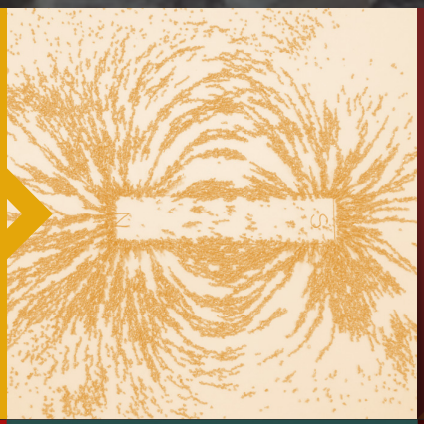
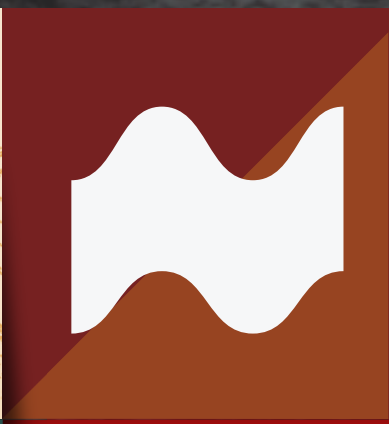
YEAR 11 PHYSICS NOTES

Modules 1 - 4

"The mind is not a vessel to be filled, but a fire to be kindled."

Plutarch





WE ARE A WAY FOR THE UNIVERSE TO KNOW ITSELF.

Carl Sagan

1-4

EVERY STAR MAY BE A SUN TO SOMEONE.

Year 11 Physics Syllabus
Dot Point Summary

Module 1: Kinematics

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
› describes and analyses motion in terms of scalar and vector quantities in two dimensions and makes quantitative measurements and calculations for distance, displacement, speed, velocity and acceleration PH11-8

Content Focus

Motion is a fundamental observable phenomenon. The study of kinematics involves describing, measuring and analysing motion without considering the forces and masses involved in that motion. Uniformly accelerated motion is described in terms of relationships between measurable scalar and vector quantities, including displacement, speed, velocity, acceleration and time.

Representations – including graphs and vectors, and equations of motion – can be used qualitatively and quantitatively to describe and predict linear motion.

By studying this module, students come to understand that scientific knowledge enables scientists to offer valid explanations and make reliable predictions, particularly in regard to the motion of an object.

Working Scientifically

In this module, students focus on designing, evaluating and conducting investigations to examine trends in data and solve problems related to kinematics. Students should be provided with opportunities to engage with all the Working Scientifically skills throughout the course.

Content

Motion in a Straight Line

Inquiry question: How is the motion of an object moving in a straight line described and predicted?

Students:

- describe uniform straight-line (rectilinear) motion and uniformly accelerated motion through:
  - qualitative descriptions
  - the use of scalar and vector quantities (ACSPH060)

Students:

- conduct a practical investigation to gather data to facilitate the analysis of instantaneous and average velocity through:
  - quantitative, first-hand measurements
  - the graphical representation and interpretation of data (ACSPH061)

Students:

- calculate the relative velocity of two objects moving along the same line using vector analysis

Students:

- conduct practical investigations, selecting from a range of technologies, to record and analyse the motion of objects in a variety of situations in one dimension in order to measure or calculate:
  - time
  - distance
  - displacement
  - speed
  - velocity
  - acceleration

Students:

- use mathematical modelling and graphs**,** selected from a range of technologies, to analyse and derive relationships between time, distance, displacement, speed, velocity and acceleration in rectilinear motion, including:
  - $\vec{s} = \vec{u}t + \frac{1}{2}\vec{a}t^2$
  - $\vec{v} = \vec{u} + \vec{a}t$
  - $\vec{v}^2 = \vec{u}^2 + 2\vec{a}\vec{s}$ (ACSPH061)

Motion on a Plane

Inquiry question: How is the motion of an object that changes its direction of movement on a plane described?

Students:

- analyse vectors in one and two dimensions to:
  - resolve a vector into two perpendicular components
  - add two perpendicular vector components to obtain a single vector (ACSPH061)

Students:

- represent the distance and displacement of objects moving on a horizontal plane using:
  - vector addition
  - resolution of components of vectors (ACSPH060)

Students:

- describe and analyse algebraically, graphically and with vector diagrams, the ways in which the motion of objects changes, including:
  - velocity
  - displacement (ACSPH060, ACSPH061)

Students:

- describe and analyse, using vector analysis, the relative positions and motions of one object relative to another object on a plane (ACSPH061)

Students:

- analyse the relative motion of objects in two dimensions in a variety of situations, for example:
  - a boat on a flowing river relative to the bank
  - two moving cars
  - an aeroplane in a crosswind relative to the ground (ACSPH060, ACSPH132)

Module 2: Dynamics

Outcomes

A student:

- designs and evaluates investigations in order to obtain primary and secondary data and information PH11/12-2
- selects and processes appropriate qualitative and quantitative data and information using a range of appropriate media PH11/12-4
- solves scientific problems using primary and secondary data, critical thinking skills and scientific processes PH11/12-6
- 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

Content Focus

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.

Working Scientifically

In this module, students focus on designing, evaluating and conducting investigations and interpreting trends in data to solve problems related to dynamics. Students should be provided with opportunities to engage with all the Working Scientifically skills throughout the course.

Content

Forces

Inquiry question: How are forces produced between objects and what effects do forces produce?

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:

- 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

Students:

- solve problems or make quantitative predictions about resultant and component forces by applying the following relationships:
  - $\vec{F}_{AB} = -\vec{F}_{BA}$
  - $\vec{F}_x = \vec{F}cos\theta$, $\vec{F}_y = \vec{F}sin\theta$

Students:

- conduct a practical investigation to explain and predict the motion of objects on inclined planes (ACSPH098)

Forces, Acceleration and Energy

Inquiry question: How can the motion of objects be explained and analysed?

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 ($friction = \mu \vec{F}_N$) (ACSPH063)

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 $\vec{F} = m\vec{a}$ and relationships of uniformly accelerated motion

Students:

- apply the law 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 ($W = \vec{F}_{net}\vec{s}$)
  - changes in gravitational potential energy of an object in a uniform field ($\Delta U = m\vec{g}\Delta\vec{h}$)

Students:

- conduct investigations over a range of mechanical processes to analyse qualitatively and quantitatively the concept of average power ($P = \frac{\Delta E}{t}$,$P = \vec{F}\vec{v}$), 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

Momentum, Energy and Simple Systems

Inquiry question: How is the motion of objects in a simple system dependent on the interaction between the objects?

Students:

- conduct an investigation to describe and analyse one-dimensional (collinear) and two-dimensional interactions of objects in simple closed systems (ACSPH064)

Students:

- analyse quantitatively and predict, using the law of conservation of momentum ($\Sigma m\vec{v}_{before} = \Sigma m\vec{v}_{after}$) and, where appropriate, conservation of kinetic energy ($\Sigma \frac{1}{2} m\vec{v}^2_{before} = \Sigma \frac{1}{2} m\vec{v}^2_{after}$), the results of interactions in elastic collisions (ACSPH066)

Students:

- investigate the relationship and analyse information obtained from graphical representations of force as a function of time

Students:

- evaluate the effects of forces involved in collisions and other interactions, and analyse quantitatively the interactions using the concept of impulse ($\Delta\vec{p} = \vec{F}\Delta t$)

Students:

- analyse and compare the momentum and kinetic energy of elastic and inelastic collisions (ACSPH066)

Module 3: Waves and Thermodynamics

Outcomes

A student:

› 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
› 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
› explains and analyses waves and the transfer of energy by sound and light PH11-10

Content Focus

Wave motion involves the transfer of energy without the transfer of matter. By exploring the behaviour of wave motion and examining the characteristics of wavelength, frequency, period, velocity and amplitude, students further their understanding of the properties of waves. They are then able to demonstrate how waves can be reflected, refracted, diffracted and superposed (interfered) and to develop an understanding that not all waves require a medium for their propagation. Students examine mechanical waves and electromagnetic waves, including their similarities and differences.

Students also examine energy and its transfer, in the form of heat, from one place to another. Thermodynamics is the study of the relationship between energy, work, temperature and matter. Understanding this relationship allows students to appreciate particle motion within objects. Students have the opportunity to examine how hot objects lose energy in three ways: first, by conduction, and, second, by convection – which both involve the motion of particles; and, third, the emission of electromagnetic radiation. An understanding of thermodynamics is a pathway to understanding related concepts in many fields involving Science, Technology, Engineering and Mathematics (STEM).

Working Scientifically

In this module, students focus on conducting investigations, collecting and processing data and information, interpreting trends in data and communicating scientific ideas about waves and thermodynamics. Students should be provided with opportunities to engage with all the Working Scientifically skills throughout the course.

Content

Wave Properties

Inquiry question: What are the properties of all waves and wave motion?

Students:

- conduct a practical investigation involving the creation of mechanical waves in a variety of situations in order to explain:
  - the role of the medium in the propagation of mechanical waves
  - the transfer of energy involved in the propagation of mechanical waves (ACSPH067, ACSPH070)

Students:

- conduct practical investigations to explain and analyse the differences between:
  - transverse and longitudinal waves (ACSPH068)
  - mechanical and electromagnetic waves (ACSPH070, ACSPH074)

Students:

- construct and/or interpret graphs of displacement as a function of time and as a function of position of transverse and longitudinal waves, and relate the features of those graphs to the following wave characteristics:
  - velocity
  - frequency
  - period
  - wavelength
  - wave number
  - displacement and amplitude (ACSPH069)

Students:

- solve problems and/or make predictions by modelling and applying the following relationships to a variety of situations:
  - $v = f\lambda$
  - $f = \frac{1}{T}$
  - $k = \frac{2\pi}{T}$

Wave behaviour

Inquiry question: How do waves behave?

Students:

- explain the behaviour of waves in a variety of situations by investigating the phenomena of:
  - reflection
  - refraction
  - diffraction
  - wave superposition (ACSPH071, ACSPH072)

Students:

- conduct an investigation to distinguish between progressive and standing waves (ACSPH072)

Students:

- conduct an investigation to explore resonance in mechanical systems and the relationships between:
  - driving frequency
  - natural frequency of the oscillating system
  - amplitude of motion
  - transfer/transformation of energy within the system (ACSPH073)

Sound waves

Inquiry question: What evidence suggests that sound is a mechanical wave?

Students:

- conduct a practical investigation to relate the pitch and loudness of a sound to its wave characteristics

Students:

- model the behaviour of sound in air as a longitudinal wave

Students:

- relate the displacement of air molecules to variations in pressure (ACSPH070)

Students:

- investigate quantitatively the relationship between distance and intensity of sound

Students:

- conduct investigations to analyse the reflection, diffraction, resonance and superposition of sound waves (ACSPH071)

Students:

- investigate and model the behaviour of standing waves on strings and/or in pipes to relate quantitatively the fundamental and harmonic frequencies of the waves that are produced to the physical characteristics (eg length, mass, tension, wave velocity) of the medium (ACSPH072)

Students:

- analyse qualitatively and quantitatively the relationships of the wave nature of sound to explain:
  - beats ($f_{\text{beat}} = [f_2 - f_1]$)
  - the Doppler effect $f' = f\frac{(v_{wave}+v_{observer})}{(v_{wave}-v_{source})}$

Ray model of light

Inquiry question: What properties can be demonstrated when using the ray model of light?

Students:

- conduct a practical investigation to analyse the formation of images in mirrors and lenses via reflection and refraction using the ray model of light (ACSPH075)

Students:

- conduct investigations to examine qualitatively and quantitatively the refraction and total internal reflection of light (ACSPH075, ACSPH076)

Students:

- predict quantitatively, using Snell's Law, the refraction and total internal reflection of light in a variety of situations

Students:

- conduct a practical investigation to demonstrate and explain the phenomenon of the dispersion of light

Students:

- conduct an investigation to demonstrate the relationship between inverse square law, the intensity of light and the transfer of energy (ACSPH077)

Students:

- solve problems or make quantitative predictions in a variety of situations by applying the following relationships to:
  - $n_x = \frac{c}{v_x}$ – for the refractive index of medium *x*, v_x is the speed of light in the medium
  - $n_1 sin\ (i) = n_2 sin\ (r)$ (Snell's Law)
  - $sin\ (i_c) = \frac{1}{n_x}$ – for the critical angle i_c of medium *x*
  - $I_1 r_1^2 = I_2 r_2^2$ – to compare the intensity of light at two points, r_1 and r_2

Thermodynamics

Inquiry question: How are temperature, thermal energy and particle motion related?

Students:

- explain the relationship between the temperature of an object and the kinetic energy of the particles within it (ACSPH018)

Students:

- explain the concept of thermal equilibrium (ACSPH022)

Students:

- analyse the relationship between the change in temperature of an object and its specific heat capacity through the equation $\Delta Q = mc\Delta T$ (ACSPH020)

Students:

- investigate energy transfer by the process of:
  - conduction
  - convection
  - radiation (ACSPH016)

Students:

- conduct an investigation to analyse qualitatively and quantitatively the latent heat involved in a change of state

Students:

- model and predict quantitatively energy transfer from hot objects by the process of thermal conductivity

Students:

- apply the following relationships to solve problems and make quantitative predictions in a variety of situations:
  - $\Delta Q = mc\Delta T$, where *c* is the specific heat capacity of a substance
  - $\frac{Q}{t} = \frac{kA\Delta T}{d}$, where *k* is the thermal conductivity of a material

Module 4: Electricity and Magnetism

Outcomes

A student:

› develops and evaluates questions and hypotheses for scientific investigation PH11/12-1
› analyses and evaluates primary and secondary data and information PH11/12-5
› communicates scientific understanding using suitable language and terminology for a specific audience or purpose PH11/12-7
› explains and quantitatively analyses electric fields, circuitry and thermodynamic principles PH11-11

Content Focus

Atomic theory and the laws of conservation of energy and electric charge are unifying concepts in understanding the electrical and magnetic properties and behaviour of matter. Interactions resulting from these properties and behaviour can be understood and analysed in terms of electric fields represented by lines. Students use these representations and mathematical models to make predictions about the behaviour of objects, and explore the limitations of the models.

Students also examine how the analysis of electrical circuits' behaviour and the transfer and conversion of energy in electrical circuits has led to a variety of technological applications.

Working Scientifically

In this module, students focus on developing questions and hypotheses, processing and analysing trends and patterns in data, and communicating ideas about electricity and magnetism. Students should be provided with opportunities to engage with all the Working Scientifically skills throughout the course.

Content

Electrostatics

Inquiry question: How do charged objects interact with other charged objects and with neutral objects?

Students:

- conduct investigations to describe and analyse qualitatively and quantitatively:
  - processes by which objects become electrically charged (ACSPH002)
  - the forces produced by other objects as a result of their interactions with charged objects (ACSPH103)
  - variables that affect electrostatic forces between those objects (ACSPH103)

Students:

- using the electric field lines representation, model qualitatively the direction and strength of electric fields produced by:
  - simple point charges
  - pairs of charges
  - dipoles
  - parallel charged plates

Students:

- apply the electric field model to account for and quantitatively analyse interactions between charged objects using:
  - $\vec{E} = \frac{\vec{F}}{q}$ (ACSPH103, ACSPH104)
  - $E = -\frac{V}{d}$
  - $\vec{F} = \frac{1}{4\pi\varepsilon_0} \times \frac{q_1 q_2}{r^2}$ (ACSPH102)

Students:

- analyse the effects of a moving charge in an electric field, in order to relate potential energy, work and equipotential lines, by applying: (ACSPH105)
  - $V = \frac{\Delta U}{q}$, where *U* is potential energy and *q* is the charge

Electric Circuits

Inquiry question: How do the processes of the transfer and the transformation of energy occur in electric circuits?

Students:

- investigate the flow of electric current in metals and apply models to represent current, including:
  - $I = \frac{q}{t}$ (ACSPH038)

Students:

- investigate quantitatively the current–voltage relationships in ohmic and non-ohmic resistors to explore the usefulness and limitations of Ohm's Law using:
  - $V = \frac{W}{q}$
  - $R = \frac{V}{I}$ (ACSPH003, ACSPH041, ACSPH043)

Students:

- investigate quantitatively and analyse the rate of conversion of electrical energy in components of electric circuits, including the production of heat and light, by applying $P = VI$ and $E = Pt$ and variations that involve Ohm's Law (ACSPH042)

Students:

- investigate qualitatively and quantitatively series and parallel circuits to relate the flow of current through the individual components, the potential differences across those components and the rate of energy conversion by the components to the laws of conservation of charge and energy, by deriving the following relationships: (ACSPH038, ACSPH039, ACSPH044)
  - $\Sigma I = 0$ (Kirchoff's current law – conservation of charge)
  - $\Sigma V = 0$ (Kirchoff's voltage law – conservation of energy)
  - $R_{Series} = R_1 + R_2 + \ldots + R_n$
  - $\frac{1}{R_{Parallel}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots + \frac{1}{R_n}$

Students:

- investigate quantitatively the application of the law of conservation of energy to the heating effects of electric currents, including the application of $P = VI$ and variations of this involving Ohm's Law (ACSPH043)

Magnetism

Inquiry question: How do magnetised and magnetic objects interact?

Students:

- investigate and describe qualitatively the force produced between magnetised and magnetic materials in the context of ferromagnetic materials (ACSPH079)

Students:

- use magnetic field lines to model qualitatively the direction and strength of magnetic fields produced by magnets, current-carrying wires and solenoids and relate these fields to their effect on magnetic materials that are placed within them (ACSPH083)

Students:

- conduct investigations into and describe quantitatively the magnetic fields produced by wires and solenoids, including: (ACSPH106, ACSPH107)
  - $B = \frac{\mu_0 I}{2\pi r}$
  - $B = \frac{\mu_0 NI}{L}$

Students:

- investigate and explain the process by which ferromagnetic materials become magnetised (ACSPH083)

Students:

- apply models to represent qualitatively and describe quantitatively the features of magnetic fields