UNIT 2: SCIENCE FOR ENGINEERING

LO4: UNDERSTAND PROPERTIES OF MATERIALS

Mr M. Oyebo - Level 3 Engineering
AIMS & OBJECTIVES

• **Learners to analyse the general properties of metals, wood and polymers**

• **To investigate force-extension graphs and to complete tasks based on it**

• **To investigate technical terms used in lesson through independent learning**

Learning Objective: To investigate material properties and force-extension graphs
STATER ACTIVITY

- **LEARNERS TO COMPLETE ‘PROPERTIES OF MATERIALS WORKSHEET’ TO EXAMINE PRIOR KNOWLEDGE OF PROPERTIES OF MATERIALS.**

Learning Objective: To investigate material properties and force-extension graphs
PROPERTIES OF MATERIALS

DUCTILITY
THE ABILITY OF A MATERIAL TO CHANGE SHAPE (DEFORM) USUALLY BY STRETCHING ALONG ITS LENGTH.

TENSILE STRENGTH
THE ABILITY OF A MATERIAL TO STRETCH WITHOUT BREAKING OR SNAPPING.

Learning Objective: To investigate material properties and force-extension graphs
PROPERTIES OF MATERIALS

STRENGTH

The ability of a material to stand up to forces being applied without it bending, breaking, shattering or deforming in any way.

ELASTICITY

The ability of a material to absorb force and flex in different directions, returning to its original position.

Learning Objective: To investigate material properties and force-extension graphs
PROPERTIES OF MATERIALS

PLASTICITY

The ability of a material to be change in shape permanently.

MALLEABILITY

The ability of a material to be reshaped in all directions without cracking.

Learning Objective: To investigate material properties and force-extension graphs
PROPERTIES OF MATERIALS

TOUGHNESS
A characteristic of a material that does not break or shatter when receiving a blow or under a sudden shock.

HARDNESS
The ability of a material to resist scratching, wear and tear and indentation.

Learning Objective: To investigate material properties and force-extension graphs
PROPERTIES OF MATERIALS

CONDUCTIVITY

The ability of a material to conduct electricity.

Learning Objective: To investigate material properties and force-extension graphs
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MAIN ACTIVITY TASK

• **Complete Cambridge Technical in Engineering Lesson Element worksheet on properties of materials.**

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**Learning Objective:** To investigate material properties and force-extension graphs
GENERAL PROPERTIES

• **Metals** – Made up of crystals containing atoms and molecules of the various elements that make up the material.

• **Good strength in Compression and Tension**, due to very strong metallic bonds holding the atom together.

• **The metallic bonds allow for free electrons to be shared**, making metals very good conductors of Heat and Electricity.

Learning Objective: To investigate material properties and force-extension graphs
GENERAL PROPERTIES

• **WOODS – FIBROUS MATERIAL MADE UP OF AN ARRANGEMENT OF PLANT CELLS (TRACHEIDS) AND RESINS.**

• **NO FREE ELECTRONS IN THE MATERIAL STRUCTURE, MAKING THEM EXCELLENT INSULATORS OF HEAT AND ELECTRICITY.**

• **GREATER STRENGTH ALONG THE GRAIN (FIBRES), GENERALLY BETTER IN COMPRESSION THAN TENSION.**

• **A TREE IS 55% CELLULOSE, 28% LIGNIN & 17% CARBOHYDRATES (LIKE SUGARS).**

• **WOOD IS CONSIDERED A NATURAL COMPOSITE.**

• **HARDWOODS AND SOFTWOODS DIFFER IN STRUCTURE.**

Learning Objective: To investigate material properties and force-extension graphs
GENERAL PROPERTIES

• **POLYMERS** – are long chain molecules containing **carbon**, **hydrogen** (hydrocarbons) and **oxygen** atoms. Along with others such as **chlorine** and **fluorine**.

• **No free electrons in the material structure**, making them excellent insulators of **heat and electricity**.

• **There are three main types of plastic**.

Learning Objective: To investigate material properties and force-extension graphs
Long chain molecules held together by strong electrostatic forces called (van der Waals bonds).

These bonds can be released by applying heat allowing the material to be reshaped.

Long chain molecules held together by rigid cross links.

These links prevent the plastic being reshaped through the application of heat.

Long chain molecules considered to be coiled like sprigs.

When the material is distorted (compressed or stretched) the molecules distort, returning to their original shape when released.

Learning Objective: To investigate material properties and force-extension graphs
ELASTIC POTENTIAL ENERGY

A force acting on an object may cause the shape of an object to change. Elastic objects can store elastic potential energy if they are stretched. For example, this happens when a catapult is used.

Elastic objects can also store elastic potential energy when they are squashed. For example, this happens when a squash ball is dropped onto a hard surface.
FORCE EXTENSION
GRAPH

• **Hooke's Law**

• **When an elastic object - such as a spring - is stretched, the increased length is called its extension. The extension of an elastic object is directly proportional to the force applied to it:**

• \( F = k \times E \)

• **F** is the force in newtons, N

• **k** is the 'spring constant' in newtons per metre, N/m

• **E** is the extension in metres, m

• **This equation works as long as the elastic limit (the limit of proportionality) is not exceeded. If a spring is stretched too much, for example, it will not return to its original length when the load is removed.**

Learning Objective: To investigate material properties and force-extension graphs
The flexibility of Elastomers

At rest

Pushed

Pulled

Elastomers

Learning Objective: To investigate material properties and force-extension graphs
MECHANICAL PROPERTIES

- **Malleability** – The ability to withstand deformation.
  - **Ductility** – The ability to be drawn out.
- **Toughness** – The ability to withstand sudden impact.
  - **Elasticity** – The ability to flex and bend.
- **Plasticity** – The ability to be shaped permanently.
- **Hardness** – The ability to resist wear, indentation or deformation.
- **Durability** – The ability to withstand wear and tear, weathering or deterioration.

- **Stability** – The ability to resist changes in size and shape due to its environment.
- **Strength** – Tensile, Compressive, Bending, Shear and Torsional.

Learning Objective: To investigate material properties and force-extension graphs.
PHYSICAL PROPERTIES

• **Fusibility**
  • Density

• Electrical Conductivity

• Electrical Insulators
  • Semi-conductors

• Thermal Properties
  • Conductivity
  • Insulator
  • Expansion

• Optical Properties
  • Opaque
  • Translucent
  • Transparent

• Magnetism

Learning Objective: To investigate material properties and force-extension graphs
PLENARY

• **Group Discussion on elements covered**

• **Write a brief fact file on the elements taught today using a single side of A5 paper**

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