202: Principles of electrical science  
**Handout 15: Basic mechanics**

**Learning outcome**

The learner will:

1. Understand basic mechanics and the relationship between force, work, energy and power.

**Assessment criteria**

The learner can:

3.3 describe the main principles of the following and their interrelationships: (force, work, energy (kinetic and potential), power, efficiency).

3.4 calculate values of mechanical energy, power and efficiency

**Basic mechanics**

**Mass**

Mass can be defined as the amount of material in an object. The SI unit of mass is the kilogram (kg).

**Acceleration**

When an aircraft takes off, it starts from rest and increases its velocity until it can fly. This change in velocity is called acceleration. Acceleration is the change in velocity with time.

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| where: |  |  |  |
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The SI unit for acceleration is the metre per second per second or m/s2.

**Example 1**

If a car accelerates from a velocity of 3 m/s to 15 m/s in 4 seconds, calculate its average acceleration.

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Thus, the average acceleration is 3 metres per second, every second.

**Force**

The SI unit of force is the Newton (N).

A mass of 1 kilogram experiences a force of 9.81 Newtons as a result of gravity. In other words, it would require a force of **9.81 Newtons** to raise a mass of 1kg against the pull of gravity (on Earth).

To calculate the force on a body due to gravity (on earth) multiply its mass by 9.81.

**Example 2**

A bundle of conduit has a mass of 800kg. What force will be required to lift it?

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A force can be described as a ‘push’ or a ‘pull’.

When a force acts on a body, it may:

1. accelerate the body
2. decelerate the body
3. deform the body, ie change its shape
4. be exactly resisted by other forces (equilibrium).

**Work done**

If a force is applied to a body and movement takes place then it is said that work has been done.

For example, when a weight is lifted, work is done.

Work is measured in terms of the distance moved by the body and the force that caused its movement. When the movement is in the same direction as the force, the work done is equal to the distance moved, multiplied by the force exerted.

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**Force** is measured in **Newtons**.- **Work done** is measured in **Newton metres** (Nm)

**Example 3**

What work must be done to lift a 200kg bundle of conduit from the floor on to a rack 2 metres high?

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**Energy**

Energy is the capacity for doing work. It may exist in potential, kinetic, thermal, electrical, chemical, nuclear, or other various forms.

The units of energy is the Newton-metre or **Joule**.

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**Power**

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|  | The unit of Power is the **watt.** | Since the watt is a small unit, the kilowatt is often used. | |
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**Efficiency**

The efficiency of a system can be defined as the ratio of output power to input power and is usually expressed as a percentage.

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The difference between input power and output power is the wasted energy or losses. Therefore:

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| or |  |  |  |

**Example 4**

A motor produces 100 watts output power and is:

1. 50% efficient
2. 70% efficient.

Calculate its input power in each case.

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**Example 5**

An electric motor drives a pump that lifts 1,000 litres of water each minute to a tank 20 metres above ground level. Calculate the power that the motor must provide if the pump is only:

1. 50% efficient
2. 80% efficient.

**NB**: One litre of water weighs 1kg (1kg = 9.81N)

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|  | Joules |  |  |
|  | Watts |  |  |

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|  | Power (Watts) |  |  |  |
| (because time taken is 1 minute) |
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