# Sample Unit – Physics – Year 11

***Sample for implementation for Year 11 from 2018***

| **Unit Title** | Module 2: Dynamics | **Duration** | 30 Hours (including three hours for Depth Study) |
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| **Unit Description** | The relationship between the motion of objects and the forces that act on them is often complex. However, Newton’s Laws of Motion can be used to describe the effect of forces on the motion of single objects and simple systems. This module develops the key concept that forces are always produced in pairs that act on different objects and add to zero.By applying Newton’s laws directly to simple systems, and, where appropriate, the law of conservation of momentum and law of conservation of mechanical energy, students examine the effects of forces. They also examine the interactions and relationships that can occur between objects by modelling and representing these using vectors and equations. In many situations, within and beyond the discipline of physics, knowing the rates of change of quantities provides deeper insight into various phenomena. In this module, the rates of change of displacement, velocity and energy are of particular significance and students develop an understanding of the usefulness and limitations of modelling. |
| **Outcomes**A student:* designs and evaluates investigations in order to obtain primary and secondary data and information PH11/12-2
* conducts investigations to collect valid and reliable primary and secondary data and information PH11/12-3
* selects and processes appropriate qualitative and quantitative data and information using a range of appropriate media PH11/12-4
* analyses and evaluates primary and secondary data and information PH11/12-5
* solves scientific problems using primary and secondary data, critical thinking skills and scientific processes PH11/12-6
* communicates scientific understanding using suitable language and terminology for a specific audience or purpose PH11/12-7
* describes and explains events in terms of Newton’s Laws of Motion, the law of conservation of momentum and the law of conservation of energy PH11-9
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| **Course requi**r**ements*** Three hours of depth study time devoted to practical investigations related to the assessment task.
* Content and skills related to outcomes and first hand investigations
 | **Formal assessment*** Assessment Task 2 - Depth Study Investigation and Report
* Assessment Task 3 - Yearly Examination
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| **Topics**1. Forces
2. Forces, Acceleration and Energy
3. Momentum, Energy and Simple Systems
 | **Inquiry questions**1. How are forces produced between objects and what effects do forces produce?
2. How can the motion of objects be explained and analysed?
3. How is the motion of objects in a simple system dependent on the interaction between the objects?
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| **Working scientifically skills****Conducting investigations – PH11/12-3****A student conducts investigations to collect valid and reliable primary and secondary data and information**Students:* Employ and evaluate safe work practices and manage risks (ACSCH031)
* Use appropriate technologies to ensure and evaluate accuracy
* Select and extract information from a wide range of reliable secondary sources and acknowledge them using an accepted referencing style

Processing Data and Information – PH11/12-4**A student selects and processes appropriate qualitative and quantitative data and information using a range of appropriate media**Students:* Select qualitative and quantitative data and information and represent them using a range of formats, digital technologies and appropriate media (ACSCH004, ACSCH007, ACSCH064, ACSCH101)
* Apply quantitative processes where appropriate
* Evaluate and improve the quality of data

Analysing Data and Information – PH11/12-5**A student analyses and evaluates primary and secondary data and information CH11/12-5**Students:* derive trends, patterns and relationships in data and information
* assess error, uncertainty and limitations in data (ACSCH004, ACSCH005, ACSCH033, ACSCH099)
* assess the relevance, accuracy, validity and reliability of primary and secondary data and suggest improvements to investigations (ACSCH005)

Problem Solving – PH11/12-6**A student** **solves scientific problems using primary and secondary data, critical thinking skills and scientific processes**Students:* use modeling (including mathematical examples) to explain phenomena, make predictions and solve problems using evidence from primary and secondary sources (ACSCH006, ACSCH010)
* use scientific evidence and critical thinking skills to solve problems

Communicating – PH11/12-7**A student** **communicates scientific understanding using suitable language and terminology for a specific audience or purpose**Students:* select and use suitable forms of digital, visual, written and/or oral forms of communication
* select and apply appropriate scientific notations, nomenclature and scientific language to communicate in a variety of contexts (ACSCH008, ACSCH036, ACSCH067, ACSCH102)
* construct evidence-based arguments and engage in peer feedback to evaluate an argument or conclusion (ACSCH034, ACSCH036)
 | **Depth Study**This module will provide students with the opportunity to plan and conduct investigations, as well as process data and information. Focus should be placed on the development of skills related to planning and conducting investigations, as well as processing and communicating information. Rather than a formally assessed depth study being incorporated in this module, students should be given feedback about the development of their investigative skills, so that these may be formally assessed later in the Year 11 course. |

| **Topic:** **Forces** |
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| **Inquiry question:** How are forces produced between objects and what effects do forces produce? |
| **Content** | **Teaching, learning and assessment** | **Web Resources** |
| **Students:*** using Newton’s Laws of Motion, describe static and dynamic interactions between two or more objects and the changes that result from:

– a contact force– a force mediated by fields | * Students review Newton’s three laws of motion and list illustrative examples. NASA’s website contains information and activities through Science Foundations about Newton’s three laws.
* Carry out first-hand investigations analysing the forces and accelerations in different situations such as dynamics trolleys, a mass hanging on a spring, a falling mass, one trolley pulling another, and an Atwood’s machine
* Compare the use of Newton’s three laws for contact forces to forces in fields.
 | <https://www.grc.nasa.gov/WWW/K-12/airplane/newton.html> |
| **Students:*** explore the concept of net force and equilibrium in one-dimensional and simple two-dimensional contexts using: (ACSPH050)

– algebraic addition– vector addition– vector addition by resolution into components* solve problems or make quantitative predictions about resultant and component forces by applying the following relationships:

– *FAB = -FBA*– *FX = Fcos(θ), FY = Fsin(θ)* | * Investigate the conditions required for an equilibrium of forces and compare using the [PhET site](https://phet.colorado.edu/sims/html/forces-and-motion-basics/latest/forces-and-motion-basics_en.html)’s interactive simulation which can be downloaded for students to use to demonstrate forces in equilibrium.
* Draw vector diagrams to represent the forces between multiple bodies in different situations
* Explore [vector addition](https://phet.colorado.edu/sims/vector-addition/vector-addition_en.html) using an interactive simulation on the PhET site that students can use to demonstrate the resolution and addition of multiple vectors.
* Calculate relative velocities in a range of scenarios such as a boat crossing a flowing river; a plane flying with a crosswind.
* Predict forces on a force table with a ring and four masses hanging on pulleys, and conduct an investigation to analyse the prediction.
 | <https://phet.colorado.edu/sims/html/forces-and-motion-basics/latest/forces-and-motion-basics_en.html><https://phet.colorado.edu/sims/vector-addition/vector-addition_en.html> |
| **Students:*** conduct an investigation to explain and predict the motion of objects on inclined planes (ACSPH098)
 | * Design and carry out an investigation to predict the acceleration of a mobile phone sliding down an incline plane using its accelerometer, or design an investigation of the velocity of a trolley down an inclined plane using photogates and data loggers.
* Complete the interactive activity showing [forces and motion on ramps](https://phet.colorado.edu/en/simulation/legacy/ramp-forces-and-motion) that can be downloaded and use offline.
 | <https://phet.colorado.edu/en/simulation/legacy/ramp-forces-and-motion> |

| **Topic:** **Forces, Acceleration and Energy** |
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| **Inquiry question:** How can the motion of objects be explained and analysed? |
| **Content** | **Teaching, learning and assessment** | **Web Resources** |
| **Students:*** apply Newton’s first two laws of motion to a variety of everyday situations, including both static and dynamic examples, and include the role played by friction (ACSPH063)
 | * Discuss with students situations involving motion to determine whether static or dynamic friction is larger (examples of demonstrations to highlight this may include using wooden blocks on different surfaces, with the blocks being pulled by force meters, starting from rest and moving at constant velocity).
* Examine static structures such as trusses and bridges to determine how Newton’s first and second law can be applied to evaluate forces at points of the structure.
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| **Students:*** investigate, describe and analyse the acceleration of a single object subjected to a constant net force and relate the motion of the object to Newton’s Second Law of Motion through the use of: (ACSPH062, ACSPH063)
* qualitative descriptions
* graphs and vectors
* deriving relationships from graphical representations including and relationships of uniformly accelerated motion
 | * Examine dynamic examples such as cars in motion to evaluate the role of the motor in overcoming friction to maintain a constant velocity.
* Apply previous knowledge of vector components into analysing examples of static tensions using force meters in 2D.
* Using the data from [this Forces and motion simulation](https://phet.colorado.edu/sims/html/forces-and-motion-basics/latest/forces-and-motion-basics_en.html) to determine the relationship between force, mass and acceleration.
* Conduct investigations using smooth surfaces, pulleys and masses to determine a graphical relationship between force, mass and acceleration and determine the proportional relationship between force and acceleration.
* Use the simulation to examine graphical relationships and those involving the [vectors for simple motion](https://phet.colorado.edu/en/simulation/legacy/forces-1d) in one dimension.
 | <https://phet.colorado.edu/sims/html/forces-and-motion-basics/latest/forces-and-motion-basics_en.html><https://phet.colorado.edu/en/simulation/legacy/forces-1d> |
| **Students:*** apply the special case of conservation of mechanical energy to the quantitative analysis of motion involving:
* work done and change in the kinetic energy of an object undergoing accelerated rectilinear motion in one dimension
* changes in gravitational potential energy of an object in a uniform field
 | * Define the law of conservation of energy and brainstorm with students where the increase in KE (kinetic energy) comes from when an object undergoes acceleration due to the influence of a force. Discuss the relationship between the gain in kinetic energy and the:
* size of the applied force
* distance that the force applies and relate to work. The gain in KE arises as a result of the work done in applying a force on an object over a distance.
* Conduct investigations to determine the relationship between the height from which an object is dropped and its resultant speed (and hence KE) on landing to determine a relationship between KE and GPE (gravitational potential energy)
* Use the [skate park simulation](https://phet.colorado.edu/sims/html/energy-skate-park-basics/latest/energy-skate-park-basics_en.html) to verify the relationship between GPE and KE and relate to conservation of energy.
 | <https://phet.colorado.edu/sims/html/energy-skate-park-basics/latest/energy-skate-park-basics_en.html> |
| **Students:*** conduct investigations over a range of mechanical processes to analyse qualitatively and quantitatively the concept of average power including but not limited to:
* uniformly accelerated rectilinear motion
* objects raised against the force of gravity
* work done against air resistance, rolling resistance and friction
 | * Using relationship and that change in mechanical energy is equivalent to work done, (where x is displacement), so with being average velocity, power=force x average velocity, or, Energy is Work done which is change in KE, so formula can be
* An object raised against gravity has work done on it equal to mgΔy (assuming uniform field) so power = =
* Students lift masses with force meters over set distances to determine the work done in lifting a mass or accelerating an object and equate to the change in GPE.
* Students analyse the change in KE over set distances using trolleys and pulleys with masses and time the motion to determine the relationship between change in KE, work and power.
* Students use the same formulae from above to calculate the change in KE, relate it to the amount of work done by the force over a distance, to calculate the ‘missing’ work, which has been performed by air resistance or friction as non-conservative forces.
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| **Topic:** **Momentum, Energy and Simple Systems** |
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| **Inquiry question:** How is the motion of objects in a simple system dependent on the interaction between the objects? |
| **Content** | **Teaching, learning and assessment** | **Web resources** |
| **Students:**●conduct an investigation to describe and analyse one-dimensional (collinear) and two-dimensional interactions of objects in simple closed systems (ACSPH064)●analyse quantitatively and predict, using the law of conservation of momentum and, where appropriate, conservation of kinetic energy, the results of interactions in elastic collisions (ACSPH066) | * Use the [collision lab simulation](https://phet.colorado.edu/sims/collision-lab/collision-lab_en.html) to investigate the nature of collisions in one and two dimensions.
* Analyse using vectors and video analysis the collision of two balls and examine the momentum of the balls before and after the collisions. In a two-dimensional analysis, have the moving ball hit the stationary ball obliquely, and examine the velocity and momentum of the objects using components to verify the conservation of momentum.
* Use a Newton’s cradle to examine the relationship between conservation of momentum and conservation of kinetic energy for an approximately elastic collision.
 | <https://phet.colorado.edu/sims/collision-lab/collision-lab_en.html> |
| **Students:**●investigate the relationship and analyse information obtained from graphical representations of force as a function of time | * Relate force vs time graphs and the area underneath the curve to impulse, which is the change in momentum of an object. To change the momentum of an object requires applying an impulse, which is a force over a time interval. The change in momentum of an object can be determined by evaluating the area underneath a force/time graph.
* Relate change in momentum during interactions to the applied force and time for collision to occur to note the inverse relationship between force and time for a given impulse. Apply this to situations including car safety features (airbags, crumple zones etc).
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| **Students:**●evaluate the effects of forces involved in collisions and other interactions, and analyse quantitatively the interactions using the concept of impulse●analyse and compare the momentum and kinetic energy of elastic and inelastic collisions (ACSPH066) | * Construct situations involving (nearly) elastic and inelastic collisions to investigate the conservation of momentum and the conservation (or lack) of kinetic energy. Draw flowcharts to illustrate energy transformations.
* Use the [collision lab simulation](https://phet.colorado.edu/sims/collision-lab/collision-lab_en.html) to examine elastic and inelastic collisions and their impacts on initial, final and total momentum and KE.
 | <https://phet.colorado.edu/sims/collision-lab/collision-lab_en.html> |

| **Reflection and Evaluation**TEACHER: CLASS:**DATE UNIT COMMENCED: DATE UNIT CONCLUDED:*** **Variations to program:** (List additional resources and outline alternative strategies used.)
* **The most effective teaching/ learning strategies and resources in this unit were:** (Please nominate three at least)
* **Less effective teaching strategies and resources for this unit were:** (Please nominate two at least)

**TEACHER’S SIGNATURE\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_DATED\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_CHECKED\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |
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