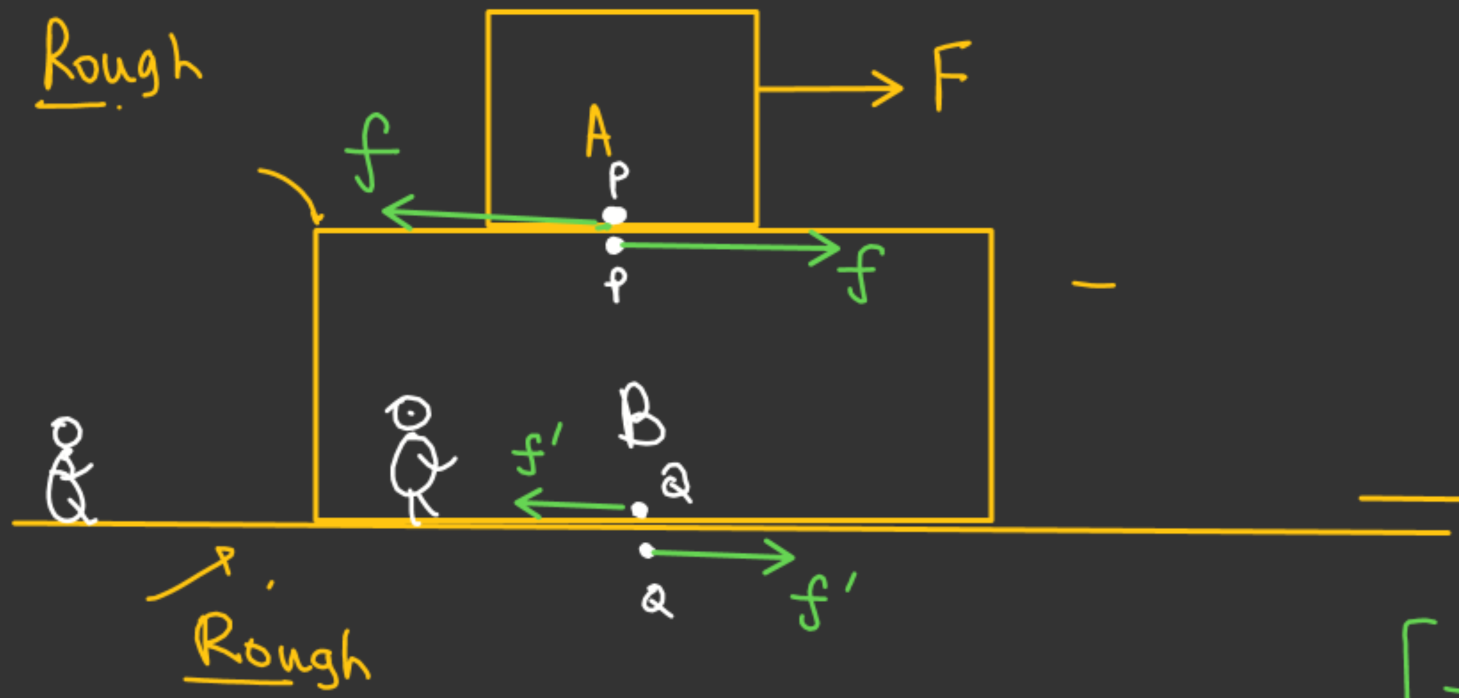
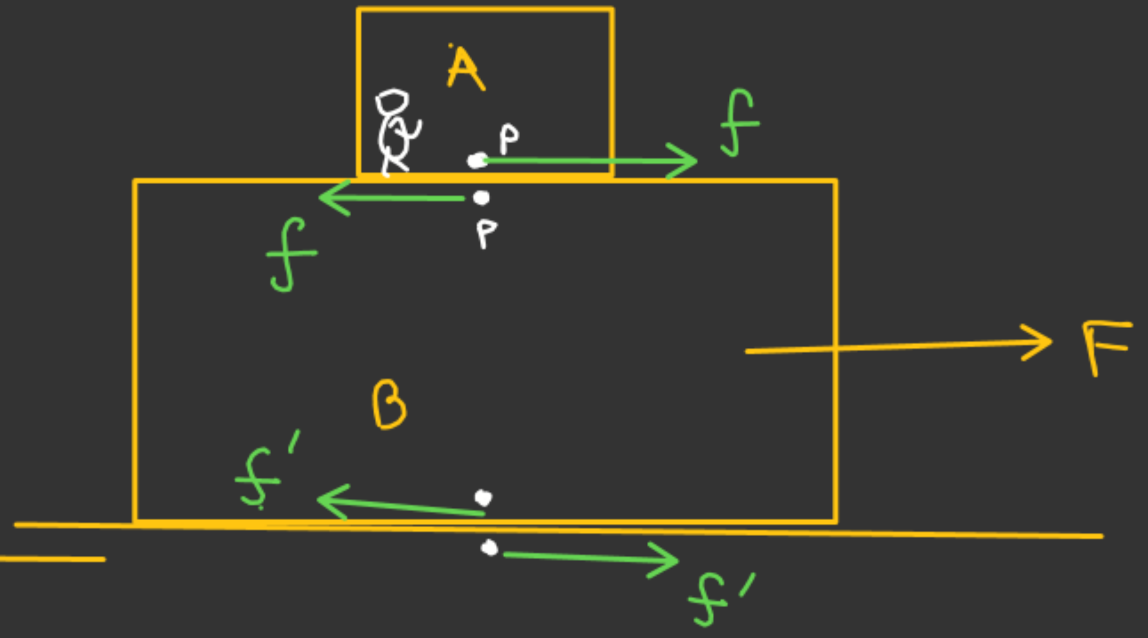
Nishant Jindal

Multiple Block Questions

Direction in Multiple block System :→

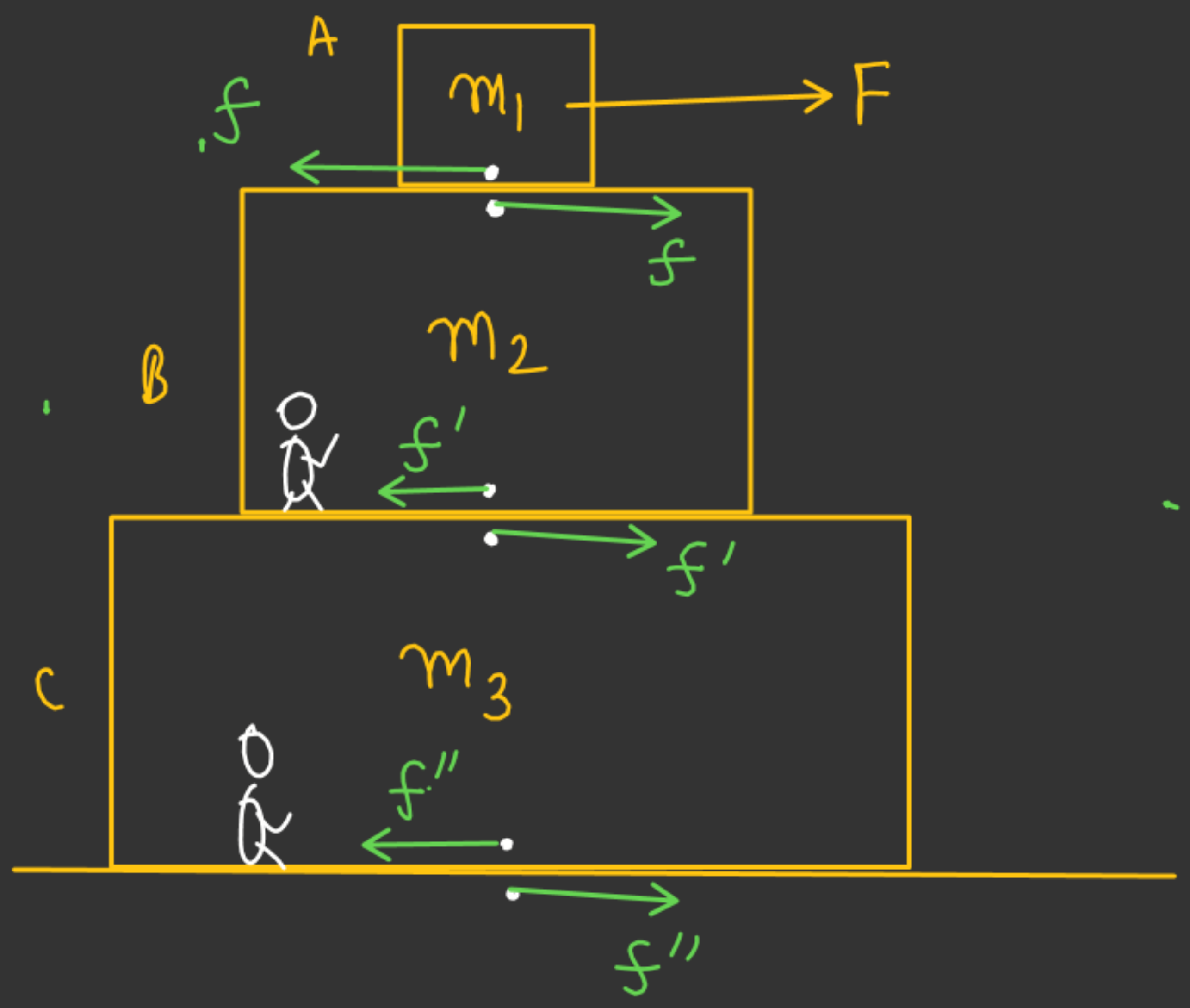


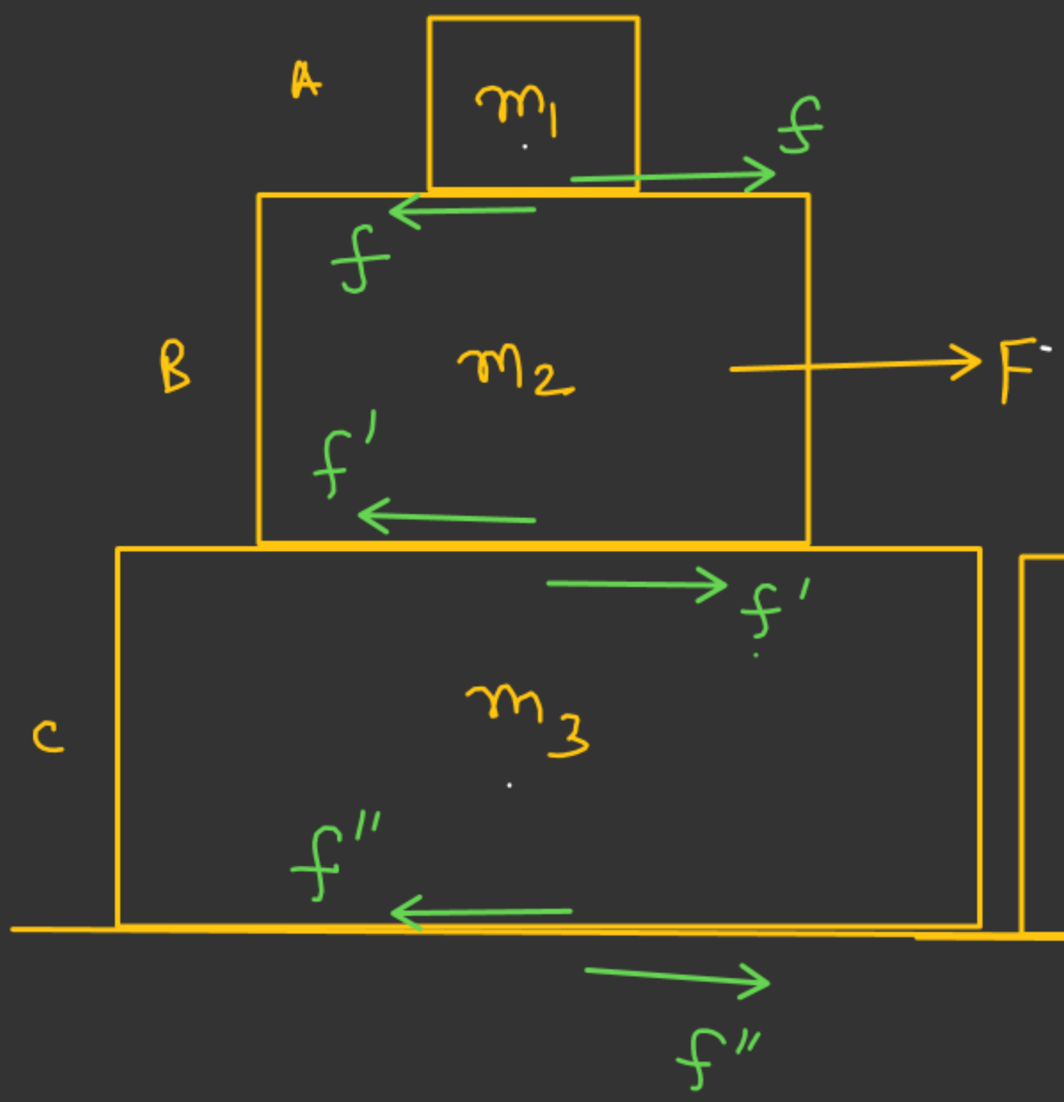


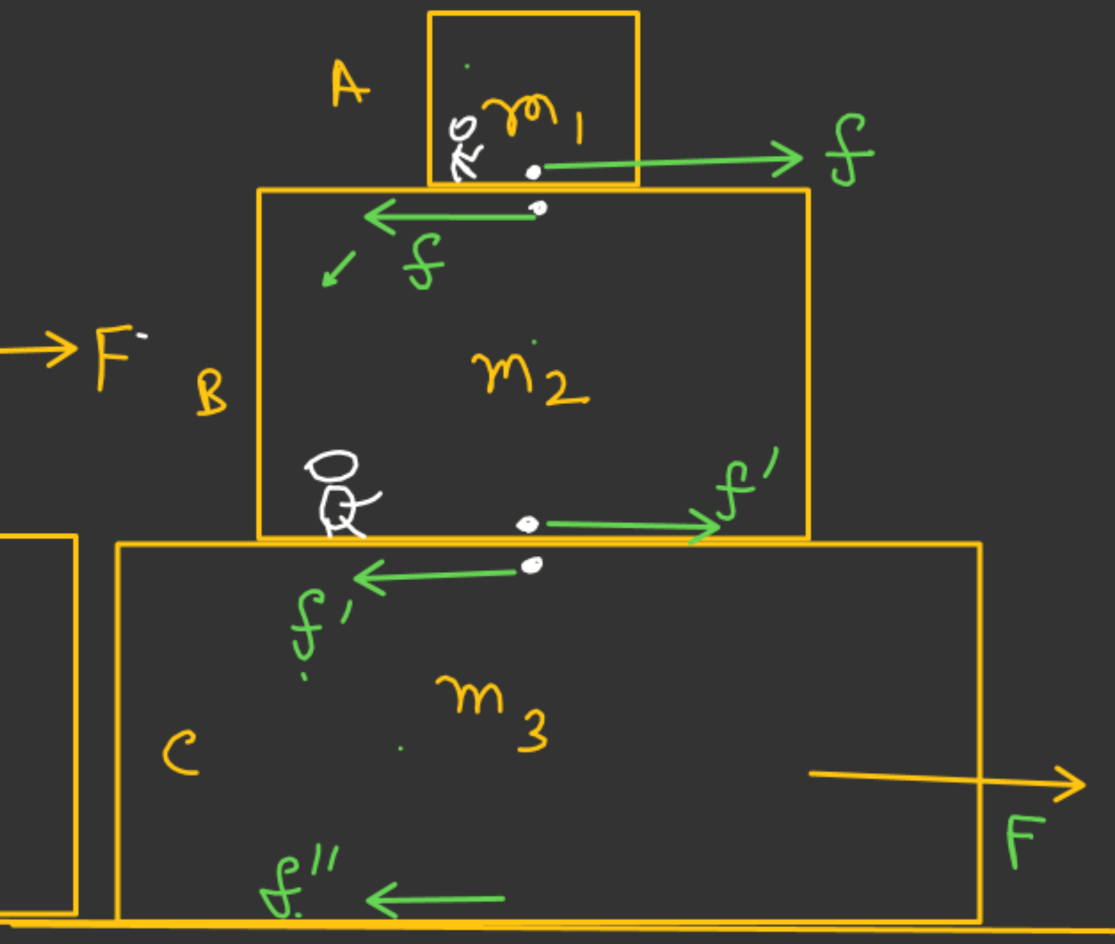
$f' \to$ Due to ground

$f \to$ Between the blocks.

All Surfaces are rough :→







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** How to Solve Multiple blocks questions

Steps :-
1. Mark direction of friction force on each blocks as per external force applied.

2. Assumed all the blocks move with common accleration.

3. Find Common accleration of the system

$$a_c = \left[\frac{F_{ext}}{M_{\underset{\text{mass of System}}{total}}} \right]$$

4. Find 'f_s' of each block by making their F-B-D.

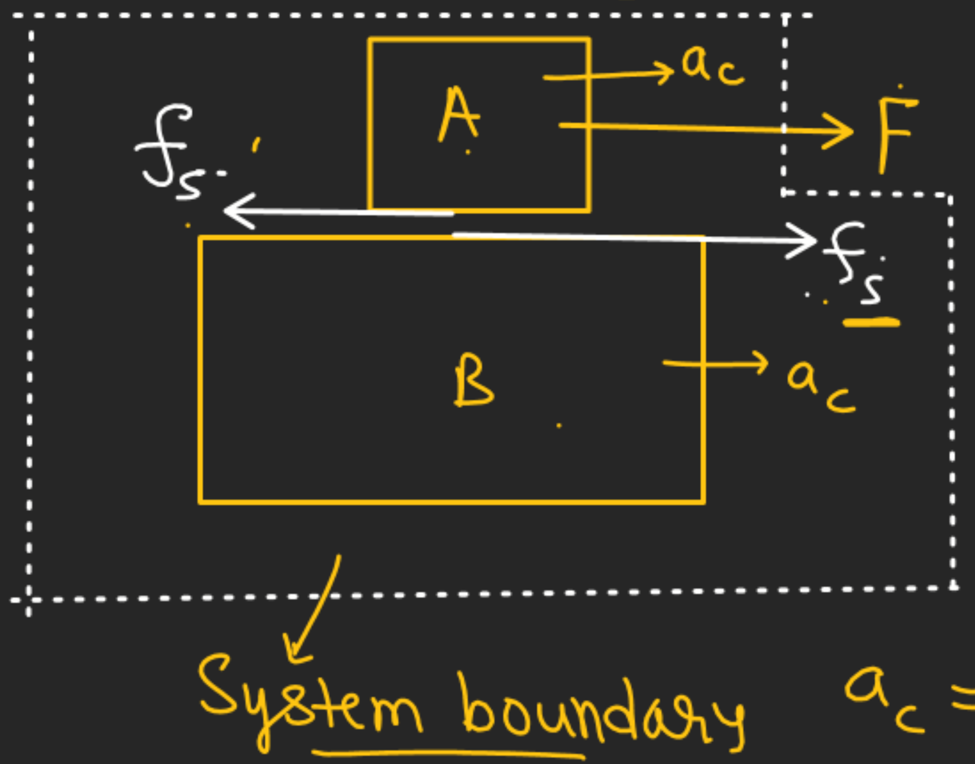
5. If $(f_s)_{calculated} < (f_s)_{max} \Rightarrow$ Our assumption is true.

$(f_s)_{calculated} > (f_s)_{max} \Rightarrow$ [Our assumption is wrong. i.e relative slipping started. K.E friction acts.
(Not possible)

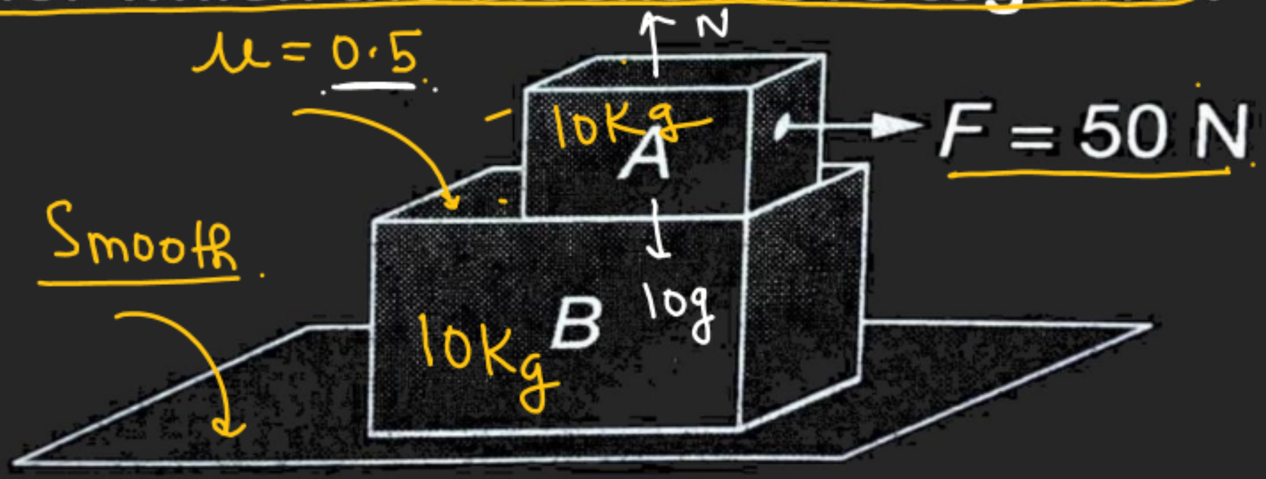
Multiple block system

FRICTION

Q.2 In the arrangement shown, calculate the acceleration of the two blocks each of mass 10 kg. The system is initially at rest and the friction coefficient between A and B is 0.5 whereas no friction exists between B and ground. Also calculate the maximum force applied on A for which the blocks move together.



Assumed both the blocks move together



For block B

$f_s = 10\,a_c$

$f_s = 10 \times \frac{5}{2}$

$= 25\text{N}$

$a_c = \frac{50}{20}$

$a_c = \frac{5}{2}\,\text{m s}^{-2}$

$(f_s)_{max} = 0.5 \times 10 \times 10$

$= 50\text{ N}$

$(f_s)_{calculated} < (f_s)_{max}$

So, Both the blocks move together.

$a = \frac{5}{2}\,\text{m s}^{-2}$

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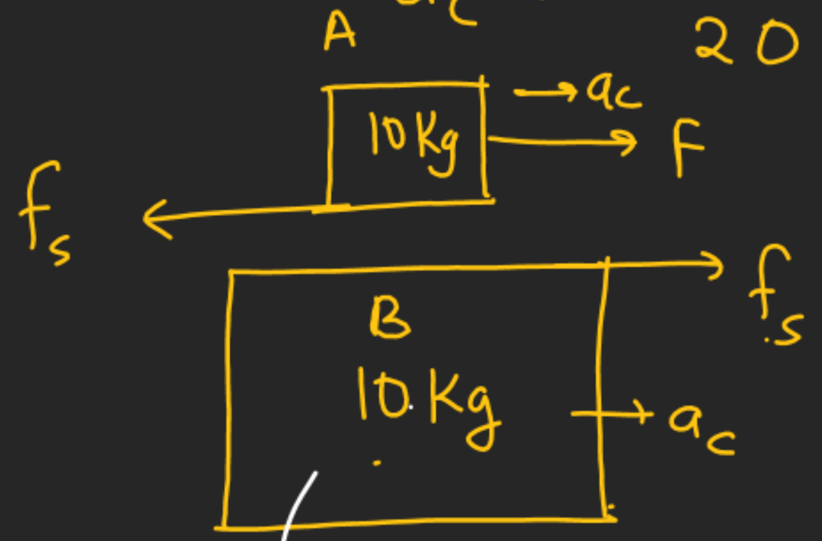
Multiple block system

FRICTION

(b) Let, $F_{max} = F$.

$$a_c = \frac{F}{20}$$



$$f_s = 10\,a_c$$

$$f_s = 10 \times \frac{F}{20} = \left[\frac{F}{2}\right] \checkmark$$

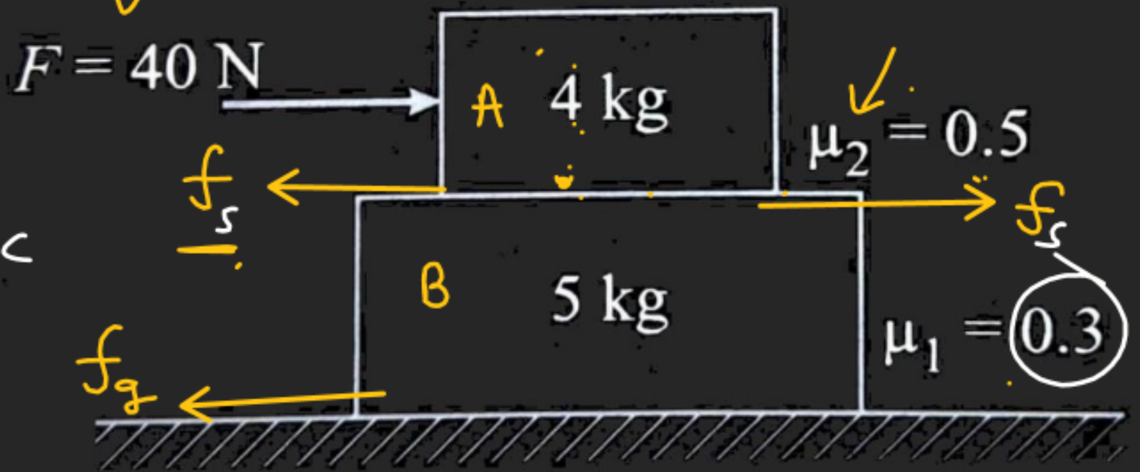
$$(f_s)_{max} = \mu \cdot N = 50$$

$$f_s \leq (f_s)_{max}$$

$$\frac{F}{2} \leq 50$$

$$\boxed{F \leq 100}$$

Q.6 Find the acceleration of the two blocks of $4\ \mathrm{kg}$ and $5\ \mathrm{kg}$ mass if a force of $40\ \mathrm{N}$ is applied on $4\ \mathrm{kg}$ block. Friction coefficients between the respective surfaces are shown in figure-~~2.2~~2. Take $g = 10\ \mathrm{m/s^2}$



Let, both the blocks move together.

$40 > (f_g)_{max}$

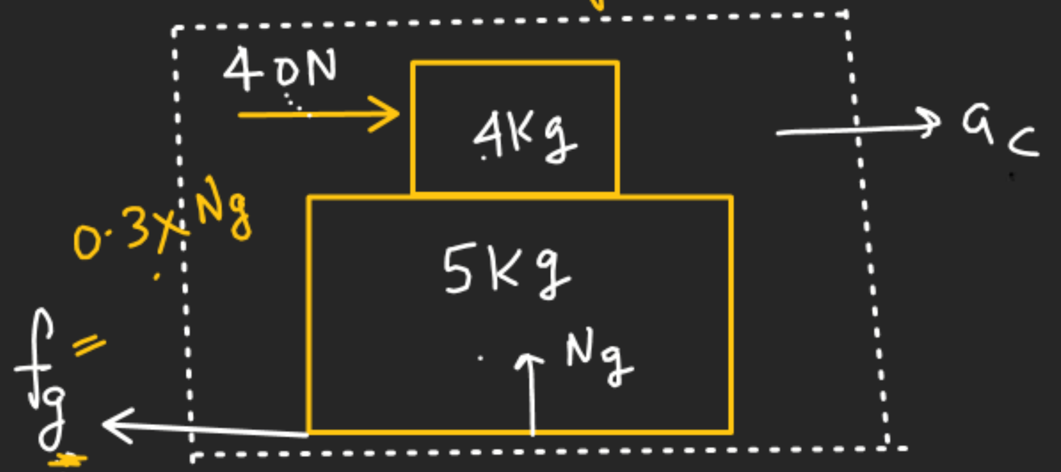
$(f_g)_{max} = 0.3 \times 90$

$= \underline{27\ \mathrm{N}}$

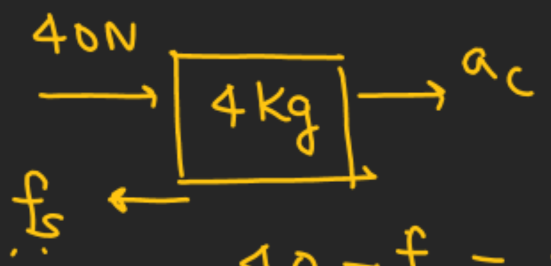
$a_c = \dfrac{40 - f_k}{9}$

$a_c = \dfrac{40-27}{9}$

$a_c = \dfrac{13}{9}\ \mathrm{m\,s^{-2}}$



$N_g = \underline{90\ \mathrm{N}}$



$40 - f_s = 4a_c$

$f_s = \left(40 - 4 \times \dfrac{13}{9}\right)$

$f_s = \dfrac{360-52}{9}$

$f_s = \dfrac{308}{9}\ \mathrm{N}$

$(f_s)_{max} = 0.5 \times 40 = \underline{20}$ ✓

$(f_s)_{calculated} > (f_s)_{max}$

Not possible

↳ Relative Motion started

Both the blocks move With different acclerations.

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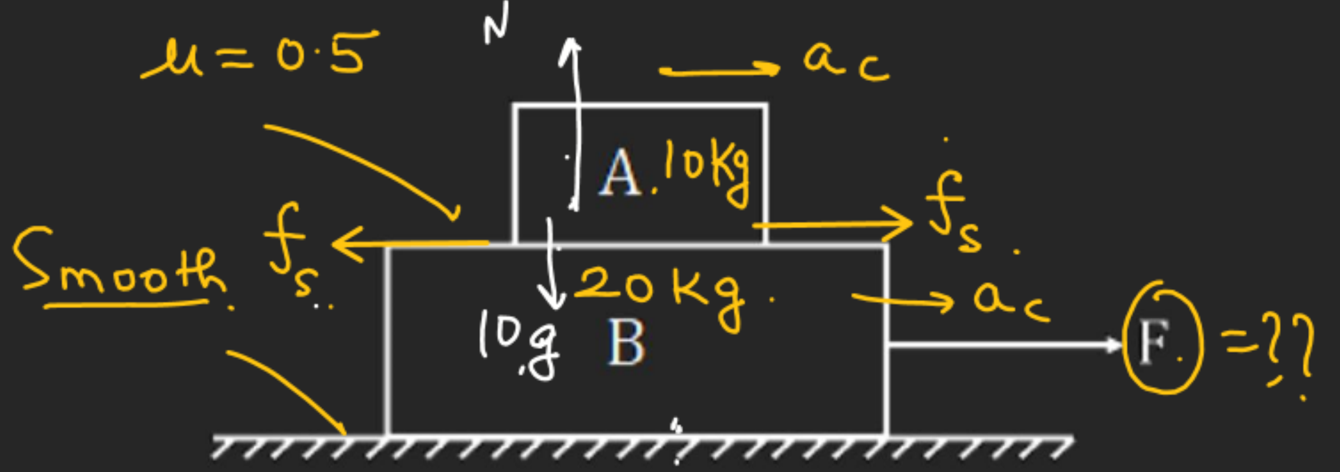
Multiple block system

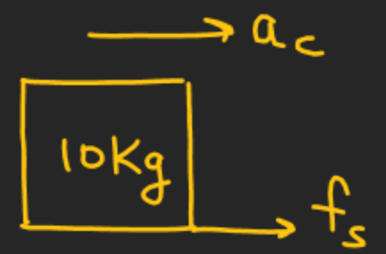
FRICTION

Q.3 In the arrangement shown, the blocks A (of mass 10 kg) and B (of mass 20 kg) are initially at rest. Calculate the minimum value of F for which sliding starts between the two blocks. Assuming the friction coefficient between A and B to be 0.5 whereas the ground is smooth.



Assume both the blocks move together.

$$a_c = \left(\frac{F}{30}\right)$$



$(f_s)_{max} = 0.5 \times 10 \times 10$
$= 50N$

$(f_s) \leq (f_s)_{max}$

$f_s = 10 a_c$

$f_s = 10\left(\frac{F}{30}\right) = \frac{F}{3}$

$\frac{F}{3} \leq 50$

$\boxed{F \leq 150} \Rightarrow$ Not to slip

For relative Motion start

$F \geq 150 \Rightarrow F_{min} = 150$ ✓

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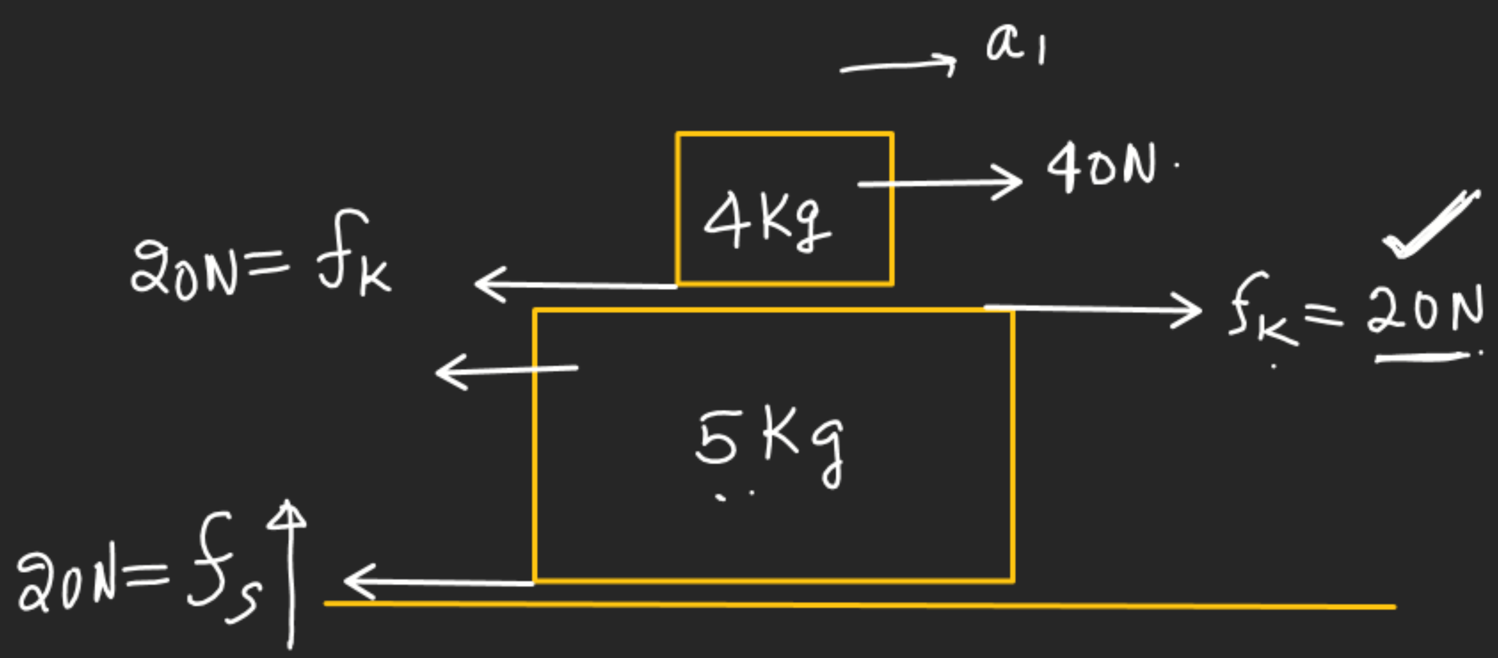
Multiple block system

FRICTION



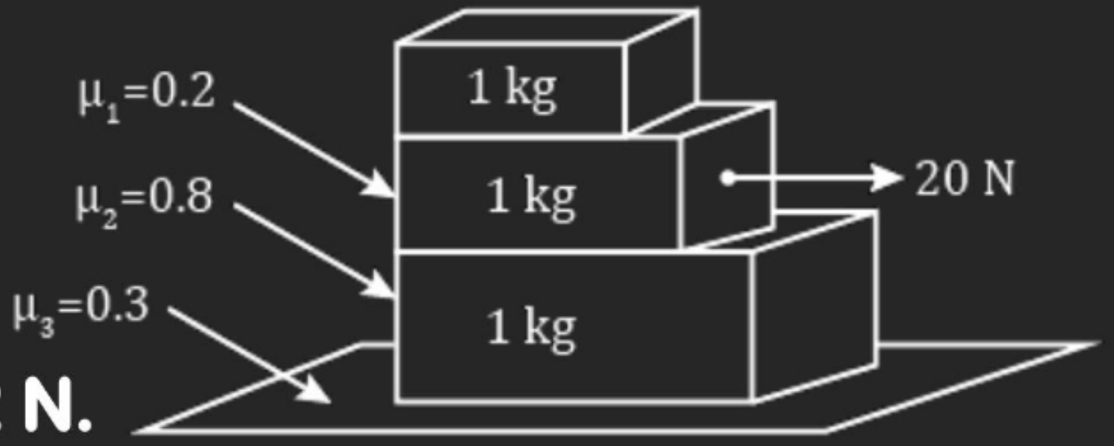
$$a_1 = \frac{40-20}{4} = \frac{20}{4} = \underline{5\,ms^{-2}}.$$

$$\boxed{a_2 = 0}$$

Maximum value of static friction due to ground = $\underline{\underline{27}}$ N.

Q.4 Three large box are kept stationary over one other as shown in figure. A horizontal force 20 N acts on middle block as shown in figure. Then select the correct statement(s).

H-W



(A) Acceleration of lowest block is 4.5 ms^{-2}.

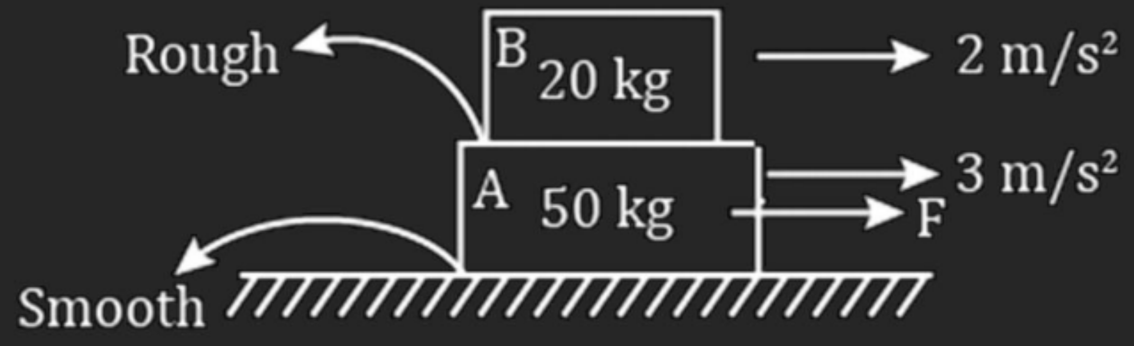
(B) Acceleration of upper most block is 2 ms^{-2}.

(C) Friction between middle and lower block is 12 N.

(D) Friction between middle and upper block is 2 N.

Q.5 A $20\ \text{kg}$ block is placed on top of $50\ \text{kg}$ block as shown in figure. A horizontal force F acting on A produces an acceleration of $3\ \text{ms}^{-2}$ in A and $2\ \text{ms}^{-2}$ in B as shown in figure. For this situation mark out the correct statement(s).

H.W



(A) The friction force between A and B is $40\ \text{N}$.

(B) The net force acting on A is $150\ \text{N}$.

(C) The value of F is $190\ \text{N}$.

(D) The value of F is $150\ \text{N}$.

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Multiple block system

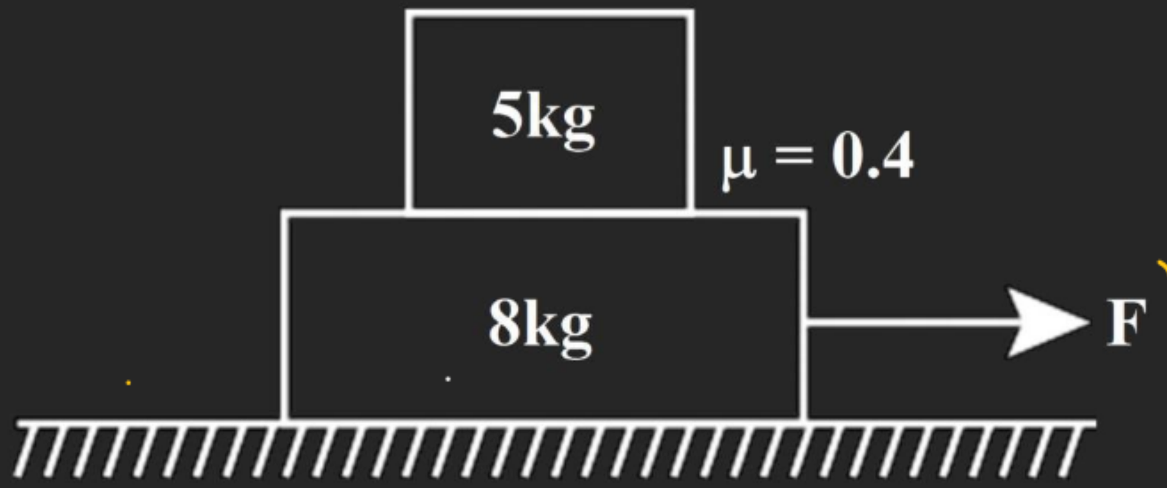
FRICTION

Q.7 Find the maximum possible force which can be applied to the 8 kg block shown in figure to move both the blocks together if bottom surface is

H-W

(a) frictionless;

(b) having friction coefficient 0.3. Take $g = 10\ m/s^2$



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Multiple block system

FRICTION

Q.8 In the situation shown in figure.

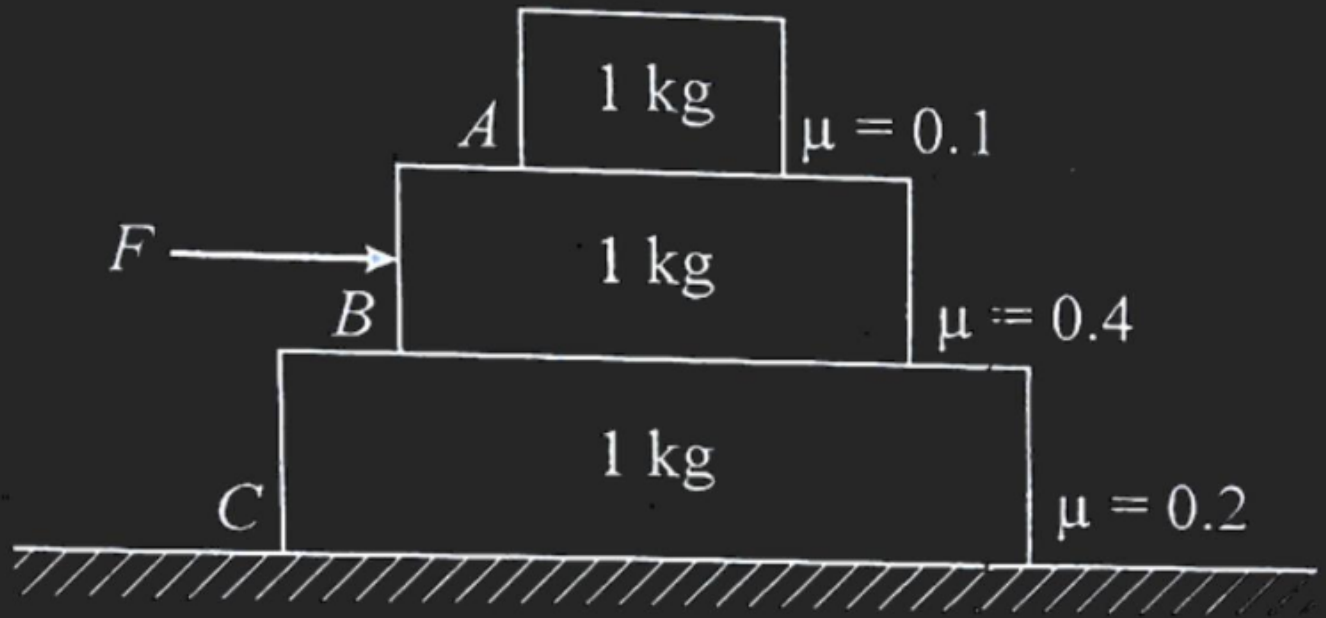
H.W

(a) For what minimum value of the force F will the system or any part of it start to move?

(b) Find the values of force F when slipping starts between

(i) A and B and

(ii) B and C. Take $g = 10\ m/s^2$



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Multiple block system

FRICTION

Q.9 (i) Find the acceleration of the two blocks shown in figure. Take $g = 10\ m/s^2$.

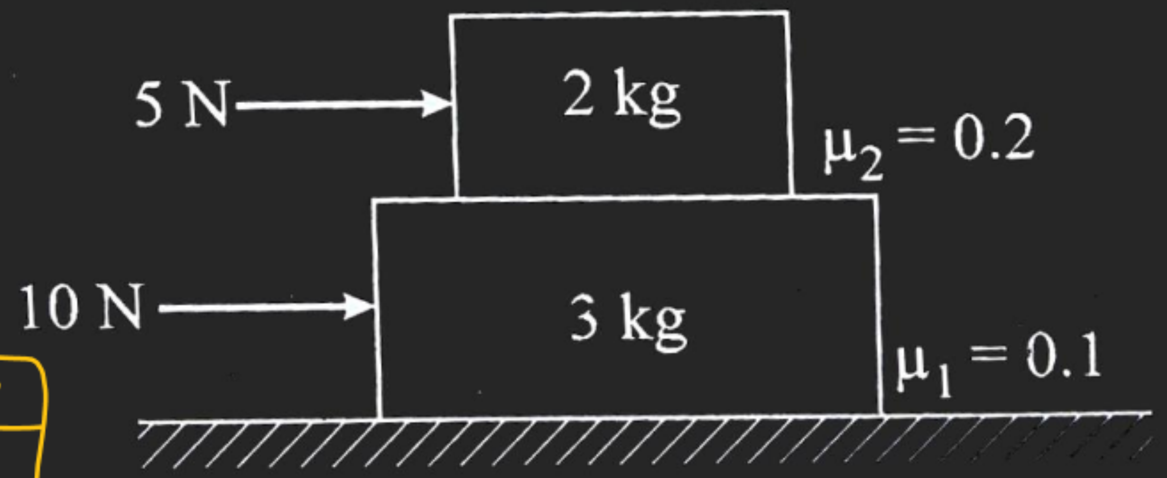
H-W

H-C-V. Friction.

page-98.

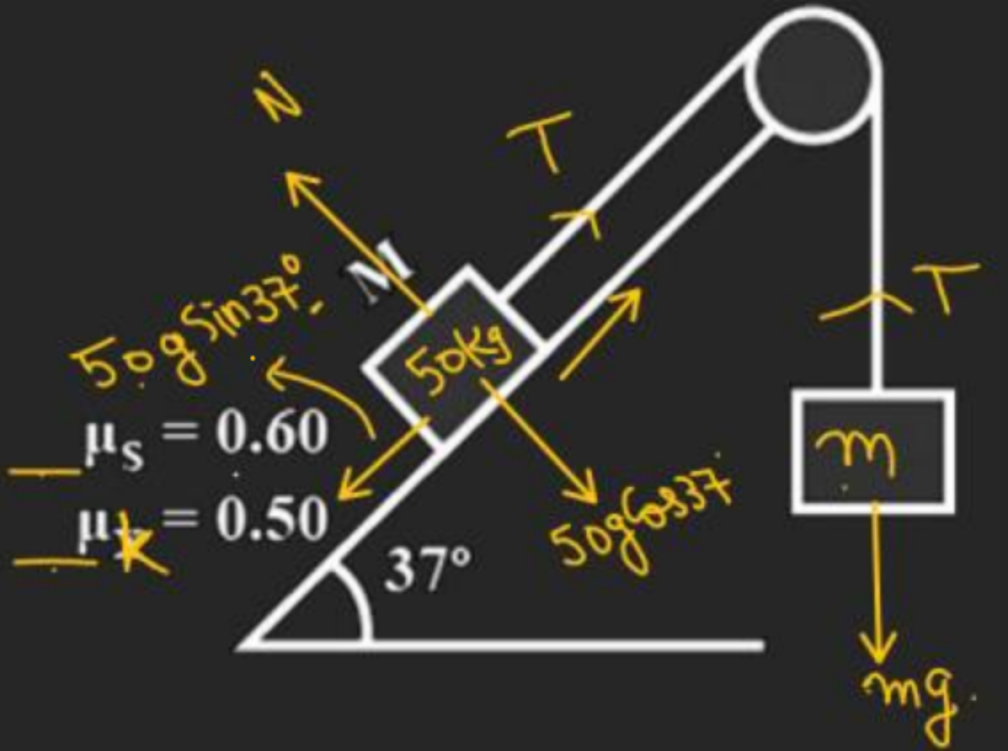
[19, 20, 21, 22, 23, 24
29,]

Toy Module ✗.



FRICTION

Q.3 Two blocks M and m are arranged as shown in Fig. If M = 50 kg, then determine the minimum and maximum values of mass of block m to keep the heavy block M stationary.



Sol^n –

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

$= 0.60 \times 400$

Minimum $= 240N$

$N = 50 \times 10 \times \frac{4}{5}$

$N = 400$ Newton ✓

$50g\sin 37° = 50 \times 10 \times \frac{3}{5}$

$= 50 \times 6$

$= 300$ Newton

For block not to slide

$300 = 240 + T$

$mg = T = 60\,N$

$m = 6\,kg$ ✓

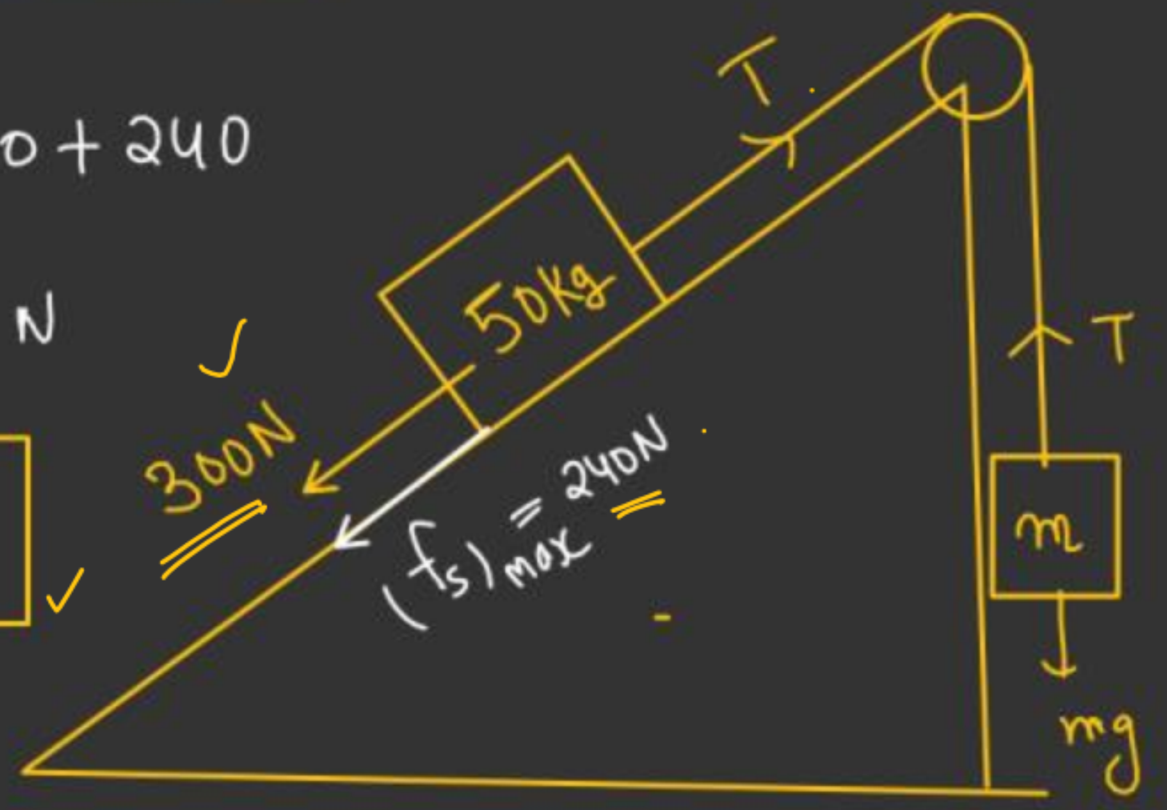
(minimum value)

For $\underline{m \rightarrow \text{maximum}}$

$$mg = 300 + 240$$

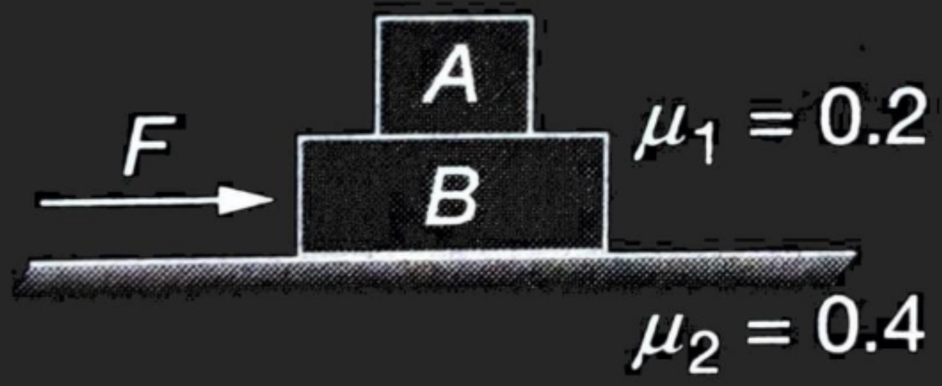
$$mg = 540 \text{ N}$$

$$\boxed{m = 54 \text{ Kg}}$$



Q.1 In the figure, $m_A = 2\ kg$ and $m_B = 4\ kg$. The minimum value of F for which A starts slipping over B is $(g = 10\ ms^{-2})$

H.W



(A) 24 N

(B) 36 N

(C) 12 N

(D) 20 N

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FRICTION

H.W.

Q.5 Block A of mass m and block B of mass $2m$ are placed on a fixed triangular wedge by means of a light and inextensible string and a frictionless pulley as shown in Fig. The wedge is inclined at 45° to the horizontal on both sides. The coefficient of friction between the block A and the wedge is $2/3$ and that between the block B and the wedge is $1/3$. If the system of A and B is released from rest, then find,

a. the acceleration of A

b. tension in the string

c. the magnitude and direction of the frictional force acting on A