Rocket Launch Workshop

Family Science WORKSHOPS

Time	Content	What's needed
5:30pm	Set up of room: semi-circle of tables around the demo table and 12 chairs total. Participant resources for each pair. Separate table for serving food and drink. Collect pizza delivery	• Food box • Role play box • Activity box
5:45pm	Greet participants on arrival, offer pizza and water Get permission forms signed Start on demographic survey and pre-workshop questionnaire	• Pizza, cups, plates • Forms, pens
6pm	Start formal introductions – round the room and volunteers briefly explain their background. **<u>Introduction</u>** What is science? Engineering? What's the difference? What is a scientist? What types of science are there? Tonight we will talk about **laws of motion** AND **air pressure** What is rocket science? It is really based on the laws of motion, and has been applied for thousands of years – Chinese fireworks, Greeks and Romans, modern warfare, and we use these principles every day. The Chinese used explosions, the Greeks used heat to create the pressure in the 'chamber' that caused the motion. Different ways to create this energy, in general tonight, the idea is to build up air pressure in a chamber to a point that it results in motion (kinetic energy). What is air? Where is it? Can we feel air pressure?	**Vocabulary:** Force Momentum Mass Thrust Acceleration Velocity Pressure Resistance Propulsion Friction Specific Impulse Stability
6:20pm	**<u>Balloon Game Example</u>** Give each person a balloon, different shapes and sizes fine. Blow up balloons and hold them closed. Everyone stand in a line and let them go – watch what happens. Ask why does this happen? Where is the air? Where is the pressure acting? <u>Explanation – First main point</u> Blowing up the balloon increases the air pressure inside, so the air 'particles' are exerting a force on the balloon walls – this is elastic potential energy. If they are given a way out, they'll want to escape (resulting in kinetic energy), and the more pressure they are under, the faster they'll escape – related to the size of the nozzle (Pressure = Force / area). So smaller area under same pressure will result in more force. *Use the water hose analogy to explain nozzle size effects on increasing speed* How to get more energy/pressure on the inside? Add more air, or heat the air, or produce the gas in some other way (burn fuel) like real rockets. Laws of motion describe how objects act. (Discuss the 3 in brief if necessary) <u>Scenario to describe Newton's Laws</u> **First Law** – you are playing in the playground, and mum wants you to come and do your homework. You want to keep playing right? (*Things keep doing what they do*) **Second Law** – Your mum comes to get you from the playground, takes your hands and pulls you into the house so you move faster than if she let you come in your own time (*Things move faster when a force is acting on a mass*)	Balloons (pump and straws) Long balloons – expel more air so gain more momentum, better trajectory Round balloons – instable and inconsistent path Wiggly balloons – difficult to predict Write the 3 laws on the white board if needed

	Third Law – You pull back on mum's hand because you want to stay outside. Who wins? Why? (*Each action has an equal but opposite reaction*). So using the third law, the air escaping from the balloon is a flow of air that causes the balloon to move in the opposite direction – i.e. propels the balloon forward with equal momentum.	
6:30pm	Let's act this out for ourselves. Volunteer to lead this section: **<u>Role Play – Air pressure</u>** Kids are air particles, representing different gases found in the air, parents are water particles. Ask what air is made of, can they name some of those gases. As they name them, they get assigned the respective poncho: Oxygen, carbon dioxide, nitrogen, hydrogen, methane, argon. Give an example of the use of each one as you go through. Demonstrators hold the elastic straps closed. Kids go into the elastic loop one at a time and move around, bumping into everything. Add in some parent 'water molecules' if they fit. Lots more pressure now! Does anyone want to get out? Everyone pushes on the elastic to get out, and the demonstrator lets go of the join to release the particles from the loop. With more mass (parents) there is less free space to move and more 'oomph' to make the elastic spring away.	• Elastic straps • Dress up air and water 'particles' (leis and ponchos) <u>Analogy</u>: when your shampoo explodes in your suitcase after a plane trip, it's the air that changes volume, so keep the bottle full to the top so the internal volume doesn't change as much.
6:40pm	Go back to tables and start to think about your water rocket designs. <u>Second main point:</u> Aerodynamics/steering – balloons went all over the place, no control. Everything that moves has to overcome these forces: friction, air resistance, gravity, etc. We can add features to our rocket to help with that: **Fins** – stability and move in a straighter line, help steer, like a rudder, but bigger fins mean more drag. How many do you need? **Nose cone** – shape and size combats air resistance, punches through the air, reduces drag **Mass** – playdough, keeps stable, gives more momentum to overcome drag Also can check centre of mass (hang on string), outer layer, etc. Students design logo for suit and dress up. A **space suit** is worn to keep a human alive in the harsh environment of outer space, radiation, vacuum and temperature extremes. Has oxygen supply and solid structure to prevent inflating in the low pressure environment.	Bottles Paper Card Tape Glue Scissors Playdough Felt pens
7:10pm	Head outside with a bucket of water, set up the launcher. <u>H&S briefing:</u> Everyone stand in safe zone. Don't move unless mission control says it's ok. Same volume water (250mL), same pressure (60psa) for each rocket (fair testing) Let the rockets off – kids/parents can pull the string. Height, landing, design, distance. Ask questions as you go. Discuss this activity, with reference to the role-play and balloons. Recap what the air pressure is doing and the forces acting on the rocket. If there is time to repeat, discuss variables they want to change and why.	Bike pump, bucket, water, jug, Launcher
7:30pm	Post-workshop questionnaires, certificates presented, photos, feedback Participants can take home the rocket they have made, and they will have instructions for variations and to make a launcher. Link for PVC pipe launcher - http://www.itsalwaysautumn.com/2013/06/21/diy-pvc-pipe-rocket-launcher.html	*http://paksc.org/pk/science-experiments/physics-experiments/209-pet-water-bottle-rocket/* http://www.wikihow.com/Build-a-Bottle-Rocket

Background Notes

Indoor alternative to water bottle rocket activity – Vinegar (CH3COOH) and baking soda (NaHCO3) and micro rocket. Explain the chemical reaction creates CO_2 which expands and pushes the foam rocket upwards (also water and sodium acetate produced).

Experiment with the volume of vinegar added. Use a tape measure to see how high they go. Make sure they are well rinsed and dried between attempts.

Background

There's air surrounding us everywhere, all at the same pressure of about 1kg per cm^2. You feel the same force on your skin whether you're on the ceiling or the floor, under the bed or in the shower. Imagine you are in a pool, as you sink to the bottom there is more water pushing down on you. This is why your drink bottle behaves differently on an airplane if you open it while in the air then close it, or if you have it closed tight before takeoff.

An interesting thing happens when you change a pocket of air pressure – things start to move because the gas needs to go somewhere. This difference in pressure causes movement that creates winds, tornadoes, airplanes to fly, and some of the experiments we're about to do together.

An important thing to remember is that higher pressure always pushes stuff around. While lower pressure does not "pull," we think of higher pressure as a "push". The higher pressure inside a balloon pushes outward and keeps the balloon in a round shape.

Rockets are a pressurized system. They move by thrust, produced either by a chemical reaction or air pressure. Thrust is the force generated by the propellant (fuel and oxidiser), flow (the mass coming out of the nozzle), and the higher the better. 80-90% of the rocket's mass is propellant, so we want the most energy we can get from this mass – we can't yet make this lighter and still have enough energy. (Liquid or solid propellants).

We have water in the chamber which takes up space, can't really compress, so it takes less effort to pressurise the chamber. Water is mass that when released generates more momentum that just air.

ΔV (change in velocity) describes the movement of the rocket, and different movements/distances require different values. The most is needed to get through the Earth's atmosphere, after that it does not take as much to get to other planets. Because the air pressure outside the chamber plays a role, and space is a vacuum.

Specific Impulse is the momentum (velocity) delivered per unit of propellant (mass). This value indicates the efficiency of the rocket, and puts limits on the mass it can handle at a given velocity. This is the most important question to ask about a rocket – what is its ISP?

Mass – lighter mass will speed up more quickly if the same force is applied. (two people on swings, heavy and light, which one easier to get to speed with the same force of push) – force.

Newton's Laws of Motion

Drive a car, walk, drink a glass of water, kick a ball, the laws are everywhere.

First Law – an object moving will keep moving at constant speed in a straight line until an external force acts on it (i.e. becomes bigger) – friction, gravity is a force. In our rockets, water is the mass which leaves the chamber and forces the rocket upwards, overcoming other forces. (momentum) Law of inertia

Things want to keep doing what they are already doing.

Second Law - Acceleration is produced when a force acts on a mass. The greater the mass (of the object being accelerated) the greater the amount of force needed (to accelerate the object).
Force = mass x acceleration

Third Law – for every force acting on an object, there is an equal but opposite force pushing back. A rocket pushes gases out very quickly which results in a large force that pushes the rocket in the other direction. (two people on skateboards; in vectors left is negative force, right is positive)

<u>Equations</u>

Pressure = force/area   Thrust = mass x velocity (thrust α velocity)

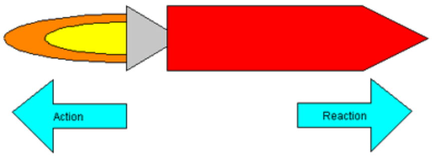
<u>Rocket Design</u>

Add ballast to give the rocket weight. Ballast can be any material that provides weight for the rocket and ensures the rocket can coast once it is launched.

Use Playdoh or clay as ballast as it is soft, malleable, and unlike pebbles or marbles, won't fall out or scatter when the rocket launches.

Determine the centre of gravity / balance by balancing it on your finger. Tie a 1m piece of string around the centre. Swing it around in a circle and see if it keeps pointing forwards.

Let's study how a rocket works to understand Newton's Third Law.



The rocket's action is to push down on the ground with the force of its powerful engines, and the reaction is that the ground pushes the rocket upwards with an equal force.

1) A cow was walking. Newton stopped it. Cow stopped. He found his first law-

"An object continue to move unless it stopped"

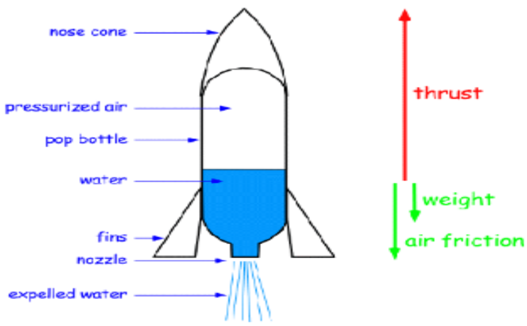
2) He gave a FORCE by kicking the cow. It gave a sound "MA!!" He formulated 2nd law-

"F=MA"

3) The cow gave kick back to Newton and he got 3rd one-

"Every action has an Equal & Opposite reaction"

http://brijeshgupta.blogspot.co.nz/2011/01/story-of-newtons-law-comedy.html



PET Bottle Water Rocket Diagram