ME1020 Homework 3

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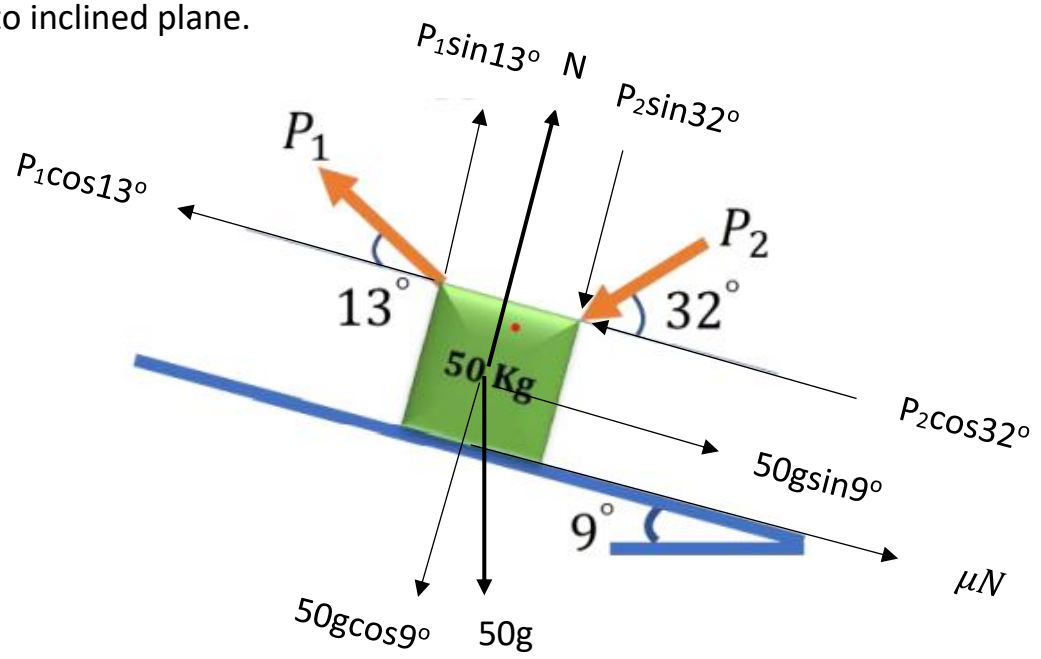
Question 1:-

a) Considering x axis parallel to the inclined plane and y axis perpendicular to inclined plane.



b) $\Sigma F_X = 0$

$\Rightarrow P_1 cos13^o + P_2 cos32^o - 50gsin9^o - \mu N = 0$ ..... (1)

$\Sigma F_Y = 0$

$\Rightarrow P_1 sin13^o - P_2 sin32^o + N - 50gcos9^o = 0$ ..... (2)

c) As the block just moves, using static friction $\mu_s = 0.8$

Eliminating N in eq (1) using eq (2) we get:-

$\Rightarrow P_1 cos13^o + P_2 cos32^o - 50gsin9^o - \mu(50gcos9^o - P_1 sin13^o + P_2 sin32^o) = 0$

Using $\mathbf{P_1=2P_2}$ in above eqtn we get:-

$$P_2 = \frac{50g(sin9^o + \mu_s cos9^o)}{[2cos13^o + cos32^o - \mu_s(sin32^o - 2sin13^o)]}$$

Solving we get $\boldsymbol{P_2 = 169.773\ N}$

Also $P_1=2P_2 \Rightarrow \boldsymbol{P_1 = 339.546\ N}$

d) Max friction is when block is just about to move
From eqtn 1 we get value of friction as

$$f = P_1 cos13^o + P_2 cos32^o - 50gsin9^o$$

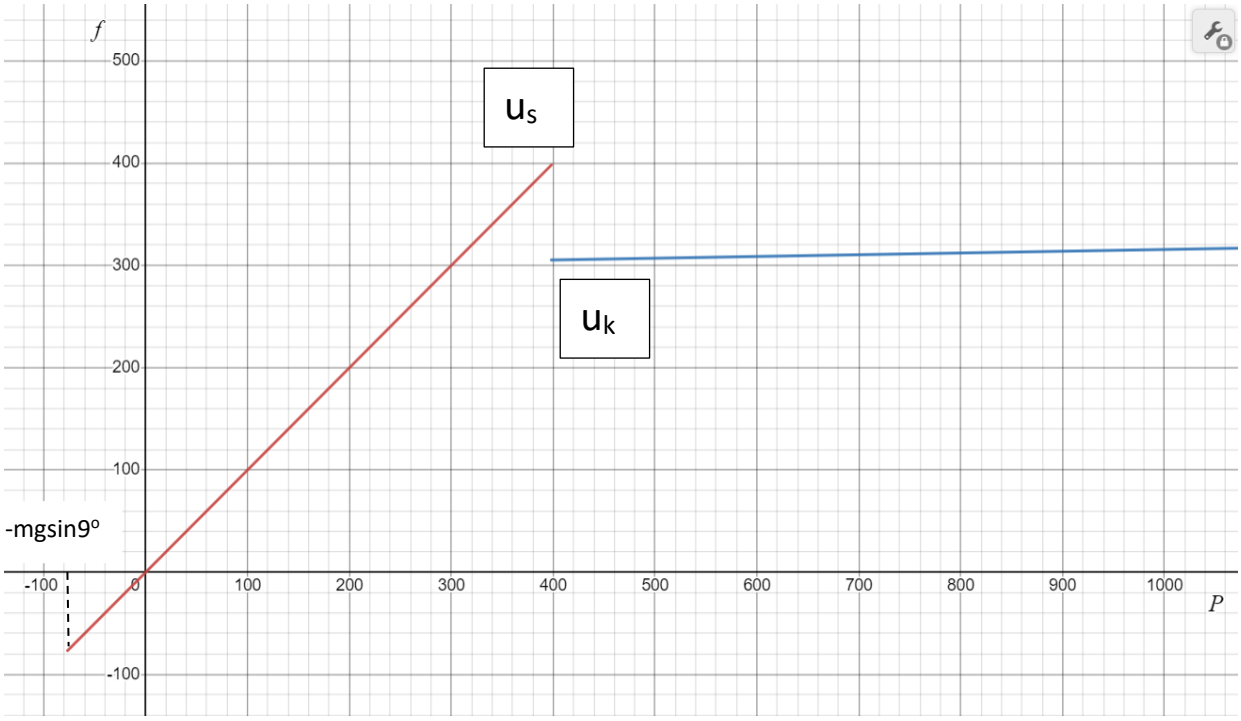
Substituting values of P_1 and P_2 in above eqtn we get f as

$$\Rightarrow \boldsymbol{f_{max} = 398.166\ N}$$

e) $P = P_1 cos13^o + P_2 cos32^o - 50gsin9^o$ ..... (3)

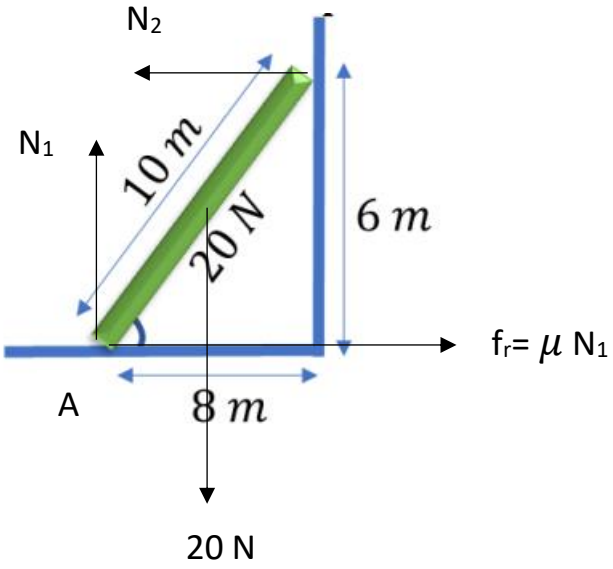
When $-mgsin9^o \leq P \leq 398.166 \Rightarrow f = P$

Also $N = \frac{398.166}{0.8}$
For block to just move
$\Rightarrow f = \mu_k N = \frac{0.6}{0.8} \times 398.166 = 298.624\ N$
When
$P > 298.624 \Rightarrow f = 298.624 + 0.017P$
The graph is following


f
500
400
300
200
100
-100
-mgsin9°
-100
0
100
200
300
400
500
600
700
800
900
1000
P
u_s
u_k

Question 2:-

a)



b) $\Sigma F_X = 0$

$\Rightarrow f_r - N_2 = 0$ .... (1)

$\Sigma F_Y = 0$

$\Rightarrow N_1 - 20 = 0$ .... (2)

$\Sigma M_A = 0$

$\Rightarrow N_2(6) - 20(\frac{8}{2}) = 0$ .... (3)

c) From eqtn (2) we get **N_1=20 N**

From eqtn (3) we get **N_2=40/3=13.33 N**

Also form eqtn(1) we get **f_r=N_2=13.33 N**

d) As the ladder is about to slip $\mathbf{f_{max}=f_r=13.33\ N}$