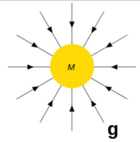
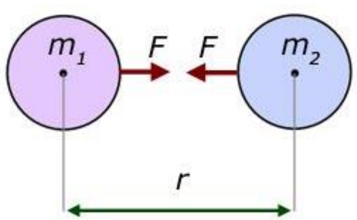
Subject: A-level Physics	Topic: Gravitational Fields	Year Group: 13

Fields

1	A force field can be represented as a vector	
2	Force fields arise from the interaction of mass, of static charge and between moving charges	
3	There are similarities between Gravitational and Electric Fields e.g. inverse square force laws, field lines, equipotentials. There are also differences between Gravitational and Electric Fields e.g. masses always attract, but charges can attract or repel	

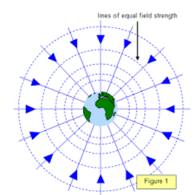
Newton's Law of Gravitation

1	Gravity is a universal attractive force between all matter
2	Equation for Newton's law of gravitation: $F = \frac{Gm_1m_2}{r^2}$
3	
4	The gravitational force between any two bodies is proportional to the produce of their masses and inversely proportional to the square of their separations

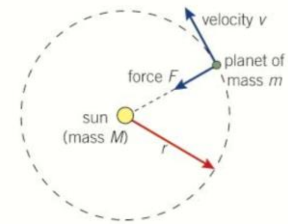
Gravitational Field Strength

1	Use field lines (with arrows) to represent the gravitational field	
2	g is the force per unit mass:	$g = \frac{F}{m}$
3	g can be calculated using:	$g = \frac{GM}{r^2}$

Gravitational Potential

1	The gravitational potential, V, is zero at infinity, and increases as you move away from an object. This means the values are always negative	
2	Work is done in moving a mass higher up in the field	
3	No work is done when you move along an equipotential	
4	In a radial field,	$V = -\frac{GM}{r}$
5	The area under a graph of g against r gives ΔV	$g = -\frac{\Delta V}{\Delta r}$

Orbits

1	Gravity provides the centripetal force to keep an object in orbit	
2	Relationship between Period time, T, and radius of orbit	$T^2 \propto r^3$
3	The radius of a geostationary satellite can be found using this equation. T = 24 hrs = 24x60x60 seconds	$\frac{r^3}{T^2} = \frac{GM}{4\pi^2}$
4	Total energy of an orbiting satellite = GPE + KE	$E = -\frac{GMm}{2r}$

Key Vocabulary

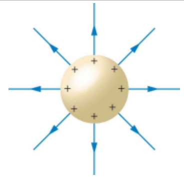
1	Field	A region in which an object experiences a non-contact force
2	Gravitational potential	The energy or work done per unit mass to move an object in a field
3	Field strength	The force per unit mass exerted by a field

Subject: A-level Physics	Topic: Electric Fields	Year Group: 13

Electrostatic charges

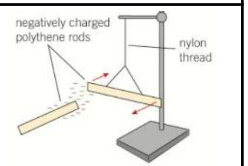
1 Electric fields are brought about by the interaction between positive and negative charges

For a charged sphere, we consider the charge to be at the centre



2 Like charges repel

Opposite charges attract



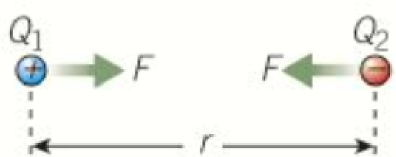
Coulomb's Law

1 The permittivity of free space, ε_0, is the constant of proportionality for electric fields

2 The force between two point charges in a vacuum:

$$F = \frac{1}{4\pi\varepsilon_0}\frac{Q_1Q_2}{r^2}$$

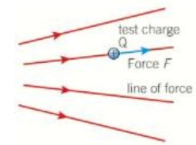
3



4 The electrostatic force between two point charges in a vacuum is directly proportional to the product of their charges and inversely proportional to the square of their separation

Radial Fields

1 Use field lines (with arrows) to represent the electric fields. The arrows point in the direction a small positive test charge would experience a force



2 E is the force per unit charge:

$$E = \frac{F}{Q}$$

3 E can be calculated using:

$$E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$$

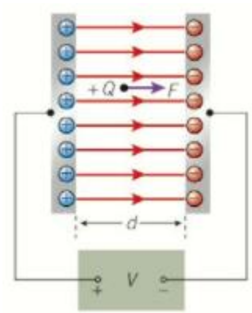
Uniform Fields

1 In a uniform field:

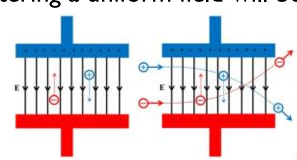
$$E = \frac{V}{d}$$

2 Work done moving a charge between the plates:

$$Fd = Q\Delta V$$

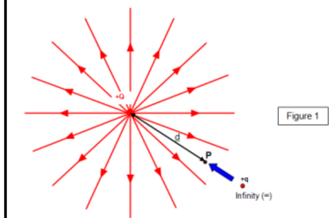


3 Particles entering a uniform field will be deflected:



Electric Potential

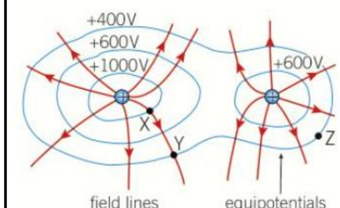
1 Absolute electric potential has a value of zero at infinity



2 The work done in moving a charge Q in an electric field:

$$\Delta W = Q\Delta V$$

3 No work is done when moving a charge around an equipotential in an electric field



4 The magnitude of V in a radial field is given by:

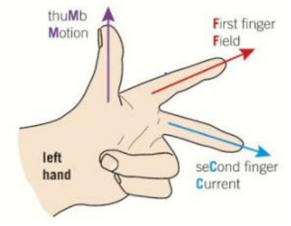
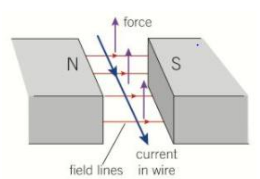
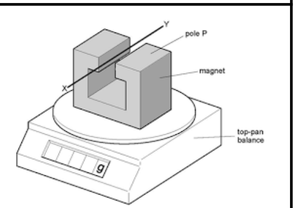
$$V = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r}$$

Key Vocabulary

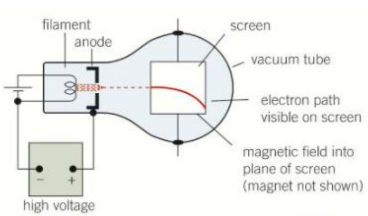
1	Absolute electric potential	The work done per unit positive charge when it is moved from infinity to that position in the field.
2	Electric potential difference	The work done per unit positive charge when moving between two points in the field

Subject: A-level Physics	Topic: Magnetic Fields	Year Group: 13

The Motor Effect

1	Fleming's Left Hand rule: First Finger = Field Second Finger = Current Thumb = Motion of Wire	
2	The force is perpendicular to the field lines and to the current in the wire	
3	A top pan balance can be used to find the force on a current carrying wire. Vary the current, flux density or length of wire to change the force	

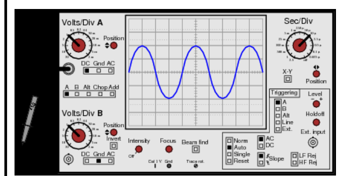
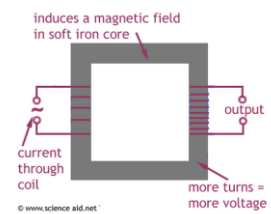
Moving Charges in a Magnetic Field

1	Charged particles moving in a magnetic field will experience a force which can deflect them
2	
3	Cyclotrons work using this principle

Electromagnetic induction

1	Faraday's Law	The induced EMF is equal to the rate if change of flux linkage
2	Lenz's Law	The direction of the induced current is always such as to oppose the change that caused it

Alternating currents

1	An oscilloscope can be used to measure the time-intervals and frequencies of AC waveforms	
2	Converting between peak-to-peak values and rms values	$I_{rms} = \frac{I_0}{\sqrt{2}}$; $V_{rms} = \frac{V_0}{\sqrt{2}}$
3	Transformers rely on AC input to produce AC output	
4	Step-up and step-down transformers	$\frac{N_s}{N_p} = \frac{V_s}{V_p}$
5	Transformers lose energy due to heating effects of eddy currents. This can be reduced by using (1) low resistance windings and (2) a laminated core	

Definitions

1	Magnetic flux density	The magnetic flux is the number of lines of force passing through a unit area of material, B. The unit is the tesla (T).
2	Magnetic flux	Defined as $\Phi = BA$ where B is at right angles to A
3	Magnetic Flux linkage	Defined as $N\Phi$ where N is number of turns of wire cutting the flux

Key equations

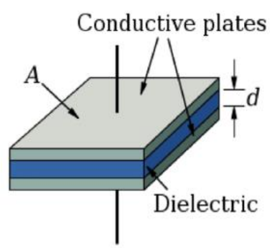
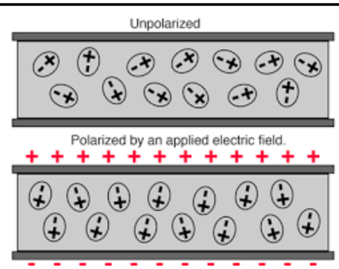
1	Force on a current carrying wire	$F = BIl$
2	Force on a moving particle at right angles to the field	$F = BQv$
3	Flux linkage	$N\Phi = BAN\cos\theta$
4	Magnitude of induced EMF	$\varepsilon = N\frac{\Delta\Phi}{\Delta t}$
5	EMF induced in a rotating coil	$\varepsilon = BAN\omega \sin \omega t$
6	Transformer efficiency	$= \frac{I_S V_S}{I_P V_P}$

Subject: A-level Physics	Topic: Capacitance	Year Group: 13

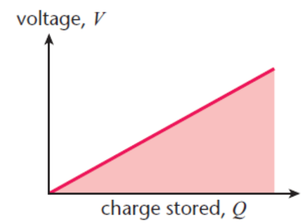
Capacitance introduction

1	Definition	The charge stored per volt (measured in Coulombs)
2	Equation	$C = \frac{Q}{V}$

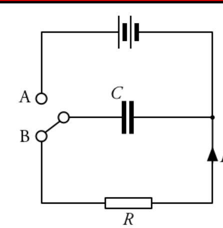
Parallel plate capacitor

1	Basic structure of a parallel plate capacitor:	
2	Factors that affect the capacitance:	1 – Surface area 2 – Separation of the plates 3 – Relative permittivity of the dielectric material
3	Equation:	$C = \frac{A\varepsilon_0\varepsilon_r}{d}$
4	Dielectrics have polar molecules inside which rotate to line up with the field. This increases the charge stored	

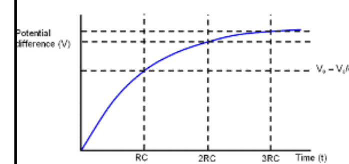
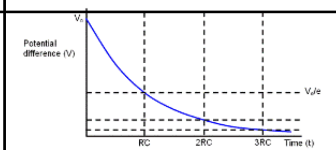
Energy stored by a capacitor

1	Energy =	$= \frac{1}{2}QV$ $= \frac{1}{2}CV^2$ $= \frac{1}{2}\frac{Q^2}{C}$
2	Area under a Charge-pd graph is the energy stored	

Capacitor charging and discharging circuit

1	Circuit for charging and discharging a capacitor though a resistor:	
2	Capacitors must be connected with the correct leg attached to the positive terminal of the power supply:	

Equations and graphical analysis

1	Charging equation: (same for I and V)	$Q = Q_0\left(1 - e^{-\frac{t}{RC}}\right)$
2	Discharge equation: (same for I and V)	$Q = Q_0 e^{-\frac{t}{RC}}$
3	Time constant:	RC is the 'time constant' for the circuit
4	Time to halve, $T_{1/2}$	= 0.69RC
5	Capacitor charging graph:	
6	Capacitor discharging graph:	
7	Area under a current-time graph represents the charge stored by the capacitor	

Required practical

1	Link to video showing method for the Capacitors required prac:	https://www.youtube.com/watch?v=bVVw6S1uqYM