BLOSSOM & ROOT

ELEMENTARY SCIENCE // LEVEL 4

Wonders of the Physical World

LABORATORY GUIDE

LEVEL 4

Exploring Physics, Engineering, and Human Anatomy

Physics Wonder No. 2: Matter

For the Outdoor Learners:

Exploring the States of Matter with Water

What You'll Need:

- A bowl or bucket (not glass)
- A cup
- Water
- Access to a freezer or below-freezing temperatures outside
- Access to a stovetop and a pan

What to Do:

1. Fill a bowl or bucket (not made of glass) with water and place it in front of your child. Ask them which state the water is currently in: a liquid, a solid, or a gas.

2. Ask them to pour the water back and forth between the bowl and a cup, several times, and point out that the water takes on the shape of the container it's in. Ask them if it'll hold that shape if they pour it out onto the ground. (Let them do this, if you like, then refill the bowl with water again.)

3. Ask them how they could change the water in the bowl from a liquid state to a solid state. (If they need prompting, ask what freezing the water would do.) Either leave the bowl outside for a few hours (if it's below freezing where you live) OR place it into the freezer for a few hours.

4. Once it has turned into ice, give it to your child to examine and observe. Ask them if it's still water. (Yes.) Ask them if it takes on the shape of its container anymore. If they say yes, help them to loosen the ice from the bowl and drop it onto a surface. Point out that it kept its shape, and did not change shapes when you dumped it out like the liquid water did. Ask them if it is now a liquid, solid, or gas.

5. Ask them what would happen if you left the bowl of ice sitting out in the sun (or if you dumped it into a pan and heated it on the stove.) Would it change states again? Allow the ice to melt back into a liquid, either in a warm and sunny spot or heated in a pan on the stove.

6. Ask your child if they can think of how to change the liquid water into a gas. If it's not already in a pan on the stove, pour it into one now and heat it to a boil. As it heats, show your child the steam rising and explain that the steam is water in its gaseous state. Explain that, if left to boil on the stove, the water in the pan would eventually all change to a gas. Ask them to describe how the gas behaves differently than the water in liquid or solid states.

Physics Wonder No. 2: Matter

For the Table-Lab Crowd:

Exploring the States of Matter with Balloons

What You'll Need:

- Several balloons
- Water
- Access to a freezer

What to Do:

1. Blow up one of the balloons and tie it off. Fill two more balloons with water. Place one in the freezer for several hours until the water inside is completely frozen. Then, place all three balloons on the table. You may wish to place them on a tray or in a pan to prevent leaks from getting on the surface.

2. Ask your child to find the balloon filled with a liquid. Once they do, ask them how they know there is a liquid inside. How does the substance inside behave? Ask them what would happen if you untied the balloon and poured the water into a cup. What shape would the water have then? What would happen if you poured the cup onto the floor. Would it still have the same shape then?

3. Ask your child to find the balloon filled with a solid. Once they do, repeat the same questions you asked in step 2.

4. Ask your child to find the balloon filled with a gas. Once they do, repeat the same questions you asked in step 2, but change "water" to "air."

5. Ask your child if they can think of ways to change any of the states of the contents in the balloons. Can they change the balloon filled with a solid to a balloon filled with liquid, without opening the balloon? Can they change the balloon filled with a liquid to a solid without opening it? How? If you can test their ideas, do so and let them observe the results.

For the Table-Lab Crowd:

Crushed Can Demonstration

What You'll Need:

- Kitchen tongs
- A saucepan (2 or 3 quart) full of ice water
- Water
- an aluminum can (soft drink can)
- Safety goggles for all participants recommended

What to Do:

Gases can be trickier to explore than liquids and solids in a homeschool setting. This is a really fun demo to explore the power of gas in the form of air pressure. **This entire demo needs to be done by an adult, and with caution**. Do not heat the can over high heat. Do not heat the can when it is empty. Do not heat it in a microwave.

1. Fill the saucepan with ice water and set it aside.

2. Put 1 tablespoon of water into the empty soft drink can. Heat the can over the stove on medium-low heat to boil the water. You will see vapor escape from the can as it begins to boil. Let the water boil for around 30 seconds.

3. Use the tongs to grasp the can. Quickly invert it over the pan, and dip it into the ice water. Be ready--the can will instantly collapse once you do this.

4. Talk to your child about what happened. When you heated the can, you caused the water in it to boil, changing some of it from a liquid to vapor (water in a gaseous state.) The vapor from the boiling water pushed air out of the can. Inverting the can full of vapor suddenly in cold water cooled it and caused the vapor in the can to condense, which made a partial vacuum. The extremely low pressure inside the can allowed the higher pressure of the outside air to crush it. Remember, temperature can change an object's state. The particles of gases (in this case, the vapor) are spaced far apart and move around rapidly. When they cool into a liquid, they condense, coming much closer together.

Physics Wonder No. 2: Matter

For the Crafts-and-Projects Families

Melting Ice Art

What You'll Need:

- Liquid watercolor paints work best for this, but you can also use food coloring
- Ice cube tray
- A chopstick or popsicle stick to stir with
- Water
- Watercolor paper
- A cookie sheet

What to Do:

1. Fill the cells of a plastic ice cube tray with water. (We recommend using a cheap tray you don't mind staining, because it's likely this activity will stain it!)

2. Add a few drops of various liquid watercolors or food coloring to each cell, stirring each one to mix it (a chopstick works well for this.) This works best with lots of color. Carefully place the tray into the freezer and let ice cubes freeze completely.

3. Once the cubes are frozen, set up your painting area. Place a sheet of watercolor paper on a cookie tray. If you'd like to do wet-on-wet painting (which can be really beautiful) soak the paper for a little while first.

4. Dump the colored ice cubes into a bowl and place it next to the painting area. Invite your child to come and create artwork with the ice cubes as they melt. There are many ways they can do this. They can gently rub the melting cubes over their paper. They can place melting cubes on one side of the paper and tilt the cookie sheet up and down to make the ice slide around, leaving trails of color behind. They can set the ice in place around the paper, and use their finger or a paintbrush to move the paint around as it melts from each cube. Let them explore freely. The point is to provide an opportunity for casual observation as the water changes from a solid state to a liquid state.

For the Crafts-and-Projects Families

States of Matter 3-D Collage Poster

What You'll Need:

- Poster board or foam core sheet
- Markers, scissors, glue, tape, etc.
- Sandwich baggies

What to Do:

For this activity, your child will make a poster that shows examples of the three common states of matter on Earth (liquid, solid, and gas.) They can use pictures cut out of magazines or printed off the internet. They can use drawings or illustrations of their own. They can also use baggies filled with substances to show the different states. For example, a baggie with some water in it, a baggie blown up with air and sealed shut, a baggie of cereal.

Allow your child to format and organize the poster however they like, but assist them if they ask. Allow them to decide the best ways to show different states of matter. Some ideas are listed below, to help them get started, if needed.

Examples of gas in picture form: clouds, gas from a volcanic eruption, steam rising from a hot beverage, exhaust escaping from a truck, etc.

Examples of liquid in picture form: beverages, bodies of water, condensation on a greenhouse window, rain and other precipitation falling from the sky, etc.

Examples of solids in picture form: dogs, trees, rocks, a table, carpeting, grass, sidewalks or pavement, buildings, cars, etc.

Engineering Wonder No. 2: Inclined Planes & Wedges

For the Outdoor Learners:

Playing with Inclined Planes

What You'll Need:

- A place to play outdoors where you can find and use sticks, rocks, etc. (bring along some popsicle sticks if you need to)
- Rubber bands or twine
- Recycled / discarded cardboard pieces and scissors or old wood scraps
- Scissors
- Two small containers

What to Do:

1. Use one of the small containers to gather up small pebbles or rocks. Find a clear area where you can work on the ground.

2. Make an "X" on the ground with a stick or some rocks. Then make another "X" about 1 - 2 feet away. Place the empty container on one "X" and the container of rocks on the other.

3. Tell your child that their job is to move the rocks from the first container to the "X" on the other side by building and using an inclined plane to deliver them into the empty container.

4. If you need to, explain that your child can build a frame for their inclined plane out of sticks (or popsicle sticks) or larger rocks, and they can make the ramp of the plane out of the scrap cardboard / scrap wood you brought along by setting it on top of the frame.

5. Depending on the age of your child, they may need a little help getting started. Show them how to build a ramp by stacking large stones "staircase-style" or by connecting sticks with rubber bands or twine. When they're done building their ramp, they can test it by setting a small pebble or rock from the container on the top of the ramp and letting it go. The pebble should slide down the ramp into the second container.

6. Your child may need to problem-solve a bit. If the ramp is narrow and the pebbles don't stay on-course, and slide off the ramp before hitting the second container, how can they fix the ramp to steer the pebble on the correct path? Allow them to trouble-shoot / problem-solve until their ramp is working the way it should. Once they're able to send all of the pebbles down the ramp into the second container, they've won the challenge.

For the Table-Lab Crowd:

Inclined Plane and Wedge Scavenger Hunt

What You'll Need:

- The scavenger hunt on the following page
- Something to mark the scavenger hunt with (stickers, a marker, etc.)
- Access to your home and neighborhood
- Camera / camera phone, or pen

What to Do:

1. Tell your child that they will be going on a scavenger hunt to find as many inclined planes / wedges as possible. If you are doing this challenge with multiple children, you can offer a prize to the person who finds the most. Or you can make it a cooperative challenge and tell them that if they can find X number of inclined planes / wedges together, they win a prize.

2. Allow your children to search for inclined planes and wedges around your home and neighborhood. Each time they find one, they make a checkmark (or place a sticker) next to the appropriate photo on the page. If they find examples that aren't on the scavenger hunt page, they need to snap a picture with your camera phone OR make a quick sketch or note of it on the back of the scavenger hunt page.

Scavenger Hunt: Inclined Planes and Wedges

Loading Docks & Loading Ramps

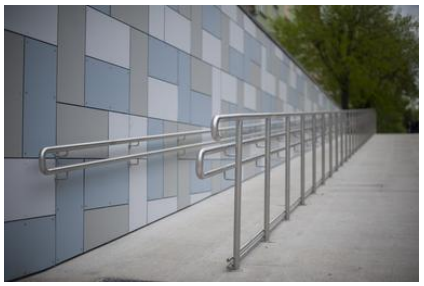
Slides

Ramps or Stairs Between Floors

Highway On-Ramps and Off-Ramps

Switch-Back Roads and Trails

Sidewalk Ramps



Ax

Funnel

Brake Wedge

Engineering Wonder No. 2: Inclined Planes & Wedges

For the Table-Lab Crowd:

STEM Challenge Using Inclined Planes and Wedges

What You'll Need:

- Lab Worksheet 2 (in student notebook)
- Pencil
- a sealable baggie
- string or twine
- rocks from the yard (or a lot of loose change)
- items to build the body of an inclined plane (ramp): LEGOs, books, etc. and something to serve as the ramp (another book, cardboard, a scrap of wood, etc.
- a spring scale that shows newtons
- a ruler

What to Do:

1. Pour the rocks or loose change into the baggie, then use the string or twine to tie the baggie shut, leaving a few inches of "ends" on both sides of the knot. Use the ends to tie a loop, creating a "handle" that the baggie can be lifted by or dragged by.

2. Attach the hook of the spring scale to the handle you made around the baggie and lift it. Show your child how to read the newtons on the side of the scale, and remind them that newtons are a unit of measurement that tell us how much force is used. Use the ruler to measure out twelve inches from the surface of the table to the bottom of the baggie as you lift it. Ask your child to record (on the lab worksheet) the number of newtons used as you lift the baggie to a height of twelve inches.

3. Review, briefly, what you learned about inclined planes this week. Ask your child if they think less force (in newtons) would be required to drag the baggie up a ramp than you just used to lift it off the table.

4. Ask the child to complete the second section of the lab worksheet, where they will guess which of the two ramp styles will allow you to use the least amount of force (in newtons) to bring the baggie to a height of twelve inches off a table.

5. <u>STEM CHALLENGE: CAN YOU BUILD A RAMP THAT MAKES IT EASIER TO BRING THE BAGGIE TO A HEIGHT OF TWELVE INCHES?</u> Help your child to construct one of the two ramps, using objects gathered from around the house. This can be as simple as a book set across a stack of books to form a ramp, or more elaborate (like a frame built out of LEGOs with a cardboard ramp on top.) This will take some trial and error, and your child needs to be sure it is sturdy enough to drag the baggie up the ramp. Be sure that the top of the ramp is twelve inches from the surface of the table.

6. Once they successfully construct the first ramp, place the baggie on the bottom of the ramp. Place the hook of the spring scale into the loop of the string, and slowly drag the baggie up the ramp by the spring scale, keeping the string parallel to the ramp. Have your child watch the newtons carefully on the side of the spring scale as you pull. Ask them to write the number of newtons used, from a static point of measurement along the way, on their lab worksheet.

7. Now it's time to construct the second ramp. Repeat steps five and six for the second style of ramp. Be sure to have your child record the number of newtons being used from a static point along the way up the ramp.

8. Compare the data collected, and have your child complete the last section on the lab worksheet. Did using a ramp reduce the amount of force (in newtons) required to bring the baggie to a height of twelve inches? Which of the two ramps allowed you to use the least amount of force to move the baggie to a height of twelve inches? Was their guess correct?

Engineering Wonder No. 2: Inclined Planes & Wedges

For the Crafts-and-Projects Families:

Model of an Inclined Plane

What You'll Need:

- Materials gathered from around the home to build an inclined plane (use whatever you have on-hand: LEGO bricks, scrap wood, blocks, cardboard, etc.
- Index cards
- Markers, pens, and / or pencils

What to Do:

1. Your child will create a model of an inclined plane, using whatever you have on-hand around your home already. This incline plane can be a very simple example, or they can construct an incline plane they have seen around their home or neighborhood (like a flight of stairs, a truck's loading ramp, a slide at the park, etc.)

2. Give them materials and space to construct their model, then ask them to create an index card about their model. The card should label their model as an inclined plane and include a few notes about what inclined planes are used for, where we can find them, etc.

3. Display their model (with corresponding label) in your homeschool space.