



Teacher's Guide for: **Roller Coasters**

Note: All activities in this document should be performed with adult supervision. Likewise, common sense and care are essential to the conduct of any and all activities, whether described in this document or otherwise. Parents or guardians should supervise children. Rock-it Science assumes no responsibility for any injuries or damages arising from any activities.

NOTE: *This is the transcript of a lesson that was videotaped during an actual Rock-it Science class with real students, not actors. The students' brainstorming comments are included on the video, but are not transcribed here because they're not part of the lesson presentation. The video also includes a discussion that the public school classroom teacher conducted following the lesson, and that discussion isn't transcribed either.*

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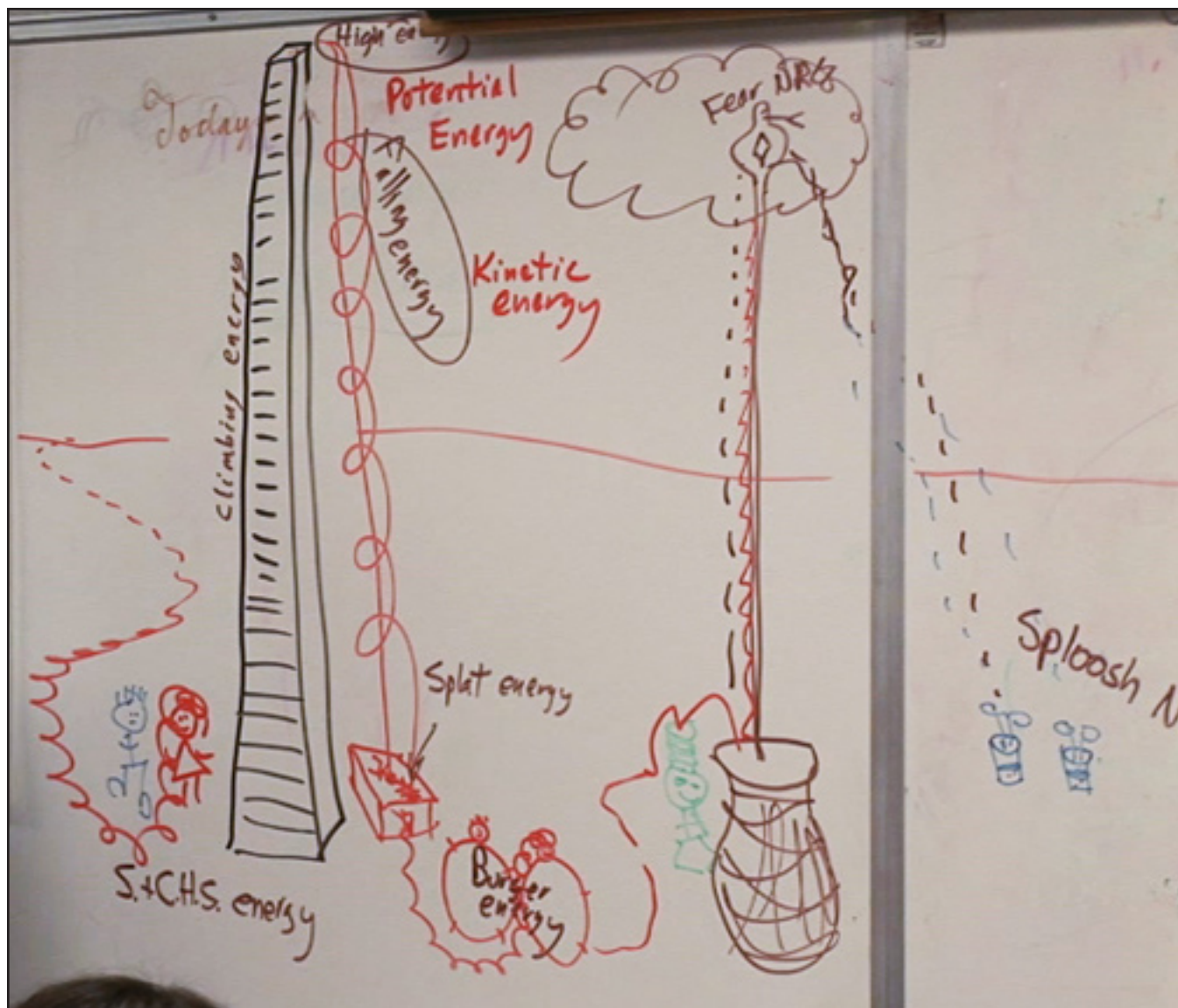
Title Page of Video

Roller Coasters
A Rock-it Science Lesson
Filmed June, 2006

Rock-it Science
2110 Walsh Ave, Unit F
Santa Clara, CA 95050
www.rockitscience.org

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Intro Quick Recap: "Kinetic and Potential Energy"



- Jack and Jill eat for breakfast a huge bowl of slime and cat hair stew.
 - They go outside and climb a skyscraper that's a thousand feet high by putting bubble gum on their hands and feet.
 - When they get to the top, they're hungry again, and they spot a hamburger store on the ground near the building.
 - They jump off the building, and Jill does some loop-de-loops on the way down. They crash through the roof of the hamburger store and land in a huge pile of freshly made hamburgers, which breaks their fall.
 - Jack and Jill were so hungry they ate all the hamburgers in the entire store.
- (Continued next page)*

Intro Quick Recap (cont): "*Kinetic and Potential Energy*"

- When they went outside, they were really chubby and could hardly walk. They wanted to find a way to get thinned down again.
 - They saw a man with a turban playing a flute next to a basket. A thick rope appeared to be rising out of the basket, extending far up into the sky.
 - Jack and Jill decided to climb the rope in order to get some exercise.
 - They climbed up into the clouds, to the top of the rope, which turned out to be a deadly snake.
 - They jumped off the snake and fell toward the ground, landing in two glasses of water that someone had left there.
 - What does this have to do with science? Do you remember what Jack and Jill ate for breakfast?
 - After they ate breakfast, they were full of slime and cat hair stew energy.
 - When they started climbing the tower, that slime and cat hair stew energy was changed into climbing energy.
 - At the top of the building, they were up high, so they now had high energy.
 - When they jumped off, they had flying or falling energy. When Jill did loop-de-loops, she had loop-de-loop energy.
 - When they hit the top of the hamburger store, they had splat energy.
 - When they ate the hamburgers, they were full of burger energy.
 - When they climbed up again, more climbing energy. Then they had fear energy. Then more falling energy.
 - When they landed in the water, they had sploosh energy.
 - Energy changes form all the time.
 - You have chemicals in you that react and create heat inside you, so you're full of heat energy. You also have chemical energy inside you that makes you work.
 - Jack and Jill used two kinds of energy: the high energy and the falling energy. Scientists call the high energy "potential energy." When something is falling or has a lot of speed, they call it "kinetic energy."
 - If you climb to the top of a slide and take your bicycle with you, when you're at the highest spot you're full of potential energy.
 - When you start zooming down, that's kinetic energy, or speed energy.
 - There's also friction. Whenever energy changes form, friction eats up some of the energy.
-

Demo Quick Recap: "Roller Coaster Loops"

- Instructor takes a length of foam, holds it by each end so it hangs in a U shape, and drops a marble into the track. It rolls down to the bottom and partway up the other side, then rolls back and forth.
- Instructor holds one end of the foam up high and puts a loop in the lower end, then drops the marble in the track. The marble should make it through to the end.
- Instructor does the same thing with two loops in the track. This time, the marble doesn't make it through the second loop. Not enough energy for it to get through.



Experiment Quick Recap: "Roller Coasters"

- Each student gets one piece of foam and one marble.
- Students can combine their foam with someone else's, using masking tape.
- Try to get as many energy changes as possible. Being high up is potential and speed is kinetic.



Equipment List: "Roller Coasters"

Items needed for Instructor:

- (None)

Items needed for Students:

Consumables:

- Tape, masking, 1 roll per 2 students

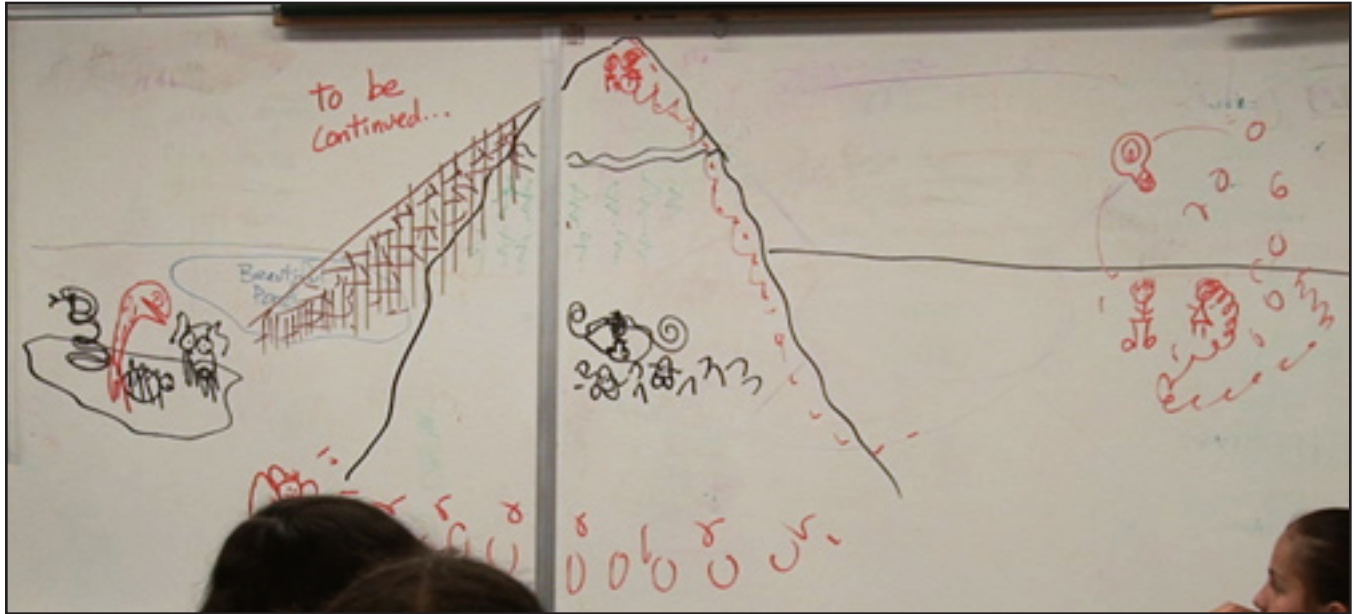
Other:

- Polyethylene foam pipe insulation, 5/8" ID x 3/8" wall, NO adhesive. Comes in 6' lengths. Cut in half lengthwise for experiment, one half per student.
- Marbles, 3/8", 1 per student

Prep Work:

- Cut foam in half lengthwise on a bandsaw. (See *Roller Coasters* video page on web site for tips on cutting foam.)

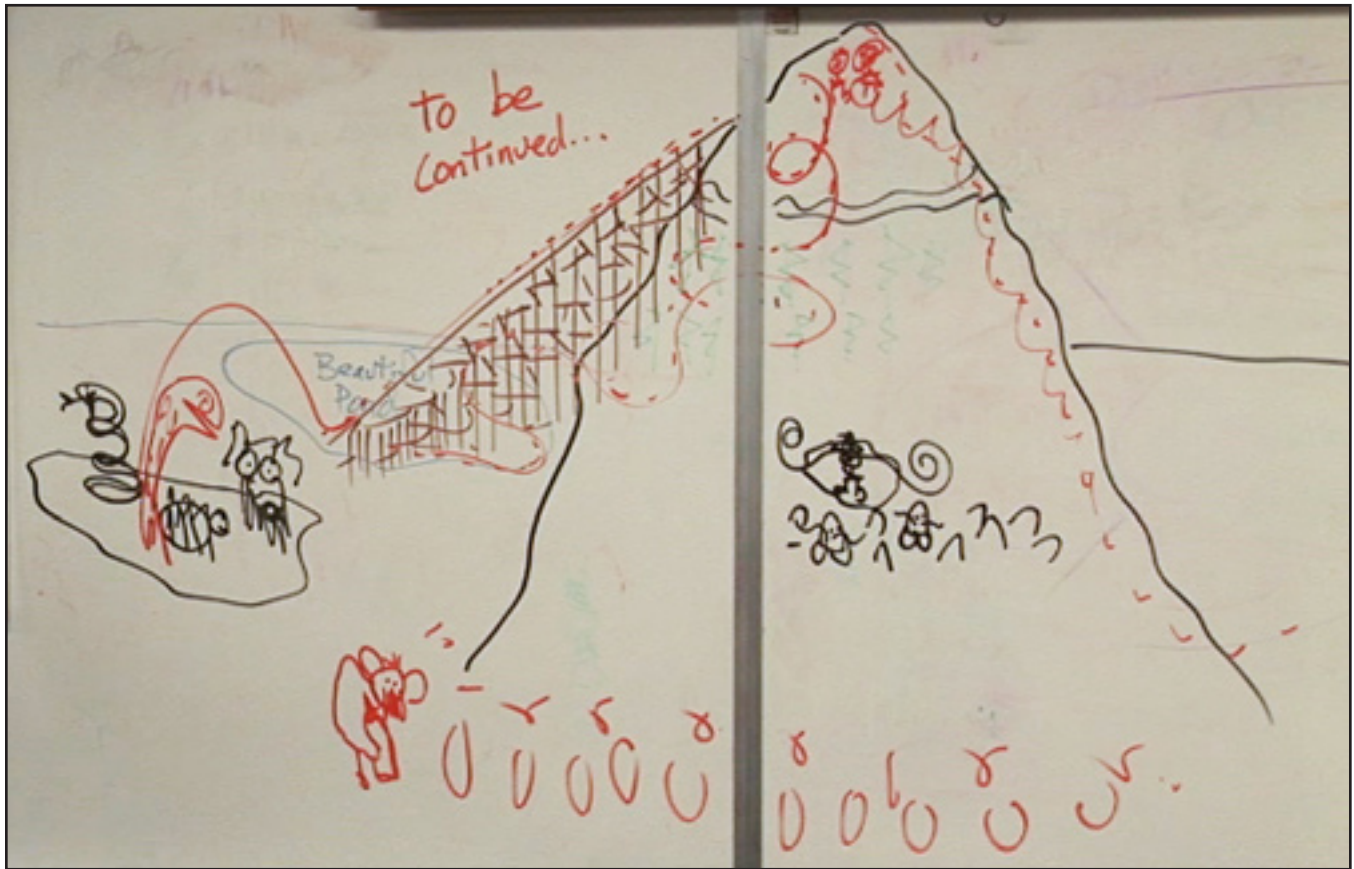
Story Recap: "Jack & Jill and the Mutated Old Men"



Part 1:

- There was a Beautiful Pond where people liked to go to swim and have a good time.
- Evil Mister Fred created a pit right next to the pond and filled it with all kinds of evil creatures so people wouldn't have such a good time. One type of creature that came out of the pit was a bunch of mutated old men.
- Nearby was a big mountain, thirty thousand feet high.
- Jack and Jill were playing soccer with their Kick-Mes, and they were getting tired. So they decided to kick their Kick-Mes up to the top of the mountain and then kick them off.
- Evil Mister Fred saw them going up the mountain and told his minions to follow them up there and trap them on the top of the mountain so they'd freeze to death. Evil Mister Fred went up there along with the minions.
- Meanwhile, the mutated old men had continued to mutate, and Evil Mister Fred couldn't control them anymore. They ate one of the Kick-Mes and started climbing up the mountain so they could eat everybody else, too.
- Everybody wanted to get off the mountain. Evil Mister Fred ordered the minions to use the trees on the mountain to build a ramp to the bottom.
- Jack and Jill thought they could just use the ramp after Evil Mister Fred and his minions went down, but the Kick-Mes said that was too easy.
- So Jack and Jill called the Acme Store of Everything and ordered a can of Instant Purple Petunia Flavored Spray Glue, and they were going to spray it on Jill's hair.

Story Quick Recap (cont.)



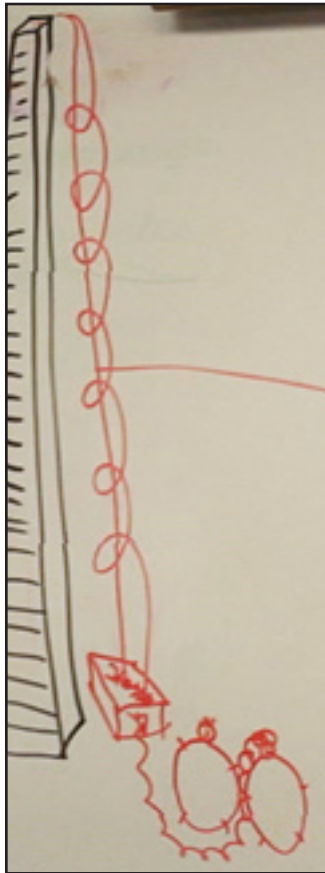
Ending:

- Jack and Jill sprayed Jill's hair with the spray glue and form it into a giant roller coaster, with loop-de-loops and corkscrews.
- Evil Mister Fred put his minions on the ramp one after another and slid them down, and he jumped on after them.
- They started going really, really fast down the ramp.
- Meanwhile, Jack and Jill put their Kick-Mes on the roller coaster and jumped on behind them.
- While they were going through the loop-de-loops and corkscrews, they used up most of their energy, so at the bottom they dropped gently into Beautiful Pond.
- But Evil Mister Fred and the minions were approaching the pond at high speed and at an angle, so they bounced off instead of going into the water. And they landed in the pit, where the evil creatures ate them up.

Transcript: Intro

We're going to have two crazy stories, and then we're going to do an experiment. And we're going to make the experiment so you don't have enough stuff to do it.

So, let's see, what is the worst imaginable kind of breakfast you can think of? *[Students: Slime.]* Slime. Okay, let's suppose Jack and Jill have for breakfast some slime and cat hair stew. And they ate a huge bowl of it. So there's Jack, and let's make Jill a different color. There's Jill. And they just ate this wonderful meal, and they're trying to find out something they can do.

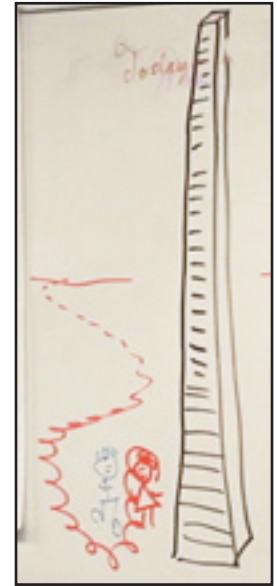


Jack & Jill jumped, fell through the roof of the hamburger store, and came out chubby.

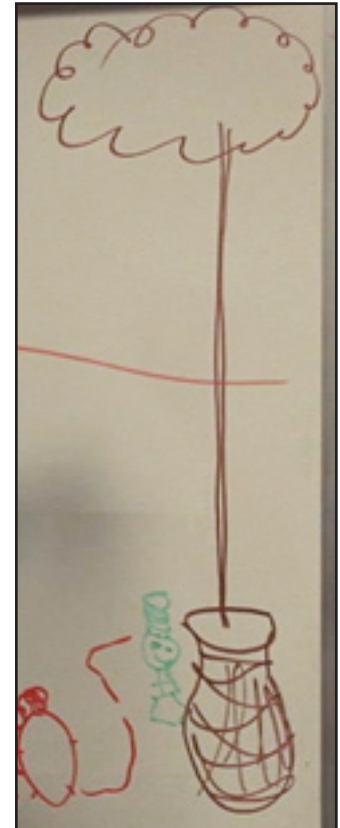
And they look around, and somebody has built a new building in their town. It's all made out of glass and steel, like that. It's a thousand feet high. And Jack and Jill say, "Yeah, this is the place for us. We're going to climb up this building." So they put some bubble gum on their hands and their feet, and they start climbing up to the top of the building. All the way to the very top. And there they are at the top. And they look around and say, "What's there to eat? We made it, we didn't die, now we're hungry." And Jack got really close to the edge and he looked down and said, "(sniff, sniff) Ahhhh, I smell hamburgers." And he looked at the bottom, and sure enough, there was a Mac-Donald's store down there.

And Jack couldn't wait. So he jumped off the top of the building -- "Ahhhhhhhhh" -- splat!! Hit the roof of the hamburger store and made a hole in it in the shape of Jack. And Jill couldn't wait either, so she jumped after him. "Ahhhhhhh," and she did some loop-de-loops on the way down -- splat! Right next to Jack. And both of them landed in a huge pile of freshly made hamburgers. And they said, "Ahhh, my favorite!" And they started eating them, "Arrr, arrr, arrr, arrr, arrr." And they ate all the hamburgers in the entire store.

When they came out, they were a little bit on the chubby side. There's Jack, and there's Jill. And they said, "Uh, oh, that was really good, but we can hardly walk anymore." And they thought, "We've got to do something to thin ourselves back down again." And they listened and they heard some music *[whistles snake charmer music]*. And they started wandering around looking for the source of the music. And they found a guy with a turban. You guys know what a turban is? It's kind of like a towel on the head. And he was playing a flute, making music. And Jack and Jill looked



Skyscraper

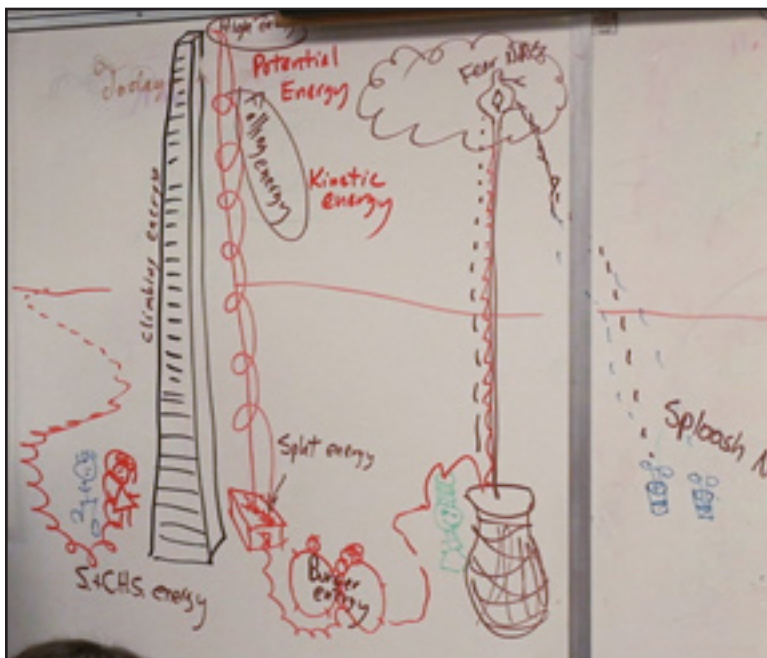


Snakecharmer

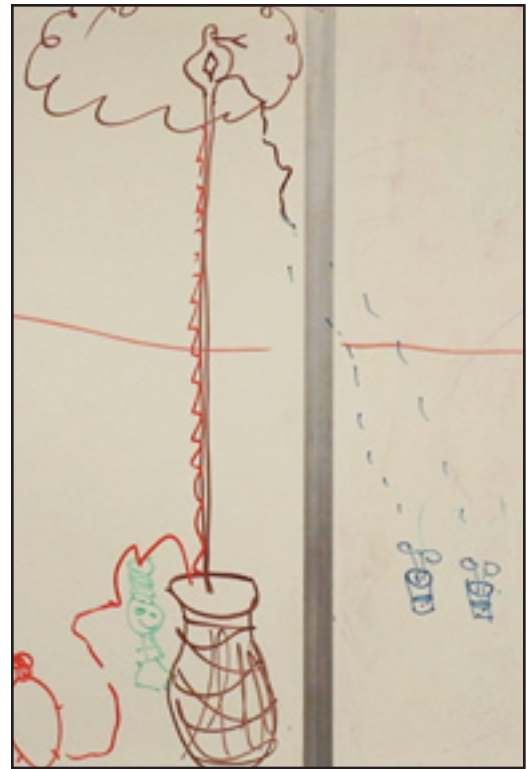
around, and right next to him there was a big wicker basket. And there was something that looked like a very, very thick rope coming out of the basket. And it disappeared up into the clouds. And Jack and Jill said, "Ah, that's the perfect place for us to be. We can exercise on that rope." So they decided to climb up to the top. So they jumped onto the guy and bounced onto the bowl, and climbed up and up and up and up and up and up, into the clouds. When they got way up into the clouds, they realized that it wasn't really a rope. It was a kind of creature that has a fat neck. What's that? [Student: Cobra!] Yeah, a cobra. This one's going to be a diamond cobra. And Jack and Jill said, "Look! Cobra!" And they jumped off again.

Now, Jack and Jill would have died. They're trying to fly. Down below them is nothing but concrete, and this could hurt, if you hit concrete. However, somebody left two glasses of water there. And Jack landed in one and Jill landed in the other. There's their feet sticking out. There's their eyes looking out from the glass. And Jack and Jill miraculously survived this incredible fall.

Now, would you agree that that is a crazy story? [Students: Yes.] What does it have to do with science? [Student: Gravity.] Gravity. Good. Do you remember what they ate for breakfast? [Students: Slime.] Slime and what? [Students: Cat hair.] Cat hair stew. Well, they were full of slime and cat hair stew energy. And when they started climbing up this tower, that slime and cat hair stew energy was changed into climbing energy.



Energy changes.



Jack & Jill saw the snake, got scared, and jumped into two glasses of water.

And when they got to the top, they were a thousand feet higher than before. So now they have high energy because they're high in the air. And when they jumped off, now they have flying energy, or falling energy. And when Jill started doing loop-de-loops, of course she had loop-de-loop energy. And when they hit the top of the hamburger store, splat energy. And then they ate all the hamburgers, so they're full of burger energy. And again, they climbed up, so there's more climbing energy. Here they received some fear energy. I'm going to abbreviate it - NRG. And then more falling energy, and then they landed into the cups of water. We can call that sploosh energy.

So you can see that energy changes forms all the time. When you're sitting there in your chair, the chemicals that are inside of you are reacting and creating heat inside of you, so you're full of heat energy. You have all kinds of chemical energy inside you that makes you work. And Jack and Jill had two kinds of energy that we're going to use today. One of them is the high energy, and one of them is the falling energy. And scientists have a name for whenever you're way up high. That kind of energy, they call it potential energy. And when something is falling or has a lot of speed, they call that kinetic energy.

So if you climb to the top of a slide and take your bicycle with you, and sit on your bicycle, and then ride down the slide, when you're at the highest spot, you're full of potential energy. When you start zooming down -- whoosh, that's kinetic energy. That's speed energy. There's another thing that goes on, too. That's friction. Whenever energy changes form, there's always some friction that eats up some of that energy. That's the crazy story number one, and that's the background stuff.

Story: "Jack & Jill and the Mutated Old Men"

The crazy story number two is going to provide a problem for you guys to solve. Let's see. What are you guys afraid of?

[Student: Heights.] Heights. What kind of animals are you afraid of?

[Students respond.] Snakes. Dogs. Spiders. Sharks.

Okay. We need a whole pit full of scary things. So sharks, spiders, snakes. Anything else that would be good in the pit?

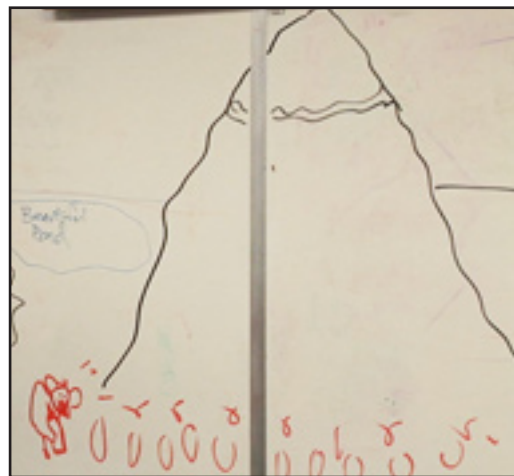
[Students respond.] Evil? Anacondas? A mutated dog! Oh, yeah. So we have a big pit out here, and it's got some black widow spiders in it. And it's got some snakes, rattlesnakes or something equally poisonous, with fangs. And a mutated dog. It's got to have a nose and some teeth, like that. And an anaconda. That's a giant fat snake, isn't it? It can swallow a whole deer or something like that. Yeah, anaconda.



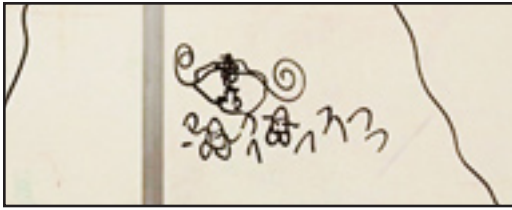
Pit of evil creatures next to Beautiful Pond.

Okay, Evil Mister Fred has created this pit of stuff that is so fearful, nobody will go near it. And he created it right next to Beautiful Lake. Here's Beautiful Lake. People like to go there swimming, Bambi's out there, bluebirds are singing, Thumper the rabbit is all there. And he wanted to create this evil spot next to the beautiful spot so people wouldn't have such a good time. So we'll call this Beautiful Pond.

And next to Beautiful Pond, we're going to need a big mountain. Something fairly tall, like Mount Everest. About thirty thousand feet high, with some snow on it, like that. And a horizon. And let's suppose that . . . We need some creatures to come out of [the pit] that can move fairly fast and can terrorize people. [Students respond.] A water snake. A mutated old man! Oh, I like that idea. A mutated old man. Okay, so Evil Mister Fred was experimenting with a bunch of old guys and mutated them. So they would have to have a hunchback tilted



Mutated old men near the mountain.



Evil Mister Fred and his minions
in his dungeon inside the mountain.

overhead, beady eyes, sharp teeth, big ears, and he's an old guy, so little tiny legs, and he should probably walk with a cane. Okay. [Student: He looks like a rat.] He looks like a rat? Yeah. And we'll put a bunch of them out here. These are all mutated old men. There's a whole army of them.

Now, Evil Mister Fred has inside of the mountain a dungeon, a cave where he can work. So he's down there thinking of evil deeds to do. And he's got all of his minions with him. And they're always trying to find ways to trap Jack and Jill. Minions, minions, minions, minions.

Jack and Jill are out here on the level spot with a whole bunch of Kick-Mes. And the Kick-Mes aren't happy unless they're being kicked around, so Jack and Jill are playing soccer with their Kick-Mes. And it takes a lot of work to keep Kick-Mes kicked into the air. They're sad if they're just sitting on the ground. And so Jack and Jill are always having to kick them hard and run around. It's a tremendous amount of exercise just kicking Kick-Mes. So there's Kick-Mes all over the place, flying through the air.



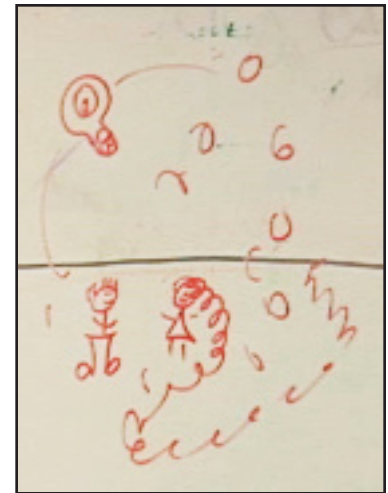
Jack & Jill and the Kick-Mes at the top.

And Jill said, "Jack, I'm tired. This is too hard work. Let's take our Kick-Mes, kick them up the side of that really tall mountain over there, and then we'll just kick them right off the thing." And so they did. They kicked them up thirty thousand feet. And now there's Kick-Mes all over the top of the mountain.

And Evil Mister Fred saw them go by, and he says, 'Oh, this is perfect. We'll trap them at the top of the mountain. If they don't freeze to death, we'll find some other evil thing to do to them. And so he got all his minions together, and Evil Mister Fred and his minions headed up to the top of the mountain.

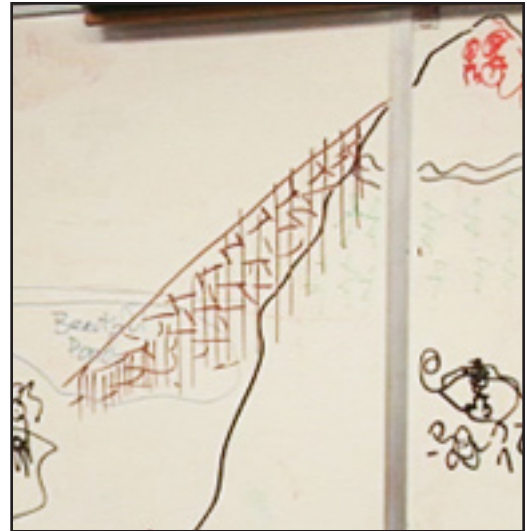
So Jack and Jill are now way up high, the Kick-Mes are all with them, thirty thousand feet, not much oxygen. And the minions are coming up the mountain to try to trap them up there.

However, they didn't plan on the mutated old men. The mutated old men continued to mutate. They were created by the Evil Mister Fred, but now they have a mind of their own. And they saw everybody go up the mountain, and they said, "Arrrrrgggghhhh." They start going up the mountain themselves to see what harm they can do. When Jack and Jill and the Kick-Mes looked down and Evil Mister Fred looked down, they saw all the mutated old men coming. And they said, "Uh, oh, this is bad. What's going to happen?"



Jack & Jill and the Kick-Mes.

And the mutated old men got one of the Kick-Mes, and they picked him up and ate him -- crunch! In one bite. And this kind of scared the rest of the Kick-Mes, so they went "Aaaaaaahhh!" running like crazy up to the top of the mountain. And everybody needed to leave the top of the mountain. They looked around, and Evil Mister Fred said, "Okay, minions, this is your job. You're going to make some way for us to escape from the mountain using all these trees. And you have to create some sort of a ramp to get us from the top of the mountain down to that pond and away from all those weird mutated old men." So the minions went right to work. The ones that were fast workers started right away building towers, towers, and more towers. And the ones that were slow workers got put down near the bottom -- well, they're going to have to climb down to the bottom. And they were creating this ramp. And the idea was to slide down it really fast and get by all those mutated old men and into the pond.



The minions built a ramp.

Meantime, Jack and Jill were looking at this and they were saying, "Yeah, we'll let them do all that work, build that thing, and we'll slide down it, too." But the Kick-Mes said, "Nah, we don't want to do that. That's no fun. Anybody can do that." So Jack and Jill called the Acme Store of Everything and ordered a can of Instant Purple Petunia Flavored Spray Glue. And the idea was, they were going to spray it on Jill's hair. Now, if you were Jack and Jill, what on earth could you be doing with Purple Petunia Spray Glue?

Imagination and Brainstorming Time

[Students make suggestions] (THERE ARE NO WRONG ANSWERS! Whatever they say, you should reply: "That's a good idea," "They might do that," etc. After brainstorming, proceed with the experiments, then finish the story.)

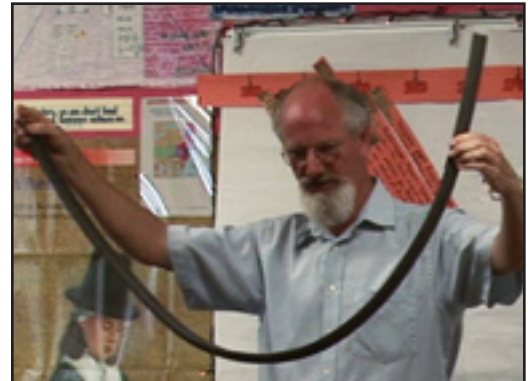
We'll leave this To Be Continued . . .

Demo: Roller Coaster Loops

Now we're going to do some experiments. In the experiment, you're going to use kinetic energy and potential energy, and tape and marbles and a piece of foam. Well, you've got a marble. That's a good thing. And you've got a piece of foam. What could you possibly do with this? *[Student responds.]* Yeah, you could make the marble go down it. So we could just . . . *[holds the tube by the ends so it forms a U-shape, then rolls the marble down from one end, and it rolls back and forth in the middle].* And it'll just keep going back and forth just as long as you want to hold it and sway back and forth.

Now suppose I did something like put a loop in it. Will the marble go down and through the loop? *[Students: Yes. If it goes fast enough. Maybe.]* Maybe? Well, let's see. We'll aim it at this guy over here. *[Holds one end up high and forms a loop near the lower end of the track.]* Now we'll do the great test. Will the marble land on the person, or will it get stuck in the loop? *[Releases the marble, which goes down the track, through the loop, and out the other end.]* Yeah, it made it through the loop.

Will it make it through two loops? *[Students: No. Yeah.]* No? Yeah? *[Makes two loops in the lower end of the track.]* Boy, that's quite a mess of loops. Well, we need a volunteer from the audience. Since he was our victim, here, you can hold this marble. And I will try to hold the loops up like this. Would you start the marble near the top, and we'll see what happens. Okay, go. *[Student drops the marble into the track near the top. It goes down the track but bounces out while going through the second loop.]* Ohhh, and it didn't make it. Did you see it? It fell out about halfway from the second loop? Not enough energy for it to get through.



Marble rolls back and forth.



One Loop.



Two Loops.

Experiment: *Roller Coasters*

Now, your objective is to make a roller coaster using this stuff that will keep the marble doing as many energy changes as possible. That means lots of highs -- potential energy -- and lows, for kinetic energy. However, each of you only gets one of these pieces of foam. You don't get to cut it. Of course, you can add yours to other people's with tape. You can tape them to walls and ceilings and floors and other people. But you don't get to tape it to places where the tape would wreck your walls. So like if there's paper on your walls, don't tape on paper, because the tape will tear your paper. You can tape to white boards, you can tape to desks, you can tape to chairs.

Now, we need to borrow a chair. Can I borrow your chair? We're going to put some chairs on top of desks like this. You can tape it to the chairs. We need another chair. Can I borrow your chair? Now, suppose you wanted to get closer to that chair. You can stand on your chair, but the rule is: The back of the chair has to be against the table. This way, if you step back, you don't fall off and conk your head on the ground. You can just step right onto the ground that way, okay?

So you can build structures, you can have the foam go anyway you want to through them. At the end, we'll give you a chance to show off your roller coaster. So whatever group you end up forming, you have until, say, like five after twelve. That's about twenty-five minutes to build something. So when we say, "Time's up," don't tear it down. Keep it together, and then we'll come by and watch the marble and see how far the marble goes through it before it falls out. Are there any questions before you get started? Okay, my assistant will pass out tubes, and I'll pass out marbles, and then we'll pass out some tape.

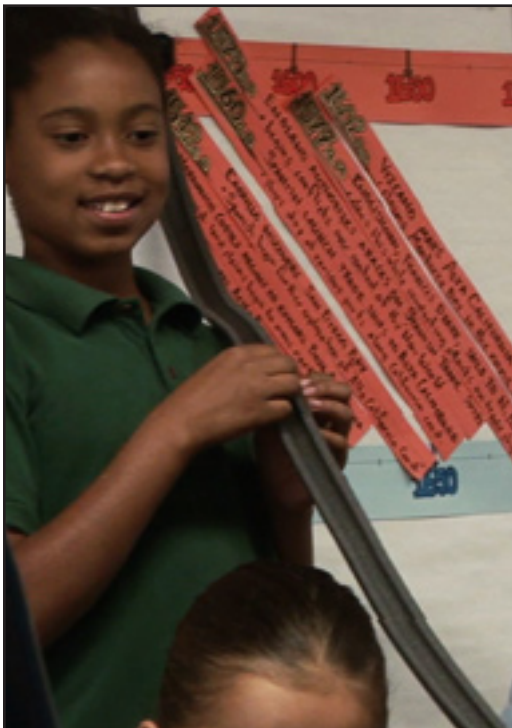


One chair on top of the desk, another with its back against the desk, for safety.



[Students receive their materials and form groups with as many others as they want, and they build and test their roller coasters until the Instructor calls "Time's Up."]

A marble passes over a piece of tape where two pieces of foam are joined.



[Instructor calls "Time's Up."] Now, we're going to start over in this corner and go from group to group and let you try and see if you can make the marble go through. [Each group demonstrates their roller coaster in turn.] Okay, we need to take them apart very carefully. Peel the tape off.



End of Story

*** DO NOT * present this part of the lesson until after the experiments!**

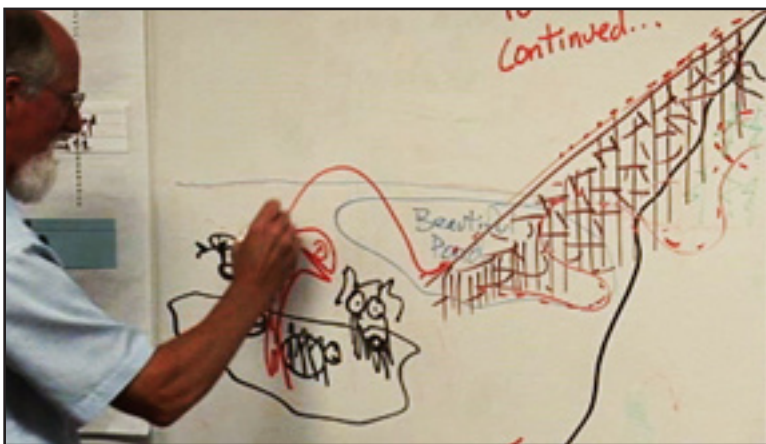
So Jack and Jill are up at the top of this thirty-thousand-foot-tall mountain. Evil Mister Fred and his minions are also up there, and they've built a ramp that they can slide down, down into Beautiful Pond. Jack and Jill and the Kick-Mes don't want to do that. What do you think they're going to do? *[Students offer suggestions.]*

Well, this is what they did. They took the spray, the petunia flavored spray, and they sprayed it all over Jill's hair. Instant glue. And they formed Jill's hair into a giant roller coaster. It went down the mountain, did loop-de-loops and corkscrews all over the place, right through the minions' whole wooden thing. And it ended up at the pond. And Evil Mister Fred looked at all this and said, "Hmph! They're wasting their time. That'll never work." And he grabbed his minions one after the other and slid them onto his ramp. And then he jumped on right after the minions. And Evil Mister Fred and the whole trail of minions went zhoooooop -- down the ramp really fast. Thirty thousand feet, you're going to go with some speed. In the meantime, Jack and Jill threw their Kick-Mes onto their roller coaster-type thing, and the Kick-Mes all started going down, with Jack and Jill following right behind.

Jack and Jill and the Kick-Mes used up almost all of their energy and ended up kerplunk -- right into Beautiful Pond. Evil Mister Fred and all his minions gathered up more and more and more speed as they went. When they hit Beautiful Pond, they were going about, oh, a hundred twenty miles an hour, and hit the water -- ker-zhoooszshh! Well, when you hit water at that speed, at an angle, you bounce off. And Evil Mister Fred and all of his buddies went ker-chinggg and landed right in the pit where he had put all these evil creatures to make life miserable for everyone else. So the snakes and the spiders and the mad mutated dog and the pythons ate up Evil Mister Fred and all the minions. And everybody lived happily ever after, except Evil Mister Fred.



The Kick-Mes' roller coaster.



Evil Mister Fred and his minions bounced off the water and landed in the pit of evil creatures.

End of Lesson

If you have questions about this lesson, please ask them through the online [Teacher Support Forum](#) on our web site.