Making Sense of Science

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Science You Can Do At Your Desk

Hi! Today we're exploring some advanced science topics using ordinary stationery supplies.

Measuring the wavelength of a laser.

Most offices would have some business cards, sticky tape and a laser pointer laying about. By joining two cards side by side at the corners, one can create a very narrow air gap between the cards. I suggest using a slip of paper to set the width of the gap, then removing it after the cards are secured together. Now shine the laser pointer through the gap between the cards and onto a dark surface a meter or so away. This works best in dimmed light (tell your boss you're helping save electricity). If the gap between the cards is oriented vertically, you will see something like this:

What's happening here? Light from the laser is exhibiting its wave-like properties by creating this interference pattern. All light consists of waves of electric and magnetic fields rippling along through space. How big are these waves? You can work it out if you know how wide the gap is between the cards. The wavelength of the light is to the width of the gap as the distance between spots is to the distance from the cards to the wall.

Or you can look up the wavelength of red laser pointers on Wikipedia and use that information to measure the width of the gap. For example, if the bright spots are on average 5mm apart (centre-to-centre) and the cards are 1m away from the wall, and since the wavelength of red laser light is 0.00066mm, then the gap must be 0.13mm wide.

Polarization of Light

Do you own a pair of polarized sunglasses? Put them on and try to look at your LCD computer monitor, LCD calculator display, mp3 player, GPS navigation device, digital watch, PDA or mobile phone display. If it's your computer monitor, tilt your head from side to side at least 45 degrees, or rotate the object with the LCD display switched on. Does the display sometimes go completely dark? If not, then you don't have polarized sunnies.

This happens because Liquid Crystal Displays (LCDs) utilize polarization of light. Light waves are oriented either vertically, horizontally, or in any combination of directions. A polarized filter such as sunglasses only lets through light with a certain orientation. Light entering an LCD display passes through a polarized filter, reflects off the backplane, and easily exits again through the same filter. But if the liquid crystal medium has an electric field applied to it, it re-orients the polarization of any light passing through. The light that came in through a polarized filter then finds itself unable to get out through the same filter. What you see is a dark segment where the light seems to have disappeared. Back-lit color LCD monitors are a bit more complicated, but the same general principle applies.

Why do we even need sunglasses that do this? Light acquires a slightly horizontal polarization when it is reflected off the water, the roads, a car's rear window etc. Therefore vertically polarized sunnies block out more reflected glare and make it easier to see on sunny days. Just remember to take them off when you sit down in front of your computer.

Otherwise you could be making an unnecessary and very embarrassing call to tech support. (This has happened.)

Rotational Stability of Various Confectionary Items

I have researched many kinds of chocolate confectionaries while working in offices, and I can say that "plain" M&M's (no peanut) are the best for present purposes. Place a plain M&M (any colour) on a hard level surface, and give it a brisk spin using your thumb and finger. Initially (if it doesn't fall on the floor) it will spin flat. But if given a fast enough spin, it will soon defy gravity, stand up and spin on its edge!<

Stability means being in or seeking the lowest energy state for a given set of conditions. An egg in a bowl tries to seek the lowest gravitational energy state by rolling towards the centre of the bowl, where it will safely remain. An unstable situation can be made by turning the bowl over and placing the egg on the outside of the bowl. This time the egg seeks lower energy states by rolling *away* from the centre of the bowl, and ends up a gooey mess on the floor. Things become even more unstable if your partner sees this before you can remove the evidence.

Back to the M&M: Rotational stability means that for a given amount of rotating momentum (or mass in motion), rotation seeks the lowest energy state. By a fluke of geometry, it happens to take less energy for the M&M to spin on its edge than it does to spin flat. Consequently, it likes to stand up to spin. For more details, see this pdf document. Warning: May contain Algebra. (For anyone who may be allergic.)

How is this in any way useful in real life? Three ways. First, satellites often need to spin while orbiting the earth, so aerospace engineers design them to spin around their most stable rotational axis. But when that's not possible, the satellite must be equipped with extra gear and sensors to continually adjust and maintain the unstable rotation. Second, machinery rotating at high speeds must be designed with stability in mind. Inventors are often flummoxed by the unexpected things that happen at high rotational speeds, because advanced topics like this aren't usually covered at Inventing School. Third, you can win bets by telling people that the amazing power of your brain will cause an M&M rise up on its edge and stay there for several seconds.

Solar Energy Absorption

Most offices have yellow sticky-notes, bright desk lamps and black felt pens. With these items you can gain valuable insight into solar energy absorption.

Begin by drawing a solid black square 2 cm in size near one corner of a pad of 3-inch yellow sticky-notes. Hold the pad with the black square directly under a bright desk lamp (note: this does not work with fluorescent, compact fluorescent, or LED lights). After about 10 seconds, feel the pad with the inside of your wrist, which is usually very sensitive to temperature. The black spot will feel noticeably hotter than the unmarked areas of the yellow pad. Why? Darker colours absorb more light, which is why they are called dark. Now, what colour do you want your next house or car to be?

A university professor once argued with me that painting something black has (in theory)little or no effect on the temperature it attains when left out in the sun. This simple test shows that there certainly is a difference. It also shows that although in theory there is no difference between theory and practice, in practice there usually is. While professors with PhD's are very useful, you can often get there faster with an experienced Research Engineer.

Electric Motor Using Spare Office Supplies

With some blu-tak, a couple of paper clips, a fridge magnet, some enameled wire and one "AA" battery, you can make your own electric motor while sitting at your desk. No, it wasn't a slow day when I figured this out. I had actually been assigned to create some engineering activities like this for schools. For full instructions, I refer you to this pdf download . There isn't room for it here, and some people will already tell me this edition is too long!

Anyone can do science almost anywhere, and it doesn't have to cost a billion dollars. I hope you enjoyed this brief journey into Stationery Science.

Regards,

John

Next time: Create a winning Innovation Culture in your organization. Its survival may depend on it.

See John in person live at the Gingin Observatory (Western Australia), March 27 2009. "Moon Landing Hoax Theories: The Real Evidence." Bookings essential. Hurry - this event will sell out! Ring (08) 9575 7740.

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