



Teacher's Guide for: **Hot Air Balloons**

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.

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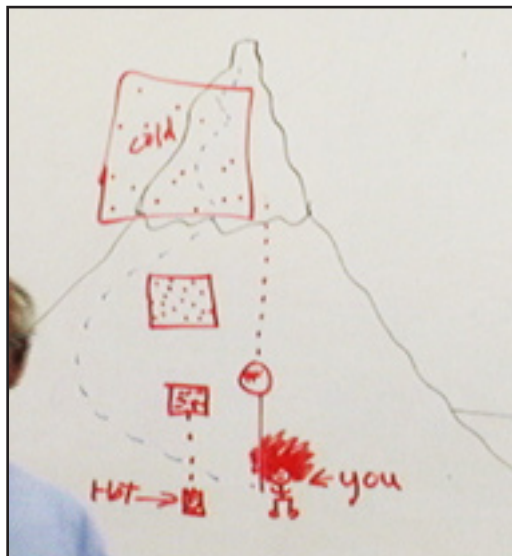
Hot Air Balloons
A Rock-it Science Lesson
Filmed July, 2009

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Intro Quick Recap:

- Tell students if you want to go someplace nice and hot, it's best to go to the top of a high mountain, because hot air rises. See if they agree or not, and why.
- When air rises, it doesn't stay the same size.
- If you let a balloon rise high enough, it will pop.
- When air goes up, it expands and keeps getting bigger and bigger until the balloon can't hold it anymore and it pops.
- As the air gets bigger and bigger, the molecules don't get as many chances to smack into each other.
- Temperature is just a measure of how often they hit each other.
- When they're up high, they try to bang into each other, but they keep missing.
- So when the air in the balloon is down low, it's relatively hot. When it's up high, it's cold. That's why you're cold as you go higher and higher.



Air expands as it rises.

Experiment Quick Recap: "Hot Air Balloons"

Experiment 1 -- Large Balloon:

- Take a thin plastic painter's tarp, about 9' x 12', fold it in half, and seal the edges with a hot air gun, leaving a small opening for a hair dryer to fit into.
- Tie a piece of string to one corner of the balloon, leaving the other end attached to the spool.
- Use a hair dryer to inflate the balloon
- Take the balloon outside and let it float upward, keeping the string attached. After a minute or so, reel it in and let the students tear it apart.

Experiment 2 -- Small Balloons (Indoors only):

- Take another plastic tarp, fold it in half, and seal the edges. Then use the hot air gun to make three seams across it, leaving openings for the hair dryer, then cut along the seams to make four smaller balloons.
- Divide the students into four groups and assist each group to inflate their balloon and see whether it rises (no string). Let them repeat the experiment three or four times.



Smaller Balloon inflated.

Equipment List: "Hot Air Balloons"

Items needed for Instructor:

- Painter's Tarp -- Thin plastic sheeting, about 9' x 12'
- Hot Air Gun
- Extension Cord
- Scissors
- Hair Dryer
- String (about 100 ft.)

Items needed for Students:

Consumables:

- Painter's Tarp -- Thin plastic sheeting, about 9' x 12'

Other (per student):

- Hair Dryers (4)

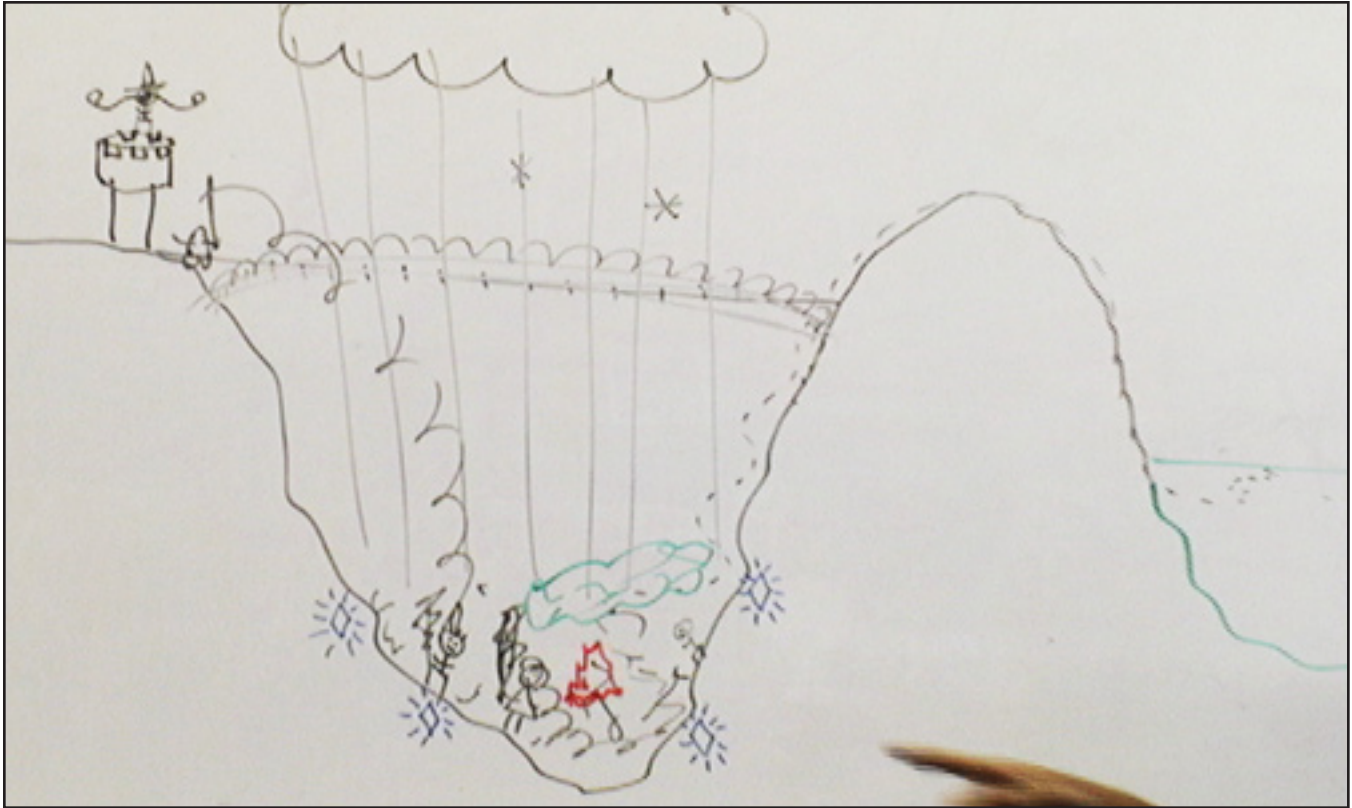
Prep Work:

- None



Use the hot air gun ONLY for sealing the edges of the plastic sheet.
Use a regular hair dryer on "high" setting to inflate it.

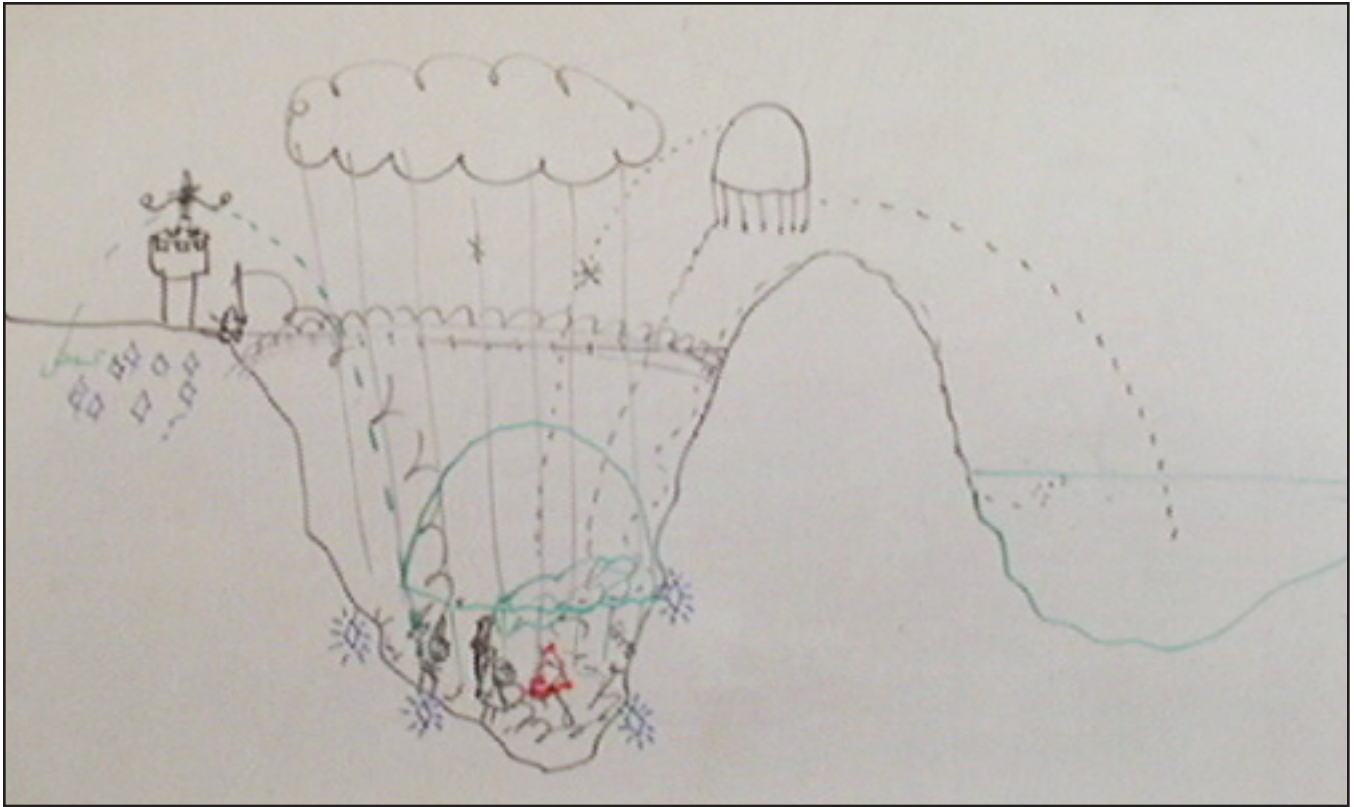
Story Recap: “*Jack and Jill and the Diamond Mine*”



Part 1:

- Evil Mister Fred set a trap for Jack and Jill with sticky paper and captured them as slaves.
- He put them to work with his other slaves digging for diamonds at the bottom of the Valley of Death. On the other side of the valley was Green Acres.
- The Valley was surrounded with barbed wire fences and guarded by minions, so there was no escape.
- Jack and Jill had nothing to work with but clubs. In order to get food, they had to deliver diamonds to Evil Mister Fred. The only water they got was when it rained.
- Everybody was miserable, hungry, thirsty, and tired. Jack said, “It could be worse!” and then it started raining.
- Everybody was too cold to work, so Evil Mister Fred told the minions to throw down some wood for a fire. They threw down their baseball bats. Jack & Jill made sparks with a stone, but the rain kept putting out their fire.
- Evil Mister Fred called the Acme Store of Everything and bought some thin plastic tarps and threw them down. Jack and Jill used them to catch rainwater and protect the fire from the rain. But they still wanted to escape.

Story Recap (cont.):



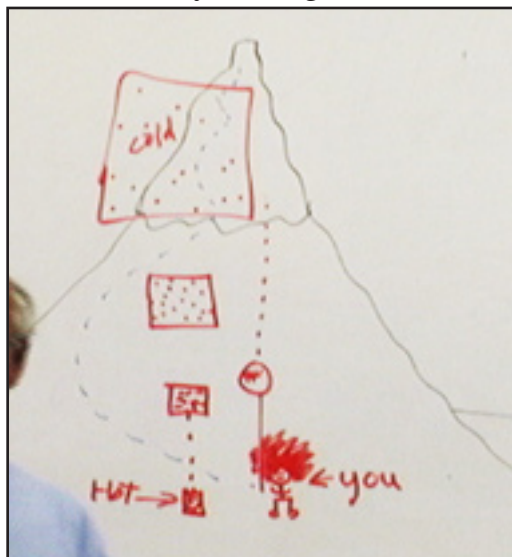
Ending:

- Jack and Jill dug up a huge pile of diamonds and decided to escape and take the diamonds.
- They took some of the diamonds and stuck them together with mud into balls.
- They stuck all their tarps together and made one big tarp-balloon.
- They tied Jill's hair to it so everybody could hang on.
- They used the minions' baseball bats to build a fire so they could use the hot air to inflate the balloon.
- They threw the diamond mud balls up over the edge of the Valley where the minions were, so the diamonds scattered all over the ground.
- The minions started fighting each other with their baseball bats, trying to get the diamonds.
- While the minions were occupied, Jack and Jill launched their balloon, and it drifted up out of the Valley.
- Evil Mister Fred ran down to stop the minions from fighting so he could gather up the diamonds, but the minions were in such a fury, they didn't recognize him as Evil Mister Fred and started hitting him with their baseball bats.
- Jack and Jill and the others escaped to Green Acres.

Transcript: Intro

This is the advertisement before the crazy story. Okay, suppose you want to go someplace nice and hot so you can enjoy yourself, put on your swimming suit, run through the sprinklers. So the best place to go is to run up to the top of a mountain, maybe about twenty or thirty thousand feet. That would be good. That would be nice and hot up there, right? No? Cold? Oh, I'm sorry, that can't be true. Everybody knows that hot air rises, so the hot air has to be up there at the top of the mountain. No? Does hot air fall? No? So hot air doesn't fall, and it's cold at the top of the mountains. What's wrong with this scene? *[Student: Hot air goes above the mountain.]* Oh, it keeps going? Is that why the sun is so hot? All the hot air goes to the sun? No? Well, as air goes up, it doesn't stay the same size. If you have a balloon in your hand and you let go of the balloon, the balloon goes up quite a ways and then it pops. Ooh, that's weird, isn't it? Why would it pop? *[Student: Because the air in it will expand and expand and expand, and eventually, once the balloon can't hold any more air, it'll explode.]* Cool -- you're right!

Yeah, as the air goes up, it expands. So a blob of air the size of this, as it goes up, keeps getting bigger, and bigger, and bigger, until it's really huge. And as it gets bigger and bigger and bigger, you know what happens? All the little molecules that are in there don't get so many chances to smack into each other. Down here, they're so close together as they wiggle around, they bang into each other. And all temperature is, is a measure of how often they hit each other. So up here, they're trying to bang into each other, but they keep missing. So the one down here is relatively hot. This one is cold. That's why it gets cold as the air goes higher and higher, and that's why you're cold when you go higher and higher. So today we're going to be doing something with hot air. We're going to see if it really does rise. But first we need a crazy story.



The air molecules are farther apart at the top.

Story: "Jack and Jill and the Diamond Mine"

Once upon a time, Evil Mister Fred set a trap. It was a clever, devious trap. He put sticky paper on the ground where Jack and Jill usually walk. And they got stuck in the sticky paper. First their feet were stuck. Then they tried to help each other by getting their feet unstuck, and then they put their hands on the paper to try to pull their feet loose. Well, they got their feet loose, but now their hands are stuck. So then, when they wanted to get their hands unstuck, they put their feet down and pulled on their hands, but their hands were still stuck tight. So then they put their head in it to get their hands off, so now their head was stuck. And Jack and Jill were stuck in this really sticky paper.

And Evil Mister Fred came along and said, "Mwa-ha-ha! I've got you now. Now you're going to become my slaves." And Jack and Jill said,



Evil Mister Fred and a minion.

“Okay, we like being slaves.” And Evil Mister Fred said, “What? Doesn’t matter. You’re going to be my slaves.”

So he took them to the Valley of Death. Here’s the Valley of Death. And on the other side of the hill is Green Acres. There’s Green Acres over here, and the Valley of Death over here. Evil Mister Fred has a castle right next to the Valley of Death. And he has all these slaves down in the valley that have to do his work. There’s Jack, here’s Jill. And the Valley of Death is surrounded by barbed wire fences, and guard dogs, and machine guns, and mine fields. And Evil Mister Fred has a whole bunch of slaves in there. People all over the place. And he gives them nothing but clubs. They can work with clubs, like that. And they have to dig holes in the ground. And down in the ground, there’s diamonds, real genuine quality diamonds. And Jack and Jill, and all the other slaves have to dig the diamonds out of the ground. When they find them, if they want any food at all, they have to give Evil Mister Fred the diamonds. If they don’t come up with any diamonds, then they don’t get anything to eat. *[Student: What about water?]* The only water they get is whenever it rains in there. And the only food they get is whatever the minions throw in over the fence. So they have to try and be nice to the minions, so the minions will throw them some food. And Evil Mister Fred thinks this is great. Everybody’s down there, and they’re moaning, they’re groaning, they’re freezing cold, they’re hungry, they’re tired, and they’ve got to dig all day for diamonds.

And then Jack said, “This is terrible. This is horrible.” Jill said, “I’ve never been in a place as bad as this. We’re tired, we’re hungry, we’re cold, we’re thirsty. This is just rotten.” And then Jack said, “Could be worse. Could be raining.” And Jill said, “Jack! Don’t say that! Every time you say that, something bad happens.” And sure enough, it started to rain. One cloud came along. It didn’t rain anywhere else, just in the Valley of Death. Cold, cold rain. And a few snowflakes, like that. And now they’re all going brrrrrrr! And nobody could work, it was so cold. And Evil Mister Fred wasn’t getting any diamonds.

So he said, “Minions, we’ve got to warm them up at least a little bit. Throw some logs and some wood down there.” So the minions said, “All right, boss!” So they started throwing their baseball bats in. Bonk! Hit Jack on the head and got a bump on his head. So now Jack and Jill have a bunch of baseball bats down there, but they don’t have any matches. And they looked around and they found some rocks. And they were trying to make sparks with the rocks. They finally did make some sparks, and they lit some of Jill’s hair on fire. And they made a little campfire there, and they were keeping kind of warm. But then the rain put out their fire, and they were complaining to Evil Mister Fred, “Evil Mister Fred,



Jack & Jill in the Valley of Death



Jack & Jill digging for diamonds with clubs.



It started to rain.

we're all going to die! You won't get any more diamonds, because we'll just be dead." And Evil Mister Fred said, "Oh! Well, it's kind of mean. But it's kind of bad, too. I want the diamonds." So he says, "All right, all right." So he called the Acme Store of Everything and he threw in some old tarps, some sheets of plastic, but they were so thin they were pretty worthless. But Jack and Jill said, "Wow, these are great. We can hold them out and catch rainwater, and we'll have something to drink. We can hold them over the fire and keep the fire going so we'll be warm. I like this. This is great."



Jack & Jill protected their fire with a tarp.

Now, Jack and Jill were down there, and every day they were slaving. And every day it would rain on them and they'd get cold. And they said, "We want to get out of here. We want to go over to Green Acres and never do this again." If you were Jack and Jill, how would you escape from this horrible place?

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 . . .

Experiment 1: "Large Hot Air Balloon"

Okay, we're going to make something to catch hot air. The fabric we're using is a painter's tarp. The plastic is kind of thin. This the kind Jack and Jill had. And what we're going to do is drape this over you guys, let it fall over your head so you can feel it. Then I'm going to bring it over this way. You can see how light it is. And it's really, really thin stuff. Today we're going to try and make a balloon out of it, but if you tug on it too hard, it tears, and you poke holes in it. See, your fingers go right through. You have to be kind of careful with it. But one of the neat things about it is, if you put two edges together and just run hot air by, the edges melt together. And that can make a balloon out of it, just by melting the edges.

So we're going to take one of these and fold it over on itself, melt around the two edges, and then we're going to fill it with hot air and let it go outside and see what it does. This one already had holes in it, so we're not going to use it. We're going to take a newer one, and we're going to set it on the floor and see how long it takes to melt around it. [Moves tables and chairs to make room for the tarp in the center of the room.]



Letting students feel the lightness of the tarp.

Okay, so we'll make a little balloon, and we'll try to make a big balloon. Then, if it's not windy outside, we'll let them go up in the air and see if they rise or not. Now, this stuff is about nine feet by about

twelve feet long. We're just going to fold it over on itself. This one had a big rip in it, so it's got some tape right in the middle. *[Folds tarp in half and sets it on the ground.]* Now, we need some dead weight -- or live weight. We need somebody who will put their toe on this corner, and somebody who will put their toe on this corner, and somebody who will put their toe on that corner, and that corner. *[Selects four students to stand on the corners.]* And you'll keep your toe on there until I say, "Take your toe off," because this fabric is so weird that when you heat it up and let it melt, it shrinks a lot. And as I approach your toe I'll say, "Let's move."



Students stand on corners of folded tarp.

[Turns on heat gun and checks the temperature with his hand.] It's working. *[Directs heat gun along edge of tarp, sealing the edges.]* Do you see it shrink? You don't have to move your toe; I'll just go around your toe. If we do it well enough, when we go outside and we fill it full of air, it should stay together. If we don't do it well enough, it gets a big old leak in it. We're not going to go all the way around, because we need someplace to put in the hot air. *[Continues with the hot air gun until all edges are sealed, leaving about a one-foot gap.]*



Sealing edges with hot air gun.

Now we're going to test this one. We'll fill this one up with some warm air. Okay, toe people, you can go sit down where you were. We'll see if we melted it enough to work. I'm going to put some string on this corner *[ties a string around one corner, leaving the end attached to the spool of string]*. Now we'll put some hot air in it. *[Puts a hair dryer through the opening and turns it on, closing the opening around the hair dryer. Bag inflates and rises off the floor.]* Since we have something that's working, let's open the big door and take it outside. We're going to take this out first. *[Student: Are you going to close that side?]* I'm going to leave it open because I might need some hot air outside.



Tie the string to one corner.



Use hair dryer to inflate.



[Everyone goes outside and Instructor uses hair dryer to add some more hot air to the balloon.] Don't touch the string or it. Let's just see what it does. [Balloon rises quickly into the air. After a minute or so, Instructor winds the string and brings it back down.] When it comes down, your job is to rip it to shreds. [Students tear up the balloon.] Okay, take all the dead body parts back inside. [Everyone goes inside.]



Adding hot air to the balloon.



The balloon rises high into the air.

Experiment: "Small Hot Air Balloons"

What if we made little ones? Would a little one work as well as a big one? Well, it's easy to find out. We'll make a few little ones and give them to you guys, and you can fill them up and see if they rise. I'll go around those three edges, then go foom! through there, and foom! through there, and foom! through there, so we'll end up with four littler ones. And then we'll fill them up with hot air and see if they float. That should be fast. *[Instructor folds another tarp in half, selects another four students to stand on the corners, and seals the edges. Then he melts three seams almost all the way across it the narrow way and cuts along the seams to make four balloons.]*



Using hot air gun to melt three cross-seams.



Cutting through the cross-seams to make four smaller balloons.

There. Now we have a bunch of little balloons. *[Divides students into four groups and gives each group a balloon.]* If yours doesn't seal all the way or has big rips in it, we'll give you scotch tape. *[Gives the first group a hair dryer.]* Who wants to be the filler person? *[One student holds the hair dryer while other members of the group help to hold the opening tight around the hair dryer until the balloon inflates completely.]* Okay, let it go. *[Balloon floats up, then comes down after just a few seconds.]* You guys save that one. *[Student: Do we get to do it again?]* Yeah, you'll get to do it again after these guys do theirs. *[Instructors help other groups inflate their balloons. Some rise high, others do not.]* Use the high setting.



Students inflate a small balloon with a hair dryer.

[Instructors help each group inflate their balloons a few more times on high heat, and the balloons rise high and float for several seconds before coming down. Afterwards, students press on the balloons to get all the air out, and the Instructors gather the remnants.] Now we'll put our tables back and we'll finish the story.



Balloons rise high into the air.

End of Story

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

Jack and Jill are down in the pit of Death, mining for diamonds. And they dug a hole down, and they struck it rich. They hit a whole pile of diamonds. They said, "Wow! There's enough diamonds here to keep us rich for the rest of our lives, and everybody else that's in here. We've got to do something. We've got to escape from here."

So they had an idea. They took some of the diamonds and they made them into balls. They stuck them together with mud. They had them set out and ready. They took one of their tarps and somebody had a good idea: put the tarp over the fire and make a great big tarp-like balloon. So they stuck all their tarps together, made this huge balloon, and they tied Jill hair to it and made places for everybody to hang on. Then they took all the baseball bats the minion had thrown at them, and they lit them on fire. Now they had some hot air filling up their balloons. And they said, "Now all we've got to do is make sure those minions don't bother us."

So they took the diamonds in the mud balls, and they threw them up over the edge, they landed on the ground, and diamonds were scattered everywhere. When the minions saw diamonds on the ground, they said, "Woo-hoo!" And they all ran out and started fighting over the diamonds. And they were arguing and wrestling, hitting each other with their baseball bats, and there was a huge amount of noise. And Evil Mister Fred saw all the minions fighting over the diamonds. He was just hollering at them, "Stop that, stop that, stop that, stop that!" The minions were so busy, they didn't pay attention to him. Baseball bats were going everywhere.

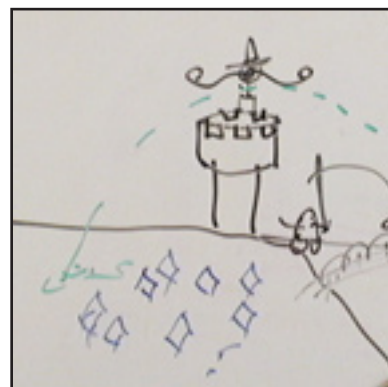
And Jack and Jill got their balloon thing all inflated, and they and all the other slaves were hanging on it. And it drifted up into the air. Evil Mister Fred and the minions were so busy, they didn't even see this giant jellyfish-like thing floating away. And Evil Mister Fred ran down the stairs of his castle, out the front door to stop the minions and collect all those diamonds. But the minions were in such a fury, they didn't recognize him as being Evil Mister Fred and started hitting him with their baseball bats. And Jack and Jill kept the rest of the diamonds and drifted over here to Green Acres. And they all lived happily ever after, except Evil Mister Fred.

End of Lesson

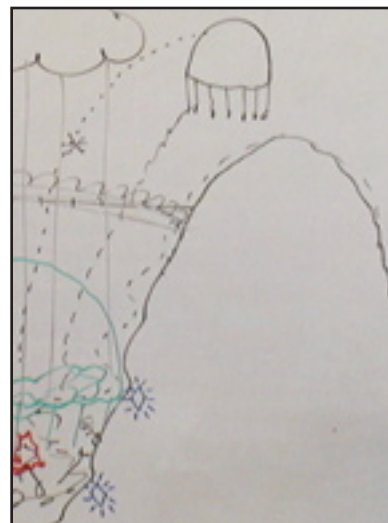
If you have questions about this lesson, please ask them through the online [Teacher Support Forum](#) on our web site.



Jack & Jill combined the tarps to make a big balloon.



Diamonds scattered everywhere.



The balloon drifted out of the Valley over to Green Acres.