

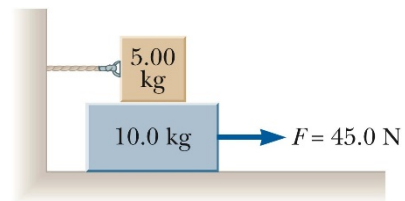
## University Physics I

### Homework Set 8

1. A rifle bullet with a mass of  $12.0\text{ g}$  traveling toward the right at  $260\text{ m/s}$  strikes a large bag of sand and penetrates it to a depth of  $23.0\text{ cm}$ . Determine the magnitude and direction of the friction force (*assumed constant*) that acts on the bullet.
2. A car is traveling at  $50.0\text{ mph}$  on a horizontal highway.
  - a. If the coefficient of static friction between the road and the tires on a rainy day is  $0.100$ , what is the minimum stopping distance of the car?
  - b. What is the minimum stopping distance of the car when the surface is dry and the coefficient of static friction is  $0.600$ ?
3. A woman at an airport is towing her  $20.0\text{ kg}$  suitcase at a constant speed by pulling on a strap at an angle  $\theta$  above the horizontal as shown in the figure at right. She pulls on the strap with a  $35.0\text{ N}$  force. The friction force on the suitcase is  $20.0\text{ N}$ .
  - a. What angle does the strap make with the horizontal?
  - b. What is the magnitude of the normal force that the ground exerts on the suitcase?

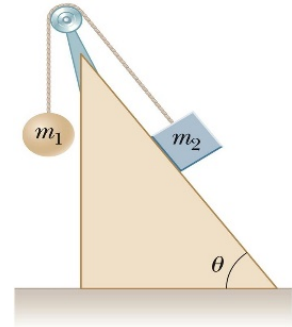


4. A  $9.00\text{ kg}$  hanging object is connected by a light, non-stretchable cord over a frictionless pulley to a  $5.00\text{ kg}$  block that is sliding on a flat table. Taking the coefficient of kinetic friction as  $0.200$ , find the tension in the string.
5. A  $3.00\text{ kg}$  block starts from rest at the top of the  $30.0^\circ$  incline and slides a distance of  $2.00\text{ m}$  down the incline in  $1.50\text{ s}$ . Find:
  - a. The magnitude of the acceleration of the block
  - b. The coefficient of kinetic friction between the block and plane
  - c. The friction force acting on the block
  - d. The speed of the block after it has slid  $2.00\text{ m}$ .
6. A  $5.00\text{ kg}$  block is placed on top of a  $10.0\text{ kg}$  block as show at right. A horizontal force of  $45.0\text{ N}$  is applied to the  $10.0\text{ kg}$ , while the  $5.00\text{ kg}$  block is tied to the wall. The coefficient of kinetic friction between all moving surfaces is  $0.200$ . Determine:
  - a. The tension in the string
  - b. The magnitude of the acceleration of the  $10.0\text{ kg}$  block.



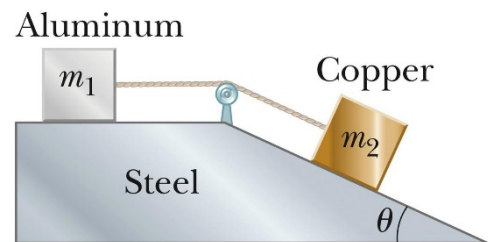
7. You are called as an expert witness in a traffic violation trial. The facts are these: A drivers slammed on his brakes and slid to a stop in  $192\text{ ft}$  with a constant acceleration. It was determined that he locked his brakes & the coefficient of kinetic friction between his tires and the pavement was  $0.650$ . He was charged with speeding in a  $45\text{ mph}$  zone, but pleads he is innocent. Using these facts, what is your conclusion: Guilty or Innocent? How fast was he going when he slammed on his brakes?

8. In the figure at right, two blocks,  $m_2 = 20.0 \text{ kg}$  and  $m_1$  are attached by a massless string over a frictionless and massless pulley. The angle of the incline is  $53.1^\circ$ . The coefficient of kinetic friction between the block of mass  $m_2$  and the incline is  $\mu_k = 0.40$ . What must the mass of  $m_1$  be if it is to descend  $12.0 \text{ m}$  in the first  $3 \text{ sec}$  after the system is released from rest?

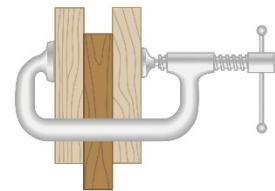


9. Two blocks,  $m_1 = 500.0 \text{ g}$  and  $m_2 = 250.0 \text{ g}$  are attached by a massless string over a frictionless and massless pulley as shown at right. The coefficients of static and kinetic friction are  $0.250$  and  $0.123$ , respectively. The angle of the incline is  $30.0^\circ$  and the blocks are initially at rest.

- In what direction do the blocks move?
  - What is the acceleration of the blocks?
10. An aluminum block of mass  $m_1 = 2.00 \text{ kg}$  and a copper block of mass  $m_2 = 6.00 \text{ kg}$  are connected by a massless string over a frictionless and massless pulley. The sit on a steel surface as shown in the figure at right. The angle of the incline is  $30.0^\circ$  and the coefficient of static friction between the aluminum and steel surface is  $0.61$  and the coefficient of static friction between the copper and steel surface is  $0.53$ . When they are released from rest, will they start to move?



- If they do, determine their acceleration and the tension in the string.
  - If they don't, determine the sum of the magnitudes of the forces of friction acting on each block.
11. The board sandwiched between two other boards in the figure at right weights  $95.5 \text{ N}$ . If the coefficient of static friction between all surfaces in contact with each other is  $0.663$ , what must be the magnitude of the compression forces (*assumed horizontal*) acting on both sides of the center of the board to keep it from slipping?



12. \*\* You are an engineer working for a manufacturing company. You are designing a mechanism that uses a cable to drag heavy metal blocks a distance of  $8.00\text{ m}$  along a ramp that is sloped at  $40.0^\circ$  about the horizontal. The coefficient of kinetic friction between the blocks and the ramp is  $0.350$ . Each block has a mass of  $2170\text{ kg}$ . The block will be placed at the base of the ramp, the cable will be attached, and then the block will be given just enough of a momentary push to overcome static friction. The block is then to accelerate at a constant rate to move up the  $8.00\text{ m}$  ramp in  $4.20\text{ s}$ . The cable is made of wire rope and is parallel to the ramp surface. The table below gives the breaking strength of the cable as a function of its diameter; the safe load tension (*which is 20% of the breaking strength*); and the mass per meter of the cable.

Cable Diameter (in.)	Breaking Strength (kN)	Safe Load (kN)	Mass per Meter (kg/m)
0.250 ( $\frac{1}{4}$ )	24.4	4.89	0.16
0.375 ( $\frac{3}{8}$ )	54.3	10.9	0.36
0.500 ( $\frac{1}{2}$ )	95.2	19.0	0.63
0.625 ( $\frac{5}{8}$ )	149	29.7	0.98
0.750 ( $\frac{3}{4}$ )	212	42.3	1.41
0.875 ( $\frac{7}{8}$ )	286	57.4	1.92
1.000 ( <b>1</b> )	372	74.3	2.50

- What is the minimum diameter of the cable that can be used to pull a block up the ramp without exceeding the safe load value of the tension in the cable? (*Ignore the mass of the cable*)
- You need to know safe load values for diameters that are not listed in the table, so you hypothesize that the breaking strength and safe load limit are proportional to the perpendicular cross sectional area of the cable.
  - Create a graph of Safe Load (SL) vs diameter squared ( $d^2$ ) that tests this hypothesis and discuss its accuracy.
  - Using a trendline equation from your previous graph, what is your estimate of the safe load value for a cable with a diameter of  $9/16\text{ in}$ ?
- If the  $9/16\text{ in}$  cable is  $9.00\text{ m}$  long, how accurate is it to ignore the cable's mass? (*Consider the fraction of the total mass (cable + block) that is due to just the cable when answering*).