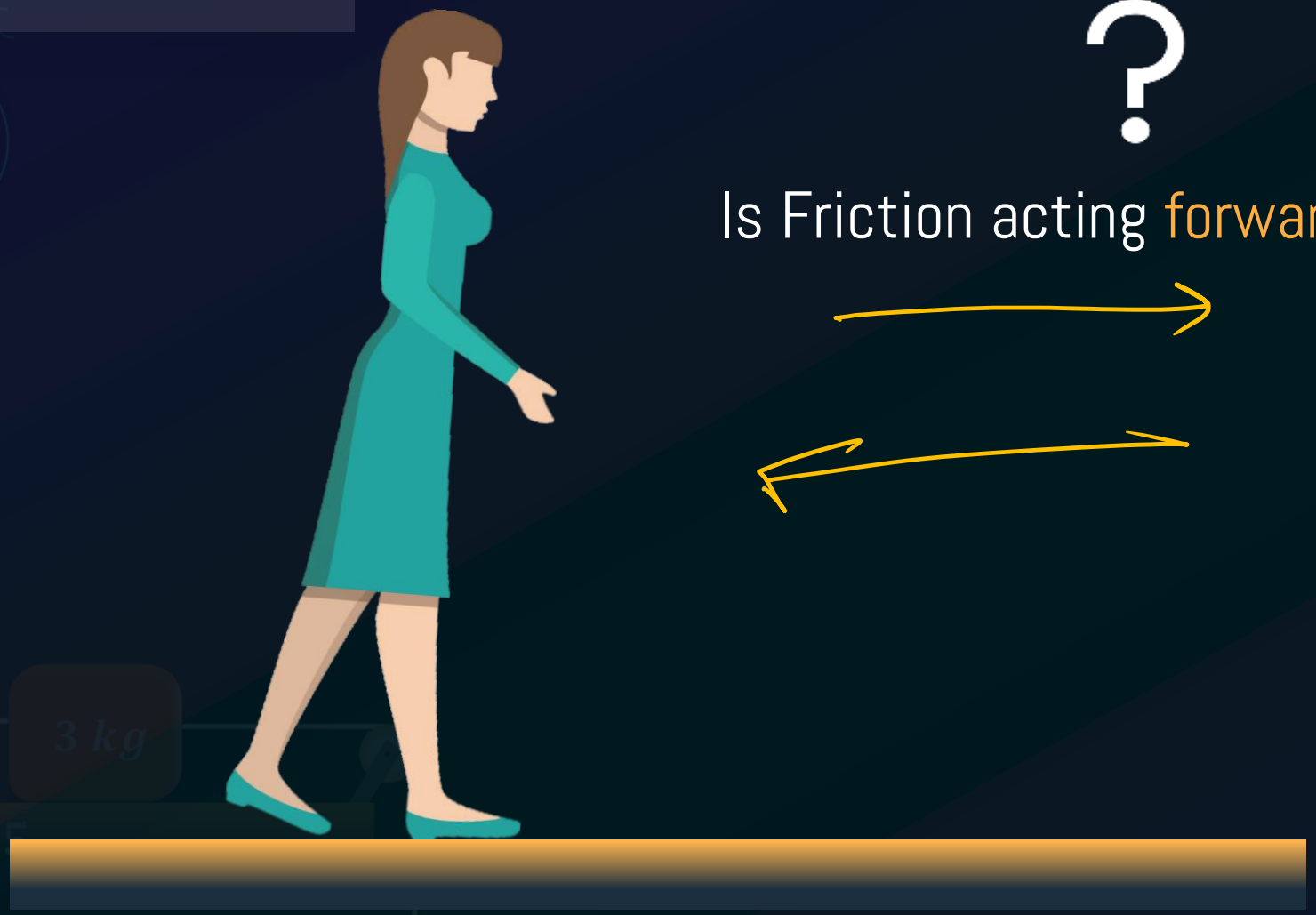
INTRODUCTION TO FRICTION L1

PHYSICS

ANUSHRI MA'AM

FRICTION



?

Is Friction acting forward or backward on the girl?

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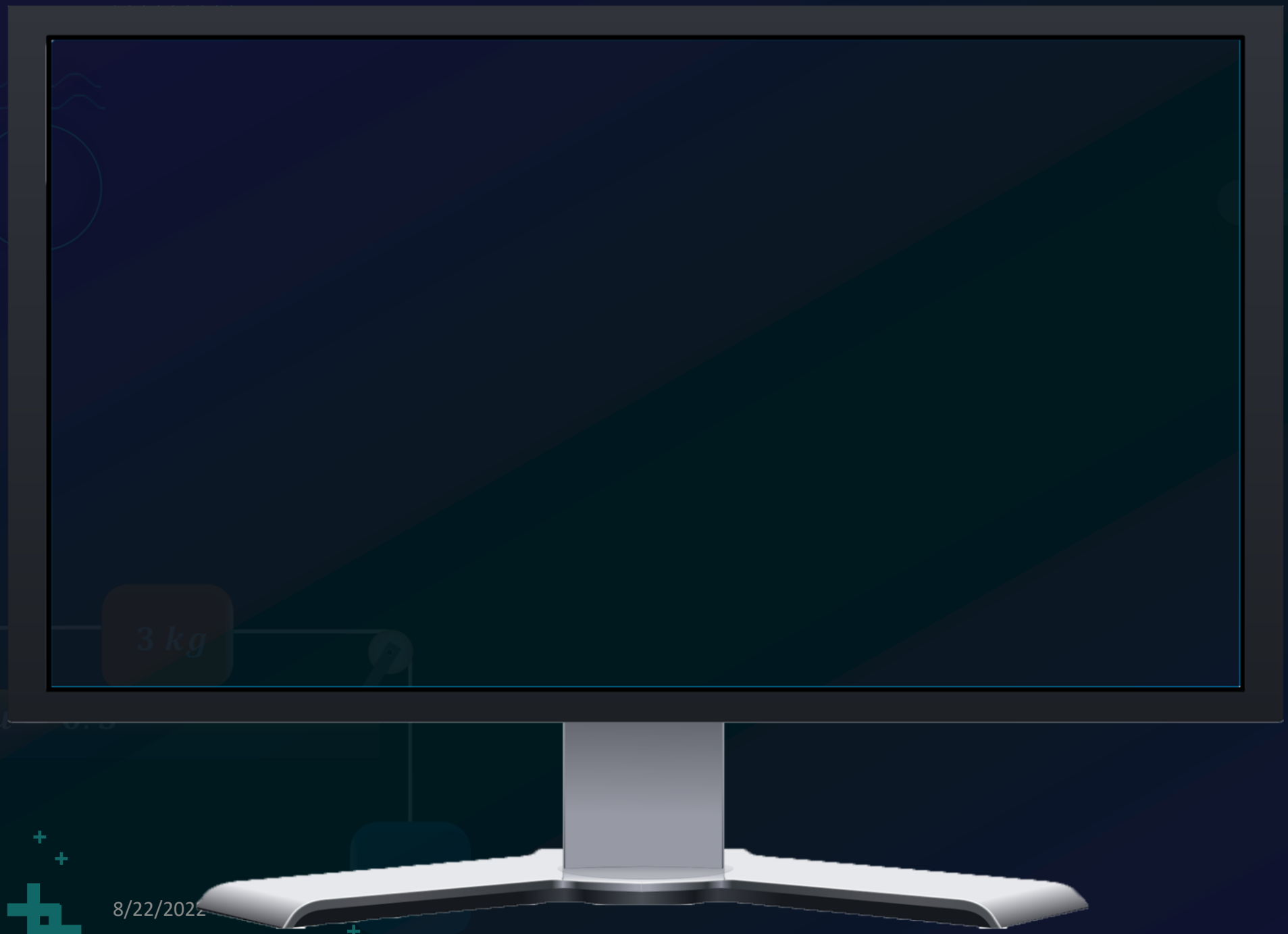


CONTENTS

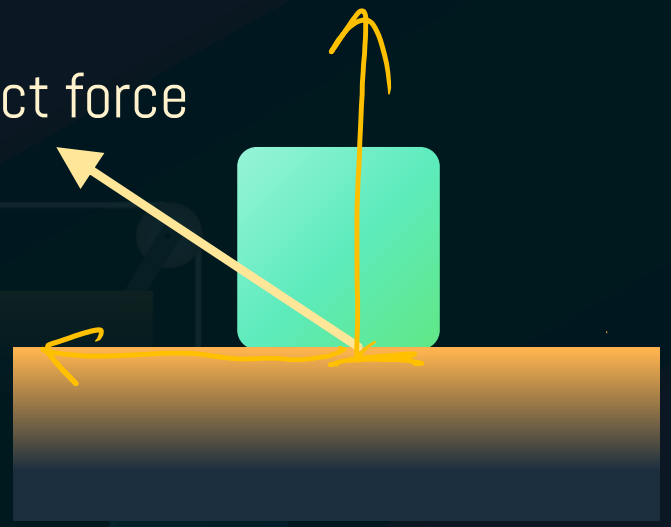
FRICTION

Friction is a force related to the two surfaces in contact, which opposes the relative motion between them.

MACROSCOPIC VIEW

When two bodies are kept in contact, electromagnetic forces act between the microscopic particles between the surfaces of the bodies. As a result, each body exerts a contact force on the other.

Contact force can act in any direction.

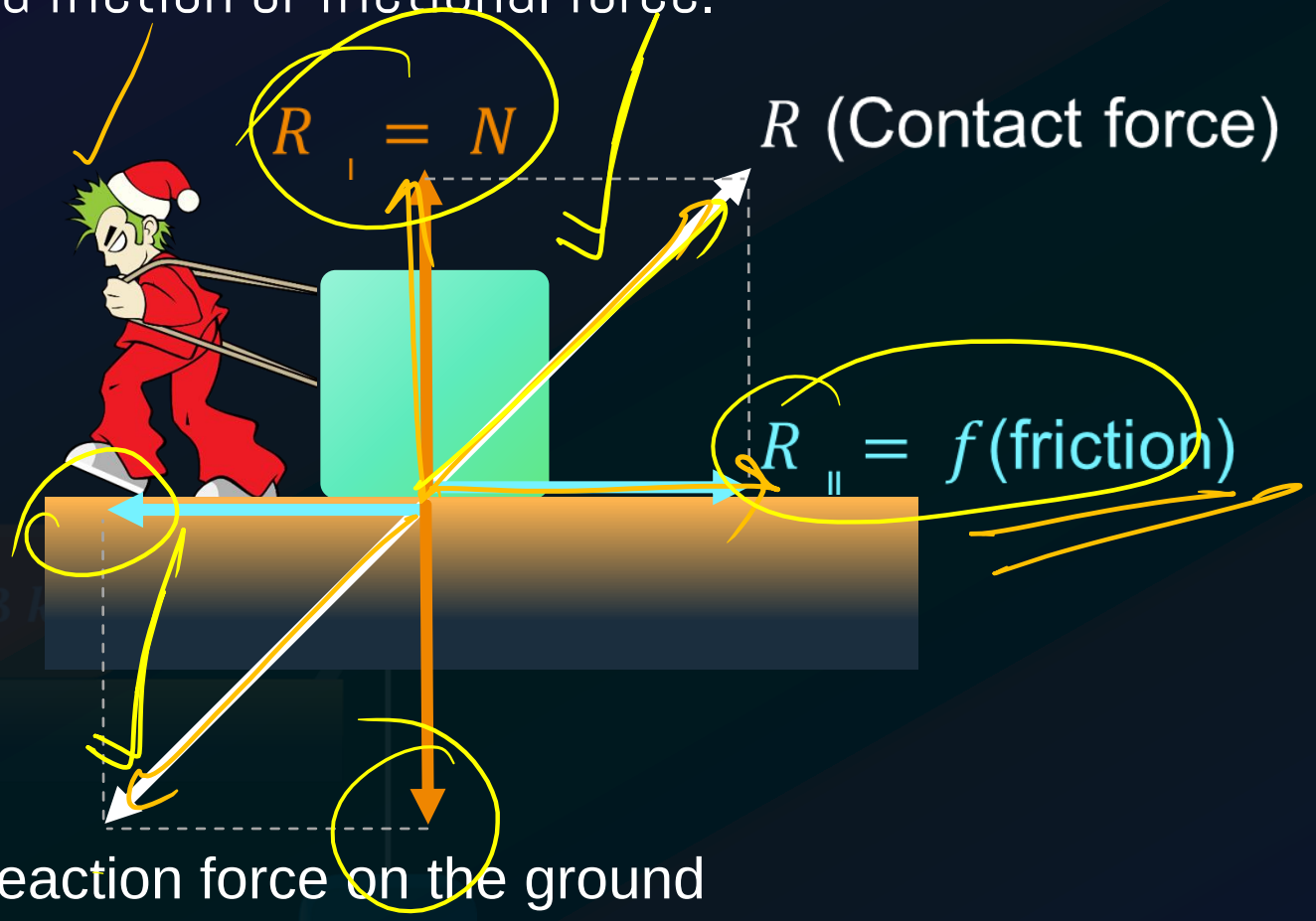


C.F

C.F.

FRICTION-COMPONENT OF CONTACT FORCE

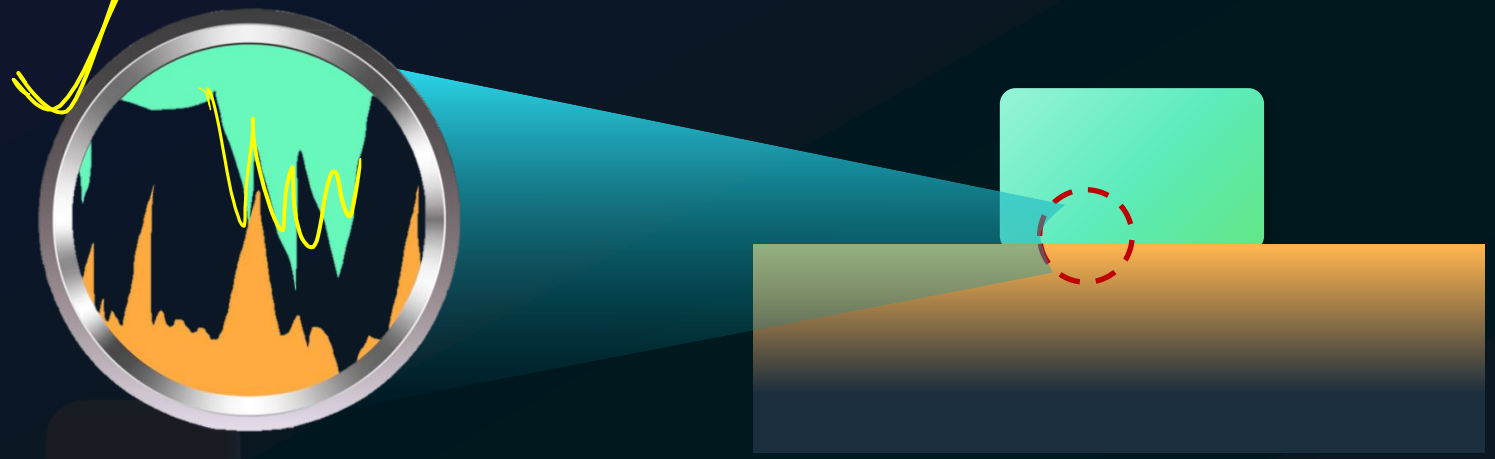
The component of the contact force which is parallel to the surface in contact is called friction or frictional force.



MICROSCOPIC VIEW

Interlocking

The interlocking between irregularities gives rise to friction.

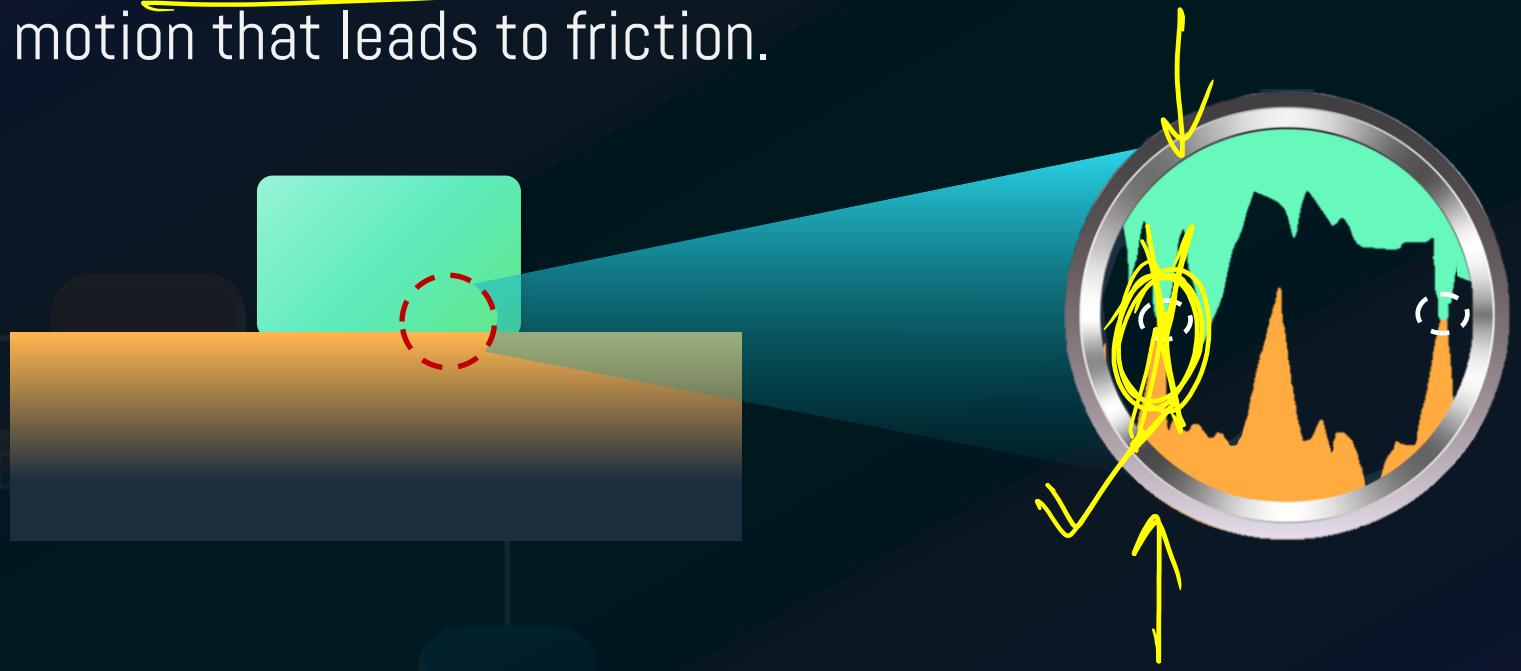


MICROSCOPIC VIEW

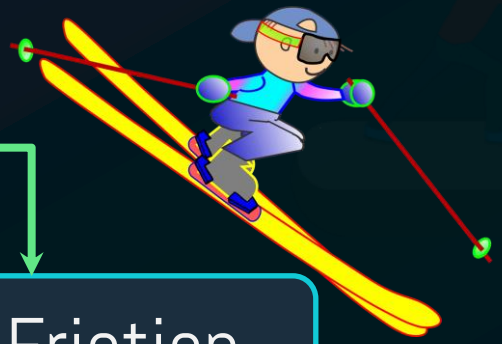
Cold Welding

When two surfaces are in contact only few points touch each other which implies, effective contact area decreases as a result pressure increases.

Bonds are formed at contact points due to high pressure which opposes relative motion that leads to friction.



Friction

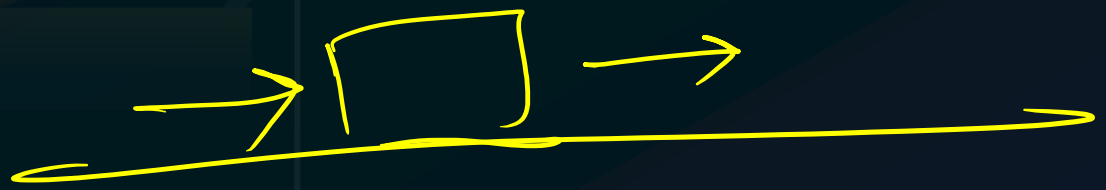


Static Friction

when there is a tendency of relative motion between two surfaces.

Kinetic Friction

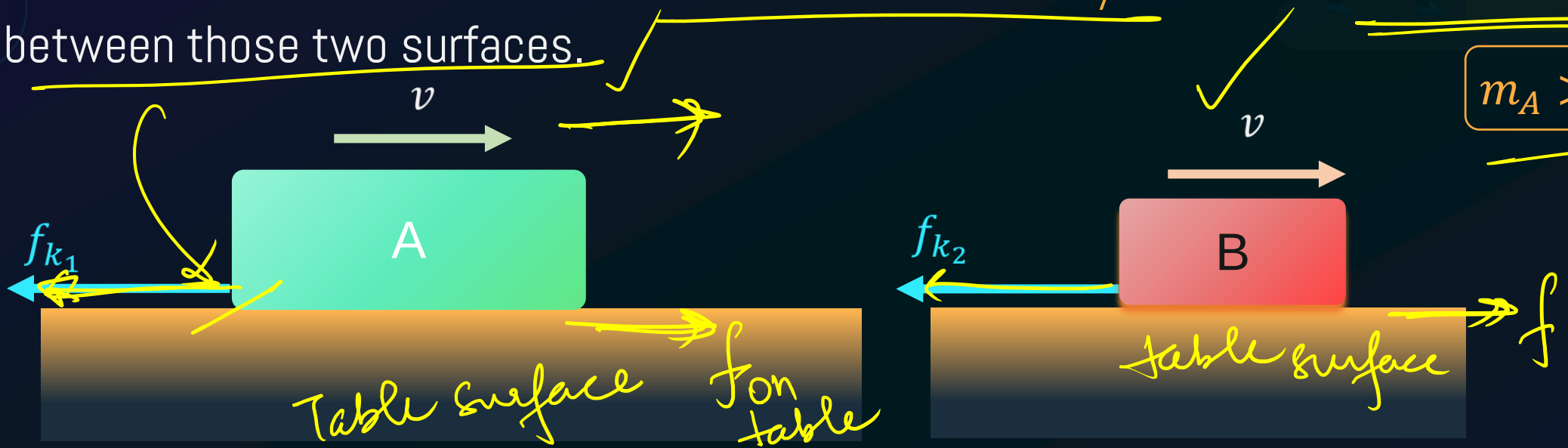
when there is relative motion between two surfaces.



CONTENTS

KINETIC FRICTION

Kinetic friction exists between surfaces in contact only when there is relative motion between those two surfaces.



can we compare f_{k_1} and f_{k_2}?

Here it is observed that $f_{k_1} > f_{k_2}$

Is $f \propto N$?

ANALYZING KINETIC FRICTION

The magnitude of the kinetic friction is proportional to the normal force acting between the block and ground.

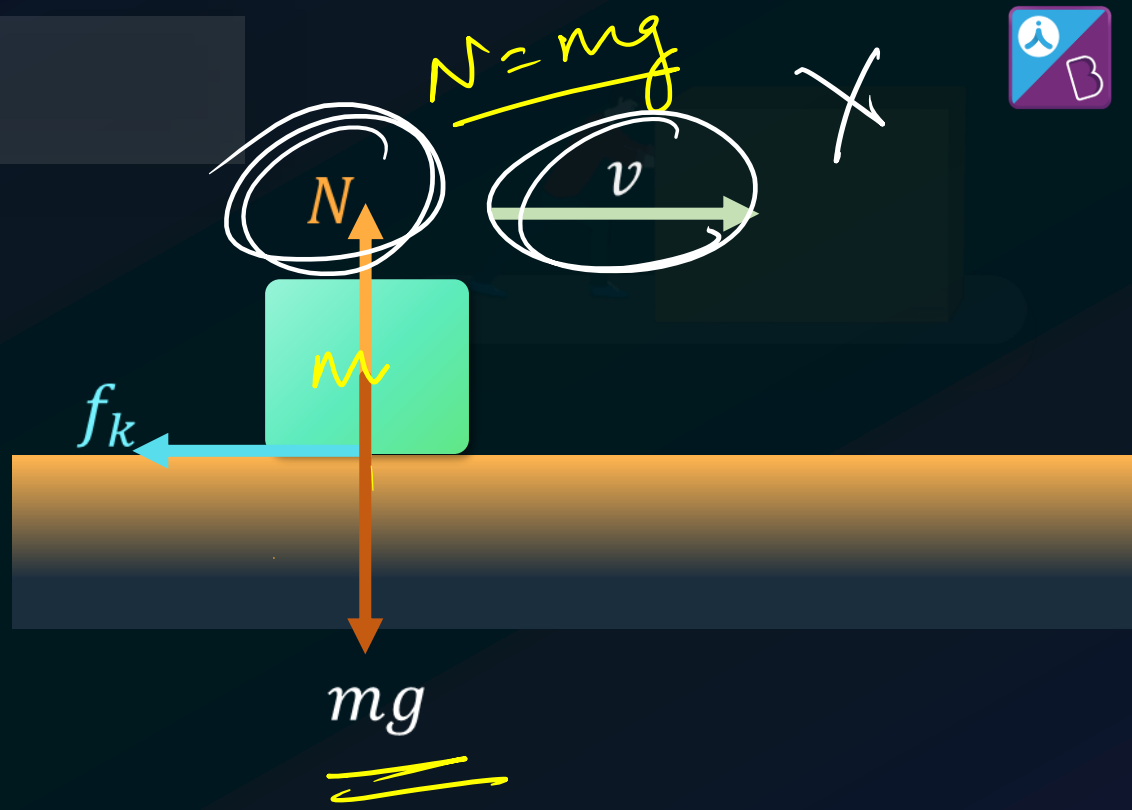
$$f_k \propto N$$

f_k is the kinetic friction
N is the normal force

Kinetic friction is given by

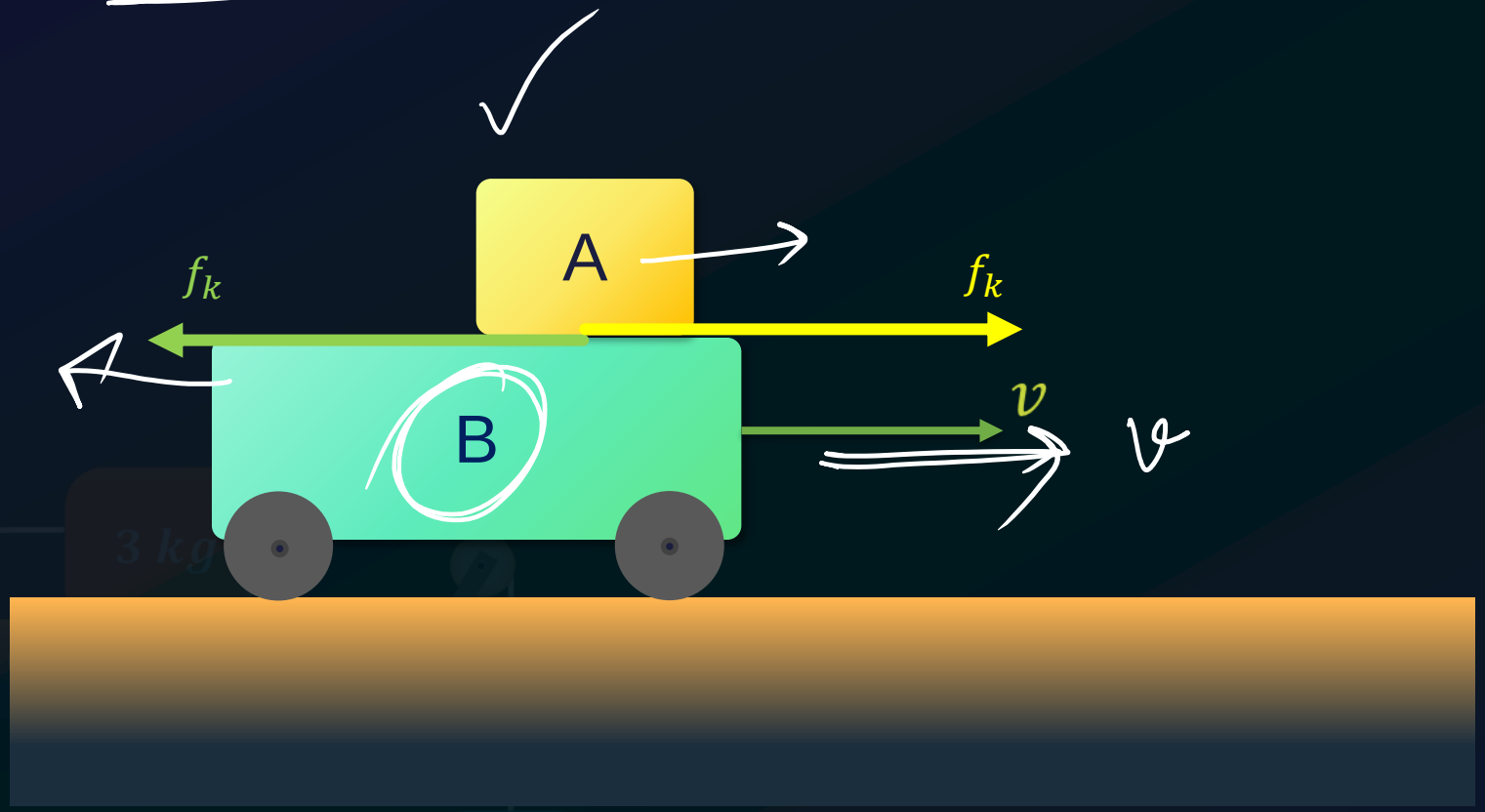
$$f_k = \mu_k N$$

Here, μ is the proportionality constant called as **coefficient of kinetic friction**



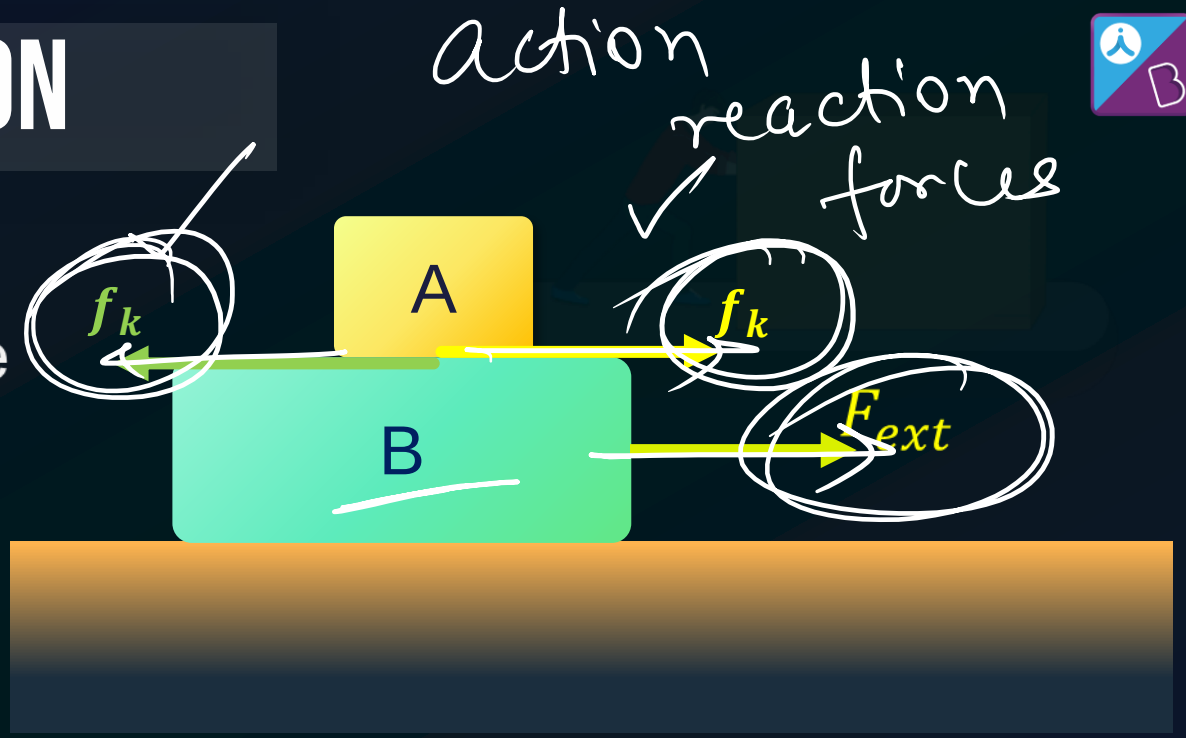
DIRECTION OF KINETIC FRICTION

For an object, the direction of kinetic friction is opposite to its relative velocity with respect to the other object in contact.



DIRECTION OF KINETIC FRICTION

The kinetic friction on body A slipping against another body B is opposite to the velocity of A with respect to B.



Kinetic friction

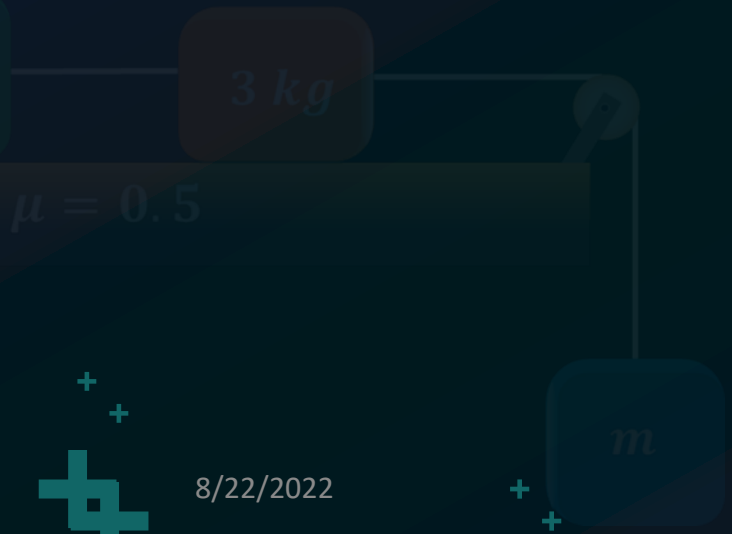
Tries to stop the relative slipping.

Not necessarily opposite to the force applied. (f_k on $A \parallel F_{ext}$)

PROPERTICES OF COEFFICIENT OF KINETIC FRICTION

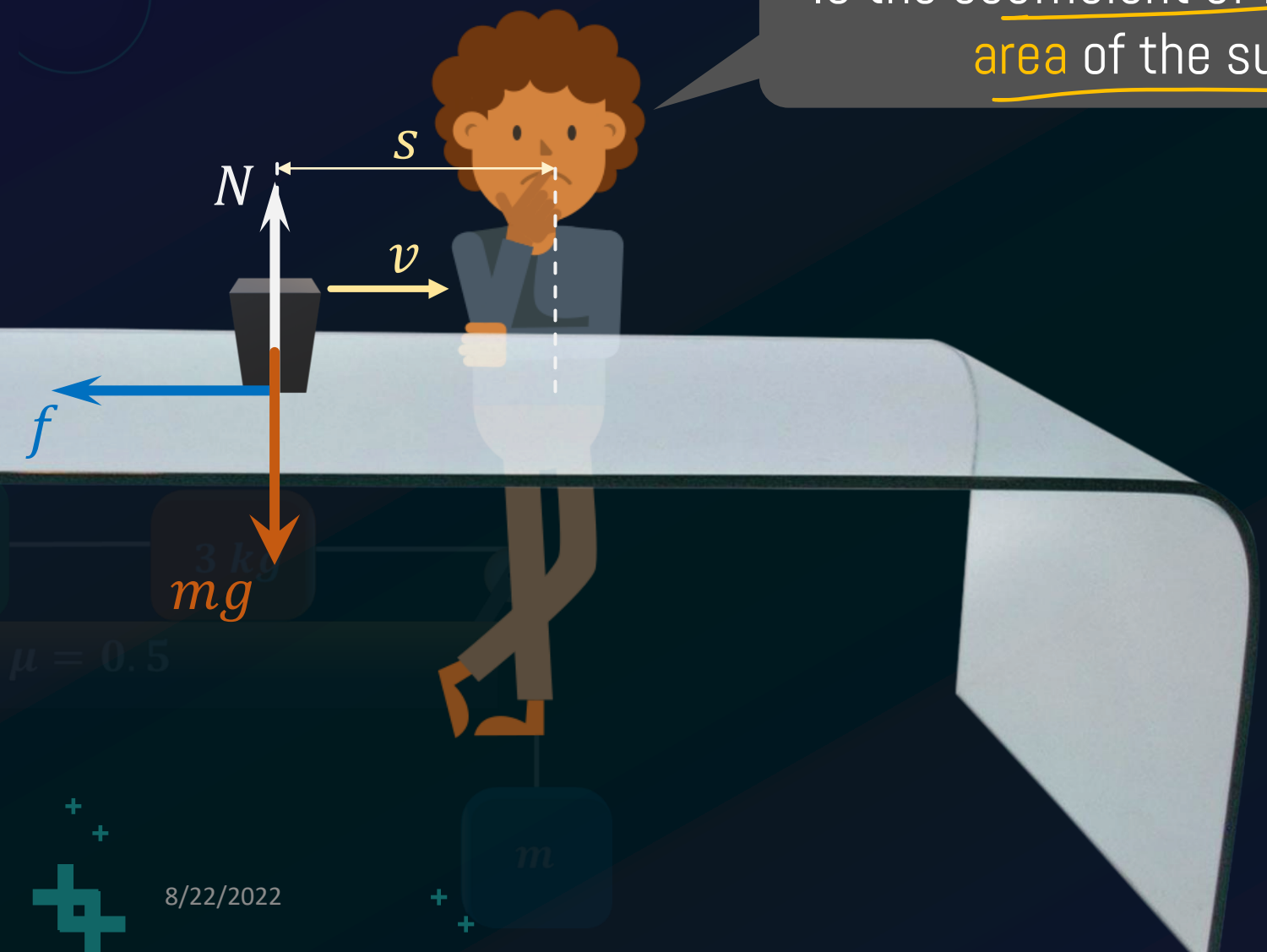
Coefficient of kinetic friction (μ) depends on nature of 'surfaces of materials in contact.'

μ *is not defined for a material alone*
but for a pair of material surfaces in contact



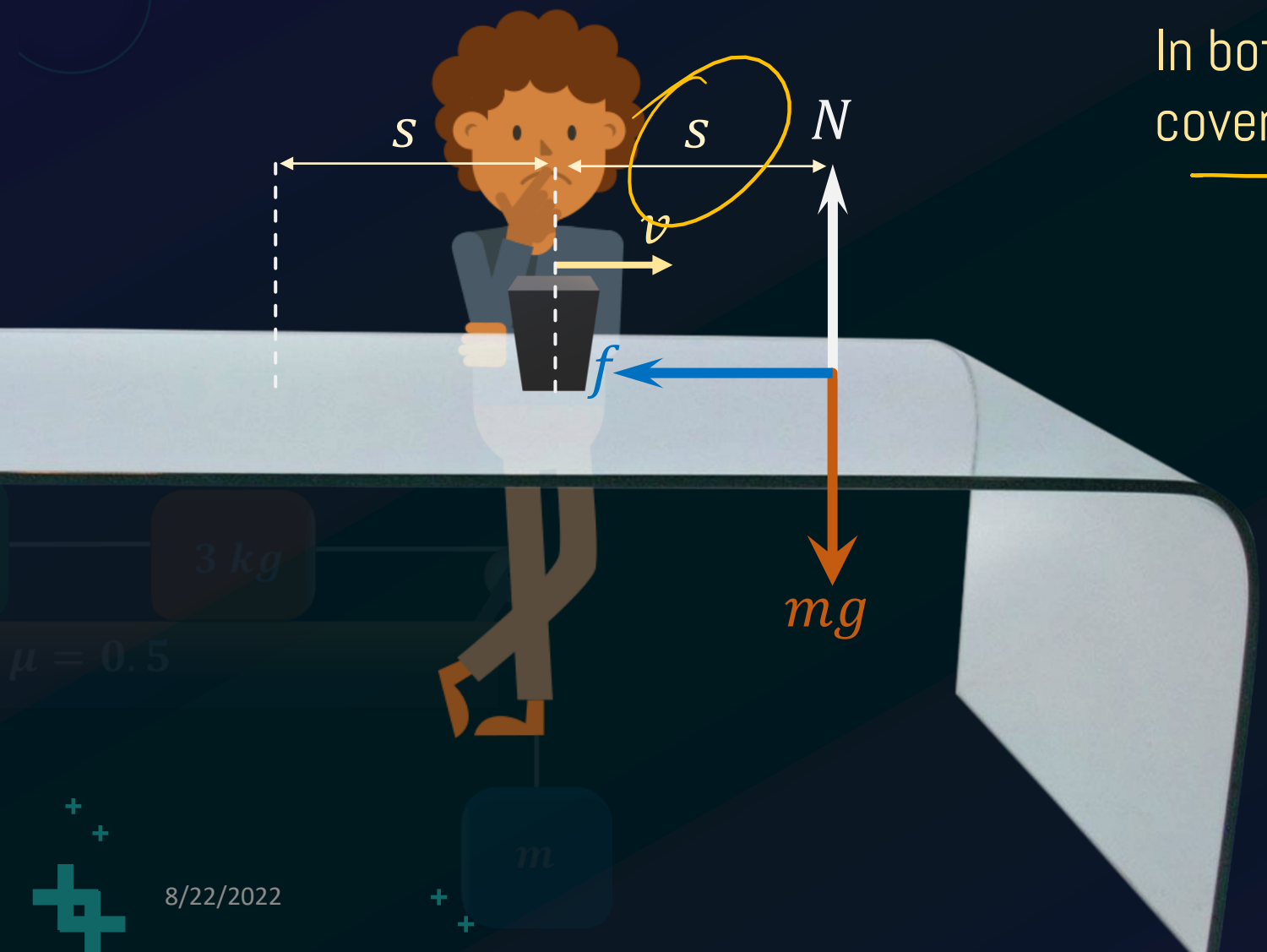
PROPERTICES OF COEFFICIENT OF KINETIC FRICTION

Is the coefficient of friction dependent on the area of the surface in contact?



PROPERTICES OF COEFFICIENT OF KINETIC FRICTION

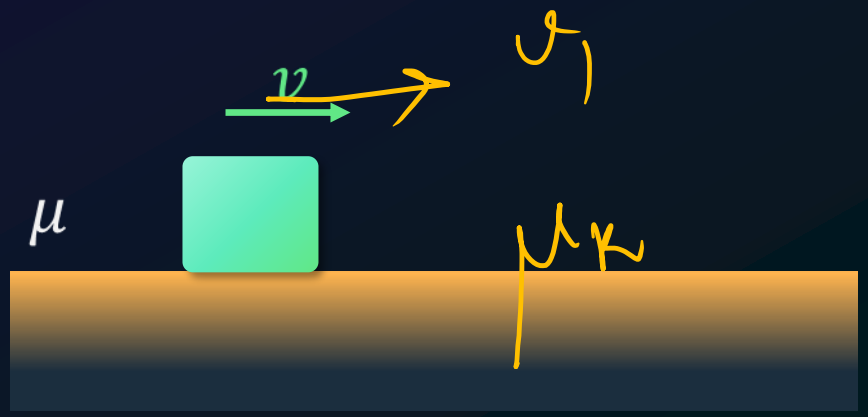
Coefficient of friction (μ) is independent of the area of the surface in contact.

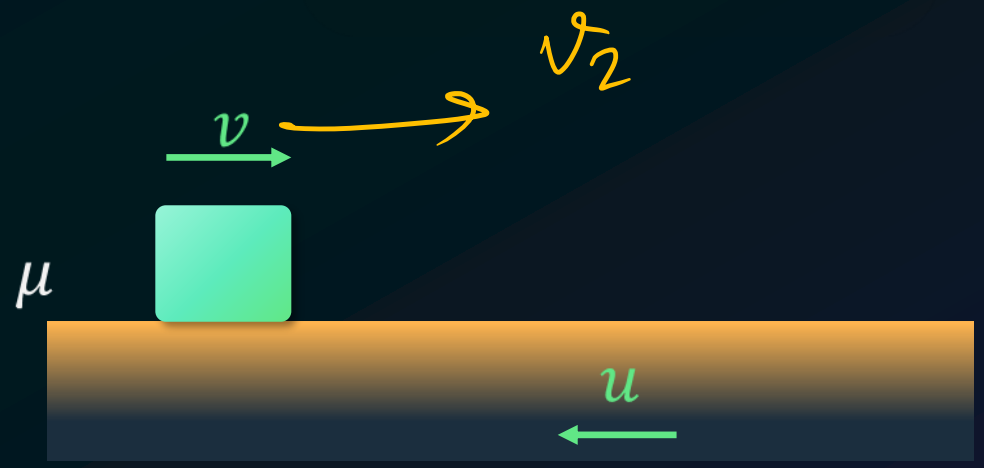


In both the cases the distance covered by the block is the same.

PROPERTICES OF COEFFICIENT OF KINETIC FRICTION

Coefficient of kinetic friction (μ) is independent of the relative speed of the surfaces in contact.



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PHYSICS | 4:00 PM

SACHIN SIR

ZOOLOGY | 5:00 PM

PANKHURI MA'AM

BOTANY | 5:00, 6:00 PM

PUSHPENDU SIR

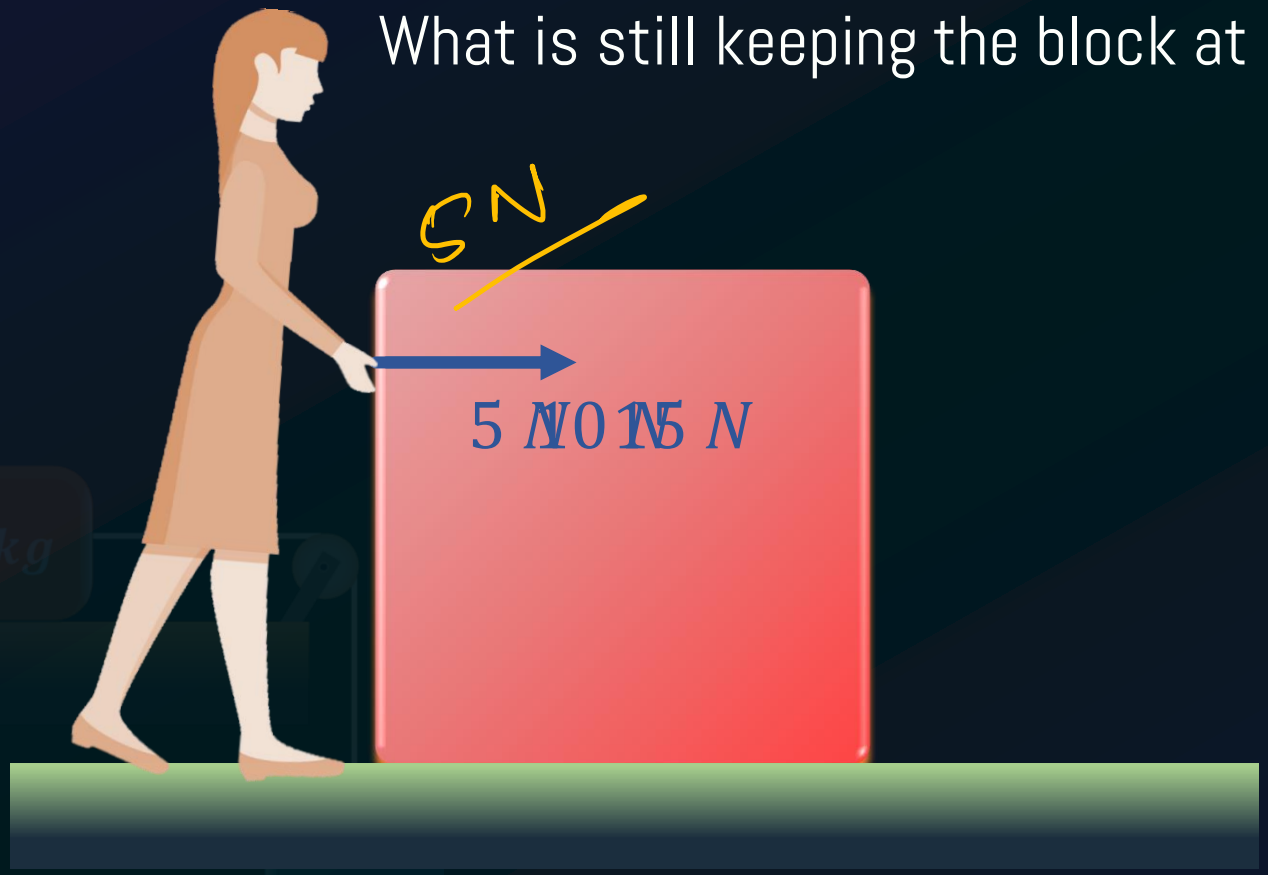
ZOOLOGY | 6:00 PM

CONTENTS

STATIC FRICTION

Why don't objects move till the appropriate/optimum amount of force is applied?

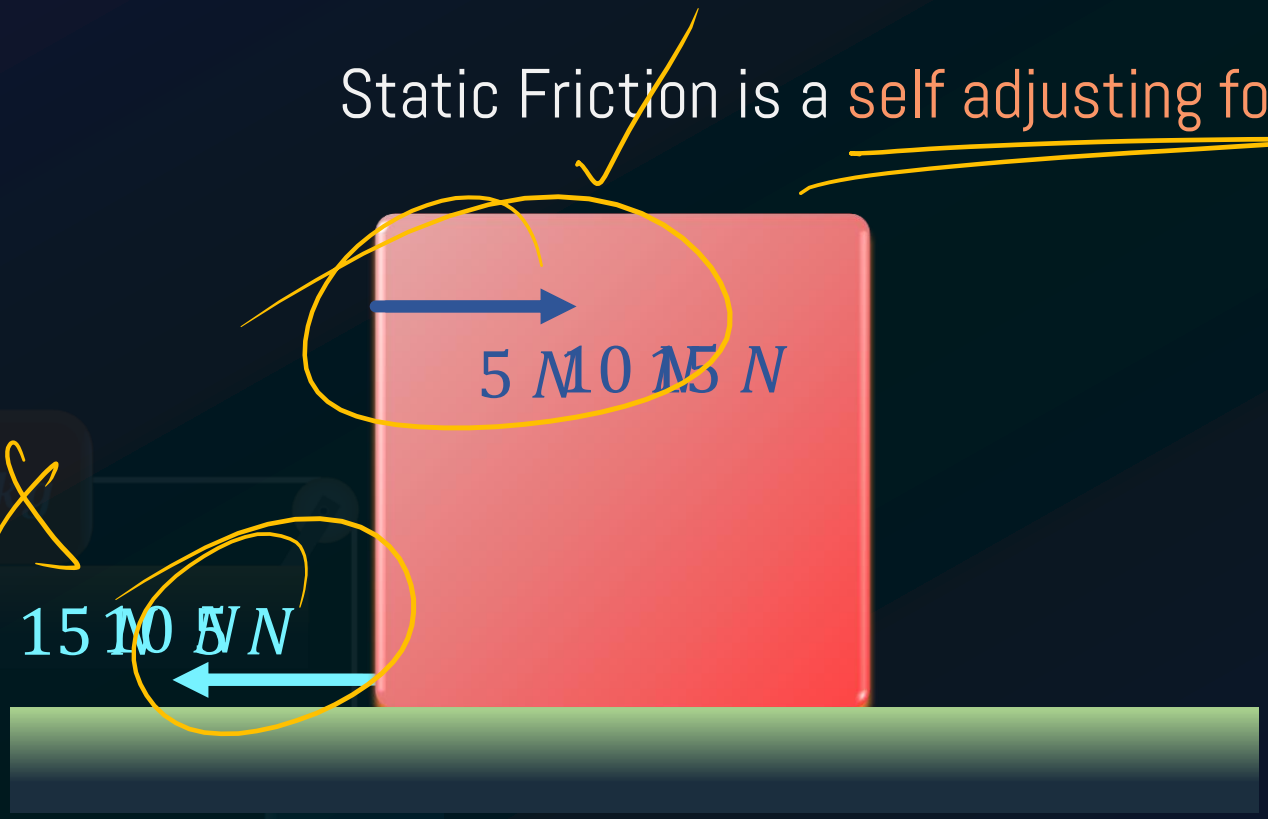
What is still keeping the block at rest?



STATIC FRICTION

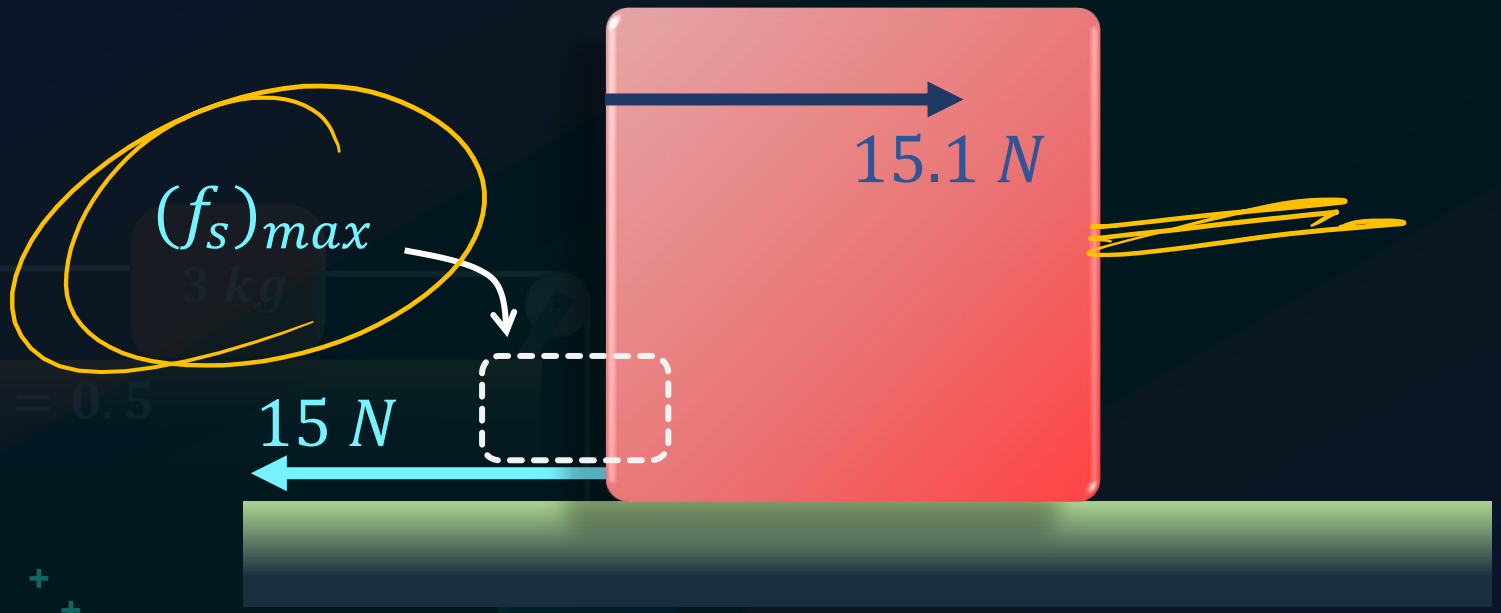
Static friction is a variable resistive force which is equal and opposite to external force until it surpasses the threshold of motion when the slipping starts.

Static Friction is a self adjusting force.



STATIC FRICTION

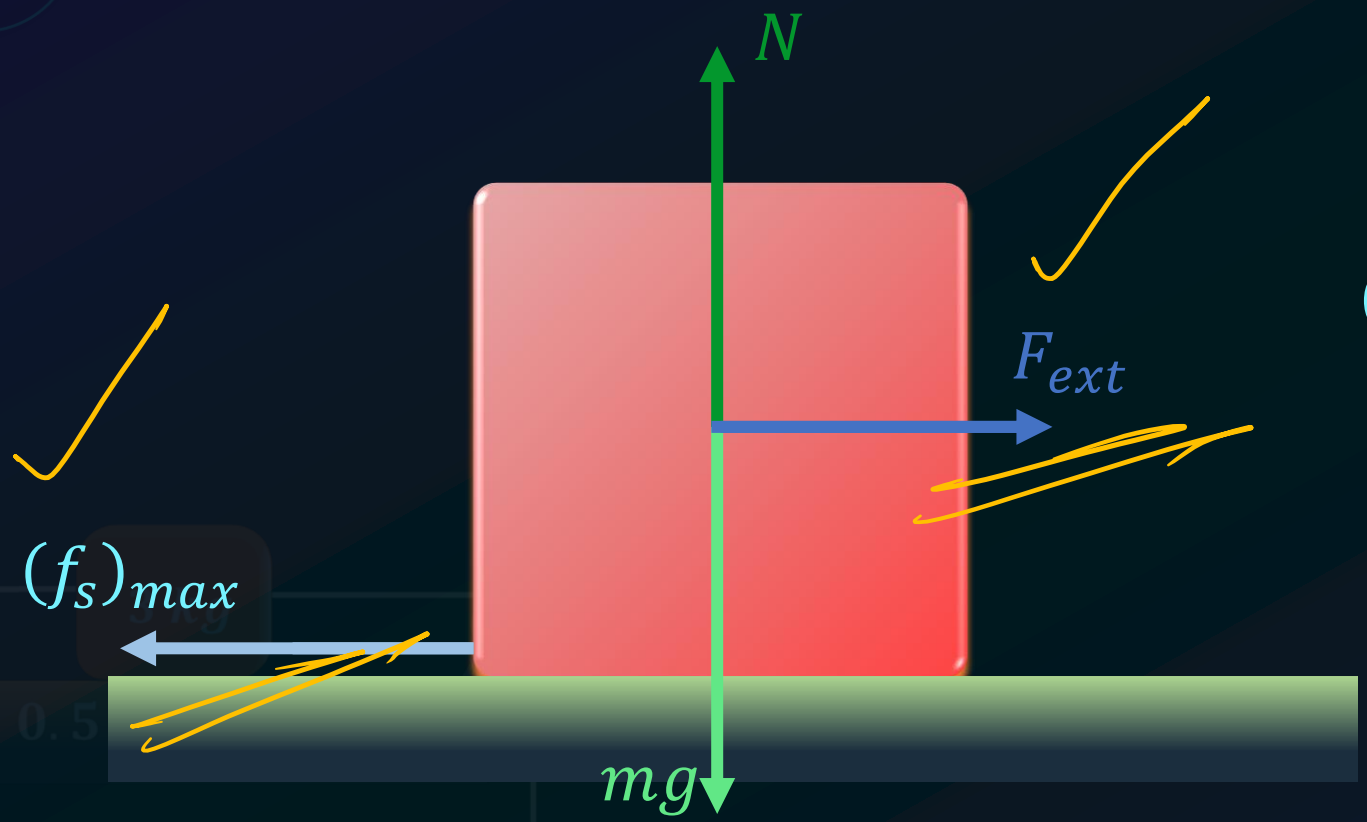
It appears that the maximum value of static friction is $15\ N$ in this case.



CONTENTS

LIMITING FRICTION

The maximum possible friction force between two surfaces before sliding begins.



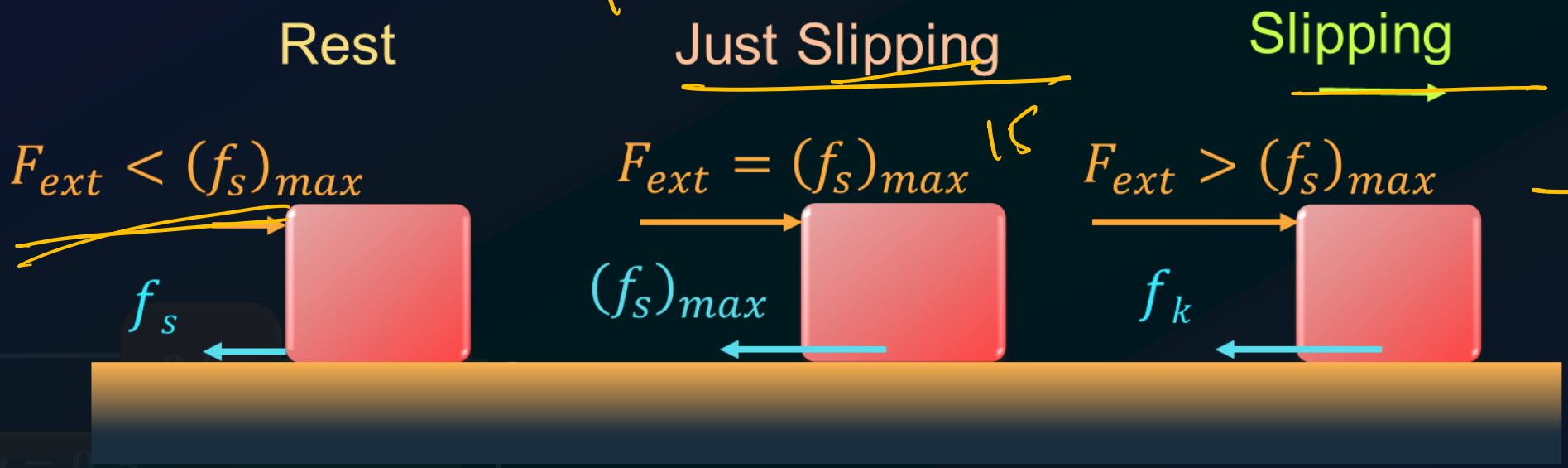
$$(f_s)_{max} \propto N$$

$$(f_s)_{max} = \mu_s N$$

$$f_l = \mu_s N$$

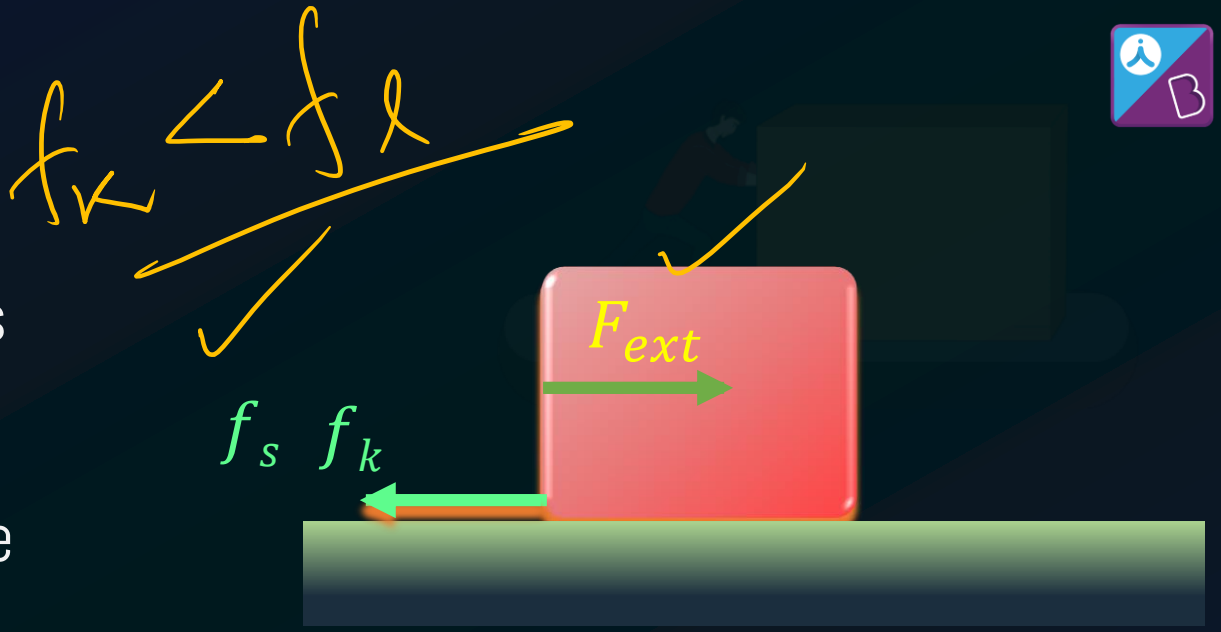
LIMITING FRICTION

If the applied external Force exceeds the value of the limiting friction, then the slipping starts i.e., relative motion. Then, the nature of friction switches to kinetic.



$$a = \frac{F_{ex} - f_k}{m}$$

FRICTION GRAPH



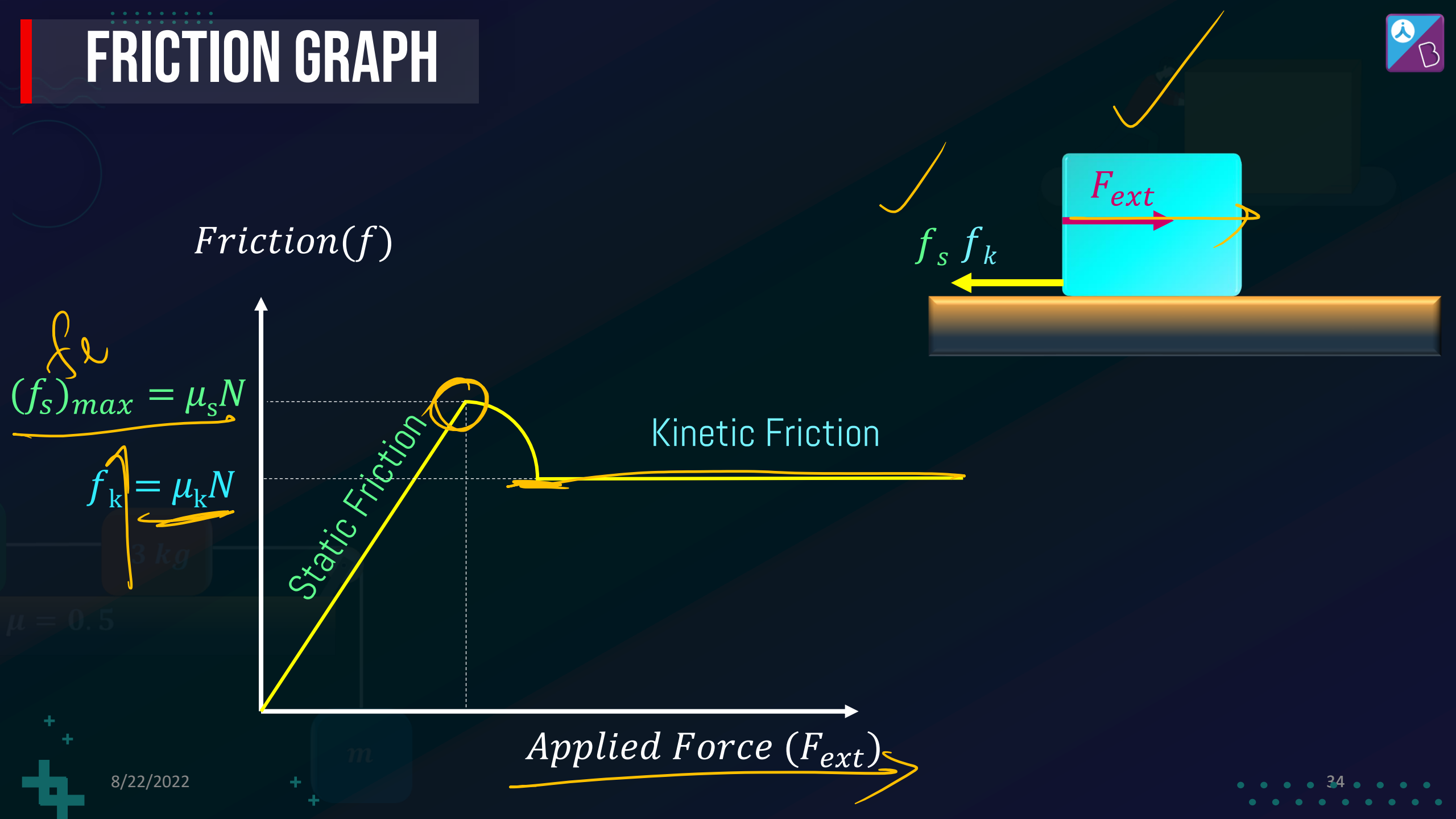
Initially, when the object is at rest, it has both interlocking and cold welding.

But while it is moving, it will only have interlocking and no cold welding.

Interlocking

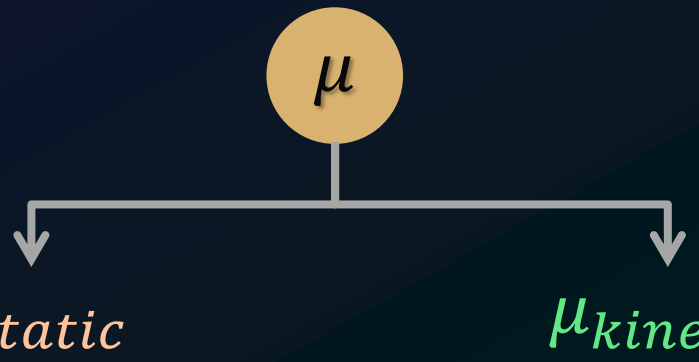
Cold welding

FRICTION GRAPH



FRICTION GRAPH

Motion is difficult to start but easier to maintain.



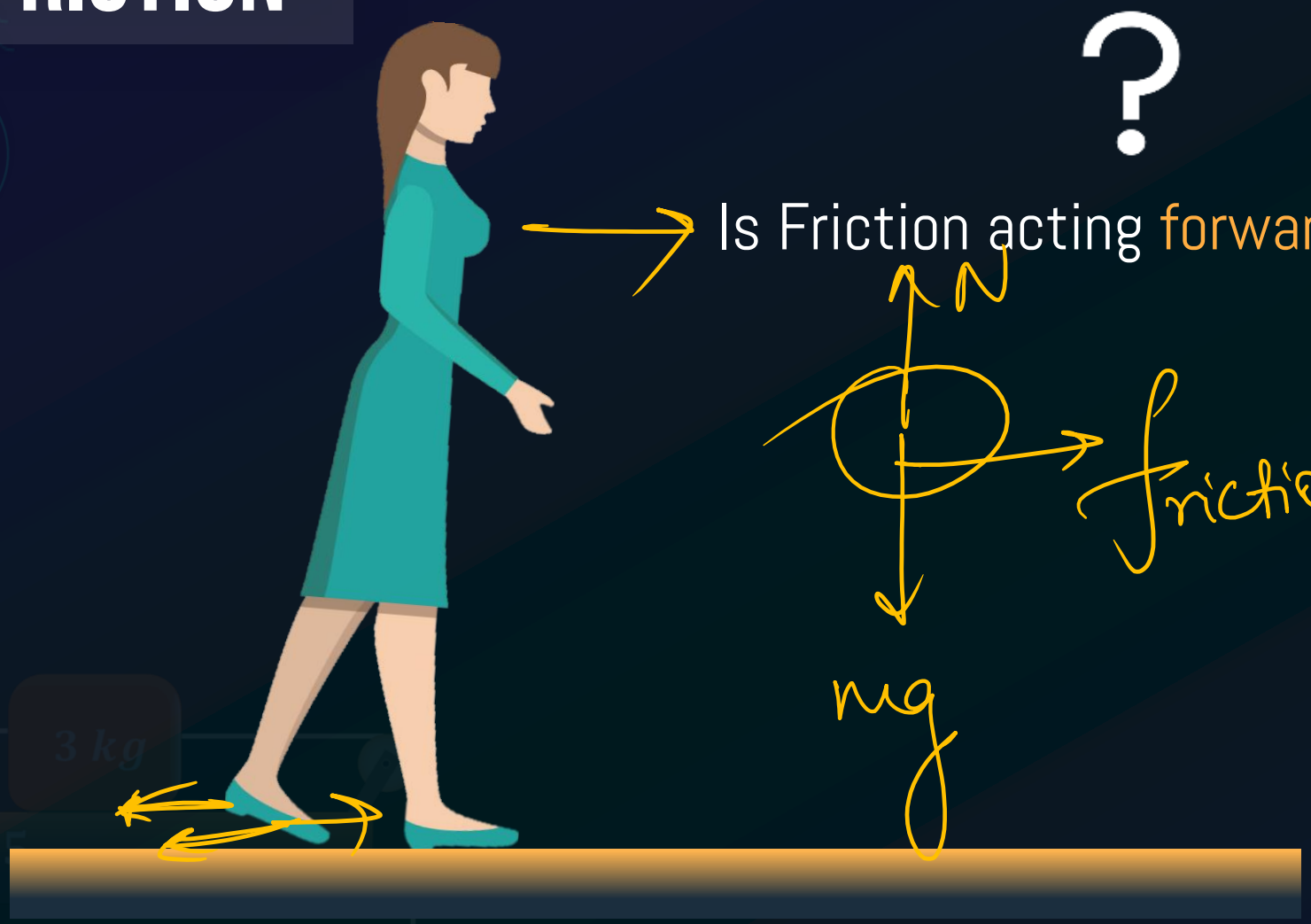
Interlocking & Cold Welding

Interlocking

$$\Rightarrow (f_s)_{max} > f_k$$

$$Hence, \mu_{static} > \mu_{kinetic}$$

FRICTION


?
Is Friction acting forward or backward on the girl?
N
Friction due to ground
mg

EXAMPLE

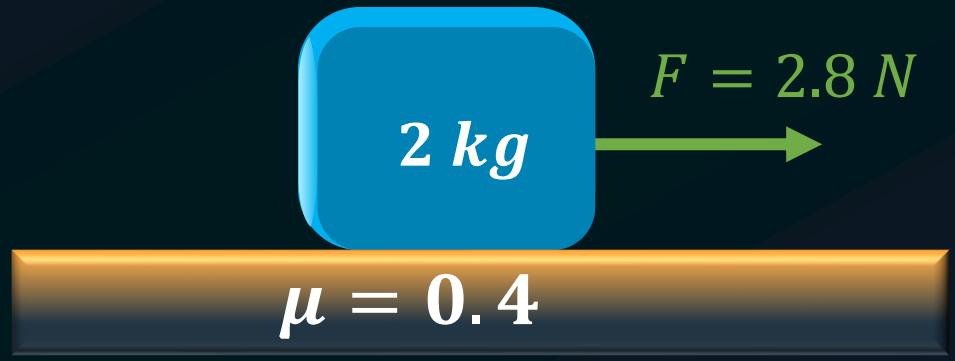
A force $F = 2.8\ N$ is applied on the block of mass $2\ kg$ as shown in the figure. Find the frictional force and acceleration of the block. (Take $g = 10\ m/s^2$)

a. $2.8\ N, 1.4\ m/s^2$

b. $8\ N, 1.4\ m/s^2$

c. $2.8\ N, 0\ m/s^2$

d. $8\ N, 0\ m/s^2$



SOLUTION

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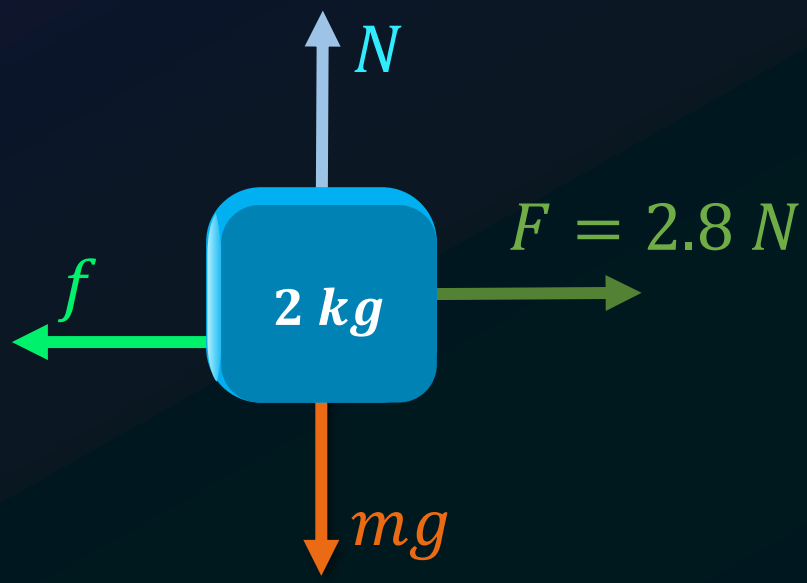
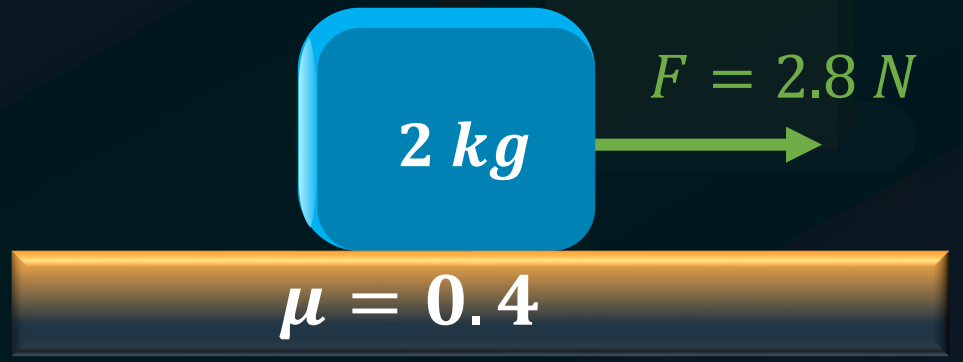
$$f_l = \mu_s N$$





$$f_s = 2.8\ N$$

$$a = 0\ m/s^2$$

ANSWER

A force $F = 2.8\ N$ is applied on the block of mass $2\ kg$ as shown in the figure. Find the frictional force and acceleration of the block. (Take $g = 10\ m/s^2$)

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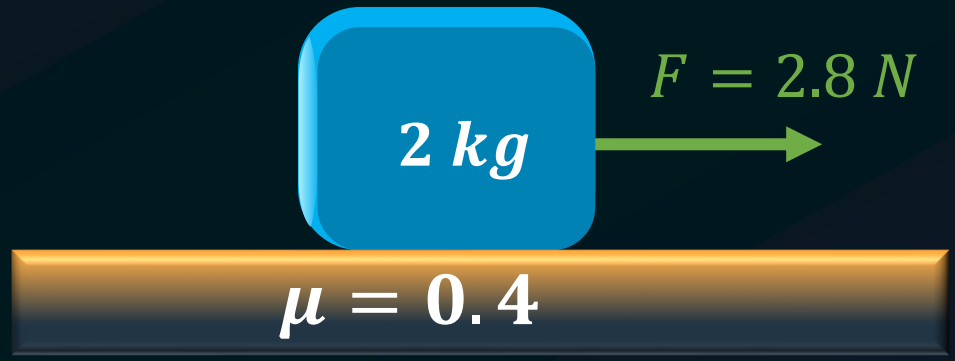


EXAMPLE

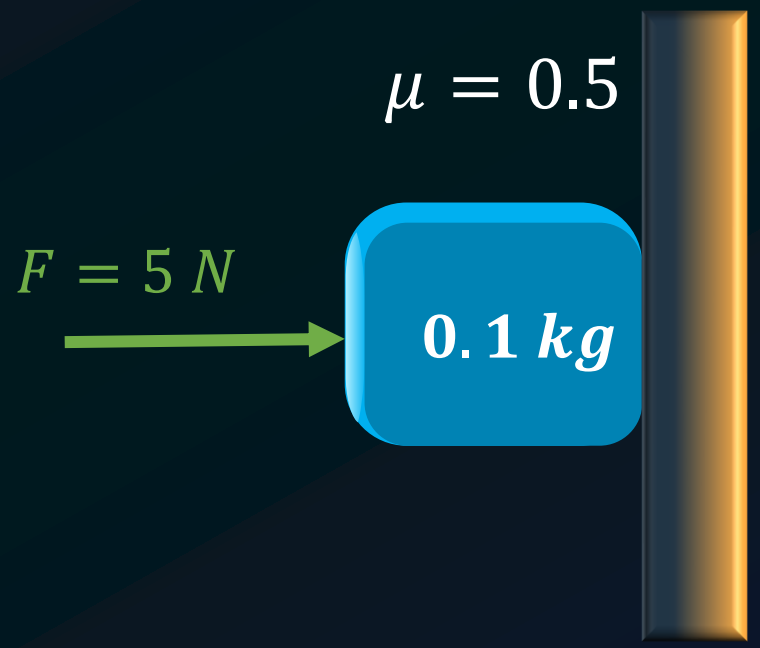
A block of mass $0.1\ kg$ is pressed against a wall with $F = 5\ N$ as shown in the figure. Find the frictional force and acceleration of the block.

a. $0.5\ N,\ \ 5\ m/s^2$

b. $0.5\ N,\ 10\ m/s^2$

c. $1\ N,\ 0\ m/s^2$

d. $1\ N,\ 10\ m/s^2$



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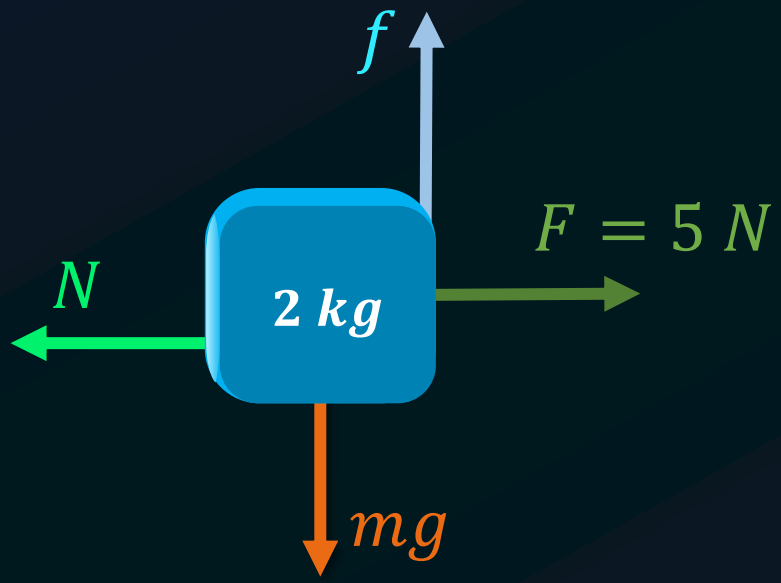

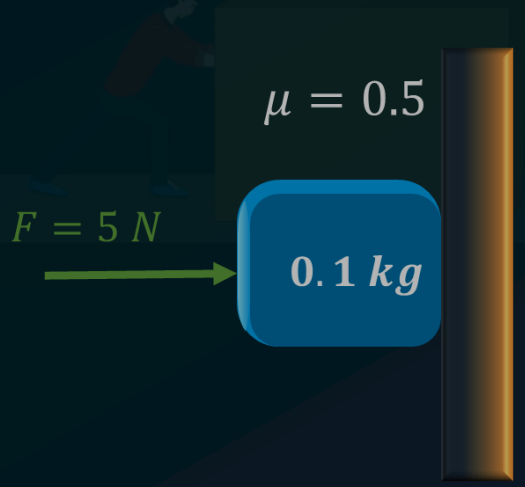

$$f_s = 1\ N$$

$$a = 0\ m/s^2$$

ANSWER

A block of mass $0.1\ kg$ is pressed against a wall with $F\ =\ 5\ N$ as shown in the figure. Find the frictional force and acceleration of the block.

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