nanogirl's LAB

SUPER POWER: Astronomy!

STAR PROJECTOR

LAB NOTES...

YOU WILL NEED

- 2 sheets of card or paper .....
- Scrap of thin card (e.g. cereal box card) .....
- Tape .....
- Pencil .....
- Scissors .....
- Ruler .....
- Pin or thumb tack .....
- Phone or tablet with torch .....
- Blu tack .....
- Elastic band .....

TO MAKE YOUR STAR PROJECTOR...

1. Watch the video of Nanogirl making her Star Projector.
2. Take one sheet of card or paper, roll from one corner and tape to make a cone.
3. Make some tabs by snipping short slits up from the narrow end of the cone then fold them outwards.
4. At the wide end of the cone, cut off any pointy corners so your cone has a flat, circular opening. This is your projector!
5. Measure and cut out a 10cm by 4cm strip from your thin card.
6. Draw a horizontal line 4cm up from one end.
7. Lie the top, back edge of your phone along the line you drew. Draw a line on the card along the top, front edge of the phone. This should give you two lines showing the width of your device.
8. Score along both of these lines using a ruler and one blade of your scissors, then fold the card along the score-lines to form a U shaped bracket.
9. Place your bracket over the top of the phone so that it's nearly covering the torch.
10. Draw a mark at the edge of the bracket to show the middle of the torch position.
11. Draw a horizontal line across the bracket at this point.
12. Make a pencil mark in the middle of this line, it should be 2cm in from the edge, then use a pin or thumb tack to make a small hole at this point.
13. It's helpful to use a lump of blu tack under the pin position to protect the surface underneath.
14. Widen this hole with scissors until it is larger than the diameter of your torch.
15. Tape the elastic band to the side of the bracket without the hole in it.
16. Use the tabs to tape the narrow end of the projector over the hole you made in your bracket. This is your star projector!
17. To make your star map, fold a sheet of paper or card in half. Draw around the wide end of the projector cone on the card to make a circle.
18. Draw a slightly larger circle around the outside of this circle and add a rectangular handle shape to it.
19. Keeping the paper folded, cut out your shape. You should have to give two similar shapes.
20. Find a star chart with a constellation that you want to draw. Using a pencil, mark out where each star goes in the centre of your circle shape.
21. Use your pin to push holes through each mark, If it's a bigger star, wiggle the pin to make a larger hole.
22. Label the handle with the name of the constellation you've drawn.
23. Turn on the torch, slide the bracket over the phone, lining the hole up over the torch looping the elastic band around the phone so it stays in place.
24. Hold the constellation slide in front of the wide end of the cone.
25. Project the light onto a wall, it helps if the room is dark, and marvel at your constellation.

WHAT'S GOING ON?

Constellations are groups of stars and planets which make a pattern in the night sky. Scientists called astronomers track the positions and shapes of the constellations.

In making a star projector, you are doing the same thing as an astronomer. Astronomers use constellations to track the seasons, the earth's orbit, and where our satellites are in space.

INVESTIGATE

Some stars look bigger than others in the sky. Sometimes, this is because the stars are closer to us. What happens to the size of your constellation when you move the projector closer or further from the wall?

Look outside on a clear night—can you see any constellations, stars or planets? Draw the shapes of any constellations you see, and project them using your star projector.

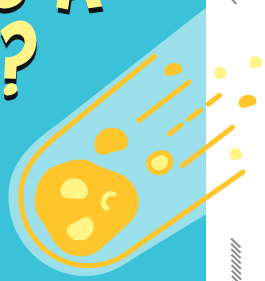
nanogirl's LAB

SUPER POWER: Comets!

COMET CATCHER

LAB NOTES...

WHAT'S A COMET?



Comets are small, irregular pieces of the solar system. They can be made of rock, ice and dust, and they orbit the Sun, just like the planets. The difference between a comet and an asteroid is that comets are made of dust held together with ice, and asteroids are usually made of pieces of rock and different minerals, without any ice. Asteroids and comets have been around since the beginning of the solar system, which means that they can tell us a lot of information about what the universe was like in the past.

The Rosetta spacecraft was designed to catch a comet and after chasing it for several years was eventually able to land a robot onto a comet's surface.

TO MAKE YOUR COMET CATCHER...

BUILD TIME 10 MINS

1. Watch the video of Nanogirl making her comet catcher!
2. Cut your plain paper into a large square.
3. Fold in half to make a triangle with the open end at the top.
4. Take the left side bottom corner and fold across the triangle so the point sits about one third of the way from the top of the triangle on the opposite side.
5. Do the same with the bottom right corner, and you should have a shape with five sides (a pentagon). The points you folded across the middle should lie over one another, like a set of folded arms.
6. Turn the whole shape over. Fold the closest sheet from the top point down.
7. Turn the shape over again and fold the top point down tucking it into the pocket made by the folded arms.
8. Open up the middle to make a cup.
9. Using the scissors, snip a small hole in the small base of the cup.
10. Cut 40 cm of string, and thread one end through the little hole.
11. Tie a knot in the end of the string that's inside the cup.
12. Cut a strip of kitchen foil as large or small as you like
13. Take the un-knotted end of the string and lay in the centre of the foil strip.
14. Scrunch up the foil around the string. This will be your comet!
15. Hold the comet catcher by its base, flick up to launch the comet then try and catch it!

YOU WILL NEED

- Plain paper ○
- String ○
- Scissors ○
- Kitchen foil ○

TIME YOURSELF!

How many times can you catch your comet in 30 seconds?

Is this easier with a longer string or a different sized or shaped comet?

What else could you make your comet from other than foil?

Can you catch the comet if your eyes are closed?

nanogirl's LAB

SUPER POWER: Gravity!

ANTI-GRAVITY GLASS & SPINNING WATER

LAB NOTES...

OVERCOMING GRAVITY

Today, you've created two forces which when strong enough can overcome gravity. You then used them to keep water in a glass even when it was upside-down! In the anti-gravity cup experiment, you used the higher air pressure outside the glass to push the card upwards so that it kept a tight seal on the rim of the glass and the water didn't spill out.

In the spinning water experiment, you created a centripetal force, which pushes the water outwards away from the centre which was your hand. In your experiment, the centripetal force pushed the water against the bottom of the cup to keep it there, even when the cup was upside down!

Remember that everything which has mass has gravity. "Mass" means how much stuff something is made of and bigger planets tend have more mass, so have stronger gravity! Our Moon is smaller than Earth, so the gravity is weaker there. Jupiter is much bigger than Earth, so if we could stand on the surface, the gravity would be about 2.4 times stronger.

BUILD TIME 15 MINS

TO MAKE YOUR ANTI-GRAVITY GLASS...

1. Watch the video of Nanogirl investigating gravity
2. Cut a square of card large enough to fit over the top of your drinking glass
3. Fill your glass up with water right to the top.
4. Place the square of card over the top of the glass and press down.
5. Over a sink or bowl, keep the pressure on the card and turn the glass upside down.
6. Let go of the card and see if it stays under the glass on its own!

TO MAKE SPINNING WATER...

1. Cut the bottom end off a plastic bottle to make a small cup.
2. Using sharp scissors, make a small hole in opposite sides of the cup, about 1 cm below the edge.
3. Measure and cut a length of string twice as long as your arm, thread one end through each hole, and the string to secure it to the cup.
4. Practice swinging the cup with no water in it first - this will tell you how strong your knots are! Spin it fast enough that the string is always tight.
5. Pour a small amount of water into the bottom of your cup, find somewhere with a lot of space, and swing it again - see if the water stays in even if the cup is upside down!

YOU WILL NEED

- **An empty recycled plastic bottle** ◯
  e.g. soda bottle or milk bottle
- **Drinking glass** ◯
- **String** ◯
- **Scissors** ◯
- **Thin card** ◯
- **Water** ◯
- **Towels** (for spills!) ◯

Investigate...

If you jump up as high as you can, how many seconds can you stay in the air for? How do you think this would change if you were on the moon, or on Jupiter?

How do you think this science is used by engineers who design theme parks?

Do you think the length of your string will make a difference?

Do you think the anti-gravity experiment would work with paper instead of card?

nanogirl's LAB

SUPER POWER: Terminal Velocity!

PARACHUTE

LAB NOTES...

parachutes

Parachutes help to slow down something which is falling by creating a large surface area that traps air underneath. This is similar to how our kite worked! The plastic sheet creates air resistance, or drag, which slows down the thing that's falling.

The fastest speed that something can fall at depends on its mass, shape, and how long it is falling for. The fastest falling speed that an object can fall at is called its "terminal velocity".

Opening a parachute changes the speed that it falls by changing its shape and air resistance. Spacecraft use huge parachutes to return to earth.

TO MAKE YOUR PARACHUTE...

1. Watch the video of Nanogirl making her parachute
2. Cut a large square sheet from your plastic sheet - larger sizes tend to work better.
3. Cut four pieces of string the same length. They should be at least as long as the length from one corner of your plastic sheet to the middle of the sheet.
4. Cut one egg cup out of the egg box, and tape it together to form a basket shape.
5. If you don't have an egg box, take a piece of paper and draw a square with each side about 5 cm long. Draw another square the same size, attached onto each side of the first square, to make a cross shape. Cut out the shape. Bend up the side squares and tape them together to make a small open-top box.
6. Use the skewer or pencil to poke 4 holes evenly spaced around the sides of your basket, near the top.
7. Using the skewer to help you, push one end of each string through each hole and tie a knot in each to stop them slipping back out.
8. Hold the 4 pieces of string up with the basket at the bottom and trim so they are all the same length.
9. Tape the ends of the string to the corners of your plastic sheet, one string per corner.
10. Hold your parachute up high, spread out the plastic so it's not tangled, and let go!
11. The challenge: can your parachute deliver something in the basket safely?

YOU WILL NEED

- Trash bin liner or thin plastic shopping bag ◯
- String ◯
- Scissors ◯
- Tape ◯
- Ruler ◯
- Pencil ◯
- Wooden skewer or sharp pencil ◯
- Empty egg box (optional) ◯
  OR **A piece of paper**

Can you add weight into your basket using a rock or marble – does it fall at the same speed? Try timing it with different conditions to compare.

If your weight falls out of the basket when it lands, can you think of a way to engineer a solution so it stays inside?

What happens if you make the plastic sheet smaller or round instead of square?

What do you think will happen if you replace the plastic with fabric like a paper towel or paper?

nanogirl's LAB

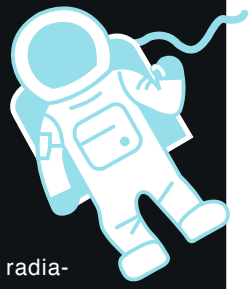
SUPER POWER: Space Suits!

SPACE SUIT TESTING MACHINE

LAB NOTES...

BUILD TIME 25 MINS

SPACE SUITS protect astronauts and let them breathe while they are outside the spaceship. Space suits can have up to 14 different layers with each layer doing a different job. The suits needs to protect the astronauts from space.



The outer layer of a space suit is very tough, and has a special name - the Thermal Micrometeoroid Garment. It stops micrometeoroids (tiny pieces of flying rock) and solar radiation from harming the astronaut.

In your experiment, you investigated why space suits need to have so many layers. The outer layer by itself is not very good at stopping tiny projectiles, but many thin layers together have the power to absorb the energy of the flying ball of blue tack, which means that the projectile loses energy and can't rip through to the underneath layers.

TO MAKE YOUR SPACE SUIT...

1. Watch the video of Nanogirl testing her space suit!
2. If you are using a tissue box, cut a piece of card big enough to cover the hole in the top, and tape it in place over the hole.
3. On your box, cut a large flap in the top close to the edge. Leave one edge attached as a hinge.
4. Place your cardboard tube in the middle of one of the ends of the box, draw around it, and cut out a circle which fits the tube tightly.
5. Push the tube halfway through the hole and tape in place to secure.
6. Halfway along the length of the box, draw a line that goes all the way around the outside.
7. On the sides of the box, measure 1 cm up from the bottom and make a mark on the line you drew. Now make a mark 1 cm down from the top. Do the same on the other side.
8. Measure 4 mm either side of each mark you made, and make a small dot.
9. Using the pointy end of a skewer, pierce the box through the small dots so you have 8 holes.
10. Slide the skewers through the holes, 2 at the top, 2 at the bottom and secure in place with blu-tack.
11. Draw around the end of your box on a spare piece of card, and cut out two pieces which are slightly narrower than the end of your box.
12. Cut out their middles leaving 1cm around the edges so they look like a frame.
13. Tape the bottom of the frames together to make a hinge.
14. Investigate your tissue. It may be 2 ply meaning there are 2 sheets together, so separate them first then slide in-between frame cutting to size.
15. Scure the tissue sample in place with the paper clips
16. Slide the tissue and card frame into the box in between the two rows of wooden skewers.
17. Take your balloon, and cut across the neck. Stretch the end of the balloon over the card tube sticking out from one end of the box. Use tape or an elastic band to keep it in place.
18. Roll a small lump of bluetack into a ball or use a dried pea or lentil and drop it into the tube so that it rests against the balloon.
19. Close the hinge lid of the box making sure that the tissue and frame are secure
20. Grab the bluetack through the balloon, pull it back and fire it at the tissue!
21. Add more layers of tissue until the back layer is not marked by the blue tack.

YOU WILL NEED

- **A cardboard box** ..... ◯
  like a tissue box or shoe box
- **Elastic band** (optional)..... ◯
- **2 x paperclips** ..... ◯
- **4 x Wooden skewers or sticks** ◯
  (equal length)
- **Blue tack** ..... ◯
- **Ruler**..... ◯
- **Tape**..... ◯
- **Scissors** ..... ◯
- **Pencil** ..... ◯
- **Tissues**..... ◯
- **1 x Balloon** ..... ◯
- **Spare card** e.g. cereal box card ..... ◯
- **Cardboard tube** e.g. kitchen roll..... ◯
  or toilet roll inner tube (or make your own!)

How many layers of tissue does it take before the impact can't be seen on the back layer?

What happens if you use something else instead of blue tack? You could try small beads, frozen peas, small stones or raisins.

Try moving the tissue paper closer to or farther away from the tube. Does this affect how many layers your projectile can pierce?

What materials other than tissue could you use in your spacesuit layers?