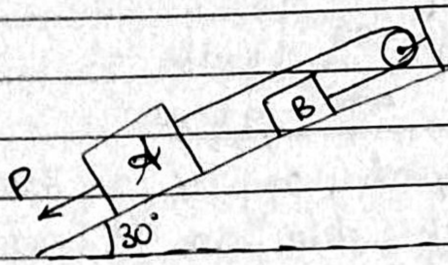
47_YASH SARANG

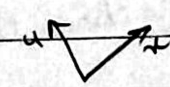
Assignment 5: Friction

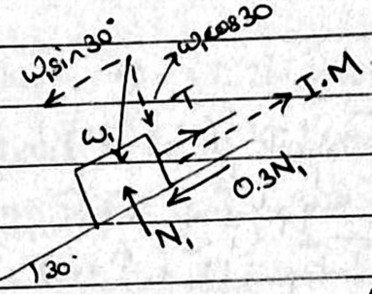
1) Determine the force P to cause motion to impend. Take masses A and B as 8kg and 4 kg repectively and coefficient of static friction as 0.3. The force P and rope are parallel to the incline plane Assume smooth pulley



→ As the force P is applied to the block A, it impends to pull it down the plane and at the same time Block B impends to travel up the plane.

F.B.D of Block B:





∴ Applying COE, $\Sigma F_x = 0$ (→ +ve)

$-0.3N_1 + T - W_1 \sin 30° = 0$

$T = 0.3 \times 33.8 + 8 \times 9.81 \times \sin 30°$

$\therefore T = 29.81\ N$

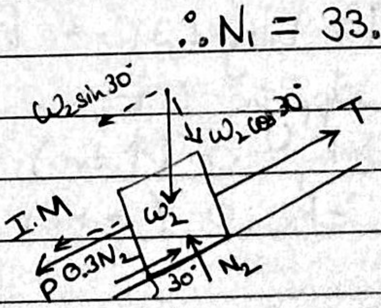
$\Sigma F_y = 0$ (↑ +ve)

$N_1 - W_1 \cos 30° = 0$

$\therefore N_1 = 8 \times 9.81 \times \cos 30°$

$\therefore N_1 = 33.98N$

F.B.D of Block A:



Applying COE,

$\Sigma F_y = 0$ (↑ +ve) $\therefore N_2 = 8 \times 9.1 \times \cos 30°$

$\therefore \Sigma F_x = 0$ (→ +ve) $\therefore 0.3N_2 + T - W_2 \sin 30° - P = 0$

$P = 0.3 \times 9.81 \times 8 \times \cos 30° + 29.81 - 8 \times 9.81 \sin 30°$

$\boxed{\therefore P = 10.96N}$

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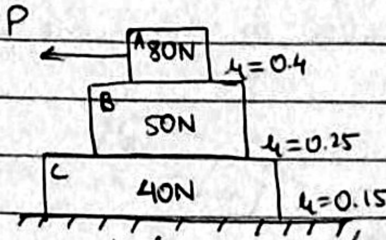
2) Three blocks are placed on the surface one above the other as shown. The coefficient of friction between the surfaces is shown. Determine the maximum value of P that can be applied before any slipping takes places.



→ When force P is applied, any of the three possibility may take place.

Possibility (1) → Block slides over B and B remains stationary with C.

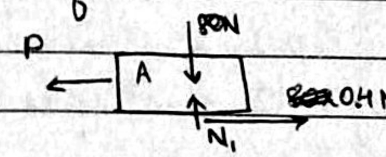
Applying COE,

$\sum F_y = 0$ (↑ +ve) $\therefore N_1 = 80N$

$\sum F_x = 0$ (→ +ve) $\therefore P = 0.4 \times 80$

$\boxed{P_1 = \cancel{24.36N}\ 32N}$

FBD of block A



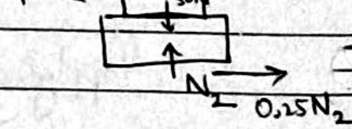
Possibility (2) → Block A and B slides over C together and C remains stationary

Applying COE,

$\sum F_y = 0$ (↑ +ve) $\therefore N_2 = 130N$

$\sum F_x = 0$ (→ +ve) $\therefore P_2 = 0.25 \times 130$

$\boxed{\therefore P_2 = 32.5N}$



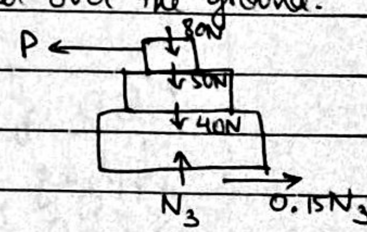
Possibility (3) → Block A, B and C slide together over the ground.

Applying COE,

$\sum F_y = 0$ (↑ +ve) $\therefore N_3 = 170N.$

$\sum F_x = 0$ (→ +ve) $\therefore P_3 = 0.15 \times 170$

$\boxed{\therefore P_3 = 25.5N}$



∴ The maximum value of P that can be applied before any slipping takes place is 25.5N.

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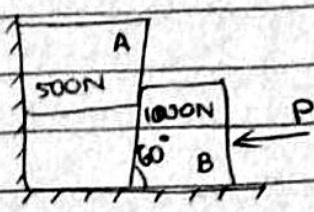
3) Two blocks A and B are resting against the wall and floor as shown in figure. Find minimum value of P that will hold the system in equilibrium. $\mu = 0.25$ at the floor, $\mu = 0.3$ at the wall and $\mu = 0.2$ between blocks

→ In this wedge problem, Wedge A ~~and~~ ~~is~~ under its own weight, impends to move down pushing wedge B to the right. Force P prevents this and holds the system in equilibrium.

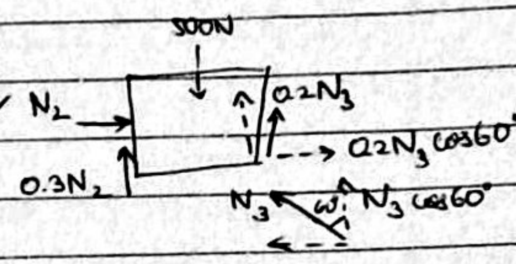


F.B.D of wedge A :

$\Sigma F_x = 0$ (→ +ve)

$0.2N_3 \cos 60° + N_2 - N_3 \sin 60° = 0$

$\therefore N_2 - 0.766N_3 = 0$ —— ①



$\Sigma F_y = 0$ (↑ +ve) $\therefore$ $N_3 \cos 60° + 0.3N_2 - 500 + 0.2N_3 \sin 60° = 0$

$\therefore$ $0.3N_2 + 0.6732N_3 = 500$ —— ②

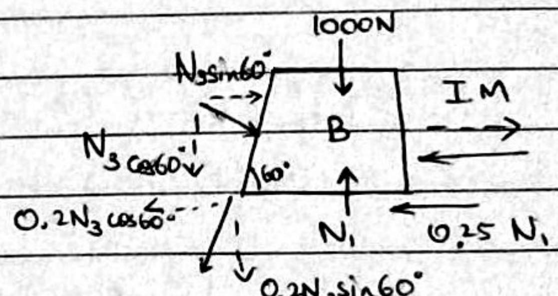
from ① and ②, we get $N_2 = 424N$ and $N_3 = 553.7N$

F.B.D of wedge B :

$\therefore \Sigma F_y = 0$ (↑ +ve)

$N_1 - 0.2N_3 \sin 60° - N_3 \cos 60° - 1000 = 0$

$\boxed{\therefore N_1 = 1372.7N}$



$\Sigma F_x = 0$ (→ +ve) $\therefore$ $N_3 \sin 60° - 0.25N_1 - 0.2N_3 \cos 60° - P = 0$

$\boxed{\therefore P = 80.97N}$

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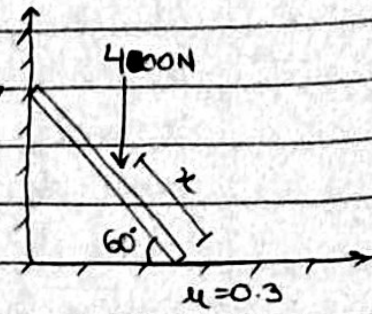
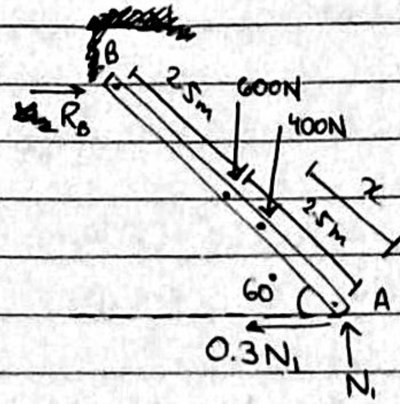
4) A person of weight P = 600N ascends the 5m ladder of weight 400N as shown. How far up the ladder may the person climb before sliding motion of ladder takes place.



→ For maximum distance 'x' the person climbs, the ladder impends to slip down and move away from the wall.

F.B.D of ladder.



$\therefore \Sigma F_x = 0$ ($\rightarrow$ +ve) $\therefore N_1 - 1000 = 0$ $\boxed{\therefore N_1 = 1000N}$

$\therefore \Sigma F_y = 0$ ($\uparrow$ +ve) $\therefore R_B - 0.3N_1 = 0.$

$\therefore R_B = 300N.$

$\therefore \Sigma M_A^F = 0$ ($\circlearrowleft$ +ve)

$x\cos 60 \times 400 + 2.5\cos 60 \times 600 - R_B\, 5\sin 60° = 0.$

$\boxed{\therefore x = 2.663m}$