# Mechanics

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| Unit Reference Number | F/618/6104 |
| Unit Title | Mechanics |
| Unit Level | 3 |
| Number of Credits | 10 |
| Total Qualification Time (TQT) | 100 |
| Guided Learning Hours (GLH) | 40 |
| Mandatory / Optional | Mandatory |
| Sector Subject Area (SSA) | 14.1 Foundations for learning and life |
| Unit Grading Structure | Pass / Fail |

## Unit Aims

The aim of this unit is for learners to investigate the motion of particles and objects under the influence of interacting forces. They will also learn about sources of energy and conservation of energy.

## Learning Outcomes, Assessment Criteria and Indicative Content

| Learning Outcomes – The learner will: | Assessment Criteria – The learner can: | Indicative contents |
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| 1. Understand the motion of objects in mathematical terms. | 1.1 Explain the relationships between displacement, velocity and acceleration.<br>1.2 Draw distance–time graphs from measurements and extract and interpret lines and slopes of distance–time graphs.<br>1.3 Discuss Newton’s Three Laws of Motion with examples. | • Relationships between displacement, velocity, and acceleration<br>○ Distance is how far an object moves. Distance does not involve direction. Distance is a scalar quantity.<br>○ Displacement includes both the distance an object moves, measured in a straight line from the start point to the finish point and the direction of that straight line. Displacement is a vector quantity.<br>○ Displacement in terms of both the magnitude and direction. |

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| | | ○ The velocity of an object is its speed in a given direction. Velocity is a vector quantity.<br>○ Vector–scalar distinction as it applies to displacement, distance, velocity and speed.<br>○ Qualitatively: motion in a circle involves constant speed but changing velocity.<br>○ The acceleration of an object can be calculated from the gradient of a velocity–time graph.<br>○ Estimate the magnitude of everyday accelerations.<br>• Distance–time graphs: A horizontal line on a distance-time graph shows that the object is stationary (not moving because the distance does not change) A sloping line on a distance-time graph shows that the object is moving.<br>• Draw distance–time graphs from measurements and extract and interpret lines and slopes of distance–time graphs, translating information between graphical and numerical form.<br>• Determine speed from a distance–time graph.<br>• Apply Newton's First Law to explain the motion of objects moving with a uniform velocity and objects where the speed and/or direction changes.<br>• Apply Newton's Second Law to estimate the speed, accelerations and forces involved in large accelerations for everyday road transport.<br>• Apply Newton's Third Law to examples of equilibrium situations. |
| 2. Understand energy changes in a | 2.1 Explain the ways energy is stored before and after such changes. | • A system is an object or group of objects. There are changes in the way energy is stored when a |

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| system. | 2.2 Calculate the changes in energy involved when a system is changed by:<br>• heating<br>• work done by forces<br>• work done when a current flow<br>2.3 Calculate the amount of energy associated with a moving object, a stretched spring and an object raised above ground level. | system changes.<br>• Changes involved in the way energy is stored when a system changes, for common situations. For example:<br>○ an object projected upwards<br>○ a moving object hitting an obstacle<br>○ an object accelerated by a constant force<br>○ a vehicle slowing down<br>○ bringing water to a boil in an electric kettle.<br>• Calculate the changes in energy involved when a system is changed by:<br>○ heating<br>○ work done by forces<br>○ work done when a current flow<br>• The kinetic energy (K.E.) of a body is the energy a body has as a result of its motion. A body which is not moving will have zero kinetic energy, therefore.<br>• K.E. = ½ $mv^2$<br>• **<u>Conservation of Energy</u>**<br>• If gravity is the only external force which does work on a body, then the total energy of the body will remain the same, a property known as the conservation of energy.<br>• Therefore, providing no work is done: Initial (PE + KE) = final (PE + KE)<br>• **<u>Power</u>**<br>Power is the rate at which work is done (measured in watts (W)), in other words |

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| | | the work done per second.<br>• It turns out that: Power = Force × Velocity<br>• Calculate the amount of energy associated with a moving object, a stretched spring and an object raised above ground level.<br>• The kinetic energy of a moving object can be calculated using the equation:<br>*kinetic energy* =0.5 ×*mass* × *speed* $^2$ |
| 3. Understand energy transfer, forces and elasticity. | 3.1 Calculate the energy transfer involved when work is done.<br>3.2 Convert between newton-metres and joules.<br>3.3 Give examples of the forces involved in stretching, bending or compressing an object.<br>3.4 Describe the difference between elastic deformation and inelastic deformation caused by stretching forces. | • The work done by a force on an object can be calculated using the equation:<br>work done = force × distance<br>(moved along the line of action of the force)<br><br>$W = Fs$<br>work done, $W$, in joules, J force, $F$, in newtons, N distance, $s$, in metres<br><br>• One joule of work is done when a force of one newton causes a displacement of one metre.<br><br>1 joule = 1 newton-metre<br><br>Students should be able to describe the energy transfer involved when work is done.<br><br>• The extension of an elastic object, such as a spring, is directly proportional to the force applied, provided that the limit of proportionality is not exceeded.<br><br>*force =spring constant ×extension F=ke* |

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| | | force, *F*, in newtons, N<br><br>spring constant, *k*, in newtons per metre, N/m<br><br>extension, *e*, in metres, m<br><br>• This relationship also applies to the compression of an elastic object, where '*e*' would be the compression of the object.<br>• A force that stretches (or compresses) a spring does work and elastic potential energy is stored in the spring. Provided the spring is not inelastically deformed, the work done on the spring and the elastic potential energy stored are equal. |

## Assessment

To achieve a 'pass' for this unit, learners must provide evidence to demonstrate that they have fulfilled all the learning outcomes and meet the standards specified by all assessment criteria.

| Learning Outcomes to be met | Assessment criteria to be covered | Type of assessment |
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| All 1 to 3 | All AC under LO 1 to 3 | Coursework –<br>The assessment focuses on breadth, challenge and application. Learners will draw on and extend the skills they have learned during the teaching of the unit. |

## Indicative Reading list


- Hibbeler, R. (2016) *Engineering Mechanics: statics and dynamics*. 14th ed. Prentice Hall
- Meriam, J. & Krasige, L. (2016) *Engineering Mechanics: dynamics*. 8th ed. John Wile