

Section Seven — Knowledge Organiser

Read on for a summary of the key facts on mechanical and electronic systems, components and their properties...

Material Properties in Systems

	Material	Uses	Properties
vehicles	steel	brake discs, engine, wheels, drive shaft, body	strong, tough, easy to work, malleable, cheap
	aluminium	body	corrosion-resistant, light
home appliances	rubber / polyurethane	washing machine drive belt	strong, flexible
	plastic / stainless steel	washing machine drum, pumps, valves	corrosion-resistant
	nickel-chromium alloy	heating elements in e.g. toasters	high melting point, corrosion-resistant

Photosensitive materials — properties **change** when exposed to **light**. E.g. **camera films**, **LDRs**, use in **PCBs**.

Anodisation — electric current used to **thicken** protective **oxide layer** on metal. **Anodised aluminium** is **harder** than regular aluminium. Used in **aircraft parts**, **pans**, **window frames**.

Laser Cutting CAM machine using CNC. Cuts in 2D, so used on sheets of plastic, wood, cardboard, fabric, metals. High precision and accuracy, but **expensive**. Used to make **mechanical components** and **PCBs**.

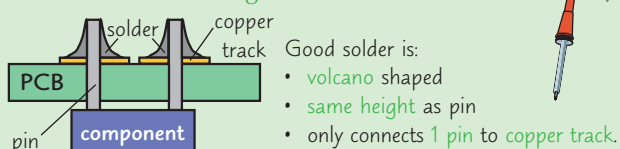
Making a Printed Circuit Board (PCB)

PCBs made using **photo-etching**:

1. Layout of **copper tracks** designed and printed onto **mask**.
2. **Mask** applied to **blank PCB** over **photosensitive layer**.
3. PCB **exposed** to **UV**, mask **blocks** UV from where tracks will be.
4. **Developer** dissolves parts of **photosensitive layer** exposed to UV and **etching chemical** dissolves **exposed copper**.
5. Remaining photosensitive layer **removed**, leaving copper tracks.

PCBs need **tiny, precise holes** (created by **drill press** or **CAM drill**) for component pins/wires to slot through. Components added by **hand** or **pick & place machines**.

Solder — **tin-based**, **electrically conductive** alloy. Used to connect components in PCB circuits. Melted with **soldering iron** and left to set.



Flow soldering — PCB passed over pan of **molten solder**. Pump creates **wave of solder** that just touches base of board, soldering components. **Quick, cheap**.

PCB lacquer — thin **polymer film**, —→ Lacquer often **fluorescent** to help **quality control**. protects finished PCB from **moisture**, **chemicals**, **dust**, **temperature changes**.

Components in Electrical Systems

Current/voltage rating — current/voltage value component is designed to work at.

Values **above** rating will **damage** component. Component **won't work** for values a lot **lower**.

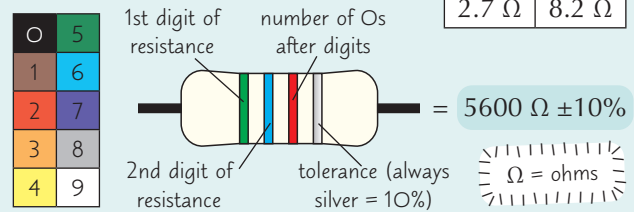
Batteries	AA/AAA (1.5 V)	PP3 (9 V)	button cell (1.5 V to 3 V)
	remote controls, clocks, torches	smoke detectors, radios, microphones	watches

Resistors

Used to **reduce current** in circuit.

E12 resistors: series of fixed resistors. Resistance always one of these **12 values**, to some **power of 10**, with **10% tolerance**.

Each resistor has **4 coloured bands**:



E12 Series	
1.0 Ω	3.3 Ω
1.2 Ω	3.9 Ω
1.5 Ω	4.7 Ω
1.8 Ω	5.6 Ω
2.2 Ω	6.8 Ω
2.7 Ω	8.2 Ω

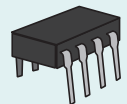
Integrated Circuits

Dual in Line package (DIL) —

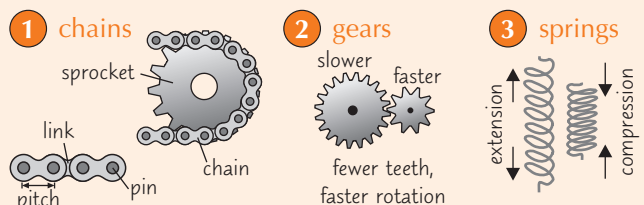
integrated circuit (IC) in rectangular plastic/ceramic casing, with two **parallel rows** of metal legs (**pins**). **Pins** connect IC to circuit. More pins = more inputs.

Programmable intelligent computer (PIC) —

common type of programmable IC (**microcontroller**). Often DILs with 3 V - 5.5 V rating. Some PICs are **one-time programmable (OTP)** but **flash memory PICs** **reprogrammable** up to 100 000 times.



Mechanical Components



Friction — force between **touching surfaces** that **opposes motion**. In a mechanical system, friction **reduces efficiency**, **wastes energy** and **damages parts**.

Lubricant — substance applied between surfaces to **reduce friction**. E.g. **graphite**, **oil**, **silicone**, **grease**.

There are loads of different components to learn...

...so get cracking. PCBs are especially important — you must know what they do and how they're produced.