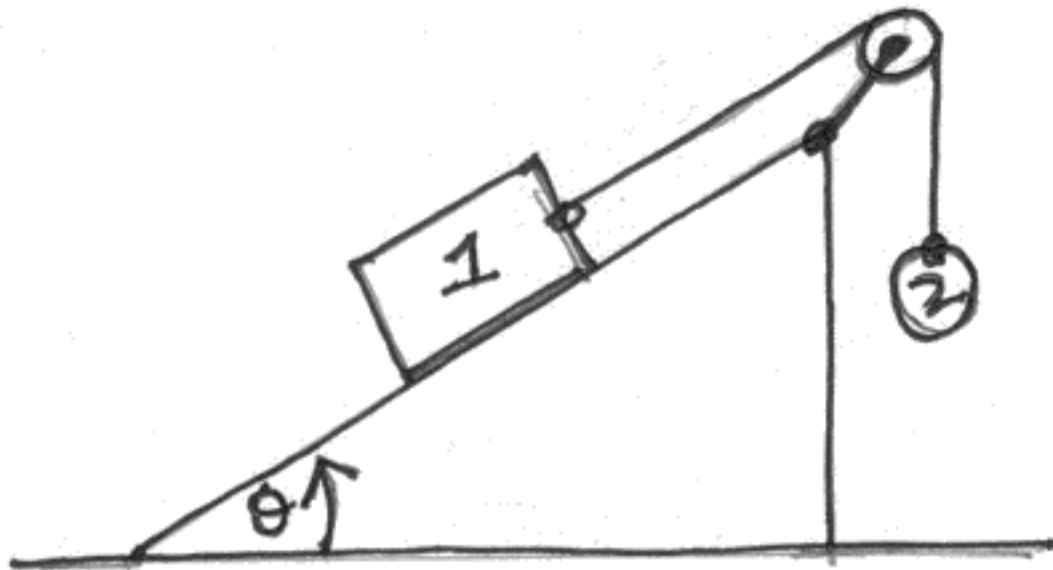


### D:(25 points) Inclined Plane and Pulley

A large weight  $w_1 = 98N$  sits on a surface inclined at an angle  $\theta = 35^\circ$  from the horizontal. A smaller weight  $w_2 = 58.8N$  is connected to the block by a string that goes up over a pulley. Suppose there is no friction. When the two weights are released, one will go up and the other will go down. Which weight goes down? Explain why. What is its acceleration?

•(2pts) Circle the weight that goes down: WEIGHT 1 or WEIGHT 2

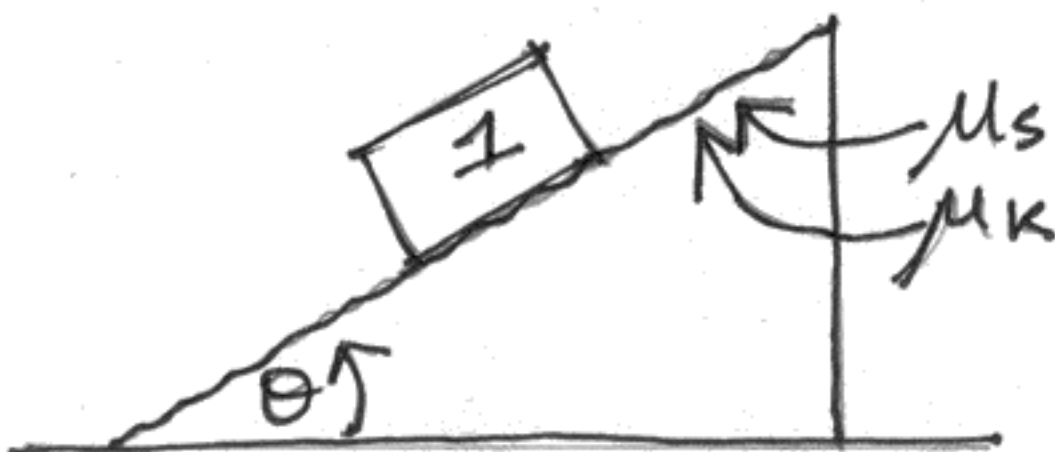
•(3pts)  $a =$  \_\_\_\_\_



Now include friction ( $\mu_k = \mu_s = 0.2$ ) but remove the small hanging weight  $w_2$ . Show that the large weight  $w_1$  slides down, and find its acceleration after it starts moving.

•(5pts) Have you shown that the large weight  $w_1$  slides down?

•(5pts)  $a =$  \_\_\_\_\_

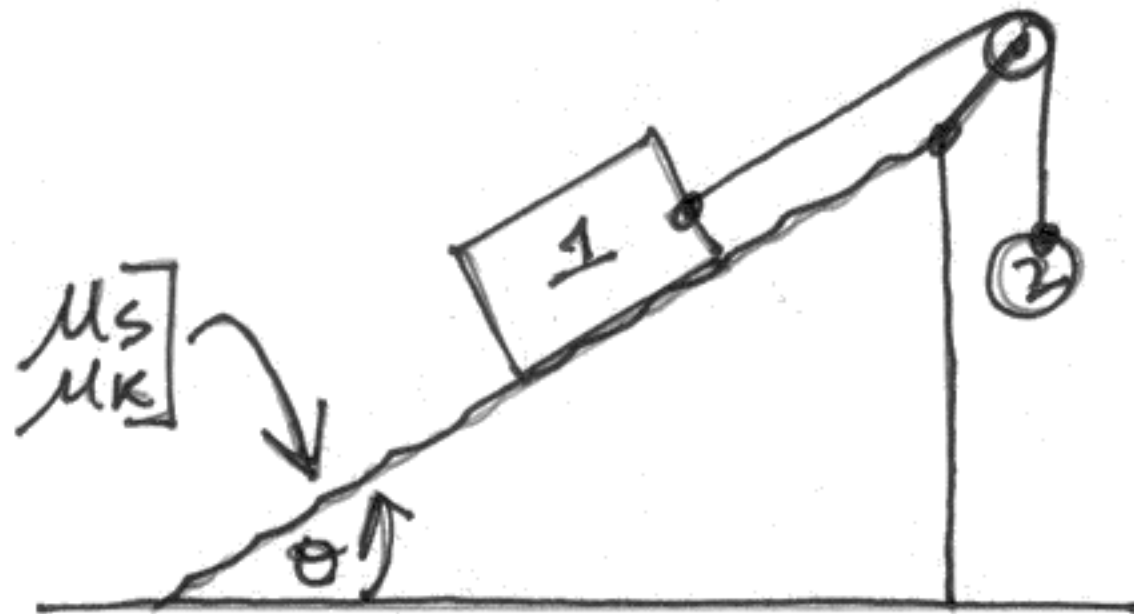


### D: Inclined Plane and Pulley (Continued)

Finally, include friction as above, but place the small hanging weight  $w_2$  again on the string. Start the weights at rest again. Find the maximum and minimum values  $w_2^{min}$  and  $w_2^{max}$  that will serve to keep the large weight  $w_1$  from moving.

•(5pts)  $w_2^{min} =$  \_\_\_\_\_

•(5pts)  $w_2^{max} =$  \_\_\_\_\_



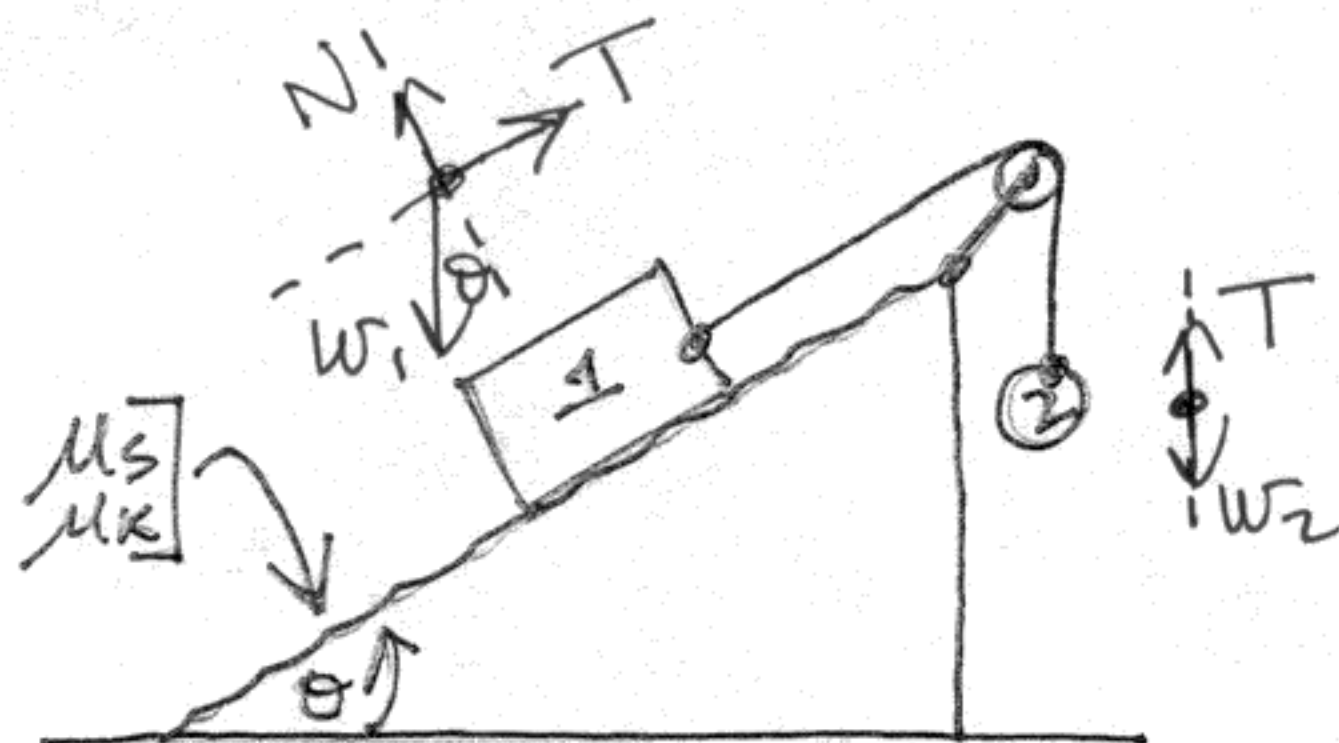


### D: Inclined Plane and Pulley (Continued)

Finally, include friction as above, but place the small hanging weight  $w_2$  again on the string. Start the weights at rest again. Find the maximum and minimum values  $w_2^{\min}$  and  $w_2^{\max}$  that will serve to keep the large weight  $w_1$  from moving.

•(5pts)  $w_2^{\min} = \underline{40.2 \text{ N}}$

•(5pts)  $w_2^{\max} = \underline{72.3 \text{ N}}$



$$T = w_2$$

$$N = w_1 \cos \theta$$

$$f_s = \mu_s N$$

$$= \mu_s w_1 \cos \theta$$

$$w_1 = 98 \text{ N}, \mu_s = \mu_k = 0.2$$

⊙ No motion  $\implies$

$$f = f_s$$

⊙ Extreme cases  $\implies$

$$f = f_{s, \max}$$

Ⓐ Min  $w_2$   $\implies$   $f_s$  points up.

$$T + f_s = w_1 \sin \theta$$

$$w_2 + \mu_s w_1 \cos \theta = w_1 \sin \theta$$

$$w_2 = w_1 (\sin \theta - \mu_s \cos \theta)$$

$$w_2^{\min} = \boxed{40.1551 \text{ N}}$$

Ⓑ Max  $w_2$   $\implies$   $f_s$  points down.

$$T - f_s = w_1 \sin \theta$$

$$w_2 - \mu_s w_1 \cos \theta = w_1 \sin \theta$$

$$w_2 = w_1 (\sin \theta + \mu_s \cos \theta)$$

$$w_2^{\max} = \boxed{72.2659 \text{ N}}$$