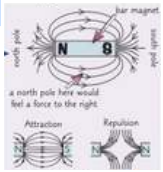
MAGNETISM & ELECTRO-MAGNETISM

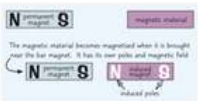
magnets & electro-magnetism

- 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



INDUCED MAGNETS

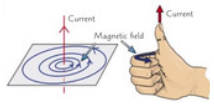
- Permanent magnets produce own field
- Induced magnets are magnetic materials turned into magnets when put into a field



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

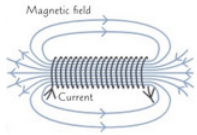
Right hand thumb rule can be used



- 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

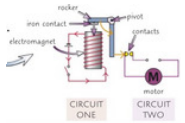
SOLENOIDS

- 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

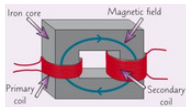


- When a current flows through a wire, a magnetic field is created
- This field is made of concentric circles perpendicular to the wire

CURRENT DIRECTION CHANGES = MAGNETIC FIELD DIRECTION CHANGES

TRANSFORMERS

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



- 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

transformers

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

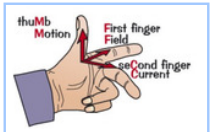
the motor effect

- 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

- 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

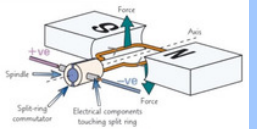
THE MOTOR EFFECT



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

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)

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

- 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

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

- 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

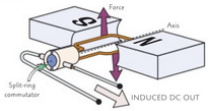
To change size of induced pd: change rate that the magnetic field is changing

generator effect

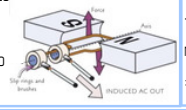
GENERATOR EFFECT

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

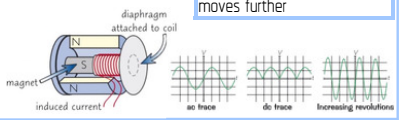


- Oscilloscopes show pd generated in coil over time
- Height of line at a given point is pd at that time
- Increasing frequency of revolutions => increases overall pd => increases peaks

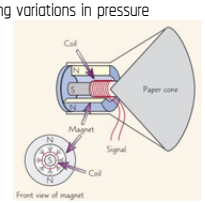
- Loudspeakers in reverse
- Sound waves hit flexible diaphragm
- Diaphragm attached to coil of wire wrapped around magnet
- Coil of wire moves in magnetic field
- Current is generated
- Movement of coil depends on properties of sound wave

MICROPHONES

Louder sounds => diaphragm moves further

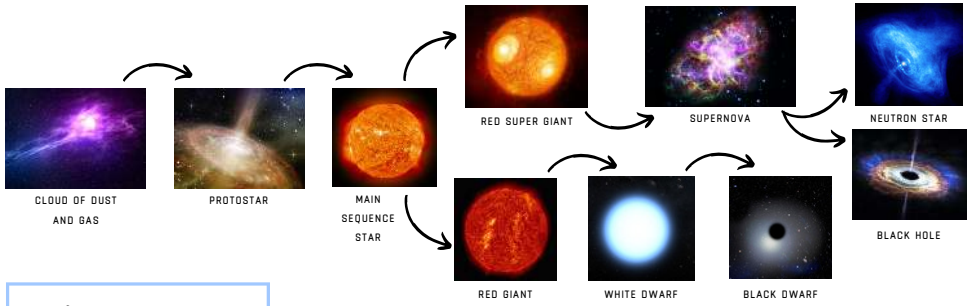


LOUDSPEAKERS & HEADPHONES:
- Ac sent through coil of wire attached to base of paper cone
- Coil surrounds one pole of permanent magnet with other pole surrounding the coil
- Current causes force on coil so cone moves
- Current reverses => force reverses direction => cone reverses direction
- Variations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



SPACE PHYSICS

life cycle of stars



CLOUD OF DUST AND GAS

- Stars are initially a cloud of dust and gas called a nebula

PROTOSTAR

- Force of gravity pulls dust and gas together to form a protostar
- Temperature rises as star gets denser and more particles collide
- When temperature is high enough, hydrogen nuclei undergo nuclear fusion, forming helium nuclei
- Huge amounts of energy is released, keeping core of star hot

MAIN SEQUENCE STAR

- Star enters long stable period
- Outward pressure caused by nuclear fusion trying to expand star is balanced with force of gravity pulling everything inwards
- Eventually hydrogen begins to run out
- Star swells into red super giant/red giant
- Becomes red as surface cools
- Fusion of helium occurs
- Heavier elements (up to iron) created in core

RED SUPER GIANT

- Stars bigger than Sun start to glow brightly again as they undergo more fusion
- Expand and contract several times forming elements as heavy as iron in various nuclear reactions

SUPERNOVA

- Eventually red super giant explodes in a supernova
- Forms elements heavier than iron and ejects them into universe to form new planets and stars
- Stars and their life cycles produce and distribute all naturally occurring elements

NEUTRON STAR

- Exploding supernova throws outer layers of dust and gas into space, leaving a very dense core behind called a neutron star

BLACK HOLE

- If the star is massive enough, a black hole will be formed
- Super dense point in space that light cannot escape from

RED GIANT

- Stars same size as Sun (or smaller) become unstable and eject their outer layer of dust and gas

WHITE DWARF

- Hot, dense, solid core

BLACK DWARF

- As white dwarf cools down, less energy is emitted
- When sufficient amount of energy is no longer emitted, it is a black dwarf

the big bang

RED SHIFT

- The universe appears to be expanding
- When we look at light from distant galaxies, we find that the wavelength has increased
- The wavelengths are longer than they should be (they are shifted towards the red end of the visible light spectrum) - this is red shift
- This suggests that the source of the light is moving away from us
- Measurements of the red shift indicate that the distant galaxies are moving away from us very quickly
- More distant galaxies have greater red shifts than nearer ones -> they are moving away faster

THE BIG BANG

- If all the galaxies are moving away from each other at great speed, there must have been a great explosion to make them move - the Big Bang
- Initially all matter in the universe occupied a very small space which was very dense and very hot
- Then it exploded, and space started expanding
- This expansion is still going on

NEW EVIDENCE

- Whenever scientists discover new evidence, they have to either make a new theory or change a current one to explain what they have observed
- There is still lots we don't know about the universe
- Observations of supernovae from 1998 to the present day suggest that distant galaxies are moving away from us faster and faster
- Currently scientists believe the universe is mostly made up of dark matter (unknown substance holding galaxies together but does not emit electromagnetic radiation) and dark energy (thought to be responsible for the accelerated expansion of the universe)

the solar system

OUR SOLAR SYSTEM

Solar system is all the objects that orbit the Sun, including:

- Planets (large objects that orbit a star, their gravity is strong enough to pull in nearby objects apart from their natural satellites)
- Dwarf planets (planet-like objects that orbit stars)
- Moons (orbit planets, natural satellites)
- Artificial satellites (orbit the Earth, man-made satellites)

Artificial satellites have two orbits:

- Polar orbits – move around the poles (vertically), used for monitoring weather, military spying
- Geostationary orbits – take 24 hours to orbit the earth so appear to stay in the same place above Earth, used for telecommunication, broadcasting

ROCK GIANTS	MY VERY EASY METHOD JUST SPEEDS UP NAMING	MERCURY VENUS EARTH MARS JUPITER SATURN URANUS NEPTUNE
GAS GIANTS		

ORBITS

- Planets move around the Sun in elliptical orbits
- If an object is moving in a circle, it is constantly changing direction, meaning it is constantly accelerating
- This also means it has a constantly changing velocity
- To accelerate, there must be a force acting on the object (gravitational force between planet and Sun or planet and satellites)
- This force is directed towards the centre of the circle
- This would cause the object to fall towards whatever it is orbiting, but as it is already moving, this just causes it to change direction
- The object keeps accelerating towards what it's orbiting, but the instantaneous velocity (90 degrees to acceleration) keeps it travelling in a circle
- Closer to star/planet = stronger gravitational force
- The stronger the force, the faster the orbiting object needs to travel to remain in orbit
- For an object in a stable orbit, if the speed of the object changes, the size (radius) of its orbit must change, too
- Faster moving objects will move in a stable orbit with a smaller radius than slower moving ones