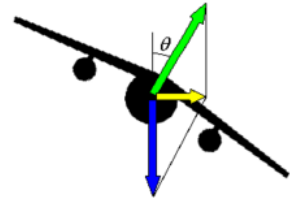
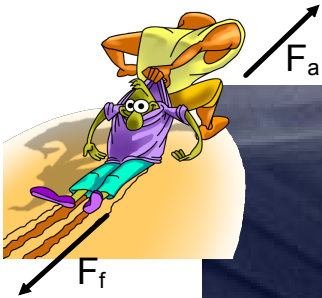


Inertia

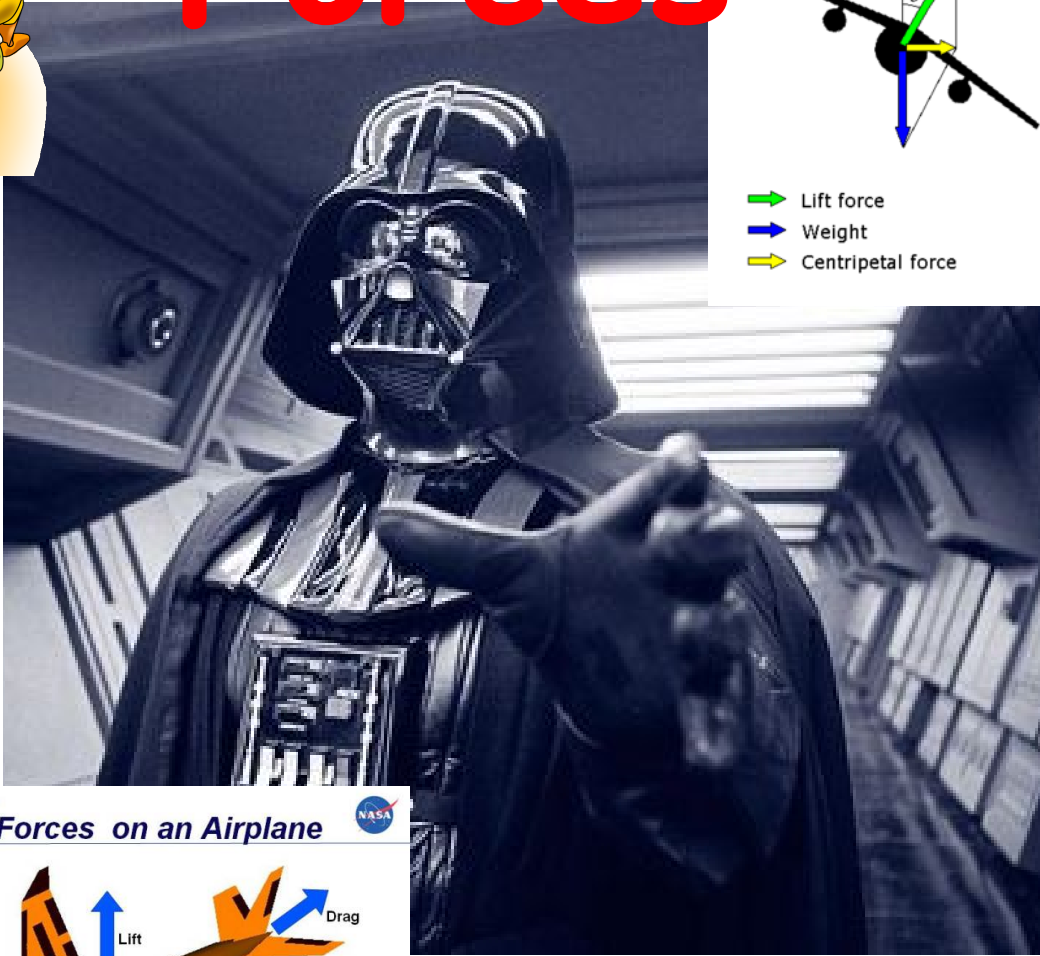
Do a close reading of pg. 126 - 128 of MHR

1. Define inertia.
2. Summarize Galileo's thought experiment on inertia.
3. Describe inertial and gravitational mass.
Are they the same?
4. What would happen, and why, if you kicked a bowling ball with the same amount of power as you would a soccer ball?

Forces

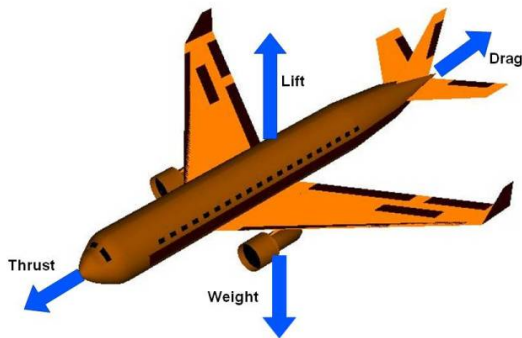


- Lift force
- Weight
- Centripetal force

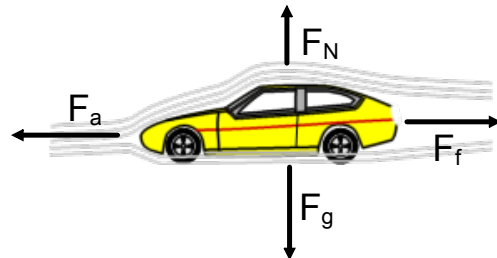


National Aeronautics and Space Administration

Four Forces on an Airplane



www.nasa.gov

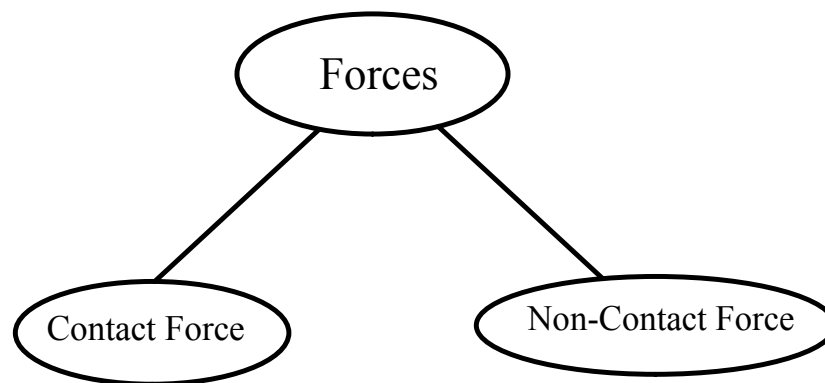


Common Forces

A *force* is defined as a push or a pull.

They are vector quantities.

In the last unit, the sum of all the forces acting on an object was referred to as the resultant force. *Net force*, F_{net} , is another term used for the vector sum of forces.



a force exerted by an object in direct contact with another object

Examples

friction
tension
normal force
applied force

a force that acts over a distance

Examples

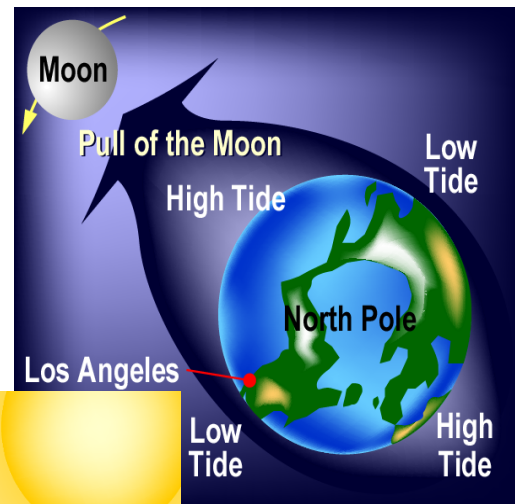
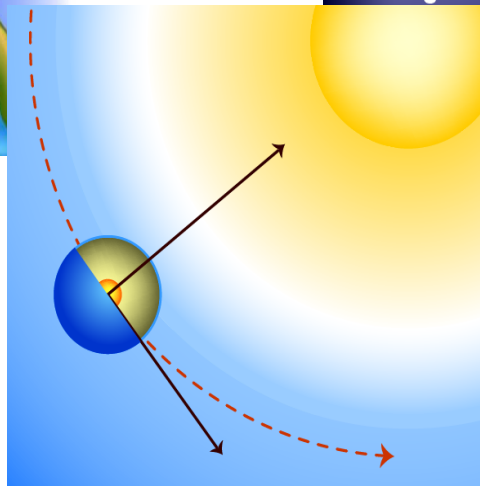
force of gravity
magnetic force
electric force

Many of the above forces can act on an object simultaneously, however, the process of problem solving for net force is independent of the type of force.

The Force of Gravity



F_g : gravitational force (force of *gravity*) - an attractive force that acts over a distance between masses



- What object is responsible for the tides on Earth, the Sun or Moon?
- What object pair has the stronger gravitational pull: Earth-Sun or Earth-Moon?

Did you know? That the interactions of the Earth-Moon tidal system is resulting in the Moon moving farther away and the Earth's spin is slowing down. Not to worry, it won't stop spinning or slow down all that much, but at some point in the distance future the Moon will only be visible from one side of the Earth.

Close Reading: Gravitational Force

Pg 130 - 133 of MHR

Terms to look for:

- Mass
- Weight
- Acceleration due to gravity

Pair and write answers to the conceptual problems on page 131.

Discussion Question

The force of gravity is dependent on the distance between an object and the Earth; looking at the formula for the force of gravity, how or where is distance taken into account?

$$F_g = mg$$

Force of Gravity Practice Problems

1. Calculate the force of gravity on a 45 kg mass located at the peak of Mt. Everest.

2. At the equator a person has a weight of 1075 N, calculate his mass.

3. How many times stronger is the force of gravity at the bottom of the Mariana Trench than on the ISS? (assume the same object at each location)

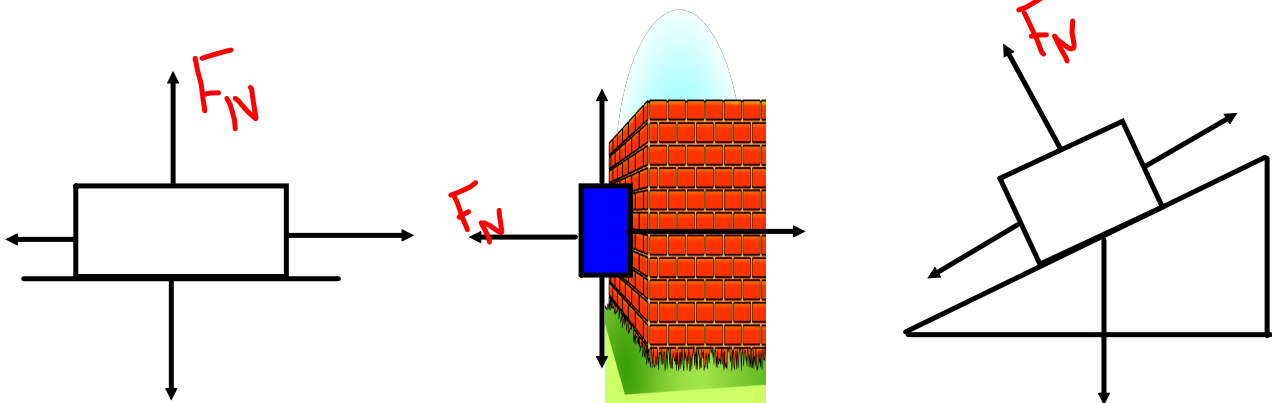
*Unless given a specific location, take the $g = 9.81 \text{ m/s}^2$ for an object located anywhere on the Earth.

Common Forces

F_a : an *applied* force
- a push or pull you exert on an object

F_N : the *normal* force
- a force that acts perpendicular to the surface on which an object rests

NOTE: "normal" means perpendicular

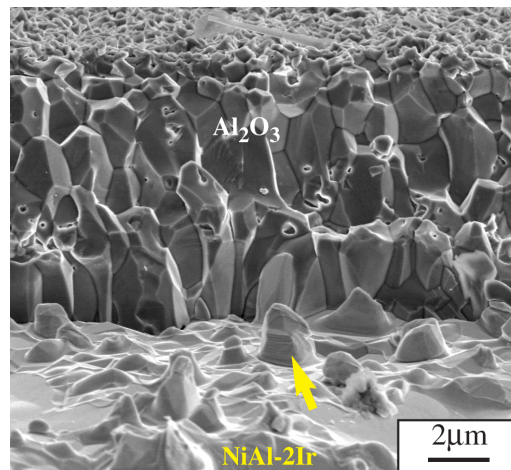
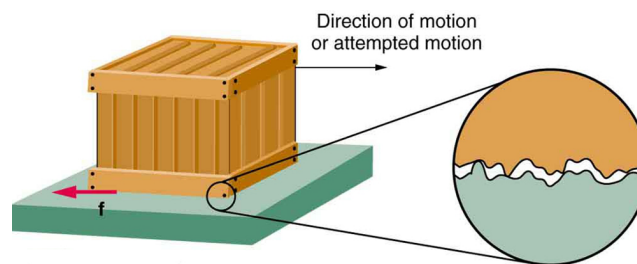
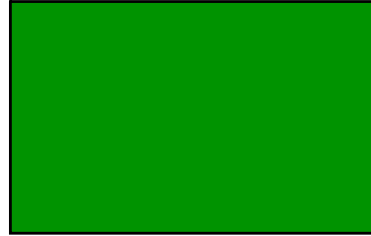


F_T : *tension*
- the force that acts along a rope, wire, string, etc.

The Force of Friction

Pair - Up

1. Rub your hands together and describe what you feel.
2. Write down what you think is happening.

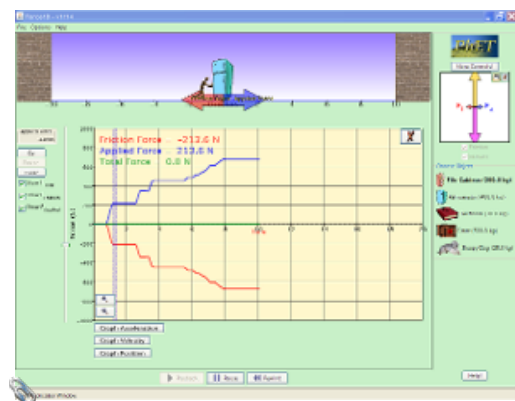
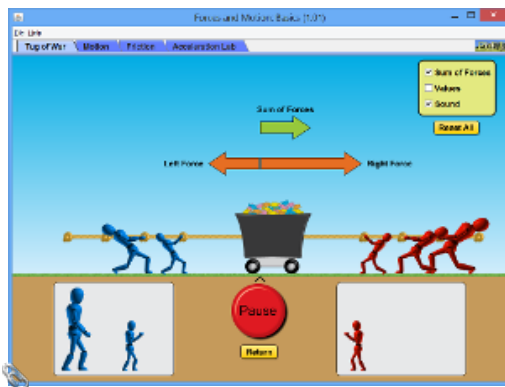


It is very important to have a detailed understanding of friction as all motion is affected by some type of friction (surface, fluid, air, etc).



Friction Demos:

1. Pulling a block of wood varying the mass.
 1. Vary the weight.
 2. Surface area.
2. Pushing objects (PhET).
 1. Visualize the vectors.
 2. Graphical Analysis.

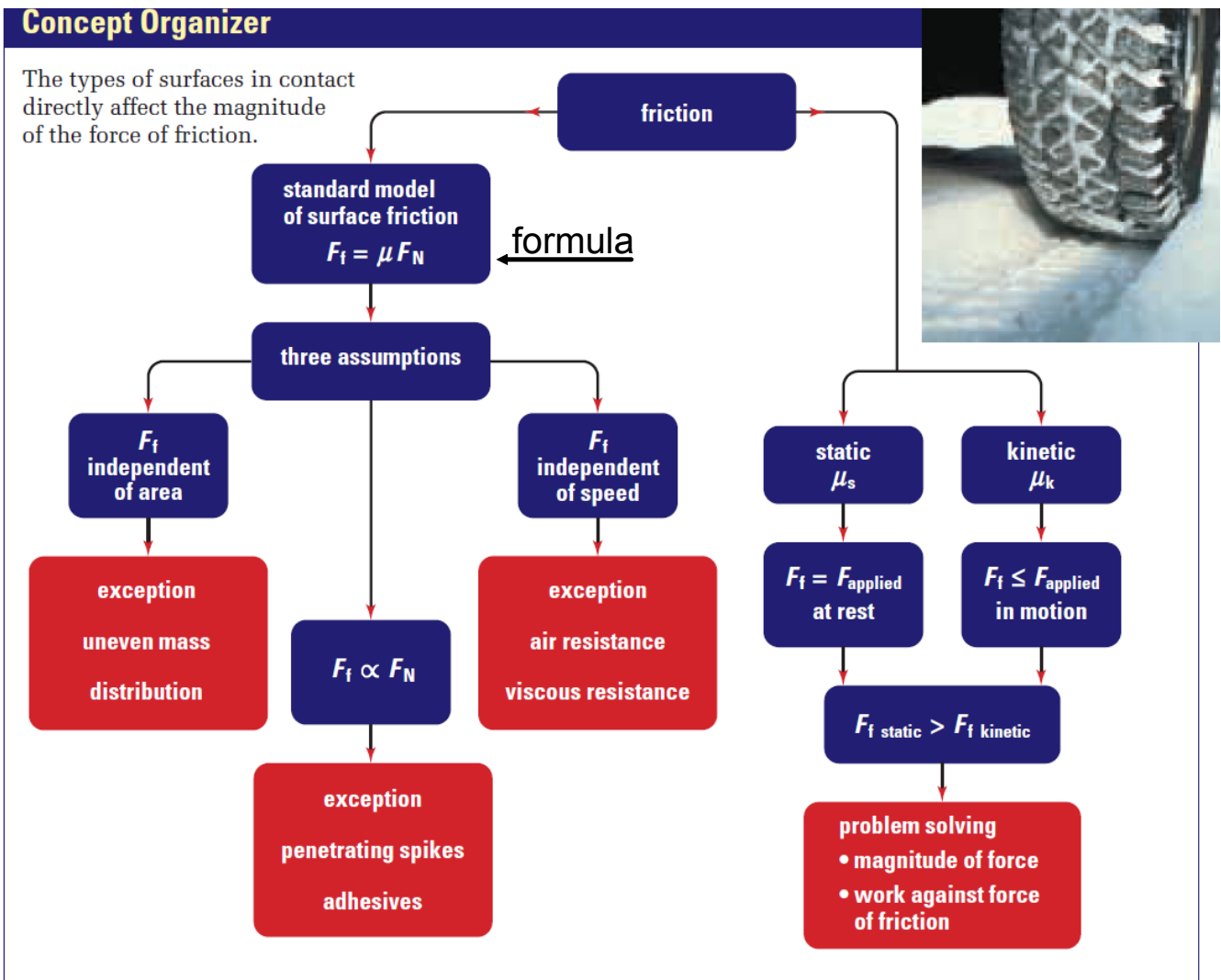


Close Reading: Friction

MHR: Pg. 137 - 141

Follow Up Questions:

1. In detail and with physics terminology, what is friction the result of?
2. Does the force of friction have a dependance on surface area? Provide an explanation.
3. Summarize 3 situations where we will not apply the basic theory of surface friction.
4. Suppose I have two smooth (to the touch) pieces of iron, how come they do not fuse when I bring them together?



In the above formula F_N is equal to the weight supported by the reference surface.

5-10 min Writing Review: Friction (hand in)

Suppose you slowly push and increase the applied force on a heavy crate. Describe the two forces of friction and how they affect the crate's motion from the first push until the crate is moving at a constant velocity. Use as much detail as possible.

Solving Problems with Common Forces

Understanding the concepts discussed thus far is the key to solving mathematical problems involving forces. Along with the strategies we previously used there are a couple more we can use for forces:

- Free Body Diagram.
- Sketch/label a diagram showing forces.

A Note about Motion and Forces

When the net force on an object is zero, it is in a state of *equilibrium*. This means that the object is either at *rest* or moving at a *constant velocity*. *It cannot be accelerating.*

*What determines an object's motion?
Why, the value of the net force of course!*

$$\text{Equilibrium : } \vec{F}_{\text{net}} = 0\text{N}$$

object at rest

object moving at
constant velocity

If the net force does not equal zero, the object will accelerate at a constant rate!

NOTE

The object will accelerate in the direction of the net force.

Free-Body Diagrams

"Physics is all about simplification."

A *free-body diagram* (FBD) is a picture that shows ALL the forces acting on an object.

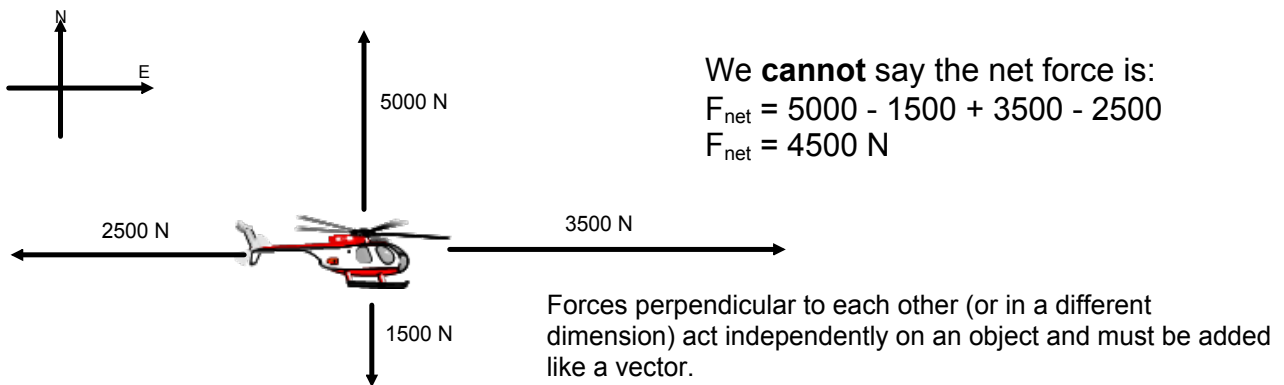
For the sake of simplicity, an object is usually represented by a dot and only the forces acting on the object are included on the diagram. The forces are represented by arrows.

When drawing FBDs, put the tail of the force vectors on the object, with the arrow pointing away from the object. NEVER draw a force vector pointing toward an object.

Net Force

The net force is the vector sum of all the forces acting on an object. Only forces acting in the same dimension (i.e. left and right or up and down) can be mathematically added (or subtracted).

Consider the four forces acting on the object below:



We can talk about the net force in each dimension:

$$F_{\text{net}} [\text{East}] = 3500 \text{ N} - 2500 \text{ N} \quad F_{\text{net}} [\text{North}] = 5000 \text{ N} - 1500 \text{ N}$$

$$F_{\text{net}} [\text{E}] = 1000 \text{ N} \quad F_{\text{net}} [\text{N}] = 3500 \text{ N}$$

To find the actual net force on the object we would need to do a scale diagram with the vectors or a calculation (grade 12).

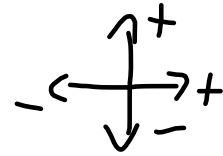
Often to identify which direction we are focusing on we use the subscripts x and y. Like in your math class, x - horizontal direction and y - vertical direction. Directions are all in the way your set up your problem for analysis - your frame of reference.

A 62 kg crate is pulled at a constant velocity with an applied force of 337 N.

- a. Calculate the force of friction.
- b. Calculate the normal force on the crate.
- c. Calculate the coefficient of kinetic friction.

A box has a weight of 625 N and is being pulled with a net force of 12 N. The coefficient of kinetic friction is 0.23.

- What is the mass of the box?
- What is the force of friction?
- What is the applied force?



$$a) \quad F_g = -625 \text{ N} \quad F_g = mg$$

$$-625 = m(-9.81)$$

$$m = 63.7 \text{ kg}$$

$$b) \quad F_f = ? \quad F_f = \mu F_N$$

$$F_f = (0.23)(625)$$

$$|F_f| = 143 \text{ N}$$

$$c) \quad F_a = ? \quad F_{\text{net}} = \sum \text{Forces}$$

$$12 = F_f + F_a$$

$$12 = -143 + F_a$$

↖ opposite direction

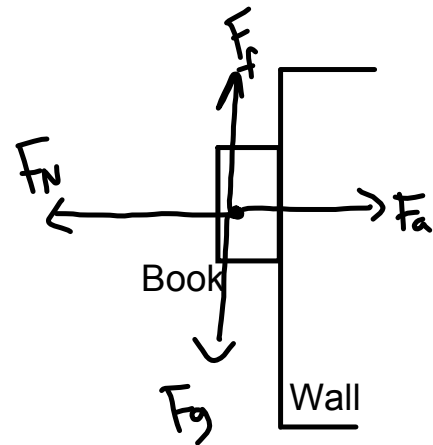
$$155 = F_a$$

A 3.4 kg book is pressed against the wall. The coefficient of static friction between wall and book is 0.23. Calculate the minimum applied force needed to keep the book from slipping down.

$$F_f = \mu F_N$$

$$|F_g| = |F_f|$$

$$|F_a| = |F_N|$$



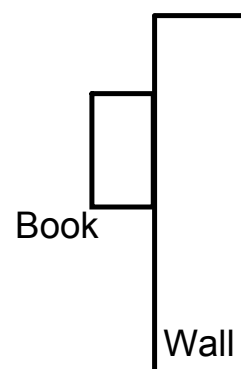
$$F_g = \mu F_a$$

$$mg = \mu F_a$$

$$(3.4)(9.81) = (0.23) F_a$$

$$145 \text{ N} = F_a$$

A 4.2 kg book is pressed up against the wall using an applied force of 75 N. For the book not to fall, calculate the minimum coefficient of static friction necessary between the wall and the book.



Attachments

forces-and-motion-basics_all.jar

forces-1d_all.jar