ELECTRONS PHOTONS AND WAVES

REVISION

UNIT G482

speed of light $c = 3 \times 10^{8} ms^{-1}$
Plancks constant $h = 6.63 \times 10^{-34} Js$
mass of electron $= 9.11 \times 10^{-31} Kg$

Electrons Photons and Waves revision

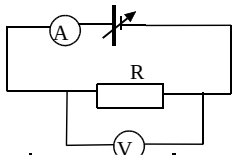
What is electric current?
Electric current is the flow of charged particles. In metals it is the flow of electrons and in electrolytes the flow of ions

How is current defined?
I = Q/t where Q is charge in coulombs (c) and t is time (s) and I is current (A)

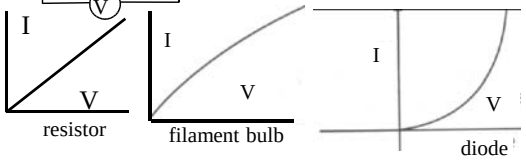
What is Kirchoffs' first law?
sum of currents entering a junction = sum of currents leaving
this is an example of the **conservation of charge**

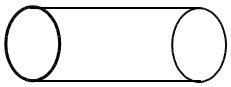
What is conventional current direction? Conventional current flow is the flow of positive charge from positive to negative. Real current electron flow is from negative to positive

What is Ohms' Law? Current is proportional to voltage at constant temperature



Current - voltage characteristics





Current drift velocity I = nAve
n - N° of charges per m^3 A- area in m^2, v- drift velocity in m/s, e - electron charge

What is potential difference? It is the electrical energy transferred to other forms per coulomb of charge. **V(V) = W/Q.**

What is E.M.F? E.m.f is the electrical energy transferred **to** charge per coulomb by a cell or power supply. **E(V) = W/Q**

How can the volt be defined? Two points are at a p.d. of 1V if 1J of electrical energy transferred per coulomb of charge that passes (V=W/Q = 1/1 = 1V)

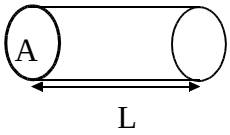
What is the definition of resistance?
Resistance is defined as **R(Ω) = V/I**

How is the ohm defined? The ohm is defined the resistance provided when a p.d. of _1V causes a current of 1A to flow. (R = V/I = 1/1 =1Ω)

Does the resistance of a conductor depend on its dimensions?
Yes R = ρL/A, A- area (m^2) L - length (m),ρ – resistivity (Ωm)

What is a thermistor? It is a resistor. The resistance of a negative temperature coefficient (NTC) thermistor drops with increasing temperature

How is resistivity defined?
ρ = AR/L



What is power? Power is the rate of energy(W) transfer. P = W/t. The unit of power is the watt (w)

How is energy transfer calculated? from P = W/t, W = Pt
W - energy transferred (J)
P - power (w)
t- time (s)

What is a kilowatt hour?
A bigger unit of energy than the joule
W = Pt
W(kwh) = P(kw) x t(h)

Define the kwh
1kwh is transferred by a 1kw device used for 1 hour
W = Pt = 1x1 = 1kwh

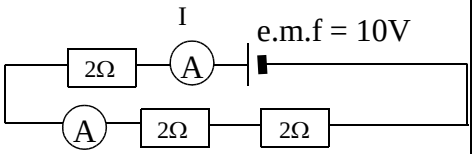
How many joules is a kwh?
W = pt = 1000 x 60 x60
= 3600000J

What are the three equations for electrical power?
$P = IV = I^2R = V^2/R$

What are the three equations for electrical energy transfer?
From W = pt
$W = IVt = I^2Rt = (V^2/R)t$

What is Kirchoffs' second law?
In any closed loop the sum of the p.d's is equal to the e.m.f of the source. This law is a consequence of the **conservation of energy**

Use the second law to calculate I



10 = Ix2 + Ix2 +Ix2 = 6I - from V = IR
so I = 10/6 = 1.67A

Fuses:fuses are made from thin wire. If there is a fault and there is too much current, they quickly melt and cut off the current preventing fire. P = IV can be used to calculate current I and decide the best fuse

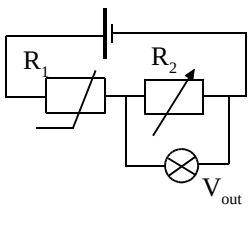
Resistors in Series
$R_{total} = R_1 + R_2$

Resistors in parallel
$1/R_{total} = 1/R_1 + 1/R_2$

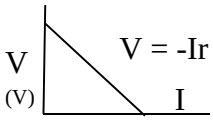
Resistance networks
To find the total resistance work out the resistance of the parallel resistors then add the series resistance

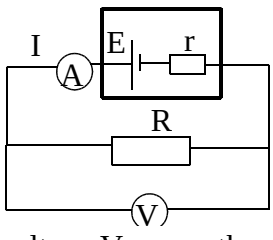
The Potential Divider

$V_{out} = \frac{V_{in} R_2}{(R_1+R_2)}$



Internal resistance(r) of a battery





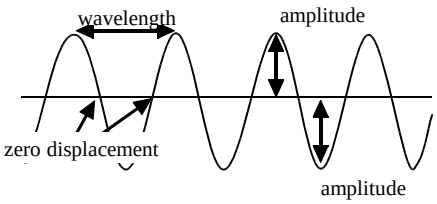
The voltmeter reads the voltage,V across the load resistance and is called the **terminal p.d.** It is less than the e.m.f. of the source because there is a potential difference across the internal resistance of the source.

From Kirchoff's second law E = IR + Ir
E = V + Ir

If this is rearranged so V = -Ir + E

a graph of V against I would give a straight line with a gradient equal to the internal resistance and the y intercept equal to the E.M.F

Describing Waves



Wave Speed

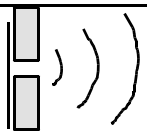
speed(m/s) = frequency (Hz) x wavelength (m)
or velocity V = f x λ

What is wave frequency?

Wave frequency is defined as the number of waves per second and the unit is Hertz (Hz)

Diffraction

Diffraction is the spreading out of waves when they pass through a gap or pass an object. Diffraction is greatest when the gap width is equal to wavelength



What is the intensity of a wave?

The intensity of a wave is the power per metre^2. Its units are Wm^{-2}. As an equation Intensity I = P/area

How is intensity of a wave related to its amplitude?

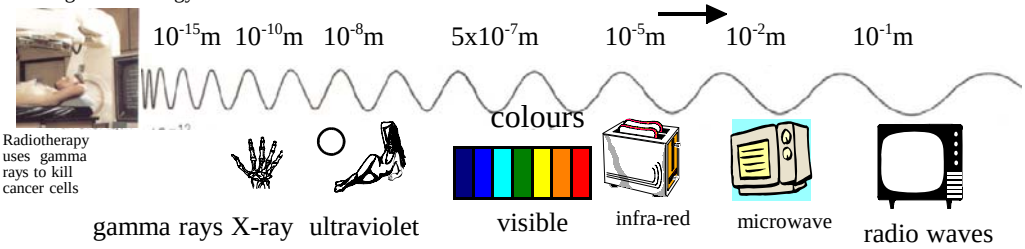
The intensity of a wave is proportional to amplitude^2, $I \propto A^2$ If the amplitude of a wave doubles its intensity x4. If the amplitude of a wave halves its intensity reduces by 1/4

If a wave has amplitude A_1 and intensity I_1 and its amplitude is changed to A_2 then we can write $I_1/I_2 = A_1^2/A_2^2$

The Electromagnetic Spectrum

Highest frequency have the greatest energy

increasing wavelength



What is the period of a wave?

The period, T of a wave is the time for one complete wave or cycle and T(s) = 1/f

Electromagnetic waves with the largest frequency have the most energy. Ultra-violet frequencies and above can ionise atoms to make ions. This changes their chemistry and may lead to cancers. Infra-red, microwave and radio wave have a heating effect on objects. Microwaves of the right frequency can cause water molecules to resonate causing rapid heating.

Ultraviolet

UV part of the spectrum is split into UV-A,UV-B, UV-C, UV-A causes skin to wrinkle, UV-B causes cancer UV-C is mostly absorbed by ozone in the atmosphere

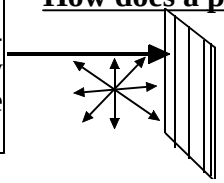
What is visible light?

Light is a transverse wave of different wavelengths. In unpolarised light vibrations are in all planes

What is polarised light?

Polarised light is light where vibrations are in a single plain (typically vertical or horizontal). Light can be polarised using a polariser.

How does a polariser work?



Light emerging from this polariser is vertically polarised

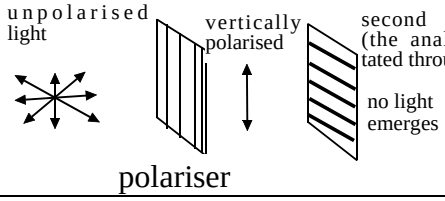
polariser

How do polaroid glasses work?

When light reflects from a surface it is partially polarised. Sunglasses contain a polariser which eliminates this polarised light.

What is Malus. Law?

This describes the relationship between the intensity of transmitted polarised radiation and the angle through which an analyser is rotated



For rotations of the analyser between 0 and 90º the transmitted intensity $\mathbf{I = I_0 \cos^2\theta}$ where I_o is the incident intensity and θ is the angle between the axis of the polariser **and the plane of polarisation of the incident** light

Interference

What is phase difference?

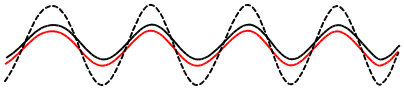
A measure of how out of step waves are in λ or degrees

The Principal of Superposition

If two waves interfere the resulting displacement is the algebraic sum of the individual displacements

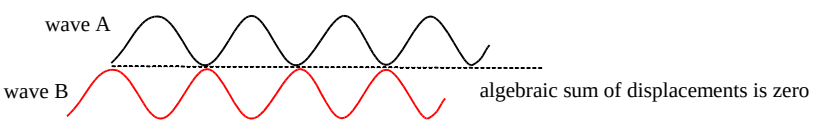
Constructive interference

Occurs when two or more waves in phase combine

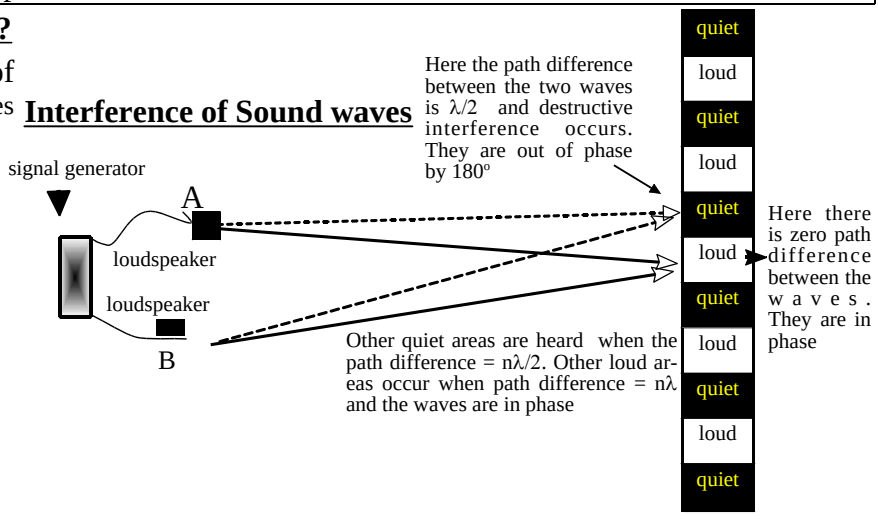


Destructive Interference

Occurs when waves combine 180º out of phase



Interference of Sound waves



Conditions for observable interference

The wave sources must be **coherent**

This means they are in phase or have a constant phase difference when emitted from the source