Tales of Physical Science
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By Joan S. Wagner

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In this themed birthday party, the guests learn about electricity and magnetism.

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"Vinyl sound is so much better than the sound from CDs because it uses an analog storage system instead of digital," said Dylan to Hunter.
"The debate between analog vs. digital music has been around for quite a while," said Hunter. "Quite honestly, I don't really hear a difference."

This story uses digital vs. analog to learn about wave energy and the properties of waves and how information today is electronically stored.

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Allison was very excited about her chemistry set that she got for her birthday.
"Let's explode something," said her friend Jordyn as they unpacked the chemistry set.
"Everyone always wants to explode things, I want to test out the chemicals and learn about their properties. If I am going to be a chemist, I need to start early," said Allison.
"I bet you change your mind when you get to college,' said Jordyn.
"I doubt it," replied Allison.

Using a chemistry set, the girls explore the properties of matter.

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As they investigate they learn about forces and motion.

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Farrah's Electric Birthday Party

Farrah was very excited. Today was her 12th birthday and she was having a party at her house to celebrate. She and her brother, Eli, were helping their mom decorate before the festivities later that afternoon.

"Let's blow up these balloons and stick them on the wall," their mom, Lisa, stated as she walked out of the kitchen where her husband, JD, was taking cupcakes out of the oven.

"Where's the tape?" asked Farrah, as she looked for the bag of multi-colored balloons.

"We don't need tape, Farrah," Lisa replied.

Farrah looked at her mom, confused. "How can it stick to the wall then?"

"Just watch," Lisa said. She blew up a balloon, rubbed it on her hair and then stuck it to the wall.

"Wow! That's cool!" the kids replied in unison.

"Do you have to rub the balloon on your hair for it to stick? What if I rubbed it on the table?" Eli wondered out loud.

"Why don't you two see for yourselves," Lisa said.

The siblings blew up balloons, tied them, rubbed them on their hair and tried to get them to stick to the wall. Eli rubbed one balloon on the table and then placed it against the wall. The balloon stuck for a second, but soon fell off so he used his hair and it worked better.

"Cool, all the balloons sticking to the wall look festive," said Farrah.

"Rats," said Farrah as she watched one of the balloons fall to the ground. "Why didn't the balloon stick to the wall anymore?"

"Think gravity," said Farrah's mom.

"I'm thinking mom, but nothing is giving me the answer."

"Wait, I think I get it. The force of gravity must have been stronger than whatever force causes the balloons to stick to the wall."

"You got it, Einstein sister," said her brother.

"But what force causes a balloon to stick to the wall?"

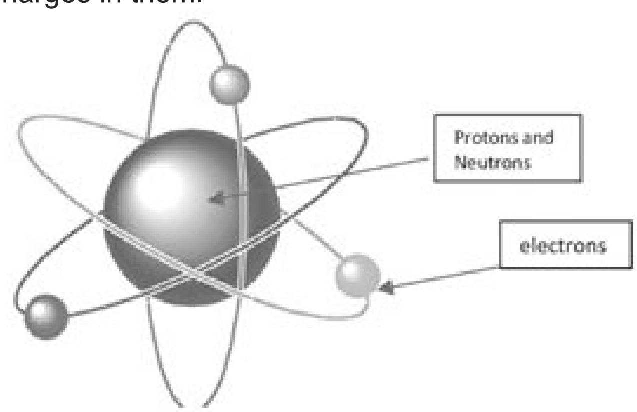
Eli loved science and thought about what he learned in his 8th grade science class. "It has to do with the makeup of matter. All matter is composed of atoms."

"Oh yeah, and atoms have positive and negative charges in them."

"Right sis, and they also have neutral charges. The positive charges are called protons and the neutral charges are called neutrons."

"And neutrons and protons are located in the center of the atom, called the nucleus."

"Right again, sis. And the electrons are located on the outside of the nucleus. Since the number of electrons and protons are equal, atoms are neutral or have no charge."



“So why did the balloon stick to the wall after mom rubbed it on her hair?” asked Farrah.

“When the balloon is rubbed on something, electrons transfer from one material to the other. The balloon typically gains electrons, giving it a negative charge,” Eli said.

Lisa was listening to her children and decided to see if they could figure it out on their own.

“I still don’t get why the balloon sticks to the wall,” said Farrah.

Eli explained, “There’s a scientific law that can explain that. My teacher told us the Law of Charges says that similar charges repel one another and opposite charges attract. So, positive charges repel or push away from each other, and positive and negative charges will attract each other.”

“Okay, Mr. Textbook, but, why does the balloon stick to the wall then?” Farrah challenged her brother.

“Since the balloon would have a negative charge from being rubbed on the hair, when it is placed by the wall, it is attracted to the opposite charges on the wall. This makes it stick,” her brother concluded.

Farrah let this sink in for a moment as she blew up another balloon. After she tied it, she asked, “Why does the balloon eventually fall off?”

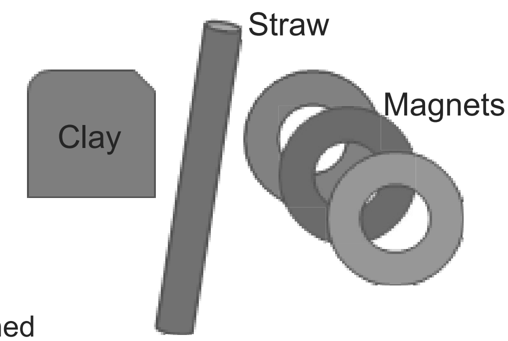
Eli picked up the balloon his sister had placed on the table and rubbed it on his head as he thoughtfully replied, “I guess it is because it loses its charge after a while, becoming neutral. Good old gravity pulls it to the floor as you noted before.”

“Close enough, though the balloon could still have a little charge left, but the pull of gravity became stronger than the attraction to the wall,” their mom said. She had listened to their conversation as she helped her husband remove the cupcakes from the pan.

“Let’s finish these balloons and ice the cupcakes before your friends come over, Farrah,” Lisa said.

Around four o’clock, Farrah’s friends had all arrived to her party. They sat around the kitchen table, talking about school, sports and ideas they had for their science projects, which were due next month.

Lisa, who was listening, planned a number of activities for them. All of the birthday parties her children attended these days always seem to have a theme. She decided to create, with Farrah’s help, a science theme birthday party on electricity and magnetism.



“I have a few fun activities you all could do now,” she said. She gathered the supplies she had prepared: a drinking straw, clay, and hoop-shaped (Ring) magnets. She gave each child a drinking straw, a bit of clay, and three magnets. She told them to play around with the magnets for a bit and then to tell her what they observed.

She went back to the kitchen to fill cups of punch and watched the kids as well. Some placed the straw into the clay at an angle and then added magnets. Others placed the straw vertically in the clay and added the magnets. A few kids played with the magnets and she could see that they noticed some magnets stuck to one another while others repelled or pushed away from one another.

This got Noe, a classmate of Farrah’s, thinking about what would happen if two magnets stuck together were placed near a single magnet.

“Look!” she yelled out, “two magnets push harder than one magnet.” She repeated the action, but placed the two magnets stuck together near the other side of the magnet. The magnets pushed away from the magnet with a force greater than when she did it with a single magnet.

“Hmm,” she thought. “Two magnets stuck together can exert a greater force than one magnet.”

Jenna said, “Well it looks like one side of a magnet attracts another magnet, and one side actually pushes the magnet away.”

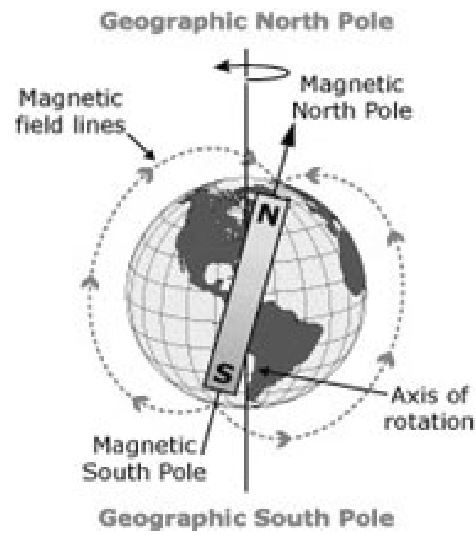
Farrah thought about the balloons and how they stuck to the wall after being rubbed.

“Mom, isn’t this like the charges in balloons?”

“Yes,” said her mom to all the children, “but your observation is not due to the charges on the magnets, but due to its poles. Magnets have north and south poles, so just like the Law of Charges, when like poles face one another they push away or repel one another, while unlike poles attract one another. This is called the Law of Poles.”

“So, the north and south poles of Earth are magnetic?” asked Carlos.

Lisa with a twinkle in her eyes said, “Yes, but we have two sets of poles.”



Carlos and the other children looked very puzzled. Eli was trying to think about his science class but was going blank.

Lisa suspected this question may come up and was prepared to provide an answer. She showed the children a picture of Earth with its geographic and magnetic poles. “See, our geographic north and south poles are where we go if we wanted to reach the most north and most south part of our planet. Notice the magnetic poles are not located there.”

“You mean, Earth is a giant magnet,” said Carlos.

“Exactly,” said Lisa. “In fact, some scientists believe some animals use the magnetic poles to navigate Earth.”

“Now that is cool,” said Carlos.

As she was explaining this, Eli was carefully placing his straw in the clay so that it was perpendicular to the table where he was sitting. He then placed the magnets on the straw.

“Hey, look at this. Some of my magnets float on the straw!” he exclaimed.

“That’s neat,” Noe said.

Eli, remembering that magnets can attract or repel, realized that the floating magnets were simply repelling one another on the straw.

“I must have placed the magnets on the straw so that like poles were pushing against one another, creating the spaces between the magnets,” he observed. One of the things he also noticed was that the spaces between the two bottom magnets got smaller when he added the third magnet. The other party guests followed Eli’s lead and had the same results.

This puzzled Eli. None of the other children seemed to know why this happened either.

Noticing their confusion, Lisa asked them, “Can you name the force that causes the magnet to slide down the straw?”

The Case of the Ball that Did Not Bounce

One day, Tiah and Amelia found a strange ball. When they dropped it, they found that it would not bounce like other balls they had encountered. Tiah was ready to place it in the recycling bin, but Amelia stopped her.

"Wait! Don't throw it away yet. Let's see if we can figure out why the ball won't bounce first."

"We're not doing an experiment, are we?" asked Tiah, with a little attitude.

Amelia grinned and nodded.

"But, that is what we do in school, Amelia. You must be kidding," said Tiah desperately.

"No Tiah, trust me, this will be fun," replied Amelia to her best friend.

"Whatever," responded Tiah.

The two girls walked into Amelia's room and sat on her bed. As they examined the ball, they noticed that it felt and looked like any ordinary rubber ball, so why didn't it bounce?

"OK, Amelia, there is nothing we can tell by how the ball feels so let's dump it and make a TikTok video," said Tiah starting to get bored.

"Don't you think it is weird that the ball feels exactly like any ordinary rubber ball but does not bounce? Come on Tiah, it is rainy outside anyway, it can be fun to find out why it doesn't bounce," replied Amelia, slightly annoyed that her friend does not share her interest.

"Whatever," replied Tiah.

"Let's see what other balls we can find," suggested Amelia.

"Why?" asked Tiah.

"You'll see," replied Amelia.

So, they went around Amelia's house and found several different balls.

"Hey, Amelia, look what I found under your sister's bed, it's one of those high bouncing balls," said Tiah, as she bounced the ball and watched it almost hit the ceiling light.

"Whew, close call. My parents wouldn't have been happy if we broke the light," said Amelia, as she watched the ball almost become a problem.

The girls took inventory of the balls they collected: a large soft rubber ball, a medium-sized rubber ball, a high bouncer ball, a tennis ball, a ping pong ball, a golf ball, and a plastic ball

"Wow, you sure have lots of balls in your home," noted Tiah. "Don't tell me you want to drop all of the balls," she continued with a touch of sarcasm in her voice.

The Case of the Dent on the Roof of Mom's Car

Walter and Evie were walking to school together. "Wow, mom was on the warpath this morning," said Walter.

"She is very upset about the big dent on her car's roof," replied Evie to her twin brother, Walter.

"Dad wasn't too pleased himself," added Walter.

Evie and Walter's mother and father could not understand how such a large dent formed on the roof of the car. Their dad discovered the dent while he was taking out the trash. He is tall and as he passed the car, he noticed the dent on the roof.

"Hey, remember when the deer ran into mom's car door last summer?" said Walter.

"Yeah." replied Evie, "mom thought that there would be a big dent, but there was only a little scratch."

Though Evie, Walter and their mom were startled by the big thud they heard when the deer struck the door, it did not hit it very hard, and just continued its journey across the road, apparently, unhurt.

"What could have caused such a big dent on the car's roof?" They remembered their dad asking over breakfast that morning.

The twins decided to take on the challenge and figure out the cause of the dent on the car's roof. Evie and Walter felt that if they could determine what was the cause of the dent, it might help prevent it from occurring again. They also thought it would be fun to try to solve the mystery of the car's dent. They loved mysteries and were inquisitive twins! In addition, they felt bad because their parents were upset about the cost of repairing the dent.

When Evie and Walter got home from school, they decided to inspect the dent and gather information about it. They obtained a step stool, and each took a turn climbing up to take a closer look at the dent.

"Hey Walter, did you notice that some of the paint in the dent is chipped?"

"Yeah, I did," replied Evie, "something hit the roof with enough force to also damage the paint. What in the world could it had been?"

"I'll get my notepad," continued Evie. "We need to write everything down."

"You can write everything down," replied Walter. "I write enough in school."

"Based on what I have seen, you can use the practice," teased his twin.

"The only practice I need is in baseball," said Walter getting annoyed at his sister.

"Okay, okay, calm down, Walter. I'll take all the notes," replied Evie.

"Good, now go get a ruler," ordered Walter to his sister.

"And why do we need a ruler?" asked Evie.

"To measure the size of the dent," replied Walter.

"Right!" said Evie.

Evie went to her room to get her ruler. When she returned, she climbed the step stool to begin the measuring.

"Measure in metric," said Walter.

"On it," replied Evie.

Object	Mass (g)	Average Width (cm)	Average Length (cm)	Average Depth (25 cm)	Average Depth (50 cm)	Average Depth (75 cm)	Average Depth (100 cm)
Ping Pong Ball	2.3	4	4	.3	.5	.7	.9
Golf Ball	45.9	4	4	.8	1	1.3	1.4
Softball	177	10	10	1	1.5	1.8	2
Can	280	8	15	2	2.5	3	3.3
Balloon	1.55	15	16	.2	.5	.5	.5
Quarter	5.67	2	2	.3	.5	.7	.8
Rock	75	4	6	.5	.7	1	1.2

"What do you notice?" asked Evie.

"Well, you don't have to be a rocket scientist to see that the mass and size of an object affect the size of the crater it creates when dropped," said Walter.

"Walter, it looks like your hypothesis, that the higher an object is dropped the deeper the crater is correct," noted Evie.

"As I said before, it is because when an object is dropped, the higher up it is, the longer it is falling. The longer it falls, the faster it is going on impact" noted Walter.

"Now I see, Walter, if two cars collide, the faster they are going, the greater the damage to the cars. So, velocity does have something to do with force in addition to the mass of an object," said Evie.

"Actually, I am not surprised, and you should not be either," replied Walter.

"I have a feeling this has something to do with Mrs. Dayton's science class."

"Evie, can you say Newton?" asked Walter.

"As in Isaac? Oh yeah, now I remember. This all has to do with Newton's Laws of Motion," said Evie.

"Right, it was what we studied last month in science class," said Walter.

"Well, Newton has 3 laws of motion," stated Evie in a matter-of-fact manner.

"Do you know which law applies to our results?" asked Walter.

"It's the one that has to do with force," replied Evie. "I remember it was sort of like a formula of some type," said Evie, wishing she could remember the formula before her brother did.

"It is Newton's Second Law of Motion. The amount of force created by an object is directly related to its mass and its final velocity," stated Walter, "when objects fall, they accelerate so the longer they fall, the faster they go, the greater its force," he continued.

As he was talking, Evie had a big grin on her face.

"Why are you smiling?" Walter asked.

Evie held up the piece of paper.

On it was the formula showing Newton's Second Law of Motion.

Force = Mass x acceleration or F = ma

4. Why was it useful to create a chart of the objects dropped?

5. How would you improve Evie and Walter's investigation?

6. Try out Evie and Walter's investigation with your improvements. Here is what you will need:

Metric ruler
Assorted balls: ping pong, golf, softball
Rock
Quarter
16 oz can of tomato sauce
Balloon

The Case of the Dent on the Roof of Mom's Car Vocabulary

1. **Force:** A push or pull that can change an object's motion or shape.
2. **Friction:** A force that opposes motion.
3. **Gravity:** A force of attraction between objects that have mass. The greater the masses and the closer they are together, the stronger the gravitational force. Mathematically, Newton described it with this formula: $F = G\ (m_1 \times m_2 / d^2)$
4. **Gravitational Potential Energy:** Stored energy dependent on the weight of matter (from pull of gravity) and the height from which it falls. Mathematically expressed as: $GPE = 9.8 m/s^2 \times \text{mass} \times \text{height}$.
5. **Heat Energy:** Energy that is transferred from an area of higher temperature to one of lower.
6. **Kinetic Energy:** Energy of motion. Mathematically expressed as $1/2m \times v^2$.
7. **Mass:** A measurement of the amount of matter in an object. Mass is not affected by gravity.
8. **Motion:** Any movement or change in position relative to an observer.
9. **Potential Energy:** Stored energy.

10. **Sound Energy:** Energy produced by the vibrations of matter.
11. **Temperature:** A measurement of the average kinetic energy in matter.
12. **Weight:** A measurement of the pull of gravity on mass.

Next Generation Science Standards Addressed in This Story

MS-PS2 Motion and Stability: Forces and Interactions

Forces and Motion

1. The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion.
2. All positions of objects and directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. To share information with other people, these choices must also be shared.
3. Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both objects have large mass—e.g., Earth and the sun.
4. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

Science and Engineering Practices

- Designing and using models
- Analyzing and interpreting data
- Constructing explanations and designing solutions
- Obtaining, gathering and communicating information

Crosscutting Concepts

- Cause and Effect
- Scale, proportion and quantity