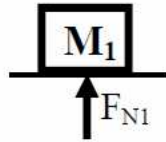


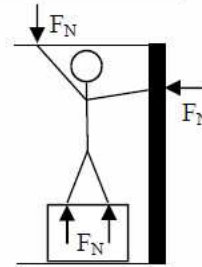
Name: _____
 Period: _____

Normal Force (F_N)

The normal force is the supporting force of a surface on an object. Without a normal force an object would break thru a surface.



"Normal" means perpendicular. F_N is always perpendicular to a surface, even if the surface is tilted.

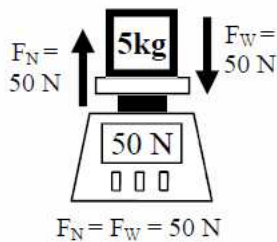


There are 4 normal forces acting on this person, because there are 4 surfaces pushing on him.

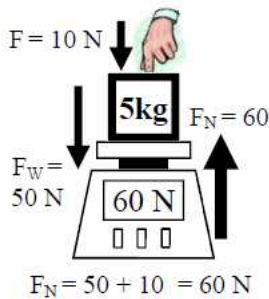
Simple, Vertical F_N

As a supporting force the normal force is exactly what a scale would read. The scale would have to give more support (more F_N) for heavier objects, for example.

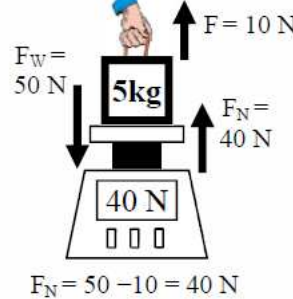
If there are no other forces, then the scale has to support the weight of the object: $F_N = F_W$.



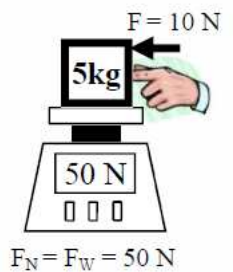
Downward forces increase the normal force.



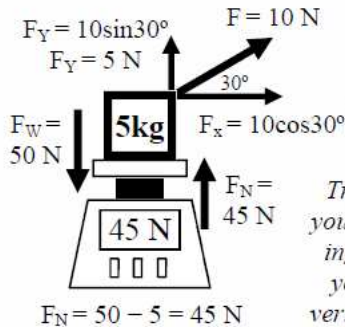
Upward forces decrease the normal force.



Sideways forces don't affect the normal force and $F_N = F_W$, again.



If a force pulls at an angle, only the vertical component affects F_N .

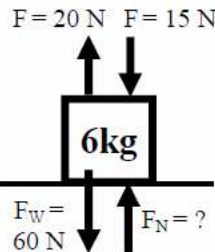


The horizontal component is irrelevant to F_N .

Try it! Put an object in your left hand while pushing or pulling on it with your right hand. Only vertical forces will matter.

Simple Normal Force (if $a_y = 0 \text{ m/s}^2$)

$$F_N = F_W \pm F_{\text{additional}}$$



Example: Calculate the normal force on the object at the left.

The 20 N force decreases F_N .
 The 15 N force increases F_N .

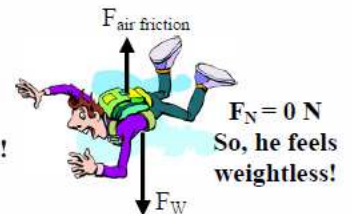
$$F_N = 60 + 15 - 20$$

$$F_N = 60 - 5$$

$$F_N = 55 \text{ N}$$

Perceived Weight

When a person is skydiving they feel weightless. Gravity is pulling them down, so they still have weight, but their perceived weight is zero. On a roller coaster you feel like your weight changes, too. At the top you feel lighter, at the bottom you feel heavier, but, again, your weight hasn't changed. What has changed is the normal force on your body! **Normal Force = Perceived weight!** If $F_N = 0 \text{ N}$ you feel weightless!



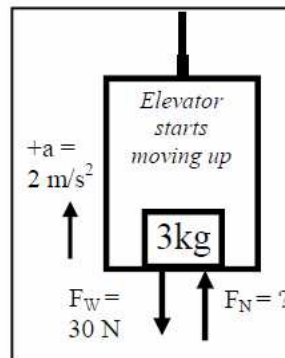
You've also experienced this change of perceived weight in an elevator.

$a = -$. When the elevator starts moving down (negative acceleration) you feel lighter because $F_N < F_W$.



$a = +$. When the elevator starts moving up (positive acceleration) you feel heavier because $F_N > F_W$.

Between floors (at constant speed) $a = 0$ and your weight feels normal. So $F_N = F_W$.



Example: How heavy does the 3 kg object feel, if the elevator accelerates up at 3 m/s^2 ?

Since all forces are vertical, use $\Sigma F_y = ma_y$.

$$F_N - 30 = 3(2)$$

$$F_N - 30 = 6$$

$$F_N = 6 + 30 = 36 \text{ N}$$

It seems heavier!

1. Let's meet Jim, he's very slim. Draw and label all of the normal forces acting on Slim Jim.

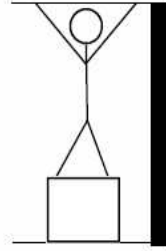
A. Jim leaning against the wall with one foot up.



B. Jim leaning against the wall, with both feet on the ground.



C. Jim standing on a table and pushing on the ceiling.



2. If a surface has to support more, it has to provide more normal force (F_N). Does the following increase or decrease F_N ?

_____ Pushing down on the object.

_____ Pulling up on the object.

_____ Setting another object on top of it.

_____ Increasing the weight of the object.

_____ Friction.

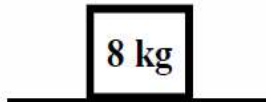
_____ Pushing sideways on an object.

_____ Decrease the weight of the object

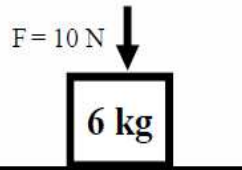
_____ Pushing down at an angle.

3. Calculate the normal force pushing up from the table in each example.

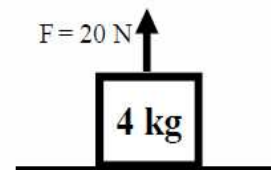
A.



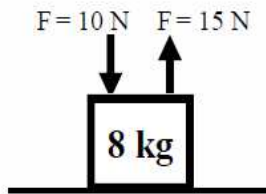
B.



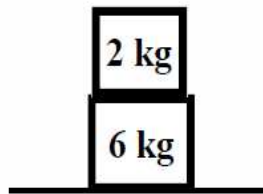
C.



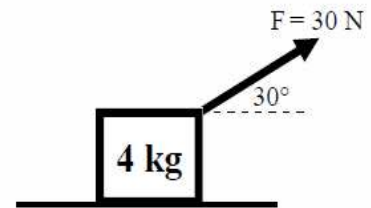
D.



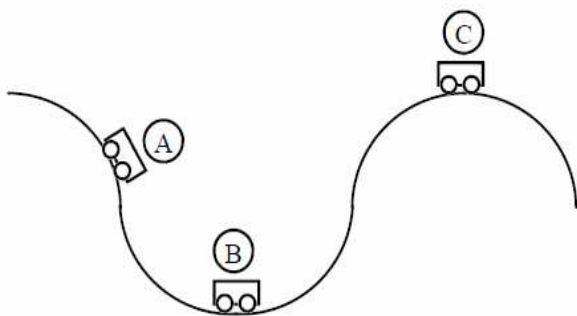
E.



F.



4. The diagram above shows a cart on a roller coaster.



- At which position do you feel heavier?
- At which position do you feel lighter?
- At which position does the track have to push harder on the cart?
- Where is the greatest normal force acting on the object?

5. A 50 kg woman is on an elevator. The elevator is accelerating downward at 3 m/s^2 .

A. Since the elevator is accelerating downward, is this + or -?

B. What is F_W for the woman?

C. Use $F = ma$ to find F_N acting on the woman.

D. Does the woman feel heavier or lighter than normal?

