Name:

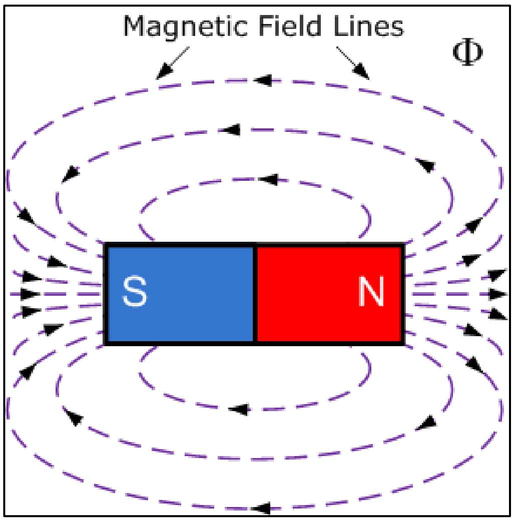
PHYSICS
BHS

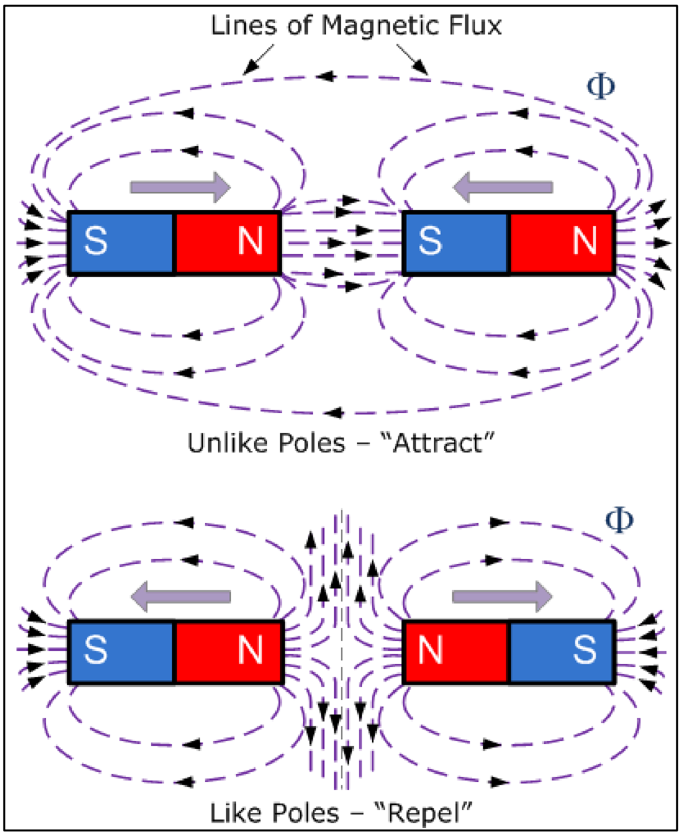
Practical Electronics

Block 4

Electromagnetism

Permeant Magnets

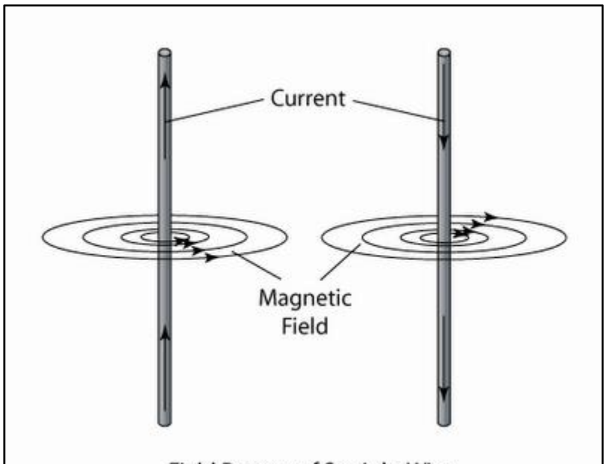




Like poles repel and unlike poles attract.

Magnetic fields are represented by magnetic field lines.

- Magnetic field lines always start and finish on magnetic poles.
- Magnetic field lines always point away **from north** poles and **towards south** poles.
- Magnetic field lines **never cross.**
- The **closer** the field lines, the **stronger** the magnetic field.



Field Pattern of Straight Wire

Fields around current-carrying conductor

When an electric current is in a conductor a magnetic field is set up around the conductor.

The direction of the magnetic field can be **reversed** by **reversing the direction of the electric current.**

The strength of the magnetic field can be **increased** by **increasing the current** in the conductor.

The magnetic field is **stronger closer** to the conductor – the field lines are closer together here.

Electromagnets

Electromagnets are essential parts of many electrical devices.

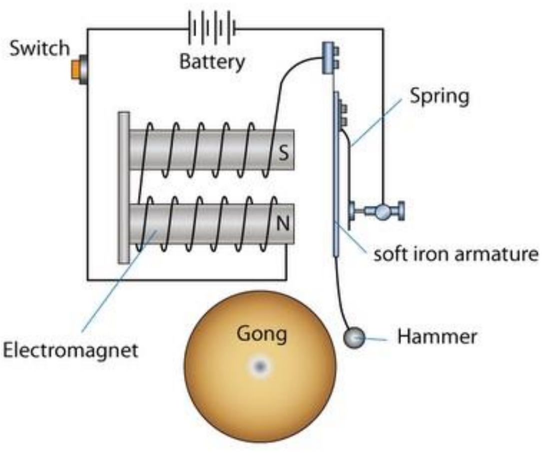
Unlike in a permanent magnet the magnetic field can **be switched off** by switching off the current.

An electromagnet can be made by winding several turns of insulated wire around a piece of soft iron and passing an electric current through the wire.

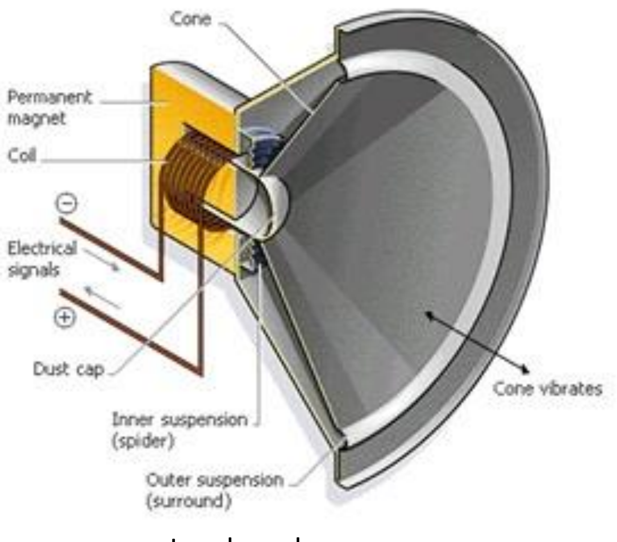
The magnetic field can be made stronger by:	
(a)	**increasing the number of turns in the coil;**
(b)	**increasing the current in the coil.**

Some examples of the use of electromagnets:

Electromagnets for separating ferrous metals during recycling



Electric bells

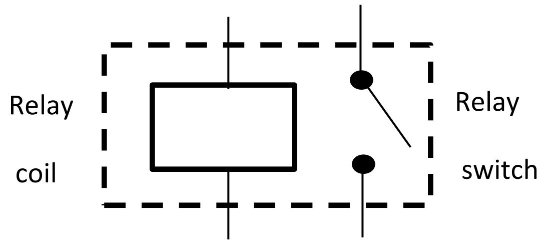


Loudspeakers

The Relay

The relay switch is an electro-mechanical device often used to **connect two circuits** of **different voltage supply**. The relay contains a coil of wire and a switch that can be magnetically attracted.

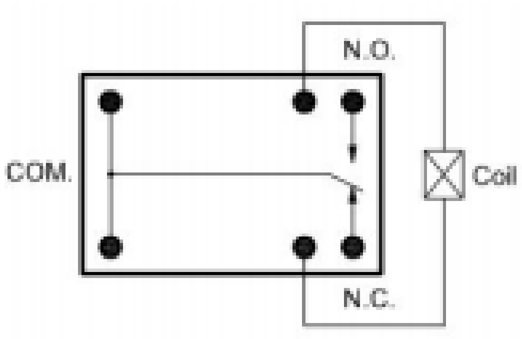
A simple Single Pole, Single Throw (SPST) relay switch may look like this:



When **no current** is flowing in the coil, there is no magnetic field present. The switch is spring loaded and **stays open (off).**

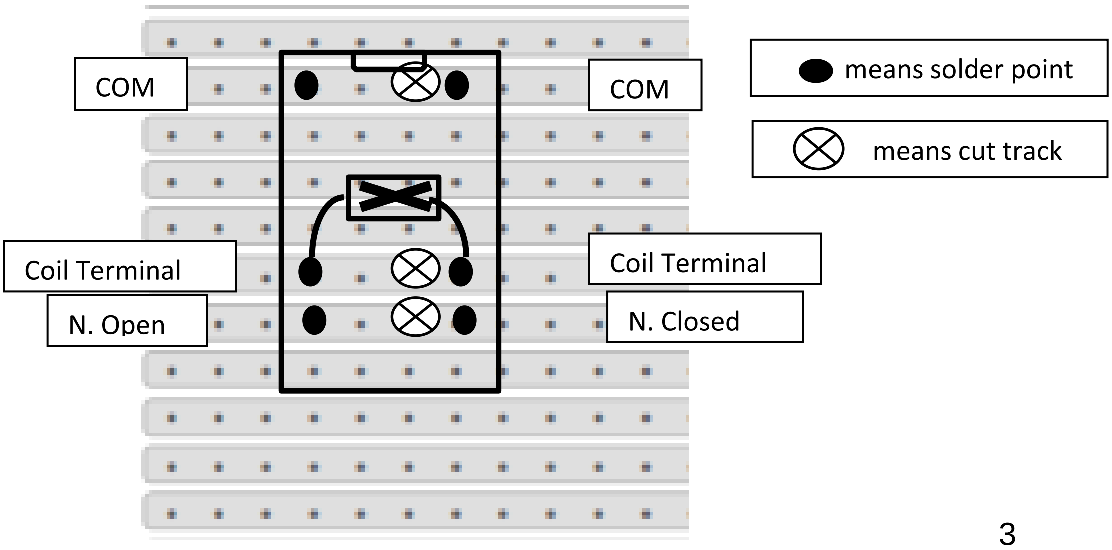
When **current flows** in the coil, a magnetic field is produced around the coil and the metal switch is attracted towards it. It is pulled across and connects to the other contact, **closing the switch (on).**

When current stops flowing in the coil, the magnetic field disappears and the switch returns to the open position as before.



Strip Board layout

When a relay is required, we will use a ***14 PIN DIL*** socket as the base. This will allow us to re-use the relays.



Back EMFs

When a current is present in a conductor a magnetic field is created. When the current is switched off, the field collapses; we have created a *changing magnetic field*.

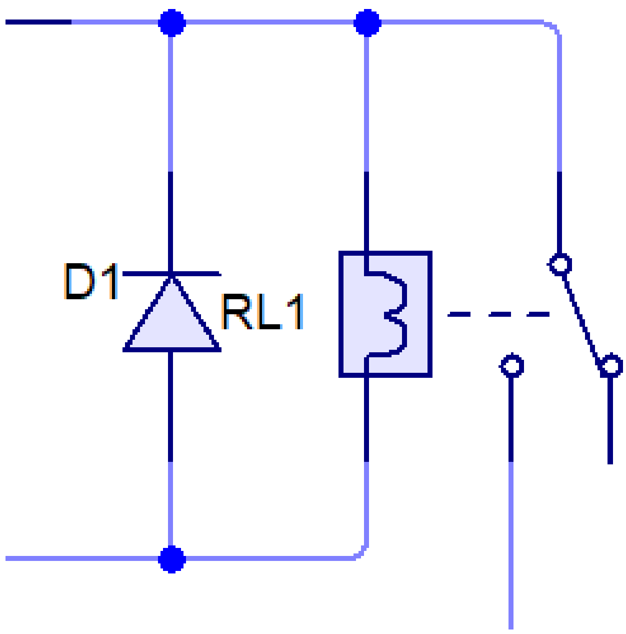
When a conductor experiences a *changing magnetic field,* a voltage is created

In the case of the relay, the collapsing magnetic field around the coil, self-induces a voltage across the coil. This voltage acts in the opposite direction to **oppose** the change in magnetic field that created it. It is known as a **back e.m.f.**

This large back e.m.f. could seriously damage sensitive electronics designed for low voltage operation.

Protection from back e.m.f

We use a **diode** in reverse bias. This prevents the current created by the back e.m.f. from flowing thus protecting the rest of the circuit.



A diode must be put in reverse bias across the coil of the relay in all circuits using relays.

Motors

When there is a current flow in a wire, a magnetic field exists around the wire. If a current-carrying wire is placed between the poles of a permanent magnet, then the two magnetic fields interact producing a force on the wire. A current and a magnetic field must both be present for the wire to experience a force.

If a current-carrying wire is placed between the poles of a permanent magnet, it experiences a force. The direction of the force is at right-angles to:

- the direction of the current in the wire;
- the direction of the magnetic field of the permanent magnet.

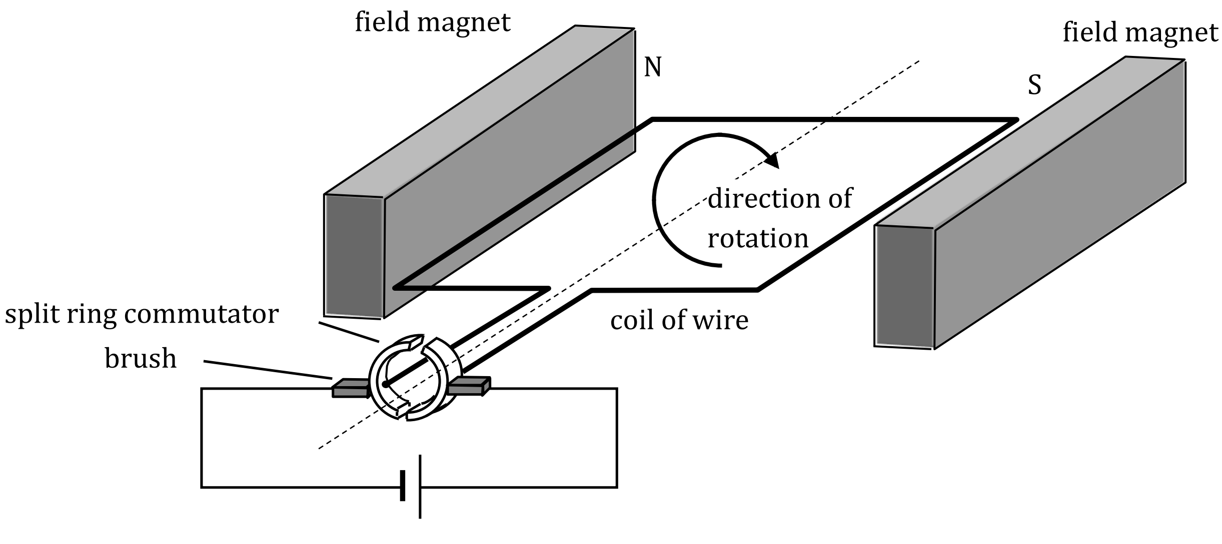
The direction of the force on the rod can be reversed by:

- reversing the direction of the current;
- reversing the direction of the magnetic field.

The size of the force can be increased by:

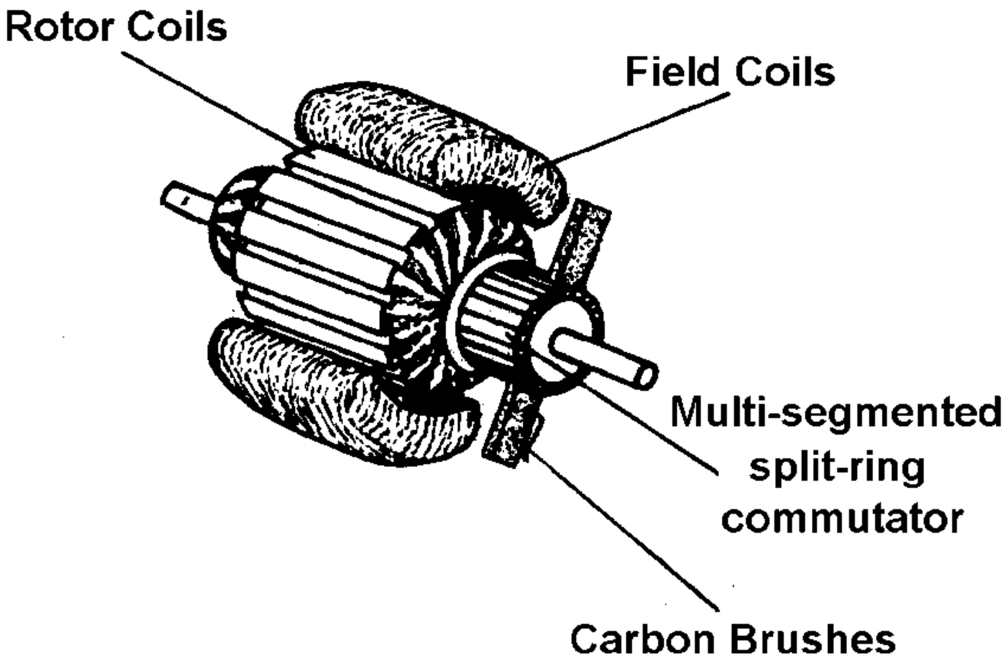
- increasing the current flowing in the conductor,
- increasing the strength of the magnetic field and
- increasing the length of the conductor lying in the magnetic field.

The Electric Motor



Commercial Motors

The motors used in appliances have a few important differences from the simple motor above.



The field magnets are electromagnets rather than permanent magnets. These provide a stronger magnetic field and are switched off when the motor is not running.

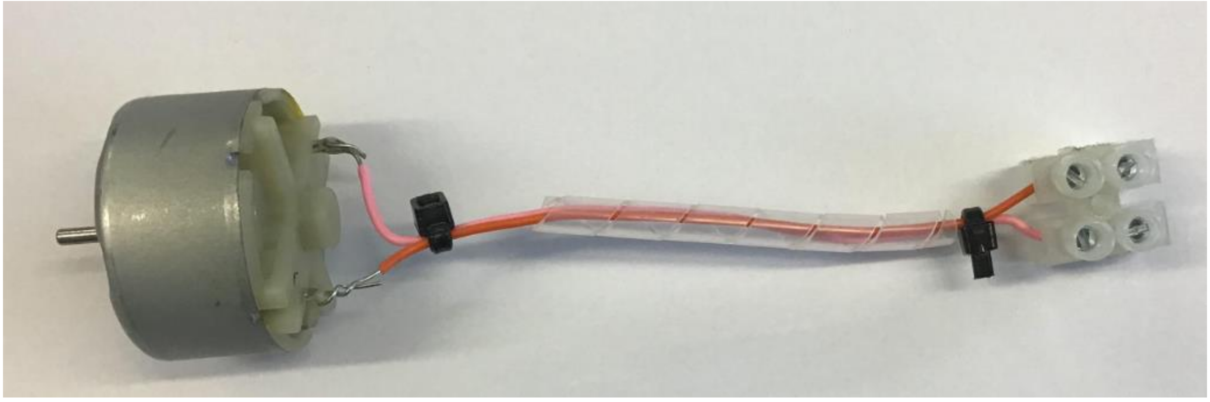
There are normally several coils with the commutator split into many more segments - two for each coil. This means there is always at least one coil in the magnetic field at any given time so that the motor readily starts turning when switched on. Also as there is a force acting on each coil as they pass through the magnetic field the motor runs more smoothly and faster. The simple motor only experiences a turning force every half turn.

Carbon is used for the brushes because it is a good conductor, withstands the high temperatures produced when the brushes rub on the fast moving commutator, and is relatively soft so that the more easily replaced brushes wear rather than the more expensive copper commutator.

The costing information for the motor used in class is below:

Component Type	Value/Code	Order Code	Item Cost (£)	No. required	Total Cost (£)	Assembly info
Motor	TruMotion Low Inertia Motor 6V 2700 rpm	37-0445	1.42	1	1.42	When connected +ve to +ve, clockwise rotation.

The motor should be connected to terminal block and loomed correctly so that it can be re-used with other circuits. It should not be soldered directly to any circuit.



The Design Process

When we encounter design problems, particularly in larger circuits with many parts, the solution can be broken into three main sections:

INPUT → PROCESS → OUTPUT

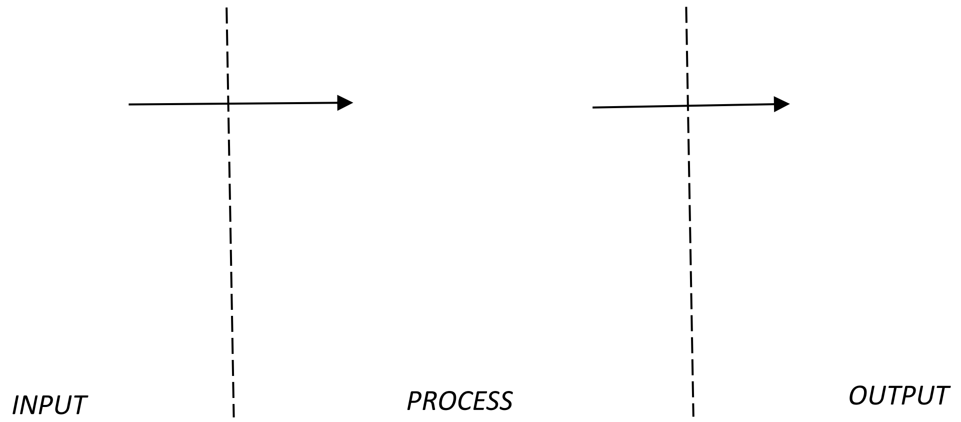
Block Diagrams

These three main sections can further be broken into other sub-blocks to add more detail but remember to be basic. The actual design of each sub block can be detailed individually later.

Assessed Practical: Heat Operated Fan

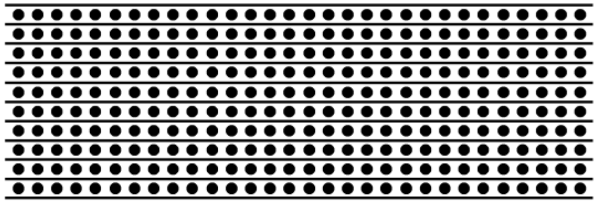
A computer requires a fan to turn on when it gets hot to prevent overheating. Your task is to design, simulate and construct a circuit for this function.

Block Diagram:



Simulation: (Print out, Annotate, and stick here)

Item ID	Component Name	Description	Order Code	Supplier	Unit Price	Quantity	Total Price

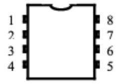


Actual size stripboard. Hole spacing 0.1” (2.54mm)

Tracks run this way

Tips:

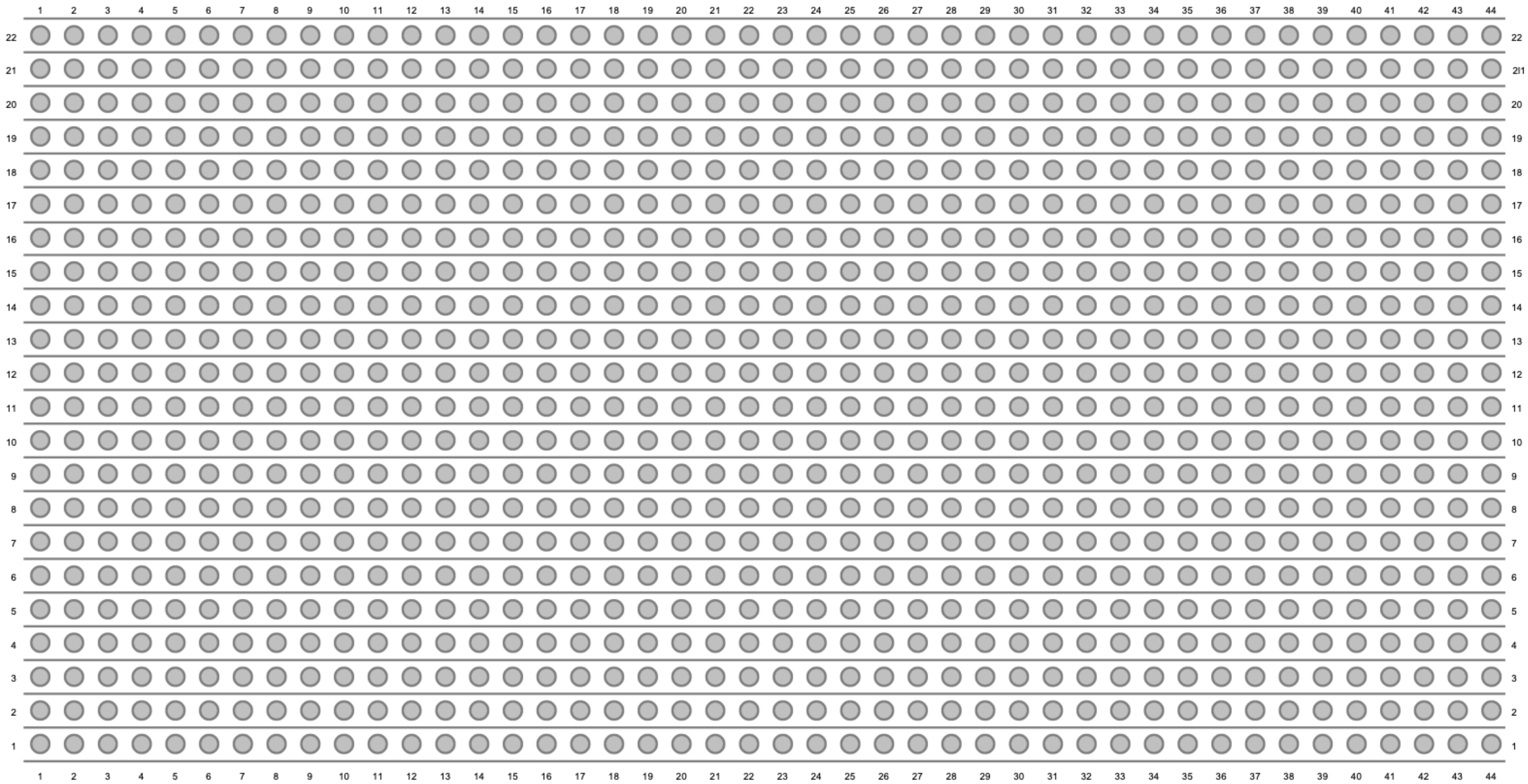
- Mark out the Vs and 0V power lines first, then place the ICs.
- Remember to cut the track between the pins of an IC. Mark the cuts on the diagram with an X.
- Try to make resistors and axial capacitors lay flat on the stripboard. Resistors usually require a gap of 4 holes, capacitors a gap of 8 holes.
- Use the actual size grid on th e left to check component spacing.
- Number the pins of the ICs as shown.



ELECTRONICS IN MECCANO

Stripboard Layout Planning Sheet

Project:	
Designed by:	
Version:	
Date:	
Notes:	



PRE-POWER UP CHECK LIST	
What will be tested	**Result**

PROTOTYPE FUNCTIONALITY TEST	

Evaluation

Evaluate your soldering skills.

Evaluate your looming skills.

Evaluate the performance of the circuit (comment on your test results).

Date:	
What I Did:	
Next Steps	

Date:	
What I Did:	
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Teacher Use Only

Analysis:	Component List		2
	Block Diagram		2
Simulation and Design	Simulation		2
	Stripboard Layout		2
Construction	Fully Constricted Stripboard		4
	Quality of soldering		3
	Neatness of Layout		3
	Safe Working		3
	Working Independently		3
	Wiring		3
Testing	Test Planning		3
	Testing and Repair		4
Reporting	Record of Progress and Planning (Log Book)		3
	Evaluation		2
		Total	/39