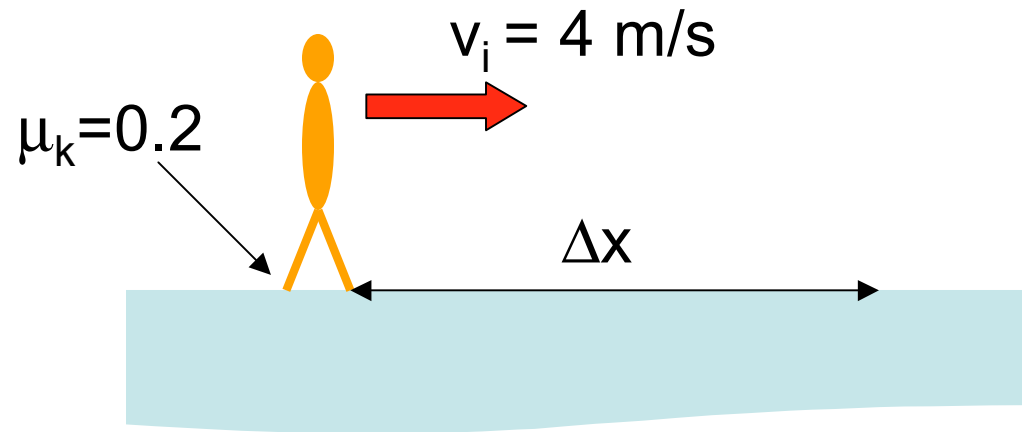
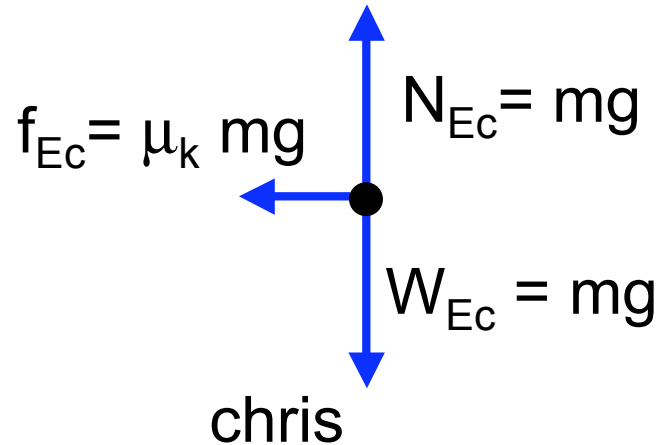
E +512 J

$$\cancel{K_f} - K_i = W$$

$$W = -K_i = -0.5 m v_i^2$$

$$W = -K_i = -0.5 \times 64 \times (4)^2$$

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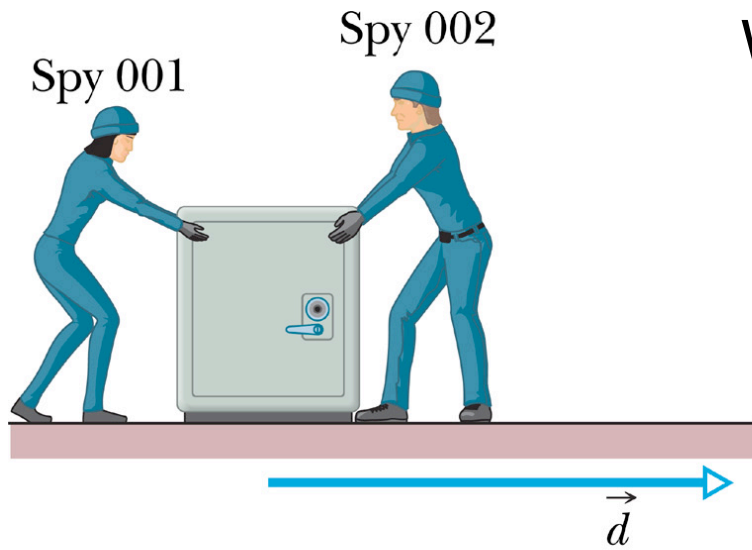


$$\Sigma W = -f_{Ec} \Delta x = -\mu_k mg \Delta x$$

$$K_f - K_i = W$$

$$0 - m(v_i)^2/2 = -\mu_k mg \Delta x$$

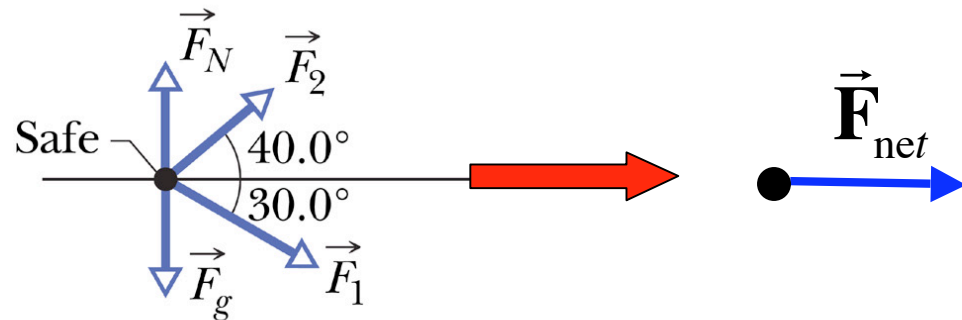
$$\Delta x = \frac{v_i^2}{2\mu_k g} = 4 \text{ m}$$



(a)

Work done by spy 001 on safe:

$$W_1 = \vec{F}_1 \cdot \vec{d}$$



(b)

which is **greater**:

A sum of works done by forces: $W_1 + W_2 + \dots$

B work done as if by one force: \vec{F}_{net}

C A & B are the same

$$\sum_i W_i = \sum_i (\vec{F}_i \cdot \vec{d}) = \left(\sum_i \vec{F}_i \right) \cdot \vec{d}$$

From old exam

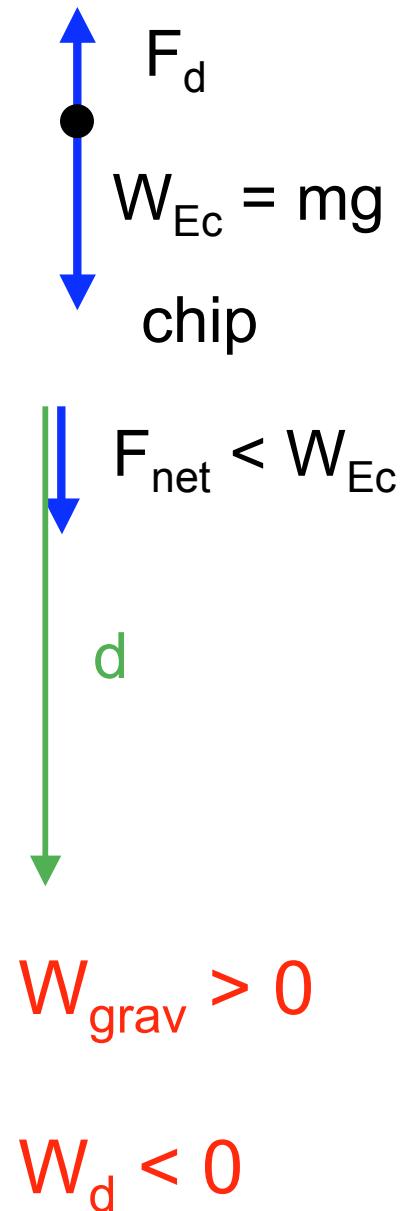
A potato chip falls out of a window 5.0 m above the ground. It begins from rest and is acted upon by air resistance (drag) as it falls.

- A. The work done by gravity = the kinetic energy at the ground.
- B. The work done by gravity $>$ the kinetic energy at the ground.
- C. The work done by gravity $<$ the kinetic energy at the ground.
- D. The change in gravitational potential energy = the kinetic energy at the ground.
- E. A & D are both true

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variant

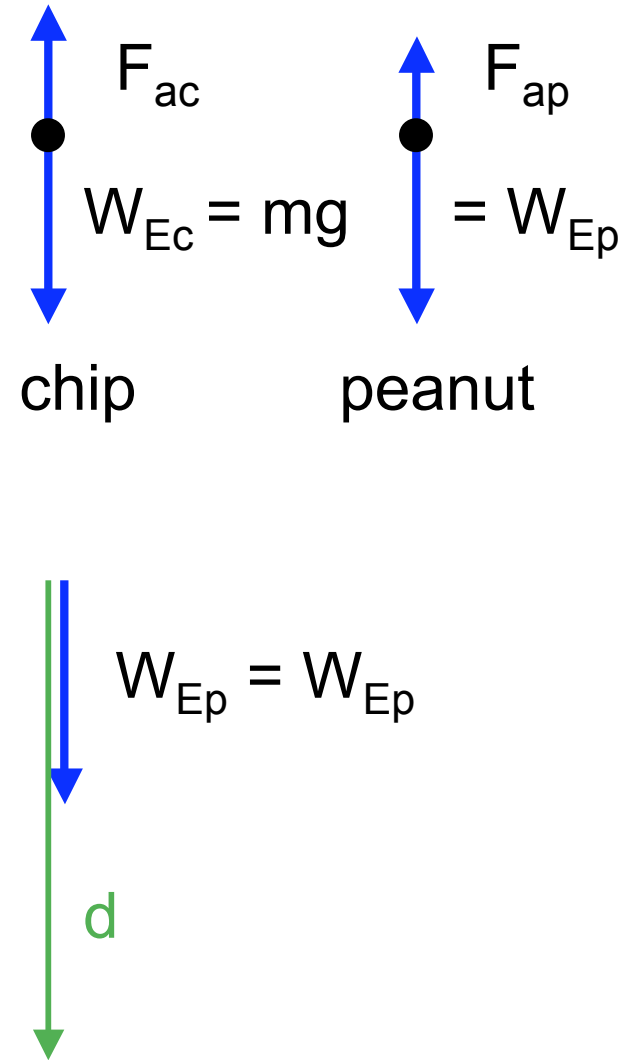
A potato chip and a peanut each have exactly the same mass and fall 5.0 m to the ground beginning from rest. The peanut lands first and is traveling faster when it lands than the potato chip. Compared to the work done by gravity **on the potato chip**, the work done by gravity ...

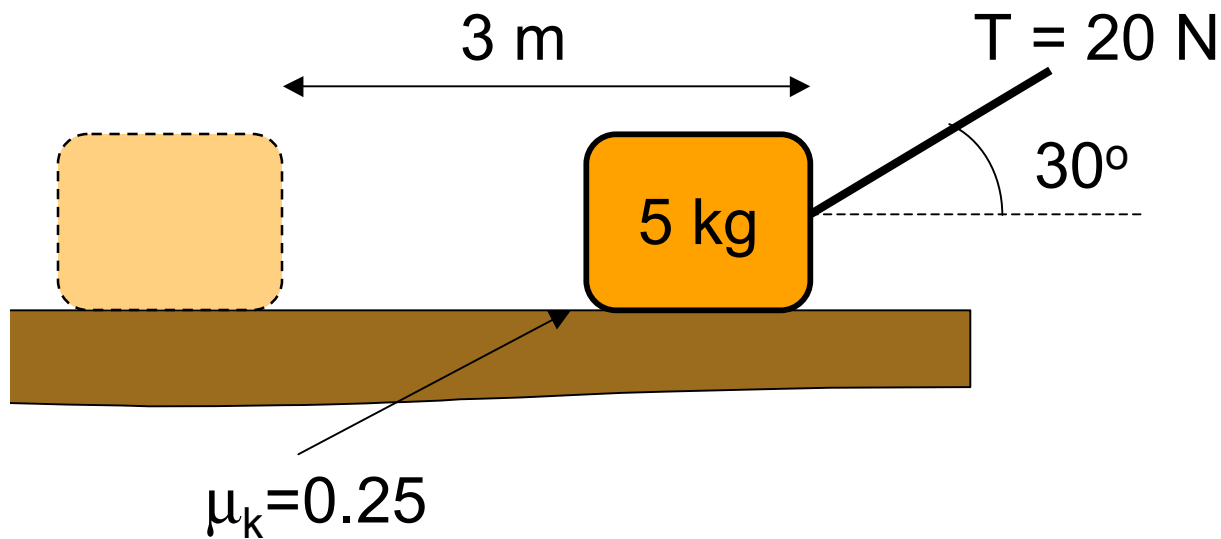
- A. ... **on the peanut** is greater.
- B. ... **on the peanut** is smaller.
- C. ... **on the peanut** is the same.

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You pull a 5 kg crate 3m across a slippery floor by exerting a constant tension of 20 N at 30° from the horizontal.

The work done by tension is:

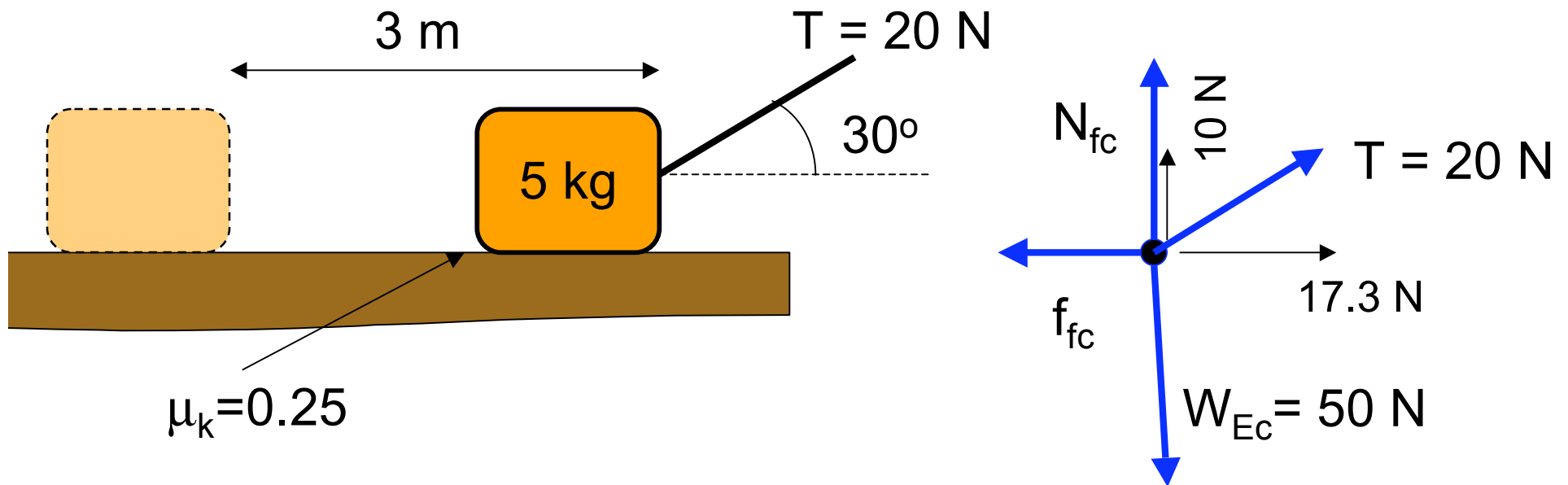
A 14 J

B 22 J

C 30 J

D 52 J

E 60 J



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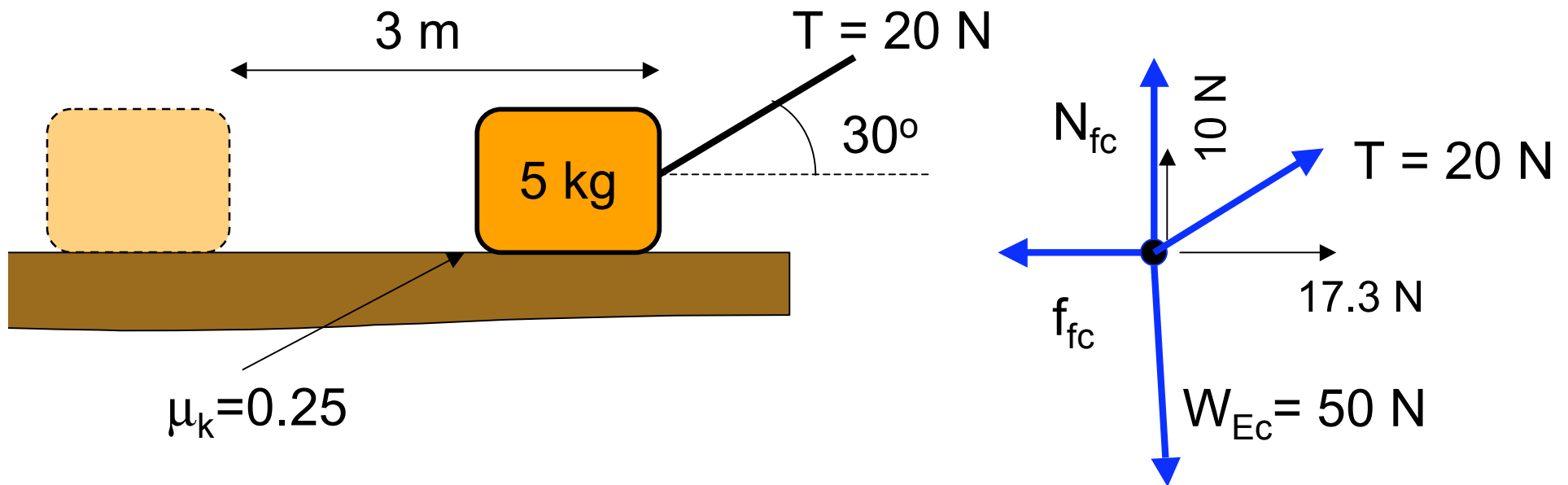
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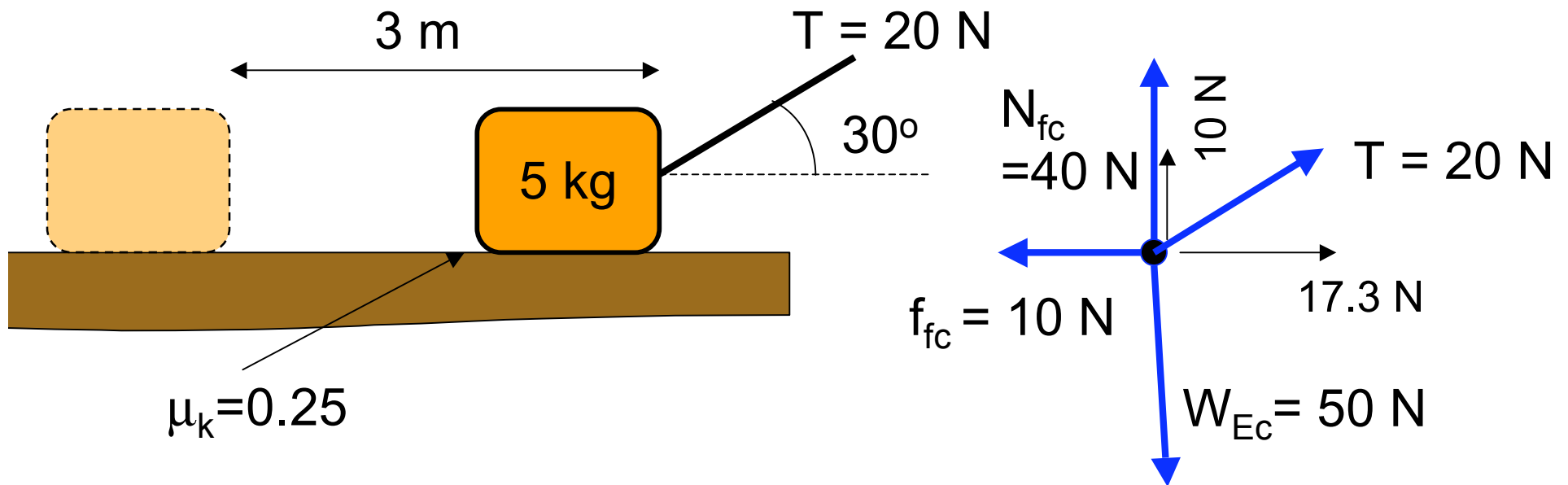
E 60 J



You pull a 5 kg crate 3m across a slippery floor by exerting a constant tension of 20 N at 30° from the horizontal.

The change in the crate's kinetic energy is:

- | | |
|---------------|---------------|
| A 0 J | B 14 J |
| C 22 J | D 30 J |
| E 52 J | |



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$$\sum \vec{F} = 7.3 \hat{i} \text{ N}$$