**Stage 1 Physics – It’s *~~not~~* Rocket Science Program - Semester 1**

This is a 10-credit program for students intending to study Stage 1 Physics.

The number of lessons is equivalent to approximately 60 hours over 1 semester, including 8 -10 hours of practical activities.

The unit covers:

* Topic 1- Linear Motion and Forces,
* Topic 4 - Energy and momentum
* Topic 3 - Heat

| **Science Understanding** | **Activities/teaching strategies** | **SIS** | **SHE** |
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| **Week 1 - Kinematics** | | | |
| Understand that astronomical distances are very large.  Definitions for Astronomical Units and Light Years.  Position in one dimension.  Displacement as change in position.  Displacement is a vector quantity and can be represented by an arrow that is proportional to its magnitude.  Distinction between displacement and distance travelled. | Activity: Students use a program such as [Stellarium](http://www.stellarium.org/) or a learning object such as [Universcale](http://www.nikon.com/about/feelnikon/universcale/scale.htm) or [Scale of the Universe](http://htwins.net/scale2/) to investigate the distances of objects within and beyond our solar system.  Conversion of light years and Astronomical Units into SI units.  In pairs students use [Phil Stooke’s maps](http://www.planetary.org/multimedia/space-images/mars/phil-stookes-curiosity-route-maps.html) of the Mars rover Curiosity to investigate the path traced on Mars to determine distance and displacement. | Working with units, notation and prefixes.  Use of significant figures.  Distinguish between scalar quantities and vector quantities, add and subtract vectors.  Given a path of an object calculate the displacement and distance travelled. Interpret or draw scale diagrams to determine distance and displacement.  Rocket Cars  Students use bottle jet drag racer to generate a pressure/distance graph then are challenged to get their cars to travel a set distance. | Students research and discuss the mission objectives of an [extra-terrestrial rover.](https://upload.wikimedia.org/wikipedia/commons/e/e2/Driving_Distances_on_Mars_and_the_Moon.png) |
| **Week 2 and 3 - Kinematics (continued)** | | | |
| Speed is the rate of change of distance Average Velocity is the rate of change of displacement. Average and instantaneous velocity in one dimension. Rockets travelling at constant velocity will take a long (to very long time) to reach astronomical bodies. Constant Acceleration Acceleration is the rate of change of velocity. If an object is travelling under constant linear acceleration then the average velocity is the average of the initial and final velocities.  Use graphical methods to represent linear motion, including the construction of graphs  showing:   * position versus time * velocity versus time * acceleration versus time.   Use graphical representations to determine quantities such as position, displacement, distance, velocity, and acceleration.  Use graphical techniques to calculate the instantaneous velocity and instantaneous  acceleration of an object. | Student expand on the distance/displacement exercise by calculating speed and velocity given the value of a ‘sol’ (solar day on Mars)  NASA Activity Resource: [The speed of Martian dust devils](http://spacemath.gsfc.nasa.gov/weekly/6Page2.pdf)  Activity: Student work out how to calculate how long it would take it would take to drive to the Moon, or ride a bicycle to Mars etc.  Students use the physics game [Super Graphing Challenge](http://theuniverseandmore.com/games/graphing-challenge/) to get an intuitive feel for position versus time and velocity versus time graphs.  Adapt graph resources from the [Physics Classroom](http://www.physicsclassroom.com/mmedia/kinema/rocket.cfm) and [NASA rocket guide](https://www.nasa.gov/pdf/265386main_Adventures_In_Rocket_Science.pdf) and [Eureka Math](http://greatminds.net/maps/images/math_documents/G9.M3.B.L13.v3.1.3.0w_Teacher_Materials.pdf) | Set out physics problems in a logical and sequential manner.  Perform algebraic manipulation to solve for an unknown.  Interpret graphs of position versus time and velocity versus time.  Calculate slope and the area under a graph. | Are we there yet?  Students determine how long it would take to get to planets and even nearby stars using the rocket speed of the Apollo rocket  (11kms-1). |
| **Week 4 - Motion in 1D** | | | |
| Equations of motion quantitatively describe and predict aspects of linear motion. Solve and interpret problems using the equations of motion:  Solve problems for objects undergoing vertical motion because of the acceleration due to gravity in the absence of air resistance.  Describe qualitatively the effects that air resistance has on vertical motion.  Use equations of motion and graphical representations to determine the acceleration due to gravity.  The acceleration of a rocket in the Earth’s gravitational field (in the absence of air resistance), is in the direction of the gravitational force. | Students analyse falling objects - either using their own video or using clips from YouTube e.g. Cat falling.  Students work out how to construct [straw rockets](https://www.youtube.com/watch?v=Bx91Qf5C8Nc) and perform calculations to determine initial velocity. | Set out physics problems in a logical and sequential manner.  Perform algebraic manipulation to solve for an unknown.  Interpret graphs of position versus time and velocity versus time.  Calculate slope and the area under a graph. |  |
| **Week 5 and 6 - Motion in 1D** | | | |
| The equations for constant acceleration in one dimension can be used to calculate the vertical component of velocity of a projectile at any instant. The height of a rocket can be determined by sighting the elevation of the rocket at its apogee.  Air resistance acts in the opposite direction to the velocity of a rocket at any instant. | Investigate the factors that affect aerodynamic drag.  **SAT 1**  **Rocket Science Motion Test**  **Distance, displacement, speed, velocity, acceleration, graphs of motion, equations of motion under constant acceleration.** | Water Rocket Investigation  Calculate the apogee of a [water rocket](http://au.rokit.com/rokit-labs/water-rocket-experiments/) given the time to reach maximum height.  Using an inclinometer at known distance from the projectile path, use trigonometry to calculate the maximum height of a bottle rocket launched vertically ([resource](http://www.us-satellite.net/nasa/endeavor/resources/mathdocs/YBottle_Rocket.pdf)).  Students record and graph data. Interpret and analyse and evaluate data. Discuss sources of error and potential improvements. |  |
| **Week 7 and 8 Forces and Newton’s Laws** | | | |
| Force exerted on an object may produce motion or may cause the object to deform.  Force is a vector quantity.  Net force in two dimensions as the vector sum of the forces acting on an object.  Newton’s First Law. In the absence of force, a body either is at rest or moves in a straight line with constant speed.  Inertia is the property of a body to resist a change in motion.  Mass vs Weight Mass is a measure of how much matter an object has, measured in kg.  Weight is a force on an object caused by a gravitational field, measured in newtons.  Newton’s Second Law *F=ma*. A body experiencing a force *F* experiences an acceleration a related to *F* by *F = ma*, where m is the mass of the body.  *Science as a Human Endeavour:*   * The g-force of an object is its acceleration relative to free-fall. * Forces at take-off are extreme and may cause blackout or red-out.   Newton’s Third Law *FA=-FB* For every action force there is an equal and opposite reaction force.  Aerodynamic drag (air resistance) acts in the opposite direction to the velocity of a rocket at any instant.  Factors such as speed, texture, cross-sectional area and mass of an object affect aerodynamic drag. | [Use a computer simulation](http://sciencelearn.org.nz/Contexts/Rockets/Sci-Media/Interactive/Rocket-launch-simulation) to investigate the effect of thrust and drag on height and time of flight of a rocket        Describe how air resistance affects the vertical component of velocity, and hence the time of flight of a rocket. Investigate the factors that affect aerodynamic drag. | [Inertial balance activity](https://www.nasa.gov/pdf/315957main_Microgravity_Inertial_Balance.pdf)  How can we weigh and object in the absence of a gravitational field?  Students will construct a calibration curve then use their inertial balance to determine the mass of an object of unknown mass.  The Range of a [Methylated Spirits Rocket](https://www.youtube.com/watch?v=NbGTlNweypk)  Students will write a risk assessment and perform test firing outside. They will then return to the classroom and under test conditions write a procedure to test the effect of one variable on the range of the rocket. |  |
| **Week 9 and 10 - Momentum** | | | |
| Momentum in 1D  Rockets engines provide the thrust necessary to accelerate a spacecraft. Most engines work by the expansion of gas forced through a nozzle.  Momentum is a property of moving objects, which depends on their mass and velocity.  Momentum can be expressed mathematically as *p = mv* .  Momentum may be transferred from one object to another when a force acts over a time interval.  The rate of change of momentum of an object with respect to time is equal to the net force acting upon the object. This can be expressed mathematically as:  *p=F/t*  The impulse of an object is equal to Ft, and consequently equals the change in momentum.  Use Newton’s Second Law in the form  *F = ma* to derive the formula:  *p = F/t*  Solve problems involving changes in momentum and impulse (for one dimension). | Ballistics examples | **Investigations Folio Task: Drop time Investigation - Two lessons**  **Students will watch a** [**video of the design challenges of Mars rover**](https://www.youtube.com/watch?v=yOcis_xc4Os) **, work out a parachute design, and then design and conduct an investigation on parachute drop time.**  **Students will design an investigation.**  **Then perform an investigation, record and graph data. Interpret and analyse and evaluate data. Discuss sources of error and potential improvements. Link the interpretation of results with physics.** |  |
| **Week 11 - Working and Living in Space (Science as a Human Endeavour)** | | | |
| Radiation is a hazard in space. On Earth the Van Allen belt generated by the Earth’s magnetic field protects us from solar radiation.  Microgravity is caused by orbiting bodies falling around a gravitational body.  Weightless environments make it difficult to manipulate tools, eat and drink.  Isolation is a problem psychologically and medically.  Medical problems are caused by weightlessness:   * Fluids move to upper part of body * Atrophied Muscles * Rapid loss of minerals/fragile bones * Space Adaptation Syndrome (Space Sickness) * Readjustment to Earth’s Gravity   Manned spacecraft and spacesuits must remain pressurised and within certain temperature ranges. |  |  | Students explore the effects of spaceflight and living in space.  e.g.  Suggest ways to overcome medical problems caused by weightlessness.  Suggest ways that astronauts can overcome problems caused by a weightless environment. Suggest ways astronauts can be shielded from radiation. |
| **Week 12 - Spaceflight ( Science as a Human Endeavour)** | | | |
| Landmarks in the Russian Space Program, NASA – Saturn, Apollo and Space shuttle programs , ESA, ESS,  Australia’s role in spaceflight history  The future of spaceflight Human colonisation of the Moon and Mars The feasibility of spaceflight beyond the Solar System | Students investigate a timeline of events in Spaceflight history  Class debate “Spaceflight is a waste of human resources” |  | **Investigations Folio SHE Task**  **Students choose from Past, Present Future, Local or Global options and examine the factors relating to spaceflight**  **They synthesise, analysis, evaluate and construct an argument for an authentic audience.** |
| **Week 13 - Energy** | | | |
| Energy exists in a number of different forms including kinetic, elastic, gravitational potential, rotational kinetic, heat, and electrical.  Energy can be transferred from one object  to another or transformed into different  forms of energy.  Describe examples of energy being transferred from one object to another and being transformed from one type to another  Explain qualitatively the meaning and some applications of various forms of energy, including kinetic energy and potential energy.  Solve problems using *K=½ mv2*  and *E=mgh*  Describe energy transfers between objects and within different mechanical systems.  Energy is conserved when transferred from one object to another in an isolated system. Solve problems using the conservation of energy. The work done on an object is equivalent to the change in energy of that object.  When a force is applied to an object causing a displacement over a distance, work is done.  Explain work in terms of an applied force. | Students calculate the energy required to send rockets into orbit. | Students perform an investigation into the efficiency of different balls bouncing using video analysis. They describe and explain the energy losses that occur in the system. |  |
| **Week 14 and 15 - Heat** | | | |
| Heat energy is a measure of the total kinetic energy of the particles within an object or substance.  Temperature is a measure of the average kinetic energy of the particles within an object or substance.  Temperature can be measured with different scales (common ones being degrees Celsius, degrees Fahrenheit and Kelvin).  Heat transfer can occur through conduction, convection, and radiation.  Objects in thermal contact ultimately reach thermal equilibrium. Most solids, liquids, and gases expand when heated. Most rockets use rapidly expanding gases. | Students examine thermal control systems within the ISS and space shuttles.  Students research temperatures ranges from re-entry to deep space. Students research heat shield materials e.g. shuttle tiles and how they work. | Students make a hero engine out of a soft drink can.  Students investigate the different energy values of various alcohols using a Stirling engine.  Students revisit the methylated spirits rocket investigation from week 8 and perform a video analysis of a rocket test to determine the chemical energy that is transformed into the kinetic energy of the rocket. By using the values determined experimentally from the Stirling engine investigation above they determine the efficiency of the system. | Students investigate ways that astronauts’ habitats are maintained at an appropriate temperature. |
| **Week 16 and 17 Rocket Science (Science as a Human Endeavour)** | | | |
| The nose cone must be shaped and textured to reduce aerodynamic drag.  Payload is the the total weight of passengers, crew, equipment and cargo carried by a spacecraft.  The fuselage is the skin of the spacecraft. It needs to withstand intense pressure and temperature changes.  Fins stabilise the rocket in flight.  A gyroscope is essential for navigation. It uses rotational inertia to spin in a single direction regardless of the motion of the spacecraft.  Rockets may be single or multistage.  The main reason for multi-stage rockets and boosters is that once the fuel is burned, the space and structure which contained it and the motors themselves are useless and only add weight to the vehicle which slows down its future acceleration. | Think, pair, share - What are the Characteristics of a well-designed rocket?  Investigation of aerodynamic stability  Student come up with a design to make a multistage balloon rocket. | Students perform an investigation on the [centre of mass centre of pressure](http://www.exo.net/~pauld/activities/flying/Flightstyrofoamplate.html). | Mythbusters  Rocketman: Feb. 20, 2016  In this final rocket special Adam and Jamie tackle the all-time fan favourite: Are gummy bears a viable rocket fuel? |
| **Week 18 - Kerbal Space Program** | | | |
|  | Students will apply knowledge to design, build and test a rocket.  Students can use either the KSP free demo, [KSPedu](http://www.kerbaledu.com/) version or KSP full version. | **Skills and Application Task 2:** **Kerbal Space Program Rocket**  **Students create rockets in the Rocket science simulator KSP and the produce either a presentation, screencast or poster that justifies and explains the features of their design e.g. stability, aerodynamics, mass, thrust, drag, fuel, energy, heat, speed, acceleration, materials, centre of mass, centre of pressure** | Simulations are a way that scientists can test complex systems as simulations can be programmed with the laws of physics. |