VCE Physics
Beginning Physics Teachers Webinar - 2020
Resource Package

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VCE Physics
Some Possible Practical Activities

To find out what equipment is needed for each of these activities, listed below, go to this page on the Vicphysics https://www.vicphysics.org/equipment/ where there is a link to a spreadsheet of the list of equipment a school needs to offer the full range of physics practical activities.

In the spreadsheet, there is a worksheet for each area of physics. For each item of equipment in a worksheet, among other descriptors there are numbers corresponding to prac numbers in the tables below for the different Areas of Study.

For example, in the Thermodynamics worksheet, there is the entry:

Item	Essential	Desirable	Shared?	Single item	Class set	Years 7 - 10	VCE	Unit 1 Heat
Thermometer 0 – 250 C by 2.0 C Mercury in glass	●				●	●	●	1, 2, 3, 4, 5, 6

Unit 1 How can thermal effects be explained? Thermodynamics

	Practical Activity	Description	Type
1	Phenomena	Introductory practical activity on heating and cooling phenomena to stimulate curiosity and generate context questions for later assessment, for example: i) Dab metho on wrist, ii) Wet thermometer in front of fan, iii) See 'vicphysics.org' for more	Introductory
2	1st Law	Calorimeter	Experiment
3	Heat Capacity	i) Mixing liquids heated to different temperatures, ii) Adding a heated block to water, iii) Determine the heat capacity of thermos, iv) Use a microwave oven to estimate heat capacity	Experiments
4	Latent Heats	i) Add ice to hot water, ii) Use a microwave oven to estimate latent heat	Experiments
5	Absolute Zero	Absolute Zero from Volume of Gas vs Temp.	Experiment
6	Energy transfer mechanisms	Keeping it Hot – design, build & test a thermos for a plastic cup of hot water from Reverse Art Truck materials.	Investigation
7	EM Spectrum	Spectra from an incandescent light globe as the voltage increases	Class exercise
8	Thermal radiation	Applets on Wien's law and Stefan-Boltzmann Law	IT
9	Energy balance	Simulation of energy flow in the atmosphere	Spreadsheet

Unit 1 What is Matter? Cosmology and Nuclear Physics

	Practical Activity	Description	Type
1	Properties of radiation	Show the range of alpha, beta and gamma radiation	Demonstration
2	Half life	Simulation with dice	Experiment
3	Half life	Measurement of a short lived radioisotope, e.g Protactinium, Caesium 137	Class exercise / experiment
4	Radioactive Decay	Simulation of radioactive decay	Spreadsheet

Unit 1 How do electric circuits work? **Electricity**

	Practical Activity	Description	Type
1	Potential difference	Measure and graph voltage drops around a simple circuit of a battery and two resistors across connecting wires, resistors and the battery	Experiment
2	Ohm's Law	Measure and graph the voltage across the and current through a resistor	Experiment
3	Resistors in series	Measure and graph the voltages across each of two resistor in series, as well as the voltage across the combination for various current values	Experiment
4	Resistors in parallel	Measure and graph currents through each of two resistor in parallel, as well as the current through the combination for various voltage values	Experiment
5	Non-ohmic resistor	Measure and graph the voltage across and the current through a 12 V light globe as the voltage is increased.	Experiment
6	Diode	Measure and graph the voltage across and the current through a diode as the voltage is increased in both orientations	Experiment
7	LDR, Thermistor	Measure and graph the voltage across and the current through an LDR or a thermistor as the voltage is increased.	Experiment
8	Voltage divider	Measure output voltage as thermistor is heated.	Experiment
9	Household wiring	Investigate a 'Wiring in a House Demonstration Board'	Experiment
10	Internal resistance	Measure and graph the voltage across and the current through an old battery under a variety of resistive loads	Experiment
11	Photovoltaic panel	Measure the voltage output and current from a PV panel under a variety of resistive load and light conditions.	Experiment
12	Dissection of an electrical device	Dissect an electrical appliance such as a heater, dryer, iron, etc Note: the power cord should be c	Exercise

These can be packaged as a booklet of activities that students can work through at their own pace.

Unit 2 How can motion be described and explained? **Motion**

	Practical Activity	Description	Type
1	Accelerated motion	Record position vs time of a glider on an inclined air track and generate displacement and velocity vs time graphs	Experiment
2	Complex motions	Use a motion detector to describe actions such as walking. Use video analysis to investigate movement in athletics.	Class exercise Experiment
3	Motion under gravity	Drop a quadratic string, a string with pendulum bobs at distances so that they hit the ground at equal time intervals. Drop 0.5kg and 5kg masses at same time on to foam. Use ultrasound motion detector to display the motion of a bouncing basketball.	Demonstrations
4	Reaction force	Use bathroom scales to investigate the reaction force	Class exercise

		when standing, leaning or in a lift.	
5	Combining forces	Use a Forces table to show vector addition of forces and also components of forces Use a Newton's cart on front bench to show force components.	Class exercise Demonstration
6	Newton's 2nd law	Record position vs time of a glider on a level air track accelerated by a falling mass. Investigate acceleration for a range of values of falling masses and total mass moved. Use a Newton's cart on front bench to investigate how acceleration depends on mass for a constant force.	Experiment Demonstration
7	Hooke's Law	Measure, graph and analyse the extension of a spring produced by various masses.	Experiment
8	Energy transfer and transformations	Measure drop and rebound height of a rubber ball. (GPE, efficiency, KE) Time 10 lifts of a 2.0 kg mass from shoulder level (GPE, Power) Time the run up a flight of stairs (GPE, Power) Measure time and distance of a loaded trolley rolling down a slope (GPE, KE) Time the drop of balls of different densities from roof height (GPE, KE, air resistance) * These can be done as a round robin of short activities	Experiment
9	Momentum in collisions	Measure speeds of air track gliders before and after impact to investigate conservation of momentum. Newton's Cradle	Class exercise Demonstration

Experimental investigations

The sporting impacts of a ball with a bat
The motion of a bungee jumper
The friction of running shoes
The performance of a parachute
The motion of weightlifting
The energy of magnetic collisions
The bounce of a basketball
The motion and energy transfer of a mechanical wind up toy
The physics of walking
The physics of a sprint start
The bounce in track shoes
Kicking a football
Design of car bumper
Shock absorbers
Energy of a catapult

Unit 2 Option 2.1 : What are stars?
Unit 2 Option 2.2: Is there life beyond the Earth's Solar System?

	Practical Activity	Description	Type
1	Solar observation	Observe changes in the sun, note safety concern.	Class exercise / homework
2	Spectral analysis	Observe spectral lines in chemical samples.	Experiment
3	Doppler shift	Show Doppler shift with sound by analogy.	Demonstration

Experimental Investigations

Sunspot activity
Online telescope observations
Spectral analysis of an incandescent lamp
Search for Pulsars through Parkes
Stellar image analysis programs

Unit 2: Option 2.3 : How do forces act on the human body?

	Practical Activity	Description	Type
1	Centre of Mass	Determine the position of the centre of mass of various objects from hammers to humans by various methods	Experiment
2	Compression, tension and shear	Use a range of everyday objects to demonstrate effects of compression, tension and shear. Investigate how the behaviour of living tissue under load compares with common building materials, including wood and metals	Demonstration Experiment
3	Young's modulus	Stretch copper wire to fracture	Experiment

Experimental Investigations

Bending of a beam
Bending of a cantilever
The creep of rubber
Properties of glued joints
Effect of reinforcing
Strength of human hair
Effect of heat treatment on metals and materials

Unit 2 Option 2.4: How can AC electricity charge a DC device?

	Practical Activity	Description	Type
1	Use of a multimeter	Measure and compare AC and DC voltages of a power pack. Measure resistance of several resistors.	Experiment
2	Use of a CRO	Measure voltages of a battery. Measure AC voltages and compare with those of a multimeter.	Experiment
3	Properties of diodes	Measure the forward and reverse bias with simple circuit to give the voltage current characteristics of a diode.	Experiment
4	Rectifier	Use diodes to construct and use both a half wave and full wave rectifier.	Experiment
5	Capacitor	Investigate the charging and discharging of a capacitor, and its use in smoothing AC.	Experiment
6	Voltage regulators	Construct and use a circuit to demonstrate the characteristics of a voltage regulator.	Experiment
7	AC to DC power supply	Construct an AC to DC power supply, use meters and a CRO to diagnose faults, and once working, evaluate its performance, then investigate the effect on the ripple voltage of changing various parameters of the circuit.	Experiment

Experimental Investigations

Frequency response of an AC to DC power supply
Efficiency of an AC to DC power supply

Unit 2 Option 2.5 : How do heavy things fly?

	Practical Activity	Description	Type
1	Measuring lift and drag	Use top loading balances to measure the lift and drag on an aerofoil.	Investigation
2	Bernoulli effect	Place a table tennis ball in an air stream from an air track hose.	Demonstration
3	Propeller thrust	Use a top loading balance to measure thrust from a propeller attached to a DC motor for different values of supply voltage	Investigation

Experimental Investigations

Aerofoil design	Drag of objects in water	When does water flow become turbulent?
Wind problems around buildings	The drop in pressure with fast flow	
	The drag on spheres and other shapes	

Unit 2 Option 2.8 : How to particle accelerators work?

	Practical Activity	Description	Type
1	Electrons in Electric and Magnetic Fields	Use a magnet to deflect an electron beam in a Maltese Cross tube, a paddle wheel tube, a deflection tube and a CRO.	Demonstration
2	Modelling Synchrotron radiation with a laser	Use a laser beam to produce diffraction patterns with fibres of different sizes, two dimensional meshes and gauzes and between two bolts.	Demonstration or class exercise
5	Two Dimensional Diffraction Effects with Microwave apparatus	Model X-ray diffraction through a crystal with microwave diffraction through an array of thumb tacks	Demonstration
6	Modelling X-ray interference in a crystal with microwaves	Model the interference of X-rays from different crystal layers with microwaves reflected from two rows of coins	Demonstration

Unit 2 Option 2.9: How can human vision be enhanced?

	Practical Activity	Description	Type
1	Introductory activity	A series of short exercises on the properties of light that can be done over about two periods, which can be used to generate a set of questions which the study of light will provide answers. See Vicphysics.org for activities and questions	Observation exercise
2	Reflection of Light in a plane mirror	Use a plane mirror to investigate the behaviour of light.	Experiment
3	Reflection of Light in a concave mirror	Use a concave mirror to investigate the behaviour of light.	Experiment
4	Refraction of Light	Use semicircular plastic dish and glass or perspex rectangular blocks to investigate Snell's law	Experiment
5	Refraction of Light in a convex lens	Use a convex lens to investigate the behaviour of light	Experiment
6	Refraction of light in the eye	Remove the optic nerve from a bull's eye, wrap the eye in clear wrap, then view the world from the back. Remove the lens, place on a glass slide and put over text	Demonstrations
7	Optical devices	Investigate the optical properties microscopes, telescopes and spectacles	Investigation

Experimental Investigations

The sensitivity of the eye	Depth of focus of a microscope	Moire fringes
	Caustic curves	Fresnel lenses

Unit 2 Option 2.10: How do instruments make music?

	Practical Activity	Description	Type
1	Types of waves	Use a slinky to demonstrate transverse and longitudinal waves.	Demonstration
2	Samples of sound waves	Use a signal generator and a loudspeaker to produce a range of frequencies and to illustrate human frequency response.	Demonstration
3	Speed of Sound	Use stop watches to measure speed of sound by echo method.	Class Exercise
4	Intensity & Intensity Level	Use a dB meter to measure a variety of sounds.	Class Exercise
5	Reflection of waves	Use a slinky to show reflection of transverse and longitudinal pulses at fixed and free ends.	Demonstration
6	Superposition of waves	Use a slinky to show the superposition of transverse pulses.	Demonstration
7	Standing waves in air	Observe nodes formed between a speaker and a reflections from a hard barrier. Alternative equipment: Sound machine	Demonstration
8	Standing waves in air	Observe sound in a large diameter long plastic tube over a Meeker burner	Demonstration
9	Standing waves in strings	Attach a weighted string to a ticker timer	Demonstration / experiment
10	Standing waves in springs	Use a slinky to show harmonics in stretched spring	Demonstration
11	Standing waves in blades	Vibrate together 3 hacksaw blades of different lengths	Demonstration
12	Standing waves in rods	Hit rods end on while holding at a node	Demonstration
13	Standing waves in air	Observe resonance with tuning forks above a variable length air column.	Experiment
14	Standing waves in air	Blow into the adjustable wooden organ pipe	Demonstration
15	Harmonics	Conduct a frequency analysis of various instruments	Investigation
16	Beats	Use two frequency sources to produce beats and show on a CRO	Demonstration

Unit 2 Option 2.11: How can performance in ball sports be improved?

	Practical Activity	Description	Type
1	Coefficient of restitution	How does the coefficient of restitution vary with ball type, impact surface and speed of impact?	Investigation
2	Friction	Transition from sliding to rolling	Investigation
3	Double pendulum	Tracker analysis of a gold swing	Investigation
4	Drag	Tracker analysis of a falling object	Investigation
5	Magnus effect	Motion of a Magnus glider	Investigation

Experimental Investigations See under Motion above.

Unit 3: How fast can things go? Motion in one and two dimensions

	Practical Activity	Description	Type
1	Circular motion	Investigate how the centripetal acceleration of a revolving rubber stopper, as measured by the number of washers on the end of the line, is affected by changes in radius and frequency. Investigate how the centripetal acceleration of a passenger in a Luna Park ride is related to the dimensions and speed of the ride.	Experiment Excursion
2	Projectile motion	Use ballistics car to demonstrate components. Investigate range, maximum height and time of flight for a range of angles and initial speed	Demonstration Experiment
3	Changes in Potential energy	Use a dropped mass attached to a spring to investigate the transformation of energy between gravitational potential energy, spring potential energy and kinetic energy. Investigate the energy transformation in a Luna park ride.	Experiment Excursion
4	Momentum and kinetic energy in collisions	Measure speeds of air track gliders before and after impact to investigate conservation of momentum and the elasticity of the collision. Newton's Cradle	Class exercise Demonstration
5	Reaction force	Use bathroom scales to investigate the reaction force when standing, leaning against a wall or in a lift. Investigate how the centripetal acceleration of a passenger in a Luna Park ride and determine the value of the reaction force.	Class exercise Excursion

Unit 3: How do things move without contact? Fields

	Practical Activity	Description	Type
1	Satellite motion	Analysis of the Moons of the Solar System	Spreadsheet
2	Coulomb's Law	Dependence of electric force on charge and separation	Experiment
3	Electric Field	Plotting of electric field of various configurations Electric fields in a wire	Experiment Experiment
4	Properties of magnets	Investigate Force between magnets Investigate magnetic field of bar and horseshoe magnets	Demonstration or Class Exercise
5	Oersted's Experiment	Show magnetic effect of an electric current in magnetic field	Demonstration
6	Left Hand Rule	Show magnetic force on current loop Show movement of Al rod on rails with horseshoe magnet Show slow oscillation of loudspeaker cone	Demonstration Demonstration Demonstration
7	Magnetic field of Solenoid	Use current balance kit to determine magnetic field of a solenoid	Experiment
8	Turning Effect in a meter	Investigate meter mechanism with small compass	Class Exercise
9	Model DC Motor	Show motor principle with models	Demonstration
10	Dissection of DC Meter	Dissect a small DC motor then reassemble	Class Exercise

Unit 3: How are fields used to move electrical energy? Electromagnetism

	Practical Activity	Description	Type
1	Electromagnetic Induction	Show generation of induced EMF by magnet in solenoid	Demonstration
2	Model Generator	Use a model generator to demonstrate production of AC and DC.	Demonstration
3	Electromagnetic Induction	Investigate Lenz' Law	Formal Experiment
4	Electromagnetic Induction	Drop strong magnet through an Al cylinder	Demonstration
5	Transformer	Show effect of Turns ratio on voltage and current	Demonstration
6	Transmission Lines	Show the effect of transformers on Power loss and voltage drop	Demonstration

Explanation of the operation of a device

AC synchronous motor	Three phase motor	Loudspeakers	Linear motor
DC shunt wound motor	Alternator	Microphone	Telephony
Magnetohydrodynamics	DC Generator	Relays	Homopolar motor
Industrial lifting magnets	Transformer	Particle accelerators	Magnetic damping
DC series wound motor	Transmission line	Mass spectrometer	Analog meter
Three phase generator	Maglev trains	MRI	

Unit 4 How can waves explain the behaviour of light?

	Practical Activity	Description	Type
1	Introductory activity	A series of short exercises on the properties of light which can be used to generate a set of questions. See vicphysics.org for activities and questions.	Observation exercise
2	Types of waves	Use a slinky to demonstrate transverse waves. Use a ripple tank to demonstrate wave properties	Demonstrations
3	Samples of sound waves	Use a signal generator and a loudspeaker to produce a range of frequencies and to illustrate human frequency response.	Demonstration
4	Speed of Sound	Use stop watches to measure speed of sound by echo method.	Class Exercise
5	Interference	Use a sound source connected to two speakers to produce an interference pattern in front of the speakers. Note nodal positions and measure distances to determine wavelength. Change spacing of speakers and change of nodal positions	Experiment
6	Doppler Effect	Swing a sound source on the end of a rope in a horizontal circle	Demonstration
7	Reflection of waves	Use a slinky to show reflection of transverse and longitudinal pulses at fixed and free ends.	Demonstration
8	Superposition of waves	Use a slinky to show the superposition of transverse pulses.	Demonstration
9	Standing waves in strings	Attach a weighted string to a ticker timer	Demonstration / experiment
10	Standing waves in springs	Use a slinky to show harmonics in stretched spring	Demonstration
11	Resonance in blades	Vibrate together 3 hacksaw blades, various lengths	Demonstration
12	Standing waves in rods	Hit the rod's end on while holding at a node	Demonstration
13	Diffraction of waves	Use a sound source at different frequencies and with speakers of different diameters to observe the amount of spreading Use of a ripple tank to show diffraction	Demonstration
14	Refraction of Light	Use semicircular plastic dish and glass or perspex rectangular blocks to investigate Snell's law	Experiment
15	Total Internal Reflection	Show total internal reflection. Show TIR in optical fibres and light pipes.	Demonstrations
16	Dispersion of Light	Show the colour components of white light. Produce a rainbow with a hose and measure each colour's angle to determine its refractive index.	Demonstration Experiment
17	Polarisation	Rotate one polaroid slide on top of another. Place layers of sellotape between the slides to show colour effects. Place a crystal of Iceland Spar on the OHP, then put a polaroid slide over it.	Demonstrations
18	Diffraction of light	Investigate diffraction of light through red and blue filters with slides of single slit of varying widths	Class Exercise of Experiment
19	Interference of light	Investigate interference of light through red and blue filters with slides of double slits of varying size FARLabs (Online)	Class Exercise or Experiment Experiment

Unit 4 How are light and matter similar? **Light and matter**

	Practical Activity	Description	Type
1	Interference and Diffraction of light	Investigate diffraction and interference of light through red and blue filters with slides of double and single slits of varying size	Class Exercise or Experiment
2	Photoelectric Effect	Discharge of electroscope with zinc plate on top with UV light	Demonstration
3	Photoelectric Effect	Investigate the effect of intensity and frequency of light incident on a metal surface on the energy of ejected electrons	Class Exercise
4	Hydrogen Spectrum	Investigate the energy levels of Hydrogen	Class Exercise
5	Energy gap in LEDs	Investigate the triggering voltage for LEDs producing light of different wavelengths	Experiment

Unit 4: Practical Investigation: Possible topics

Motion of a parachute
Motion of a balloon
Forces and energies of a bouncing ball
Sweet spot of a tennis racket

Energy transfer in a pole vault
Motion on a trampoline
Physics of a sprint start

Forces and energies in stretched rubber
The bounce time of a ball

Efficiency of a cycle dynamo

Efficiency of a DC motor

Sellotape and polarised light
Patterns in stressed materials
Double refraction of Iceland spar

Brewster's angle
Fresnel lenses
Optical activity of sodium chlorate

Light scattering and polarised light

A Sample Units 1 & 2 Course Plan

Unit 1: Thermodynamics: How can thermal effects be explained?

Weeks	Key Knowledge		Activities
	Dot Points	**Action**	http://www.vicphysics.org/thermodynamics.html
1.0			Introductory practical activity on heating and cooling phenomena to stimulate curiosity and generate context questions for later assessment.
	• convert temperature between degrees Celsius and Kelvin	convert	Convert temperatures from one scale to the other.Exp't: Absolute Zero from Volume of Gas vs Temp.
	• describe the Zeroth Law of Thermodynamics as two bodies in contact with each other coming to a thermal equilibrium *	describe	
	• explain internal energy as the energy associated with random disordered motion of molecules	explain	Describe the different forms of energy in each of monatomic, diatomic and multi-atom gases Identify which forms of energy relate to temperature
	• describe temperature with reference to the average *translational* kinetic energy of the atoms and molecules within a system **	describe	* This is over simplification of the Zeroth Law ** Temperature is more accurately related to average *translational* kinetic energy
1.0	• investigate and apply theoretically and practically the First Law of Thermodynamics to simple situations: $\Delta U = Q - W$ *	investigate, apply	Experiments on Energy: i) Calorimetry, ii) Mechanical Equivalent of heat.
	• investigate and analyse theoretically and practically the energy required to: – raise the temperature of a substance: $Q = mc\Delta T$ – change the state of a substance: $Q = mL$	investigate, analyse	Heat capacity: i) mixing liquids, ii) adding heated block to water, iii) heat capacity of thermos, iv) using a microwave oven Latent Heat: i) Add ice to hot water
	• explain why cooling results from evaporation using a simple kinetic energy model	explain	* First Law refers to change in internal energy, (ΔU), not U, and W as Work done *by* the system
1.0	• distinguish between conduction, convection and radiation with reference to heat transfers within and between systems	distinguish	Keeping it Hot – design, build & test a thermos for a plastic cup of hot water from Reverse Art Truck materials.
	• apply thermodynamic principles to investigate at least one issue related to the environmental impacts of human activity with reference to the enhanced greenhouse effect	apply	Introduce an issue based research task to be done partially in class over following weeks, but mostly at home. Outline possible topics with proposals to be submitted the next day. Encourage a team approach with 3 - 4 students per topic.

Unit 1: Thermodynamics: How can thermal effects be explained? continued

Weeks	Key Knowledge		Activities
	Dot Points	Action	http://www.vicphysics.org/thermodynamics.html
1.0	• identify regions of the electromagnetic spectrum as radio, microwave, infrared, visible, ultraviolet, x-ray and gamma waves • describe electromagnetic radiation emitted from the Sun as mainly ultraviolet, visible and infrared • calculate the peak wavelength of the re-radiated electromagnetic radiation from Earth using Wien's Law: $\lambda_{max} T$ = constant • compare the total energy across the electromagnetic spectrum emitted by objects at different temperatures such as the Sun • describe power radiated by a body as being dependent on the temperature of the body according to the Stefan-Boltzmann Law, $P \propto T^4$ • explain the roles of conduction, convection and radiation in moving heat around in Earth's mantle (tectonic movement) and atmosphere (weather)	identify describe calculate compare describe explain	Spectra from an incandescent light globe as the voltage increases Applets on Stefan-Boltzmann
0.5	• model the greenhouse effect as the flow and retention of thermal energy from the Sun, Earth's surface and Earth's atmosphere • explain how greenhouse gases in the atmosphere (including methane, water and carbon dioxide) absorb and re-emit infrared radiation • analyse changes in the thermal energy of the surface of Earth and of Earth's atmosphere • analyse the evidence for the influence of human activity in creating an enhanced greenhouse effect, including affecting surface materials and the balance of gases in the atmosphere.	model explain analyse analyse	A spreadsheet modeling activity of the effect of i) decreased Arctic Sea Ice, ii) increased greenhouse gases
1.0	Revision, Test and SACs		SACs: from: Class presentation for each group's issue based research alongside individual submission, Annotated portfolio of practical activities, Answers to a batch of the initial context questions and/or Test

Total: 5.5 weeks

Unit 1: Electricity: How do electric circuits work?

Weeks	Key Knowledge		Activities
	Dot Points	Action	http://www.vicphysics.org/electricity.html
1.0	• apply concepts of charge (Q), electric current (I), potential difference (V), energy (E) and power (P), in electric circuits • explore different analogies used to describe electric current and potential difference • investigate and analyse theoretically and practically electric circuits using the relationships Q = IT, E = VQ • justify the use of selected meters in circuits	apply explore investigate, analyse justify	Role play with smarties. Experiment with simple circuits. Measure V and I. Do lots of problems
1.0	• model resistance in series and parallel circuits using i) (I–V) graphs, ii) resistance as the potential difference to current ratio, including R = constant for ohmic devices and iii) resistors in series and parallel • calculate and analyse the effective resistance of circuits comprising parallel and series resistance	model calculate analyse	Measure voltages and currents of individual resistors as well as the combinations to discover relationships. Measure resistors with multimeter to confirm relationships. CUPs activities 8, 9 Expt: Series & Parallel Circuits
0.4	• investigate and analyse theoretically and practically electric circuits using the relationships E = Pt , P = VI • compare power transfers in series and parallel circuits • apply the kilowatt-hour (kW h) as a unit of energy	Investigate, analyse compare, apply	Analyse and interpret domestic power bills with and without PV panels
0.7	• calculate and analyse the effective resistance of circuits comprising voltage dividers and potentiometers	calculate analyse	Expt: Voltage Dividers
1.0	• investigate and apply theoretically and practically concepts of current, resistance, potential difference and power to the operation of electronic circuits comprising resistors, light bulbs, diodes, thermistors, light dependent resistors (LDRs), light-emitting diodes (LEDs) • investigate practically the operation of simple circuits containing resistors, variable resistors, diodes and other non-ohmic devices • describe energy transfers and transformations with reference to transducers	investigate, apply investigate describe	Investigate experimentally various circuit elements. including: • Resistance of a Light Globe Filament • The Diode • The Light Dependent Resistor • The Thermistor

Unit 1: Electricity: How do electric circuits work? continued

Weeks	Key Knowledge		Activities
	Dot Points	**Action**	http://www.vicphysics.org/electricity.html
0.5	• model household (AC) electrical systems as simple direct current (DC) circuits • explain why the circuits in homes are mostly parallel circuits • model household electricity connections as a simple circuit comprising fuses, switches, circuit breakers, loads and earth • compare the operation of safety devices including fuses, circuit breakers and residual current devices (RCDs)	Model Explain Model compare	Investigate a Wiring in a House Demonstration Board. Dissect a household appliance
0.4	• describe the causes, effects and treatment of electric shock in homes and identify the approximate danger thresholds for current and duration.	describe	Discuss risks and safety features
0.5	Revision, Test and SAC		SACs: Annotated portfolio of practical activities Test

Total: 5.5 weeks

Unit 1: What is matter and how is it formed?

Weeks	Key Knowledge		Activities
	Dot Points	**Action**	http://www.vicphysics.org/matter.html
1.0	• apply a simple particle model of the atomic nucleus to explain the origin of α, β-, β+ and γ radiation, including changes to the number of nucleons • explain nuclear transformations using decay equations involving α, β-, β+ and γ radiation • analyse decay series diagrams with reference to type of decay and stability of isotopes	apply explain analyse	Demo: radioactive sources Marshmallow nuclei: http://www.lbl.gov/abc/marsh-nuclei/pdf-dwnlds/marsh-whole.pdf Take the particle tour: http://particleadventure.org/ Research a decay chain
1.0	• describe the radioactive decay of unstable nuclei with reference to half-life • model radioactive decay as random decay with a particular half-life, including mathematical modeling with reference to whole half-lives • explain that for every elementary matter particle there exists an antimatter particle of equal mass and opposite charge, and that if a particle and its antiparticle come into contact they will annihilate each other to create radiation. • relate predictions to the subsequent discoveries of the neutron, neutrino, positron and Higgs boson	describe model explain relate	Prac: half-life of dice Prac: half-life of a radioactive source Take the particle tour: http://particleadventure.org/ Compare the duration between prediction and discovery
0.4	• distinguish between the two types of forces holding the nucleus together: the strong nuclear force and the weak nuclear force • explain nuclear stability with reference to the forces that operate over very small distances	distinguish explain	Compare strength and range of the strong and weak nuclear forces Compare the interactions each force describes
0.6	• compare the processes of nuclear fusion and nuclear fission • explain, using a binding energy curve, why both fusion and fission are reactions that produce energy • explain nuclear energy as energy resulting from the conversion of mass: $E = mc^2$	compare explain explain	Calculations of mass difference in fission and fusion reactions using supplied data and then of energy release using $E = mc^2$

Unit 1: **What is matter and how is it formed? continued**

Weeks	Key Knowledge		Activities
	Dot Points	**Action**	http://www.vicphysics.org/matter.html
0.4	• compare the nature of leptons, hadrons, mesons and baryons • describe quarks as components of subatomic particles	compare describe	Describe the family tree of particles Identify examples of each type Compare the mass and charge of various particles Design your own hadron from quarks and give it a name
1.0	• describe the Big Bang as a currently held theory that explains the origins of the Universe • describe the origins of both time and space with reference to the Big Bang Theory • explain the changing Universe over time due to expansion and cooling • explain the change of matter in the stages of the development of the Universe including inflation, elementary particle formation, annihilation of anti-matter and matter, commencement of nuclear fusion, cessation of fusion and the formation of atoms. • apply scientific notation to quantify and compare the large ranges of magnitudes of time, distance, temperature and mass considered when investigating the Universe	describe describe explain explain apply	Show a Brian Cox video Compare the Big Bang model and the Inflation model Describe how model explain how i) the temperature and ii) the size of the universe changed over time since the origin of the universe. Use a poster of the formation of the universe to identify when each of the significant events occurred. Use standard form for data values in the tasks above.
0.3	• explain light as an electromagnetic wave that is produced by the acceleration of charges • describe the production of synchrotron radiation by an electron radiating energy at a tangent to its circular path • model the production of light as a result of electron transitions between energy levels within an atom.	explain describe model	Demonstrations and comparisons: a) radio waves from Van de Graff, Ruhmkoff coil, antenna b) Comparison with X-ray tubes, c) Lines in Spectra as evidence of energy levels
0.3	Revision, Test, Assessment		SACs: Evaluation of a blog discussion from 'The Conversation'. Possible topics: Cost of LHC, Impact of mini black holes, particle physics, early universe, etc. Test

Time: 5 weeks

Unit 2: Movement: How can motion be described and explained?

Weeks	Key Knowledge		Activities
	Dot Points	**Action**	http://www.vicphysics.org/movement.html
1.5	• analyse graphically, numerically and algebraically, straight-line motion under constant acceleration: $v = u + at$, $v^2 = u^2 + 2as$, $s = \frac{1}{2}(u + v)t$, $s = ut + \frac{1}{2}at^2$, $s = vt - \frac{1}{2}at^2$ • graphically analyse non-uniform motion in a straight line	analyse analyse	Various practical activities using timers, motion sensors. Do lots of problems CUPs activities 1, 2, 4
0.2	• identify parameters of motion as vectors or scalars	identify	
1.5	• model the force due to gravity, F_g, as the force of gravity acting at the centre of mass of a body, $F_g = mg$, where g is the gravitational field strength (9.8 N kg^{-1} near the surface of Earth) • model forces as vectors acting at the point of application (with magnitude and direction), labelling these forces using the convention 'force on A by B' or $F_{\text{on A by B}} = -F_{\text{on B by A}}$ • apply Newton's three laws of motion to a body on which forces act: $a = F_{net}/m$ • apply the vector model of forces, including vector addition and components of forces, to readily observable forces including the force due to gravity, friction and reaction forces	model model apply apply	Do 3rd law first, then 1st, then 2nd law. CUPs activity 5, 3, 7 Do problems on free body diagrams Identify some topics involving friction, air resistance and other forces as possible practical investigations for later in the year. Exp'ts to confirm Newton's 2nd Law of Motion, i) $a \propto F$ *for constant m, ii)* $a \propto 1/m$ *for constant F.* Expt on vector addition of forces
1.0	• apply concepts of momentum to linear motion: $p = mv$. • explain changes in momentum as being caused by a net force: $F_{net} = \Delta p/\Delta t$ • analyse impulse (momentum transfer) in an isolated system (for collisions between objects moving in a straight line): $I = \Delta p$ • investigate and analyse theoretically and practically momentum conservation in one dimension.	apply explain analyse investigate analyse	CUPs activity 12 Investigate momentum transfer in collisions, e.g air track Identify some topics involving impacts as possible practical investigations for later in the year.

Unit 2: Movement: How can motion be described and explained? continued

Weeks	Key Knowledge		Activities
	Dot Points	**Action**	http://www.vicphysics.org/movement.html
1.5	• apply the concept of work done by a constant force using: – work done = constant force × distance moved in direction of force: $W = Fs$ – work done = area under force-distance graph • investigate and analyse theoretically and practically Hooke's Law for an ideal spring: $F = -k\Delta x$ • analyse and model mechanical energy transfers and transformations using energy conservation: – changes in gravitational potential energy near Earth's surface: $Eg = mg\Delta h$ – potential energy in ideal springs: $E_s = \frac{1}{2}k\Delta x^2$ – kinetic energy: $E_k = \frac{1}{2}mv^2$ • analyse rate of energy transfer using power: $P = E/t$ • calculate the efficiency of an energy transfer system: η = *useful energy out / total energy in*	apply investigate analyse analyse, model analyse calculate	CUPS activity 11 Round robin exercise of short activities on energy transfer Identify some topics involving energy transfer as possible practical investigations for later in the year.
1.0	• calculate torque: $\tau = r_{\perp} F$ • investigate and analyse theoretically and practically translational forces and torques in simple structures that are in rotational equilibrium	calculate investigate analyse	Identify some topics involving rotation as possible practical investigations for later in the year
0.8	Revision, Test and SAC		

Total 7.5 weeks

VCE PHYSICS ADJUSTED UNIT 4 COURSE PLANNING – 2020 – Updated with released Exam Dates

Study Score Contributions: Exam: 60%, SACs: 40% (Fields: 8%, Electromagnetism: 8%, Motion : 8%, Waves & Light: 5%, Light & Matter: 6%, Prac Inv: 5%)

	Beginning	Topics to be Done	Practical Activities & Other Tasks
TERM 3			
Week 1	13/7	Unit 3 Mid year school based exams	
Week 2	20/7	**Waves and Light:** *Nature and types of waves* Properties of waves, wave equation Superposition, resonance	
Week 3	27/7	Standing waves in strings Diffraction Interference	Resonance in stretched spring demonstration Demonstration with water and sound waves Demonstration with sound waves
Week 4	3/8	Light as an electromagnetic wave Young's double slit experiment:	Interference and Diffraction experiment
Week 5	10/8	Path difference and line spacing Assessment Task	**Assessment: Annotations (5%)**
Week 6	17/8	**Light and Matter:** Diffraction of light Diffraction and resolution	Resolution experiment
Week 7	24/8	Photoelectric effect	Photoelectric Effect experiment
Week 8	31/8	Particle and wave models of light Limitation of wave model in explaining PE effect Wave-like nature of electrons andmatter	
Week 9	7/9	De Broglie wavelength & Photon momentum Line spectra & Energy level transitions	Spectral lines experiment

	Beginning	Topics to be Done	Practical Activities & Other Tasks
Week 10	14/9	Quantised states and standing waves Single particle double slit experiment	
		Topic Test on both Areas of Study	**Assessment: Test (6%)**
TERM 4			
Week 1	5/10	**Analysis and Evaluation of a Practical Investigation:**	Investigation begins
Week 2	12/10	Analysis and Evaluation of a Practical Investigation	Investigation continues
Week 3	19/10	Analysis and Evaluation of a Practical Investigation	Investigation concludes Preparation of Poster or Practical Report **Submission (5%)**
		Revision begins	
Week 4	26/10	Revision	
Week 5	2/11	Revision. Swot Vac	
Week 6	9/11	Exams begin	

Conceptual Understanding Procedures for Physics
An initiative of Monash University
http://monash.edu/science-education/2015/resources/conceptual-understanding-procedure/

What is a CUP?
A Conceptual Understanding Procedure, or CUP, is a teaching procedure designed to aid development of understanding of concepts that students find difficult.

They are constructivist in approach, i.e., they are based on the belief that students construct their own understanding of concepts by expanding or modifying their existing views. The procedure also reinforces the value of cooperative learning and the individual student's active role in learning.

CUPs were developed in 1996 by Dr David Mills and Dr Susan Feteris, School of Physics, at Monash University and Pam Mulhall (now in the Education Faculty at the University of Melbourne) and Brian McKittrick. CUPs were further updated in 1999, 2001 and 2007 by Pam Mulhall and Brian McKittrick.

Examples of CUPs
These are suitable for senior high school and first year university/college. Master copies of both A4 and A3 sheets are provided in Adobe Acrobat format.

Title	**Concepts involved**
1. Driving to Hilary's	Displacement, velocity and acceleration in 1-D.
2. Throwing a hockey ball	Velocity and acceleration during vertical flight.
3. Hitting a golf ball	Action/reaction pairs (Newton's third law). Dependence of motion on net force.
4. Dropping a golf ball and a foam ball	Forces acting on falling objects.
5. Forces on a tin of peaches	Forces on an object resting on a surface.
6. Swinging the billy can	Forces on an object moving in a vertical circle.
7. Rudolph's trouble with Newton's third law	The motion of an object depends on the net force on the object.
8. Hot stuff	Heating and temperature change.
9. What is the current?	The current in basic series and parallel circuits.
10. What is the voltage?	The voltage between points in basic series and parallel circuits.
11. Energy of a soccer ball in flight	Conservation of energy.
12. Momentum in to traffic accidents	Conservation of momentum.
13. Where did the light go?	Reflection and refraction of light at an interface

What does a CUP consist of?
A qualitative question requiring an answer in diagrammatic form is considered in 3 stages:
Individual: Each student thinks about their response to the question on an A4 sheet.
Triplet**:** In groups of three, students discuss their responses and try to reach consensus. The group response is shown on an enlarged version of the question printed on an A3 sheet.
Whole class: The A3 sheets from each group are displayed so the whole class can view them. The teacher facilitates a whole class discussion in which groups explain/ defend/ modify their responses, the aim being to reach a whole class consensus.

How do I use a CUP?
Monash University has prepared a step-by-step guide for using CUPs 'Using a CUP' (pdf 45Kb), or an alternative version (doc 75Kb).

Physics Ideas & VELS Standards: Level 6

The Education Department's website has several pages of teaching ideas, each on different aspects of the topic of Forces, Electricity and Magnetism. Each page has three sections:

- Contrasting student and scientific ideas,
- Critical teaching ideas,
- Teaching activities

The pages are :

- Newton's Laws of Force and Motion: http://www.education.vic.gov.au/school/teachers/teachingresources/discipline/science/continuum/Pages/newton.aspx
- Forces on Passengers (which is included below as an example) http://www.education.vic.gov.au/school/teachers/teachingresources/discipline/science/continuum/Pages/forcepasseng.aspx
- What is Force**:** http://www.education.vic.gov.au/school/teachers/teachingresources/discipline/science/continuum/Pages/force.aspx
- Pushes and Pulls: http://www.education.vic.gov.au/school/teachers/teachingresources/discipline/science/continuum/Pages/pushespulls.aspx
- Forces on Stationary Objects: http://www.education.vic.gov.au/school/teachers/teachingresources/discipline/science/continuum/Pages/stationary.aspx
- Friction as a Force: http://www.education.vic.gov.au/school/teachers/teachingresources/discipline/science/continuum/Pages/friction.aspx
- Forces without Contact: http://www.education.vic.gov.au/school/teachers/teachingresources/discipline/science/continuum/Pages/forcescontact.aspx
- Making things move: http://www.education.vic.gov.au/school/teachers/teachingresources/discipline/science/continuum/Pages/stationary.aspx
- Gravity: http://www.education.vic.gov.au/school/teachers/teachingresources/discipline/science/continuum/Pages/gravity.aspx
- Making sense of voltage: http://www.education.vic.gov.au/school/teachers/teachingresources/discipline/science/continuum/Pages/voltage.aspx
- Electrostatics - a non contact force: http://www.education.vic.gov.au/school/teachers/teachingresources/discipline/science/continuum/Pages/electrostatics.aspx
- Electric circuits: http://www.education.vic.gov.au/school/teachers/teachingresources/discipline/science/continuum/Pages/electriccircuit.aspx
- Magnetism - A non Contact Force: http://www.education.vic.gov.au/school/teachers/teachingresources/discipline/science/continuum/Pages/magnetism.aspx

Each webpage also has links to references e.g:

Gunstone, R and Watts , M (1985) 'Force and motion'. In R Driver, E Guesne and A Tiberghien (Eds) *Children's ideas in science*, Milton Keynes, UK: Open University Press, pp 85-104.

Resources on Forces on Passengers

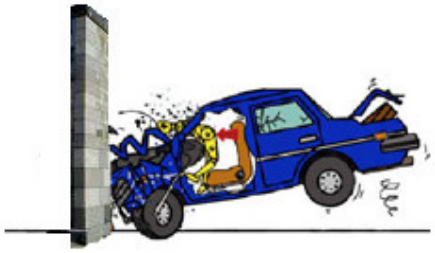
This focus idea is explored through:

1. Contrasting student and scientific views

Student everyday experiences

At this level of conceptual development many middle year students will still hold strong views based on their everyday experiences.

These views are explored in the focus ideas Pushes and pulls and What is a force? (See links above)



Students are sometimes unable to correctly identify the forces that act on them when they travel as a passenger in a train, bus or car. This confusion often originates from the perspective of viewing the vehicle's motion from inside the vehicle.

When a car brakes suddenly, students believe that they are thrown forward by a sudden 'forward' force. See Research link: Mitchell (2007)

Another everyday experience is the apparent sideways force that suddenly appears to act on occupants and objects in a car when the car turns a sharp corner.

Scientific view

When a car brakes, the force from the brakes slows the car but not any unrestrained occupants – they continue to move forward at the speed the car was travelling at just before braking. To the occupant it appears as though they are thrown forward. In fact they continue to move with no new forces acting on them until they encounter a force from the restraining seat belt or air bag.

Seat belts and air bags are designed to apply braking forces to the passengers over an extended period of time so the impact forces on the passengers will be reduced and the chances of passenger survival increased.

Similarly, as a car turns a sharp corner the seatbelt and car seat must push on the passengers to make them change their direction of motion to be the same as the turning car.

2. Critical teaching ideas

- When a car brakes, the car slows down but any unrestrained passenger or object in the car does not.
- The unrestrained passenger or object will be stopped by a force on them from another object like the windscreen, steering wheel or airbag.
- A larger force will slow an object down more quickly.
- An airbag or seat belt is designed to extend the time taken for a passenger to slow down during braking, reducing the forces on the passenger.

See Research link : Mitchell (2007), Loughran, Berry & Mulhall (2006)

Explore the relationships between ideas about forces and motion in the Concept Development Maps - Laws of Motion

For insights into students' alternative conceptions before developing the following see the focus idea link Pushes and pulls.

Activities should be selected that promote discussion of the forces acting on objects that are moving and stationary in everyday life. A central purpose of these discussions is to identify whether the forces are in balance with each other or if they result in a push or pull which changes the object's speed and/or direction.

Students need to move towards an understanding that all the forces are in balance on a stationary object and that any imbalances will cause the object to either speed up or slow down in the direction of the imbalance.

A more difficult understanding is that all the forces are also in balance for any object moving in a constant direction with a constant speed. For example, students more easily accept the idea that the forces on a roller skating student are in balance if the student is standing still and find it harder to accept the idea if the student is roller skating at a constant 12 km/hr along a straight path.

3. Teaching activities

Open up discussion via a shared experience

Attach a rubber band or a length of elastic to a laboratory cart with free rolling wheels. Ask students to predict what will happen if they pull the cart using the rubber band or elastic so it remains stretched by a fixed length. Get students to perform the activity and explain their observations in terms of balanced and unbalanced forces. Why is it difficult to maintain pulling the cart using this method for only a short period of time?

See research link : Gunstone & Mitchell (1998), Loughran, Berry & Mulhall (2006)

Challenge some existing ideas

POE (Predict-Observe-Explain): using the same cart as above, use plasticine to loosely stick a plastic action figure to the cart. Ask the students to predict what will happen when the cart collides at high speed with a stationary brick or another cart. Students should explain what they observe in terms of balanced and unbalanced forces. Discuss the apparent 'forward' force as seen by the action figure in terms of the overall motion of the cart and the different forces acting on the cart and the action figure.

Provide an open problem to be explored via play

Place a round glass marble on a flat table top and invite a student to make it move by blowing on it using a drinking straw. After asking students to identify the forces involved, see if they can then change its direction once it is moving again by just blowing through the drinking straw. Discuss how this would be best attempted.

Focus students' attention on overlooked detail

There are many excellent road safety resources in schools that can be used to investigate the balanced and unbalanced forces at work in vehicle motion and collisions. Identify everyday experiences that students have with bicycles, skateboards, rollerblades, roller skates and scooters. Students are often experts at using this equipment to perform complex tricks but lack the precise language needed to identify the balanced and unbalanced forces and where they act.

Titles of current items from Previous "Vicphysics News"

Resources and Events for Teachers organised by Area of Study with Teaching Strategies first and a large selection of General topics at the end of this list.

Teaching strategies

D50. Student Misconceptions in Physics: Some Useful Resources
D51. Fermi Questions
D91. Some More Fermi Questions
D113. Demonstration Videos for Physics Teachers
D114. Misconceptions: Resources
D115. Girls and Physics
D182. Do instructional videos really improve student learning? Dr Derek Muller at The Perimeter Institute
D188. Video Tutorials for Teachers: Using diagrams and interrogating formulas
D244. 'Teaching High School Physics' A Kindle resource
D251. Conceptual Understanding Procedures (CUPs) back on line
D258 US Websites on teaching strategies and curriculum materials including the Diagnoser
D262 Course Planning Resources for Units 1 & 2 in 2016
D265 Course Planning: Which SACs? Which Pracs?
D266 Rubrics for Assessing Posters
D268 Course Planning: week by week program
D271 PhysPort: Supporting Physics Teaching with Research-based Resources
D275 Institute of Physics (IOP) "Physics Education" Journal: Free downloads of selected articles.
D278 Share My Lesson: An online resource of 1000's of lesson plans
D288 Resources for Flipping Physics
D305 The Science of Thinking
D306 Paul Hewitt's Videos for Physics Teachers:
D308 Flipping Physics: More Resources
D311 How do you start teaching the topic of electric circuits?
D319 Some Resources on Uncertainties and Graphing
D320 Teaching Physics for the first time: Some UK Resources
D339 The Physics Front
D340 Science Journal: The Google App
D341 Adobe app to convert photos to pdf (free)
D342 The Physics Teaching Podcast
D343 Google Jamboard – a 'whiteboard' app.
D345 Accessing Physics Education Research: PERbites
D346 Home Learning Resources and Home Teaching Resources
D347 PhyPhox Physics Phone Experiments
D348 UNESCO Coronavirus School Closures: Solutions
D349 Positive Physics: Online Problem Bank
D350 Interactive Video Vignettes
D351 OpenStax - Publisher of high-quality, peer-reviewed, free textbooks
D352 Adapting Perimeter Institute's Resources for online classrooms
D353 The Living Physics Portal: Online resources for physics course for life sciences
D368 Parallel Pedagogy: Learning the concepts simultaneously : Intro mechanics

Unit 1

Thermodynamics

D85. 'Geothermal Energy from Uranium Deposits' and other physics podcasts from University of Melbourne
D123. CSIRO publication: Climate Change: Science and Solutions for Australia
D144. The Weather of Who We Are: An ABC Ockham's Razor podcast
D156. Free iPad book on Heat Energy for Years 8 - 12 and Free Physics resources from TES
D210 Turn your iPhone into a personal spectroscope.
D360 Teaching Resources for Climate Science
D361 Climate Change resources from Perimeter Institute
D362 NASA Climate Change website

How do Electric Circuits Work?

D311 How do you start teaching the topic of electric circuits?

What is Matter?

D81. Quantum to Cosmos Festival Video on Demand (from the Perimeter Institute)
D93. Youtube videos on Ionising Radiation
D104. Scale of the Universe Animation: A 'must show' to students
D109. Web Resources for Astronomy & Particle Physics and Quantum Physics
D118. Astronomy Resources including "How I killed Pluto and why it had it coming"
D122. Up Close: Radioactivity Podcasts from the University of Melbourne
D131. Nobel Prize in Physics to Prof Brian Schmidt, ANU - Resources
D132. Rutherford's big discovery – 100 years later (a 10 min video)
D134. Faster than light Neutrinos
D166. Higgs Boson and the Future of Physics
D179. A smartphone app to hunt for the Higgs Boson
D186. A new topic at NOVA: Science in the News - Higgs Boson
D190. Fish Tank Cloud Chamber - Instructions with video
D191. Using LEGO to teach Nuclear Physics
D224 Ruhmkorff Coil and detecting ionising radiation
D227 Smashing Physics: A Royal Institution Youtube talk by Jon Butterworth from CERN
D228 Information is Beautiful: A visualisation on nuclear exposure
D236. Radioactivity Decay App - Free
D254 2015 Nobel Prize in Physics: for the discovery ... that shows neutrinos have mass
D256 Feynman Poetry on Atoms
D260 Nuclear Resources from ANSTO
D261 A Brief History of Everything by Neil deGrasse Tyson: A Youtube video
D279 A Capella Physics: Gravitational Waves
D292 Radioactive 'zombie' cows - A beat up or fake news?
D293 Cosmogenic Radionuclide Dating - An Age article
D295 Radioactive cloud over Europe
D296 ANSTO Resources
D300 Travelling Wave reactor
D301 2017 Nobel Prize in Physics
D312 PhysicsWorld Magazine: Focus on Nuclear Energy - Free download
D315 LEGO and Particle Physics
D359 LIGO and Gravitational Wave Astronomy – Educational Resources
D366 Image of the Black Hole and other resources from the Perimeter Institute

Unit 2

Motion

D14. Lunar Olympics: A NASA initiative!
D41. Multimedia resources for Mechanics from University of New South Wales
D55. How fast could have Usain Bolt run?
D111. Video analysis software: Tracker, Kinovea
D172. How can a bike go at a constant speed? A talkphysics discussion
D203. Physics, Skating and Ice
D212 Graphing challenge - Kinematics Game
D213 Red Bull Stratos Jump analysis
D250. Star Wars VII trailer and using Tracker software
D253 Tacoma Narrows Bridge Collapse: Analysis of film and video footage
D255 Juggling Giant Newton's Cradles: Youtube video
D289 Cheap High Speed Video Recording for Analysis in Physics Experiments
D337 NASA Digi Kit for High School Physics
D369 Why a tennis ball goes flying when bounced with a falling basketball?

Unit 2 Options

1. What are stars?
2. Is there life beyond Earth's Solar System?

D3. Astrophysics resources at CSIRO
D17. More Astrophysics Resources from CSIRO
D23. Victorian Space Science Education Centre Newsletter
D40. Astronomy material from WA
D43. A Moon Clock Resource
D46. PULSE: PULsar Student Exploration online at Parkes
D61. Astounding Astrophotographs
D62. Galaxy Zoo, where you can help astronomers explore the Universe
D68. Prof Rachel Webster talks on 400 Years of Astronomical Telescopes : audio file
D89. Women in Astronomy
D96. Galaxiki: A fictional galaxy that anyone can edit
D104. Scale of the Universe Animation: A 'must show' to students
D131. Nobel Prize in Physics to Prof Brian Schmidt, ANU - Resources
D145. Universe Sandbox: Interactive Astronomy Software for Everyone
D146. Australia and SKA
D147. Black Holes booklet - free download from Institute of Physics (UK) also another on exoplanets
D159. Astronomy Resources from the UK National Schools' Observatory
D162. UK Astronomy Resources from The University of Leicester
D170. NASA Astronomy Resources developed by Australian researchers
D193. Video of a Rotating Moon from Lunar Reconnaissance Orbiter
D199. Exoplanets: a teaching and learning resource guide
D200. A Catalogue of Astronomy Apps for Phones and Tablets
D206. AstroEDU An online science activity database
D220 Astronomy Resources
D239. Exoplanet Physics for Junior Science
D243. 100,000 Stars - A 3D visualisation
D267 Astrophysics Youtube Videos from Monash University
D279 A Capella Physics: Gravitational Waves
D280. Space Tourism Posters from NASA
D359 LIGO and Gravitational Wave Astronomy – Educational Resources

3. How do forces act on the human body?

D325 Built: The Hidden Stories Behind our Structures by Roma Agrawal

4 How do heavy things fly?

D90. Paper planes

D129. 'A robot that flies like a bird' video - TED: Riveting Talks by Remarkable People

5. How do fusion and fission compare as viable nuclear energy power sources?

D85. 'Geothermal Energy from Uranium Deposits' and other physics podcasts from University of Melbourne

D98. Nuclear Information Project

D101. One of the greatest public lectures in the history of science: Fusion & Eddington

D110. Japanese Tsunami and FukuShima Reactor: Web Resources

D184. ANSTO's 60th anniversary celebrations: An e-book and an Apple app

D247. Future of Nuclear: The Conversation series of articles

D260 Nuclear Resources from ANSTO

D263 Uranium Documentary Series by Derek Muller on SBS starting 9th August

D281. The Nuclear blogosphere: Nuclear Hitchhiker, Restricted Data, Nuke Power Talk, Energy From Thorium

D296 ANSTO Resources

D300 Travelling Wave reactor

D312 PhysicsWorld Magazine: Focus on Nuclear Energy - Free download

6. How is radiation used to maintain human health?

D24. Teaching Medical Physics: An archived resource

D64. Age News Story on Fluorine 18 as a tracer in PET Scans

D93. Youtube videos on Ionising Radiation

D171. Physics of Cancer: a free download from the IOP's *Physics World*

D184. ANSTO's 60th anniversary celebrations: An e-book and an Apple app

D194. The Science of Medical Imaging: Three articles in 'The Conversation'

D260 Nuclear Resources from ANSTO

D292 Radioactive 'zombie' cows - A beat up or fake news?

D293 Cosmogenic Radionuclide Dating - An Age article

D295 Radioactive cloud over Europe

D296 ANSTO Resources

7. How do particle accelerators work?

D165. Accelerators and Beams: Tools of Discovery and Innovation: A free 36 page download

D296 ANSTO Resources

8. How can human vision be enhanced?

D56. Atmospheric Optics: Website on rainbows, haloes, glories, coronas and much more

D73. Shining a light on the usefulness of physics

D85. 'Moving and seeing again: The promise of neural interface technologies' and other physics podcasts from University of Melbourne under heading of 'Geothermal Energy from Uranium Deposits'

D97. Bionic Eye

D225 Observing a real image: An impressive Youtube video from Exploratorium

D241. Project LITE: Light Inquiry Through Experiments: A Resource

D242. International Year of Light: Resources

D277 Seeing the world as a colour blind person does: A free app.

D338 Optics for Kids

D344 International Day of Light – Resources page

9. How do instruments make music?
D161. Physics App - Spectrogram for Sounds
D221 Web resources for Sound
D235. Visualising Sound: A Youtube video

10. How can performance in ball sports be improved?
D55. How fast could have Usain Bolt run?
D197. Science of the Olympics 2012
D203. Physics, Skating and Ice

12. How does the Human Body use electricity?
D298 Backyard Brains: Resources for electrical experiments on Neuroscience

Unit 3

Electric Gravitational and Magnetic Fields
D165. Accelerators and Beams: Tools of Discovery and Innovation: A free 36 page download
D208 Benjamin Franklin and Electrostatics
D269 Webpages for Unit 3 topics of Fields, Electrical Energy and Motion
D309 More iPhone Physics - Video analysis and magnetic fields
D310 A simple and quick Experiment on Coulomb's Law
D314 A cheap DC Motor Prac
D364 Resources on Fields from Perimeter Institute: Grav, Magnetic and Electrical
D367 Lagrange's Halo or how China landed a spacecraft on the far side of the Moon and receives images of the lunar surface**.**

Electromagnetism
D157. App for Unit 3 Electromagnetism
D269 Webpages for Unit 3 topics of Fields, Electrical Energy and Motion
D356 The Power Grid: 4 videos
D357 The Engineering Mindset: Videos from basic to three phase power
D365 Wireless Charging: An Application of Electromagnetic Induction

Motion
D44. Using Dark Matter to teaching Circular Motion and Gravitation (movie and resources)
D111. Video analysis software: Tracker, Kinovea
D203. Physics, Skating and Ice
D204. A Human Loop the Loop. A slot car can, can a human?
D229 Amusement Park Physics: Some resources from the US and Europe
D255 Juggling Giant Newton's Cradles: Youtube video
D264. Dare Devil Demo: Connected bodies and Circular motion
D269 Webpages for Unit 3 topics of Fields, Electrical Energy and Motion
D285. Gravitational Waves detected
D289 Cheap High Speed Video Recording for Analysis in Physics Experiments
D330. Viewing Satellite Orbits in Real time
D369 Why a tennis ball goes flying when bounced with a falling basketball?

Relativity
D15. Results of Pirelli Relativity Challenge: The international multimedia competition
D252 General Relativity: Holiday reading and viewing
D359 LIGO and Gravitational Wave Astronomy – Educational Resources
D363 Resources on Contemporary Physics from Perimeter Institute: Relativity, Quantum

Unit 4

Light as a Wave

D5. Producing colour with sticky tape and 2 Polaroid filters: A Conference follow up
D56. Atmospheric Optics: Website on rainbows, haloes, glories, coronas and much more
D73. Shining a light on the usefulness of physics
D135. Newton's first paper on a new theory of light and colour - online at the Royal Society archive
D142. Focus on Optics and Lasers: A Physics World Publication - Free Download
D151. Light Field Camera: 'Shoot now, focus later'.
D210 Turn your iPhone into a personal spectroscope.
D225 Observing a real image: An impressive Youtube video from Exploratorium
D233. 2014 Nobel Prize in Chemistry - Physics related, again! Fluorescence Microscopy and diffraction limits
D241. Project LITE: Light Inquiry Through Experiments: A Resource
D242. International Year of Light: Resources
D245. Unlocking your car with your brain - Youtube video from Sixty Symbols
D283 Exploring Light: Hands-on Activities and Strategies for Teachers: A free online course
D338 Optics for Kids
D344 International Day of Light – Resources page

Light and Matter

D39. Video of the Double Slit Experiment with Electrons
D109. Web Resources for Astronomy & Particle Physics and Quantum Physics
D158. A Boy and his Atom: The World's Smallest Movie
D160. The Life of Psi - Philosophical interpretations of Quantum Mechanics
D232. 2014 Nobel Prize in Physics: Resources Blue LEDs
D233. 2014 Nobel Prize in Chemistry - Physics related, again! Fluorescence Microscopy
D317 Physics Books for Babies: Quantum entanglement for babies
D328 Quantum Biology: A good reference
D358 Up and Atom – Quantum videos by Jade Tan Hughes
D363 Resources on Contemporary Physics from Perimeter Institute: Relativity, Quantum

EPI

D111. Video analysis software: Tracker, Kinovea
D124. The Language of Measurement: A resource for investigations
D185. Digital Cameras with High Speed Video option
D240. Making a Science Poster - Some Tips
D246. EPIs and Posters See also D249
D248. Slow motion analysis of experiments: Exploding balloons, deformed balls, strange reflections and breaking rods - A Physics Education article
D249. Extended Practical Investigations and Posters
D270 Extra resources at 'EPI' and 'Useful Websites' webpages
D289 Cheap High Speed Video Recording for Analysis in Physics Experiments
D291 A map of Physics: Youtube video
D319 Some Resources on Uncertainties and Graphing

General

D8. Mythbusters: Science on TV
D12. Web resources from the Harry Messel International Science School
D22. UK Website to help new Physics Teachers
D35. Scientists in Schools Scheme
D38. "Why is it so?" Sumner Miller videos now on the ABC website
D42. Multimedia Resources for the Sciences from WGBH Education Foundation
D45. The Naked Scientists
D48. "ScienceAlert" An Australian Science news website
D49. "Alternative Energy" resource that also aids Africa: "Letting Chibobo Shine"
D57. What is that old equipment in the back cupboard used for? "Instruments for Natural Philosophy"
D58. Institute of Physics (IOP) "Physics Education": Free downloads of selected articles.
D63. Colin Hopkins' CDROM material
D70. Photonics Simulator for Year 10 Science
D71. Richard Feynman Lectures now available on the web
D73. Shining a light on the usefulness of physics
D76. Bite-size videos about science
D77. Slow Motion Animation, 'Slowmation', for Lower Secondary and Upper Primary
D80. Alice & Bob in Wonderland (from the Perimeter Institute)
D88. 'Physics for an Advanced World': A resource to promote physics
D89. Women in Astronomy
D90. Paper planes
D92. Physics Crosswords
D94. Physics Lyrics to Popular Songs - Check the website
D95. Historical articles from 'Nature'
D99 Internet Resources for Physics and Astronomy Education: www.compadre.org
D102. Richard Feynman: BBC Interviews online
D105. More Physics on YouTube: Rapper, radioactivity, Bill Nye, etc
D108. Orders of Magnitude - Listings in Wikipedia
D117. GeoGebra: A free software package
D119. Big History Project
D121. Perimeter Institute: Resources for Science and Physics Teaching
D126. BBC Radio Reith Lectures now on line featuring Oppenheimer, Rees, Lovell, Bertrand Russell and Melvyn Bragg programs on science
D127. How many balloons would lift a house?: Short articles for teachers and students
D129. 'A robot that flies like a bird' video - TED: Riveting Talks by Remarkable People
D136. Strandbeests: Machines using windpower to walk
D138. Understanding Uncertainty: Making sense of chance, risk, luck, uncertainty and probability
D139. Nuffield Physics Teachers' Handbook and other resources
D140. Exploring Physics Apps
D143. The Royal Society: Online picture library
D141. Extra Applets and Web Resources
D149. Physics Questions without Numbers: A Resource
D150. One Minute Physics: Video animations from New Scientist
D152. POSTnotes: Briefing Notes on Science and Technology Issues: British Parliamentary Office
D153. Some Physics Humour from The Guardian Newspaper and other sources
D154. Scientific Valentines - A flickr site of amusing valentine posters with a scientific edge
D155. Beginning Teaching: some useful hints
D156. Free Physics resources from TES and a Free iPad book on Heat Energy for Years 8 - 12
D163. 'fizzicseducation' - School visits, kids parties, video science club
D164. Achieving order from chaos: A cute video
D167. SPT: Supporting Physics Teaching - A UK Online Resource from the Institute of Physics

D168. Nova: Science in the News - 'Agriculture in the face of climate change' (Aust Academy of Science)
D169. BBC Radio and Melvyn Bragg: Science interviews
D173. Benchmarks on equipping science in schools - the UK experience
D174. 'Project Physics' - The highly regarded text book is now available on line
D175. Physics Applets on Compadre - New Edition
D178. Blog: An astrophysicist's-eye view of societal issues relating to energy production, climate change, and economic growth
D180. Revision strategies, Advice for students and Course summaries
D181. Some engaging Videos: Glass harp and Meissner Effect
D183. Oscilloscope apps and software CROs
D185. Digital Cameras with High Speed Video option
D187. Freely Accessible Remote Laboratory for students - FARLabs
D189. Sally Ride Science: A website compilation of STEM resources (Science, Technology, Engineering and Mathematics)
D192. Bohemian Rhapsody and String Theory - An engaging video.
D195. Lessons from Finnish Education
D196. Blogs by Physics Teachers
D198. Making Physics Toys from Recycled materials: Arvind Gupta:
D201. Physics Manual for Lab Techs
D202. Physics: A Force for Future Security - an article in The Conversation - a SHE activity?
D205. 'Science' in the Classroom: A Resource from the Journal 'Science'
D207. Earth Exploration Toolbook A Geoscience web resource for schools
D209 Demonstration webpage on Canadian Physics Teachers' Website
D211 Resources for Promoting Careers in Physics (US)
D214 A Brief History of Physics (animated) from the BBC Science Club
D216. Science And Technology In Society: SATIS Materials for classroom use
D217. Physics Online Resources from TES (Times Educational Supplement)
D218. Electrolights: A blog explaining day to day physics
D219 Real World 21st Century Examples for Physics
D222 Conceptions of Energy: a new UK approach
D223 Resources from the Distance Education Centre - the old 'Correspondence School'.
D226 Stunning Images: The 2014 International Earth & Sky Photo Contest
D230. Hundreds of Videos of Physics Demonstrations
D231. Datamouse: Making two photogates from a mouse
D234. More Resources from the Distance Education Centre - the old 'Correspondence School'.
D237. Teacher Developed Websites
D238. Pioneering Women of Physics: A Poster Resource
D240. Making a Science Poster - Some Tips
D257 Seven Brief Lessons on Physics: A bestselling book by Carlo Rovelli, a theoretical physicist
D270 Extra resources at 'EPI' and 'Useful Websites' webpages
D273 2016 Nobel Prize in Physics - The Secrets of Exotic Matter
D274 Some Engaging Videos: Quarks, rocket powered bike, tennis racket effect, homopolar motor, direct measurement videos, site of 877 videos
D276 Scientists and Mathematicians in Schools: A CSIRO initiative
D282. Physics Simulations from Interactives.ck12.org
D286. Bottle Flip Physics
D287 Classic Physics Papers: Links to original papers
D294. Free eBooks from Physics World
D297 Perimeter Institute Resources
D299 Visual Illusions
D302 The Back Story of the History of the Nobel Prizes in Physics
D303 2017 Nobel Prize in Chemistry won by three physicists

D304 Physics of Fidgets:
D307 The Mechanical Universe:
D313 Cosmic Vertigo: ABC Radio National Podcasts
D316 Physics Footnotes: A source of useful videos
D318 Science in Virtual Reality: An App for your Smart Phone
D320 Teaching Physics for the first time: Some UK Resources
D321 Physics Applets
D322 Activities for Physics at Home
D323 Essays on Physics
D324 Posters: Free downloads
D326 Citizen Science: Activities for Students
D327 STEM Resources from Vivify
D329 oPhysics: Interactive Physics Simulations
D331 Quantum to Cosmos: A Journey through the Universe: A PI Resource
D332 Another Poster from the Perimeter Institute: All known physics in one equation
D333 Physics Problem sheets: 80 pages from a retired teacher
D334 Background readings from the Institute of Physics - Many free to download
D335 Resources from the Perimeter Institute
D336 Internet Resources for Physics Teaching
D339 The Physics Front
D340 Science Journal: The Google App
D342 The Physics Teaching Podcast
D343 Google Jamboard – a 'whiteboard' app.
D350 Interactive Video Vignettes
D351 OpenStax - Publisher of high-quality, peer-reviewed, free textbooks
D352 Adapting Perimeter Institute's Resources for online classrooms
D353 The Living Physics Portal: Online resources for physics course for life sciences
D354 The Physics Toolbox – Data analysis tools
D355 IOP Spark: Resources from the Institute of Physics (Over 2000 resources)
D370 Equipment Designs for Physics Demonstrations.