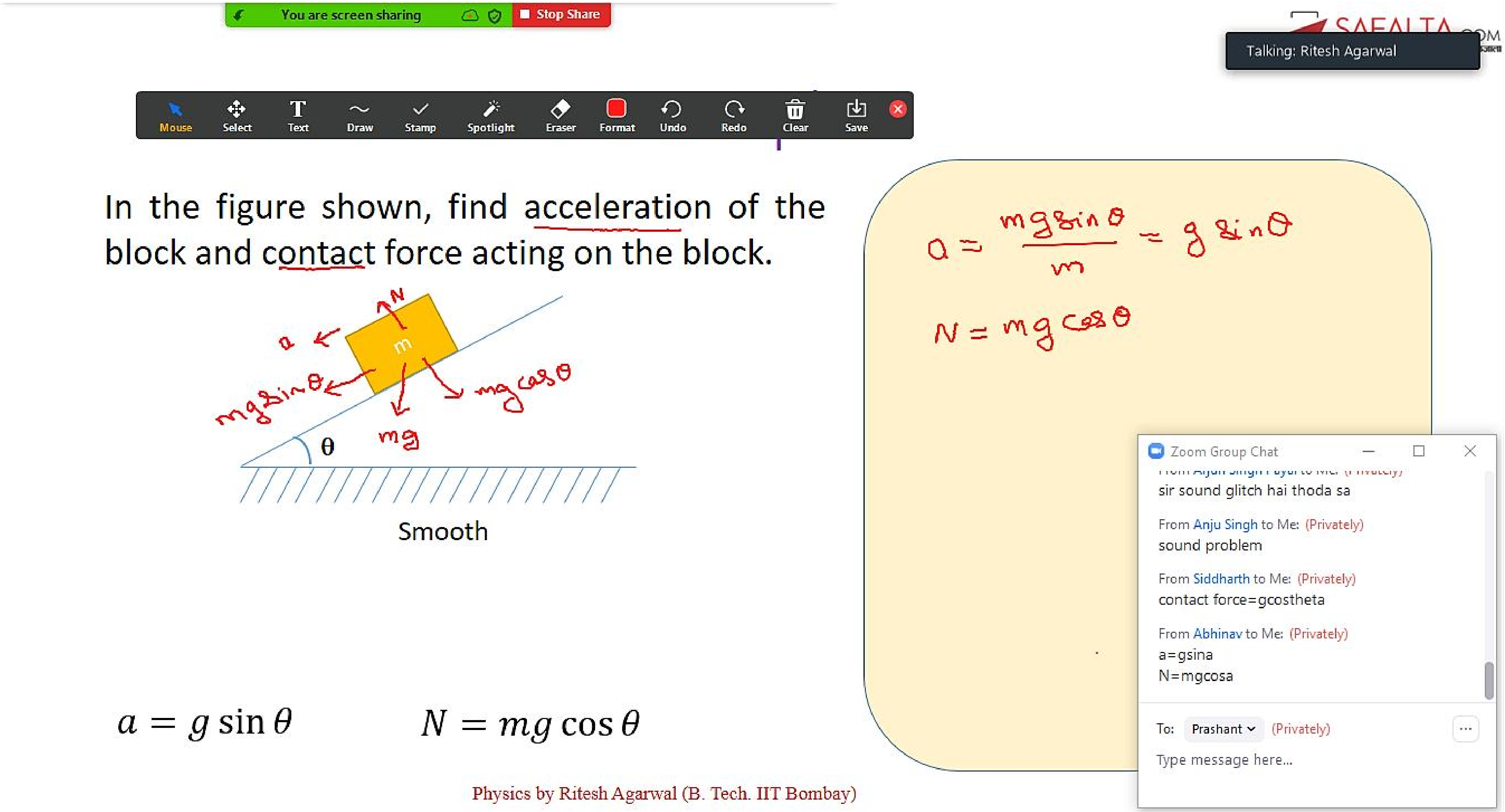


In the figure shown, find acceleration of the block and contact force acting on the block.

$a = g\sin\theta$ $\quad$ $N = mg\cos\theta$

$$a = \frac{mg\sin\theta}{m} = g\sin\theta$$

$$N = mg\cos\theta$$

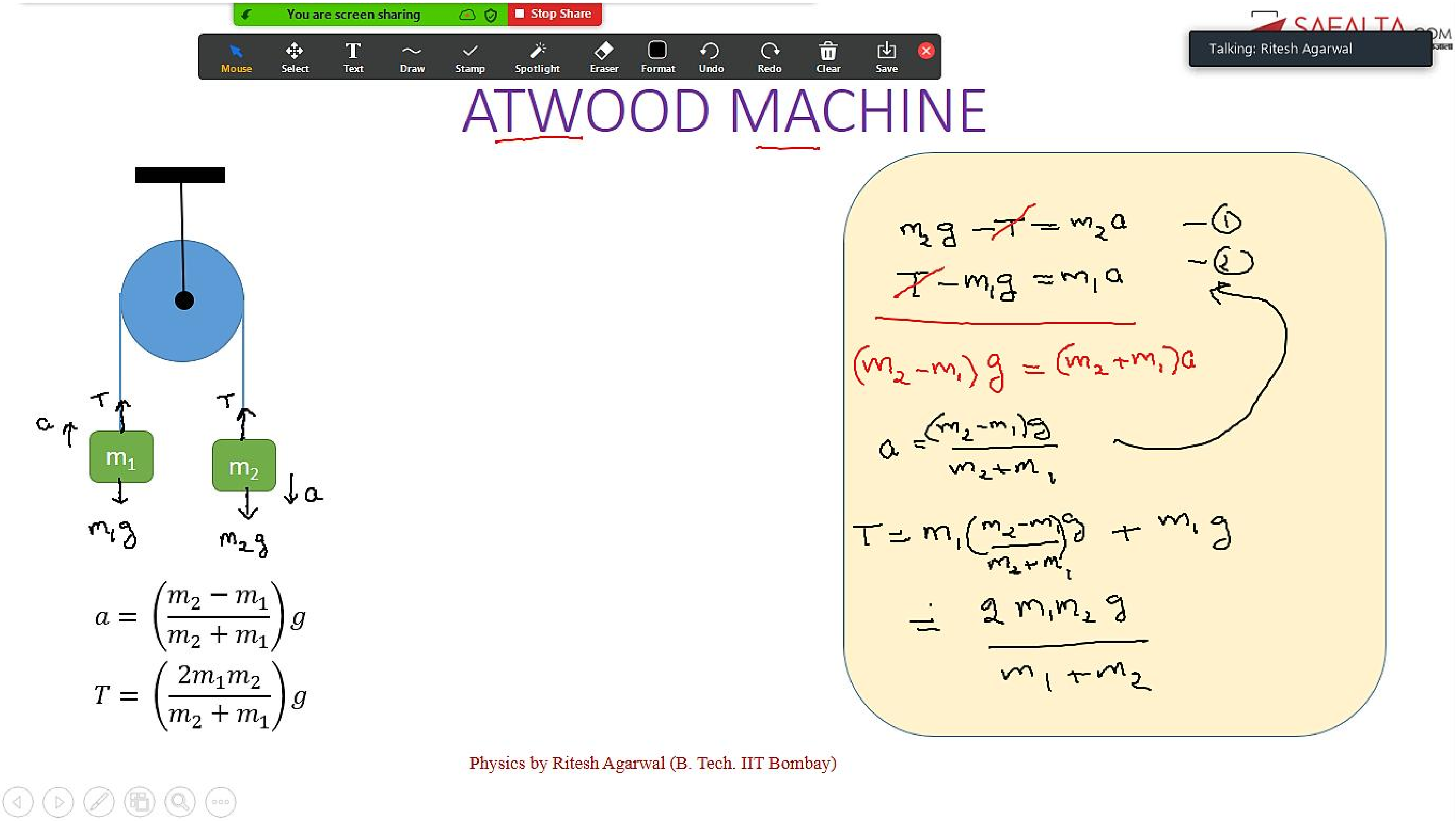
sir sound glitch hai thoda sa

From Anju Singh to Me: (Privately)
sound problem

From Siddharth to Me: (Privately)
contact force=gcostheta

From Abhinav to Me: (Privately)
a=gsina
N=mgcosa

Physics by Ritesh Agarwal (B. Tech. IIT Bombay)



ATWOOD MACHINE

$$a = \left(\frac{m_2 - m_1}{m_2 + m_1}\right) g$$

$$T = \left(\frac{2m_1m_2}{m_2 + m_1}\right) g$$

$$m_2 g - \cancel{T} = m_2 a \quad — ①$$

$$\cancel{T} - m_1 g = m_1 a \quad — ②$$

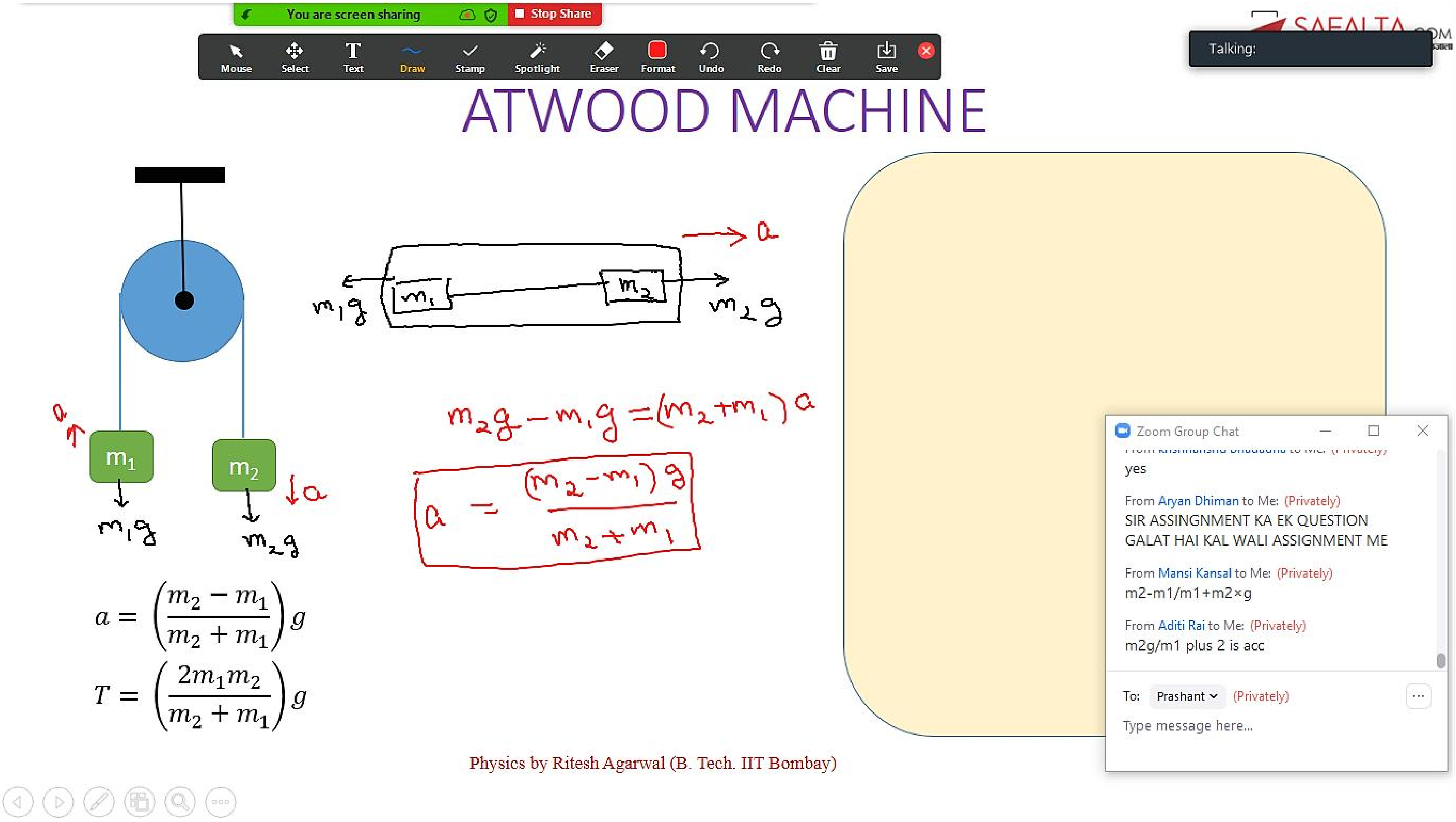
$$(m_2 - m_1) g = (m_2 + m_1) a$$

$$a = \frac{(m_2 - m_1) g}{m_2 + m_1}$$

$$T = m_1 \left(\frac{m_2 - m_1}{m_2 + m_1}\right) g + m_1 g$$

$$= \frac{2 m_1 m_2 g}{m_1 + m_2}$$

Physics by Ritesh Agarwal (B. Tech. IIT Bombay)



ATWOOD MACHINE

$$m_2g - m_1g = (m_2+m_1)a$$

$$\boxed{a = \frac{(m_2-m_1)g}{m_2+m_1}}$$

$$a = \left(\frac{m_2 - m_1}{m_2 + m_1}\right)g$$

$$T = \left(\frac{2m_1m_2}{m_2 + m_1}\right)g$$

Physics by Ritesh Agarwal (B. Tech. IIT Bombay)

Zoom Group Chat

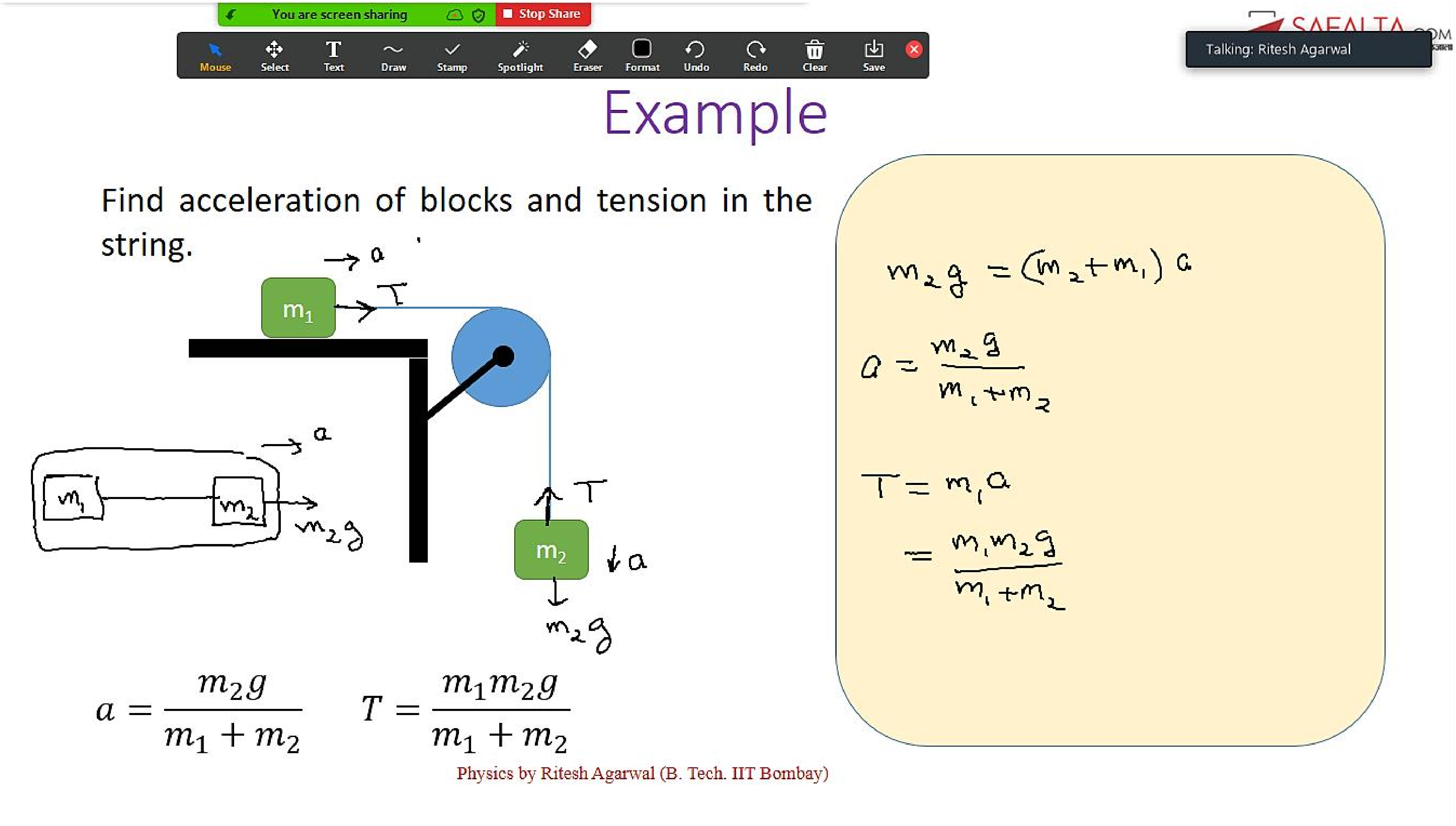
yes

From Aryan Dhiman to Me: (Privately)
SIR ASSINGNMENT KA EK QUESTION GALAT HAI KAL WALI ASSIGNMENT ME

From Mansi Kansal to Me: (Privately)
m2-m1/m1+m2×g

From Aditi Rai to Me: (Privately)
m2g/m1 plus 2 is acc

To: Prashant (Privately)
Type message here...



Example

Find acceleration of blocks and tension in the string.

$$a = \frac{m_2 g}{m_1 + m_2} \qquad T = \frac{m_1 m_2 g}{m_1 + m_2}$$

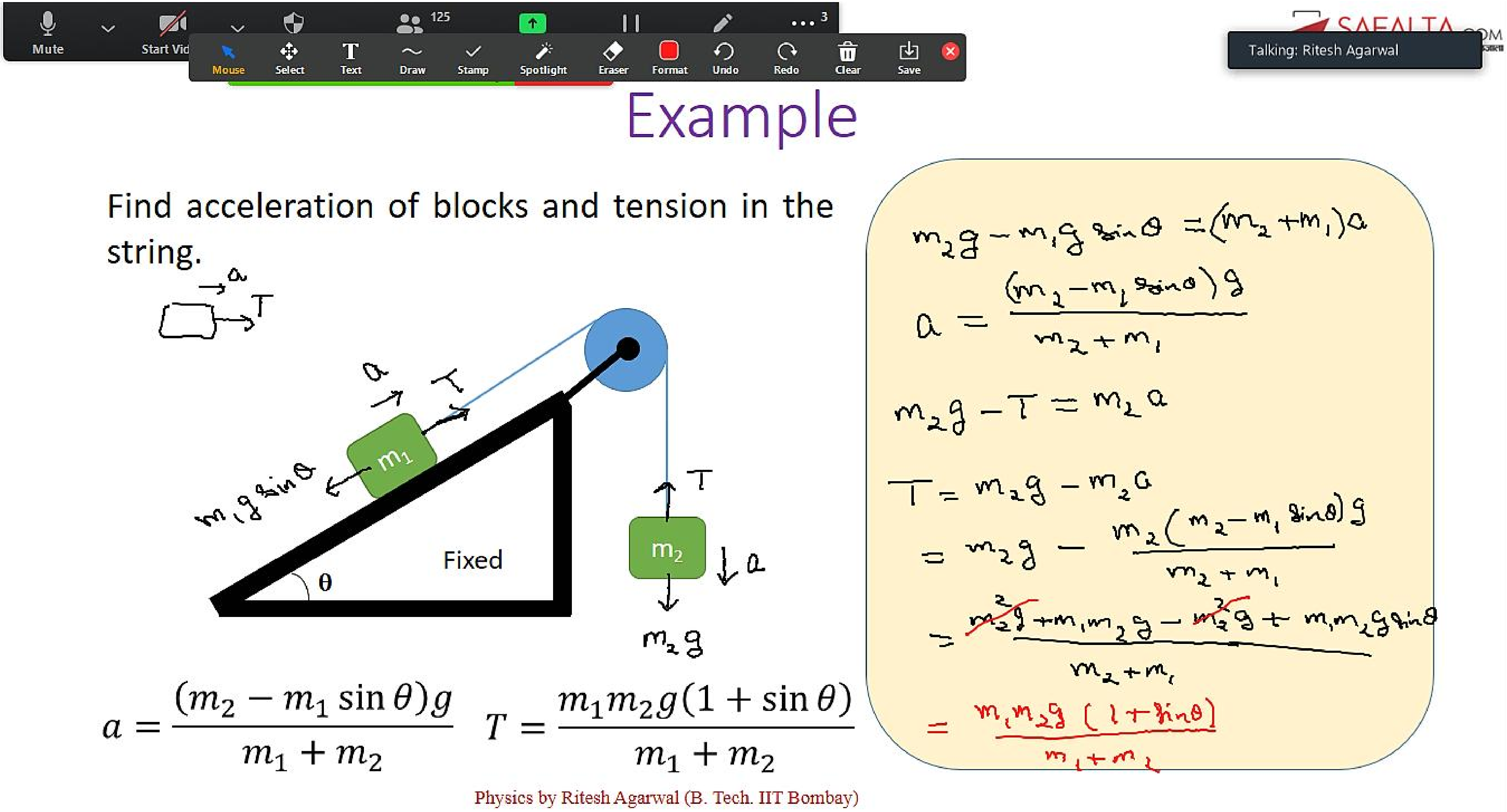
$$m_2 g = (m_2 + m_1)\, a$$

$$a = \frac{m_2 g}{m_1 + m_2}$$

$$T = m_1 a$$

$$= \frac{m_1 m_2 g}{m_1 + m_2}$$

Physics by Ritesh Agarwal (B. Tech. IIT Bombay)



Example

Find acceleration of blocks and tension in the string.

$$a = \frac{(m_2 - m_1\sin\theta)g}{m_1 + m_2} \qquad T = \frac{m_1 m_2 g(1+\sin\theta)}{m_1 + m_2}$$

$$m_2g - m_1g\sin\theta = (m_2+m_1)a$$

$$a = \frac{(m_2 - m_1\sin\theta)g}{m_2+m_1}$$

$$m_2g - T = m_2a$$

$$T = m_2g - m_2a$$

$$= m_2g - \frac{m_2(m_2 - m_1\sin\theta)g}{m_2+m_1}$$

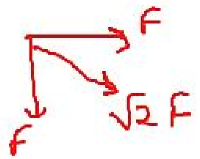
$$= \frac{\cancel{m_2^2g} + m_1m_2g - \cancel{m_2^2g} + m_1m_2g\sin\theta}{m_2+m_1}$$

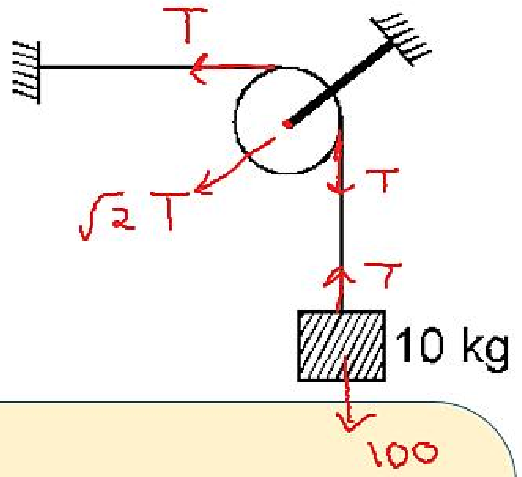
$$= \frac{m_1m_2g(1+\sin\theta)}{m_1+m_2}$$

Talking:

Example

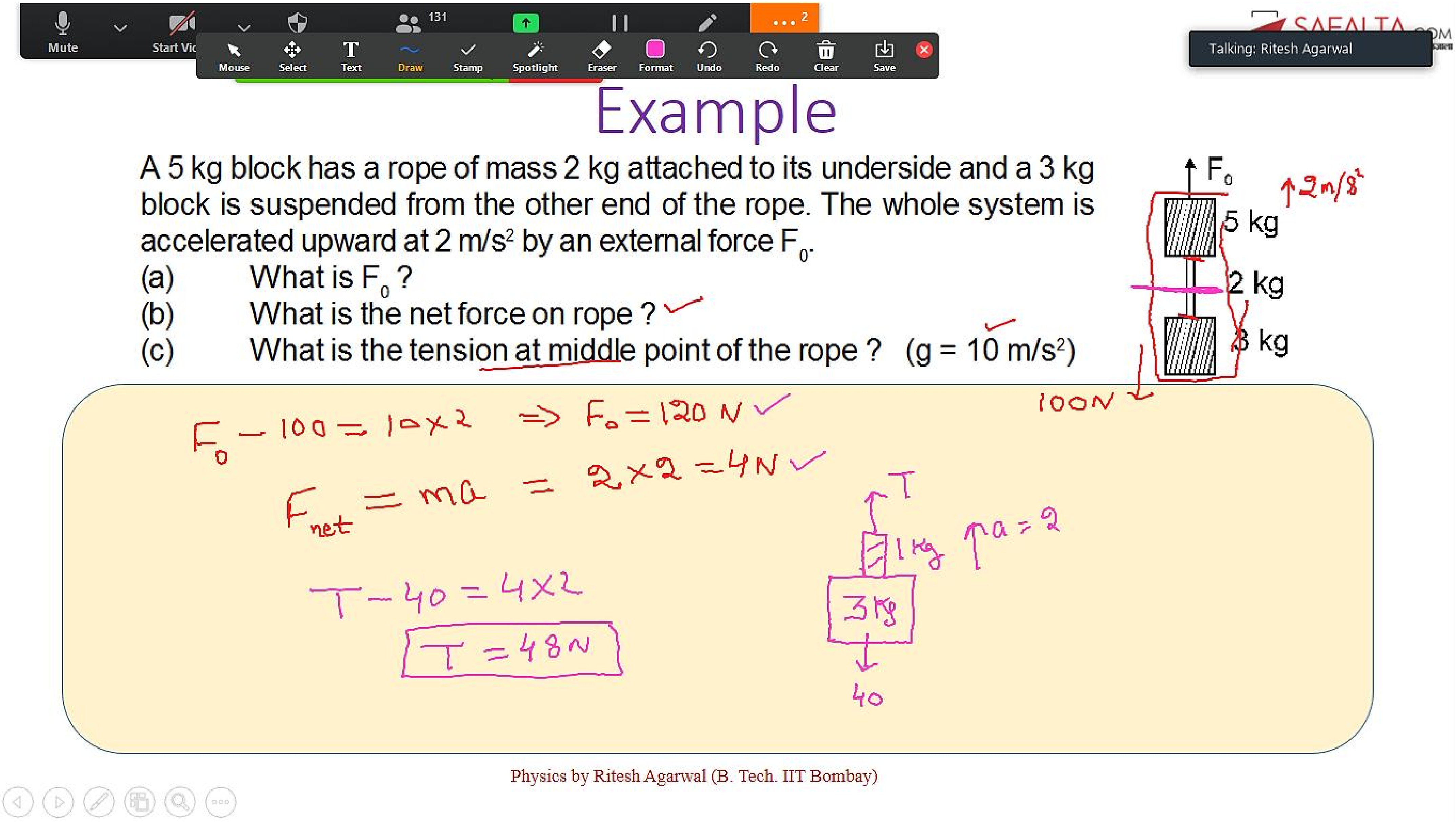
Find magnitude of force exerted by string on pulley.





$T = 100N$

$\sqrt{2}T = 100\sqrt{2} = 141N$



Example

A 5 kg block has a rope of mass 2 kg attached to its underside and a 3 kg block is suspended from the other end of the rope. The whole system is accelerated upward at 2 m/s² by an external force F_0.

(a) What is F_0 ?

(b) What is the net force on rope ? ✓

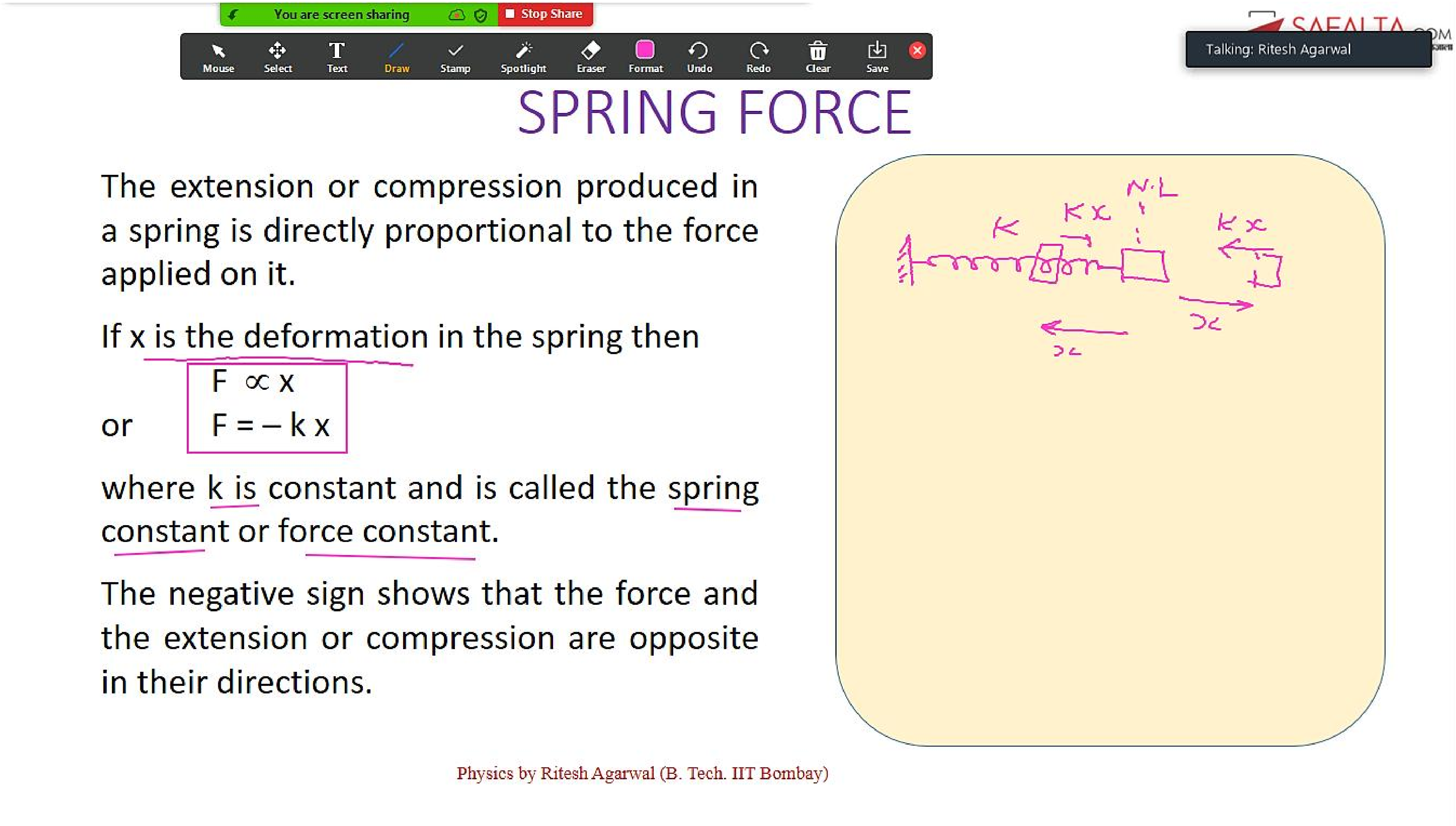
(c) What is the tension at middle point of the rope ? (g = 10 m/s²)

$F_0 - 100 = 10 \times 2 \Rightarrow F_0 = 120\ N$ ✓

$F_{net} = ma = 2 \times 2 = 4N$ ✓

$T - 40 = 4 \times 2$

$\boxed{T = 48N}$



SPRING FORCE

The extension or compression produced in a spring is directly proportional to the force applied on it.

If x is the deformation in the spring then

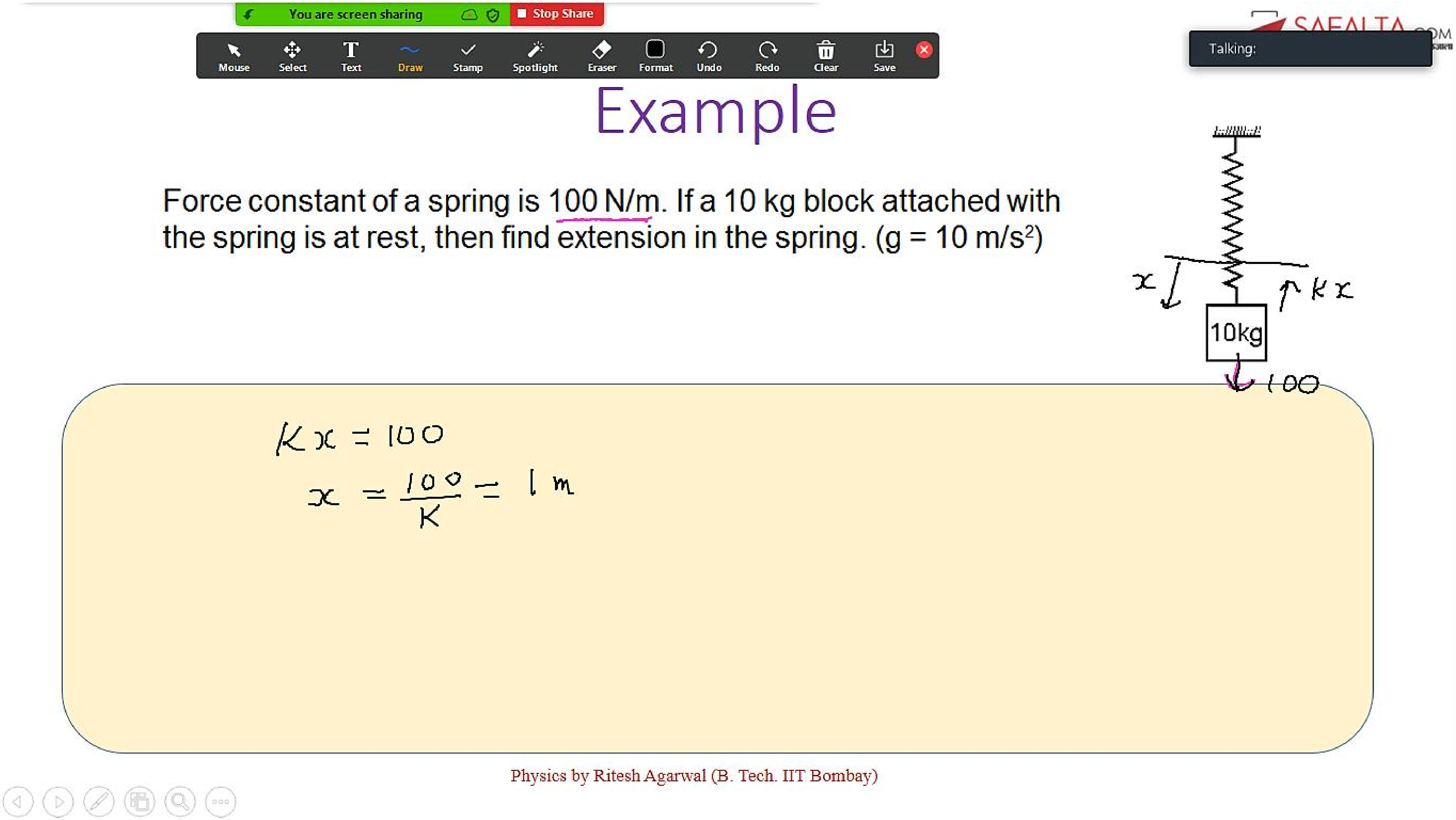
$$F \propto x$$

or $F = -kx$

where k is constant and is called the spring constant or force constant.

The negative sign shows that the force and the extension or compression are opposite in their directions.

Physics by Ritesh Agarwal (B. Tech. IIT Bombay)

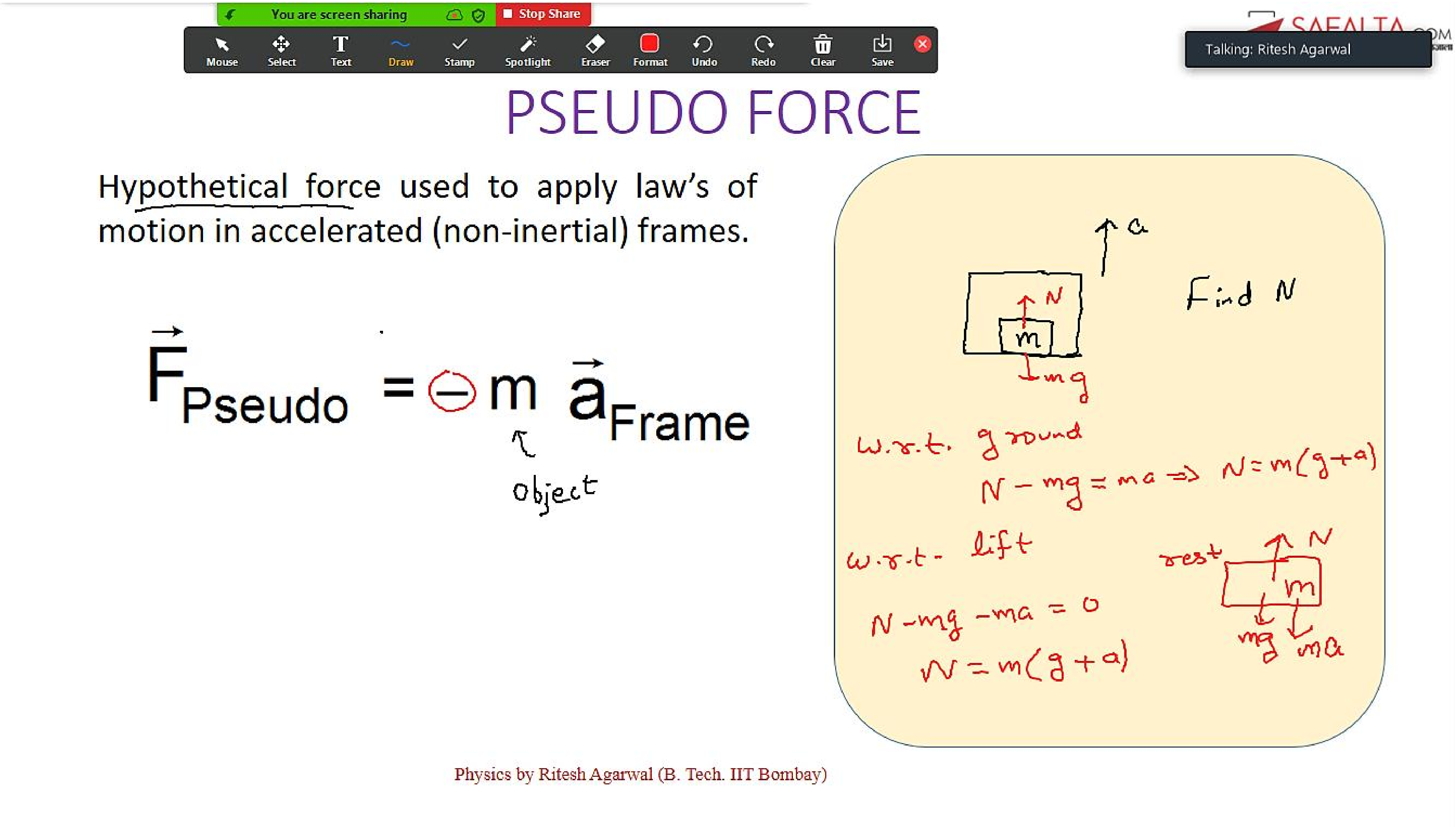


Example

Force constant of a spring is 100 N/m. If a 10 kg block attached with the spring is at rest, then find extension in the spring. (g = 10 m/s^2)

$$Kx = 100$$

$$x = \frac{100}{K} = 1\ m$$



PSEUDO FORCE

Hypothetical force used to apply law's of motion in accelerated (non-inertial) frames.

$$\vec{F}_{Pseudo} = \ominus \underset{\uparrow \atop \text{object}}{m} \; \vec{a}_{Frame}$$

Find N

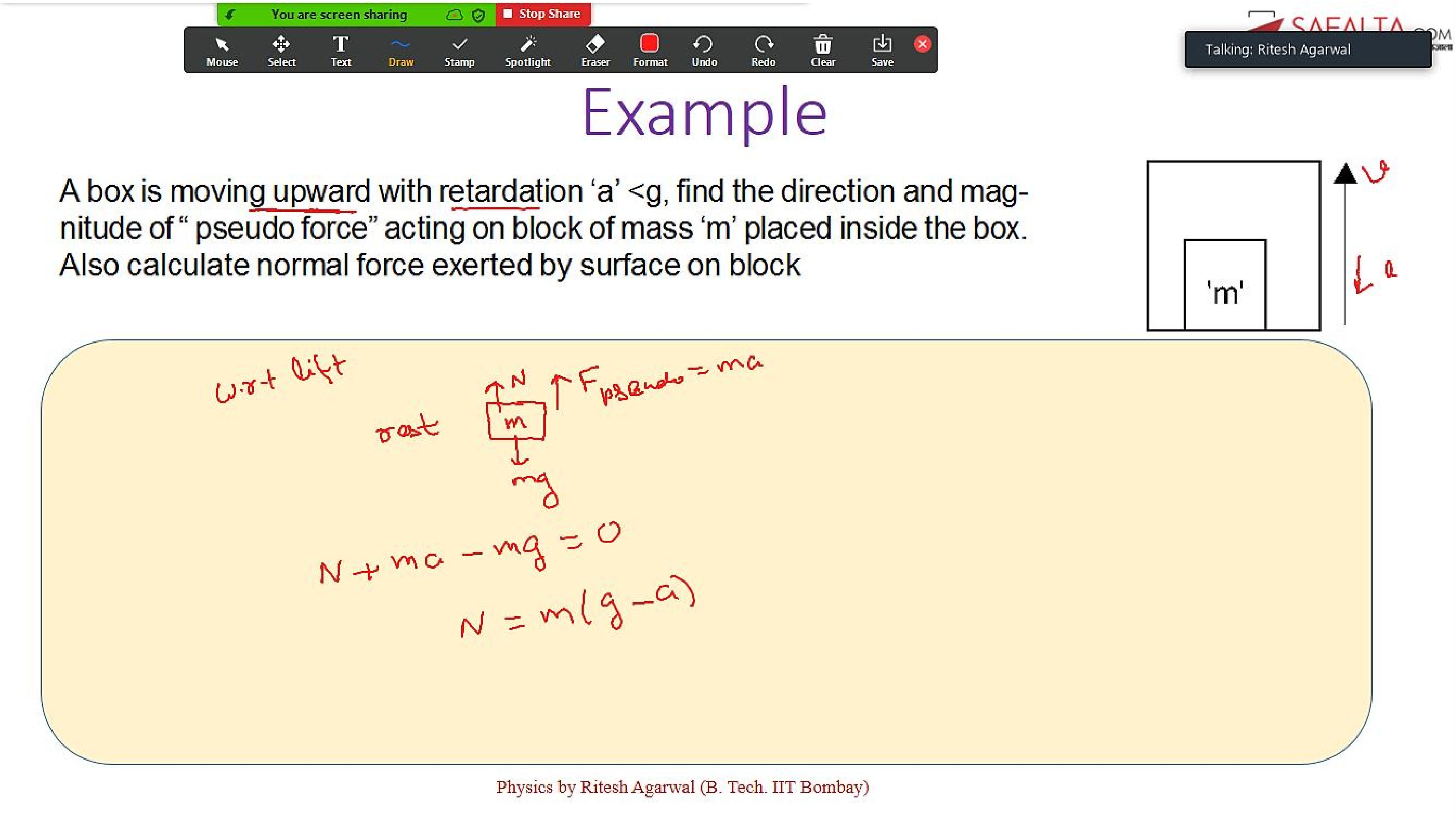
w.r.t. ground

$N - mg = ma \Rightarrow N = m(g+a)$

w.r.t. lift

$N - mg - ma = 0$

$N = m(g+a)$



Example

A box is moving upward with retardation ‘a’ <g, find the direction and magnitude of “ pseudo force” acting on block of mass ‘m’ placed inside the box. Also calculate normal force exerted by surface on block

w.r.t lift

rest

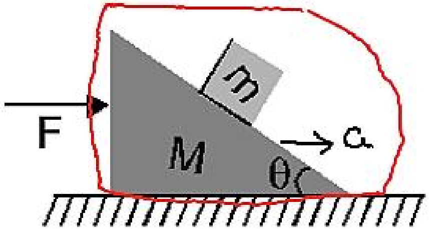
N ↑ m ↓ mg ↑ $F_{pseudo} = ma$

$$N + ma - mg = 0$$

$$N = m(g - a)$$

Example

All surfaces are smooth in the adjoining figure. Find F such that block remains stationary with respect to wedge.

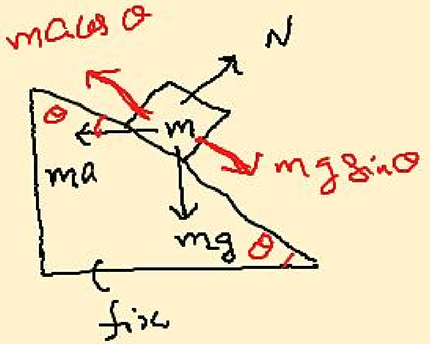


Let acc. of wedge be a

w.r.t. wedge

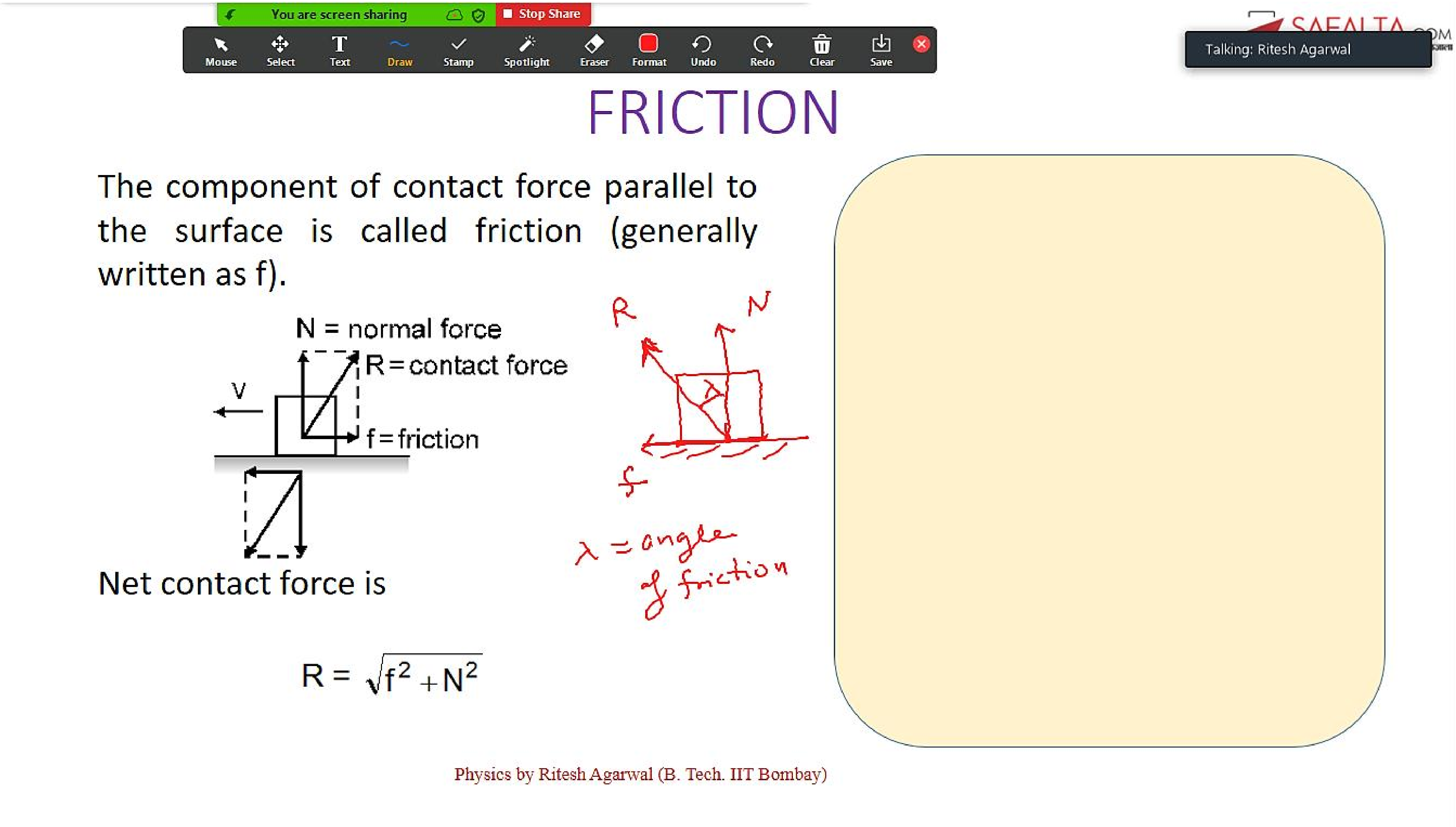
$$\cancel{m}g\sin\theta = \cancel{m}a\cos\theta$$

$$\boxed{a = g\tan\theta}$$



$$F = (M+m)a$$

$$= (M+m)g\tan\theta$$



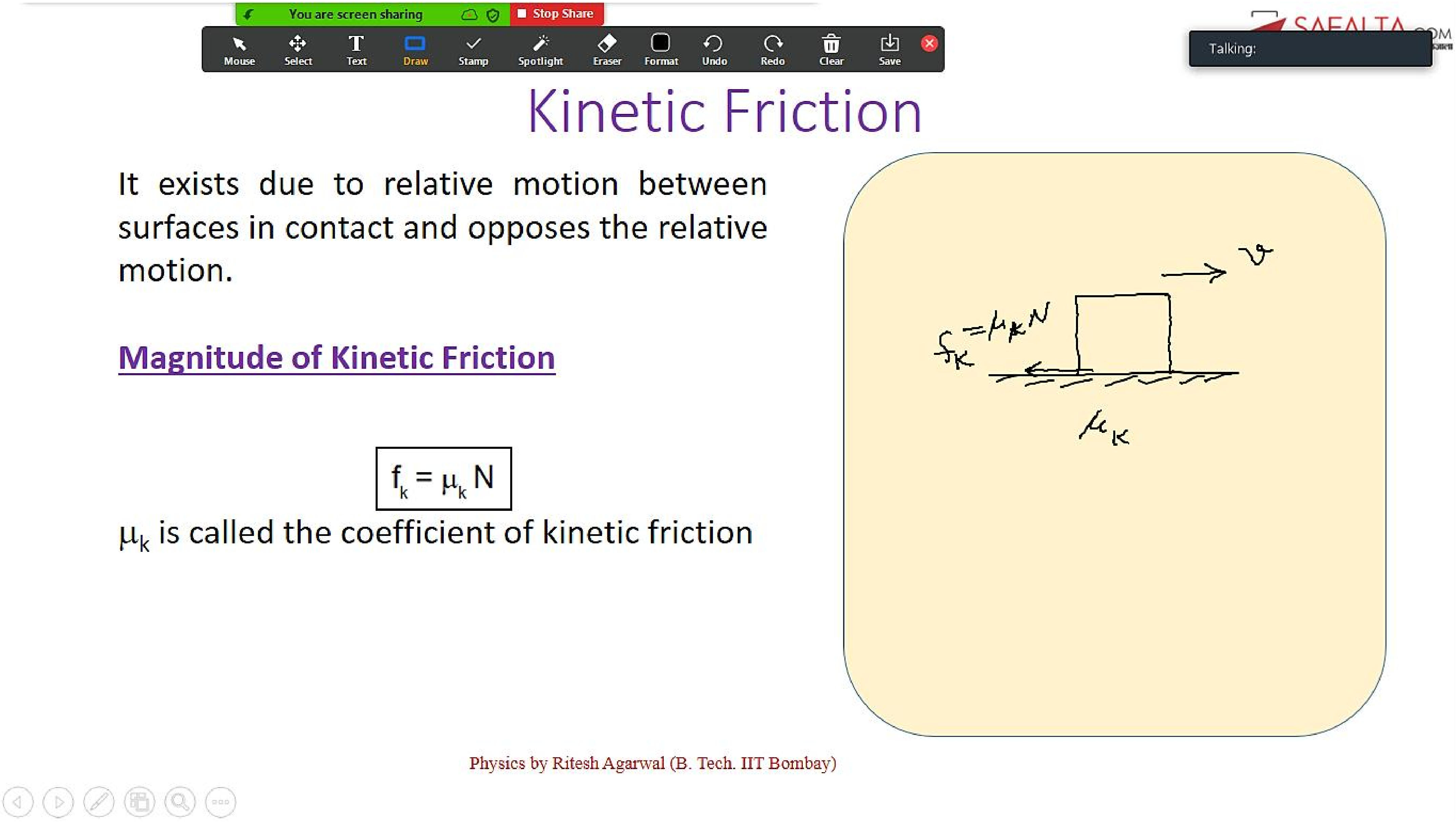
FRICTION

The component of contact force parallel to the surface is called friction (generally written as f).

λ = angle of friction

Net contact force is

$$R = \sqrt{f^2 + N^2}$$



Kinetic Friction

It exists due to relative motion between surfaces in contact and opposes the relative motion.

Magnitude of Kinetic Friction

$$\boxed{f_k = \mu_k N}$$

μ_k is called the coefficient of kinetic friction

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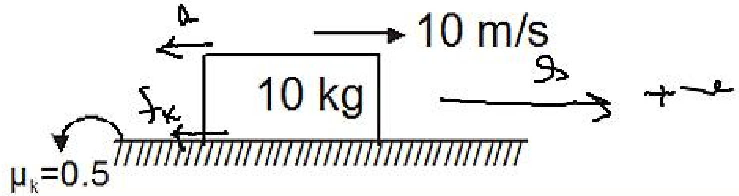
Talking:

Example

Find out the distance travelled by the blocks shown in the figure before it stops.



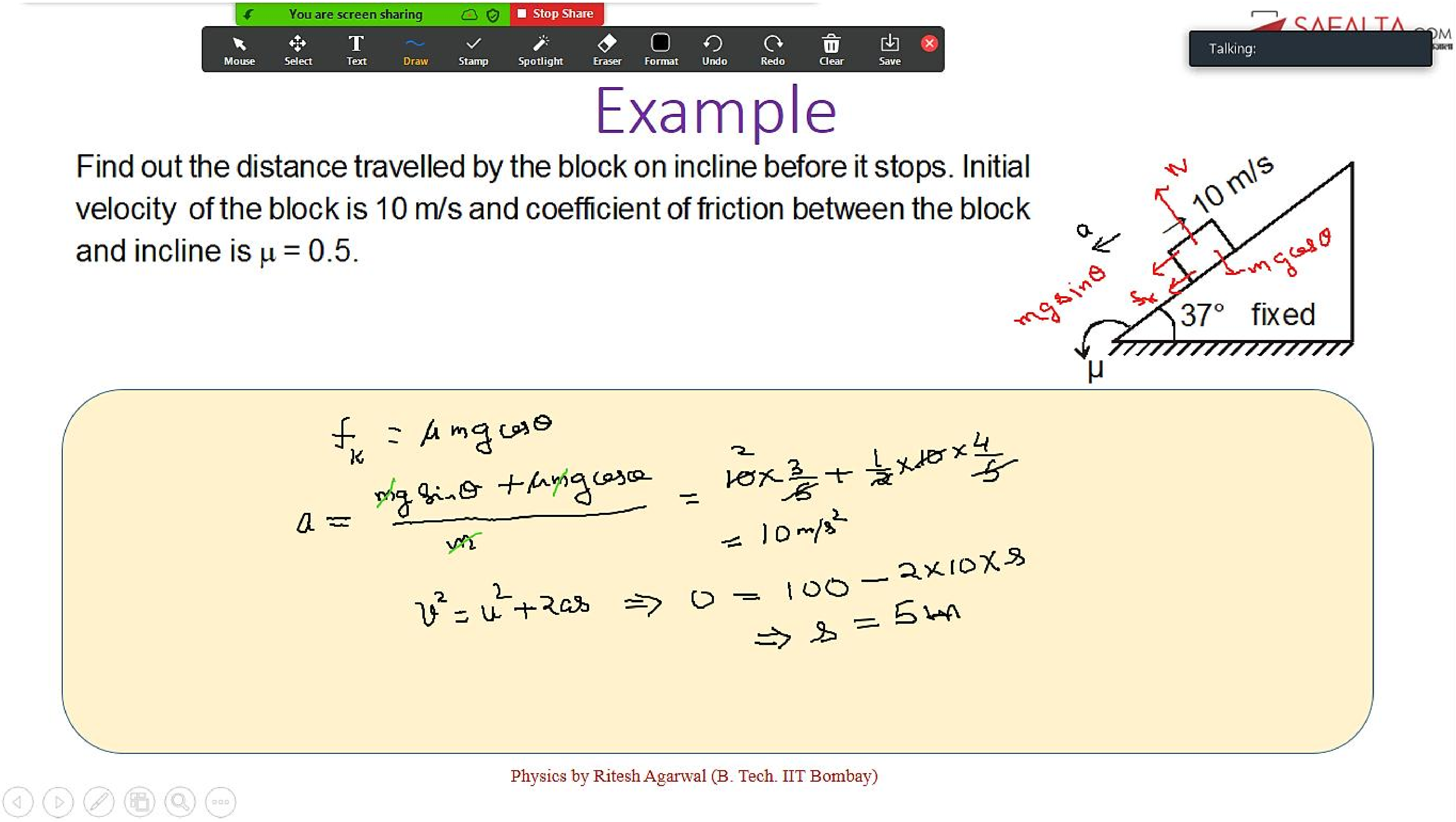
$N = mg = 100$

$f_k = \mu_k N = 0.5 \times 100 = 50$

$a = \frac{f_k}{m} = \frac{50}{10} = 5 m/s^2 = const$

$v^2 = u^2 + 2as$ $\Rightarrow s = 10 m$

$0 = 100 + 2(-5)s$



Example

Find out the distance travelled by the block on incline before it stops. Initial velocity of the block is 10 m/s and coefficient of friction between the block and incline is μ = 0.5.

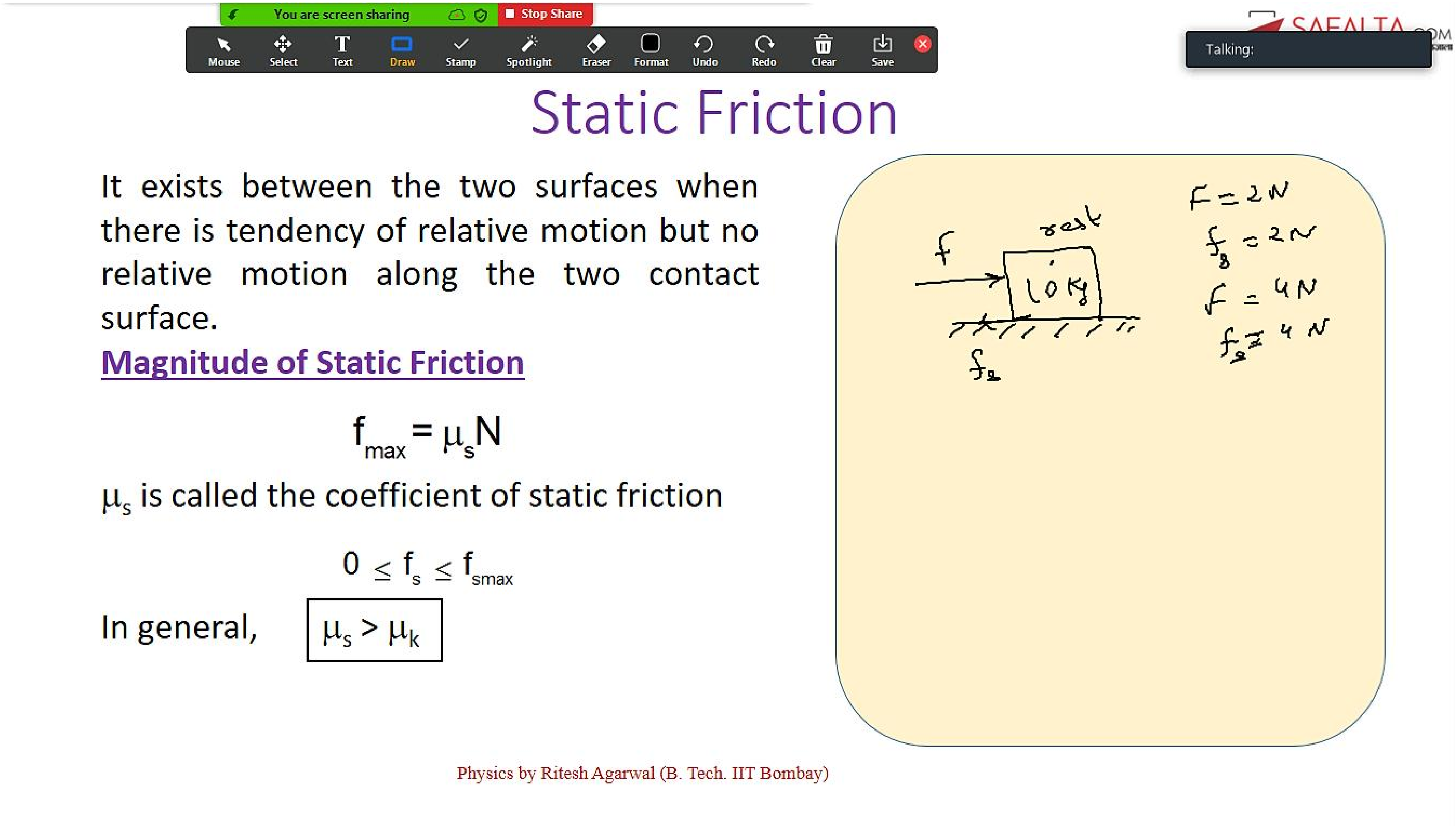
$$f_k = \mu mg\cos\theta$$

$$a = \frac{\cancel{m}g\sin\theta + \mu\cancel{m}g\cos\theta}{\cancel{m}} = \overset{2}{\cancel{10}} \times \frac{3}{\cancel{5}} + \frac{1}{\cancel{2}} \times \cancel{10} \times \frac{4}{\cancel{5}}$$

$$= 10\ m/s^2$$

$$v^2 = u^2 + 2as \Rightarrow 0 = 100 - 2 \times 10 \times s$$

$$\Rightarrow s = 5\ m$$



Static Friction

It exists between the two surfaces when there is tendency of relative motion but no relative motion along the two contact surface.

Magnitude of Static Friction

$$f_{max} = \mu_s N$$

μ_s is called the coefficient of static friction

$$0 \leq f_s \leq f_{smax}$$

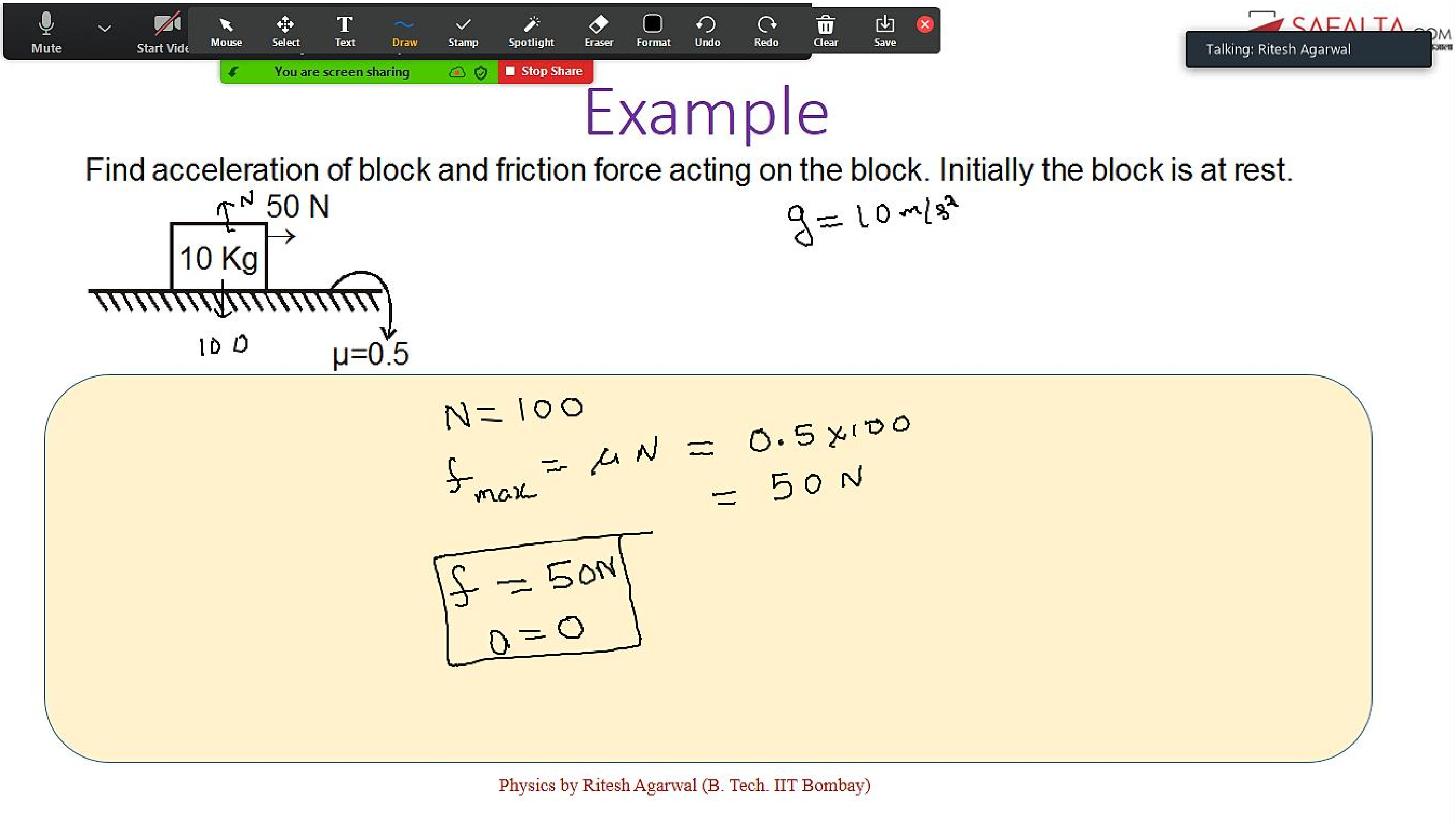
In general, $\boxed{\mu_s > \mu_k}$

$F = 2N$

$f_s = 2N$

$F = 4N$

$f_s \neq 4\,N$



Example

Find acceleration of block and friction force acting on the block. Initially the block is at rest.

$g = 10\ m/s^2$

$N = 100$

$f_{max} = \mu N = 0.5 \times 100$

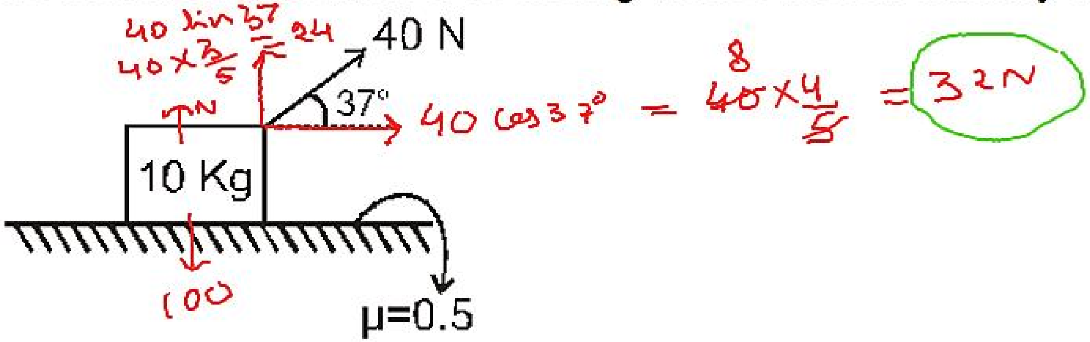
$= 50\ N$

$$\boxed{\begin{array}{c} f = 50N \\ a = 0 \end{array}}$$

Talking:

Example

Find out acceleration of the block and friction force acting on the block. Initially the block is at rest.



$40 \sin 37 = 24$

$40 \times \frac{3}{5}$

$40 \cos 37° = \overset{8}{\cancel{40}} \times \frac{4}{\cancel{5}} = \boxed{32N}$

$N + 24 - 100 = 0 \Rightarrow N = 76$

$f_{max} = \mu N = \frac{1}{2} \times 76 = \boxed{38N}$

$a = 0$

$f = 32N$