Name: ____________________

Period: ____________________

Newton's Second Law and Weight

You already know that if you push harder on an object it will accelerate more. Also, if you push with the same force on a heavier object it will have less acceleration. You instinctive know Newton's Second Law of Motion.

Newton's Second Law: F = ma

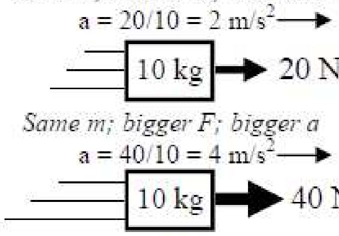
The acceleration of an object is proportional to the force acting on it and inversely proportional to its mass.

OR

More force causes more acceleration; more mass causes less acceleration.

Same m; smaller F; smaller a

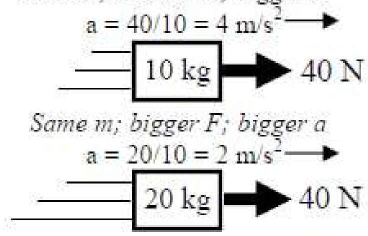
Same m; bigger F; bigger a



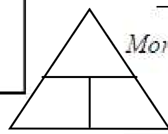
More force causes more acceleration. Doubling the force, doubles the acceleration.

Same F; smaller m; bigger a

Same m; bigger F; bigger a



More mass causes less acceleration. Doubling the mass, halves the acceleration.



Force (*in Newtons*) → **F = ma** ← Mass (*in kg*), Acceleration (*in m/sec²*)

Force equals mass times acceleration.

Ex. How big a force does it take to give a 50 kg object an acceleration of 40 m/s².	
Variables: m = 50 kg a = 40 m/s² F = ______	*Equation:* F = ma *Solve:* F = 50(40) F = 2000N

The acceleration of a mass is actually due to the **net force** acting on the object:

$$F_{net} = \Sigma F = ma$$

*You must add up **all** of the forces to find the acceleration.*

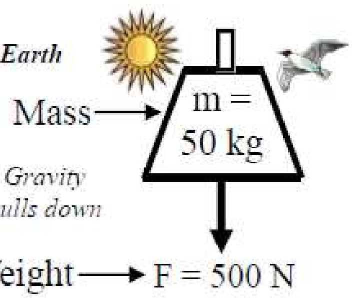
Mass vs. Weight

In everyday speech we use mass and weight interchangeably, but in science mass and weight are very different.

Mass is the amount matter in an object (all of its atoms and molecules).

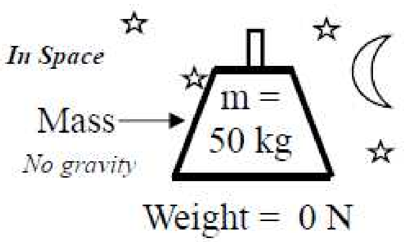
Weight is the force of gravity pulling on mass.

On Earth



Mass is measured in kg; Weight is a force measured in N.

In Space

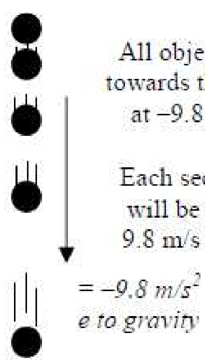


In space an object still has mass, because it still has its atoms and molecules, but there is no weight, because there is no gravity.

Acceleration Due to Gravity

All objects fall with the same acceleration: -9.8m/s². This is known as the acceleration due to gravity (g). ***This is not the force of gravity.***

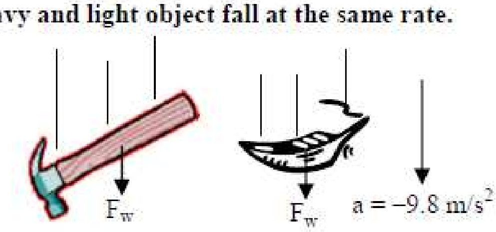
g is a constant: –9.8 m/s²
The acceleration of all falling objects is the same on the earth.



All objects fall towards the earth at –9.8 m/s².

Each second it will be going 9.8 m/s faster.

Heavy and light object fall at the same rate.



If it wasn't for air friction a feather and a hammer would fall at the same rate: -9.8 m/s². In air, the hammer's extra weight allows it to push thru the air molecules faster.

Measuring Weight

If you already know mass it is easy to calculate weight: just multiply mass times 9.8 m/s².

To make calculations easier we often use g = 10 m/s².

Force of Weight (*in Newtons*) → $\mathbf{F_w = mg}$ ← Mass (*in kg*), Acceleration due to gravity (*9.8 m/sec²*)

Weight equals mass times the acceleration due to gravity.

Ex. Find the weight of a 2 kg mass.	
Variables: m = 2 kg g = 10 m/s² F_w = ______	Equation: $F_w = mg$ Solve: F = (2)(10) F = 20 N

Ex. Find the mass of a 2 N object.	
Variables: F_w = 2 N g = 10 m/s² m = ______	Equation: $F_w = mg$ Solve: 2 = (m)(10) m = 2/10 = 0.2 kg

1. Weight	A. The units of weight and force.
2. Mass	B. Newton's Second Law mathematically.
3. N	C. The acceleration due to gravity = $-9.8 m/s^2$.
4. F = ma	D. The force of gravity on matter.
5. g	E. How much matter an object contains.

Will an object accelerate faster or slower?
If its mass is increased?
If the force pulling on it decreases?
If the force pushing on it increases?
If its mass is decreased?

Why is F = ma not entirely correct?

More, less, or the same as on the Earth?

When an astronaut lands on the moon:

The astronaut's mass is: ________________

The astronaut's weight is: ________________

The astronaut's inertia is: ________________

Without air friction, which falls faster, heavy or light objects?
Why?

If there is air friction, which falls faster?
Why?

How fast is the acceleration due to gravity?

If an object falls from rest, how fast will it be going:
after 1 second? after 2 seconds? after 6 seconds?

Using the weight equation, calculate the weight of a 45 kg rock?

Calculate the mass of a 10 N apple.

What is the mass of a 100 gram apple in kilograms?

What is the weight of the above apple?

What is the weight of a 250 N object?

If 100 kg person weighed 400 N on the planet Zorg, what is the acceleration due to gravity on Zorg?

Which of Newton's Three Laws Applies: Law 1, 2, or 3?

___ Pushing a cart down the hall, when you try to turn it it tries to go straight.

___ More acceleration takes more force.

___ When you push your knuckles into a table, it hurts your knuckles.

___ A ball thrown into the ground bounces back up.

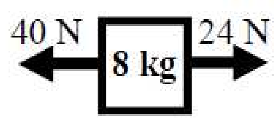
A 6 kg object experiences a $5 m/s^2$ acceleration? Find the force that caused this acceleration.

A 3 kg rock accelerates to the left at $12 m/s^2$. Find the net force that caused this.

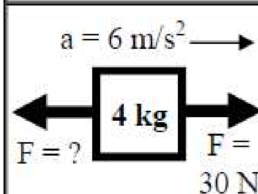
A 12 kg box is pushed to the left by a 48 N force.
Find its acceleration.

A) Calculate the object's net force.

B) Calculate the object's acceleration.



Calculate the object's acceleration.



Find the force pulling left.

12 N pulls to the left and 20 N pulls to the right on a 2 kg object.
Draw the problem:

Calculate the object's acceleration.

