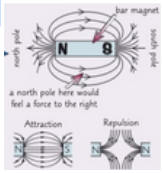
MAGNETISM & ELECTRO-MAGNETISM

magnets & electro-magnetism

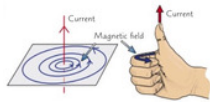
- Magnets have two poles (north & south)
- Produce magnetic fields (region where other magnets & magnetic materials experience force)
- Can show a field by drawing field lines
- Lines go north -> south
- Closer lines = stronger field
- Closer to magnet = stronger field



ELECTROMAGNETS

- Compasses show direction of fields
- North pole of tiny bar magnet inside compass is attracted to south pole of magnet so compass points in direction of field

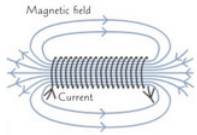
Right hand thumb rule can be used



- Strength of magnetic field changes with current and distance from wire
- Larger current => stronger field
- Closer to wire => stronger field
- Can be increased by wrapping wire into a coil -> SOLENOID

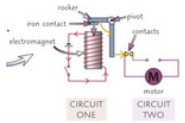
SOLENOIDS

- This is because field lines of each loop of wire line up with each other, resulting in lots of field lines pointing in the same direction that are very close together
- Magnetic field in a solenoid is strong and uniform (same strength everywhere)
- Outside the coil, the field is like one around a bar magnet



- Field strength of solenoid can be increased by putting a block of iron in the centre
- Iron core becomes an induced magnet when current is flowing
- If current is stopped, the magnetic field disappears, so solenoids with iron cores can be turned on and off -> THIS IS AN ELECTROMAGNET

Uses of electromagnets:
- In cranes in scrapyards to pick up things
- Within other circuits to act as switches

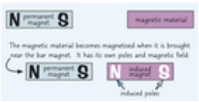


- When a current flows through a wire, a magnetic field is created
- This field is made of concentric circles perpendicular to the wire

CURRENT DIRECTION CHANGES = MAGNETIC FIELD DIRECTION CHANGES

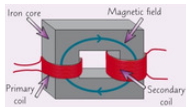
INDUCED MAGNETS

- Permanent magnets produce own field
- Induced magnets are magnetic materials turned into magnets when put into a field



transformers

- Alternating pd applied across primary coil
- Iron core magnetises and demagnetises quickly
- Changing magnetic field induces alternating pd in secondary coil
- If secondary coil is in complete circuit, current is induced
- Ratio between primary and secondary pds = ratio between number of turns on primary and secondary coils



- Change size of pd of ac
- All have two coils of wire (primary & secondary) joined by iron core
- Almost 100% efficient

STEP-UP

- Increase pd
- Have more turns on secondary coil than primary
- Vs > Vp

STEP-DOWN

- Decrease pd
- Have more turns on primary coil than secondary
- Vs < Vp

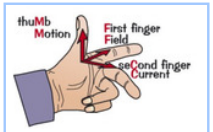
VP/VS = NP/NS
INPUT PD/OUTPUT PD = TURNS ON PRIMARY/TURNS ON SECONDARY

the motor effect

- Current carrying wire (conductor) put between magnetic poles
- Wire's magnetic field interacts with magnetic field it is in
- Magnet and conductor exert a force

F = BIL
FORCE = MAGNETIC FLUX DENSITY X CURRENT X LENGTH OF CONDUCTOR
Mfd is how many field lines there are in a region
More lines => stronger magnetic field

THE MOTOR EFFECT

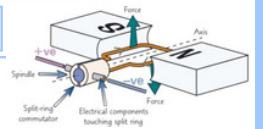


- Shows that if current or magnetic field is reversed, direction of force will be reversed

- To experience full force, wire must be at 90 degrees to magnetic field
- If wire is parallel no force will be experienced
- Force always acts at 90 degrees to magnetic field of magnet and direction of current in wire
- Stronger magnetic field => stronger force
- Higher current => stronger force

FLEMING'S LEFT HAND RULE

ELECTRIC MOTORS



- One force acts upwards other acts downwards
- Causes coil on spindle to rotate
- Split ring commutator swaps contacts every half turn to keep it rotating in same direction
- Direction of motor can be reversed by either swapping polarity of dc supply (reversing current) or swapping magnetic poles over (reversing field)

generator effect

Induction of pd (and current if complete circuit) in wire which is moving relative to magnetic field or experiencing a change in magnetic field

GENERATOR EFFECT

- Moving magnet in coil of wire or moving conductor in magnetic field
- Shifting magnet from side to side changes current if conductor is in a complete circuit
- Reversing direction of magnet/conductor => pd/current reverses
- Polarity of magnet reverses => pd/current reverses
- Same effect can be created by turning magnet end to end in coil or turning coil inside magnetic field
- This is how generators produce ac or dc

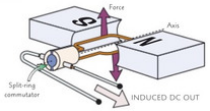
- As magnet turns magnetic field of wire changes Pd induced which makes current flow in wire
- Magnet at half turn then direction of magnetic field through coil reverses
- Pd and current reverse
- If magnet keeps being turned then pd will keep reversing every half turn => ac
- Change in magnetic field induces current in wire
- Magnetic field created around wire
- This field acts against change that made it
- Induced current always opposes the change that made it

To change size of induced pd: change rate that the magnetic field is changing

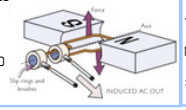
SPEED OF MOVEMENT/MAGNETIC FIELD STRENGTH INCREASES = INDUCED PD/CURRENT INCREASES

GENERATORS

Dynamos:
- Work in same way as alternators
- Have split ring commutator instead of slip rings
- Connection swaps every half turn so current flows in same direction



Alternators:
- Generators rotate coil in magnetic field (or vice versa)
- As coil/magnet spins current is induced in coil
- Current changes direction every half turn
- Instead of split ring commutator alternators have slip rings and brushes so contacts DONT swap every turn

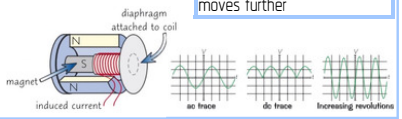


- Oscilloscopes show pd generated in coil over time
- Height of line at a given point is pd at that time
- Increasing frequency of revolutions => increases overall pd => increases peaks

MICROPHONES

- Loudspeakers in reverse
- Sound waves hit flexible diaphragm
- Diaphragm attached to coil of wire wrapped around magnet
- Coil of wire moves in magnetic field
- Current is generated
- Movement of coil depends on properties of sound wave

Louder sounds => diaphragm moves further



LOUDSPEAKERS & HEADPHONES:
- Ac sent through coil of wire attached to base of paper cone
- Coil surrounds one pole of permanent magnet with other pole surrounding the coil
- Current causes force on coil so cone moves
- Current reverses => force reverses direction => cone reverses direction
- Variations in current make cone vibrate
- Air around cone vibrates, creating variations in pressure
- Sound wave
- Frequency of sound wave = frequency of ac