Victorian Physics Teachers' Network

Laboratory Technicians Workshop

Camberwell Grammar School
Wednesday 13 September 2023.

Man Lam
Mount Alexander College

Neil Champion
Science Consultant

Title	Equipment			Tips	
	Name	**Supplier**	**Cost**	**How to set up**	**Troubleshooting**
Primary colour light show (poor school version)	3 x LED flood lights: blue, green, and red cellophane	LED flood lights: Bunnings; cellophane: $2-Shop or Officeworks	LED flood light $29.44ea; cellophane, coloured $1.5ea.	wrap the primary colour cellophane on the Led lights, make sure the lamps will not get too hot to melt the cellophane. Preferably use power extended board with individual switches so that individual colours can be switched off without the need to plug and unplug.	If the LED is not powerful enough or the room is not dark enough, place the lamps closer to the screen.
Notes	Primary colour show. It is to clarify that primary colours are red, green and blue not as arts teachers suggested, yellow, blue and red. Yellow was clearly created so it is not a primary colour. Even for colour subtraction, the correct colours are, magenta, cyan and yellow. Not red or blue.				
Vic Curric.	Physical Science (9/10): Light can … disperse to produce a spectrum which is part of a larger spectrum of radiation.				
VCE	N/A				

Vortex cannon	smoke(fog) machine; smoke machine fluid; big bucket; elastic string; silver wrapped light reflective wall insulation; paper cups	Smoke machine: Bunnings or Jaycar; Bucket: Bunnings; Elastic string; Bunnings; builders' silver insulation sheet: Bunnings	Jaycar smoke machine & fluid, $179+$30; bin, $10; elastic string, $5; silver insulation sheet, $31.80.	Use a hole saw (biggest size is OK) to drill a hole in the plastic bin. If you need to make the hole smaller, cover it with cardboard. Use duct tape to attach silver insulation sheet to the bin. Use elastic string to make a mechanism so that the sheet will bounce inward.	Although you can use a black bin bag for the film, but it is very easy to get ripped. Building sheets are much stronger and will last years.
Notes	Vortex cannon: When I made this many years ago, I was trying to clarify the concept of contact and non-contact forces. Many students just thought that 'not touching' is non-contact, for example, if you blow a paper with your mouth, they see this as a non-contact force.				
Vic Curric.	Physical Science (7/8): Change to an object's motion is caused by unbalanced forces acting on the object ; Earth's gravity pulls objects towards the centre of Earth. Physical Science (9/10): The explanation of the motion of objects involves the interaction of forces and the exchange of energy and can be described and predicted using the laws of physics.				
VCE	U1AoS2: Motion.				
Polarizer tube	2 x A4 polarizer sheets; 50 mm or larger acrylic transparent tube; ping pong ball	Arcylic tube :- Aliexpress or ask your arts department, Polarizer sheet: - Aliexpress or extract them from some old LCD monitors	2 x polarizer sheets (glueless), $30; acrylic tube, $15.	Roll two crossed polarizers and place inside the tube. If the polarizers cross each other, the invisible disc will be thicker.	No black disc in the middle: Make sure you have two polarizers cross each other. Glueless polarizer sheets are much easier to roll.
Notes	Polarizer tube: This was a permanent display in the reception at the Synchrotron. I was so impressed by it so I made one for myself.				
Vic Curric.	Physical Science (7/8): The properties of sound [light] can be explained by a wave model				
VCE	U1AoS1: identify all electromagnetic waves as transverse waves travelling at the same speed, c, in a vacuum … U2Aos2#2.8: Physics of Human Vision. investigate sunglasses including the function of polarised lenses, photochromatic lenses and the benefits and possible damaging effects of tinted lenses				

Coherer	pure DC power supply or battery pack; M6 bolt; 6mm tube; iron filings; copper wire	DC power supply: AliExpress (get 30V 10A - it can be used in many other experiments); thick copper wire: - Science Supply or strip one from single core electric cable from Bunnings; iron filings; 6mm bolt and 6mm PVC pipe	DC power supply, $120	YouTube search for "Ludic Science, Coherer" or just "coherer"	It is on all the time: most likely you added too much iron filings (you need just a few grains, ~10-30 grains are enough. A rippleless DC supply is a must - the common IEC lab one has a 'lumpy' output and can't be used. If you can't afford a constant DC power supply, use batteries.
Notes	Coherer: This is similar to the Hertz experiment to show EM wave.				
Vic Curric.	Physical science (9/10): The interaction of magnets can be explained by a field model; magnets are used in the generation of electricity and the operation of motors				
VCE	U2AoS2#2.12: AC electricity charge a DC device. U3AoS2: Field Models				
Light AM modulation	Al-cased LED torch; a small solar panel; old stereo	Any metal case LED torch will do the job, can get it from supermarket or Bunnings; small solar panel: Science Supply; old stereo: - pick from the street or eBay or Facebook	Torch $7; Stereo from $0 from Marketplace to $250 from JBHiFi	File down the bottom opening of the metal case torch. Connect a wire to the anode of the battery pack. Another wire connect to the case. Do not turn the torch. If you short the two wires together and the torch lights up, it is good, otherwise, check the connection again. Then	Do not use red LED torch. They may not be powerful enough to drive the solar panel to provide a voltage. Another possible problem is that your audio source is not powerful enough. Use a stereo instead of your phone.

		Marketplace. Prefer to have powerful one.		connect the wires to a stereo audio output. When you play music, you may need the light flashed quickly. Then you connect the input of a loudspeaker with a solar panel. Then point the LED light to the solar panel. You will then hear music from the speaker.	
Notes	Light AM modulation: This demonstrates the concept of amplitude modulation (AM). Many students think AM just refers to a bandwidth of EM waves. They do not realize that AM is actually a way to transmit the signal, but the traditional AM radiowaves just use certain bandwidths at the very beginning of broadcasting due to its long wavelength.				
Vic Curric.	N/A				
VCE					
Moon phases	polystyrene balls x 8 50 mm and one bigger one say 100 mm ball; poly black paint, yellow paint; large polystyrene sheet	Polystyrene balls: $2 Shops or Spotlight; get a glue that will not attack polystyrene e.g. hot glue gun etc.	Polystyrene, $20; Paint, ask your school arts department for free or $2 shop around $10	Cut a big hole in the middle of a cardboard sheet. Glue a Yellow sun on the cardboard. Then glue the black and white moon on the cardboard surrounding the middle big hole. Make sure the while side faces to the Sun.	There is a weakness in this model. This model shows there will be an eclipse of the Sun and an eclipse of the Moon every month. (The Moon's path is tilted at an angle relative to the Sun's equatorial plane)
Notes	Moon phases: I made this for my daughter who is in primary school. They were taught moon phases, day and night etc.				
Vic Curric.	Earth & Space (7/8): Predictable phenomena on Earth, including seasons and eclipses, are caused by the relative positions of the Sun, Earth and the Moon.				
VCE	N/A				

Ring magnet to show vortex	a ring magnet (from microwave oven); salt and pepper; power pack; Al foil	There are two ring magnets in most microwave ovens that you can pick from street but remember to short the cap before doing anything after you open the microwave oven case; Al foil and DC power supply like batttery pack etc	Ring magnet Marketplace $1-5 each.	Use glue to attach a piece of Al foil on the top of a ferrite magnet. Make sure the foil covers the inner side of the ring magnet. Put the ring in a a petri dish or small tray. Add a bit of NaCl or $NaHCO_3$ in the middle. Add H_2O to the middle of the ring & connect the foil to a DC supply. Touch the other electrode to the middle of the ring. The solution should start turning. Black pepper powder in the middle hole for easier observation of the fluid movement. Change the polarities or flip the magnet to observe the change of direction of the vortex. After some time, the solution may get cloudy if Al foil and salt are used. Aluminium chloride is not conductive, so change your solution if you need to run the experiment for long.	Perhaps, using an overhead projector can improve the visibility as the ring is quite small. I reckon it is possible to use Helmholtz coils to provide a vertical magnetic field. But you still need to make a ring/plate by aluminium foil to create a horizontal electric current such that the fluid will move horizontal and perpendicular to the direction of the current. I have not tried this idea myself … yet!
Notes	Ring magnet to show vortex. Just another alternative way to show Lorentz force.				
Vic Curric.	Physical science (9/10): The interaction of magnets can be explained by a field model; magnets are used in the generation of electricity and the operation of motors				
VCE	U3AoS2: describe … magnetism and electricity using a field model				

Bernoulli Gun	electric pump (the more powerful, the better); packaging foam; PVC pipes and joints	electric pump:- You may try any electric pump you already have or any air compressor from Bunnings, PVC pipes and joinery: Bunnings (I used 50 mm tubes). Packaging foam: Spotlight or any package materials you have handy	Bunnings plumber section <$50. And in the tool section to get a deburring tool and tube cutter tools, $50 (will save you a lot of time)	Connect the PVC tubes and insert the pump inside the tube. The polystyrene balls should start to shoot out. You may need to vary the length of the side tube. If too long and your pump is not powerful enough, the polystyrene balls may not be sucked up.	The polystyrene balls are too big or jammed the tube. Use smaller balls. And if your school can afford, get gas compressor (~$200) is the best. Gas compressor can do a lot of other experiments and not a waste.
Notes	Bernoulli gun: I think year 11 needs to learn Bernoulli's equation.				
Vic Curric.	Physical Science (9/10): The explanation of the motion of objects involves the interaction of forces and the exchange of energy and can be described and predicted using the laws of physics.				
VCE	U2AoS2#2.3: How Heavy Things Fly. Explain the production of aerodynamic lift with reference to: (i) Bernoulli's principle and pressure differences (ii) conservation of momentum and downwash				

One ring to rule them all	Old stereo, active powered speaker with 3.5 jack, i.e. the one needs to be plugged in the wall or need a battery, air coil (50 turns, 2A version, IEC EM1915-020), *2, iron rods (from restore stands) *10, restore stand bases (thick one)* 5 , some electric wires	old stereo: eBay or Marketplace or JB HiFi if your school can afford it; the air coil: you can order them from Science Supply but these are not listed in their website, you need to send an email to ask; some long iron bars – retort stands can do the job.	Air Coil (the technical name is Helmholtz coil) $100 each - remember to get 2 x 2A version; Stereo $0 from Marketplace to $500 from JBHiFi	Connect the stereo audio output to a Helmholtz coil. The other Helmholtz coil connect to a speaker. Place the coils close to each other. You may also insert iron bars inside the coils to observe the change of the loudness. Or insert different materials between the coils to see which materials are the best to block the magnetic field.	Use stereo instead of phone. We need a powerful signal. To block the magnetic field, you may need a few thick retort stand bases. Quite an easy setup. A pair of Helmholtz coils will provide a very good uniform magnetic field over a relatively large volume. This arrangement can be used for many other applications. To create a uniform magnetic field, the diameter of the coils must be at least 1.5 times the distance between the coils. In this demonstration, the gap between the coils is not crucial.
Notes	One ring rules all: This is another one demonstrating transformers and the use of iron cores inside the coils, as well as demonstration of magnetic shielding. Unlike Light AM modulation using EM waves, this one uses a magnetic field to transmit signals.				
Vic Curric.	Physical science (9/10): The interaction of magnets can be explained by a field model; magnets are used in the generation of electricity and the operation of motors				
VCE	U2AoS2#2.12: AC electricity charge a DC device. U3AoS2: Field Models				

High frequency open circuit	One electronic signal generator; 10 m or more wire	digital signal generator capable of generating waves up to a few megahertz; Some long wire around (20-30m):- Jaycar or Science Supply	Signal generator (AliExpress $160)	Connect the LED with the 10m wire in a complete circuit without any power source. Then connect one leg of the LED with the positive input of the signal generator and leave the ground input of the signal generator open. Ramp up the frequency until the LED lights up itself.	You need to have decent signal generator. A good signal generator can also be used for many other experiments, and it will be a good investment.
Notes	High frequency open circuit: stray capacitors play an important role. Perhaps, it just shows the kids that AC is very different from DC.				
Vic Curric.	Physical science (9/10): Electric circuits can be designed for diverse purposes using different components; the operation of circuits can be explained by the concepts of voltage and current.				
VCE	U2AoS2#2.12: AC electricity charge a DC device. U3AoS2: Field Models				
PDLC	Polymer - Dispersed Liquid Crystal	PDLC: Aliexpress	Aliexpress, $21	Demo only. Don't let students destroy the film.	Make sure you turn off the PDLC power after use. It draws quite a lot of power and can drain the battery in a relatively short time. Remember remove the batteries from the case, if it is not to be use for a long time. PDLC may become popular in open office, toilet, bathroom.
Notes	PDLC: An application of electric fields. Perhaps, it can be related to LCD monitors but with colours.				
Vic Curric.	N/A				
VCE	N/A				

Faraday's Motor	Strong Nd magnet; retort stand; copper or Nichrome wire; DC power supply, salt or $NaHCO_3$; electric wire	retort stand: Science Supply; metallic paper clips; IEC power pack, or batteries pack; Nd magnet: Science supply or AliExpress - the bigger the magnet, the easier to setup.	Science Supply 15 x 10mm, $8.50	Put a magnet on the base of the retort stand. Hang a metal wire just above the magnet. Then put a bucket of water with salt. Place a piece of Al foil in the solution and hanging outside the bucket. Connect the wire and the Al foil with a DC supply. You may need to give a little kick to start the motion.	The wire may not move freely. Make sure the wire is non-magnetic otherwise, it will just be attracted by the magnet in the middle and not able to move around. I use solder wire, fuse wire or copper wire. With use, Al / NaCl solution may get cloudy, so change the solution (also when the conductivity reduces). Fuse wire with high current density may burn out, but it turns faster than other types of wires. Copper wire is good but will form a green oxide after some time.
Notes	Faraday's motor. The first electromagnetic motor. Many physics teachers would be interested to show it to their Year 12 kids.				
Vic Curric.	Physical science (9/10): The interaction of magnets can be explained by a field model; magnets are used in the generation of electricity and the operation of motors. Physical Science (9/10): The explanation of the motion of objects involves the interaction of forces and the exchange of energy and can be described and predicted using the laws of physics.				
VCE	U3AoS2: Field Models: investigate and analyse theoretically and practically the generation of electromotive force (emf) including AC voltage and calculations using induced emf: $\varepsilon = -N\frac{\Delta\Phi_B}{\Delta t}$, with reference to: (i) rate of change of magnetic flux (ii) number of loops through which the flux passes (iii) direction of induced *emf* in a coil				

Mapping electric field with ripple tank	Sodium bicarbonate; ripple tank; grid paper	Old ripple tank with grid marking or attach a clear grid under the glass surface of the ripple tank; Sodium bicarbonate or NaCl; multimeter and leads	You should have several lying around, $0; Ripple tank 40 cm x 40 cm Science Supply, $280.	Place two straight Al angles in the ripple tank parallel to each other. Add salt or sodium bicarbonate solution into the tank. Connect the angles to a 12V DC supply. Then use the multimeter to measure the voltage at different points between the electrodes. Note connect the *com* probe with the ground of the DC power supply.	Make sure you wash the probes and alligator clips with water after the experiment otherwise, they can get rusted.
Notes	Mapping electric fields: This is a very quick way to obtain the data and to map electric fields. Students can explore the effect of different shapes of electrodes.				
Vic Curric.	Physical Science (9/10): Electric circuits can be designed for diverse purposes using different components; the operation of circuits can be explained by the concepts of voltage and current. Physical Science (7/8): [field concept] … Earth's gravity pulls objects towards the centre of Earth Physical Science (9/10): [field concept] … magnets are used in the generation of electricity and the operation of motors.				
VCE	U1AoS3: apply concepts of charge (Q), electric current (I), potential difference (V), energy (E) and power (P), in electric circuits. U3AoS2: Field Model U3AoS2: Effects of Fields. Potential energy changes in a uniform electric field: W = qV, $E = \frac{V}{d}$ U4AoS2: Investigate the field between electrodes, *for example*, with respect to (i) area of constant field (ii) edge effects (iii) solutions of different concentrations (iv) different p.d.across solution (v) different anions and cations (vi) different electrodes				