SUPERCHARGED SCIENCE

Unit 2: Motion

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Appropriate for Grades:
Lesson 1 (K-12), Lesson 2 (K-12)

Duration: 6-12 hours, depending on how many activities you do!

We're going to study velocity, acceleration, and Newton's three laws of motion in this unit. You'll get to throw things, build g-force accelerometers, and much more as you uncover the basis of all physics in our crash-course in projectile motion. Here's what you need to do to so we get the most out of this unit together.

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Materials for Experiments

How many of these items do you already have? We've tried to keep it simple for you by making the majority of the items things most people have within reach (both physically and budget-wise), and even have broken down the materials by experiment category so you can decide if those are ones you want to do.

NOTE: This material list is for the entire Experiment section online.

Velocity Experiments
Vehicle with a licensed driver
Small ball (ping pong, golf ball, tennis ball, bouncy ball, etc.)
Wagon or skateboard
Friends
Hardcover book
Toilet paper tube
Plastic cup
A ball that is larger than the end of the toilet paper tube but smaller than the plastic cup
Stop watch or clock with a second hand
Feathers, small pieces of paper, plastic bag or anything light and fluffy (cotton or dust bunnies will work, too)
Tape measure or ruler
Calculator

Optional: broom

Acceleration Experiments
At least 3 feet of fairly smooth board (a slightly sloping driveway works)
Books, wood chunks, something to prop one end of the board up on
A hard smooth ball (a golf ball, racket ball, pool ball etc.)
A timer
Pencil, paper (or your journal)
Measuring tape or yard stick
Chalk or masking tape to mark off distances
Empty 2-liter soda bottle
Clean wine cork (use the one from your compass from Unit 1)
Water
Hot glue gun with glue sticks
Bicycle wheel
Rope (about 3')

Office chair that spins freely
10 balloons (get a pack that has the round 7-9″ and balloon-animal kind)
6 straws
6 thin, round, wooden skewers
1 sheet of copy paper
1 index card
Scotch tape and scissors
Small piece of stiff cardboard (about 4″ x 6″) – you can use a cereal
2 foam cups
Fishing line (or heavy thread) – you'll need to span a room in your house, so about 20′ is typically a good estimate
Heaviest rock you can throw safely
Baking soda (about 1/4 cup)
Distilled white vinegar (about 1/4 cup)
Alka seltzer (get a pack of 24 tablets)
Film canister or small M&M container with the snap-on lid (or use a plastic bottle with a tight-fitting cork)
Chicken broth soup in a can (unopened)
Clam chowder soup in a can (unopened)
Long (4′+) table or slightly slanted driveway
8 small, round film canister or milk-jug lids (anything round about the size of a quarter that you can punch a hole through the center and use for wheels)

Additional Items for Grades 9-12:

1/2″ or larger clear diameter tubing, 12-18″ long
Nylon (or metal, but it's more expensive) barbed union – check the plumbing aisle in the hardware store
Food coloring (3 drops, any color)
Permanent marker
1 car tire valve (visit your local car tire repair shop and ask for one – usually about $0.25 each)
empty 2L soda bottle (NOT water bottle!)
Bicycle pump
Water
Drill and 1/8″, 1/4″, 3/8″ and 1/2″ bit (or just use a single 1/2″ spade bit and you won't need to pre-drill using all those other drill bits listed)
Razor (must be sharp)
Goggles or face shield
Vice grips (if you have a vice, we'll be using it as well)
Optional: foam craft sheet

Key Vocabulary

Acceleration is the rate of change in velocity. In other words, how fast is a change in speed and/or a change in direction happening.

Force is a push or a pull, like pulling a wagon or pushing a car.

Gravity is a force that attracts things to one another. Gravity accelerates all things equally. Which means all things speed up the same amount as they fall.

Mass is a measure of how much matter (how many atoms) make up an object.

Terminal velocity means something has speed but no acceleration. This is normally used when something falling cannot gain any more speed because the air resistance pushing against that something is equal to the force of gravity pulling down on that something.

Velocity has both a speed (like 55 mph) and a direction (northeast).

Weight is a measure of how much gravity is pulling on an object.

Unit Description

We're going to study velocity, acceleration, and Newton's three laws of motion in this unit. You'll get to throw things, build g-force accelerometers, and much more as you uncover the basis of all physics in our crash-course in projectile motion. Here's what you need to do to so we get the most out of this unit together.

Newton has a famous quote that goes *"If I have seen farther than others, it is because I have stood on the shoulders of giants."* One of the giants he was referring to was Galileo. Thanks to the discoveries of Galileo and others, Newton was able to make many of his own discoveries. The most famous of which are Newton's Laws of Motion.

Objectives

Lesson 1: Velocity

Velocity is how fast something is going and in what direction it is going. **Direction** is what separates the term **velocity** from **speed**. If we were talking about a car, we could say that car is traveling with a velocity of 30 miles per hour due East. We will basically just be using the speed aspect of velocity, since for our purposes, the directional aspect confuses things more than necessary.

There is another term that is useful here and that is terminal velocity. The term **terminal velocity** is normally used when something falling cannot gain any more speed because the air resistance pushing against that something is equal to the force of gravity pulling down on that something. When those two forces are equal and in opposite directions from each other, the falling object stops accelerating and stays at the same velocity.

This is why feathers drop so much more slowly than bowling balls. A feather has a very large amount of air resistance and gravity pulls very lightly on it (the feather is very light). The amount of friction force quickly equals the amount of gravitational force and so the feather accelerates only a small amount, gains little speed and drops nice and easy.

The bowling ball has very little air resistance and gravity pulls pretty hard on it (the bowling ball is heavy). A bowling ball can accelerate quite a bit and gain a lot of speed before the force of air resistance pushing up equals the force of gravity pulling down.

Quick quiz, how fast does gravity accelerate things? If you said 32 ft/s^2, 9.8 m/s^2 or 22m/h^2 you win!

Highlights for velocity:

1. Velocity is the speed and direction of an object.

2. Terminal Velocity is when something cannot gain any more speed because the friction pushing against that something is equal to the force of gravity pulling down on that something.

3. You can find how far something falls by using the formula **d=vt** or distance = velocity times time.

Objectives

Lesson 2: Acceleration

Before we get into Newton's Second Law, we need to get up to speed with acceleration. In physics **acceleration is defined as a change in velocity**. In other words, it is a change in speed or a change in direction. It is how much time it takes something to go from one velocity to another.

Remember that velocity is speed and direction. If you go straight ahead on your bike at a constant speed of 5 mph you are not accelerating. Neither your speed nor your direction is changing. Now, if you are stopped at a stop light and it turns green, you are accelerating as your speed increases from 0 mph to 10 mph. The same thing happens if you are traveling at a nice even 10 mph and slow to a stop.

In physics we don't use the word deceleration. We use positive and negative acceleration. Now what happens if you are in a car and it turns a corner at a constant speed of 15 mph? Is it accelerating or not? Well, the speed is not changing but its direction is, so it is indeed accelerating.

Remember back when we talked about gravity? We learned that gravity accelerates things at 32 feet per second^2. Now this may make a little more sense. Gravity made something continue to increase in speed so that after one second of having the force of gravity pull on something, that something has reached a speed of 32 feet per second. When that thing started falling it was at 0 velocity, after a second it's at 32 feet per second after 2 seconds it's at 64 feet per second and so on.

It's the old formula **v = gt** or velocity equals the gravitational constant (32 ft/s^2) times time. If something has an acceleration of 5 ft/s^2 how fast will it be going after 1 second…2 second…3 seconds? After one second it will be going 5 ft/s; after two seconds 10 ft/s; and after three seconds 15 ft/s. Again, it's just like **v = gt** (v is velocity, g is the gravitational constant, t is time) but put the rate of acceleration of the object in place of g to get the formula **v = at** or velocity equals acceleration times time.

Highlights for acceleration:

1. Acceleration is the rate of change in velocity. In other words, how fast is a change in speed and/or a change in direction happening.
2. Velocity is speed and direction.
3. A formula for acceleration can be a = (change in velocity)/time

Textbook Reading

One of the giants he was referring to was Gallileo. Thanks to the discoveries of Gallileo and others, Newton was able to make many of his own discoveries. The most famous of which are Newton's Laws of Motion.

Newton's three laws of motion predict the motion of virtually all objects on Earth and in space. You are about to know *all* of them. Newton's Laws are all they used to launch space craft to the moon and soon you will understand them all. Pretty powerful stuff, eh?

Newton's Three Laws of Motion are:

1. An object at rest tends to stay at rest, an object in motion tends to stay in motion unless a force acts against it.

2. Force is proportional to acceleration.

3. Every action has an equal and opposite reaction.

Newton's First Law

At first glance Newton's first law seems rather obvious. Especially the first part, *"An object at rest tends to stay at rest"* Well....of course. When was the last time you saw your table move across the room for no reason? Last time you were eating your potatoes did they float off your plate and into the lamp? NO! It's really the second part that is an amazing statement.

Especially if you consider when the statement was made:

"An object in motion tends to stay in motion." Think about that. When was the last time you saw an object keep moving on its own? If you push a toy car, does it just go and go until it hits the wall? Last time you threw a ball, if your buddy missed it did it just keep sailing down the street? No! Both objects stopped. All object stop right? Well, yes but only on a *planet*.

The reason things stop is because of two things we talked about in Unit 1: the forces of gravity and friction. Without them, things would just keep going. This is why planets, comets, space shuttles, meteors and more, never stop moving. They have no air resistance (in space there's no air and as such no friction from air) and they may or may not have much gravity pulling on them. Things in orbit (the moon, satellites, etc.) do feel the pull of Earth's gravity but they are moving fast enough to keep falling around the Earth and not into the Earth.

Now imagine Newton sitting there in 1700, he has never seen a frictionless place or a place with no gravity. He's never seen the pictures from the space shuttle of things floating around. No one's been to the moon yet. For him to "see" the reality that in such places things would never stop moving is pure genius.

Aristotle said the natural state for most objects was to be at rest. Newton, without ever seeing any evidence to the contrary, said the natural state for a moving object was to continue moving. When you can see through what everybody has believed to be true for centuries you are a true genius (or out of your head!).

Why is it hard to move a bowling ball? There is a term in physics that really kind of encompasses Newton's first law, and that is **inertia**. Inertia is a quality of an object that determines how difficult it is to get that object to move, to stop moving, or to change directions. Generally, the heavier an object is, the more inertia it has. I like to think of inertia as a mule. It is often very hard to get a mule to move, and once you do get him moving it is very difficult to get him to stop or to change directions!

Quick quiz! Which has more inertia, a ping-pong ball or a train? If you said "train" you're right. It is very easy to get a ping-pong ball to move and it is very easy to get it to stop. A train, on the other hand, is quite difficult to move or stop!

Newton's Second Law

Newton's Second Law is one of the toughest of the laws to understand but it is very powerful. In its mathematical form, it is so simple, it's elegant. Mathematically it is **F=ma** or Force = Mass x Acceleration. An easy way to remember that is to think of your mother trying to get you out of bed in the morning. Force equals MA! (Did I mention physics jokes are usually pretty bad?)

In English, Newton's Second Law can be stated a few different ways: The more mass something has and/or the faster it's accelerating, the more force it will put on whatever it hits. **F=ma** For example, a car colliding at 30 mph will hit a lot harder than a bumblebee colliding at 30 mph.

The more mass something has, the more force that's needed to get it to accelerate. **a=F/m** This, by the way, is a mathematical definition for acceleration. For example, it is a lot harder to get a train to accelerate than it is to get a ping pong ball to accelerate.

Now here's an interesting definition. The definition of mass can be stated as **m=F/a**. In other words mass is how much force it takes to accelerate something. This is a major difference between mass and weight. Something with great weight on Earth may be weightless in space (since there's no gravity) but it will still be just as difficult to get it to accelerate.

Newton's Third Law

Are you ready for Newton's Third and final law of motion? **Every action has an equal and opposite reaction**. Even though this is the most well known of Newton's Three, it seems to me to be the hardest to fully comprehend.

Again, it is a tribute to Newton that he was able to "see" this law. For every action, every force, the same action/force happens in the opposite direction. As you sit on your chair reading this, gravity is pulling down with a certain force (the force of your weight and the weight of the chair). The floor is pushing up with the same force.

Quick quiz - what would happen if the floor pushed up with more force than force of the chair pushing down? There would be an upward force which would cause an acceleration of the chair causing your mass to lift upwards! (That's Newton's Second Law, right?) Because the force up and the force down is equal, the net force is zero and there is no motion.

This law helps you walk. As you walk, you push backwards against the ground. The ground gives an equal and opposite push to you so you move forward. Try to imagine someone walking in a canoe. (I don't recommend trying this, unless you know how to swim and are willing to get wet!) As the person steps forward, the canoe moves backward. The equal and opposite force of the walking moves the person forward just as far as it moves the canoe backward.

"But how come as I walk on my floor, my house doesn't move backwards like the canoe?" Ahhh, good, I'm glad you're paying

attention. Let's go back to Newton's Second Law again.

Force equals mass times acceleration. What is the mass of you compared to your house? Pretty small right? So the force you create to move your mass forward, is nowhere near the force that is required to move the house backward (especially since your house is anchored to the earth.) You do push backward on your house but due to the immense inertia of the house it doesn't move.

Activities, Experiments, Projects

Lesson 1: Velocity

Note: This section is an abbreviated overview of the experiments online.

Experiment: Chicken and the Clam

Next time you watch a drag race, notice the wheels. Are they solid metal discs, or do they have holes drilled through the rims? I came up with this somewhat silly, but incredibly powerful quick science demonstration to show my 2nd year university students how one set of rims could really make a difference on the racetrack (with all other things being equal).

Here's what you need: two unopened cans of soup. One should be clam chowder, the other chicken broth. Prop up a long table up on one end about 6-12" (you can experiment with the height later). You're going to roll them both down the table at the same time. Which do you expect to reach to bottom first – the chicken or the clam?

Not only do my college students need to figure out which one will win, they also have to tell me *why*. The secret is in how you calculate the inertia of each. Take a guess, then watch the video, do the activity, then read the explanation at the bottom (in that order) to get the most out of this experiment.

Inertia is a quality of an object that determines how difficult it is to get that object to move, to stop moving, or to change directions. Generally, the heavier an object is, the more inertia it has. An elephant has more inertia than a mushroom. A sumo wrestler has more inertia than a baby. Inertia is made from the Latin word "inert," which means "lacking the ability to move". Inertia isn't something people have a grasp of, though, as it's something you must mathematically calculate from an object's mass and size.

When riding in a wagon that suddenly stops, you go flying out. Why? Because **an object in motion tends to stay in motion unless acted upon by an outside force** (Newton's First Law). When you hit the pavement, your motion is stopped by the sidewalk (external force). Seatbelts in a car are designed to keep you in place and counteract inertia if the car suddenly stops.

Did you know that Newton had help figuring out this First Law? Galileo rolled bronze balls down an wood ramp and recorded how far each rolled during a one-second interval to discover gravitational acceleration. And René Descartes (the great French philosopher) proposed three laws of nature, all of which Newton studied and use in his published work.

All of these thinkers (and many more) had to overcome the long-standing publicly-accepted theories that stemmed from the Greek philosopher Aristotle, which was no small feat in those days. Aristotle had completely rejected the idea of inertia (he also thought that weight affected falling objects, which we now know to be false). But remember that back then, people argued and talked about ideas rather than performing actual experiments to discover the truth about nature. They used words and reason to navigate through their world more than scientific experimentation.

Who wins, and *why*?

The chicken soup wins, for a very simple reason. Imagine that the cans are transparent, so you can see what does on inside the cans as they roll down the ramp. Which one has just the can rolling down the ramp, and which has the entire contents locked together as it rolls? The can of the chicken soup will rotate around the soup itself, while the clam chowder acts as a solid cylinder and rotates together. So the inertial mass of the clam is much greater than the inertial mass of the soup, even though the cans weigh the same.

Experiment: Ta-Da!

Ever wonder how magicians work their magic? This experiment is worthy of the stage with a little bit of practice on your end. Here’s how this activity is laid out: First, watch the video below. Next, try it on your own. Last, watch the video at the very bottom.

For this incredibly easy, super-amazing experiment, you’ll need to find a plastic cup, hard covered book, toilet paper tube, and a ball that’s a bit smaller then the opening of the cup but larger than the opening of the toilet paper tube.

1. Put the cup on a table.

2. Put the book on top of the cup.

3. This is the tricky part. Put the toilet paper tube upright on the book, exactly over the cup.

4. Now put the ball on top of the toilet paper tube.

5. Check again to make sure the tube and the ball are exactly over the top of the cup.

6. Now, hit the book on the side so that it moves parallel to the table. You want the book to slide quickly between the cup and the tube.

7. If it works right, the book and the tube fly in the direction you hit the book. The ball however falls straight down and into the cup.

8. If it works say TAAA DAAA!

This experiment is all about inertia. The force of your hand got the book moving. The friction between the book and the tube (since the tube is light it has little inertia and moves easily) causes the tube to move.

The ball, which has a decent amount of weight, and as such a decent amount of inertia, is not effected much by the moving tube. The ball, thanks to gravity, falls straight down and, hopefully, into the cup. Remember the old magician's trick of pulling the table cloth and leaving everything on the table? Now you know how it's done. "Abra Inertia"!

So inertia is how hard it is to get an object to change its motion, and Newton's First Law basically states that things don't want to change their motion. Get the connection?

Activities, Experiments, Projects

Lesson 2: Acceleration

Note: This section is an abbreviated overview of the experiments online.

Experiment: Driveway Races

This experiment is one of my favorites in this acceleration series, because it clearly shows you what acceleration looks like. The materials you need is are: a hard, smooth ball (a golf ball, racket ball, pool ball, soccer ball, etc.), tape or chalk, and a slightly sloping driveway (you can also use a board for a ramp that's propped up on one end).

Are you ready to get started really discovering what acceleration is all about?

Here's what you do:

1. Place the board on the books or whatever you use to make the board a slight ramp. You really don't want it to be slanted very high. Only an inch or less would be fine. If you wish, you can increase the slant later just to play with it.

2. Put a line across the board where you will always start the ball. Some folks call this the "starting line."

3. Start the timer and let the ball go from the starting line at the same exact time.

4. Now, this is the tricky part. When the timer hits one second, mark where the ball is at that point. Do this several times. It takes a while to get the hang of this. I find it easiest to have another person do the timing while I follow the ball with my finger. When the person says to stop, I stop my finger and mark the board at that point.

5. Do the exact same thing but this time, instead of marking the place where the ball is at one second, mark where it is at the end of two seconds.

6. Do it again but this time mark it at 3 seconds.

7. Continue marking until you run out of board or driveway.

Take a look at your marks. See how they get farther and farther apart as the ball continues to accelerate? Your ball was constantly increasing speed and as such, it was constantly accelerating. By the way, would it have mattered what the mass of the ball was that you used? No. Gravity accelerates all things equally. This fact is what Galileo was proving when he did this experiment. The weight of the ball doesn't matter but the size of the ball might. If you used a small ball and a large ball you would probably see differences due to friction and rotational inertia. The bigger the ball, the more slowly it begins rolling. The mass of the ball, however, does not matter.

Experiment: Ball Launcher

This is a satisfyingly simple activity with surprising results. Take a tennis ball and place it on top of a basketball… then release both *at the same time*.

Instant ball launcher!

You'll find the top ball rockets off skyward while the lower ball hit the floor flat (without bouncing much, if at all). Now why is that? It's easier to explain than you think…

Remember **momentum?** Momentum can be defined as **inertia in motion**. Something must be moving to have momentum. Momentum is how hard it is to get something to stop or to change directions. A moving train has a whole lot of momentum. A moving ping pong ball does not. You can easily stop a ping pong ball, even at high speeds. It is difficult, however, to stop a train even at low speeds.

Mathematically, momentum is mass times velocity, or **Momentum=mv**.

One of the basic laws of the universe is the **conservation of momentum**. When objects smack into each other, the momentum that both objects have after the collision, is equal to the amount of momentum the objects had before the crash. Once the two balls hit the ground, all the larger ball's momentum transferred to the smaller ball (plus the smaller ball had its own momentum, too!) and thus the smaller ball goes zooming to the sky.

Do you see how using a massive object as the lower ball works to your advantage here? What if you shrink the smaller ball even more, to say bouncy-ball size? Momentum is mass times by velocity, and since you aren't going to change the velocity much (unless you try this from the roof, which has its own issues), it's the mass that you can really play around with to get the biggest change in your results. So for momentum to be conserved, after impact, the top ball had to have a much greater velocity to compensate for the lower ball 's velocity going to zero.

You can also try a small bouncy ball (about the size of a quarter) and a larger bouncy ball (tennis-ball size) and rest the small one on top of the large one. Hold upright as high as you can, then release. If the balls stay put (the small one stays on top of the larger) at impact, the energy transfer will create a SUPER high bounce for the small ball. (Note how high the larger ball bounces when dropped.)

What happens if you try THREE?

Exercises for Unit 2: Motion

Lesson 1: Velocity Exercises

1. What is velocity?

2. What's the difference between speed and velocity?

3. What is terminal velocity?

4. Why do feathers have a low terminal velocity?

5. Why do bowling balls have a high terminal velocity?

6. Gravity pulls equally on a man with a closed parachute and the same man with an open parachute. Why does the man fall more slowly with an open parachute?

Lesson 2: Acceleration Exercises

1. What is acceleration?

2. If a car is going 35 mph and comes to a stop at a stop sign. Did it accelerate?

3. Is the moon accelerating?

4. What is force?

5. Does something with a lot of inertia need a lot or a little force to get it going?

6. What makes an object change its motion?

7. What happens if something is moving downhill and the force of gravity is 4 Newtons but the force of friction is 3 Newtons?

8. If you are riding your bike and stop pedaling why do you slow down?

9. If you are riding your bike and air friction, as well as the friction from the bike is 10 Newtons, how much force do you need to exert to keep moving forward at a constant speed?

10. What's Newton's Third Law?

11. You are floating in space and your Super 3000 Space Jets short out on you. You are holding a wrench. How do you get back to the space ship?

12. I'm hammering a nail into a hard piece of wood. I'm using one of my son's light hammers and getting nowhere fast. Finally, I grab a hammer with a heavier head and it goes much easier. Which one of Newton's Laws did I finally remember?

13. David Letterman, a long time ago, had a race down a hallway with a fire extinguisher and a rolling office chair. As he shot the fire extinguisher one way, the chair zipped down the hallway. (Don't try this at home!!) Which of Newton's Laws was Dave delicately demonstrating?

14. I'm riding on my bike and I accidentally hit the front brakes instead of the back brakes. The bike stops and flips me right over the handle bars. As I'm falling, I realize that I am quite a comical example of which of Newton's Laws?

15. What two things on Earth cause Newton's First Law to appear to not be true?

Answers to Velocity Exercises

1. Velocity is the speed and direction of an object.

2. Speed is just a number. Velocity is a number and a direction.

3. Terminal velocity is when something falling cannot gain any more speed because the air resistance pushing up against that something is equal to the force of gravity pulling down on that something.

4. Gravity pulls on them very lightly and they have a lot of air resistance.

5. Gravity pulls pretty hard and they have little air resistance.

6. Gravity pulls the same on both (they weigh the same) but air resistance is much greater with an open parachute. The force of air resistance equals the force of gravity much more quickly with an open parachute so the fall is slower.

Answers to Acceleration Exercises

1. Acceleration is the rate at which velocity is changing. In other words, it is the rate speed and/or direction is changing.

2. Yes, it changed speed and you could say it accelerated negatively since it lost speed. (Remember, there's no such thing as deceleration in physics.)

3. Yup, did I get you with that one? I get most folks. The Moon is not changing speed but it is constantly changing direction.

4. A force is a push or a pull on something.

5. A lot of force is needed to get an object with a lot of inertia moving.

6. Force causes acceleration which is a change in motion (slowing down, speeding up or changing directions).

7. It speeds up. That something is accelerating because there is a net positive force of 1 Newton. The force of gravity is greater than the force of friction.

8. The force of friction is acting on your bike, slowing you down.

9. 10 Newtons. Any less and you slow down, any more and you speed up. If the net forces equal zero, acceleration is zero, so there is no change in speed.

10. Every action has an equal and opposite reaction.

11. You can throw the wrench so that it goes in the opposite direction of the ship. The force of the throw will have an opposite force on you and you will zip to the ship. See how handy physics is?!

12. Newton’s Second. The heavier head of the hammer has a larger mass. The larger mass with the same acceleration will hit with a greater force on the nail then the lighter hammer will. F=ma

13. Newton’s Third Law. Every action has an equal and opposite reaction. The action of the fire extinguisher firing will have an equal and opposite reaction which zips Dave backwards down the hall.

14. Newton's First Law. An object in motion tends to stay in motion. An object at rest tends to stay at rest. Since I was moving, I continued moving even though the bike stopped. Luckily, my face broke my fall! (Helmets are a good idea!)

15. Gravity and Friction are two ever present forces on this planet that cause things to stop moving. If these forces did not exist, there would be nothing to stop objects from moving all over the place.

