12.1 Constraints & Deformations

Write into notes please

- Stress caused by normal use.
- ***Constraints*** are the different types of stresses

1. Compression (crush)
2. Tension (stretch)
3. Torsion (twist)
4. Deflection (bend)
5. Shearing (cut)

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Write into notes please

- **Deformation** is the change in shape caused by a constraint.
  1. **Elastic (go back to original shape)**
  2. **Plastic (changed into new shape)**
  3. **Fracture (break)**

12.2 Mechanical Properties

Write into notes please

- ***Mechanical properties*** of a material determine how it will react when subjected to one or more constraints.

Main
1. Hardness (resist dents without breaking)
2. Elasticity (return to it's original shape)
3. Resilience (resist shocks)
4. Ductility (stretches)
5. Malleability (flattened/bent without breaking)
6. Stiffness (keep it's shape)

Other
7. Resist Corrosion
8. Electrical conductivity (carry current)
9. Thermal conductivity (transmit heat)

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12.3 Categories of Materials and their Properties

Write into notes please

- Let's have a closer look at the following materials and their properties:
  1. Wood and Modified Wood
  2. **Ceramics**
  3. Metals and Alloys
  4. Plastics
  5. **Composites**

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Please paste table into notes!

Metals and alloys	Electrical conductivity Hardness Magnetism Oxidation	
Ceramics	Hardness Low electrical conductivity Wear resistance Heat resistance Corrosion resistance	
Composites	Durability Hardness Elasticity Lightness Resilience Stiffness Corrosion resistance	
Plastics	Thermoplastics	Chemical neutrality (unreactive) Elasticity Lightness Resilience Corrosion resistance
	Thermosetting plastics	Hardness Resilience Heat resistance Stiffness

You need to be able to explain using these properties why a certain material is or is not a good choice

---

Write into notes please

Degradation and Protection of Wood

- **Treated wood** is made resistant to rot by:
  - □*Dipping it in an **alkaline solution** containing copper. This wood usually has a **greenish colour**.*
  - □*Heating it to a **high temperature**.*
- ***Some woods, such as cedar, have a natural resistance to rot.***
- *Coatings (paint, stain, varnish)*

Properties of Ceramics

- Their properties depend on the raw material and the method of baking.
- Ceramics can be a good choice for many objects because:
  - Low electrical conductivity
    - used as insulators
  - High degree of hardness
    - building materials & cutting tools
  - Heat resistance and low thermal conductivity
    - dishes, cookware & thermal insulators
  - Resistance to corrosion
    - used in ducts for fumes or water
  - Fragility - very fragile, but some can be made so resilient they are used in engines ☹

Refer to table! And add examples please!

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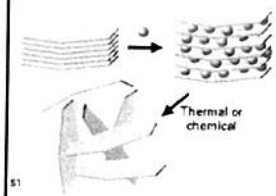
The Degradation and Protection of Ceramics

Write into notes please

- Can be degraded by some acids & bases
- A thermal shock (a sudden change in temperature) can cause damage to a ceramic object.
- Glazes can be used to protect the ceramics



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The Degradation and Protection of Metals & Alloys

Please write into notes

- The main cause for metal and alloy degradation is ***oxidation***, where the material reacts with oxygen. This is commonly referred to as rusting.
- Metals & Alloys can be protected by coating it with a substance that isolates it from the oxygen in the air:
  - Metallic coatings: zinc, chrome, gold, silver, nickel, aluminum, lead
  - Other coatings: paint, enamel, grease, resin

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Techniques to enhance the properties of Metals & Alloys

Write into notes please

- ***Steel heat treatments***
- These methods include:
  - Quench hardening
    - Atoms are rearranged at high temperatures and then set by
    - dropping into a cool liquid (water, oil, …)
    - Hardens the steel but is brittle!
  - Tempering
    - Atoms are rearranged at lower temperatures than quenching
    - Hardens the steel (less brittle than above & softer)
  - Annealing
    - Very slow process!
    - Relieves stress (caused by welding)
    - Returns original properties (ductility)

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Types of Plastics

Write into notes please

- A ***thermoplastic*** is a plastic that becomes soft enough when heated to be molded or remolded and that hardens enough when cooled to hold its shape.
  - Most plastic objects are made of this type.
  - Most thermoplastics can be recycled
- A ***thermosetting plastic*** is a plastic that remains permanently hard, even when heated.
  - Often harder and more resilient than thermoplastics
  - Include melamine and polyesters
  - Cannot be recycled in Quebec

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The Degradation and Protection of Plastics

Write into notes please

- Plastics tend to degrade over time. This process is usually slow, but can be detected as cracks and changes in colour appear.

THE MAIN CAUSES OF PLASTIC DEGRADATION

Cause	Description	Example of a method of protection
Penetration by a liquid	Substances in the liquid state (such as water) or solutions (such as an acid) can penetrate certain plastics and cause them to degrade	Protection with a waterproof coating
Oxidation	Oxygen and other gases with similar properties can react with the polymers in certain plastics and cause the material to degrade	Addition of antioxidants, such as carbon black
Ultraviolet rays	Ultraviolet rays, especially those from the sun, can damage plastic polymers	Addition of pigments that absorb ultraviolet rays

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Plastics

Write into notes please

- made from fossil fuels
  - petroleum and natural gas
- Monomers are extracted from the fossil fuels and are arranged into long chains called polymers.
- ***Plastic*** is a material made of polymers, to which other substances may be added to obtain certain desirable properties.

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Types of Plastics

Write into notes please

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  - Cannot be recycled in Quebec

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The Degradation and Protection of Plastics

Write into notes please

- Plastics tend to degrade over time.
  - Slow
    - Cracks form
    - Change in colour
- Causes & Prevention
  - Penetration of a liquid →Waterproof coating
  - Oxidation →Add an antioxidant
  - UV →Add a pigment that absorbs UV

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Kevlar is a composite

The Degradation and Protection of Composites

Write into notes please

- The degradation of composites usually takes one of two forms:
  1. The deformation or fracture of the matrix (body) or the reinforcement (skeleton).
  2. The loss of adherence between the matrix and the reinforcement.
- The speed of degradation depends on the type of matrix and reinforcement and the conditions of use.

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Write into notes please

12.4 Projections

- A ***projection*** is the representation of a three-dimensional object on a two-dimensional surface.
- Two of the most commonly used projections are:
  1. isometric
  2. multiview.

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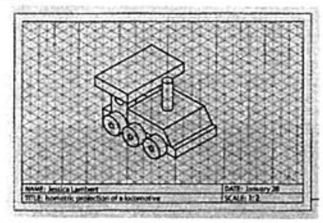
Write into notes please

- A drawing is an <u>isometric</u> <u>projection</u> if the lines representing the length, width, and height make angles of 60° or 120°.
- It is in 3D



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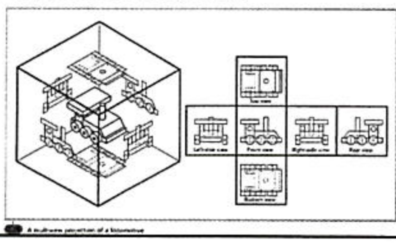
Write into notes please

- In a <u>multiview projection</u>, each face of the object is drawn separately looking at it from straight on. (not distorted)
- Usually only the top, front and right side of the object are illustrated.



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Write into notes please

12.5 Engineering Drawings

- A ***<u>general arrangement</u>*** is a technical drawing representing the overall appearance on an object.
- It usually includes:
  - □Multiview projection (top, front, & right side)
  - □Isometric projection drawn to scale.
  - □and a ***title block***
    - □Name
    - □Date
    - □Title
    - □Scale

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- An ***<u>exploded view</u>***
  - □separates the parts.
  - □uses an isometric projection.
  - □Must give a list of parts.
  - □See p404

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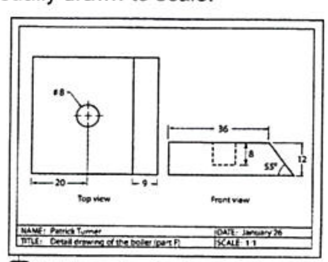
Write into notes please

12.6 Detail Drawings:

- specify all of the relevant information for manufacturing a part.
- Are usually drawn to scale.



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Scale in Drawings

- 1:1 object is drawn life size
- 1:2 **reduced scale** (drawing of object is ½ of its actual size, also 1:5, 1:100 etc)
  - 1 cm on drawing is 2 cm in real life (1:2)
- 2:1 **enlarged scale** (a small object is drawn larger than in real life, also 5:1, 100:1 etc)
  - 5 cm on drawing is actually 1 cm in real life (5:1)

12.7 Precision

- Since machines, tools, instruments, and the people operating the machines are not perfect, the manufactured parts may be slightly different from the dimensions indicated on the drawing.

Write into notes please

- A ***dimensional tolerance*** is an indicator of the maximum acceptable difference between a specified measurement and the actual measurement on the finished object.
  - Ex.1 3.0 ± 0.5 cm → From 2.5 to 3.5
  - Ex.2 $12^{+0.1}_{0}$ → From 12.0 to 12.1
  - Ex.3 $22^{+0.1}_{-0.2}$ → From 21.8 to 21.1

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Write into notes please

- The ***functional dimensioning*** of a drawing specifies the information required for the object to work.
  - Eg. How much play is required for a blade to slide freely in a utility knife is shown as the space between the blade and the guide.

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12.8 Developments

Write into notes please

- A ***development*** is the representation of the surface area required to make a part by bending.
  - Eg Sheet metal
  - The development shows the surface area of the material &
  - the lines where the sheet will be bent.

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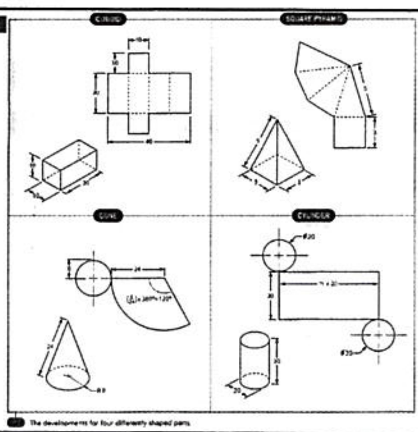

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Write into notes please

12.9 Diagrammatic Representations

- A ***diagram*** is a simplified representation of an object, a part of an object, or a system.
- Diagrams are used to help explain an object's operating principals as well as any other characteristics that must considered during the manufacturing process.
- Depending on the type of information that a drafter wishes to display, one of the following common diagrams will be chosen:
  - Design Plan
  - Technical Diagram
  - Circuit Diagram

see page 409

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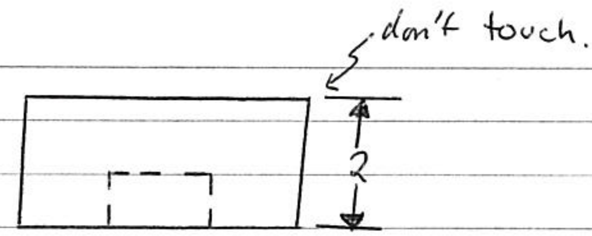
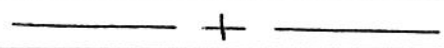
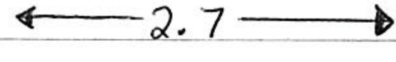
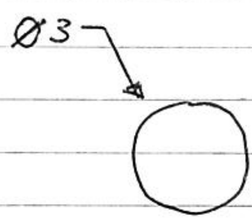
Visible lines



Hidden line

Centre line 

Dimension line 



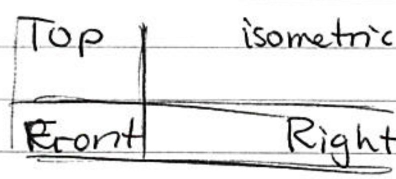
diameter is 3.

R radius

 degree of an angle.

Do not repeat dimentions! Spread out on multiview.

Always



isometric.

Tolerance Practice.

3.52 ± 0.01	3.51 to 3.53
2.55 ± 0.06	2.49 to 2.61
$1.75^{+0.03}_{\ 0}$	1.75 to 1.78
$1.30^{\ 0}_{-0.01}$	1.29 to 1.30

Write into notes please

12.9 Diagrammatic Representations

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  - ☐ Design Plan
  - ☐ Technical Diagram
  - ☐ Circuit Diagram

see page 409

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The Most Common Types of Diagrams

THE MOST COMMON TYPES OF DIAGRAMS

Type of diagram	Purpose	Information usually conveyed
Design plan	Provides information on one or more of the operating principles of an object.	• Names of the parts • Movement of the parts • Operational forces involved • Any other useful information for understanding how the object works
Technical diagram	Provides information on the selected manufacturing process of an operational object.	• Important shapes and dimensions to be considered in the manufacture of parts • Names of the parts • Materials to be used • Linking components, if applicable • Types of guiding controls, if applicable • Any other useful information for manufacturing the object
Circuit diagram	Provides information on the layout of various components of an electrical circuit.	• Various circuit components • Any other useful information for understanding how the electrical circuit should be built

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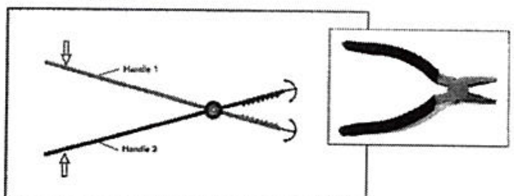
- Design Plan
  - ☐ Name of parts
  - ☐ Movement of parts
  - ☐ Shows forces
  - ☐ Other…

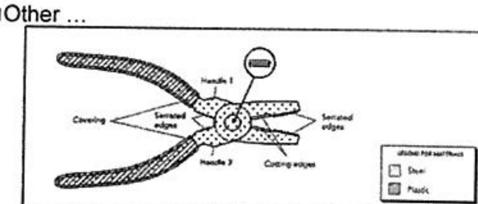
Write into notes please



Design plan for a pair of pliers

- Technical Diagram
  - ☐ Name of parts
  - ☐ Material to be used
  - ☐ Links
  - ☐ Guiding
  - ☐ Other …

Write into notes please



Technical diagram for a pair of pliers

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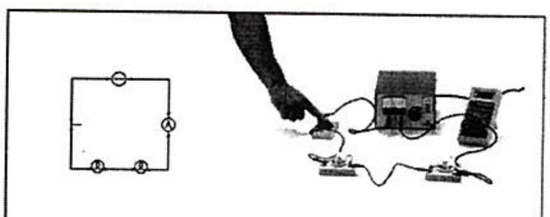
- Circuit Diagram
  - ☐ Shows circuit components
  - ☐ Other….

Write into notes please



Circuit diagrams for an electrical circuit assembly

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Standardized Symbols In Diagrams

SYMBOLS USED IN DIAGRAMS

Elements symbolized	Examples			
Forces and constraints	Force	Compression	Tension	Shearing
Motion	Unidirectional translation	Bidirectional translation	Unidirectional rotation	Bidirectional helical motion
Links and guiding controls	Complete link	Translational guiding control	Rotational guiding control	Translational and rotational guiding control
Electrical components	Battery	Light bulb	Electrical wire	Push-button switch

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Write into notes please

12.10 Manufacturing: Tools & Techniques

- Once the materials have been chosen and the plans have been drawn, the object must be manufactured.
- ***Manufacturing*** is the process of creating a technical object.
- The various steps in the manufacturing of an object require the use of various instruments.

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Write into notes please

- A ***tool*** is an instrument to manufacture an object.
  - A ***hand tool*** is powered by human force.
  - A ***machine tool*** is powered by forces other than human.
- The manufacturing process is usually divided into three parts:
  1. Measuring and laying out the parts
  2. Machining the parts
  3. Assembling and finishing the parts

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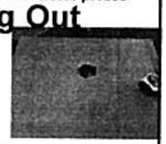
Write into notes please

Step 1 Measuring & Laying Out



- Find the info from:
  - the detailed drawings, or
  - manufacturing process sheet.
    - has the steps needed to make a part, &
    - A list of the materials and tools required.

- ***Measuring out*** is determining the size/position of a marking.
- ***Laying out*** is tracing markings or reference points onto a material.

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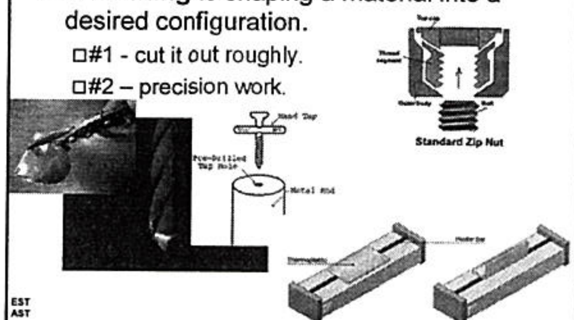
Step 2 Machining

Write into notes please

- ***Machining*** is shaping a material into a desired configuration.
  - #1 - cut it out roughly.
  - #2 – precision work.



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Write into notes please

- ***Cutting*** = giving a material a desired shape.
- ***Drilling*** = making a hole in a material.
- ***Tapping*** = a machining technique in which screw threads are formed <u>inside</u> holes drilled into a material.
- ***Threading*** = a machining technique in which screw threads are formed <u>around</u> a rod.
- ***Bending*** a material is curved into a certain shape.

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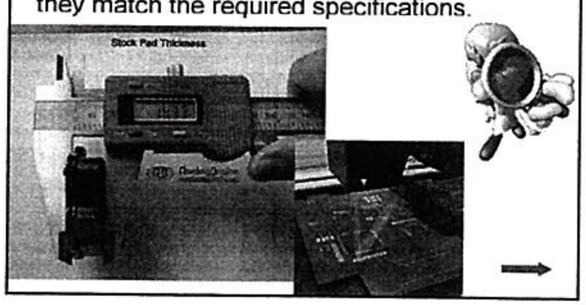
Step 3 Inspection

Write into notes please

- Throughout the machining phase, the parts are measured and inspected to ensure that they match the required specifications.



Write into notes please

Step 4 Assembling and Finishing

- ***Assembling*** = various parts are united to form a complete technical object.
  - Techniques used for assembling include:
    - nailing,
    - screwing,
    - bonding,
    - Riveting & bolting,
    - welding.
- ***Finishing*** The finish protects the materials from the elements and enhances the appearance of the object.
  - Finishing techniques include:
    - painting, varnishing, staining,
    - polishing.

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