GP: Free Response Questions **Name:** ______________________________

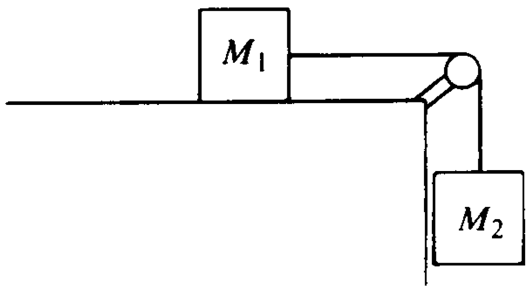
AP Physics 1 – McNutt Date: __________ Period: __________

LINEAR MOMENTUM PRACTICE

For each question, please highlight/underline the important information given, and then organize your answers into coherent statements that are backed by equation-based evidence. You will need to identify and rearrange formulas to determine the correct answers.

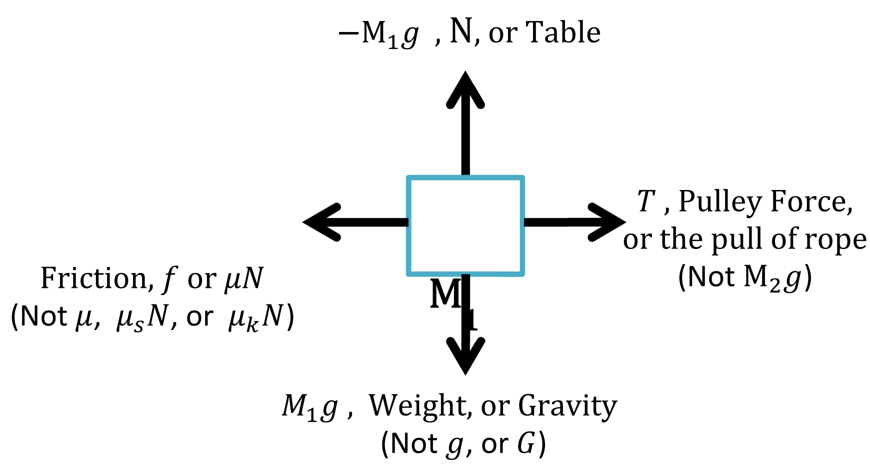
[1987B1.]

- LINEAR MOMENTUM



In the system shown above, the block of mass M_1 is on a rough horizontal table. The string that attaches it to the block of mass M_2 passes over a frictionless pulley of negligible mass. The coefficient of kinetic friction μ_k between M_1 and the table is less than the coefficient of static friction μ_s.

a.) On the diagram below, draw and identify all the forces acting on the block of mass M_1.



b.) In terms of M_1 and M_2 determine the minimum value of μ_s that will prevent the blocks from moving.

- Start with the Main Force Equation: $\sum F_{External} = m_{Total} \cdot a$
- The maximum force of static friction on mass M_1 is $(\mu_s \cdot N)$
- And Normal Force for M_1 is $N = (M_1 \cdot g)$
- $M_2 \cdot g - \mu_s \cdot M_1 \cdot g = 0$
- Reduces to $\mu_s = \frac{M_2}{M_1}$

The blocks are set in motion by giving M_2 a momentary downward push. In terms of M_1, M_2, μ_k, and g, determine each of the following:

c.) The magnitude of the acceleration of M_1

- Start with the Main Force Equation: $\sum F_{External} = m_{Total} \cdot a$
- Now Kinetic Friction is acting on M_2 and the formula becomes

  $(M_2 \cdot g - \mu_k \cdot M_1 \cdot g) = (M_1 + M_2) \cdot a$
- Rearrange the formula to solve for a

  $$a = \frac{(M_2 \cdot g - \mu_k \cdot M_1 \cdot g)}{(M_1 + M_2)}$$

d.) The tension in the string.

- Start with the Main Force Equation: $\sum F_{External} = m_{Total} \cdot a$
- For the hanging block becomes the formula

  $(M_2 \cdot g - T) = (M_2 \cdot a)$
- Substitute a from the above equation in part (c.)

  $$(M_2 \cdot g) - T) = \left[M_2 \cdot \left(\frac{(M_2 \cdot g) - \mu_k \cdot M_1 \cdot g)}{(M_1 + M_2)}\right)\right]$$

- Now it's time to rearrange & solve for T
- Cancel from the above equation in part

  $$(M_2 \cdot g) - T = \left[M_2 \cdot \left(\frac{(M_2 \cdot g) - (M_2 \cdot g) - \mu_k \cdot M_1 \cdot g)}{(M_1 + M_2)}\right)\right]$$

  $-(M_2 \cdot g)$

- Divide $-T$ by -1 to isolate $(-\mu_k)$ & turn the entire equation into

  $$\frac{(-T) =}{(-1)} \quad \frac{\left[M_2 \cdot \left(\frac{(-\mu_k) \cdot M_1 \cdot g)}{(M_1 + M_2)}\right)\right]}{(-1)}$$

- This gives you a reduced answer of $T = \frac{M_2 \cdot M_1 \cdot g}{(M_1 + M_1)}(1 + \mu_k)$