

Friction

The force of friction always opposes the motion of an object. It "always" acts opposite to the direction of motion or attempted motion.

$$F_f \propto F_g$$

The force of friction is proportional to the weight of the object. i.e. You find it more difficult to slide a heavy piece of furniture across a floor than a lighter one.

$$F_f \propto F_N$$



The force of friction is proportional to the normal force on the object. The normal force is a reaction force to the weight of an object. On flat surfaces $F_N = mg$.

\propto means proportional to

Mathematically

$$F_f = \mu F_N$$

$$F_f = \mu mg$$

Where F_f is the force of friction in Newtons, F_N is the normal force in Newtons (usually equal to mg) and μ (mu) is the proportionality constant called the coefficient of friction. It has no units. pg 53

μ depends on the nature of the two surfaces in contact. It does not depend on 1) the speed of the surfaces
2) the amount of area in contact

Static Friction, F_s , is the friction which keeps an object stationary.

Uses μ_s , the coefficient of static friction.

Kinetic Friction, F_k , is the friction experienced when an object is in motion. Uses μ_k , the coefficient of kinetic friction.

In most situations the force needed to start an object moving from rest is greater than the force needed to keep it going

$$F_s > F_k$$

Example 2 A small cardboard box filled with toys has a mass of 10.0 kg. It is given a push across a level floor. The box starts sliding at 6.0 m/s, coming to rest in 2.2 s. Find the coefficient of friction between the box and the floor.

$$v_i = 6 \text{ m/s}$$

$$v_f = 0$$

$$t = 2.2 \text{ s}$$

$$a = ?$$

$$a = \frac{0 - 6}{2.2}$$

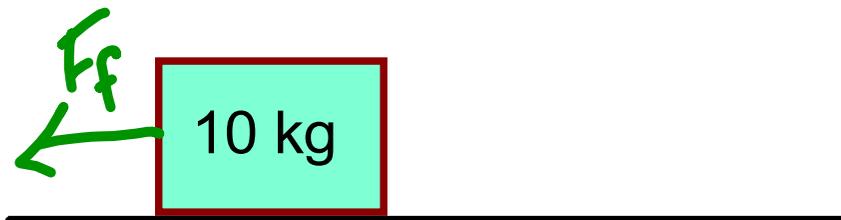
$$a = -2.7 \text{ m/s}^2$$

$$F_{\text{net}} = ma$$

$$= 10 \times (-2.7)$$

$$= -27 \text{ N} = F_f$$

comes from friction

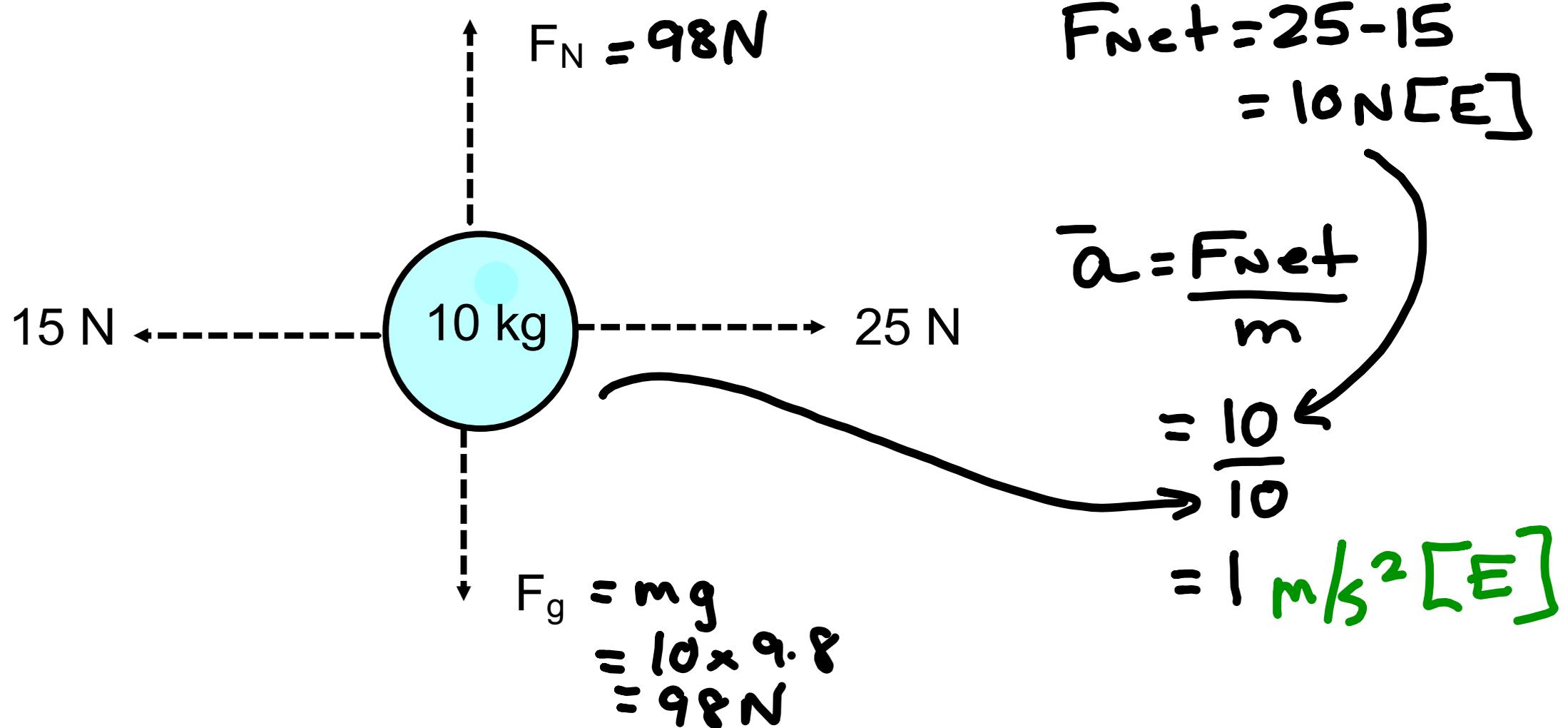


$$F_f = \mu mg$$

$$27 = \mu (10)(9.8)$$

$$\mu = \frac{27}{98} = 0.28$$

Example 1: An object is pushed east by a force of 25 N. The force of friction is 15 N. If the object has a mass of 10.0 kg, what is the acceleration of the object?



Example 3: A person with a mass of 70 kg is wearing rubber soled shoes and is walking on wet concrete. Determine the F_k the person needs to walk.



wet concrete

Example 4: An applied force of 41 N [Forward] is needed to start a 315 kg object moving. Calculate the coefficient of static friction in this scenario.

