Physics Class Work – Friction Problems

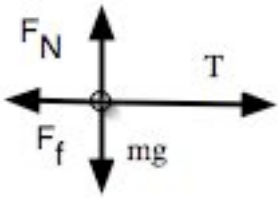
Example

Coefficient of friction can be determined from the force required to drag and object at constant speed, and the weight of the object. A 49-N block is pulled by a horizontal force of 50.0 N along a rough horizontal surface at a constant acceleration of 6 m/s/s. What is the coefficient of friction?

Answer to example 4:

Fg = 49-N
T = 50.0 N
a = 6 m/s/s.
μ = ?

Free-body diagram:



This free body diagram shows normal force cancelling weight, and friction partially offsetting tension or applied force.

Sum the forces: In the vertical axes forces are equal and opposite as there is no vertical acceleration.
F_N = -Fg
F_N = mg = 49 N

Also, m = 49/9.81 = 4.99 kg

In the horizontal axis,
Fnet = T + Ff
Fnet = (50 N) + Ff

Newton's Second Law:
Fnet = ma

Fnet = (4.99 kg)(6) = 30.0 N

Therefore, Ff = Fnet – T = 30.0 N – 50.0 N = -20.0 N (directed against the motion)

Thus μ = Ff/Fn = 20.0N/49.0N = 0.408

Problems

1. A 15.0 kg block is pulled by a horizontal force of 30.0 N along a rough horizontal surface at constant velocity. What is the coefficient of friction?
Tension on a string pulls a block along a horizontal surface.

2. A car is traveling at 60.6 mph on a horizontal highway. The acceleration of gravity is 9.8 m/s2. If the coefficient of friction between road and tires on a rainy day is 0.056, what is the minimum distance in which the car will stop? Answer in units of m.

3. If the coefficient of kinetic friction between a 35 kg crate and the floor is .30, what horizontal force is required to move the crate at a steady speed across the floor? What horizontal force is required if μk is zero?

4. A 300 lbs car is loose inside a shopping mall where uk=0.5 If the car is initially traveling at 60 f/sec.
a) what is the kinetic friction force, if the brakes are locked?
b) what distance will it take to stop if the brakes are locked?

5. Car A is towing car B. Both cars have the same mass ma = mb = 1000 kg. Car A has four-wheel drive, and the static coefficient of friction between its tires and the road is μs = 1.00 Neglect any friction force acting on car B. Car A is accelerating at 1m/s/s. Calculate the tension in the horizontal rope connecting the cars.

6. A 4.0 kg toboggan rests on a frictionless icy surface and a 2.0 kg box rests on top of the toboggan. The coefficient of static friction between the box and toboggan is .60, whereas kinetic friction coefficient is .51.. The box is pulled by a 30 N force along the horizontal parallel to the icy floor. What are the magnitudes and directions of the resulting accelerations of the block and toboggan?

7. Four blocks are arranged on a frictionless surface. Two smaller placed on two larger, and a cord connects the two top (small) blocks, and a cord is used to pull the first large block. There is friction only between the top and bottom blocks. What is the maximum value of F applied to one of the blocks to make all four move with the same acceleration?

8. A block of mass 1.95 kg slides with an initial speed of 4.33 m/s on a smooth, horizontal surface. The block now encounters a rough patch with a coefficient of kinetic friction given by μk = 0.260. What is the acceleration of the block when it is in the rough patch?

9. A packing crate is placed on a plane inclined at an angle of 35° from horizontal. If the coefficient of static friction between the crate and the plane is 0.65, will the crate slide down the plane?

10. Suppose that you are standing on a train accelerating at 0.10g. What minimum coefficient of static friction must exist between your feet and the floor if you are not to slide?

11. In attempting to move a heavy couch (mass 200 kg) across a rug-covered floor, a man finds he must exert a horizontal force of 700 N to get the couch to barely move. Once the couch starts moving, the man continues to push with 700 N and his daughter, a physics major, estimates that it then accelerates at 1.10 m/s2. Determine (a) the coefficient of static friction and (b) the coefficient of kinetic friction between the couch and the rug.

12. A 2500kg car traveling 14.0 m/s on an icy, level road approaches an intersection. The brakes lock and the car skids 25.0m. What is the coefficient of friction between the tires and the surface?

13. A 10,000-kg load sits on the flat bed of a 20,000-kg truck moving at 12.0 m/sec. The load is not tied down to the truck and has a coefficient of static friction of 0.500 with the truck bed. Calculate the minimum stopping distance for which the load will not slide forward relative to the truck.