SCIENCE EDUTAINMENT I: GUARANTEED ENGAGEMENT IN CHEMISTRY

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Globally students show less interest in the physical sciences due to a lack of engagement, relevance and connection with their interests. So that is our challenge!
In this session we will cover simple, practical chemical activities and demonstrations that will engage and connect!

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1. Turmeric powder's greatest secret

Goldenrod paper turns bright red when dipped in bases (ammonia, sodium bicarbonate, washing soda) and turns back to its normal color when dipped in acids (vinegar, lemon juice). Use the paper to test the acid-base nature of household chemicals, introduce acid-base indicator concepts or study reversible reactions and equilibrium shifts (as predicted by Le Chatelier). Goldenrod paper's yellow colour is obtained from a dye that is found in turmeric powder (curry)! It reacts reversibly with acids & bases producing visible colour changing products.

2. Hydrogen gas in the kitchen

Hydrogen, the gas that holds the key to carbonless combustion, can be easily prepared from household chemicals. In this demonstration aluminium foil and drain cleaner (sodium hydroxide (NaOH)) react:

$$2Al\ (s) + 2NaOH\ (aq) + 2H_2O \text{ ---> } 2NaAlO_2\ (aq) + 3H_2 + energy$$

Sodium aluminate, hydrogen gas and heat are the reaction products.

3. A Jumping Pringles can

The hydrogen gas from a balloon replaces the air inside a Pringles can. The can has a small hole at the top and is positioned vertical on a bench top or floor. When lit, the flame and can resonate and then the gas mixture combusts to produce water and energy.
Safety: Ear protection, goggles!

$$2H_2\ (g) + O_2\ (g) \text{ ---> } 2H_2O\ (g) + energy$$

4. Cotton wads and Ping Pong balls carry the same genes!

Natural plant fiber is known as cellulose. When nitrated and dried, the cellulose in cotton is turned into cellulose nitrate (or nitro cellulose, gun cotton, flash cotton) . Having its own source of internal oxygen, the gun cotton easily completely combusts in a flash of light. And ping pong balls? Well - they are made from "celluloid" the commercial name for cellulose nitrate. Beware!

5. Amazing polymers

5.1 Super Absorbent Polymers (SAP)

Sodium polyacrylate is one of only a few man-made polymers that are hydrophilic. The SAP has a high concentration of sodium or potassium ions which attract water through a process known as osmosis. It is a very important driving force in nature. As a result of absorbing the water, the SAP turns into a gel. By sprinkling table salt onto the gel, the reverse osmotic

process is favoured. Water now passes through the gel membrane to the outer higher salt concentration. It is the well known baby nappy powder. Distilled water is far better absorbed than babies' urine that contains around 0.9% salt.
Super absorbent polymers act like giant sponges. Some can soak up as much as 500 times their own weight in water!

5.2 Ghost Pebbles & Expanding Gel Spheres
Light changes its speed when it passes into a less dense / denser optical medium.
This causes the light rays to bend (refract). The solid ghost & gel sphere crystals refract light when it enters and leaves the crystals. Furthermore, the various planes of the crystals scatter the refracted light at different angles.
But . . .
When left in water, the fully gelled super absorbent crystals contain up to 95% water, so they have the same optical density as water. This minimizes refraction when submerged in water and the crystals & spheres become invisible.

Both can be coloured using food dye and be dried and reused. The molecules exhibit some extraordinary volume increases. The gel spheres expand from 113 mm^3 to 33,512 mm^3. That is more than 29000% !!!

5.3 Instant Expanding Snow
Instant snow is a sodium salt of a crosslinked polyacrylic acid. It is used as artificial snow on ski slopes and film sets. It easily expands to 40 times its original volume or can soak up water to more than 100 times its own mass. Industrially it is used for spill containment and as blood absorber in hospitals.
The crosslinked molecules have a high sodium content and absorb water readily through an osmotic process, expanding as the water moves in. The snow will shrink as it loses water over time but a fine water mist can reset the volume.
Can be dried & reused.

5.4 Instant Wet Snow
Wet snow is a superabsorbent polyacrylamide polymer. Simply add 15 ml powder to 1 liter water and stir to get a fantastic snow-like polymer that has a very slippery feel. It is used in agriculture as water retainer in soils and absorbs large quantities of water and nutrients. Advantages for agriculture are numerous: it increases water holding capacity of soils for several years, reduces the leaching of fertilizers, reduces evaporation and aerates the soil.

5.5 Thermoplastic Polymers: Poly caprolactone
Thermoplastics are polymers that can be heated and reformed over and over. **Poly caprolactone** is a great example of a thermoplastic as it melts conveniently at 58 to 60 °C. After heating, it can be shaped by extrusion – that is forcing it through a die. The heated polymer can also be poured or pressed into a mould.

5.6 Thermoset Polymers: Mushrooms in Minutes
Thermoset polymers' molecules form cross linkages when they are heated. This creates a rigid, permanent structure.
The 'Mushrooms in Minutes' pack produces a spectacular demonstration when two liquids react to form a rigid polymer structure in an exothermic reaction. The end product is **polyurethane** and represents a 25 times expansion of the original volumes with a density of only 0.032 g/

cm^3. Adding tiny air pockets to a polymer lowers the density of the polymer and produces polymer "foam" with better insulation, absorption and floating properties.

6. Hydrophobic sand

Hydrophobic sand is simply ordinary sand that has been exposed to the vapours of a silicon compound known as **trimethyl hydroxysilane**. This silicone compound is a covalent compound but since it has a backbone consisting of C and Si atoms (similar type of atoms), it is non-polar. Water on the other hand is a polar covalent compound as it is made up of hydrogen and oxygen atoms (different atoms) that do not share their bonding electrons equally.
It is a well-known fact that non-polar and polar covalent compounds have no affinity for each other - a generalization that has lead to the expression: "Like dissolves like". And therefore the treated sand is not "wetted" by the water.
Substances that are attracted to water is "hydrophilic". A substance repelled by water is known as "hydrophobic". Regular sand grains are attracted to water as they have areas that are polar and non-polar.
Other well-known hydrophobic substances are oil, silicone lubricants, a duck's feathers and Scotchguard® spray.

7. Water: An amazing chemical

It takes a lot of energy to raise water's temperature. This is due to its inter molecular hydrogen bonds. Water roughly requires 10 times more energy than iron to raise its temperature through $1^{\circ}C$. In these two demos we will look at water's insatiable demand for energy and its huge energy storage capacity.

7.1 Light a match with water

7.2 Water's heat capacity

8. The Soft Drink Can & The Activity Series of metals

The Activity Series of metals provides information about the ability of one metal to replace another in solution. Aluminium, for instance, will displace from solution copper ions as copper is below it on the list.
Soft drink cans are lined with an internal plastic coating so the aluminium metal is not in direct contact with the acidic liquid. In this demonstration a fine file or screwdriver is used to remove the liner around the inner circumference of the can. A solution is prepared using 3 teaspoons of copper(II) chloride in 250 ml water. This is poured into the prepared can and left to stand for 5 minutes. Check that the solution is above the scratched level. The aluminium is "corroded" through electrochemical action. A single displacement reaction takes place and only the paint holds the two parts together.

$$Al\ (s) \ + \ Cu^{2+}\ (aq) \ \text{---}> \ Al^{3+}\ (aq) \ + \ Cu\ (s)$$

Carefully drain the solution from the can and break the can in half with a slight wrist action. Look for the pure copper formed on the can.
Substitute: Copper(II) sulphate with table salt (NaCl). Cl^- acts as catalyst.
Safety: Copper and its solutions are toxic, corroded can ends are very sharp!

9. Dust Explosions

It is a well-known fact: Increasing the surface area of a substance greatly increases its rate of reaction.

A milk can or large coffee can is fitted with a plastic tube and film canister. The tubing and canister is held in position with silicone. A candle is positioned next to the central canister. Three teaspoons of **Dusting Sugar** (or lycopodium powder, "dragon's breath") is added to the canister. The candle is lit, the plastic or cork lid is positioned and on a count of three the sugar is blown into the flame. The gas pressure and flame should send the lid flying.
Any fine combustible powder can act almost explosively due to its large surface area. Dust explosions occur in mines, grain elevators and confectionery factories.
Safety: Stay clear of flammable material.

10. Piezo igniters, hair spray & combustion engines

A piezo igniter consists of a small, spring-loaded hammer which, when a button is pressed, hits a quartz crystal. Quarts is piezoelectric, so it creates a voltage when deformed. A simple gas combustion chamber will be demonstrated that uses hair spray (butane) as fuel. This will be linked to the internal combustion process in the motor car's engine.
Safety: Use only low mass projectiles.

11. Maximizing the Cola / Mentos Eruption

Soft drink bottles are filled with water solutions super saturated in CO_2 gas. The gas is mostly present as bicarbonate and carbonate ions in solution. By providing "nucleation sites" on Mentos candies' surfaces, the gas formation reaction is favoured and copious amounts of gas forms rapidly. Dissolving CO_2 gas in water is an exothermic process, so heating the Cola will enhance the gas formation in the reverse process.