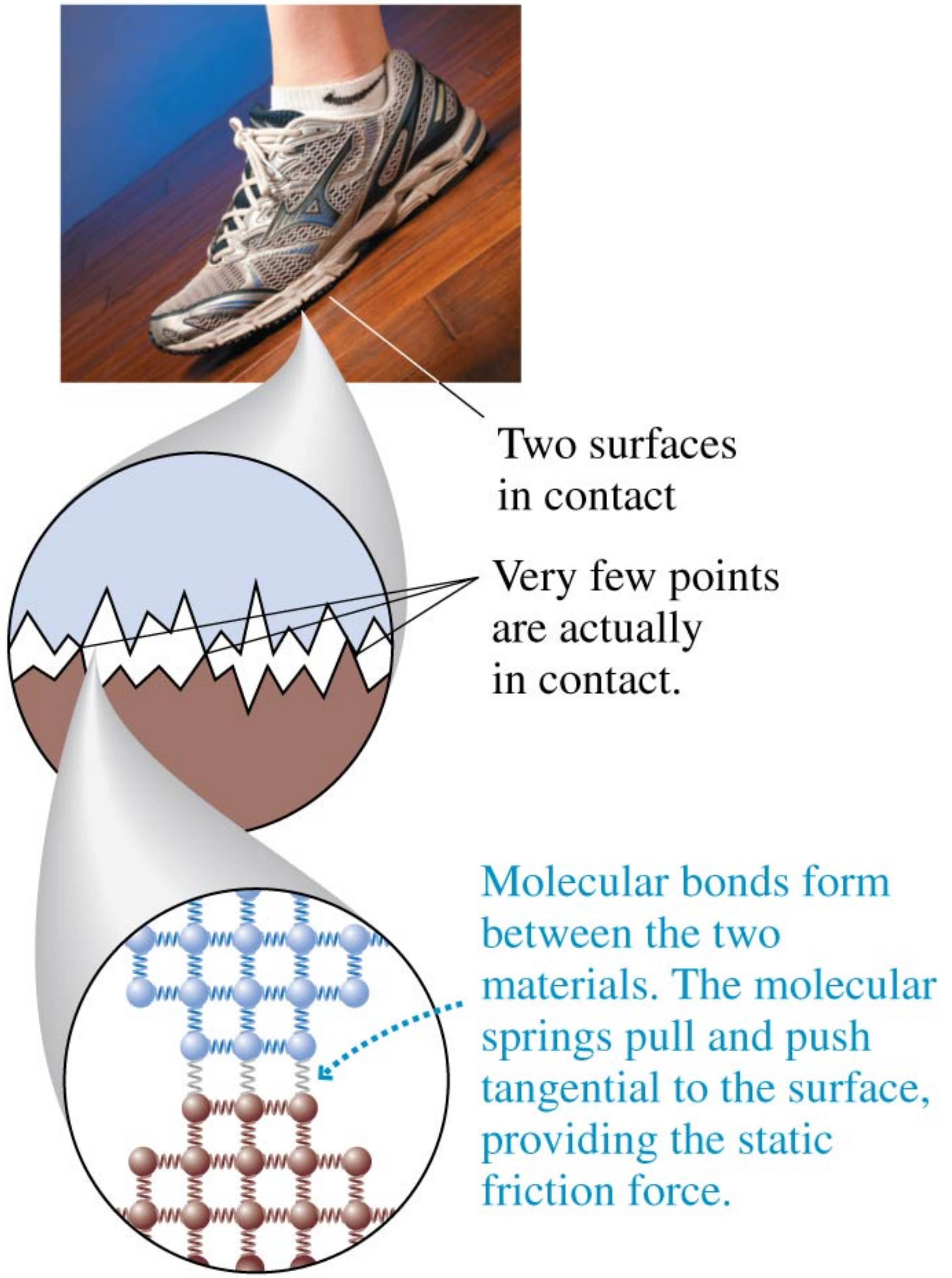
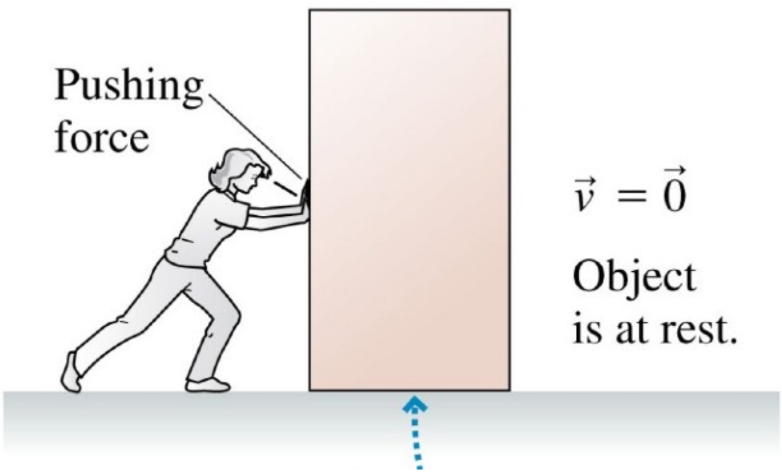
Static Friction

Both surfaces are "rough" on a microscopic scale

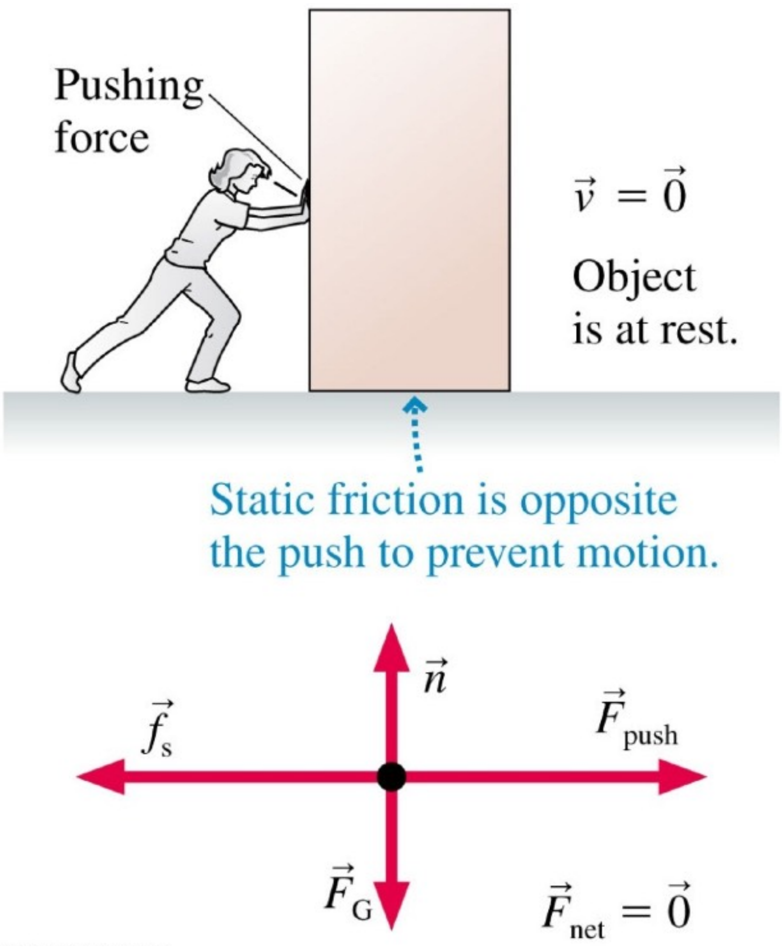
Molecular bonds produce a force tangent to the surface



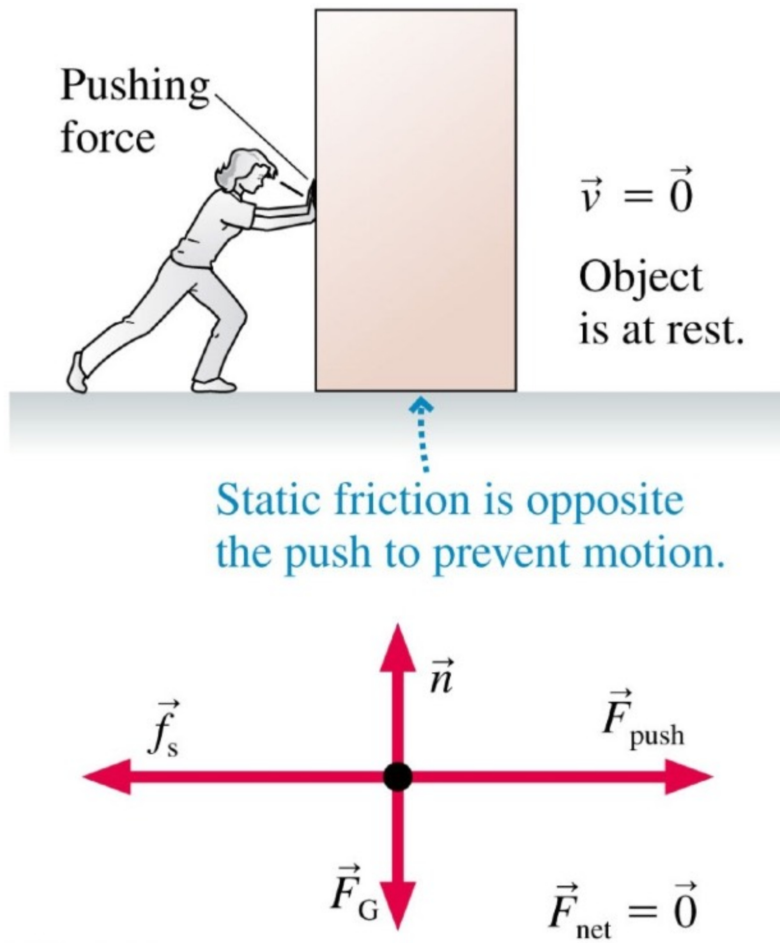
Static Friction

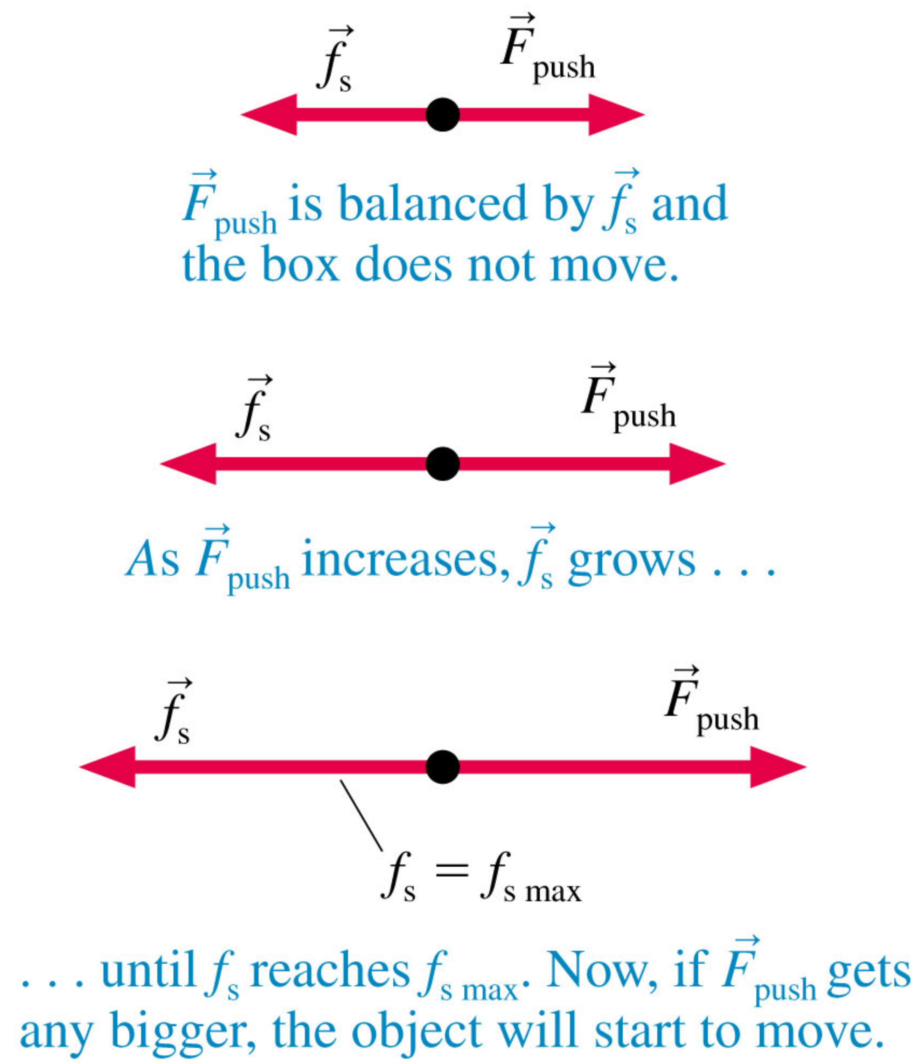


Static Friction

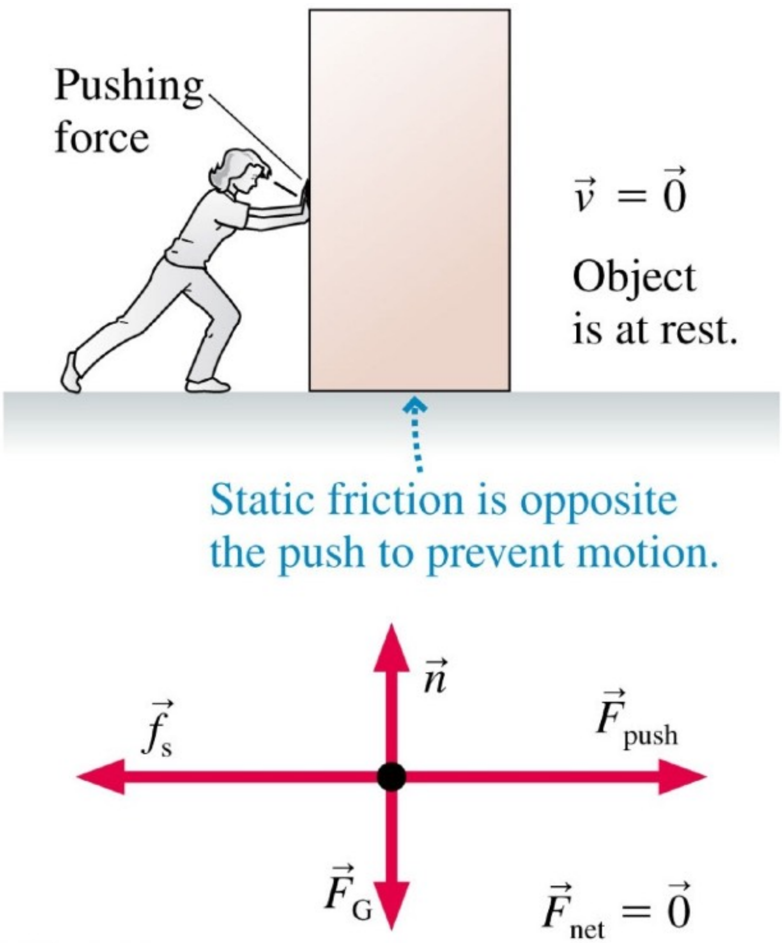


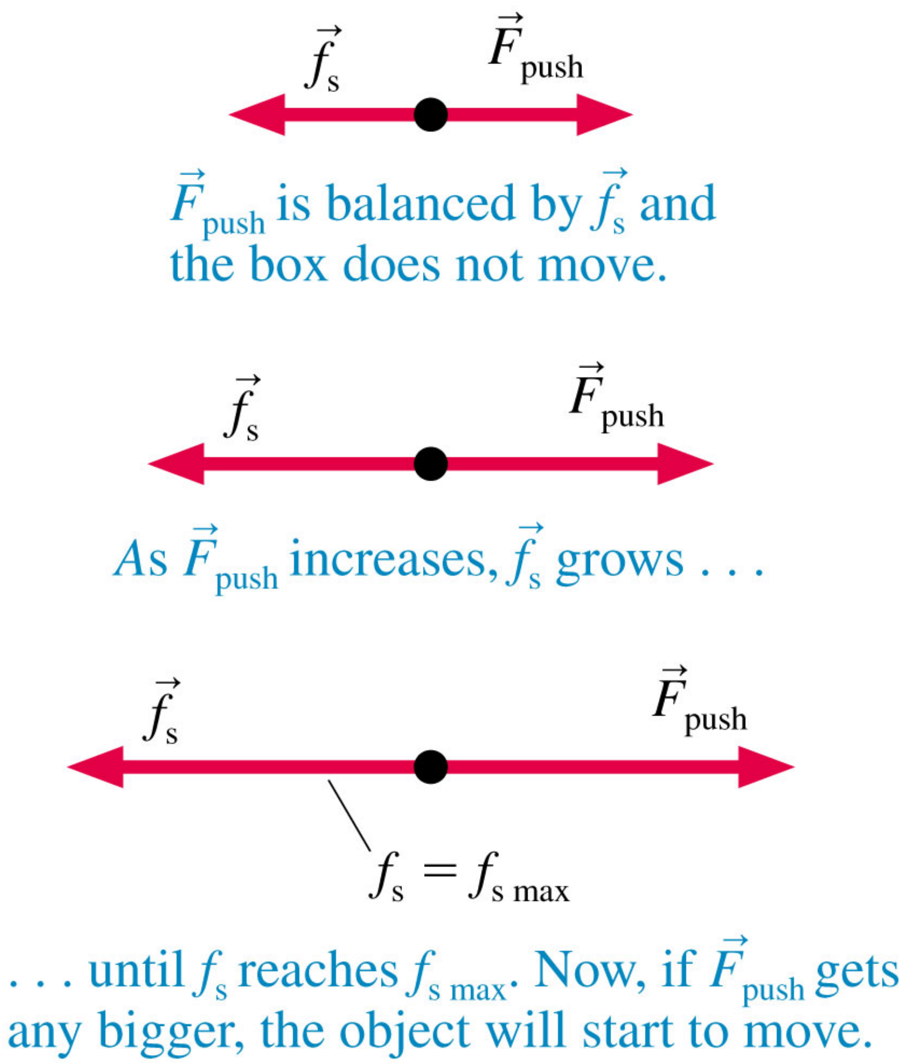
Static Friction





Static Friction



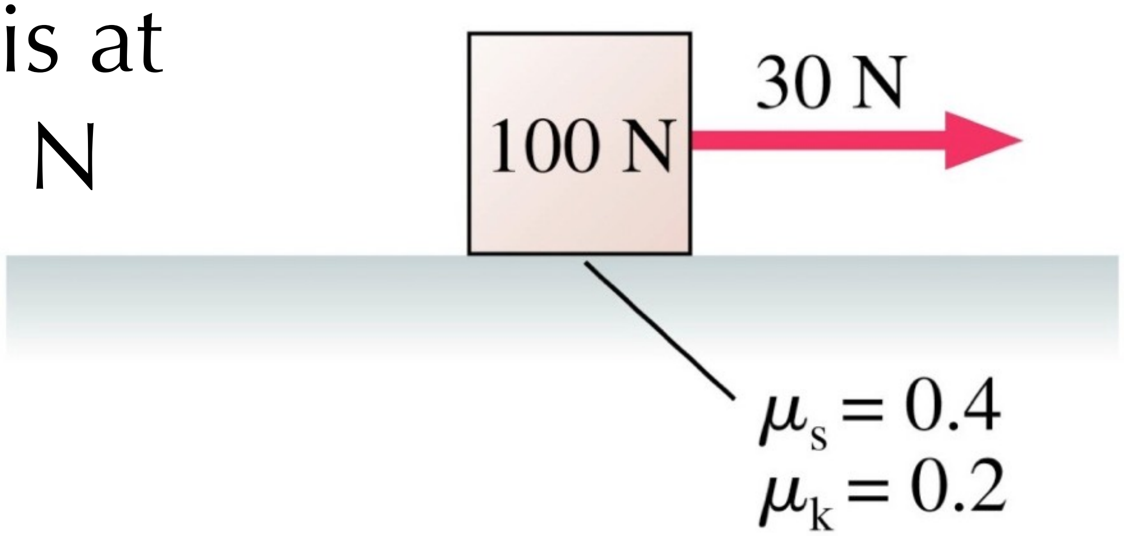


Static friction has a maximum possible size $f_{s\ \mathrm{max}}$

$$f_{s\ \mathrm{max}} = \mu_s n$$

Question #10

A box with a weight of 100 N is at rest. It is then pulled by a 30 N horizontal force.



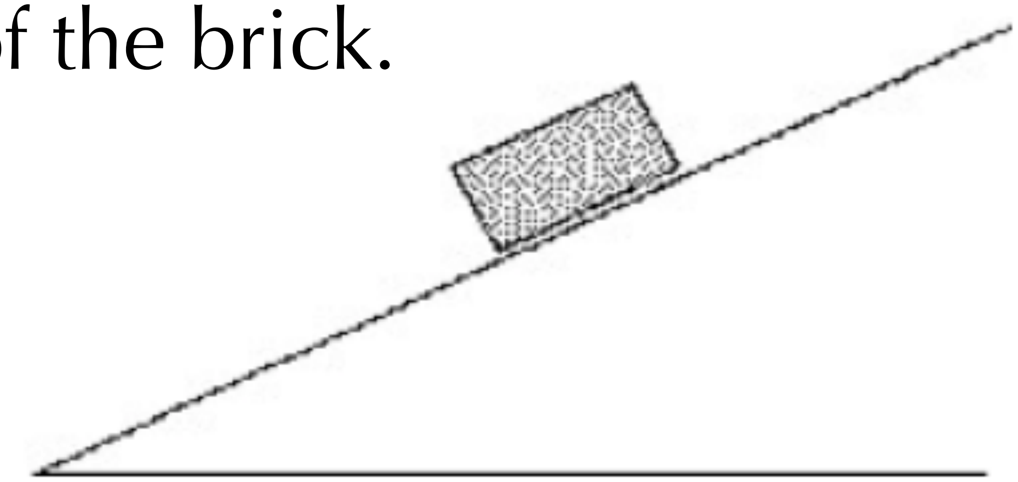
Does the box move?

D Yes
E No
B Not enough information to say.

Question #11

A brick is resting on a rough incline as shown in the figure, the friction force acting on the brick is?

a) equal to the weight (mg) of the brick.
b) greater than the weight of the brick.
c) zero
d) less than the weight of the brick.



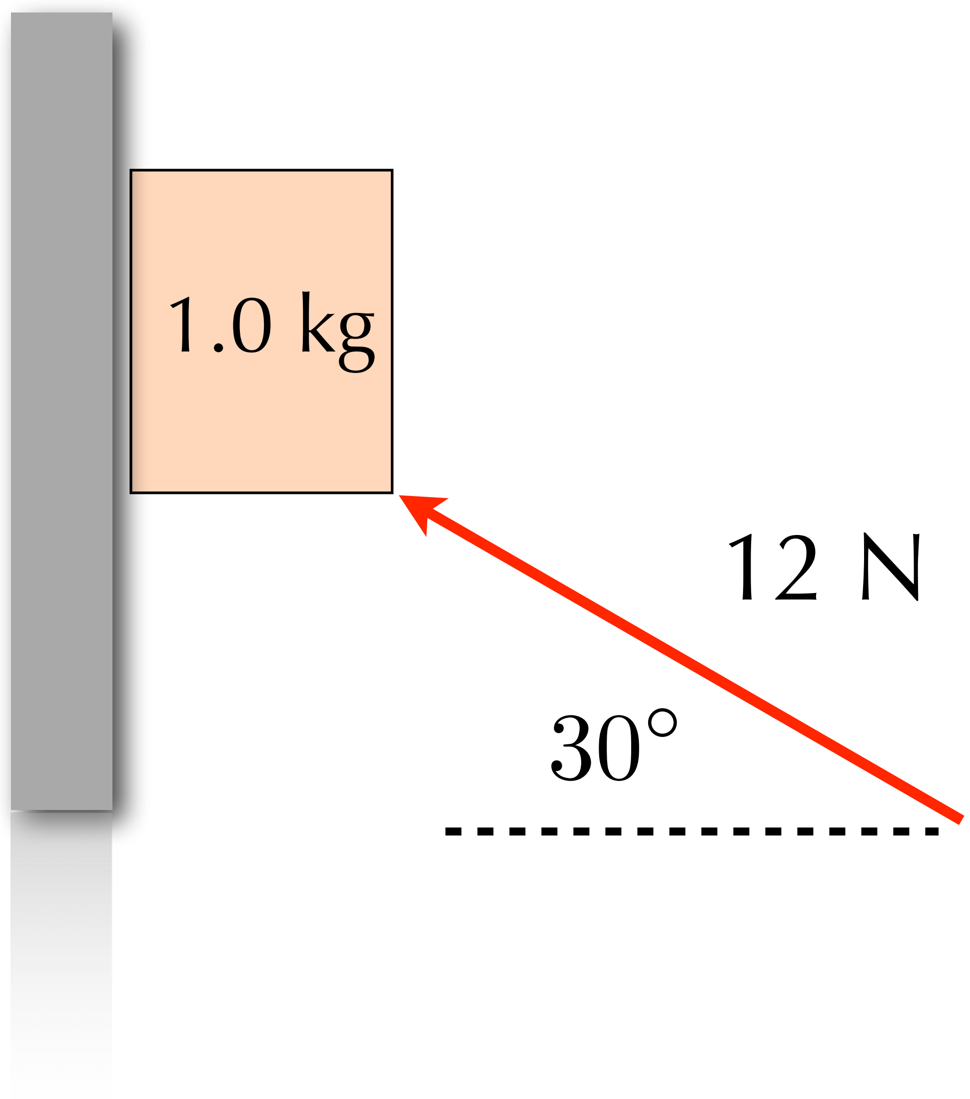
Question #12

A packing crate rests on a horizontal surface. It is acted on by three forces: 600 N to the left, 200 N to the right, and friction. If the 600 N force is removed, the new net force on the crate is?

a) 400 N to the left
b) 200 N to the left
c) 200 N to the right
d) zero

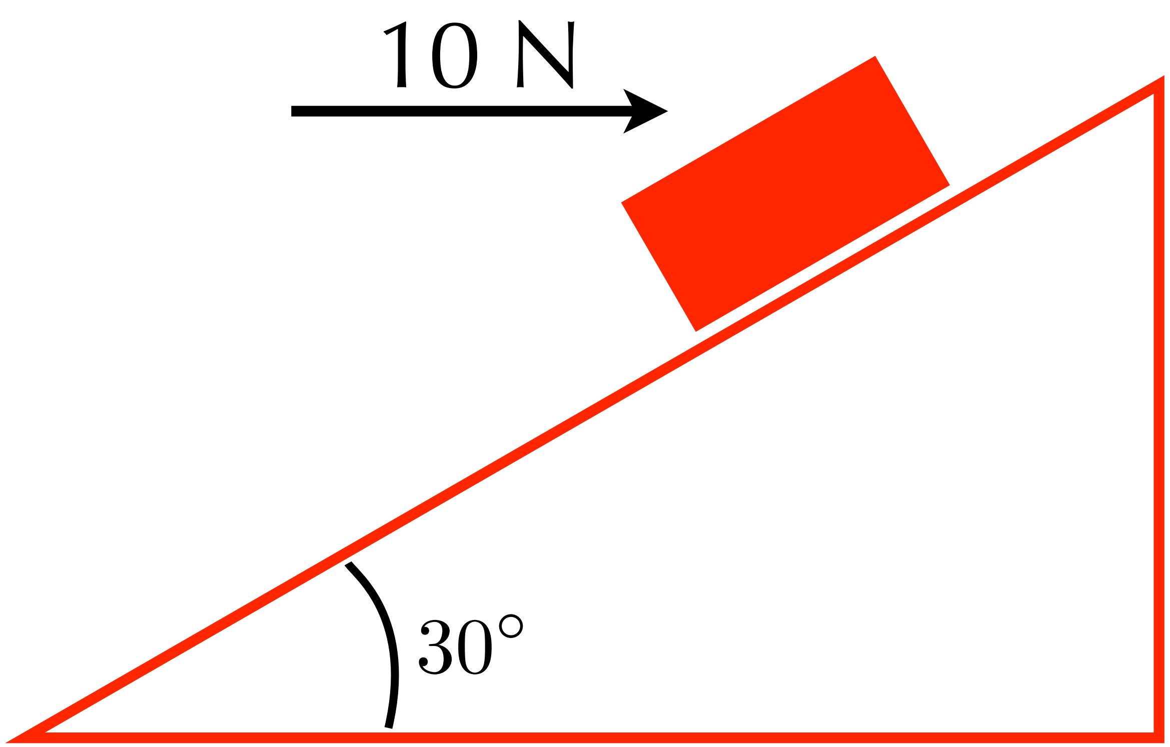
Static friction problem #1

A 1.0 kg wood block is pressed against a vertical wood wall by a 12 N force. The coefficient of static friction between the block and the wall is 0.5. If the block is initially at rest, will it move upward, move downward, or stay at rest?



Static Friction problem #2.

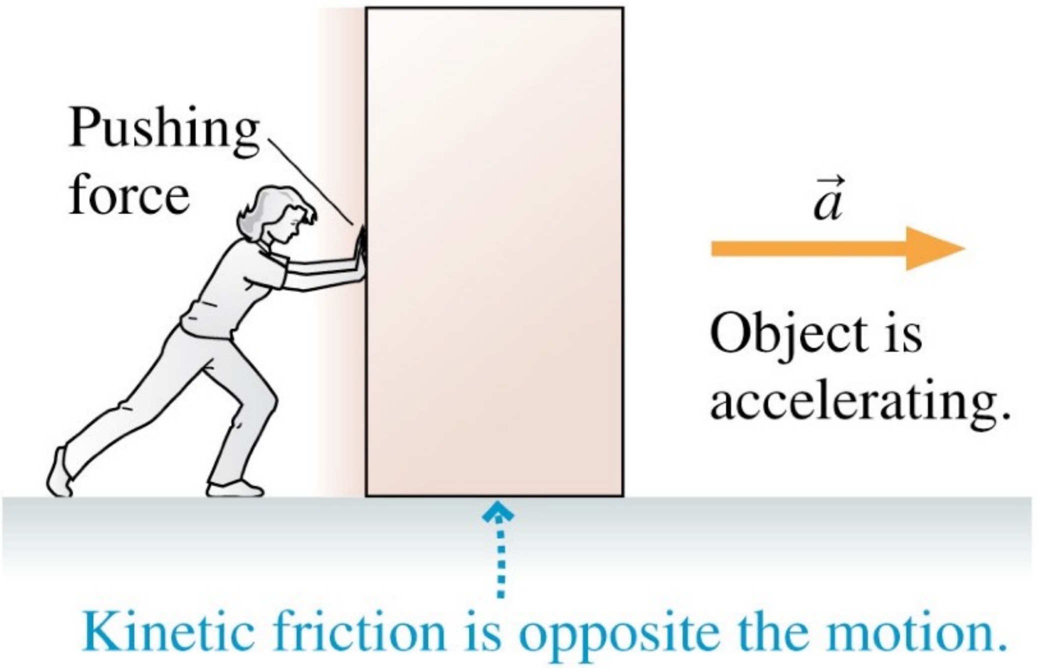
A 15 kg box is placed on a 30 degree incline. The coefficient of static friction between the box and the incline is 0.7. A 10 N force is exerted horizontally on the box. Will the box move? If so, in which direction?

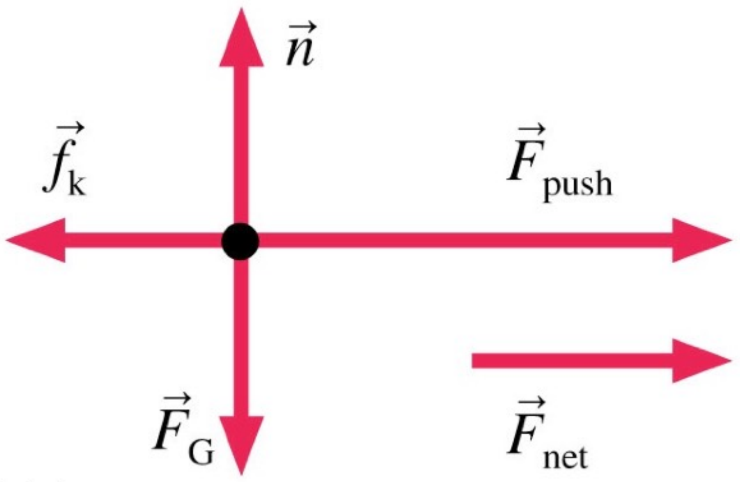


Kinetic Friction

$$f_k = \mu_k N$$

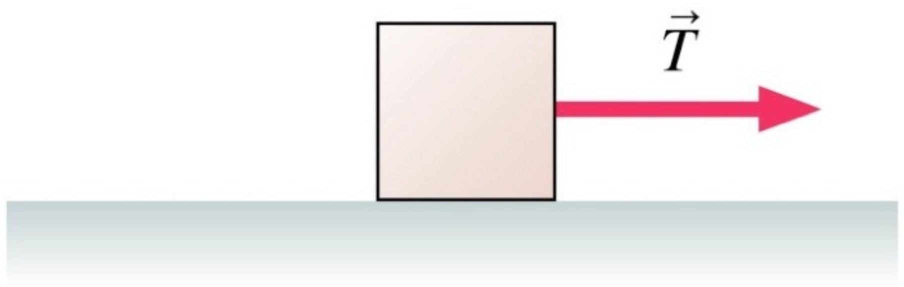
The direction of the kinetic friction force is opposite the velocity.





Question #13

A box is being pulled to the right over a rough surface. $T > f_k$, so the box is speeding up. Suddenly the rope breaks.

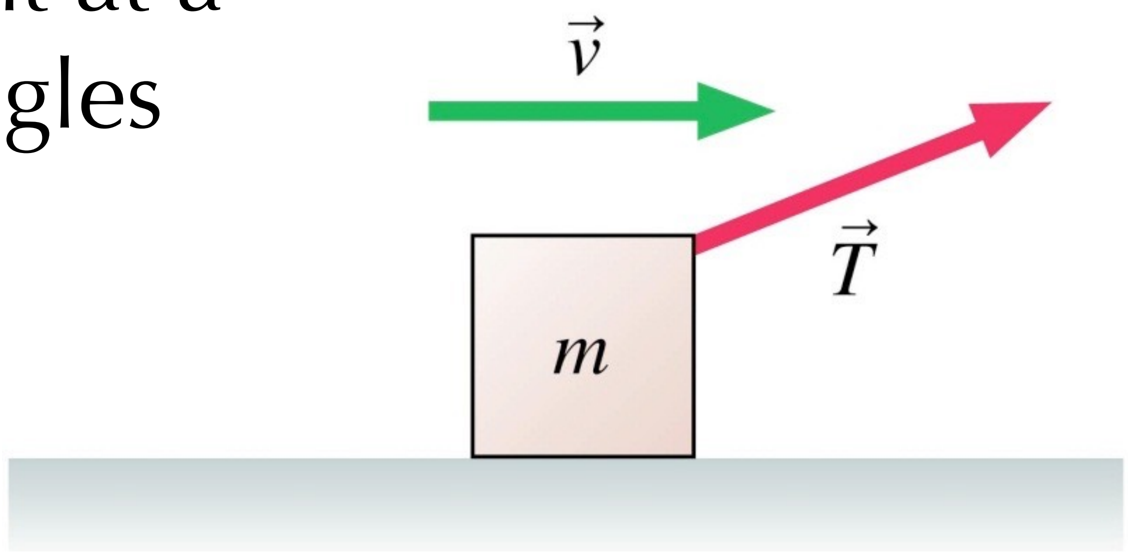


What happens? The box

a) Continues speeding up for a short while, then slows and stops.
b) Continues with the speed it had when the rope broke.
c) Slows steadily until it stops.
d) Keeps its speed for a short while, then slows and stops.
e) Stops immediately.

Question #14

A box is being pulled to the right at a steady speed by a rope that angles upward. In this situation:



a) $N > mg$

b) $N = mg$

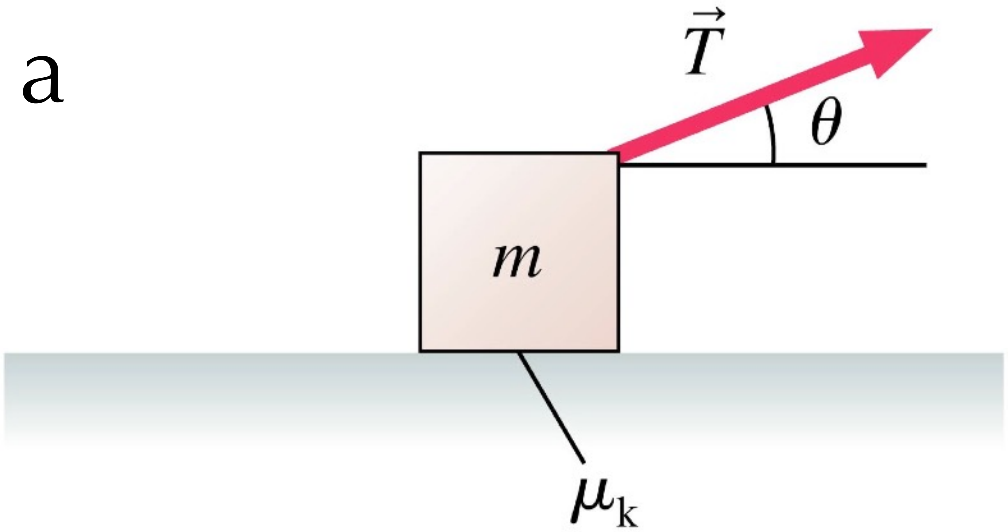
c) Not enough information to judge the size of the normal force

d) $N = 0$

e) $N < mg$

Question #15

A box is being pulled to the right by a rope that angles upward. It is accelerating. Its acceleration is:



a) $\dfrac{T}{m} - \mu_k g$

b) $\dfrac{T}{m}(\cos\theta - \mu_k \sin\theta) - \mu_k g$

c) $\dfrac{T}{m}(\sin\theta + \mu_k \cos\theta) - \mu_k g$

d) $\dfrac{T}{m}(\cos\theta + \mu_k \sin\theta) - \mu_k g$

e) $\dfrac{T}{m}\cos\theta - \mu_k g$

You'll have to work this one out. Don't just guess!

Drag

Air exerts a force on objects as they move through it.

The drag force direction is opposite to the object's velocity

Drag

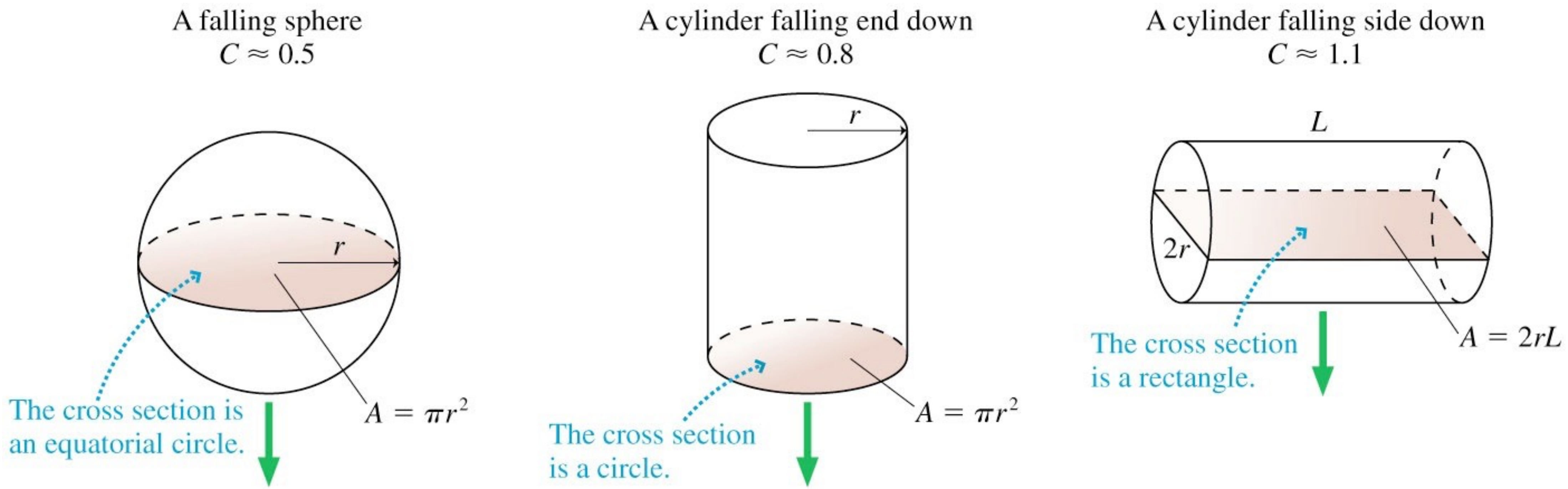
What things do you think would affect the size of the drag force?

Drag

$$F_{\mathrm{D}} = \frac{1}{2}\rho A C v^2$$

- A is the cross sectional area of the object
- ρ is the density of the air, which is about 1.2 kg/m^3.
- C is the **drag coefficient,** which is a dimensionless number that depends on the shape of the object

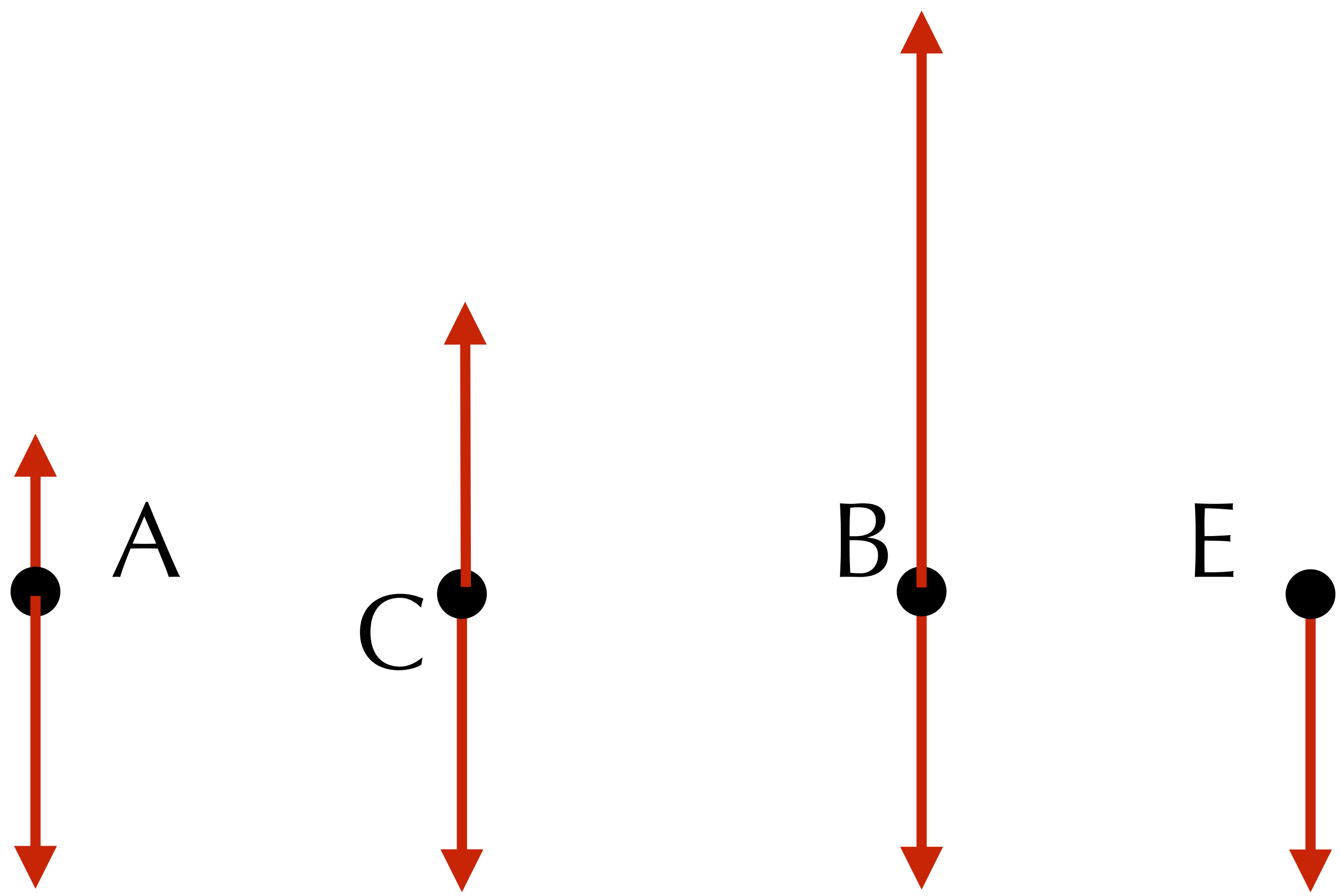
Drag



A falling sphere
$C \approx 0.5$
r
The cross section is
an equatorial circle.
$A = \pi r^2$
A cylinder falling end down
$C \approx 0.8$
r
The cross section
is a circle.
$A = \pi r^2$
A cylinder falling side down
$C \approx 1.1$
L
$2r$
The cross section
is a rectangle.
$A = 2rL$

Question #1

Which is the correct free-body diagram for the man **immediately after** jumping out of the plane?



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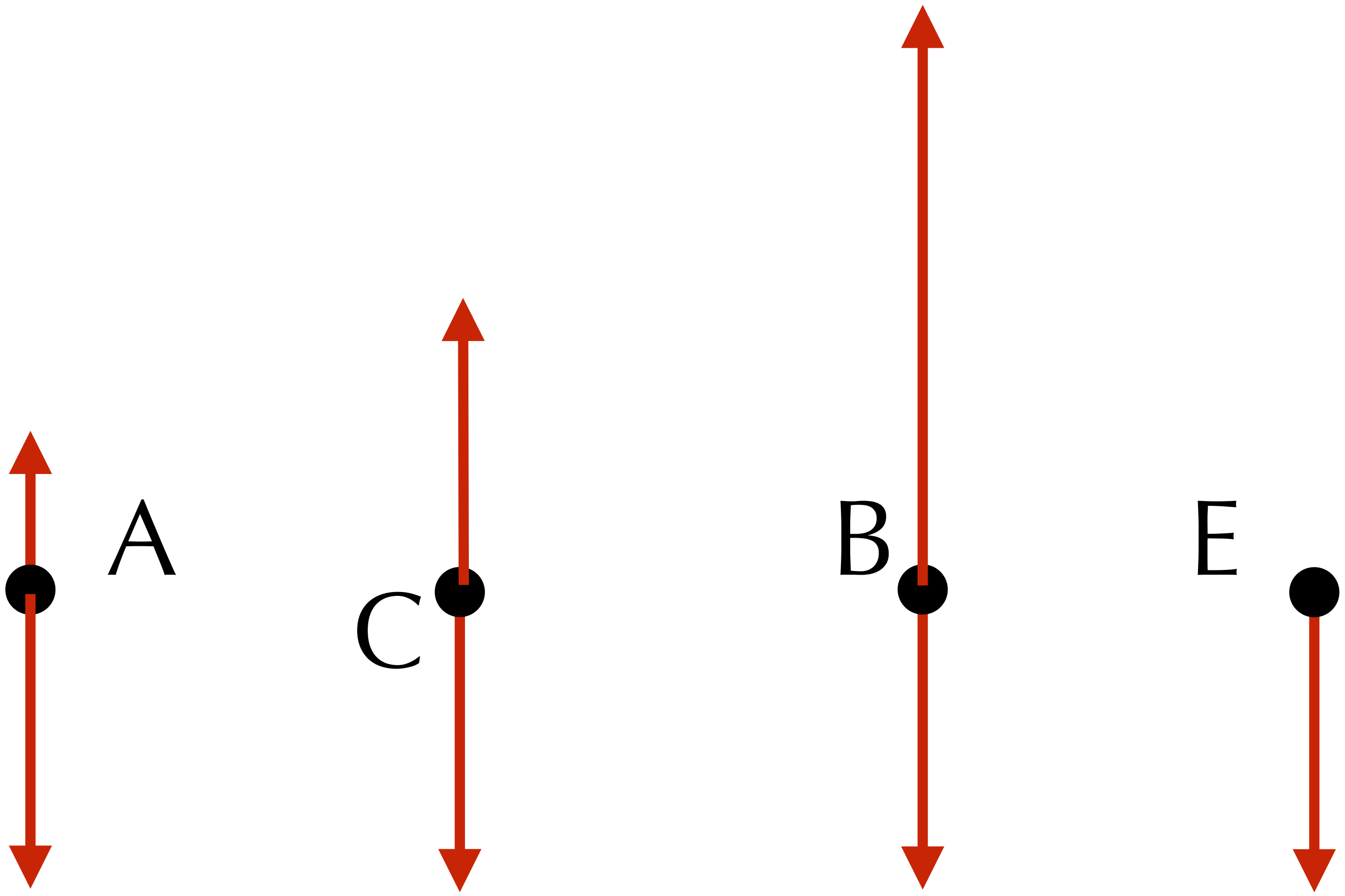
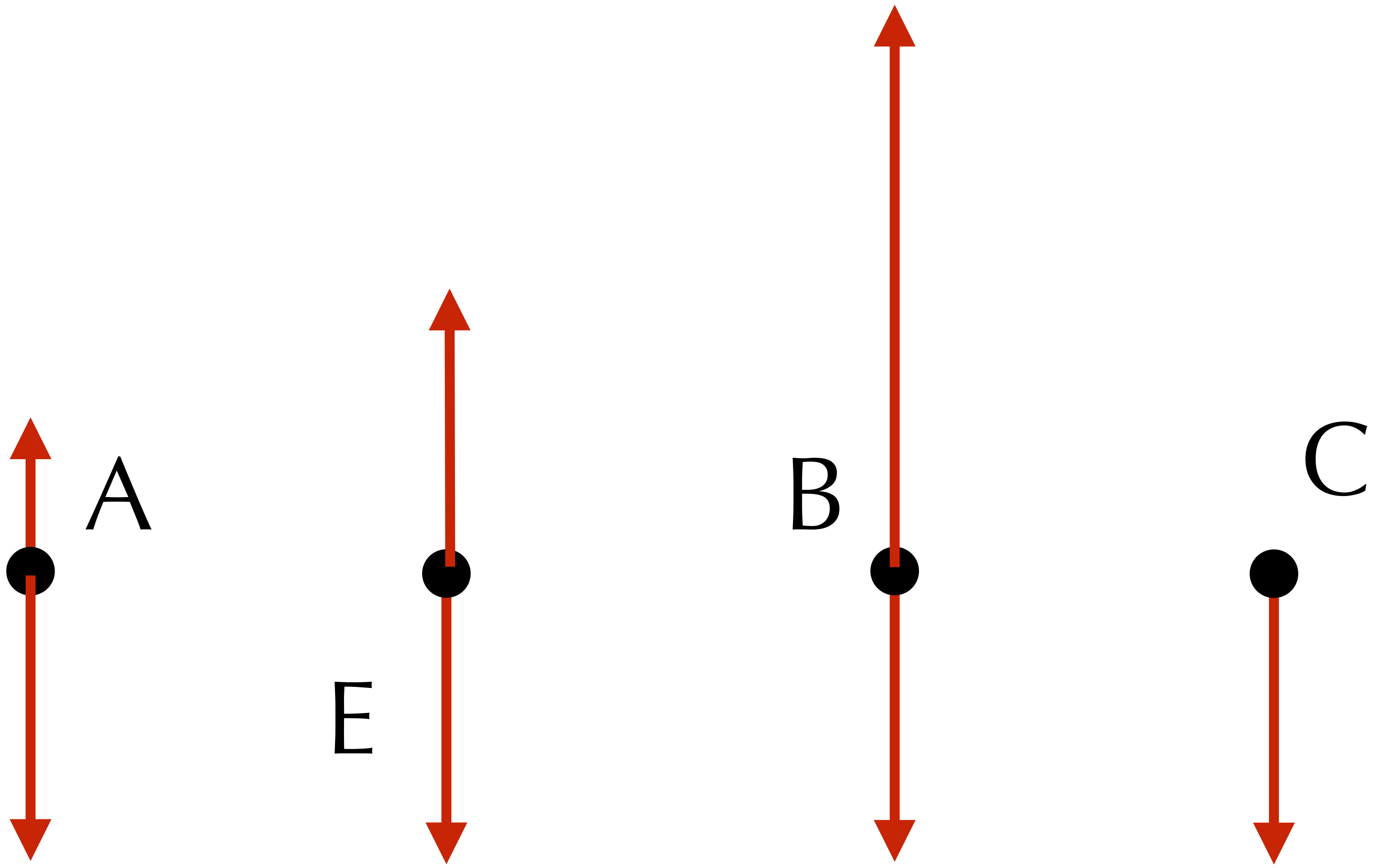


Question #2

Which is the correct free-body diagram for the man a short time after jumping out of the plane?



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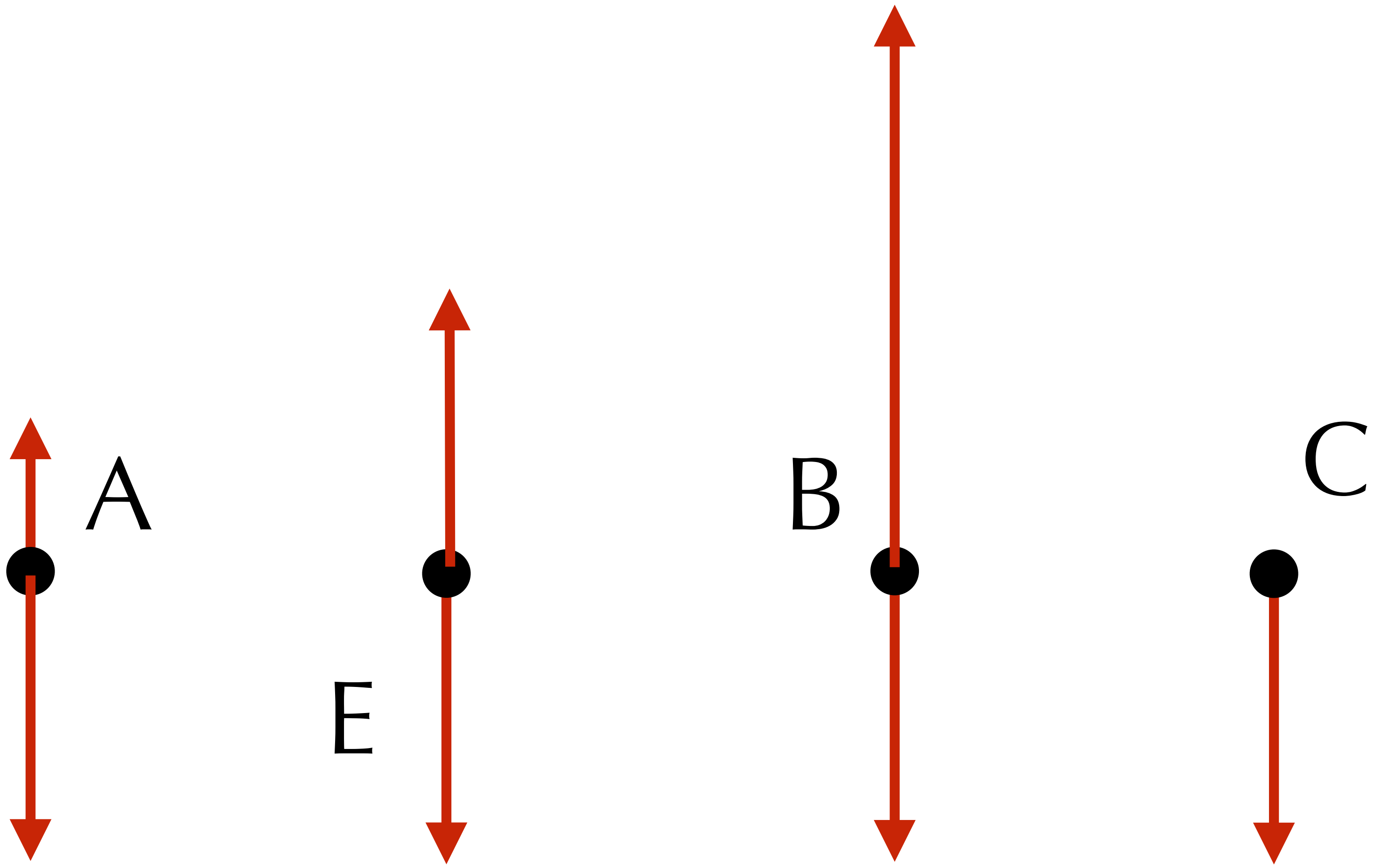
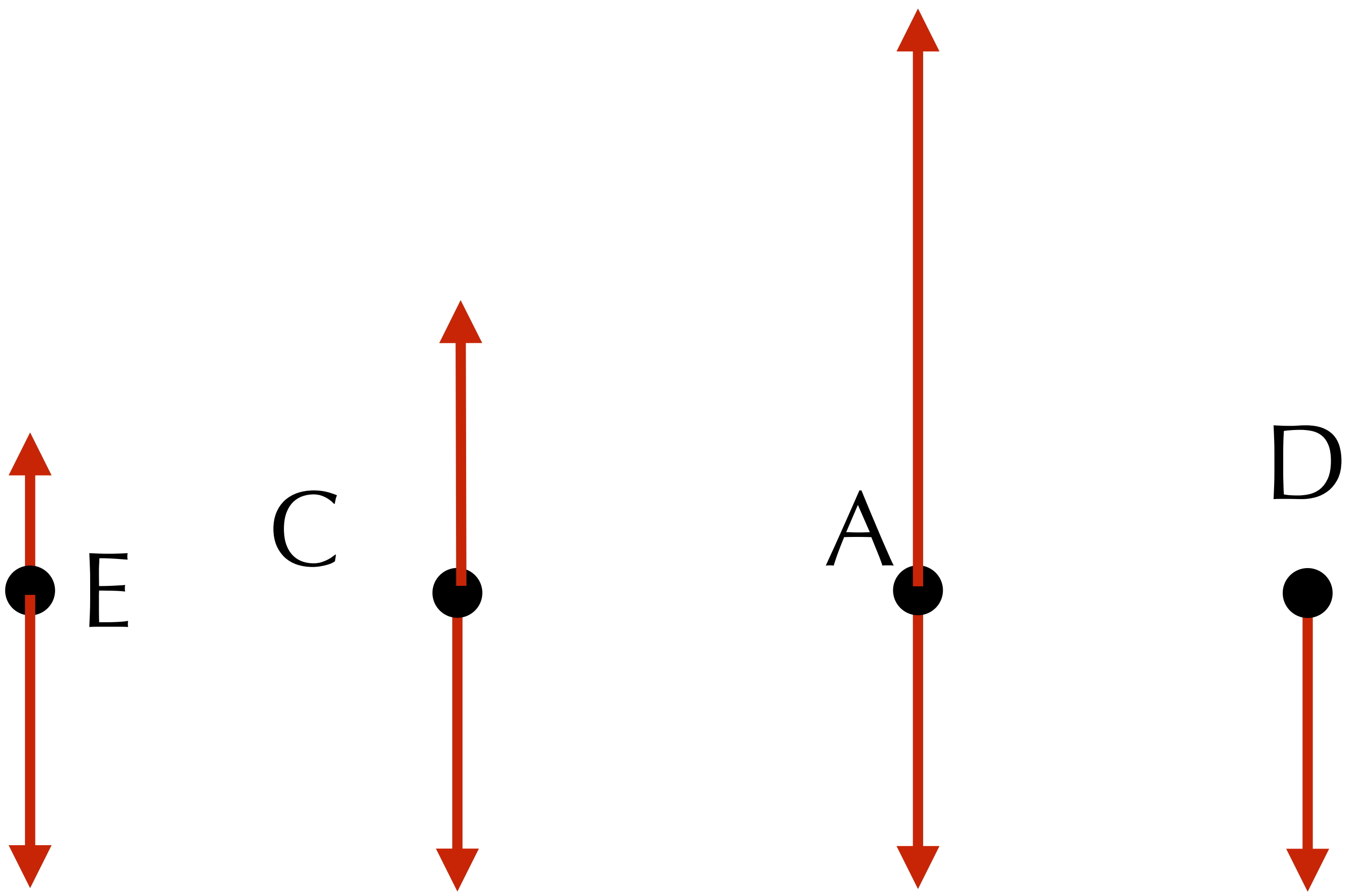


Question #3

Which is the correct free-body diagram for the man a long time after jumping out of the plane?



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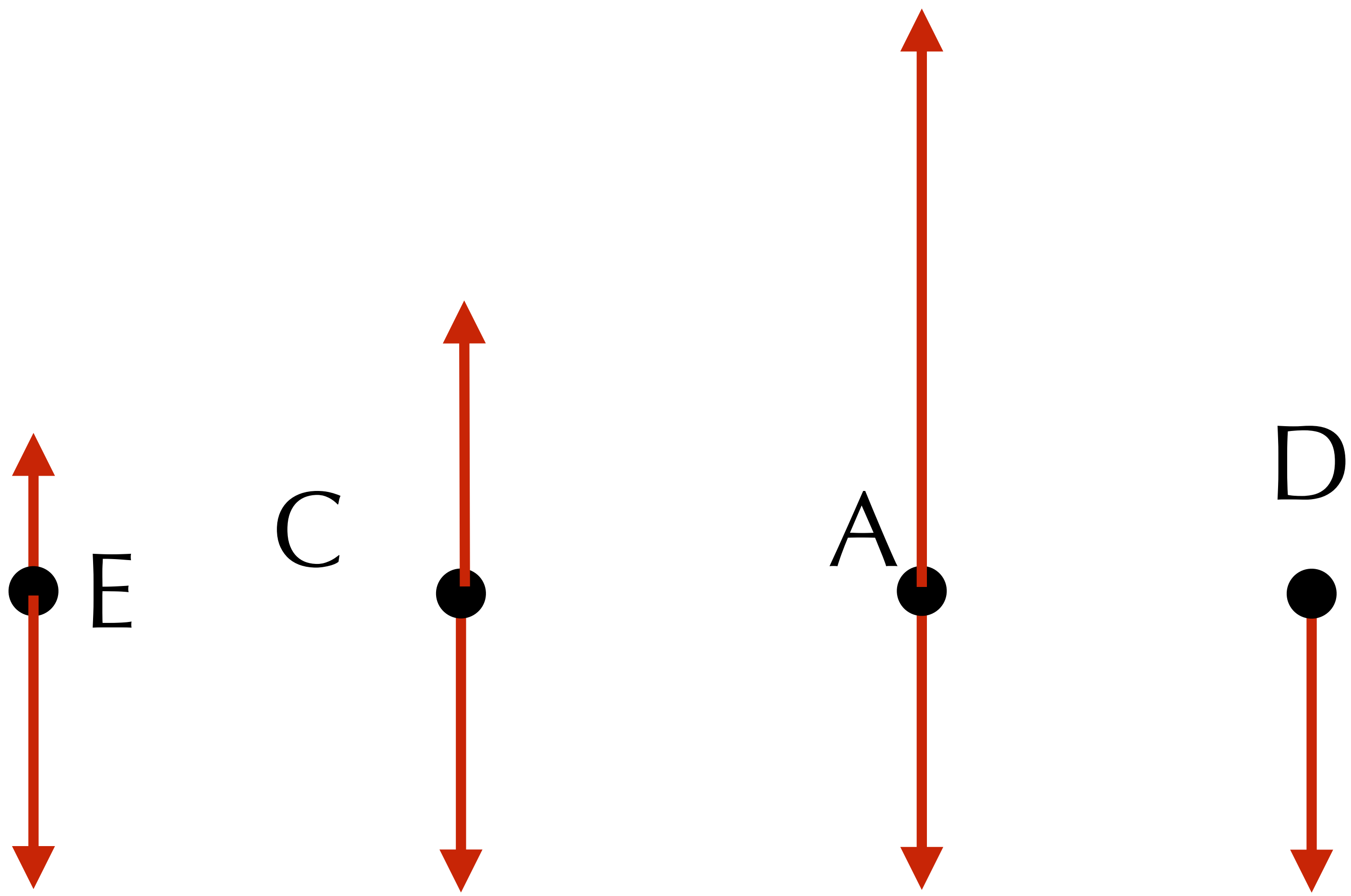

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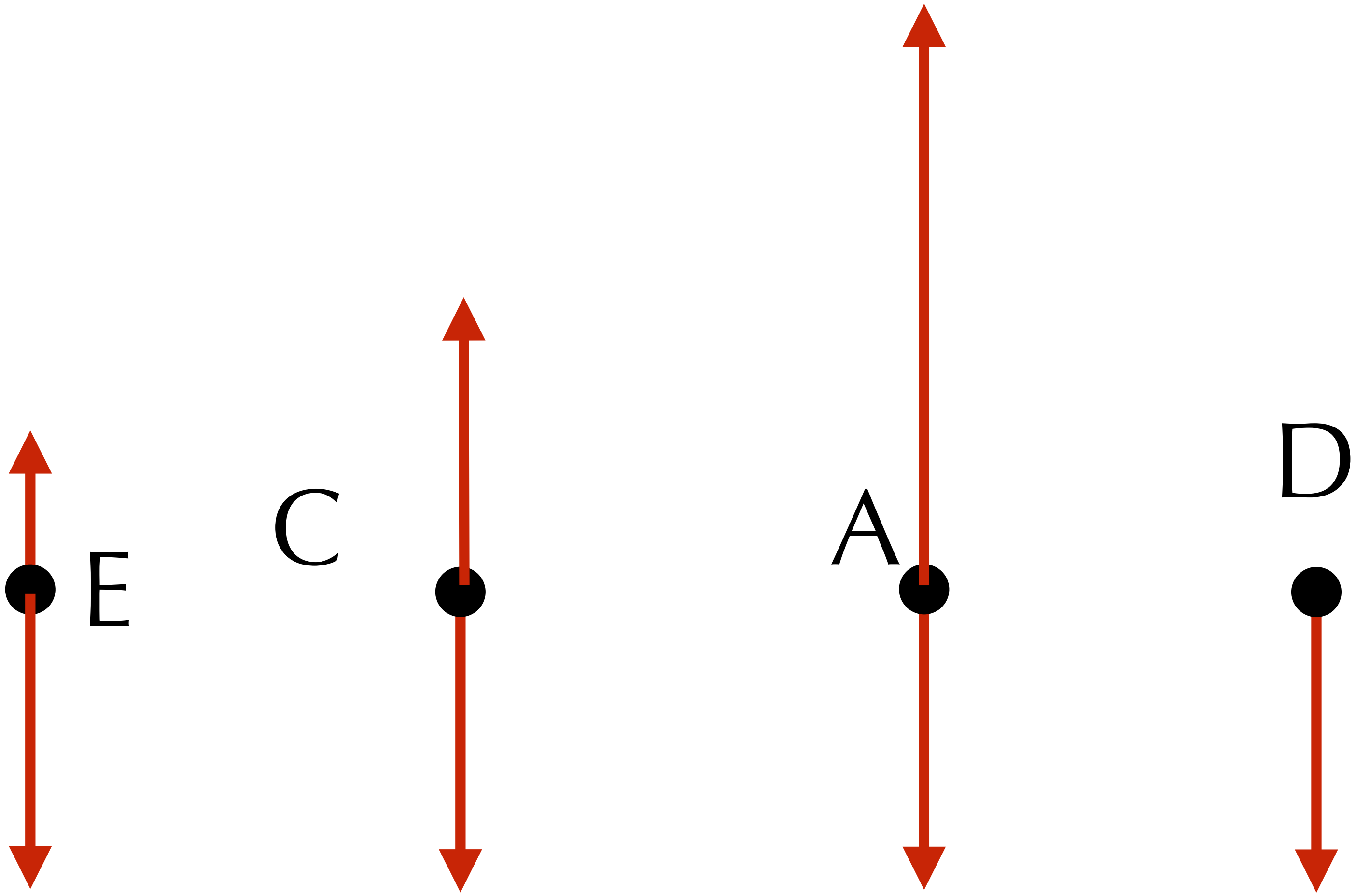

$$v_{\text{term}} = \sqrt{\frac{2mg}{C\rho A}}$$