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**Knowledge Rich Curriculum Plan**

SCIENCE- Physics Year 11

| **Lesson/Learning Sequence**  | **Intended Knowledge:***Students will know that…* | **Prior Knowledge:***In order to know this, students need to already know that…* | **Working Scientifically** | **Tiered Vocabulary and Reading Activity** |
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| **Lesson:** **Contact and non-Contact Forces** | * Students will know that forces are interactions between a pair of objects.
* Students will know that forces are either contact forces or non-contact forces
* Students will know that a contact force only acts when the objects are physically touching
* Students will know that a non-contact force acts when the objects are physically separated
* Students will know that friction, air resistance, tension and normal contact forces are examples of contact forces

Students will know that gravitational force, electrostatic force and magnetic force are examples of non-contact forces | * ***Students need to already know that forces are pushes and pulls***

***Students need to already know that forces are vector quantities.*** |  | Tier 2Tier 3Contact force: a force that requires interacting objects to touch to occurNon-contact force: a force that can occur when the interacting objects aren’t touching |
| **Lesson:** **Resultant Force** | * Students will know that a number of forces acting on an object can be replaced by a single force that has the same effect as all of the original forces acting together, and this is known as the resultant force
* Students will know that a resultant force can cause an object to accelerate, decelerate, change shape or change direction
* Students will know that if an object has a resultant force of 0N acting on it whilst in motion it will continue to move at constant motion
* Students will know that if if an object has a resultant force of 0N acting on it whilst stationary it will remain stationary

Students will know how to determine the resultant force of 2 forces acting in a straight line | ***Students need to already know that the unit for force is Newtons.*** |  | Tier 2Tier 3Resultant force: a single force that has the same effect as all the forces that are acting on an object. |
| **Lesson:** **Resultant Force (HT)** | * Students will know that not all forces act on an object in a straight line.
* Students will know how to resolve a resultant force into two components
* Students will know how to use vector diagrams to illustrate the resolution of forces.

Students will know how to use vector diagrams to determine the resultant of two forces, including magnitude and direction |  | Interpreting diagramsDrawing scale diagramsMeasuring angles | Tier 2Component: part of a larger wholeTier 3Vector diagrams: diagrams that represent the magnitude and direction of a quantity |
| **Lesson:** **Gravity and Weight** | * Students will know that weight is the force acting on an object due to gravity.
* Students will know that the force of gravity close to Earth is due to the gravitational field around Earth
* Students will know that the weight of an object depends on the gravitational field strength and the object's mass
* Students will know that the equation used to calculate weight is:

Weight = mass x gravitational field strengthW = m g* Students will know that the unit of weight is Newtons
* Students will know that the unit of gravitational field strength is N/ kg
* Students will know that the weight of an object may be considered to act at a single point referred to as the object's centre of mass
* Students will know that the weight of an object can be measured using a calibrated spring-balance

Students will know how to perform calculations using the weight equation | ***Students need to already know that the unit of mass is kg*** | Measuring weight using Newtonmeters | Tier 2Calibrate: adjust to take into account all factorsTier 3Centre of mass: a single point on an object where the weight acts at. |
| **Lesson:** **Newton's first law** | * Students will know that an object in motion will remain at constant motion unless an external force is applied to it
* Students will know that if a resultant force acts on an object it will cause the velocity (speed and/ or direction) to change
* HT only - Students will know that the tendency of objects to continue in their state of rest or of uniform motion is called inertia

Students will know how to apply Newton's first law to explain the motion of objects | * ***Students need to already know that if the resultant force acting on a stationary object is 0N the object will remain stationary***

***Students need to already know that if the resultant force on a moving object is 0N then the object will continue to move at constant velocity.*** |  | Tier 2Tier 3Inertia: Property of matter that causes it to remain in state of rest/ constant motion, unless an external force is applied |
| **Lesson:** **Terminal Velocity** | * Students will know that an object in free fall accelerates due to gravity
* Students will know that eventually the resultant force acting on an object will be 0, and therefore the object will move at terminal velocity
* Students will know how to explain the forces acting on an object, and how these result in an object reaching terminal velocity.
* PHYSICS ONLY: Students will know how to draw and interpret velocity-time graphs for objects that reach terminal velocity.
 | * ***Students need to already know that velocity is speed with direction***
* Students need to already know that if a resultant force is = 0, then an object will remain at constant speed
 |  | Tier 2Tier 3Terminal Velocity: a constant speed a free-falling object eventually reaches |
| **Lesson:** **Newton's second law** | * Students will know that the acceleration of an object is proportional to the resultant force acting on an object, and inversely proportional to the mass of the object
* Students will know that the equation that links resultant force, mass and acceleration is:

Resultant force = mass x accelerationF = m a* Students will know that the unit of acceleration is m/s2
* Students will know how to explain that inertial mass is a measure of how difficult it is to change the velocity of an object (HT only)
* Students will know how to use the resultant force equation to calculate force, mass and acceleration
* Students will know how to estimate the speed, accelerations and forces involved in large accelerations for everyday road transport

Students will know how to convert between units | * ***Students need to already know that the unit of force is Newton***

***Students need to already know that the unit of mass is kg*** |  | Tier 2Proportional: having a constant ratio with another quantityTier 3Inertial mass: a measure of how difficult it is to change the velocity of an object |
| **Lesson:** **Required Practical - Newton's Second Law** | * Students will know that in this investigation the independent variable is force, the dependent variable is acceleration and the control variables are mass and the amount of friction
* Students will know how to investigate the effect of increasing force on the motion of an object

Students will know how to investigate the effect of varying the mass of an object on the acceleration of an object produced by a constant force | ***Students need to already know that the acceleration of an object is proportional to the resultant force applied on the object and inversely proportional to the mass of the object.*** | Recording dataInterpreting DataInterpreting Graphs | Tier 2Tier 3 |
| **Lesson:** **Momentum (HT only)** | * Students will know that momentum is defined by the equation:

momentum = mass x velocityp = m v* Students will know that the units of momentum are kg m/s

Students will know how to use the momentum equation to calculate momentum, mass and velocity | * ***Students need to already know that the unit of mass is kg***
* ***Students need to already know that the unit of velocity is m/s***

***Students need to already know how to convert units*** |  | Tier 2Tier 3Momentum: a measure of the tendency of an object to continue moving |
| **Lesson:** **Conservation of Momentum (HT only)** | * Students will know that in a closed system, the total momentum before an event is equal to the total momentum after the event
* Students will know how to describe and explain examples of momentum in an event, such as collisions

Students will know how to complete calculations involving an event, such as the collision of two objects (TRIPLE ONLY) | * ***Students need to already know that the equation for calculating momentum is:***

***Momentum = mass x velocity*** |  | Tier 2Conservation: Remaining the sameTier 3 |
| **Lesson:** **Car Safety** | * Students will know that when a force acts on an object that is moving, or able to move, a change in momentum occurs
* Students will know that the equation linking force and change in momentum is:

Force = change in momentum ÷ time taken* Students will know that car safety features, such as airbags, seat belts and crumple zones, reduce force by increasing the time taken for a change in momentum
* Students will know how to explain how further safety equipment, such as crash mats and cycle helmets, reduce the force felt

TRIPLE ONLY: Students will know how to complete calculations involving the change in momentum equation | * ***Students need to already know that the unit of mass is kg***
* ***Students need to already know that the unit of velocity is m/s***

***Students need to already know how to convert units*** | Interpreting Data | Tier 2Tier 3 |
| **Lesson:** **Stopping Distance** | * Students will know that the stopping distance of a vehicle is the sum of the thinking distance and the braking distance
* Students will know that the thinking distance is the distance the vehicle travels during the driver's reaction time
* Students will know that the braking distance is the distance the vehicle travels under the braking force
* Students will know that the greater the speed of the vehicle, the greater the stopping distance
* Students will know that reaction times vary from person to person, with typical values ranging from 0.2 to 0.9 s
* Students will know that a driver's reaction time can be affected by tiredness, drugs, alcohol and distractions
* Students will know that when brakes are applied on a vehicle, work is done by the friction force between the brakes and wheels to reduce the kinetic energy of the vehicle, causing the temperature of the brakes to increase
* Students will know that the greater the speed of a vehicle the greater the braking force needed to stop the vehicle.
* Students will know that large decelerations can lead to brakes overheating and/ or loss of control.
* Students will know how to evaluate the effect of various factors on braking distance
* Students will know that the braking distance of a vehicle can be affected by adverse road and weather conditions (such as wet or icy conditions) and poor condition of the vehicle (such as brakes or tyres)
* Students will know how to measure human reaction times.
* Students will know how to evaluate measurements from simple methods to measure the different reaction times
* Students will know how to evaluate the effect of various factors on thinking distance.
* TRIPLE ONLY: Students will know how to estimate the distance for a vehicle to make an emergency stop varies over a range of speeds typical for that vehicle

TRIPLE ONLY: Students will know how to interpret graphs relating speed to stopping distance for a range of vehicles | ***Students need to already know that kinetic energy is a store of energy in a moving object*** |  | Tier 2Tier 3Stopping Distance: the total distance a car travels when coming to a stopThinking distance: the distance a car travels when the driver responds to a stimulus and applies their foot to the brakeBraking distance: the distance a car travels when the brake has been applied |
| **Lesson:** **Newton's Third Law** | * Students will know that whenever two objects interact, the forces they exert on each other are equal and opposite

Students will know how to apply Newton's Third Law to examples of equilibrium situations | ***Students will already know that forces at equilibrium have a resultant force of 0N.*** |  | Tier 2Tier 3Equilibrium: when two opposing forces are balanced and cancelling each other out |
| **Lesson:** **Forces and Elasticity** | * Students will know that at least two forces are required to stretch, compress or twist an object
* Students will know that elastic deformation means that an object is able to return to its original shape once the forces have been removed
* Students will know that inelastic deformation means that an object is unable to return to its original shape after the forces have been removed
* Students will know that the extension of an object is directly proportional to the force applied, up until the limit of proportionality.
* Students will know that the equation that links force, spring constant and extension is:

force = spring constant x extensionF = k e* Students will know that, when looking at compressed elastic objects, the extension is the compression of the object
* Students will know how to calculate work done in stretching a spring using the equation:
* elastic potential energy = 0.5 x spring constant x extension squared
* Students will know how to use the force equation to calculate force, spring constant and extension
* Students will know how to describe the difference between linear and non-linear relationships between force and extension

Students will know how to interpret data from an investigation of the relationship between force and extension | * ***Students will already know that the unit for force is N***
* ***Students will already know that the unit of extension is m***

***Students will already know that the unit of spring constant is N/m*** | Interpreting graphsInterpreting data | Tier 2Compress: squashTier 3Elastic deformation: object returns to its original shape when forces are removedInelastic deformation: object doesn’t return to its original shape when forces are removed |
| **Lesson:** **Hooke's Law Required Practical** | * Students will know the method used to investigate the effect of increasing the force applied to an elastic object on the extension of the elastic object
* Students will know that the independent variable is the force
* Students will know that the dependent variable is extension

Students will know that the control variables include the object the force is being applied to | * ***Students will already know how to convert cm to m***

***Students will already know that the force of weight is changed when mass is changed*** | Interpreting graphsIdentifying and controlling variables |  |
| **Lesson:** **Moments (triple only)** | * Students will know that a force or a system of forces may cause an object to rotate
* Students will know how to describe examples in which forces cause rotation
* Students will know that the turning effect of a force is called the moment of the force
* Students will know that the size of the moment of a force can be calculated using:

Moment of a force = force x distanceM = F d* Students will know that the unit of moments is Nm
* Students will know that the distance is the perpendicular distance from the pivot to the line of action of the force, in metres
* Students will know that if an object is balanced, the total clockwise moment about a pivot equals the total anticlockwise moment about the pivot
* Student will know how to calculate the size of the force or the distance from a pivot acting on an object that is balanced
* Students will know that a simple lever and gear system can be used to transmit the rotational effects of a force

Students will know how to explain how levers and gears transmit the rotational effects of forces | ***Students will already know that the unit for force is N*** |  | Tier 2Tier 3Moment: the turning effect of a force |
| **Lesson:** **Pressure (triple only)** | * Students will know that the pressure in fluids causes a normal force to any surface
* Students will know that the pressure at the surface of a fluid can be calculated using:

Pressure = force normal to a surface ÷ area of the surface* Students will know that the unit of pressure is pascals, Pa
* Students will know that the pressure due to a column of liquid can be calculated using the equation:

Pressure = height of the column x density of the liquid x gravitational field strengthp = h ρ g* Students will know how to explain why in a liquid pressure at a point increases with the height of the column of liquid
* Students will know how to calculate the differences in pressure at different depths in a liquid
* Students will know that a partially/ totally submerged object experiences a greater pressure on the bottom surface than on the top surface. This creates a resultant force upwards (upthrust)

Students will know the factors that influence floating and sinking | * ***Students will already know that a fluid can be either a liquid or a gas***
* ***Students will already know how to calculate area of simple shapes, such as circles, rectangles and squares***

***Students will already know that the unit of density is kg/m3*** |  | Tier 2Submerged: under waterTier 3Fluid: liquid or gasNormal: at right angles |
| **Lesson:** **Atmospheric Pressure (triple only)** | * Students will know that the atmosphere is a relatively (to the size of the Earth) thin layer of air around the Earth
* Students will know that the atmosphere gets less dense with increasing altitude
* Students will know that atmospheric pressure is caused by air molecules colliding with a surface.
* Students will know that the number of air molecules above a surface decreases as the height of the surface above ground level increases.
* Students will know that as height increases there is less air above a surface than there is at a lower height. This means that atmospheric pressure decreases with an increase in height.
* Students will know how to describe a simple model of the Earth's atmosphere and of atmospheric pressure

Students will know how to explain why atmospheric pressure varies with height above a surface. | ***Students will already know that the Earth's atmosphere consists of gases.*** |  | Tier 2Tier 3 |