

Teacher Notes- “Energetic Atoms- Active & Spaced Out”

This lesson is a classic example of how showing someone is better than just telling them. Being told that a 50 foot-long trash bag filled with air will heat, expand, and rise is not exciting news. But take students outside and let them see for themselves, and you’ve got a lesson with “end of the year” status- one they’ll still remember on the last day of school.

Once students understand the cause of what's going on inside the bag, they'll grasp what essentially drives the states of matter: energy.



Materials per student:

Student Handout

Additionally:

- 1 solar bag (see *Beforehand* for purchasing options)
- 2-tennis balls
- PowerPoint- “Energetic Atoms”
- Sign on your door-telling students to meet outside

Beforehand:

1. Purchase a solar bag, which is essentially a 50 foot long continuous trash bag. Do an internet search for “science solar bag” and you’ll find some for around \$20 apiece (buying 2 is not a bad idea- they do tear). It’s item # WW4648400 at sciencekit.com.
2. While you’re on the internet, search for “mars solar bag” and you’ll find some unbelievable pictures.
3. **When to do this:** you must have sunlight for the solar bag to work. If it isn’t shining the day you planned to do this, go to plan B, which is your next day’s lesson. Hopefully tomorrow the sun will be out.
4. Buy a roll of black duct tape. This is what you’ll use to patch the inevitable small holes and tears that otherwise would render your solar bag useless.
5. Launch the website that streams the video mentioned towards the end- <http://streamer.cen.uiuc.edu/var/PhysicsVan.wmv> , and cue it to start at the 5 minute mark. Many thanks to the PhysicsVan! program at the University of Illinois for graciously allowing us to use their resources.

6. Put up the sign that tells students to meet outside. Meet in a clear, open area that's away from power lines, trees, light poles, and anything else that the bag can snag on. The day before, walk around the area and look for things that could cause your "runners" to slip or catch their feet.
7. If appropriate, notify teachers or neighbors whose windows you'll be doing this in front of. Most will appreciate not being surprised.
8. Think about student discipline. Sometimes a change in scenery is all some kids need to go wild. Decide ahead of time what your plan will be to control them. You're going to be busy managing this activity, so you won't have time to deal with problem students.
9. Read all instructions that come with the solar bag carefully, especially the warnings about where to do the solar bag activity. Have 2 people always holding onto some part of it (that way there's no chance it gets away!).
10. This activity can adapt to be used with classes that run 25-45 minutes. It is presented in its barest form, so there's plenty of room to add to it. At the end is a list of "accessories", which are further topics you can add on which will lengthen and deepen the discussion.

Procedure: (the first 20 minutes outside, the last 20 minutes inside)

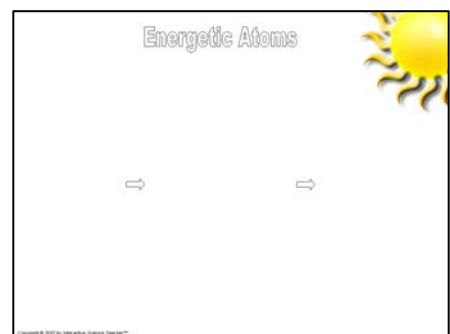
1. When students meet you outside, introduce the lesson:

"Students, we are here today to demonstrate a sophisticated scientific instrument. It's called a solar bag. Actually, it's really nothing more than a 50 foot-long continuous trash bag. Since it's such a nice day, we're going to spend the first part of class seeing what happens when this is filled with air. Then we'll go back inside and piece together an explanation that you'll all understand."^{*1}

2. Unroll the solar bag, and explain what it is- 1 mil plastic (very thin!). Two important things about the bag that make it work- 1. it has very little mass, 2. it's black.^{*2}
3. Ask for 3 volunteers (who will be your "runners") who have an over-abundance of energy. Two will jog side-by-side holding the mouth of the bag open while the other is the "caboose" whose job is to run behind holding the tail and make sure it doesn't catch on anything. Explain to the two in front to run down a hundred feet or so and back, and to STAY TOGETHER so the bag doesn't get pulled apart. If the grass is wet tell them to not run full speed.
4. Send off the runners. When they return, it will be about $\frac{3}{4}$ full, which is full enough. Grab the open end of the solar bag, close it shut, then draw in the slack with your hand until the balloon is firm.
5. In the very first minute of heating, point out to students the wrinkles in the bag, because they will soon be gone. This is important visual evidence that will be referred to later.

6. While waiting for the bag to swell up, hover, then rise, talk to them about the science going on inside. The sun's heat is being absorbed, so the atoms respond by speeding up, which makes them collide harder, causing them to spread. That's why the wrinkles disappear, and eventually it rises. Kids also like to hear about what happened last hour or last year when you tried this (as long as you assure them theirs is the best).^{*3}
7. On a warm day (65-85 degrees Fahrenheit) it will take about 5 minutes for the bag to lift completely off the ground. Colder than that- it will hover just over the top of the grass. You can tether it on a rope, and the directions do recommend this (and it's not a bad backup system), but if you did that, untying it without damaging the bag would be difficult. Just hold the solar bag shut with your hand- it will still lift.
8. After a few minutes of seeing it floating, most students will be ready to go back in inside, which is fine because we still need to talk in detail about what happened. Send everyone back in and roll up the bag, beginning with the knotted end. Tell students to stand at the open end of the bag as you roll it up to feel the hot air blowing out.

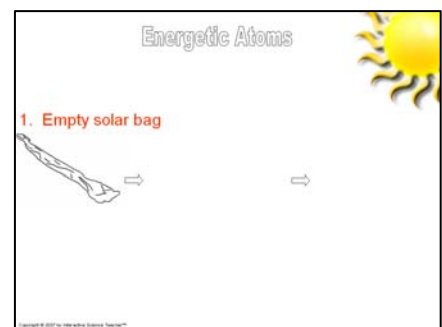
9. Back inside, give students the "Energetic Atoms" handout.



10. If you are using the PowerPoint "Energetic Atoms", start it now. It will guide you and your students through the rest of the class period.

11. Advance the slide and show the first drawing of the empty bag and have students draw this in the same place on their worksheet. Tell them their artistic ability will not be graded. As long as they realize this is supposed to be an un-inflated solar bag, that's all we need.

12. Move onto the first statement, "1. Empty Solar Bag". Make sure students number it, because the homework will reference these steps.




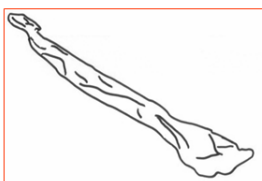












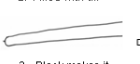

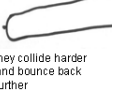
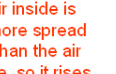







13. The middle drawing is of the solar bag that's been just-inflated. Again, students, do your best.
14. Click to show statements 2 ("filled with air") then 3 ("black makes it absorb sunlight"). Statement 3 is the most crucial- it causes 4-6.

(end of Teacher Notes preview)

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| <p>Energetic Atoms</p>  <p>⇒</p> <p>⇒</p> <p>Interactive Science Teacher</p> | <p>Energetic Atoms</p>   <p>⇒</p>  <p>Interactive Science Teacher</p> | <p>Energetic Atoms</p>  <p>1. Empty solar bag</p>  <p>⇒</p>  <p>Interactive Science Teacher</p> |
| <p>Energetic Atoms</p>  <p>1. Empty solar bag</p>  <p>⇒</p> <p>2. Filled with air</p>  <p>⇒</p> <p>3. Black makes it absorb sunlight</p> <p>Interactive Science Teacher</p> | <p>Energetic Atoms</p>  <p>1. Empty solar bag</p>  <p>⇒</p> <p>2. Filled with air</p>  <p>⇒</p> <p>3. Black makes it absorb sunlight</p>  <p>⇒</p> <p>4. That energy excites the air atoms, making them move faster</p> <p>Interactive Science Teacher</p> | <p>Energetic Atoms</p>  <p>1. Empty solar bag</p>  <p>⇒</p> <p>2. Filled with air</p>  <p>⇒</p> <p>3. Black makes it absorb sunlight</p>  <p>⇒</p> <p>4. That energy excites the air atoms, making them move faster</p>  <p>⇒</p> <p>5. They collide harder and bounce back further</p>  <p>⇒</p> <p>6. The air inside is now more spread apart than the air outside, so it rises.</p> <p>Interactive Science Teacher</p> |

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| <p>◆ Student Handout</p> <p>Energetic Atoms</p>  <p>⇒</p> <p>⇒</p> | <p>◆ Drawings & Pictures</p>  <p>Drawing-Bag Inflated</p>  <p>Drawing-Bag Uninflated</p>  <p>Pic-Bag Inflated</p>  <p>Pic-Bag Uninflated</p> |
| <p>◆ Quick Notes</p> | <p>◆ Printable student answer sheet</p> |

Teacher *Quick* Notes- "Energetic Atoms"

Materials per student:

Handout- "Student Handout- Energetic Atoms" (located in the *Resource* folder)

Additionally:

1 solar bag

2 tennis balls

PowerPoint- "Energetic Atoms" (located in the *Resource* folder)

Sign-that tells students to meet outside

Procedure:

1. Meet students outside.
2. Ask for 3 volunteers to fill the solar bag.
3. Clamp the open end of the bag shut with your hand and allow it to "bake" in the sun until it floats, usually around 5 minutes. Observe as many details as you can that show the bag expanding.
4. Roll up the bag and go back inside for the explanation.
5. Give students the "Energetic Atoms" handout.
6. Begin the PowerPoint "Energetic Atoms".
7. Advance the slide and show the first drawing, of the empty bag.
8. Have students copy the first statement, "1. Empty Solar Bag".
9. Make the middle drawing is of the solar bag that's been just inflated.
10. Click to show statements 2 then 3.
11. For the last drawing, ask students to draw it noticeably thicker than the middle one.
12. Move onto statement 4.
13. Copy statement 5 and then statement 6.
14. Show minutes 5-7 from the webcast
<http://streamer.cba.nrc.edu/vm/PhysicsVan.swm>
15. Assign the following 2 homework questions:
 1. Explain the liquid nitrogen balloon trick by rewriting statements 2-6.
 2. What would have happened outside if you were using a white solar bag?

Energetic Atoms

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