FIRST Team 353 The POBots

STEM is FUN! How-To Manual

This ***STEM is FUN! How-To Manual*** is for anyone who wants to have fun with Science, Technology, Engineering and Math. It's a great resource for schools, clubs, Boy and Girl Scout Troops, homeschoolers, science fairs and birthday parties. People have been asking the POBots how we do it all, so we are sharing what we know. Have Fun!

For more information about the POBots, and to download a copy of this ***STEM is FUN! Activity Book*** and our ***STEM is FUN! Do It Yourself!*** Manual, please visit: www.POBots.com.

For more information about SBPLI School-Business Partnerships of Long Island, Inc., please visit: http://www.sbpli-lifirst.org/.

For more information about FIRST Robotics, please visit: http://www.firstinspires.org/.

If you would like more information about how the POBots can help your Boy or Girl Scout Troop, school or community launch a ***STEM is FUN! Activity Night***, please email: STEMISFUN@POBots.com and put "STEM is FUN" in the subject line.

STEM is FUN! Activities

Candy Graphing: Use a chart to count the number of different colored Smarties in the pack. Then eat the results!

Chutes & Ramps: Race your friends to get your ball through the tube to the finish line.

Cup Stacking: How tall can you make a cup tower? How do different types of foundations of cups affect the height and strength of your tower? How much weight will it hold?

Flying Butterflies & Hawks: Decorate a butterfly or hawk, attach it to your wrist and make it fly.

Lots of Legos: A swimming pool full of thousands of Legos where kids can build anything they can imagine.

Make a Robot, Take a Robot: Draw a robot, add it to the Wall of Invention and take one home that excites your imagination.

Mechanical Engineering Challenges: How high a tower can you build out of two sheets of paper and some tape? Can you build a structure that can support $1.00 in pennies? What about a paper table that can support books? This can be a team or individual activity.

Paper Airplanes: Design a paper airplane and compete against your friends: whose plane can fly the fastest? The farthest? The highest?

Parachutes & Wind Tubes! Build a parachute out of a paper cup and a plastic bag, then ***blast*** it out of the Wind Tube!

Pinwheels: Decorate a pinwheel, attach it to the eraser at the end of a pencil, and spin away!

Squishy Circuits: Learn the basics of electrical circuits hands-on using dough, LED lights and batteries.

Candy Graphing

The graph on the next page is designed to be used with Smarties. You can make a graph to use with M&Ms, Skittles, jelly beans, Halloween candy, or with buttons, stickers, beads or any other small, colored objects. ***Tip:*** Be sure the kids can have candy and be aware of peanut allergies.

Supplies

- Candy Graph or Color Graph
- Cellophane tubes of Smarties candy, snack size bags or M&Ms, or small zip lock bags/sandwich bags with random numbers and colors of the objects to be graphed

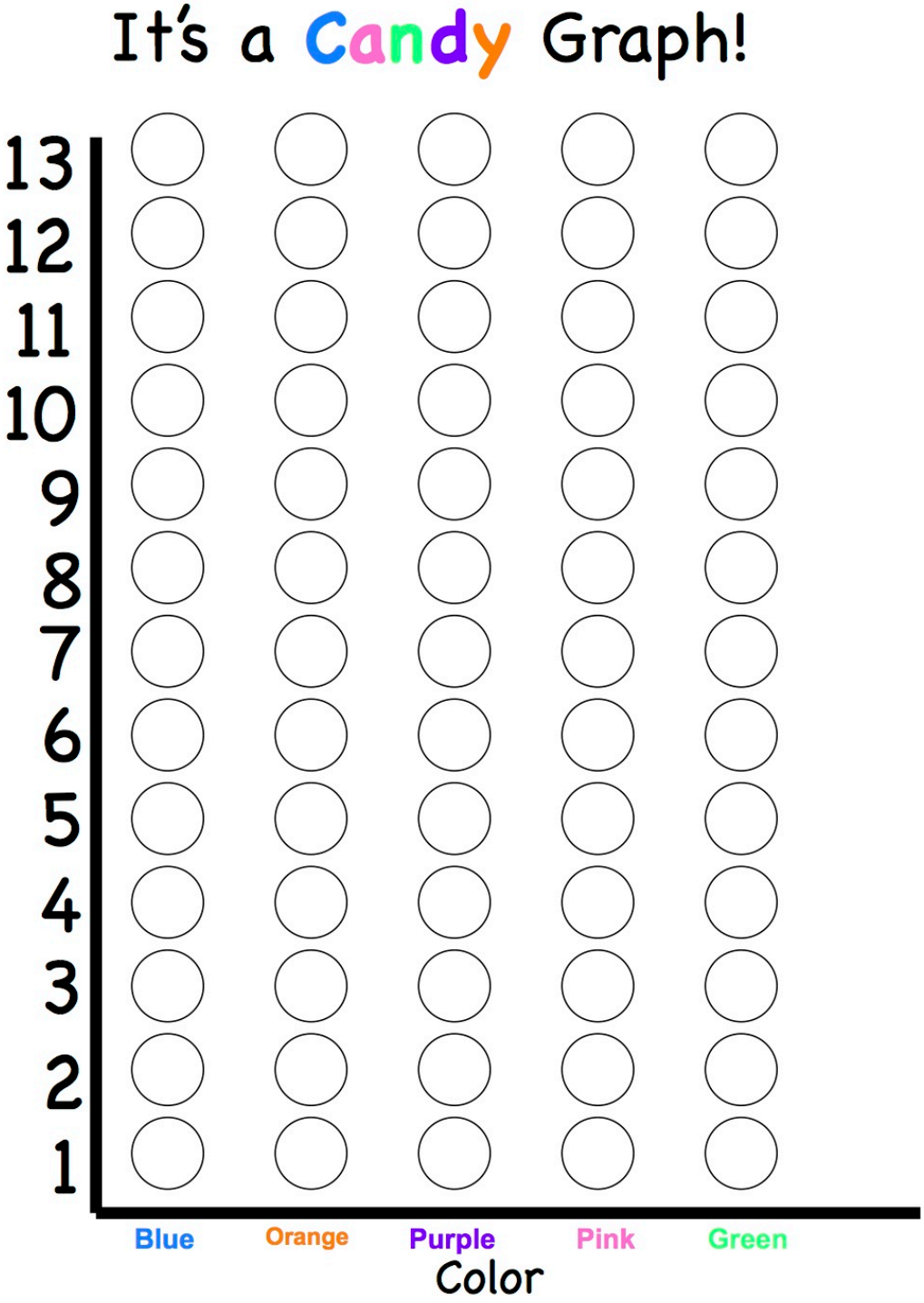
Sample Questions

- Which color do you have the most of?
- Which do you have the least of?
- Do other kids have a graph that looks exactly like yours? Why not?
- How many more blues do you have then pink?
- How many candies total do you have

NOTE: This activity should not be done with young children who may put graphing objects (buttons, etc.) in their mouths unless there is adequate supervision. Supervision is needed with toddlers.

Resources:

http://filefolderfun.com/KindergartenMath/CandyGraphing
http://www.examiner.com/article/graph-your-halloween-candy-with-a-free-printable
http://www.kiwicrate.com/projects/Halloween-Candy-Graphs/785


It's a Candy Graph!
13
12
11
10
9
8
7
6
5
4
3
2
1
Blue
Orange
Purple
Pink
Green
Color

Chutes & Ramps

Tip: Unless the kids are old enough to safely handle sharp scissors to cut plastic and to make straight cuts in the cardboard towel roles, prepare these supplies ahead of time.

Supplies

- Plastic water bottles with tops and bottoms cut off, labels removed
- Paper towel roles
- Sharp scissors
- Masking tape or duct tape to tape bottles/tubes together
- Large piece of heavy duty cardboard or other material that can stand on its own – for paper towel roles
- Tape that can be removed and placed in a different position (to aid in construction and so that kids can experiment with changing the slope of the chutes/ramps)
- Balls that can fit through the water bottles and travel easily through the paper towel chutes (e.g., marbles, super balls, ping pong balls for paper towel roles, balls made out of aluminum foil, anything that can role)
- Plastic cups to catch the balls at the end of the chutes

Construction

Water Bottles

- Cut off tops and bottoms of water bottles and tape them together by slipping the narrow end (the one that had the opening) of one bottle into the bottom of another. Be sure to cut off enough of the open end so that the ball can roll through. You can make vertical cuts in the bottom end of the bottle and slip it over the open end of the other bottle. This will help ensure that the ball can role easily through the chute.
- Make the chute as long as you would like.
- Use clear plastic bottles so the kids can see the balls racing through the chutes.

Paper Towel Tubes

- Cut paper towel tubes in half length-wise and tape them together with no overlap, making a seam between each section by wrapping the tape all around the cardboard. Be sure there are no bumps on the inside of the chute so that nothing inhibits the ball as it rolls down.
- Once you have a few half-tubes taped together tape them on a sturdy piece of cardboard or other vertical surface. Do this with tape that is easy to pull up and re-stick, or with Velcro. It's best to be able to move the chutes a bit so the kids can change the slope and see the difference in how quickly the ball rolls.
- When you want to make a "switch-back", place a new chute, running in the other direction, at the end of the first one. Test this before you put the new chute in place. You will probably have to place the new chute a little higher, and maybe place a small tube so that the ball does not jump the track. See pictures on the first page for illustration.

Sample Questions

- What type of ball rolls fastest – large marble, small marble, ping pong ball, super ball? Why?
- What happens when you change the slope of the chute?
- What can you do to make the balls roll slower?
- What can you do to make the balls roll faster?

Resources

http://tinkerlab.com/toilet-paper-roll-marble-run/
http://illinoisearlylearning.org/tipsheets/physics-rolling.htm
https://van.physics.illinois.edu/qa/listing.php?id=183
http://easyscienceforkids.com/inclined-planes/
https://van.physics.illinois.edu/qa/listing.php?id=183

Cup Stacking

Kids love cup stacking! They love working alone and in groups. In general, they are cooperative, patient and kind to one another. On the next page there are some suggested "Rules" you may want to consider posting to help ensure that everyone has fun and that the cups remain unbroken so you can use them again and again. ***Tip:*** Buying cups in bulk saves money.

Supplies

- Lots of plastic cups that are all the same size – 16 ounce cups work great – laid out in approximately 1-foot stacks
- A lot of floor space (tile, wood or carpet works)
- Timer if you are going to do speed stacking

Possible Games

- Build the Tallest Tower – How high of a tower can you build?
- Build The Great Wall of Teamwork – How long can you make the wall? How high?
- Speed Stacking – Who can build a 4-foot tower (or other height) the fastest and not have it collapse?
- Team Work – can a group of kids build a tower without talking at all? How can they communicate to work as a team if they can't talk?
- Count the number of cups you used. Estimate the number of cups you used – how do you do this with a square or rectangle? A pyramid? A circular tower?

Sample Questions

- What base is the best to build a tall tower? Pyramid? Straight line? Curved line? Why do you think this is so?
- Why is it better to have a bigger base than to just stack cups on top of each other, rather than stacking the cups top-to-top and bottom-to-bottom? Why do you think this is so?
- What happens when you don't place the cups touching each other? What happens as the stack gets taller?

Resources

http://www-tc.pbskids.org/fetch/parentsteachers/activities/pdf/FETCH_StackEmUp.pdf

Welcome to Cup Stacking!

Rules to Help Everyone Have Fun!

1. Have Fun!
2. Make New Friends!
3. Try Your Best!
4. Have Fun!
5. Share
6. Clean Up When You are Done
7. Be Gentle With the Cups
   - ➔ Do Not Step on the Cups
   - ➔ Do Not Throw the Cups
   - ➔ Do Not Squash the Cups
8. Have Fun!

Gracious Professionalism!

Coopertition!

Flying Butterflies & Hawks

Supplies

- Pictures of hawks and butterflies or anything that flies
- Scissors to cut out the pictures (or pre-cut them)
- Crayons or markers to decorate the picture
- Ribbon or string
- Tape

Construction

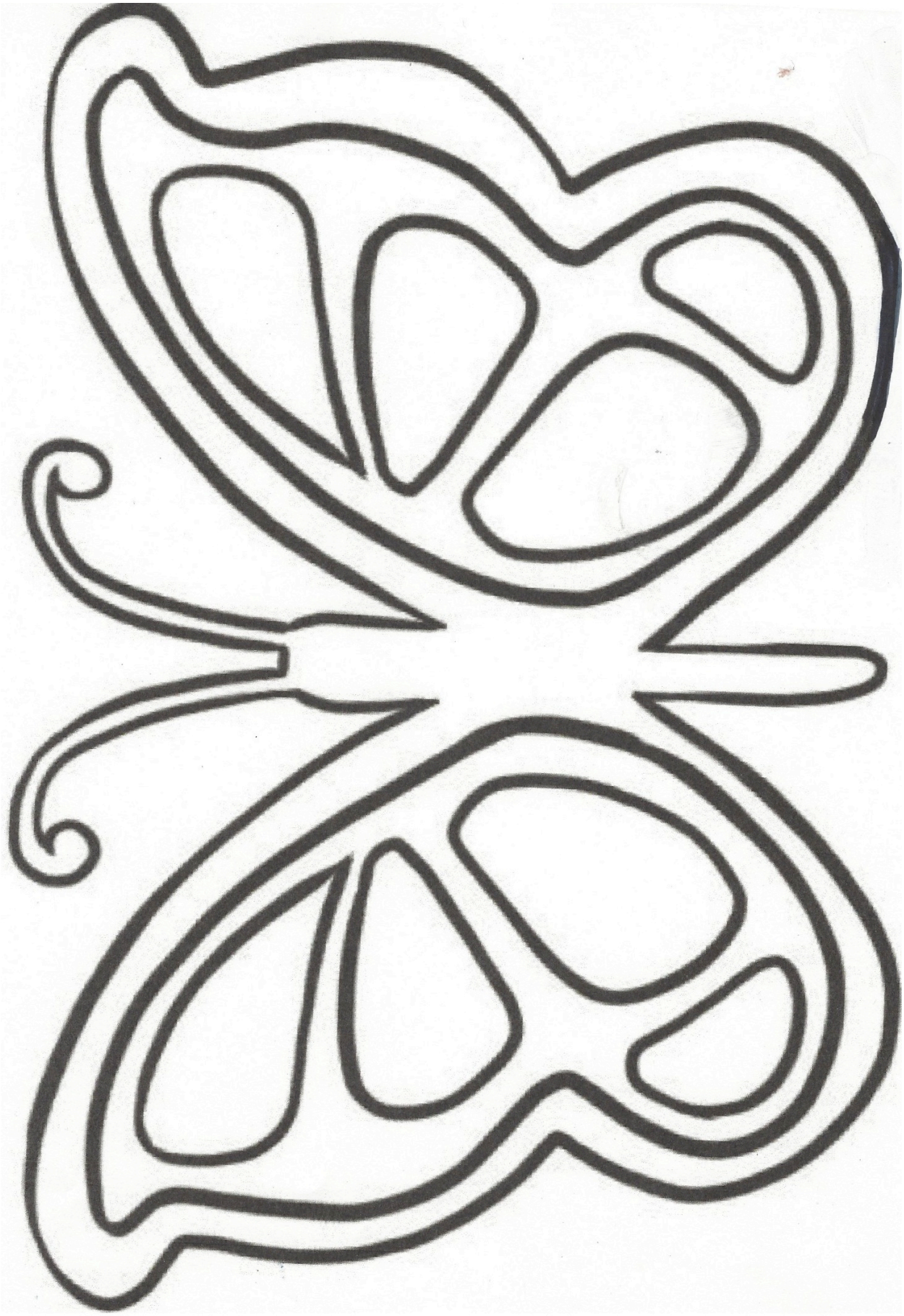
- Once the hawk or butterfly is cut out and decorated, tape a piece of ribbon or string in the middle of the back of the shape.
- Tie the picture to the wrist so that the child can remove it.
- You can also draw and decorate your own – real or imagined – flying creatures.

Sample Questions

- Does the butterfly move when your arm is still?
- Why does it “fly” when you move your arm? What are you doing to make the air move?
- How can you make the butterfly faster?

Why does this work?

The air is made up of molecules, which are very, very, very small. When you move your butterfly up and down, you are moving the molecules around. This is similar to when you are in the water and move your hand, or kick your feet up and down and the water moves.



Lots of Legos

Kids – and grown-ups – can play with Legos all day long. They're fun and you can invent lots of games to play with them. ***Tip:*** You can sometimes get Legos at tag sales, online, and from families whose kids have outgrown them and want to donate them to a worthy cause.

Supplies

- Legos – as many as you can get
- Small swimming pool or other large container
- Small stools for kids to sit on, or kids can sit on the floor OR
- Table and chairs for kids to work at

Possible Games

- Build the Tallest Tower – How high can you stack Legos before they fall over? How can you make your tower stronger?
- Team Work – Can a group of kids build a tower or other shape without talking at all? How can they communicate to work as a team if they can't talk?
- Count Legos
- Do a graphing project (see Candy Graphing)
- Treasure Hunt – make a list of Legos to collect (e.g., blue square, red rod 10 "studs" by 2 "studs", enough Legos to make a square)
- Team Work – Build a town with different buildings, vehicles, etc.

Sample Questions

- What base is the best to build a tall tower? Pyramid? Straight line? Curved line? Why do you think this is so?
- Is your tower stronger if you use the small square Legos or longer ones? Why do you think this is so?

Resources

http://discoverexplorelearn.com/25-lego-learning-activities/
http://www.learningliftoff.com/20-fun-activities-learning-legos/#.Vuw5nGQrK2w

Make a Robot, Take a Robot

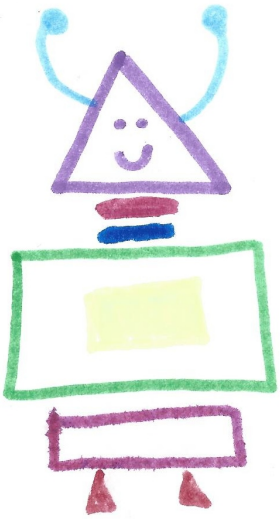
This is a fun activity to get the imagination flowing! People draw robots on the front of index cards and, on the back, put information about the robot: it's name, what it does, how it works, etc. "Engineers" can be as creative as they want to be. You can also develop "robot missions" for young engineers to address, or problems for them to solve, such as, "The mission for your robot is to fly to Mars," or "Can you design a robot that can solve the problem of trash in the ocean?"

For your children, you may want to have volunteers to write the information about the robot and to engage them in further discussion about what robots are and what they can do.

In order for an "Engineer" to take a robot, s/he must design one, provide information about it and post it on the "Make a Robot, Take A Robot" board. You will have to make some robots to post on the board to get the ball rolling.

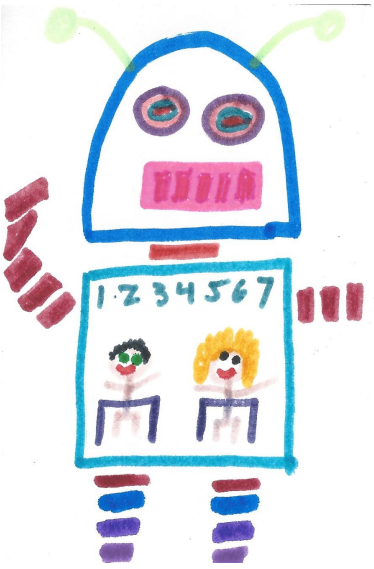
Supplies

- Index cards
- Crayons and/or markers
- Pens
- Masking Tape
- Vertical surface to put robot drawings on (e.g., wall or cardboard)



I am a robot! I play sports with my human friends.

I fly around school and attend classes so that kids who are sick can still go to school with their friends. The kids at home watch on their computers.



Mechanical Engineering Challenges

There are lots of simple and fun engineering activities that teach the basics of mechanical engineering. Here are some links to get you started.

Penny Bridge
http://www.mos.org/sites/dev-elvis.mos.org/files/docs/education/mos_engineering-bridges_paper-bridges.pdf

Paper Building Blocks
http://babbledabbledo.com/science-for-kids-paper-building-blocks/

Gumdrop Engineering Challenge
http://thehomeschoolscientist.com/gumdrop-structures-engineering-challenge/

Foil Boat Engineering Challenge
http://thehomeschoolscientist.com/foil-boat-engineering-challenge/

Straw Rocket Engineering Challenge
http://thehomeschoolscientist.com/straw-rocket-engineering-challenge/

Paper Airplanes

Supplies

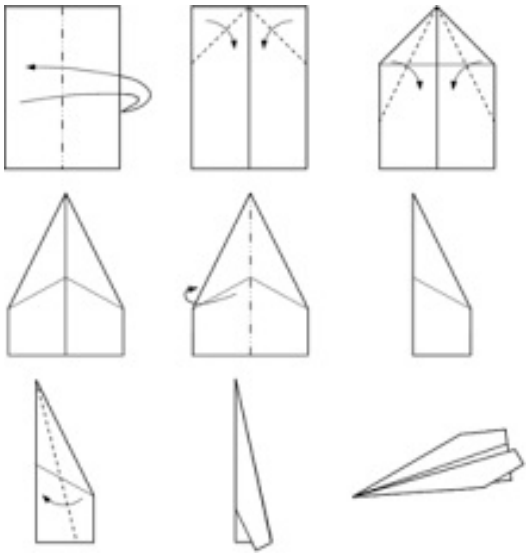
- Paper
- Scissors
- Samples of paper airplanes
- Instructions on how to make different paper airplanes

Sample Questions

- What shapes fly the fastest?
- What shapes fly the farthest?
- What shapes fly the highest?
- What happens when you launch your plan into the wind?
- What happens when you launch your plane and the wind is behind you?

Resources

http://allpaperplanes.weebly.com/the-physics.html
http://www.scientificamerican.com/article/bring-science-home-paper-planes-drag/
http://www.funpaperairplanes.com/learn_about_flight.html



Parachutes & Wind Tubes

Supplies

- Wind Tube (see resources below for instructions on how to build one) OR Hairdryer (set on coolest and strongest setting)
- Plastic cups
- Pipe cleaners or tape
- Plastic grocery bags
- Small weights (pennies, nuts & bolts, etc.) or Lego people
- Anemometer (measures air speed) *optional*

Construction

- See resources list below if you would like to build a wind tube/tunnel
- Parachute with pipe cleaners: put small two holes about one inch from the top of the cup; thread pipe cleaner through the holes, twisting the end at the top of the cup to keep it in place; attach one handle of the plastic bag to the other end of each pipe cleaner.
- Parachute with tape: Tape the handles of the plastic bag to either side of the cup.

Instructions

- Slip the cup under the bottom of the wind tube above the fan, let the bag fill with air and launch.
- If you are using a hair dryer, have one person hold the cup and hold the open bag up a little bit so air can get into it, filling bag with air and then launching.
- An anemometer will allow you to measure the velocity of the air at its source (the mouth of the fan or hair dryer) and farther up the “air stream”.
- Try putting different weights in the cup to see how quickly it launches and how high it goes.
- Put a Lego person in the cup and launch your astronaut to another planet!
- Try launching other objects such as a balloon, paper plate with and without holes in it, empty plastic berry basket, etc.

Sample Questions

- Why does the parachute go up?
- What happens when you put different weights in the cup?
- Can you make your parachute hang in the air, why is this happening?
- What happens when you launch other objects?
- Look at the Beaufort Scales below and on next page, and guess the velocity of the wind when you are at the beach on a windy day flying a kite, during a hurricane, standing in front of a fan.

Resources

http://www.exploratorium.edu/pie/downloads/Wind_Tubes.pdf
http://tinkering.exploratorium.edu/wind-tubes
http://m.instructables.com/id/Wind-Tube/

BEAUFORT NUMBER	WIND	SYMBOL	WIND SPEED (MPH)
0	calm		less than 1
1	light air		1-3
2	slight breeze		4-7
3	gentle breeze		8-12
4	moderate breeze		13-18
5	fresh breeze		19-24
6	strong breeze		25-31
7	moderate gale		32-38
8	fresh gale		39-46
9	strong gale		47-54
10	whole gale		55-63
11	storm		64-75
12	hurricane		more than 75

BEAUFORT SCALE

Force		Anemometer reading mph	kmh	m/s	knts	Description		Effect on kite
0		0-1	<1	<0.3	0-1	Calm; smoke rises vertically.	Calm	Launch frustration
1		1-3	1-5	0.3-1.5	1-3	**Direction of wind shown by smoke drift, but not by wind vane.**	**Light air**	Very large lightweight deltas, Rokkaku etc, may fly on a light line
2		4-7	6-11	1.5-3.3	4-6	**Wind felt on face; leaves rustle; ordinary vanes moved.**	**Light Breeze**	Sutton ff30 lofts 650g at 3.5mph
3		8-12	12-19	3.3-5.5	7-10	**Leaves and small twigs in constant motion; wind extends light flag.**	**Gentle Breeze**	Drogue needed on Flowform kites
4		13-18	20-28	5.5-8.0	11-16	**Raises dust and loose paper; small branches are moved.**	**Moderate Breeze**	
5		19-24	29-38	8.0-10.8	17-21	**Small trees in leaf begin to sway; crested wavelets form on inland waters.**	**Fresh Breeze**	Reduce kite size increase line weight & drogue size
6		25-31	39-49	10.8-13.9	22-27	Large branches in motion; whistling heard in telegraph.	Strong Breeze	
7		32-38	50-61	13.9-17.2	28-33	Whole trees in motion; inconvenience felt when walking.	Near Gale	KAP not possible without severe risk of injury to operator and equipment.
8		39-46	62-74	17.2-20.7	34-40	Breaks twigs off trees; generally impedes progress.	Gale	
9		47-54	75-88	20.7-24.5	41-47	Slight structural damage occurs (chimney-pots and slates removed).	Severe Gale	
10		55-63	89-102	24.5-28.4	48-55	Seldom experienced inland; trees uprooted; considerable structural damage occurs.	Storm	
11		64-72	103-117	28.4-32.6	56-63	Very rarely experienced; accompanied by wide-spread damage.	Violent Storm	
12		73-83	≥118	≥32.6	64-71		Hurricane	

Pinwheels

Supplies

- Templates or pre-drawn pictures for pinwheels
- Markers to decorate the pinwheels
- Scissors to cut our pinwheels
- Pencil with an eraser on top
- Straight pins

Construction

- Design pinwheel or use existing template and decorate
- Cut out pinwheel, folding triangles into the middle, piercing with pin and putting pin into eraser

Instructions

- Blow pinwheel or use a hair dryer to blow air at pinwheel and see what happens

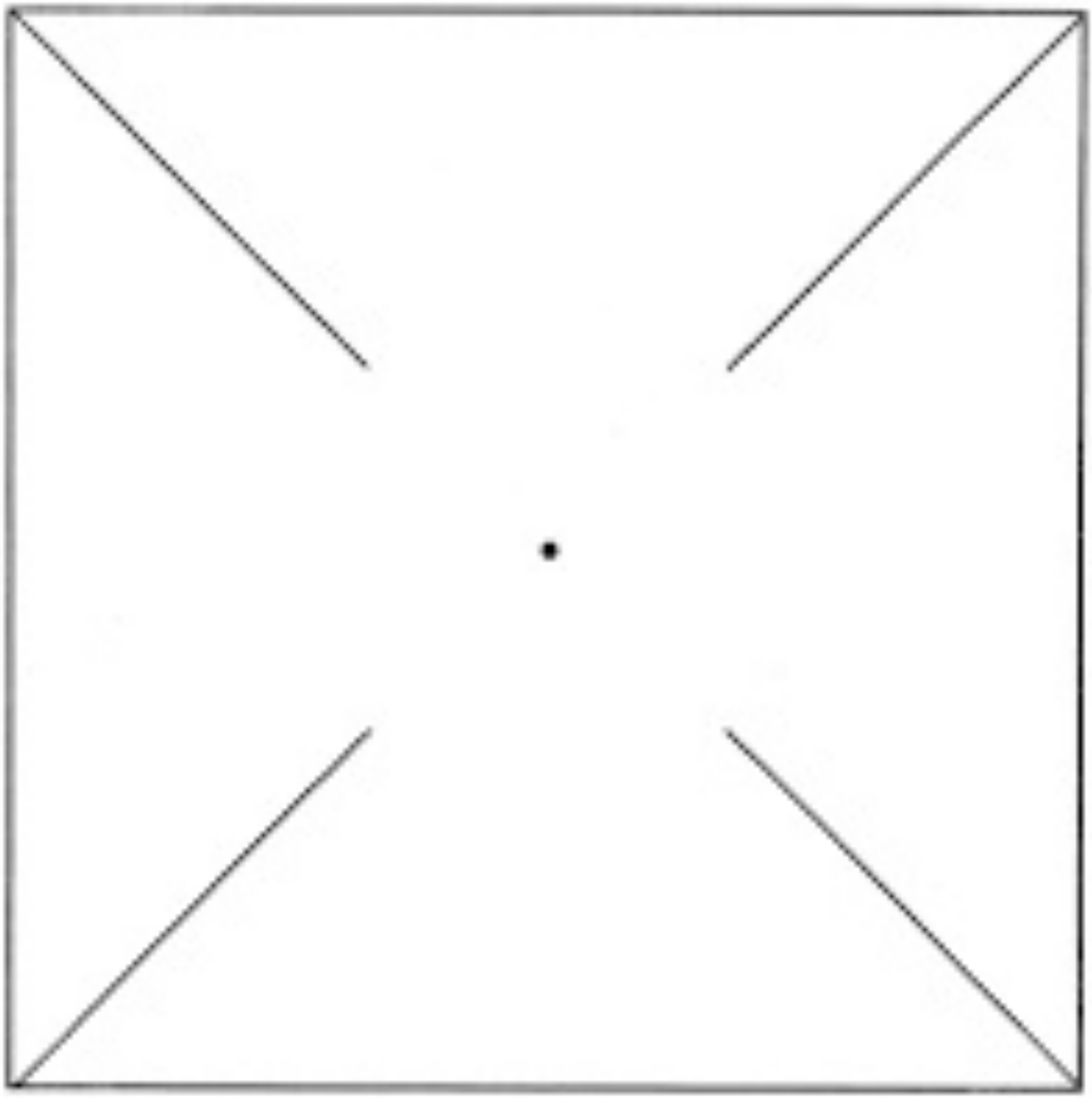
Sample Questions

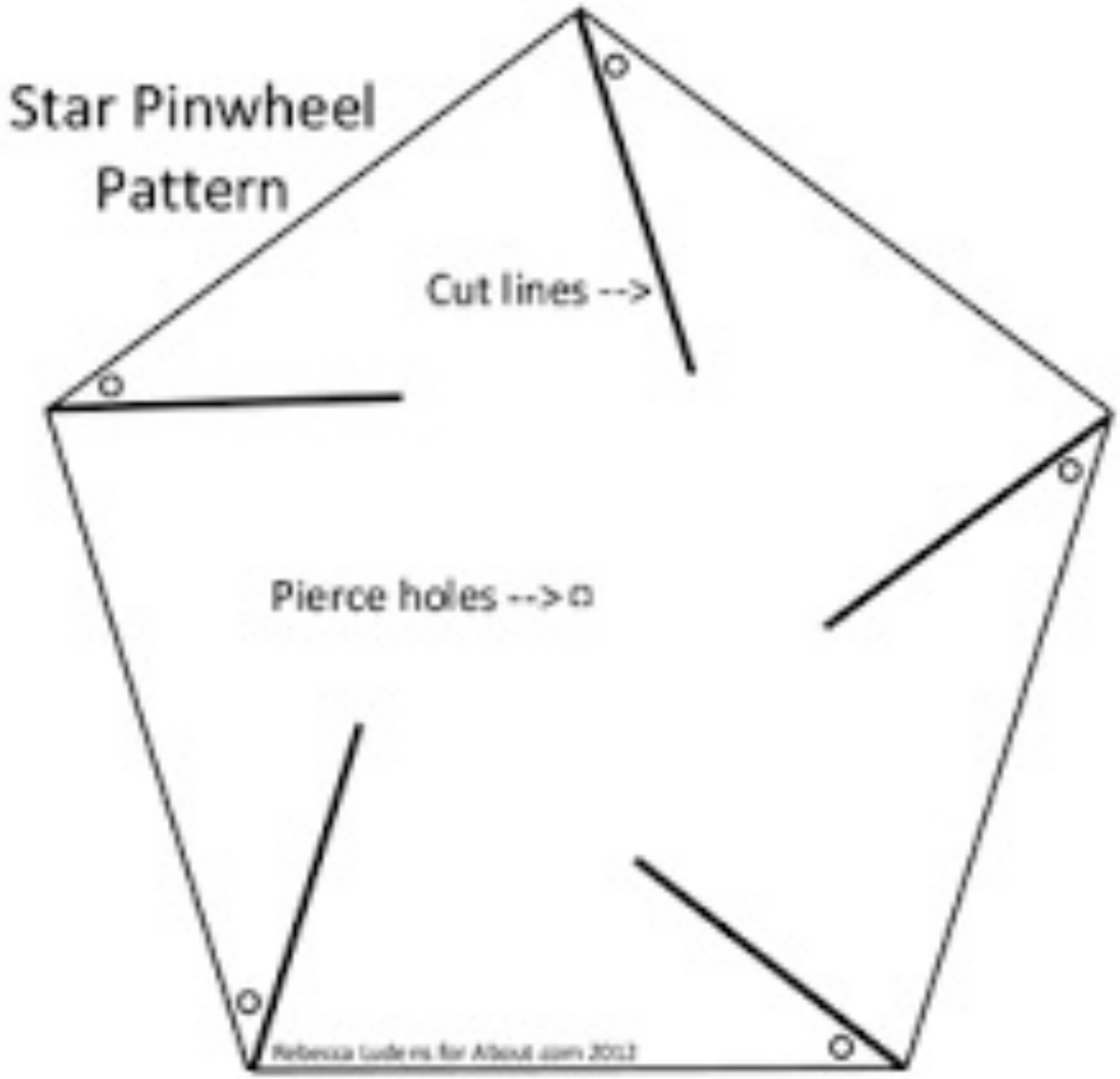
- What happens when you blow lightly? More forcefully?
- What happens then you have a pinwheel with bigger “pockets” to catch the air? Smaller pockets?
- What happens if you add more pockets or cut off some of the pockets?

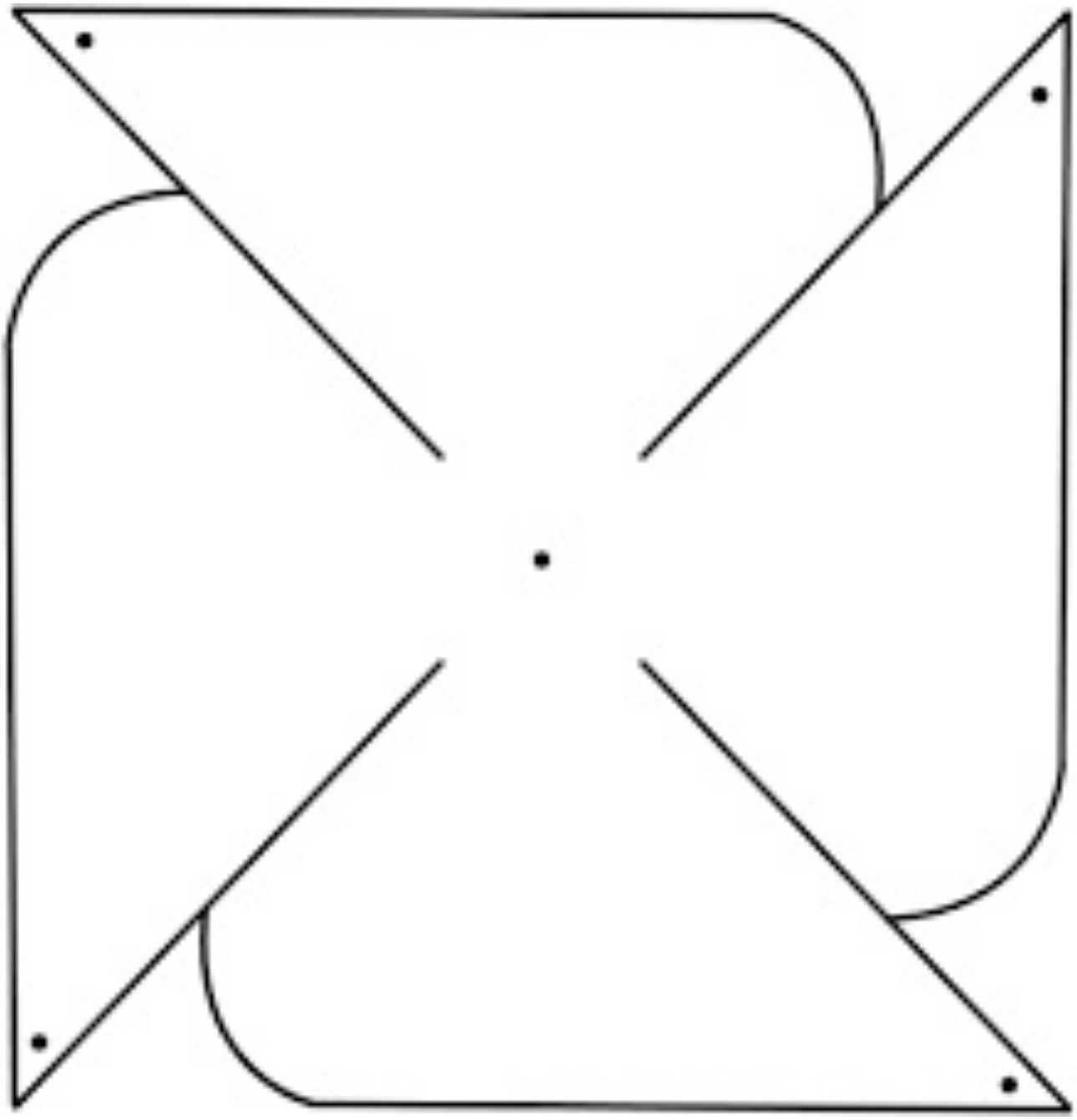
Resources

http://www.scientificamerican.com/article/spinning-symmetry-with-pinwheels/
http://www.nrel.gov/education/pdfs/educational_resources/elementary/pinwheels.pdf
http://science-at-home.org/spinning-pinwheels/
http://www.practicallyfunctional.com/how-to-make-a-pinwheel-template/

PINWHEEL TEMPLATE




Star Pinwheel Pattern
Cut lines -->
Pierce holes -->



Squishy Circuits

NOTE: This project involves electricity and should be supervised by an adult. DO NOT touch the two wires on the battery snap to one another or you will get shocked – it will hurt!

Supplies

- Play Doh OR make your own Squishy Circuit Dough (see resources below)
- LED bulbs with resistors (10 mm nice & big, but any size will do)
- 9 volt battery
- 9 volt battery snap with contacts

Instructions

- Mold dough into shapes
- Put one end of LED resistor into one piece of dough and the other into a second piece of dough – do not let the pieces of dough touch.
- Attach battery snap to the battery and put one contact into each piece of dough. NOTE: If an LED does not light up, reverse the resistors.

Sample Questions

- What happens when the pieces of dough touch, or you use another piece of dough to create a "bridge between the two pieces"?
- What happens if you unplug the "snap" from the battery?
- If you have more batteries and snaps, can you make a chain or circle of dough and lights?

Recipes for Dough

http://www.instructables.com/id/How-to-make-conductive-play-dough/?ALLSTEPS
http://courseweb.stthomas.edu/apthomas/SquishyCircuits/howTo.htm
NOTE: Add Cool Aid powder to make colors – it smells good, too!

The Science of Squishy Circuits

https://www.ted.com/talks/annmarie_thomas_squishy_circuits?language=en
http://lizastark.com/portfolio/wp-content/uploads/2012/03/Squishy.pdf
http://preschoolpowolpackets.blogspot.com/2014/09/electricity-with-preschoolers-squishy.html