Lettergram.Net – What is Force?

The purpose of these assorted documents is to explain what a force is, how forces work, and how to solve simple force based questions.

*Requisites: Firm grasp of Trigonometry, Vectors, Newton's Laws (at least conceptually), and basic understanding of reality.

The Different Forces:

Strong Force – Holds atoms together.

Weak Force - Pushes atoms apart.

Electromagnetic – Anything to deal with electrical charge of atoms.

Gravitational – The attraction of two masses divided by the distance squared.

There are thousands of essays written on each of the forces above, this study guide will simply cover gravitational and physics concepts which will be needed to understand basic Newtonian motion. There will however be further study guides on each of the forces, which are available at lettergram.net.

Force – Anything that influences and object or particle to change velocity, position, state, or shape, most commonly used to describe as acceleration on an object or particle over a time interval.

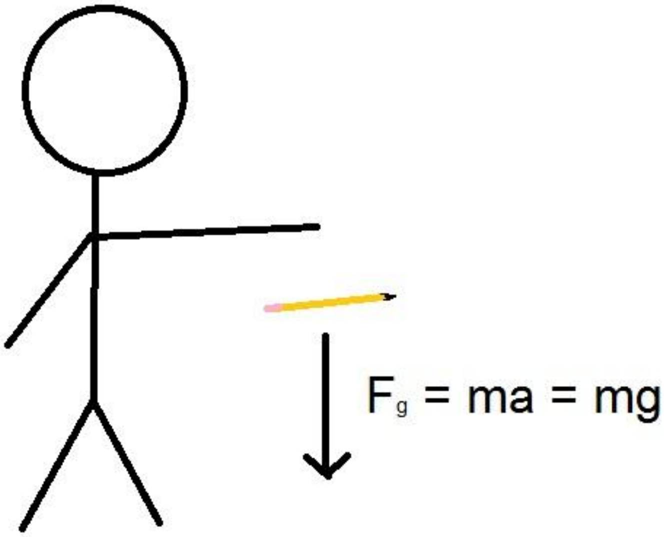
In equation form it is represented by: $\vec{F} = m\vec{a}$

By using the definition we can arrive that a force has units represented by kilogram * meters per second squared ($kg*m/s^2$). By using just the definition (not equation) we are effecting the mass (SI units for physics is Kg), by an acceleration or a distance over a given time interval. Which gives us $kg*m/s^2$. $Kg*m/s^2$ can also be referred to as Newtons with the symbol 'N.'

Once it is understood what a force it, by using the definition we can apply it to many different situations in order to solve for the movement of objects.

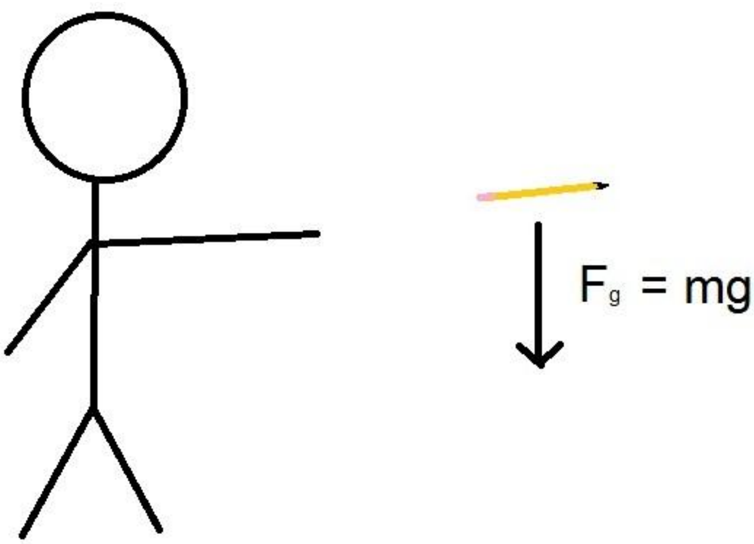
In most introductory physics courses when solving for simple Newtonian motion air resistance is negligible.

Example 1: A man drops a pencil.



The forces involved are simple; we have the force of gravity acting on an object, which is to say we have the mass of the pencil multiplied by the acceleration due to gravity (which on the surface of earth is averaged to me 9.8 m/s^2.

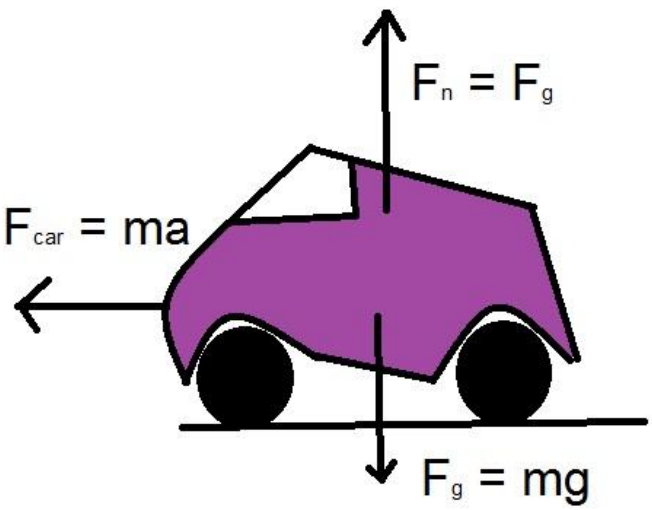
Example 2: A man throws a pencil (an action I would not advise).



In this case there is still only one force acting on the pencil, gravity. However, ponder this, previous to the throw or rather during the throw was there a net change in acceleration?

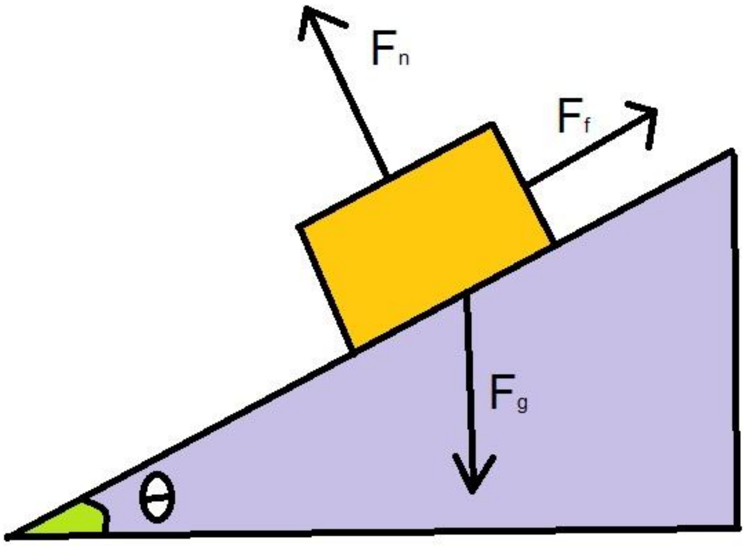
The answer should be yes, when the man started moving the pencil forward in order to throw it (and increase the pencils velocity forward) there must have been some net acceleration in that direction, which in turn based on our equation means that there must be a force applied. Once in the air this man has no more effect on the pencil and the only force on the object would be that of gravity.

Example 3: A car drives down a road.



In the example there are three separate forces acting upon the car. The force of due to gravity was already explained, the two new forces are the force of the car and the normal force. The force of the car is fairly simple to explain, when the car accelerates or when the driver puts his foot on the gas pedal the car exerts a force on the road, which they propel the car forward. Since the way in which we calculate force is mass multiplied by the acceleration the F_{car} = ma. The force normal is a little more difficult to explain. To understand the normal force we must have a fair grasp of Newton's three laws; in Newton's third law he explained that when ever one object (object A) applies a force to another, the object receiving the force (object B) pushes back on the object delivering the force (object A) with as much force as is delivered.
Visit: http://lettergram.net/newtons-three-laws-concepts/
For more information or further review.

Example 4: A block slides down an incline.



In this example we know that:

F_g = mg

F_n = The resistive force of the incline.

And the unknown (to this point) is F_f which is the force due to friction. The easiest way to understand this concept is to simply rub your hands together, now rub the table, now your pants. Notice how each time you rub a different one of these objects you can feel a resistance on your hand, this resistance is what is called friction. The difference in the resistance is what is called the coefficient of friction and it comes from a very simple concept. Alright put your hand lightly on the table and pull it away slowly, then put your hand on the table pushing down hard and pull away at essentially the same strength. You should notice a difference in the difficulty it was to pull your hand away. Looking at this difference there are several factors acting on it:

1) The force normal (or resistance of the table to your hand)
2) The force your hand is applying on the table.
3) The force of friction.

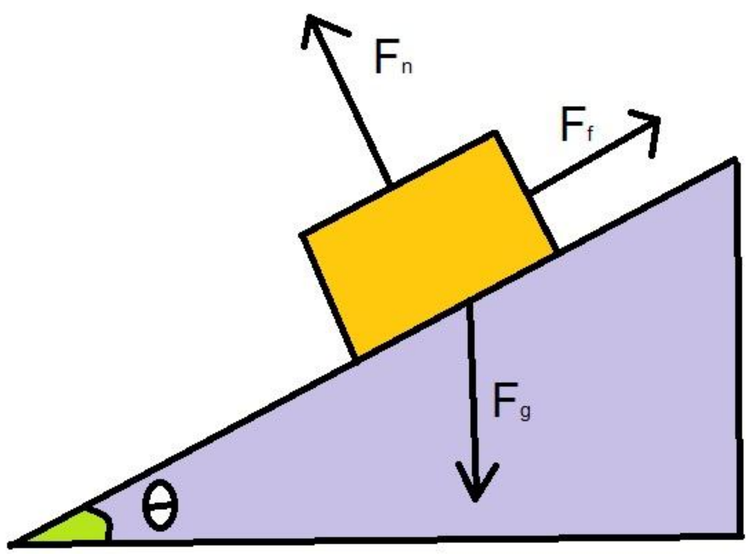
Because both the force of your hand on the table and the force of the table on your hand cancel each other out (unless of course you shove your hand right through the table), the only force that is causing your hand to pull away more slowly is that of friction.

You may then ask, “Why, when I put my hand lightly on the table, is the force of friction essentially less when I pull away?”

The answer is simple: “The force of friction is equal to the coefficient of friction multiplied by the force normal (or the force which is pushing back on the object).”
*Think of the coefficient of friction as the ratio of resistance between two objects, which is caused by the very very small bumps on the surface of the objects. Look at your hand for a moment, see the lines, that helps cause more friction on your hands and therefore increases the coefficient of friction on your hands.

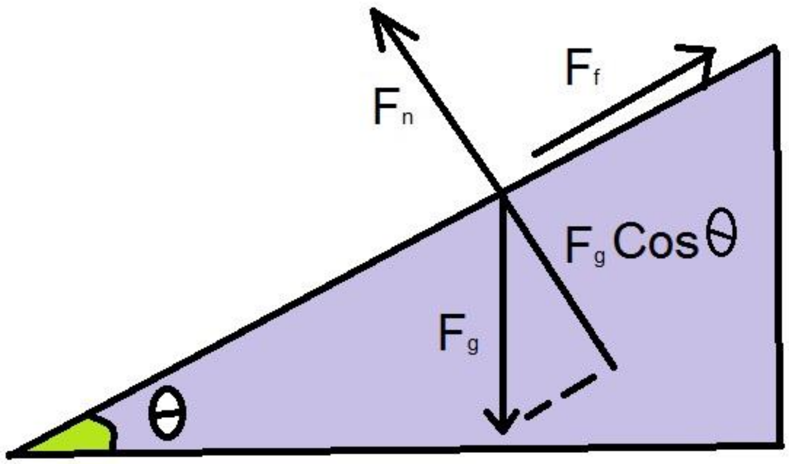
Based on what was explained we then get: $F_f = F_n * \mu$
(μ is often the denotation of the coefficient of friction)

Looking again at example 4:



It is also clear that the normal force does not simple equal the force of gravity this time (because F_n equals the force of the block pushing on the incline, and the block is only pushing on the incline with a portion of F_g), if you do not understand why please visit lettergram.net and search “vectors.”

In this case we should redraw the picture in order to obtain a better understanding of how the normal force is working on the block:



In order to obtain the normal force, we must first find the force which the block is applying on the incline. To do so, the force of gravity must be broken down into the same x and y plane as the other vectors (again look this up on lettergram.net if you have issues), by doing so the vectors can then be determined and unknowns solved for:

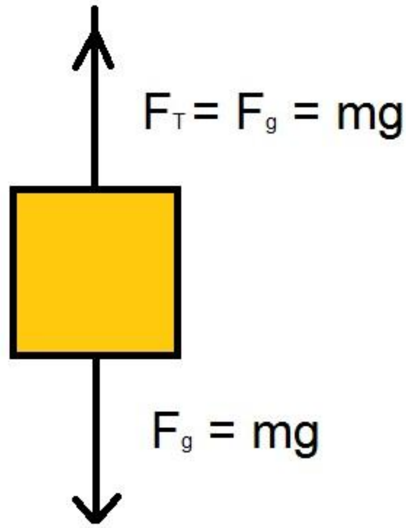
$F_g = mg$

$F_g \, Cos\theta = mgCos\theta$

$F_n = mgCos\theta$

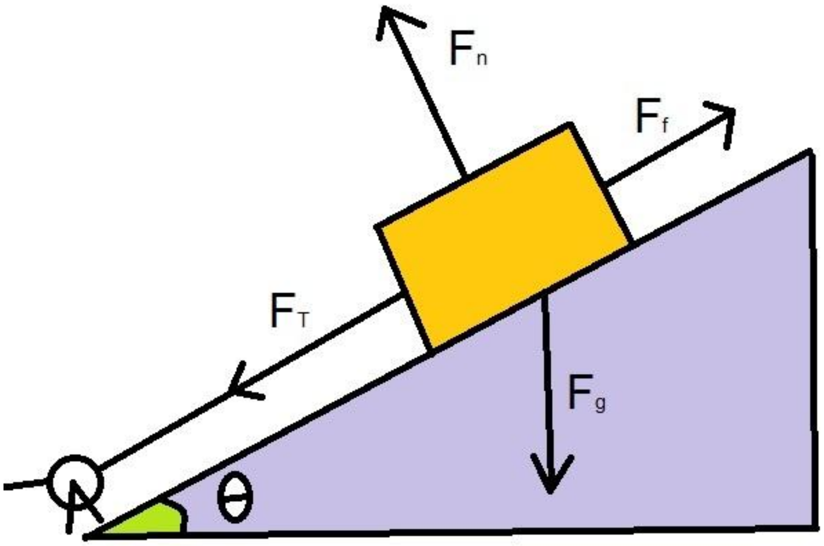
$F_f = \mu mgCos\theta$

Example 5: A block on a rope.



In this example we already know what F_g is, the new force is the force of tension or F_T, this force functions much like the normal force. If the rope is attached to an object and that object is moved, the rope moves, if the rope is grabbed the force which the rope was pulled also works on the object. Essentially, the rope is just a way to attach the object to another object (seems fairly strait forward), which means that any force on the rope, acts on the block, which causes a tension force. The tension force is the force the rope exerts on the block.

Example 6: All together now!



In this example all of the common forces are working together, a rope is acting in order to pull a block down an incline, the force of friction is resisting that motion, the force of gravity is pulling down on the block, and the force normal pushing back on the block. In order to solve for all the variables we can do the same thing we did in example 4, and at the end add what we now understand about tension.

$F_g = mg$

$F_g \, Cos\theta = mgCos\theta$

$F_n = mgCos\theta$

$F_f = \mu mgCos\theta$

$F_T = F_f$

(Because the tension in the rope is only caused by the block resisting the ropes pull, if there was no resistance there would be no tension force. There is always some form of resistance when solving these problems.)

$F_T = \mu mgCos\theta$

I would like to rap this guide up with a simple step process to solving these problems:

Steps:

1) Draw out the problem.
2) Draw it out as a diagram of forces (such as example 4).
3) List all known variables.
4) Solve for what you are trying to find using variables, and using vector rules.
5) Plug in the information you have and solve for unknown variables.
6) Check using logic (You do not want to say, for example, a person weighs 1,000kg).
7) If everything seems logical, CONGRADULATIONS, if not, redo.

Recommendations:

Because I do not know the specific knowledge each individual has using this guide, I would recommend that if there is something I mention that you do not fully understand you either use YouTube to find a video; Tweet me via Twitter *(though I may be a while getting back); Comment on the related post on Lettergram.net or simply ask your teacher.