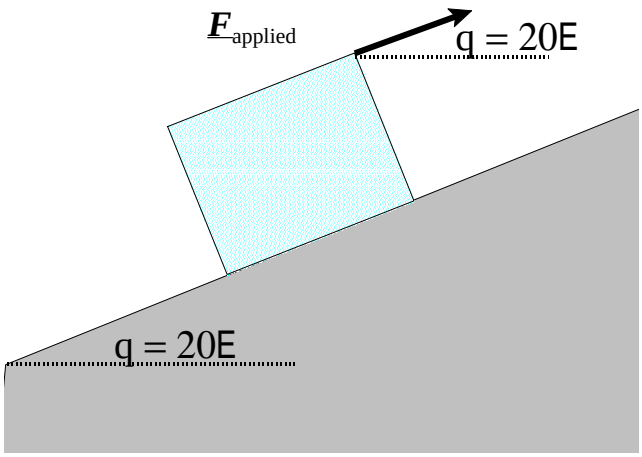
Example 1

Given box weighing 30.0 N,
$F_{applied}$ = 25.0 N up the slope and
μ_{static} = 0.800
$\mu_{kinetic}$ = 0.750

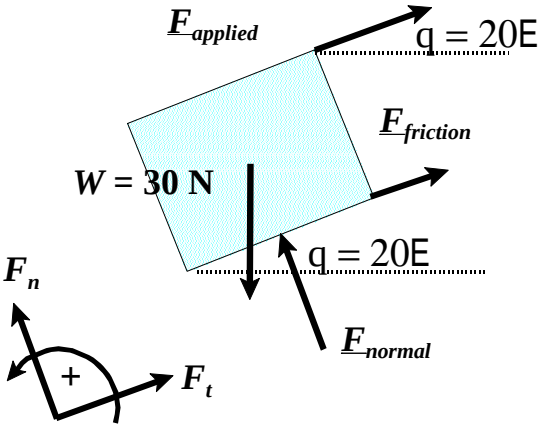
Space diagram:

What is the frictional force, if any?



Solution

Steps 1 and 2:
Make free-body diagram and draw axes



Steps 4 and 5. Select equation and solve.

G F_n = 0:
Therefore, $F_{normal} - W \cos \theta = 0$
$F_{normal} = W \cos \theta = 30 \cos 20E = 28.19$ N

Determine maximum static frictional force.
$F_{static} = \mu_{static} \times F_{normal} = 0.800 \times 28.19 = 22.6$ N

Determine frictional force necessary to create static equilibrium, called F_{eqm}. It replaces the frictional force by assuming that the surface friction can any size large enough to prevent motion, i.e., static equilibrium in the tangential direction. Thus,

G F_t = 0:
Therefore, $F_{eqm} + F_{applied} - W \sin \theta = 0$
$F_{eqm} = W \sin \theta - F_{applied} = 10.26 - 25.0 = -14.74$ N

If the force required for equilibrium is greater that the maximum frictional force of the surfaces then the box must be in motion. That is, if $|F_{eqm}| > F_{static}$ then object is <u>not</u> in equilibrium.

Since $|F_{eqm}|$ (= 14.74) is less than F_{static} (= 22.6) the box is in static equilibrium and the frictional force is equal to F_{eqm}.

Answer

$F_{friction} = -14.74$ N

Example 2

If applied force increases to 35.0 N what is the frictional force?

Solution

Recalculate F_{eqm} since F_{normal} and F_{static} do not change.

G $F_t = 0$:

Therefore, $F_{eqm} + 35.0 - W \sin\theta = 0$

$F_{eqm} = W \sin\theta - 35 = 10.26 - 35.0 = -24.74$ N

Now $|F_{eqm}|$ is greater than maximum static friction, $F_{static} = 22.6$, therefore the box must be in motion up the incline due to the applied force. In this case the friction is the maximum kinetic friction. Thus,

$$F_{kinetic} = \mu_{kinetic} \times F_{normal} = 0.750 \times 28.19 = 21.14 \text{ N}$$

The frictional force will be opposite to direction of motion and equal $F_{kinetic}$, therefore

Answer

$F_{friction} = -21.1$ N