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PHYSICS notes

- General physics
 - The density of an object only changes when the substance is heated or cooled.
 - An object sinks if its density is more than the liquid on which it is placed on, but floats if less dense.
 - When there is no air resistance the acceleration of any object is constant (constant = 10m/s^2)
 - Easier to lift an object on the moon because gravity is less on the moon and there is no air resistance.
 - Resultant Force.
 - Gravitational, electrostatic and magnetic forces can be applied from a distance, other than that you have to be in contact with the object to apply a force.
 - A force applied on an object can cause a change in speed, direction and shape.
 - Acceleration, velocity etc. is a vector quantity.
 - When an object moves in a circle it is accelerating and at constant speed at the same time; because the direction is changing but the speed is constant.
 - Centripetal force is caused by tension in the string (ball on a string), gravity (satellite in space), friction between the tires and the road (a car on the road).
 - For an object to be in equilibrium state the resultant force has to be equal or zero (forces up = forces down) and the resultant moment has to equal zero (clockwise moment = anticlockwise moment).
 - For the stability of an object it has to have a wide base and a low center of mass.
 - To find the center of mass draw two points A and B,

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hang the object from each hole so that it can swing freely. Tie a weight to each point then draw the vertical line, the center of gravity is where the lines intersect.

- When a car is going up a hill K.E. = Same, G.P.E = Increases, Chemical Energy (petrol) = Decreases and the total energy stays the same as energy is not lost, created or destroyed.
- Internal energy = Thermal energy.
- Fission = Power stations, Large molecules --> Small molecules.
- Fusion = Sun, Small molecules --> Large molecules.
- The mass lost is converted into heat energy.
- In barometers the space at the top is a vacuum, because air would prevent the mercury from rising.
- The width of the barometer does not affect the height of mercury.
- Water manometers are more accurate to measure gas pressure.
- To get the total pressure, remember to add the atmospheric pressure.
- The gas pressure can be converted from mm of Hg to Pa by using $P = \text{density} \times \text{gravity} \times \text{height}$, but remember to use the total pressure.
- Pressure = force/area
- The more the area, the more the force & the less the area the, the less the force.

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Thermal Physics

- The pressure is the same on all the walls of the containers as the molecules move in a random motion.
- Temperature is proportional to K.E. + Molecules hit the walls harder and more often.
- Brownian motion: The tiny, fast-moving air molecules, which are in a constant random motion, are hitting the larger smoke particles from all directions.
- Evaporation: It is the vaporization of liquid, when the fast moving molecules/energetic molecule leave the surface without the temperature reaching its boiling point.
- The greater the surface area, the more the evaporation of particles.
- Evaporation occurs at surface of liquid: no bubbles.
- Boiling occurs throughout the liquid: bubbles appear.
- We feel cold after bath because the high energetic molecule evaporate leaving behind, dull/less energetic molecules.
- Thermal expansion: molecules gain kinetic energy and force results in pushing each other further apart.
- Volume = less area so the particles hit the walls harder and more often.
- Mercury is used to measure high temperature.
- Alcohol is used to measure low temperatures.
- The capillary tube of a thermometer is narrow so a small change in temperature results in a large change in volume of the liquid.
- Thermocouples have a low specific heat capacity this means they can measure rapidly changing temperatures and they don't take much heat away from the object they are measuring the temperature of them.
- During melting or boiling the temperature stops rising because extra energy is needed, which is taken from the

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heat source, to overcome the strong forces of attraction which are holding the molecules together. This energy will not increase the speed of the molecules it will only break the bonds.

- In an experiment the value for the latent heat of fusion is too low as energy is taken in from the surroundings which melt the ice.
- In an experiment the latent heat of vaporization is too high as energy is lost to the air from the heater therefore not all the energy is used for evaporating the water.
- The value for the latent heat of vaporization is much higher than the value for fusion because a large amount of energy is needed to break the bonds between the molecules to move them far apart
- $\text{Energy} = \text{Mass} \times \text{Specific heat capacity} \times \text{Change in temp.}$
- $\text{Energy to break bonds} = \text{Mass} \times \text{Latent heat of fusion/vaporization.}$

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○ Waves, Light & Sound

- Waves transfer energy from one place to another.
- There are 2 types of waves: Transverse and Longitudinal waves
- Transverse wave: A wave in which the particles vibrate perpendicular, to the direction of movement. A complete wave consists of 1 crest and 1 trough. E.g. Light waves
- Longitudinal wave: A wave in which the particles vibrate back and forth in the direction of movement. It consists of compressions and rarefactions. E.g. Sound waves
- Compressions are the area in a wave where the particles are closer to each other and the pressure in that area is highest.
- Rarefactions are the area in a wave in which the particles are far apart and the pressure is least.
- The larger the frequency and amplitude the greater the energy of the wave.
- When a wave gets refracted, its Speed decreases, Wavelength decreases, Frequency = Same.
- When a wave gets reflected, it's Speed = Same, Wavelength = Same, Frequency = Same.
- When a wave gets diffracted, it's Speed = Same, Wavelength = Same, Frequency = Same.
- Radio waves are easily diffracted because they have a large wavelength.
- In the spectrum of light all the colors have the same speed, but different wavelengths & frequencies.
- Objects that produce light are called luminous objects and the object which uses the light from source to reflect and make it see is called illuminated objects.
- When a light wave travels from a less dense material to a more dense material, the refractive index is more than 1.

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- When a light wave travels from a more dense material to a less dense material, the refractive index is less than 1.
- A fish in a pond appears to be higher than it actually is because light refracts.
- Total incidence angle is always = Total reflection.
- Reflective index = speed of light in air/speed of light in that material.
- Reflective index = $\sin i / \sin r$
- Reflective index = $1/\sin C$ (C stands for critical angle).
- Total internal reflection is when the ray is travelling to a less dense material from a more dense material and also if the incidence angle is above 42 degrees.
- The center of a lens is called its optical center, C.
- The line through C at right angles to the lens is called the principle axis.
- The fatter the lens, the stronger it is and the shorter its focal length.
- Parallel light, e.g. Sun, must be used to find the focal length of a lens.
- When the object is beyond 2F the image comes in between F and 2F, real, inverted and smaller than the object.
- When the object is in between F and 2F the image comes beyond 2F, real, inverted and same size as the object.
- When the object is before F the image appears in, real, inverted and smaller than the object.
- Dispersion of white light occurs because each fraction of white light has a different wavelength, so they are slowed down by different amounts.
- A spring is used to represent longitudinal waves.

The speed of sound in:

Air 330 m/s

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Water 1400 m/s

Wood 4000 m/s

- Ripple tank can be used to see transverse wave.
- When a loudspeaker moves out the air is compressed, when it moves in the air is rarefied.
- Frequency = number of vibrations per second.
- Speed (m/s) = Frequency (Hz) x Wavelength (m)
- The speed of sound increases as the particles move closer together.
- Gamma Rays, X-Rays, Ultra-Violet are Carcinogenic.

Wave Use

1. Gamma Rays → Sterilize food & equipment, Treat Cancer

2. X-Rays → Go through body to check for broken bones

3. Ultra-Violet → Suntan, Make fluorescent materials glow

4. Light → Allows you to see

5. Infrared → Heating, Remote Control, Mobile phones, Night sight

6. Microwaves → Send messages, Cook food

7. Radio & T.V. → Send messages

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- Electricity & Magnetism
 - Ferrous (magnetic) metals are Iron, Steel, Nickel & Cobalt.
 - The true test for a magnet is that it repels another magnet.
 - When a ferrous metal is magnetized the domains are turned so that they are lined up.
 - Making Magnets: Stroking, Electrically (D.C.) & Induction.
 - Demagnetizing a magnet: Heating, Hammering, and Electrically (A.C.).
 - Uses of permanent magnets: Compasses, Door catches.
 - Uses of electromagnets: Scrap yards, Electric bell, and Electric relay.
 - Conductors have free moving electrons in them, insulators don't.
 - In electrostatic experiments metals cannot be used as they are good conductors of electricity and don't stay charged.
 - In ammeters and voltmeters Red terminal = Positive, Black terminal = Negative.
 - Current in a series circuit always remains same but gets divided in parallel.
 - Voltage in a series gets divided but remains same in the parallel circuit.
 - When the resistors are connected in parallel the total resistance is always less than the smallest resistor.
 - Advantages of parallel circuits: each appliance can be switched on and off independently, if one appliance "blows", the rest is unaffected, appliances in parallel gain the full voltage of the battery (e.g. lamps are brighter).

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- Voltmeters must have a high resistance so that the current doesn't flow down the voltmeter; instead the current continues to flow around the circuit.
- In a voltage/current graph the gradient = resistance, therefore the resistance of the conductor is constant as the gradient is constant.
- Resistance in series = $R1 + R2$
- Resistance in parallel = $R1 \times R2 / R1 + R2$
- Diode is a device which only allows voltage to flow one way.
- Diode used for changing A.C. to D.C. This process is called rectifying
- Temperature increases = Resistance Increases.
- Thickness of wire increases = Resistance decreases.
- Length of wire increases = Resistance Increases.
- Appliances that use a large current must have thick cables to avoid overheating.
- In a short circuit the wires become very hot and the battery quickly drains.
- Three pin plugs: Earth = Yellow/Green stripes, Live = Brown, Neutral = Blue.
- Electricity enters via the live wire and returns via the neutral.
- The earth wire protects the user from getting an electrical shock; it's connected to the metal casing of the appliance.
- Fuses are connected to the live wire, so if the current is too high, the fuse melts before the current reaches the appliance. Switches are also connected to the live wire.
- Circuit breakers contain an electromagnet which, when the current exceeds the rated value of the circuit breaker, becomes powerful enough to pull a pair of contacts apart and break the circuit.

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- Advantages of circuit breakers: Much faster than fuses, Can be reset by pressing a button.
- Reversing the current of a wire reverses the direction of the magnetic field.
- To make a magnetic field stronger: High Current, More Number of turns on the coil.
- Motors: When a wire carrying a current is placed at 90 degree between the poles of the magnet the wire experiences a force.
- Fleming's left hand rule: Thumb = Direction of Movement, First Finger = Direction of Magnetic Field, Second Finger = Direction of Current in a wire.
- The split ring reverses the current after every half turn so the coil keeps turning the same way.
- To change the direction of spin: Change the polarity of the magnets or change the direction of the current.
- To make the motor spin faster: wind more number of turn, Increase the current through the coil & stronger magnets.
- Generators: When coil cuts a magnetic field a voltage (current) is induced.
- To find the current induced → Fleming's right hand rule: Thumb = Direction of Movement, First Finger = Direction of Magnetic Field, Second Finger = Direction of Current in a wire.
- To increase the voltage (current) induced: Move the wire faster, Use a stronger magnet, Use more turns on the coil.
- Maximum current is induced when the coil is perpendicular to the magnetic field. When it's parallel there's no cutting, hence no current.
- When an alternating current is passed through the primary coil a changing magnetic field is set up in the soft

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iron core, which is cut by the secondary coil. Hence, an E.M.F. is induced in the secondary coil.

- The soft iron core helps to concentrate the magnetic field through the coils.
- A step-up transformer is used near power stations to increase the voltage and to decrease current so there's no overheating and energy loss is reduced.
- Transformers don't work with D.C. because the current is not changing so there's no cutting.
- The soft iron core helps to concentrate the magnetic field through the coils.
- Thermionic Emission occurs when electrons at the surface of the cathode are given enough energy to escape, by heating.
- Y and X –Shift Knobs move the display vertically and horizontally.
- The fluorescent screen transfers Kinetic Energy into Light Energy.
- Y-Gain Knob sets the scale for the C.R.O.
- When D.C. current is supplied to Y-gain, a dot appears at the top and when A.C. current is supplied a line from top to bottom appears.
- Voltage (current) is connected to the Y-Plates.
- Time Base is connected to the X-Plates.
- When using a voltage divider we must connect up terminals A, B and C.
- As the slider moves towards B the voltage decreases, as it moves towards A the voltage increases.
- In Reed switches & relays all the contacts are in a glass tube.
- A Reed switch is operated by a magnet.
- A Reed relay is operated by a coil which produces a magnetic field.

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- LDR: Light increases the resistance decreases.
- Thermistor: Temperature Increase= Resistance decreases.
- Capacitors are used for storing charges; they are used in time delay circuits (e.g. TV).
- Advantages of a transistor: Fast, Cheap, Doesn't wear out; because it has no moving parts.
- Logic gates are made from transistors.
- All gates are mentioned below:

- AND gate:

A	B	Result (A x B)
0	0	0
0	1	0
1	0	0
1	1	1

- OR gate

A	B	Result (A+B)
0	0	0
0	1	0
1	0	0
1	1	1

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- NOT gate:

A	Result (A^{-1})
0	1
1	0

- NAND gate:

A	B	Result ($(A \times B)^{-1}$)
0	0	1
0	1	1
1	0	1
1	1	0

- NOR gate:

A	B	Result ($(A+B)^{-1}$)
0	0	1
0	1	0
1	0	0
1	1	0

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o Atomic Physics

- The mass of an electron is 1/1840 A.M.U.
- We can write the nucleon and proton numbers of an element in a shorthand form called nuclide notation.
- An atom is nearly empty space apart from a tiny, heavy (dense), positive nucleus.
- Background radiation varies slightly as the radioactivity is random.
- Cosmic radiation is the reason of background radiation and the source for it are sun, moon, earth etc.

Name	Alpha®	Beta®	Gamma®
Nature	2 proton and neutrons	Fast moving electrons	Electromagnetic wave
Source	Nucleus	Neutron changers into electron, proton and anti-neutrino	-
Charge	+2	-1	0
Mass	4 A.M.U	1/1840 A.M.U	0
Speed	10% light speed	50% light speed	Light speed
Absorption	Paper Stops it completely	5mm Aluminum stops it completely	25mm lead doesn't stop but decrease radiation
Ionization Power	Strongest	Weak	Very weak
Deflection In electric field	Slightly Toward negative	Strongly Toward positive	None

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Deflection in Magnetic field	Deflection is opposite to Beta's® deflection	Deflect use Flemings left hand rule	None
Range	About 5 cm	1 meter or more	Extremely large range
Detectors	Photographic film, Cloud chamber, spark counter, Gold leaf electroscope & GM tube	Photographic film, Cloud chamber & GM tube	Photographic film, Cloud chamber & GM tube

- The spark counter: The Alpha source ionizes the air, the positive ions move towards the cathode and the negative ions move towards the anode, so a spark is produced. Only works with alpha as they are excellent in ionizing.
- Geiger-Muller tube: Works the same way as the spark counter but can detect all types of radiation. Thin Mica window so alpha radiation can pass through; a large potential difference is needed so that there is an anode and a cathode to attract the charges. To differentiate between different types of radiation, the count of pulses is recorded and is transferred to a scaler or ratemeter.

Safety Precautions;

- Keep all radioactive materials in sealed containers made of thick lead.
- Keep as far away from radioactive source as possible and use tongs.
- Waste radioactive products are either buried underground or under the sea.

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- Keep exposure time as short as possible.
- Don't eat or drink near a radioactive substance.
- Label radioactive sources with radioactive sign.
- Wear a radioactive badge: Hole to detect alpha, Aluminum to detect beta, Lead to detect gamma.
- Half-life is not affected by temperature, pressure or chemical reactions.

Radioactivity Uses:

Detect cracks in underground pipes, Thickness control in paper industry, Long half-life to keep activity constant
Sterilizing equipment in hospitals, Smoke detector, to keep activity constant and detectors will last longer

Smoke Detectors:

Alpha radiation ionizes the air, therefore a sensor detects radiation. Smoke reduces radiation and the sensor turns the alarm on.

