Higher

Learn me statements

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UNCERTAINTIES

1.1	I can identify that **all measurements of physical quantities are liable to uncertainty** which I can express in absolute or percentage form.
1.2	I can quantify and recognise scale reading, random and systematic uncertainties in a measured quantity.
1.3	I can express uncertainties in absolute or percentage form
1.4	I know that **random uncertainties arise when an experiment is repeated and slight variations occur.**
1.5	I can explain that **scale reading uncertainty is a measure of how well an instrument scale can be read.**
1.6	I know that **scale reading uncertainty is an indication of how precisely a scale can be read.**
1.7	I can state that **random uncertainties can be reduced by taking repeated measurements.**
1.8	I can explain that **systematic uncertainties occur when readings taken are either all too small or all too large.**
1.9	I can recognise that **systematic uncertainties can arise due to measurement techniques or experimental design.**
1.10	I know **the mean of a set of repeated measurements is the best estimate of the 'true' value of the quantity being measured.**
1.11	I know that **when systematic uncertainties are present, they offset the mean value**
1.12	I know **when mean values are used, the approximate random uncertainty should be calculated.**
1.13	I can correctly calculate, use and identify uncertainties during data analysis.
1.14	I know that **when an experiment is being undertaken and more than one physical quantity is measured, the quantity with the largest percentage uncertainty should be identified and this may often be used as a good estimate of the percentage uncertainty in the final numerical result of an experiment.**
1.15	I can express the numerical result of an experiment in the form final value ±uncertainty.

State how random uncertainties arise.

- **random uncertainties arise when an experiment is repeated and slight variations occur.**

State how random uncertainties are reduced.

- **random uncertainties can be reduced by taking repeated measurements**

Explain how systematic uncertainties occur.

- **systematic uncertainties occur when readings taken are either all too small or all too large**
- **systematic uncertainties can arise due to measurement techniques or experimental design.**
- **Arising from bad experimental design or bad use of equipment or unreliable equipment**

State the best estimate of the true value being measured.

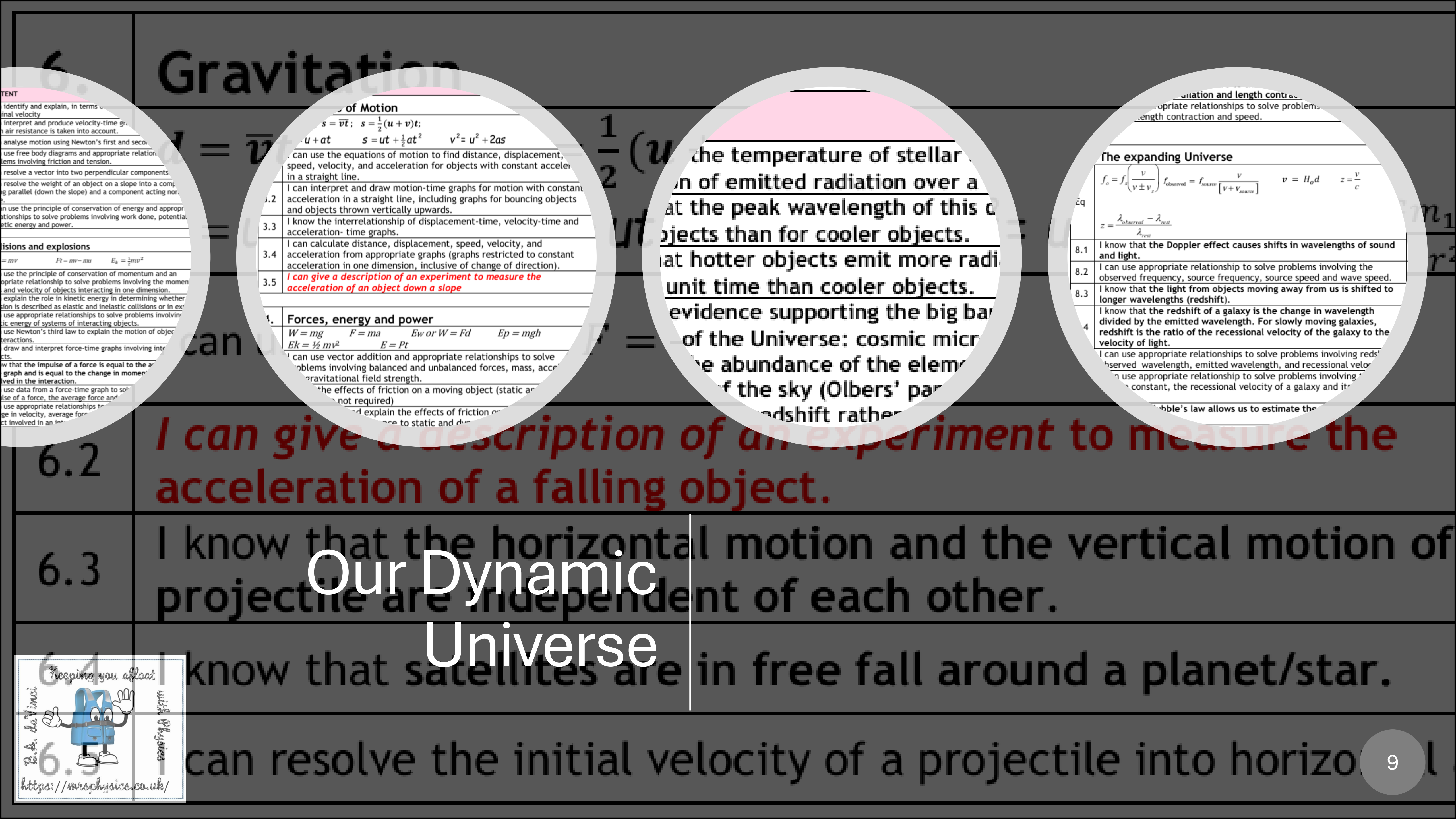
- the mean of a set of repeated measurements is the best estimate of the ‘true’ value of the quantity being measured.

State the effect of systematic uncertainties.

- **systematic uncertainties make all measurements too small or all too large**

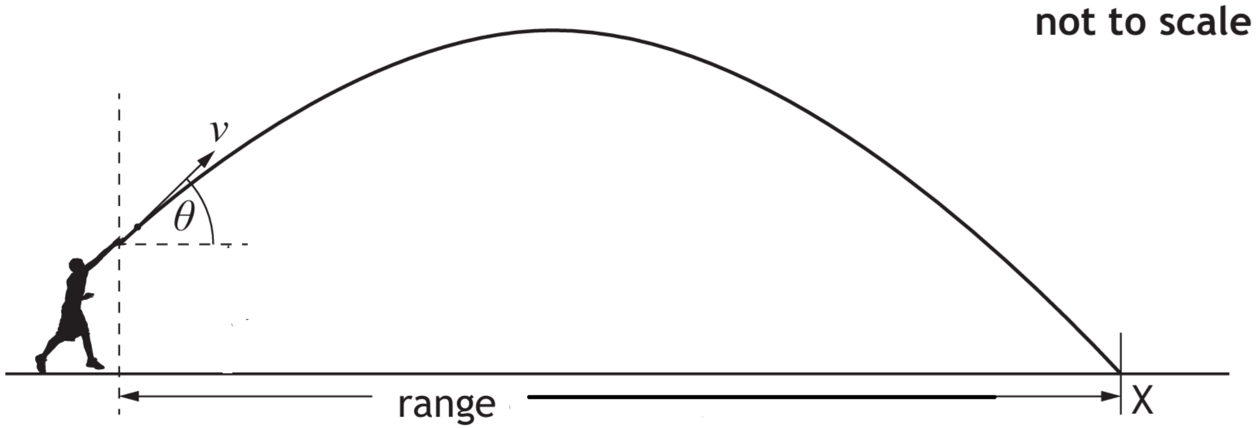
State how to determine the percentage uncertainty in the final result from a number of readings.

when an experiment is being undertaken and more than one physical quantity is measured, **the quantity with the largest percentage uncertainty should be identified and this may often be used as a good estimate of the percentage uncertainty in the final numerical result of an experiment.**



Our Dynamic Universe

State the vertical and horizontal components for an object thrown at an angle

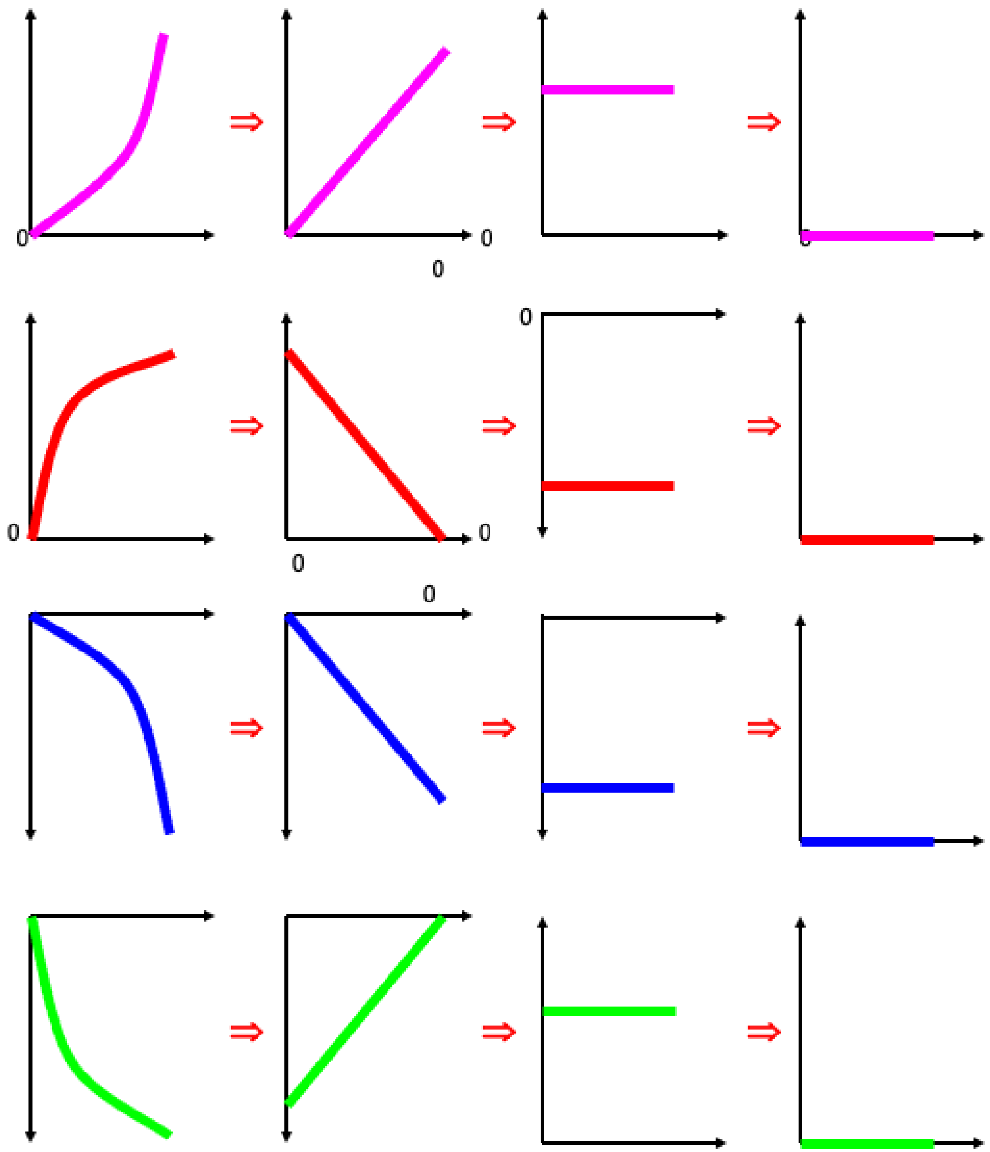


- Horizontal component = $v \cos \theta$
- Vertical component = $v \sin \theta$

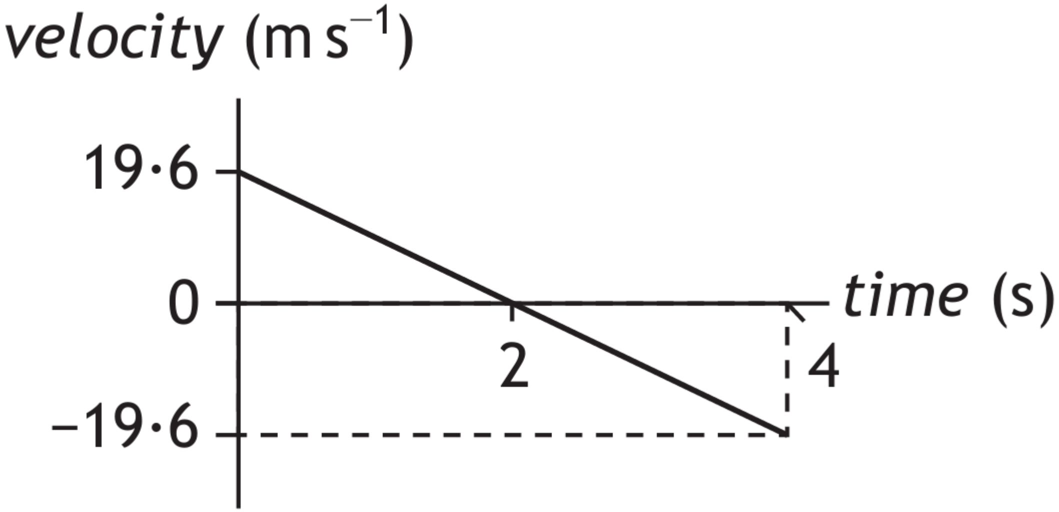
The graph to the right is the gradient of the previous one

So if you find have an s-t graph the next one right is the v-t graph and the next one right is the a-t graph.

Likewise the graph to the left is the area under the previous graph, so if you have an a-t graph to the left is the v-t graph and to the left of that the s-t graph.

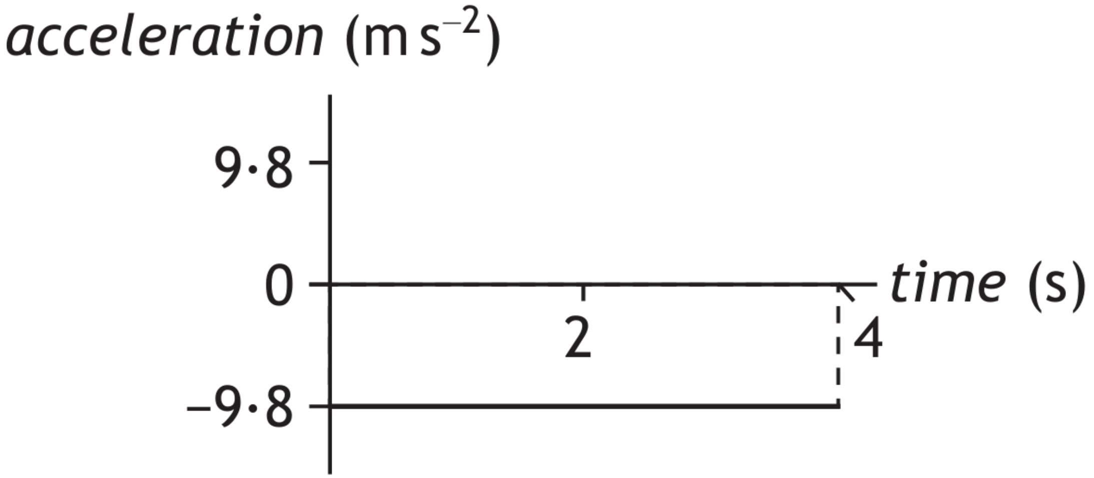


Sketch a v-t graph for an object thrown up in the air and caught on its return



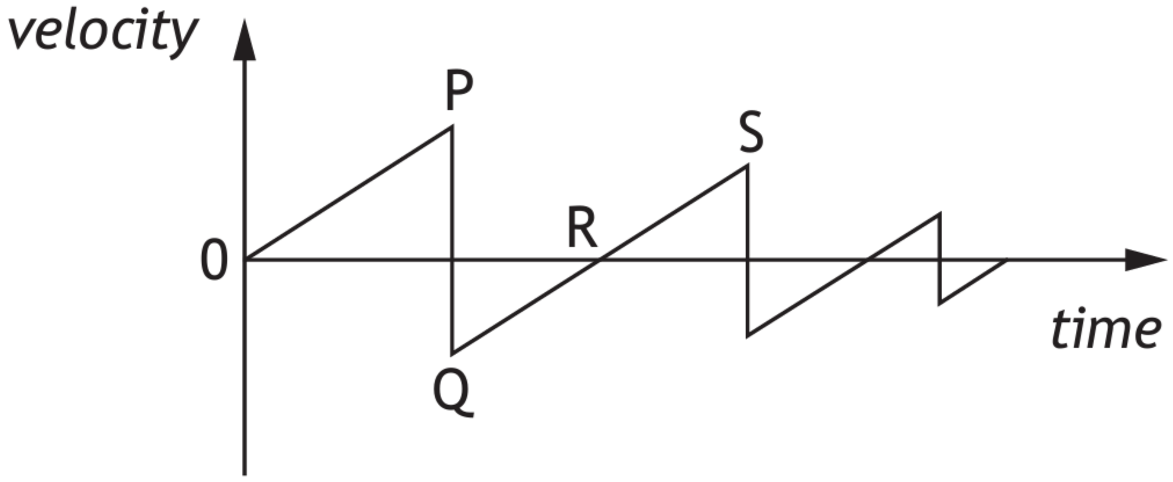
- For earth the gradient should be 9.8 ms^{-2}
- the initial velocity and time can vary
- The initial and final vertical velocities should be constant if the ball is caught at the same height
- The area under the graph should equal zero, as the bottom half is the negative displacement (return journey)
- The area under the top half of the graph represents the max height reached
- The gradient= acceleration =g = negative

Sketch a a-t graph for an object thrown up in the air and caught on its return



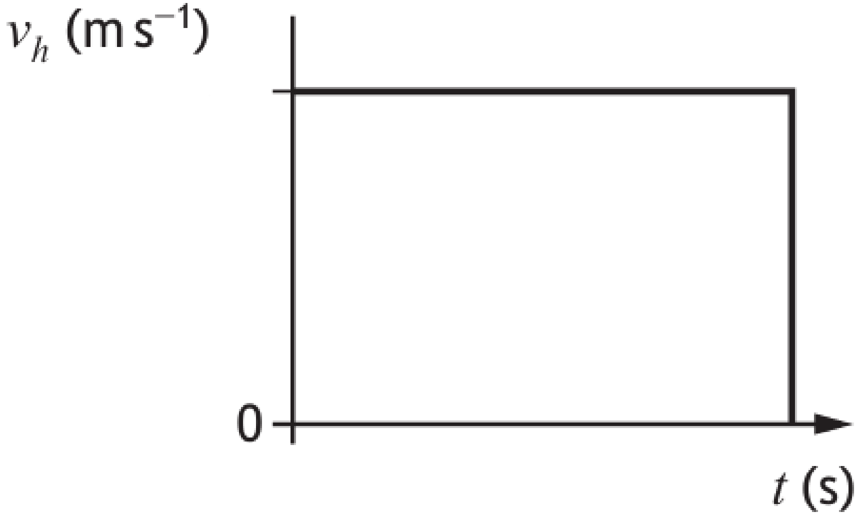
- For earth the gradient should be zero
- For Earth the value of a = - 9.8 ms^{-2}
- The area under the graph should equal the change in velocity,
- The time depends on how long the object remains in the air

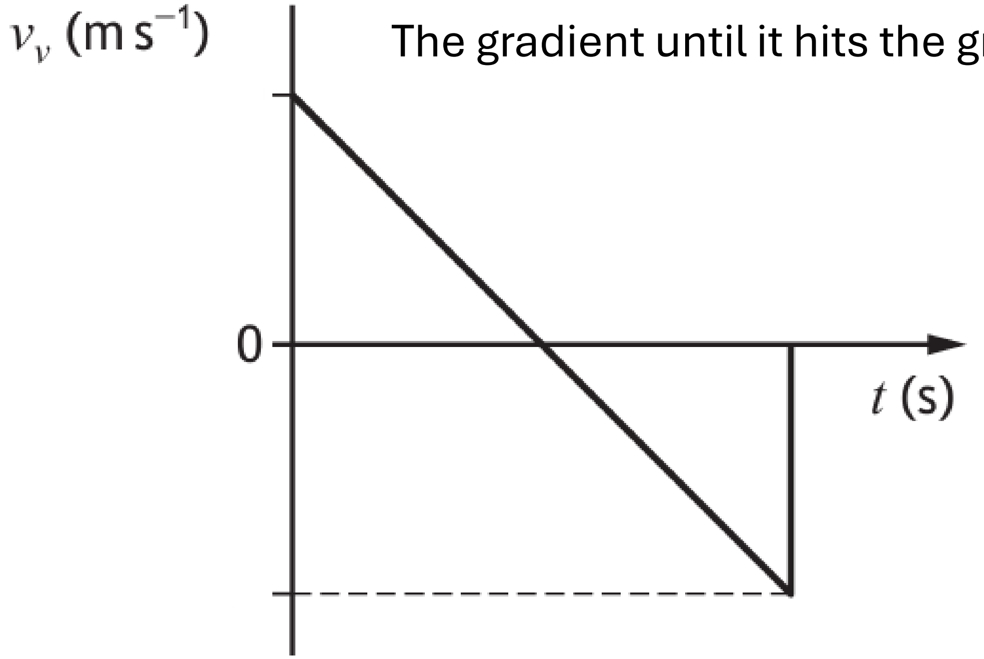
Sketch a v-t graph for an object dropped and allowed to bounce several times



- For Earth the gradient,0P/QS should be equal and equal 9.8 ms^{-2}
- the initial velocity is zero as dropped from rest
- The gradient PQ/ST >> 0P/QS as this is the acceleration during the bounce and the rate of change of velocity is great.
- The velocity at P>S so after the bounce the ball must have lost Ek, the collision is inelastic

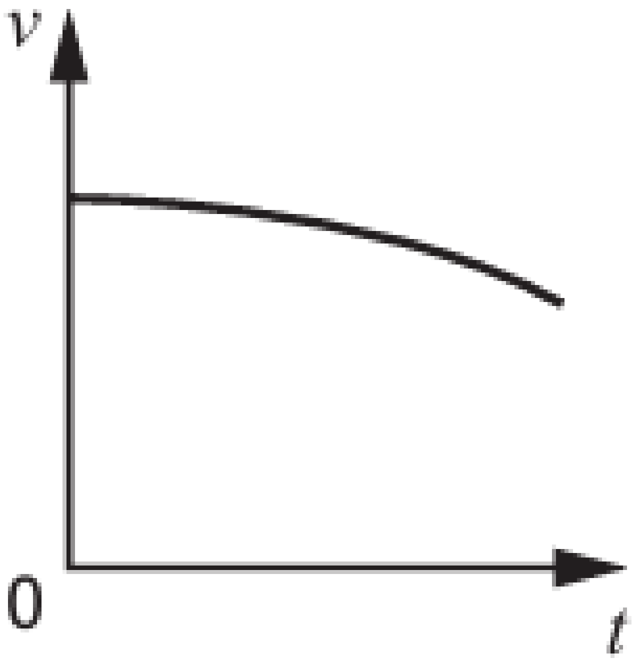
Sketch v-t graphs of the horizontal and vertical motions for an object thrown at an angle



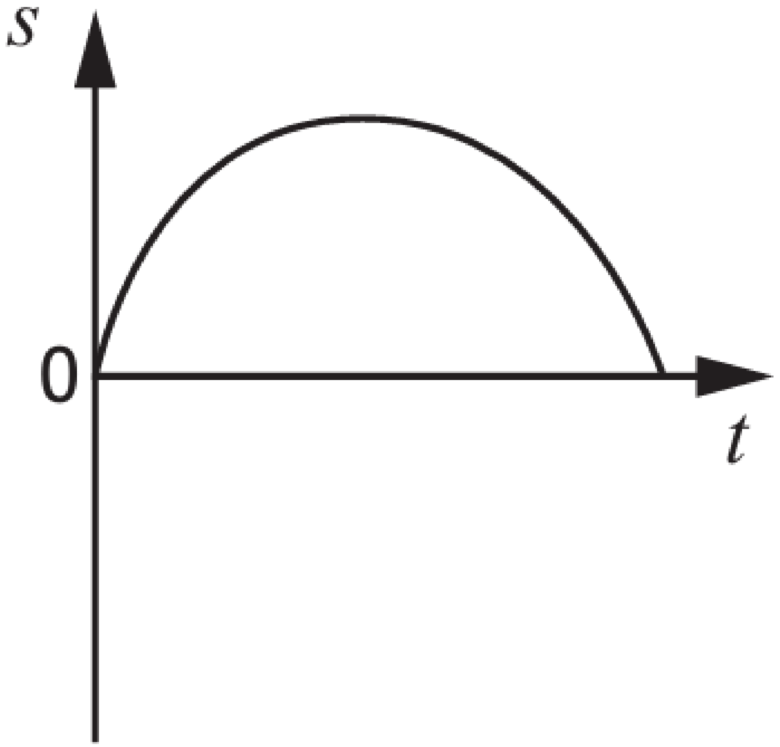


The gradient until it hits the ground = g

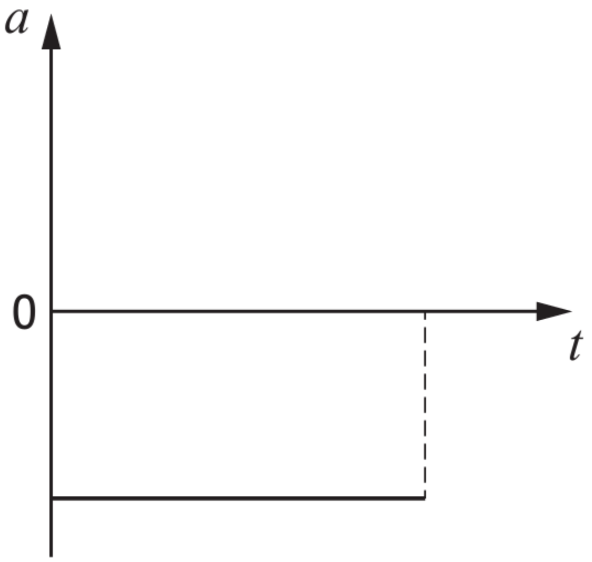
Sketch v-t graphs of the horizontal motion for an object thrown from a cliff when air resistance is accounted for

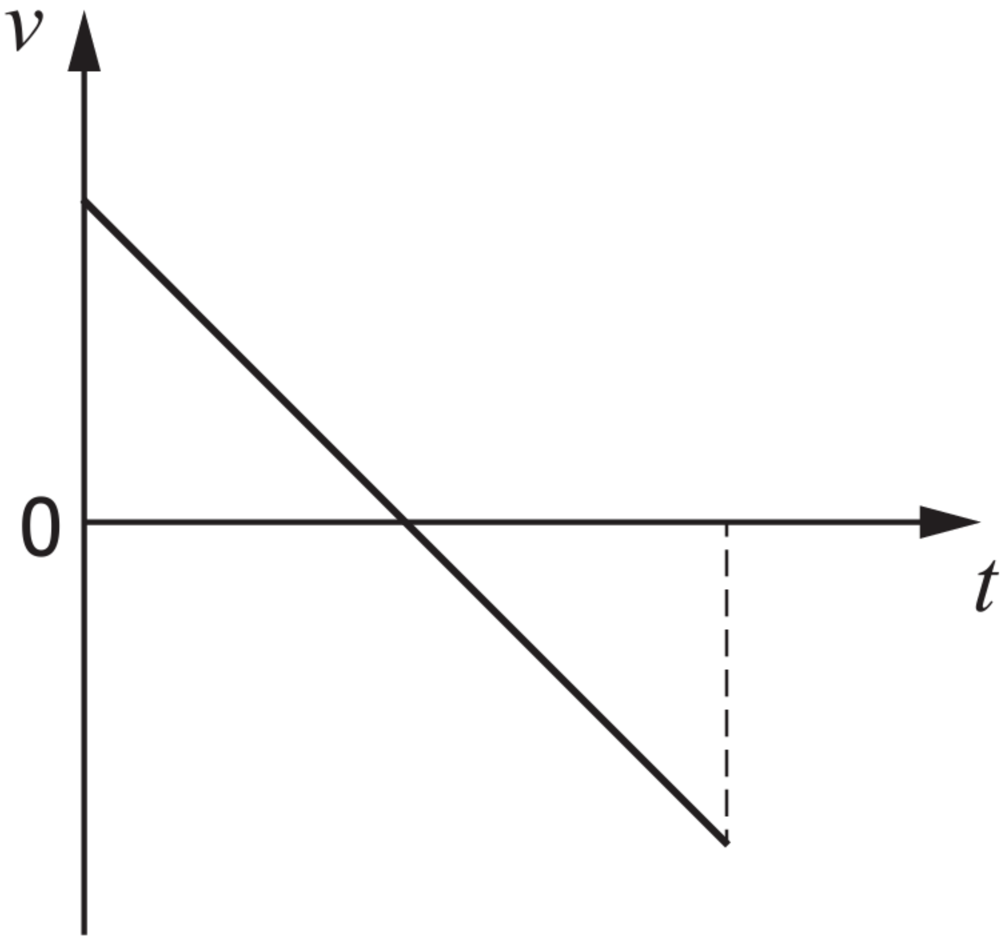


Sketch a displacement-time graph for a ball thrown vertically upwards and returing to its original position



A ball is thrown vertically up and it falls back. The a-t graph is shown. Sketch the corresponding v-t graph





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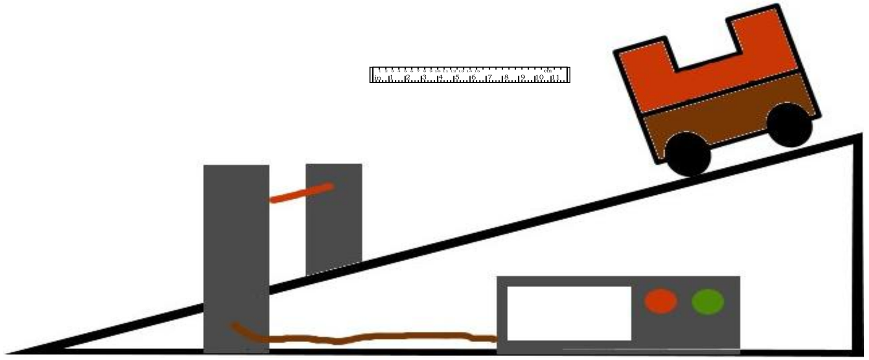
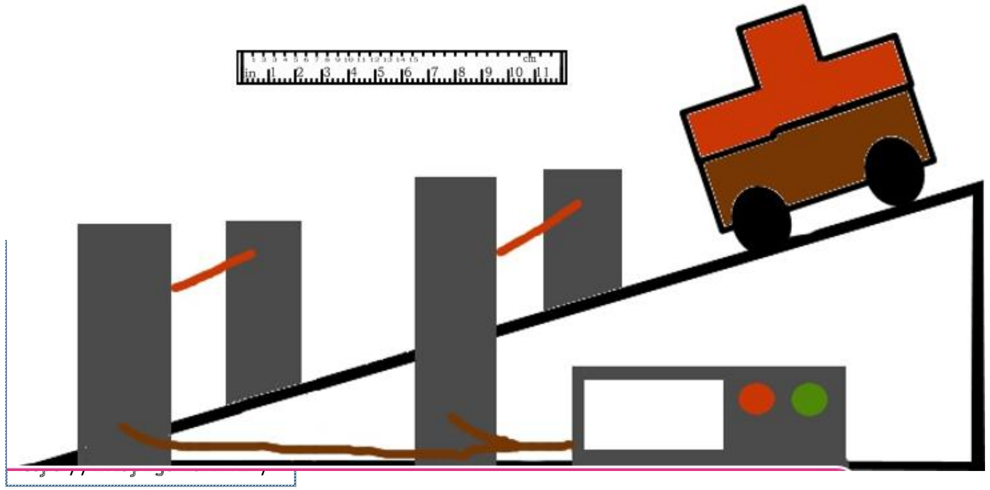
State the effect of friction on an object

- Friction opposes motion, so will slow an object or cause an object with a force on it to move at constant velocity.
- The force of friction increases with speed.

Give a description of an experiment to measure the acceleration of an object down a slope

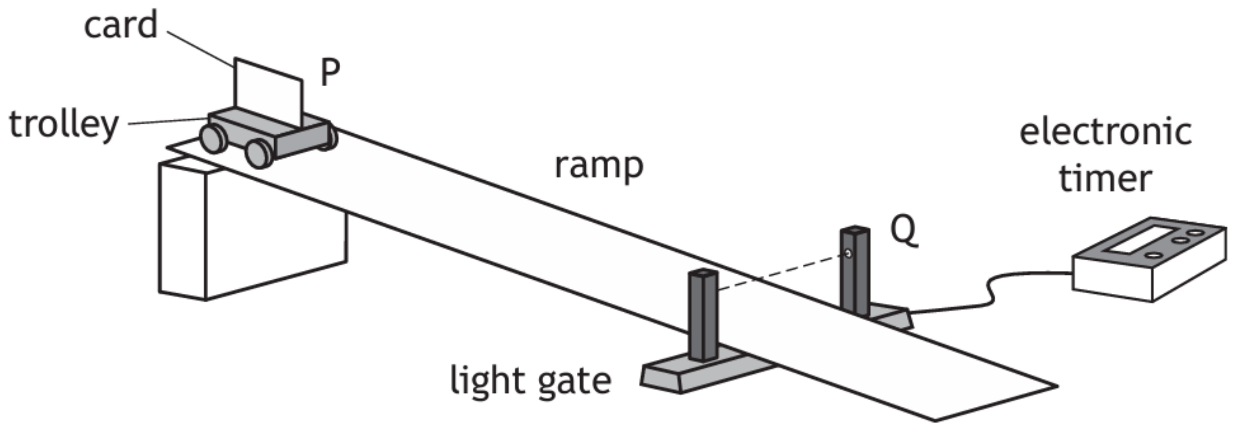




Measurements	Calculations
t_1 time to pass first light gate	$u = \frac{l}{t_1}$
t_2 time to pass second light gate	$v = \frac{l}{t_2}$
t_3 time between light gate	t_3
length of mask	l
	$a = \frac{v - u}{t_3}$

Give a description of an experiment to measure the acceleration of an object down a slope

A student uses the apparatus shown to determine the acceleration of a trolley as it moves down a ramp.



The trolley is released from rest at point P and moves down the ramp.

A card attached to the trolley passes through a light gate at point Q.

The time for the card to pass through the light gate is displayed on the electronic timer.

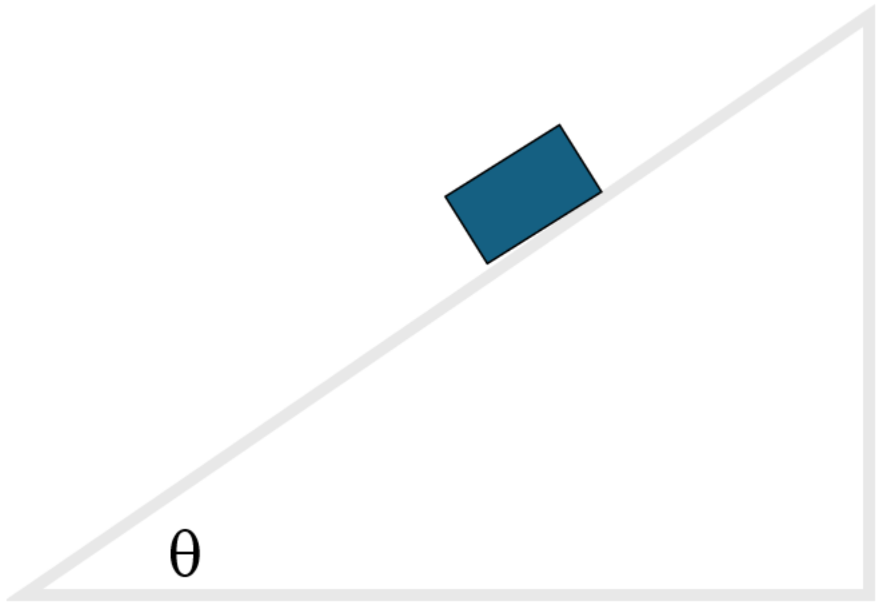
The vehicle's acceleration a is determined using the relationship

$$v^2 = u^2 + 2as$$

Explain in terms of forces why an object reaches terminal velocity

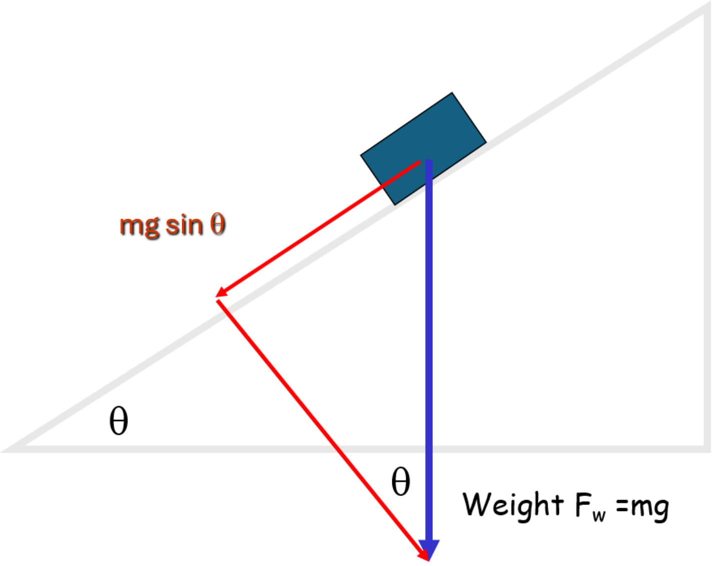
- Forces are balanced (mustn’t just say equal, must have equal and opposite)
- Frictional forces increase with speed
- Terminal speed achieved when forward forces balance the frictional forces

State the force/component of force acting down the slope



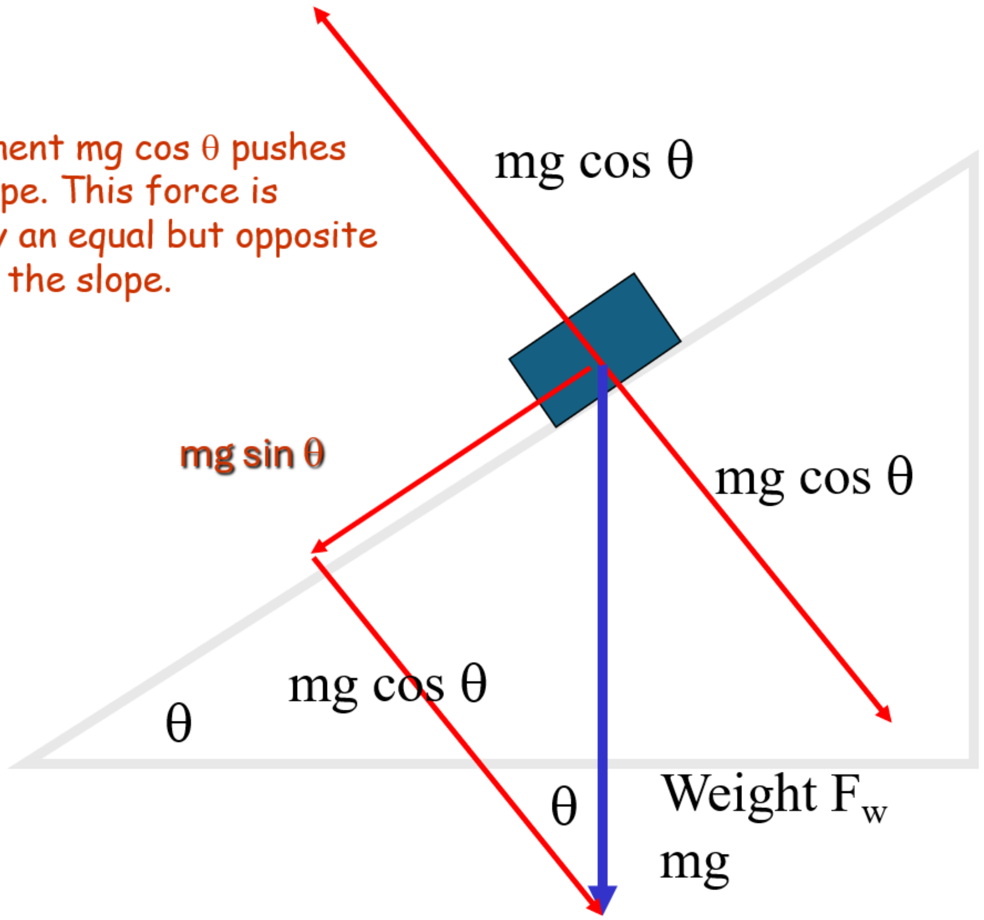
$$mg \sin\theta \text{ or } W\sin\theta$$

So the important component that gives the block the motion down the slope is mg sin θ



State the force/component of force normal to the slope.

The component mg cos θ pushes into the slope. This force is balanced by an equal but opposite force from the slope.



$mg\cos\theta$ or $W\cos\theta$

This is balanced by the reaction force from the slope

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State what is meant by the conservation of momentum

- **In the absence of external forces, <u>total</u> momentum before is equal to the <u>total</u> momentum after**

State what is conserved and lost during an elastic collision

- **Total energy is conserved**
- **Total Momentum is conserved**
- **Total Kinetic energy is conserved**

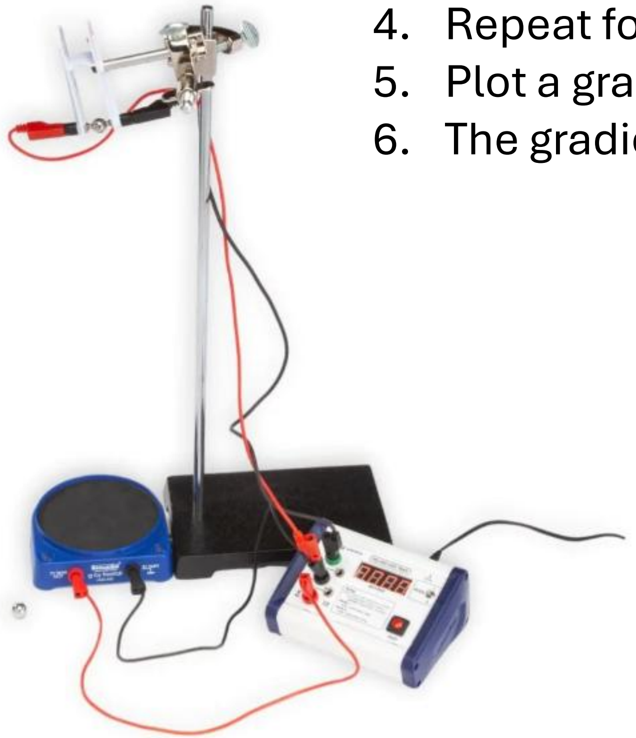
State what is conserved and lost during an inelastic collision

- **Total energy is conserved**
- **Total Momentum is conserved**
- Total Kinetic energy is lost (to other forms)

Force time graphs

Describe an experiment to measure the acceleration of a falling object.

1. Measure and record the height between bottom of ball and trap door
2. Close the switch to release the ball and start timer
3. Record the time to fall
4. Repeat for other heights
5. Plot a graph of 2s against t^2
6. The gradient is g the acceleration due to gravity

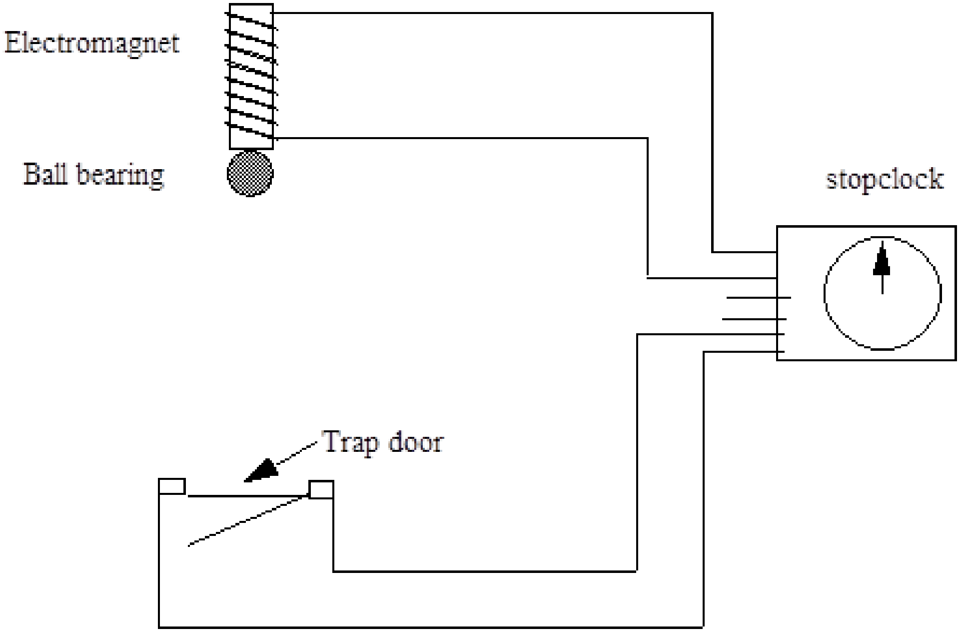


$$s = ut + \frac{1}{2}a\,t^2$$

Where u= 0 ms^{-1}

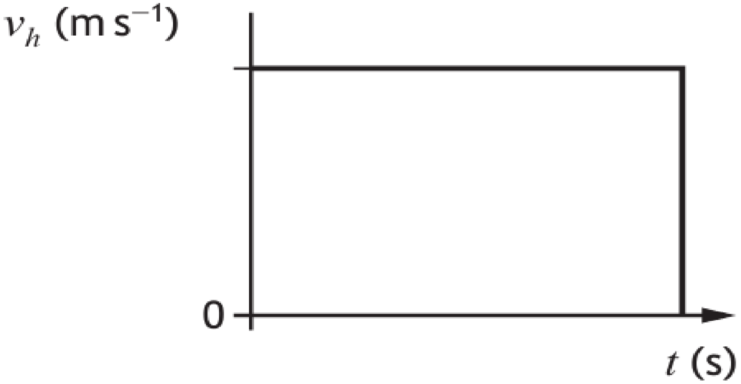
$$y = mx + c$$

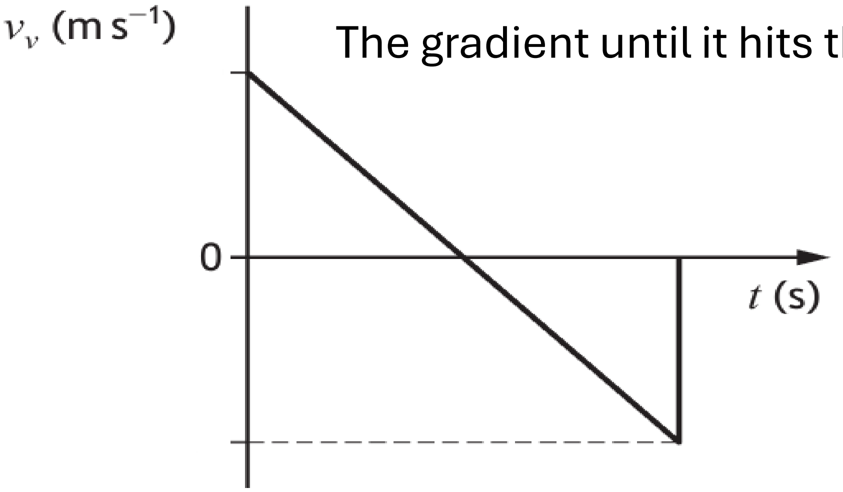
$$2s = a\,t^2$$



Describe the horizontal and vertical motions of a projectile

- Motions are independent
- Horizontally (ignoring air resistance) horizontal motion is constant
- Vertically (ignoring air resistance) motion is constant acceleration and is equal to g





The gradient until it hits the ground = g

Describe the motion of a satellite around a star or planet

- satellites are in free fall around a planet/star
- Satellites have a constant horizontal velocity and a constant downwards acceleration

State the speed of light for two observers in different frames of reference

- **the speed of light in a vacuum is the same for all observers.**

- **measurements of space, time and distance for a moving observer are changed relative to those for a stationary observer, giving rise to time dilation and length contraction**

State Einsteins two postulates

1. All the laws of physics are the same in all inertial frames of reference.
2. The speed of light (in a vacuum) is the same in all inertial frames of reference.

State the effect of the Doppler effect

- **Doppler effect causes shifts in wavelengths of sound and light.**

State how distant galaxies are moving relative to us

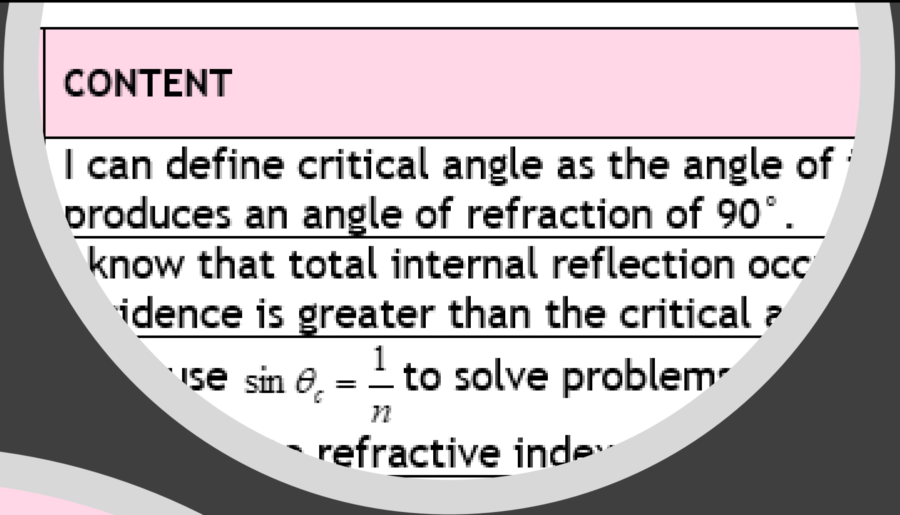
- Distant galaxies are moving away from us
- The further the galaxy, the greater its recessional velocity.

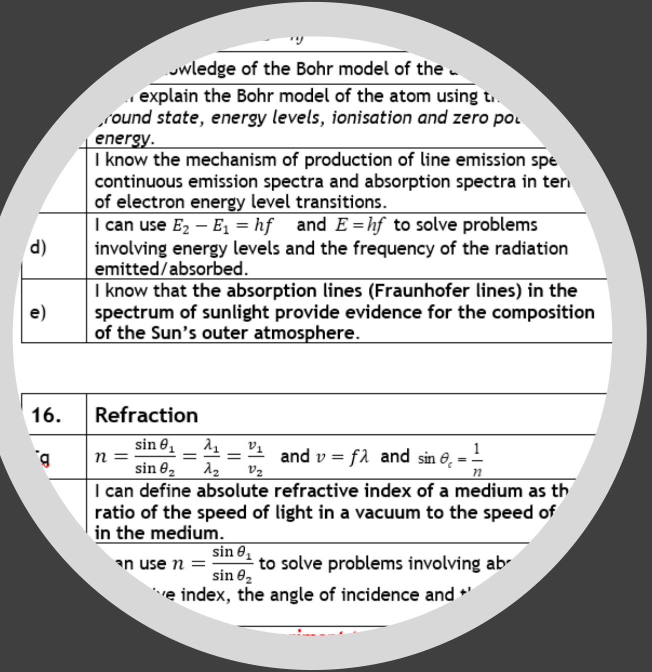
State evidence supporting the big bang

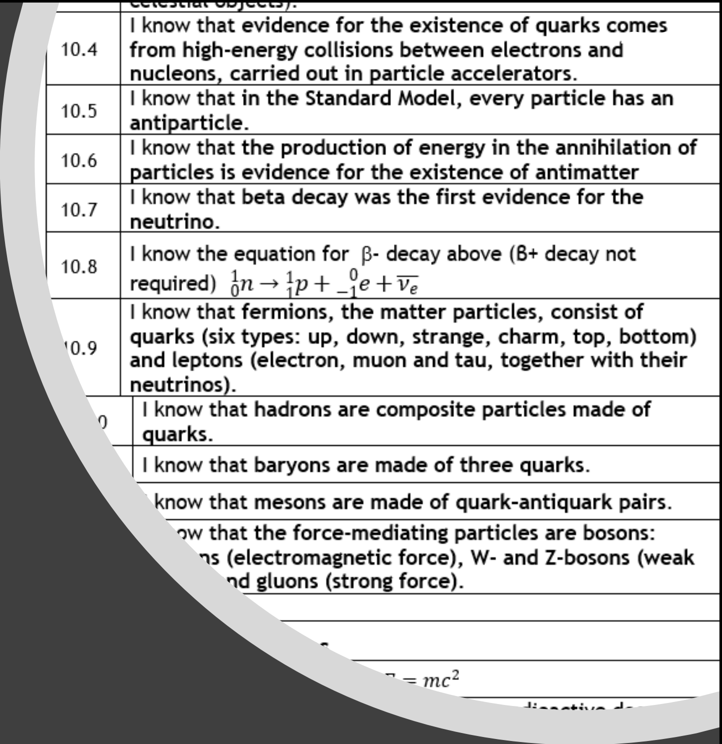
1. cosmic microwave background radiation,
2. the abundance of the elements hydrogen and helium,
3. the darkness of the sky (Olbers’ paradox) and
4. the large number of galaxies showing redshift rather than blueshift.

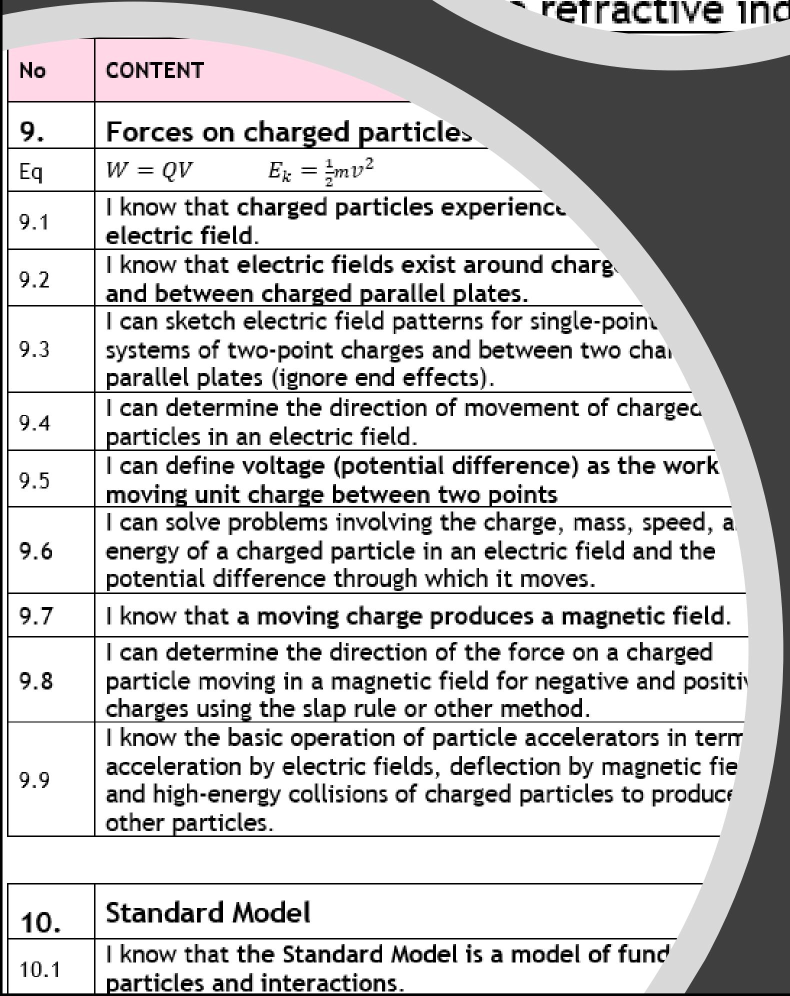
State what the big bang suggests about our universe.

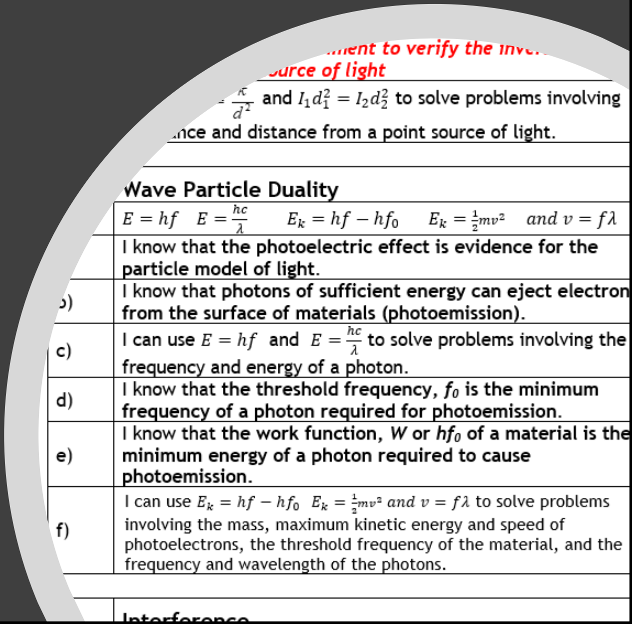
- The expansion of the Universe.











Particles and Waves

State what is meant by the Standard Model

- **the Standard Model is a model of fundamental particles and interactions**

State what is meant by a fundamental particle

- Fundamental particles cannot be broken down any further, so leptons and quarks are considered fundamental
- Protons and neutrons are made of more than one particle so are not fundamental

Define the terms a) hadron, b) baryon, c) meson

- Hadrons are made up of quarks (which cannot exist alone)
- Baryons (3 syllables) are hadrons made up of 3 quarks
- Mesons (2 syllables) are hadrons made up of a quark and anti-quark pair

Define the terms a) lepton, b) exchange particle

a) Leptons are fundamental particles that exist on their own

- They have a whole charge

b) Exchange particles carry the force between two particles

Name the quarks

6 Quarks –

- up,
- down,
- charm,
- strange,
- top,
- bottom

Name the leptons

6 Leptons

- electron,
- electron neutrino,
- muon,
- muon neutrino,
- tau,
- tau neutrino

State the a) 4 fundamental forces, b) the particles that experience it, c) force carrying particle d) the range, and e) relative strength (NB gravity not required though)

Force	Particles Experiencing / nature	Force Carrier Particle	Range	Relative Strength
GRAVITY Acts between objects with mass	All particles with mass (acts between particles with mass)	Graviton (not yet discovered, not in the course)	Infinite ∞	Much weaker
WEAK FORCE governs particle decay	Quarks and leptons (responsible for nuclear fusion and radioactive decay except alpha decay	W^+, W^-, Z^0 (W and Z)	Short range 10^{-18} m	
ELECTROMAGNETISM acts between electrically charged particles	Electrically charges (acts between charged particles)	Photon	Infinite ∞	
STRONG FORCE binds quarks together	Quarks and Gluons (acts between quarks)	Gluon	Short range (diameter of the nucleus) 10^{-15} m	Much stronger

Name the bosons and associated force

- 4 Gauge Bosons (force carriers) but graviton not on the course
- photon (electromagnetic force)
- Z and W± bosons (weak nuclear force)
- gluon (strong nuclear force).

Define the term fermion

- Fermions are matter particles, so all quarks and leptons

State what causes beta decay
State what evidence is provided by beta decay

- Beta decay is caused by the weak force and
- is evidence of the neutrino

Descibe antiparticles

- Every type of particle of "ordinary" matter (as opposed to antimatter) is associated with an antiparticle with the same mass but with opposite physical charges (such as electric charge).
- For example, the antiparticle of the electron is the positron (antielectron). The electron has a negative electric charge, the positron has a positive electric charge.
- Particles and their antiparticles can annihilate each other producing energy

State the evidence for the existence of antimatter

- the production of energy in the annihilation of particles

State what is meant by the strong force

- Strong force holds quarks together and
- so holds protons and neutrons together in the nucleus.
- It acts over a very small range (the diameter of the nucleus) but it is very strong compared to the other forces of nature

State what is meant by a fermion

- Fermions are matter particles they consist of the 6 quarks and the 6 leptons

State whether something can be a hadron, lepton, fermion, baryon and meson at the same time

- Fermions- leptons, baryons, meson, hadrons
- Leptons- fermions
- Hadrons- either baryon or meson (not both), fermion
- Baryons- hadrons, fermions
- Mesons- hadrons, fermions

State the equation for beta decay

$$^{1}_{0}n \rightarrow {}^{1}_{1}p + {}^{0}_{-1}e + \overline{\nu_e}$$

State what beta decay is evidence for.

ν_e the neutrino

State what make up the group called fermions

- **fermions, the matter particles,**
- **consist of quarks (six types: up, down, strange, charm, top, bottom)**
- **and leptons (electron, muon and tau, together with their neutrinos).**

State what is meant by composite particles

- hadrons are composite particles made of quarks.
- i.e they cannot exist alone

State what the force mediating particles are

- **the force-mediating particles are bosons:**
- **photons (electromagnetic force),**
- **W- and Z-bosons (weak force),**
- **and gluons (strong force).**

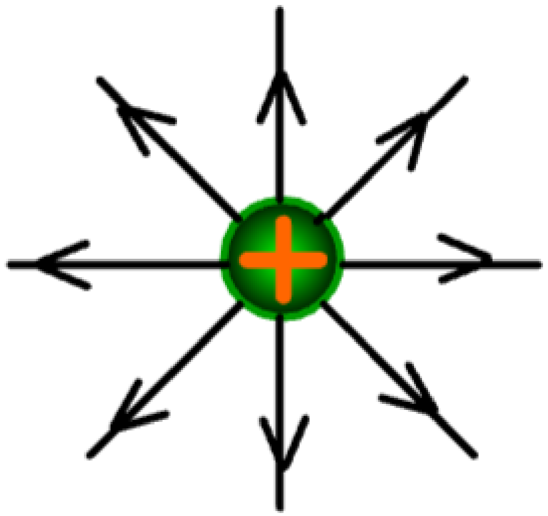
State what charged particles experience in an electric field

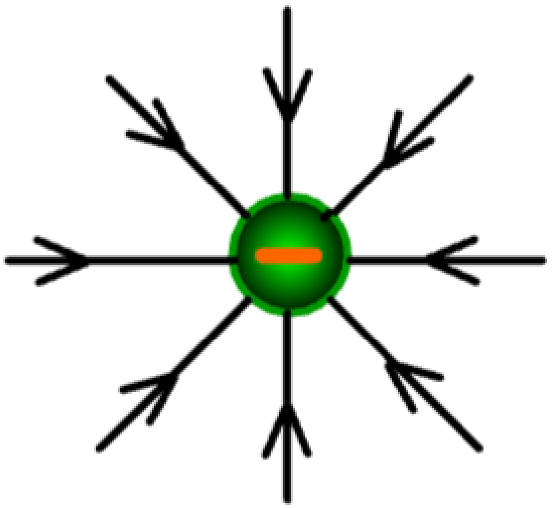
- charged particles experience **a force** in an electric field.

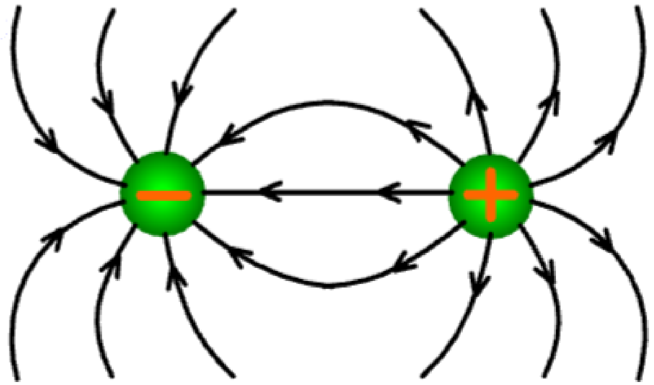
State what exist around charged particles and between charged parallel plates.

- electric fields

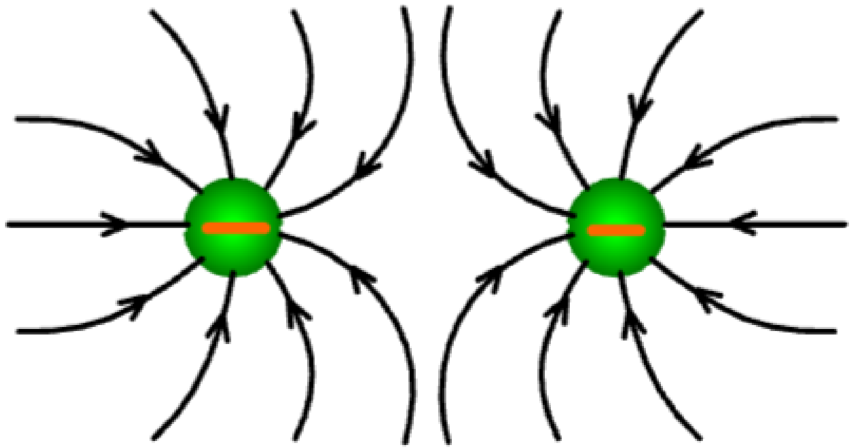
Sketch the electric field lines around a) a positive charge particle b) a negative charge particle c) a positive and negative charged particle d) between two negative particles and e) between charged parallel plates.

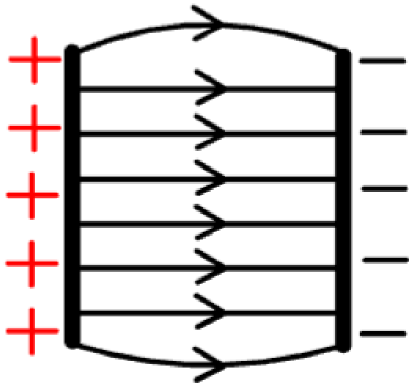






Note: The arrows on field lines between two positive charges would be reversed





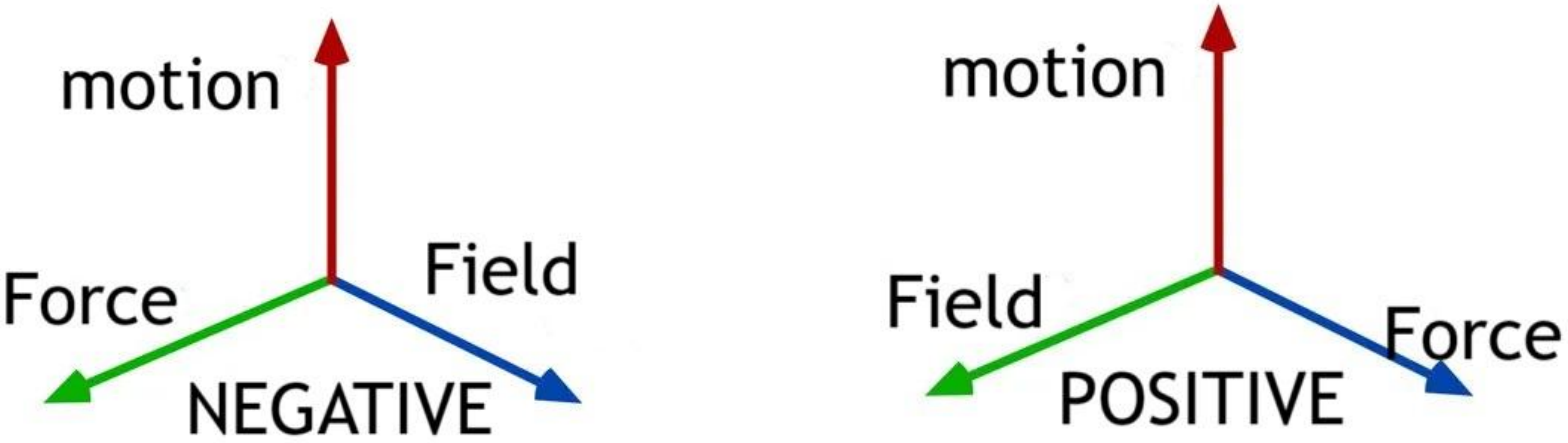
define voltage

- (potential difference) as the work done moving unit charge (1 coulomb) between two points

State what is produced by a moving charge

- A magnetic field

determine the direction of the force on a charged particle moving in a magnetic field



Negative particles have a force field and positive particles field the force
If the motion is up!
If you get these results your method works!

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Explain how particle accelerators work.

- In a particle accelerator an electric field is used to change the particle’s speed (SQA: accelerate) while it is most common to use a magnetic field to change the particle’s direction (SQA: deflect)

In particle accelerator state the function of

a) electric fields,

b) magnetic fields

c) high-energy collisions

- electric fields accelerate particles,
- magnetic fields deflect particles
- and high-energy collisions of charged particles produce other particles

Describe nuclear fission

- Nuclear Fission (must spell it correctly) – big nucleus splitting into smaller parts
- Induced/Stimulated Fission: usually caused by neutron bombardment
- Spontaneous Fission: random event, no external trigger.
- The products of a nuclear reaction have less mass than the particles did before. The difference in mass is converted into energy according to $E = m c^2$.

Describe nuclear fusion

- Nuclear Fusion (must spell it correctly) –
- Small nuclei combine to make a more massive nucleus.
- The products of a nuclear reaction have less mass than the particles did before.
- The difference in mass is converted into energy according to
- $E = m c^2$.

State what is meant by a spontaneous nuclear reaction

- When a large nucleus decays into smaller nuclei and energy without the need for a neutron to start the reaction, mass is not conserved during the reaction but is converted to energy according to $E=mc^2$

$$^{239}_{92}U \rightarrow \, ^{239}_{93}Np + \, ^{0}_{-1}e$$

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State what is meant by a induced nuclear reaction

- When a neutron collides with a large nucleus which decays into smaller nuclei creating energy, mass is not conserved during the reaction but is converted to energy according to $E=mc^2$

$${}^{1}_{0}n + {}^{238}_{92}U \rightarrow {}^{145}_{56}Ba + {}^{94}_{36}Kr$$

$${}^{1}_{0}n + {}^{235}_{92}U \rightarrow {}^{98}_{42}Mo + {}^{136}_{54}Xe + 2\,{}^{1}_{0}n + 4\,{}^{0}_{-1}e$$

Summarise the effects of α, $\beta+$, $\beta-$, γ, neutron emission on the mass and atomic numbers

$^{A}_{Z}X$

Particle	Symbol	Changes to Mass No, A.	Changes to Atomic No. Z
α	$^{4}_{2}He$	-4	-2
β / $\beta-$	$^{0}_{-1}e$	0	+1
$\beta+$	$^{0}_{+1}e$	0	-1
γ	γ	0	0
$^{1}_{0}n$	$^{1}_{0}n$	-1	0

State what is required for fusion reactors

- **require charged particles**
- **at a very high temperature (plasma)**
- **this plasma has to be contained by magnetic fields.**

State the meaning of the term irradiance

- **Irradiance is the power per unit area incident on a surface**

$$I = \frac{P}{A}$$

- it is measured in Watts per square metre

State the relationship between I and r

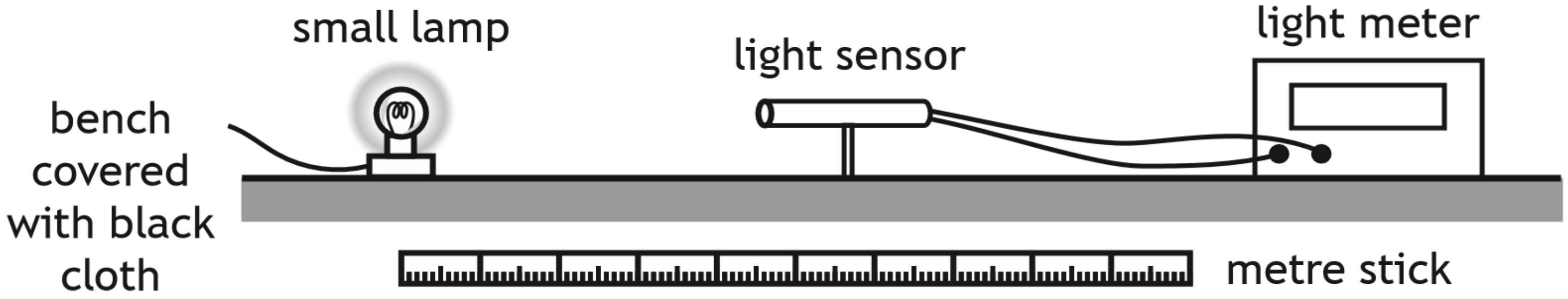
- **irradiance is inversely proportional to the square of the distance from a point source**

$$I = \frac{k}{d^2}$$

$$or$$

$$I_1 d_1^2 = I_2 d_2^2$$

Describe an experiment to verify the inverse square law for a point source of light



Reduce/remove/account for background light

Obtain values of irradiance for different distances

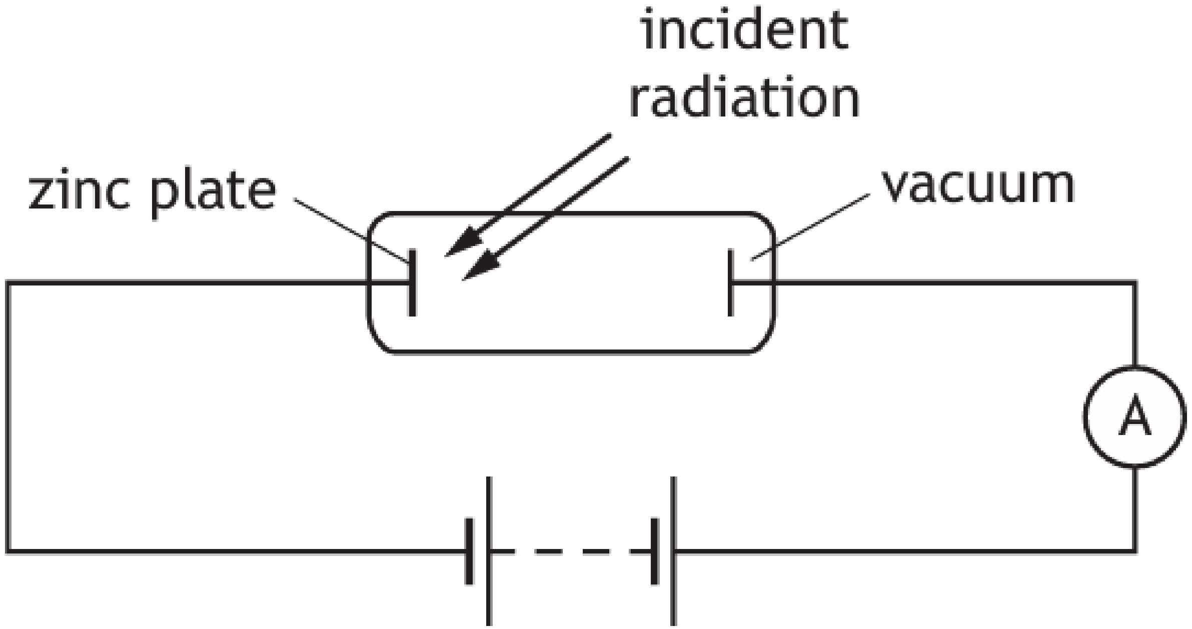
Plot graph of I against $\frac{1}{d^2}$

Graph of I against $\frac{1}{d^2}$ is a straight line through the origin

(then this verifies the inverse square law of light)

State evidence for the particle model of light.

- the photoelectric effect



State the meaning of photoemission.

- When electrons are ejected from the surface of materials when photons of sufficient energy are incident on the metal

State what can occur when photons of sufficient energy are inident on the surface of a metal.

- electrons can be ejected from the surface of materials

State the meaning of threshold frequency

- f_0 is the minimum frequency of an incident photon required for(to cause) photoemission

State the meaning of work function

- the work function, W or hf_0 of a material is the minimum energy of a photon required to cause photoemission

State evidence for the wave model of light.

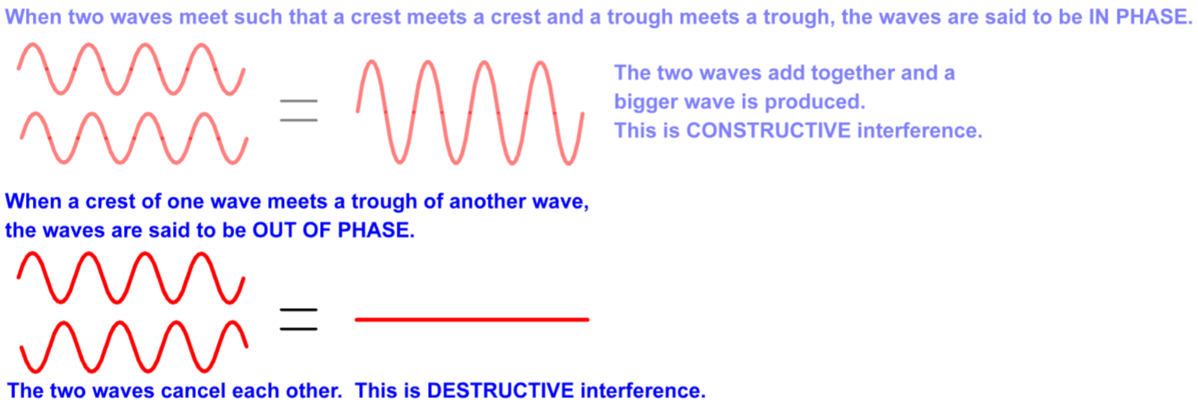
- interference

State the meaning of the term coherent waves

- Coherent waves have a **constant phase relationship**
- Waves from coherent sources
  - have the same velocity.
  - have the same wavelength.
  - have a constant phase relationship

describe of the conditions for constructive and destructive interference

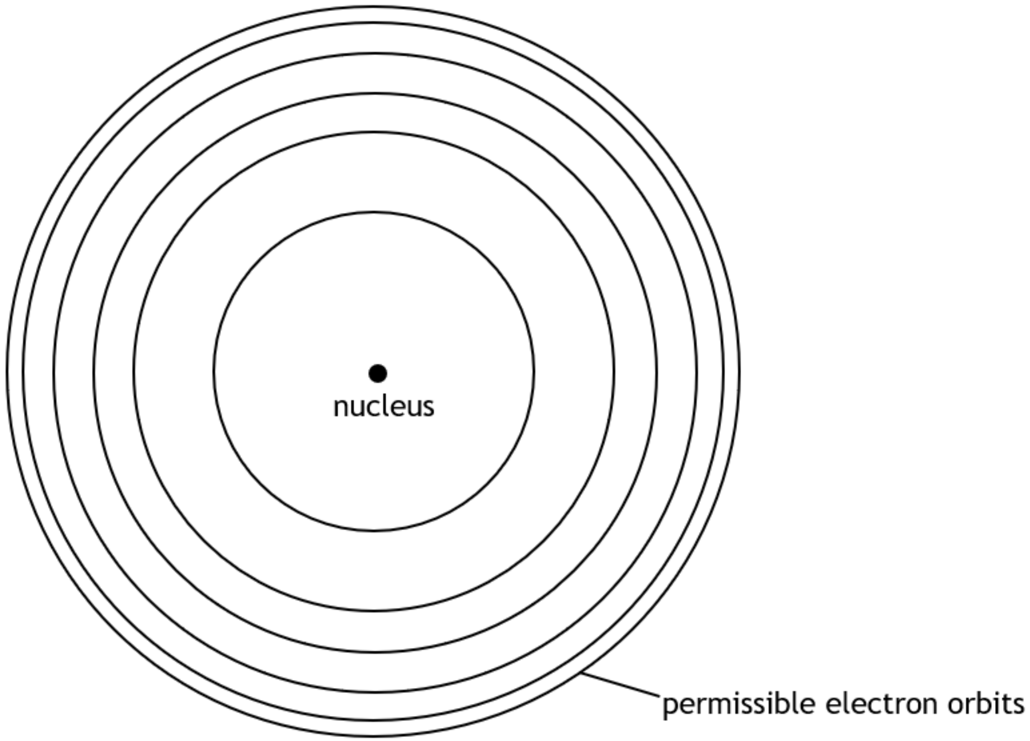
- maxima are produced when the path difference between waves is a whole number of wavelengths
- minima are produced when the path difference between waves is an odd number of half-wavelengths

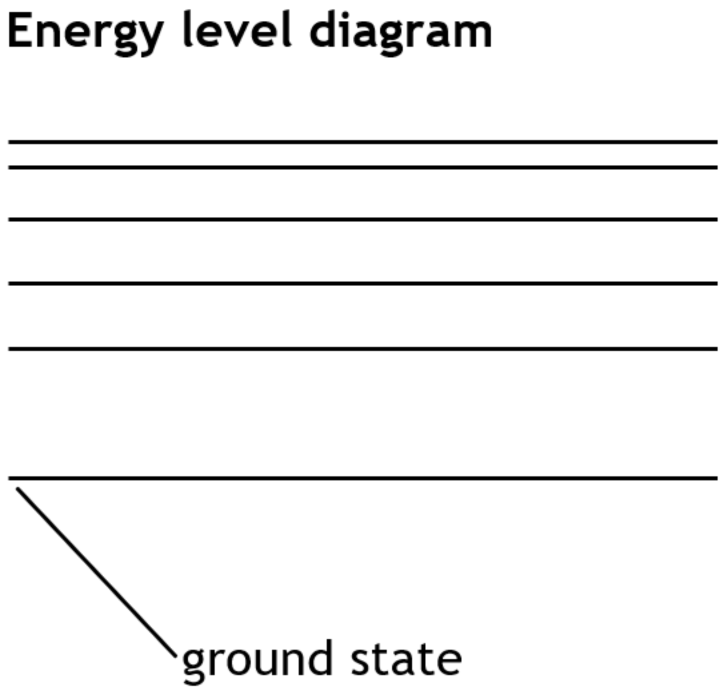


Describe the Bohr model of the atom.

- Nucleus: A small, positively charged central region containing protons and neutrons.
- Electrons: Negatively charged particles that orbit the nucleus at specific, fixed distances (called shells or energy levels).
- Orbits: Electrons occupy specific, circular orbits around the nucleus, similar to planets orbiting a sun. Each orbit has a unique energy level associated with it.
- Quantization: Electrons can only occupy specific, discrete energy levels (orbits) and cannot be found between them. This means that an electron can jump from one orbit to another by emitting or absorbing energy in the form of photons.
- Stationary states: Each energy level (orbit) is a stationary state, meaning that an electron remains in that state until it gains or loses energy to transition to another orbit.
- Ground state: The lowest energy level (orbit) is called the ground state, where the electron is closest to the nucleus.
- Excited states: When an electron gains energy, it moves to a higher energy level (excited state), and when it loses energy, it returns to a lower energy level.
- Electrons do not orbit in continuous paths, but rather jump between discrete energy levels.
- The energy of an electron is quantized, meaning it can only have specific values.
- The model explains the emission and absorption spectra of atoms, as electrons transition between energy levels by emitting or absorbing photons of specific energies.

Sketch a labelled diagram of the Bohr model of the atom.





Explain the Bohr model of the atom using the terms ground state, energy levels, ionisation and zero potential energy.

- **Ground State**: In the Bohr model, the ground state refers to the lowest energy level of an atom, where an electron occupies the closest orbit around the nucleus. This state has the most negative energy value.
- **Energy Levels**: The Bohr model proposes that electrons occupy specific, quantized energy levels or orbits around the nucleus. Each energy level has a unique energy value, with higher energy levels corresponding to greater distances from the nucleus.
- **Ionisation**: According to the Bohr model, ionisation occurs when an electron gains sufficient energy to transition from a lower energy level to a higher one, effectively "jumping" to a more distant orbit. This process requires an external energy source, such as a photon, and results in the electron being removed from its original energy level.
- **Zero Potential Energy**: In the Bohr model, the energy of an electron at infinite distance from the nucleus (i.e., completely separated from the nucleus) is considered to be zero potential energy. This serves as a reference point for calculating the energy of electrons in other orbits. The energy of an electron in a fixed orbit around the nucleus is always negative, relative to this zero potential energy.

In summary, the Bohr model describes the atom as having:

1. A ground state with the lowest energy level, where the electron is closest to the nucleus.
2. Quantized energy levels or orbits, with each level having a unique energy value.
3. Ionisation occurring when an electron gains energy and transitions to a higher energy level.
4. Zero potential energy serving as a reference point for calculating electron energies.

State evidence for the composition of the Sun's outer atmosphere

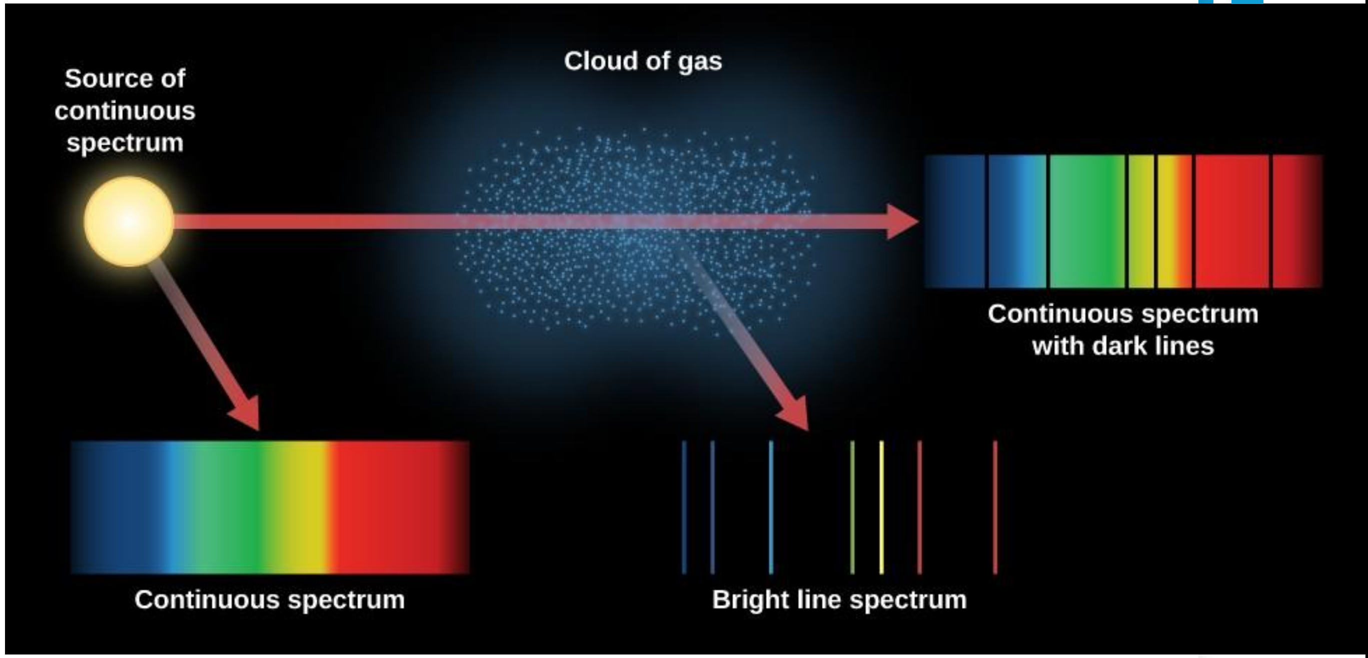
- **the absorption lines (Fraunhofer lines) in the spectrum of sunlight**

Explain Fraunhofer Lines

The Fraunhofer lines are a set of dark absorption lines observed in the optical spectrum of the Sun.

These lines are formed when light from the Sun's central core (photosphere) passes through the cooler outer atmosphere (chromosphere).

The atoms and molecules in the chromosphere absorb specific wavelengths of light, resulting in the characteristic dark lines.

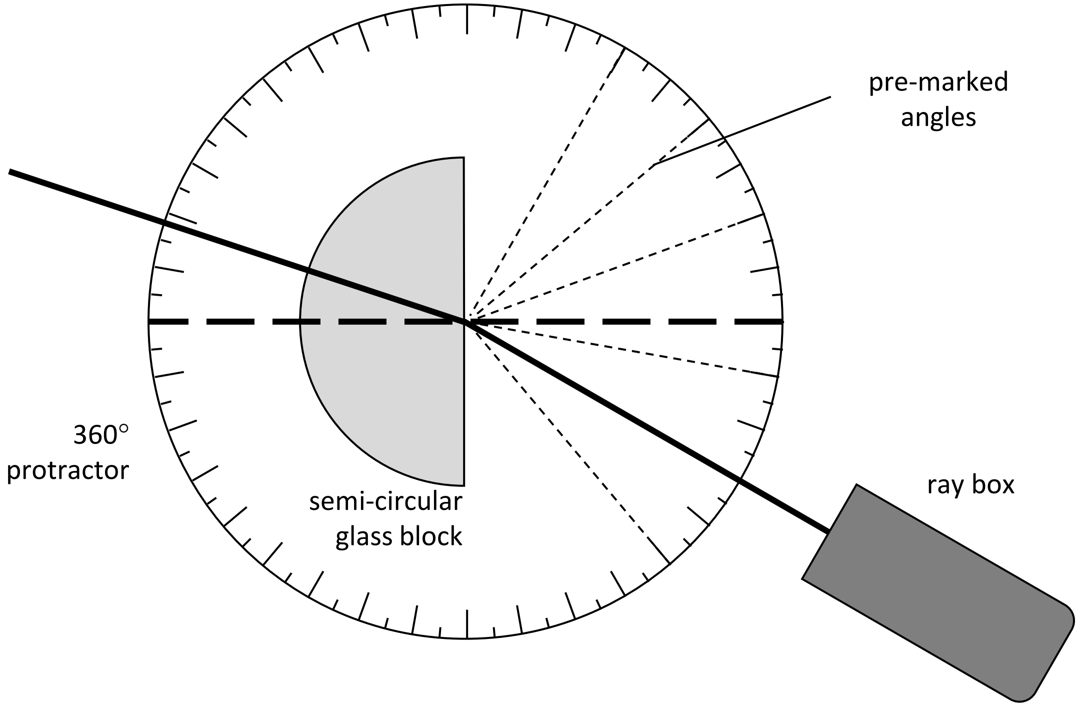


define absolute refractive index

- absolute refractive index of a medium is the ratio of the speed of light in a vacuum to the speed of light in the medium.

$$n = \frac{v_1}{v_2}$$

Describe an experiment to determine the refractive index of a medium.



- Shine monochromatic light into block along line of known angle
- Mark the angle of refraction
- Repeat for other angles of incidence
- Measure angles with a protractor
- Plot a graph of $\sin\theta_{air}$ against $\sin\theta_{material}$.
- Gradient is the refractive index

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State how the refractive index of a medium changes with incident radiation

the refractive index of a medium **increases** as the

frequency of incident radiation increases

define critical angle

- **the angle of incidence which produces an angle of refraction of 90°**

State the conditions for total internal reflection to occur

- total internal reflection occurs when the angle of incidence is greater than the critical angle

Electricity

- Unit 3

CONTENT
electrons then become contained in energy bands separated gaps.
I know that for metals we have the situation where one or m bands are partially filled.
I know that some metals have free electrons and partially fil valence bands, therefore they are highly conductive.
I know that some metals have overlapping valence and conduction bands. Each band is partially filled and therefor they are conductive.
I know that in an insulator, the highest occupied band (calle valence band) is full. The first unfilled band above the valen band is the conduction band. For an insulator, the gap betw the valence band and the conduction band is large and at ro temperature there is not enough energy available to move electrons from the valence band into the conduction band where they would be able to contribute to conduction. The no electrical conduction in an insulator.
I know that in a semiconductor, the gap between the valenc band and conduction band is smaller and at room temperatu there is sufficient energy available to move some electrons the valence band into the conduction band allowing some conduction to take place. An increase in temperature incre the conductivity of a semiconductor.
I know that, during manufacture, semiconductors may be do with specific impurities to increase their conductivity, resu in two types of semiconductor: p-type and n-type.
I know that, when a semiconductor contains the two types o doping (p-type and n- type) in adjacent layers, a p-n junctic formed. There is an electric field in the p-n junction. The electrical properties of this p-n junction are used in a numb devices.
I know and can explain the terms forward bias and reverse bia Forward bias reduces the electric field; reverse bias increas the electric field in the p-n junction.
I know that LEDs are forward biased p-n junction diodes tha emit photons. The forward bias potential difference across junction causes electrons to move from the conduction ban the n-type semiconductor towards the conduction band of t type semiconductor. Photons are emitted when electrons 'f from the conduction band into the valence band either side the junction

No	CONTENT
b)	I can use $E = V + Ir$ and $V = IR$ to solve problems in lost volts, t.p.d., current, external resistance, and i resistance.
c)	*I can describe of an experiment to measure the E internal resistance of a cell.*
d)	I can determine electromotive force, internal resista circuit current using graphical analysis.
20.	**Capacitors**
eq	$C=\frac{Q}{V}$ $Q=It$ $E=\frac{1}{2}QV=\frac{1}{2}CV^2=\frac{1}{2}$
a)	I know that a capacitor of 1 farad will store 1 coul when the potential difference across it is 1 volt.
b)	I can use the equation C=Q/V to solve problems invo capacitance, charge and potential difference.
c)	I can use the equation $Q=It$ to determine the charg capacitor for a constant charging current.
d)	I know **the total energy stored in a charged capacit the area under a charge-potential difference grap**
e)	I can use $E=\frac{1}{2}QV=\frac{1}{2}CV^2=\frac{1}{2}\frac{Q^2}{C}$ to solve problems i energy, charge, capacitance, and potential differen
f)	I know the variation of **current** with time for both ch discharging cycles of a capacitor in an RC circuit (ch discharging curves).
g)	I know the variation of **potential difference** with tin charging and discharging cycles of a capacitor in an (charging and discharging curves).
h)	I know the effect of resistance and capacitance on c discharging curves in an RC circuit.
i)	*I can describe experiments to investigate the vari current in a capacitor and voltage across a capac time, for the charging and discharging of capacit*

No	CONTENT
17.	**Monitoring and Measuring A.C.**
eq	$T=\frac{1}{f}$ $V_{rms}=\frac{V_{peak}}{\sqrt{2}}$ $I_{rms}=\frac{I_{peak}}{\sqrt{2}}$
a)	I know that **an A.C. is a current which changes direct instantaneous value with time.**
b)	I can use $V_{rms}=\frac{V_{peak}}{\sqrt{2}}$ $I_{rms}=\frac{I_{peak}}{\sqrt{2}}$ to solve proble peak and r.m.s. values.
c)	I can determine the frequency, peak voltage and r.m.s graphical data.
d)	I can use $T=\frac{1}{f}$ to determine the frequency.
18.	**Current, potential difference, power and resistance**
eq	$V=IR$ $P=IV=I^2R=\frac{V^2}{R}$ $R_T=R_1+$
Eq	$\frac{1}{R_T}=\frac{1}{R_1}+\frac{1}{R_2}+\ldots$ $V_2=\left(\frac{R_2}{R_1+R_2}\right)V_S$
a)	I can use relationships involving potential difference, resistance and power to analyse circuits even those th involve several steps in the calculations.
b)	I can correctly use calculations involving potential divi
19.	**Electrical sources and internal resistance**
eq	$E=V+Ir$ $V=IR$
a)	I can correctly use and explain the terms electromotiv (E.M.F), internal resistance, lost volts, terminal poten difference (t.p.d) ideal supplies, short circuits and ope

Explain the term A.C

- a current which **changes direction** and **instantaneous value** with time

State how to determine the peak voltage from an oscilloscope trace

1. Count the number of boxes on y-gain, from the centre of wave to the peak
2. Multiple by the y-gain (watch for mV etc)

This is the peak voltage

State how to determine the frequency from an oscilloscope trace

1. Count the number of boxes on time axis, for one wave.
2. Multiple by the time base setting, giving the period.
3. Frequency = 1/period

$$T = \frac{1}{f}$$

Explain the term electromotive force.

- EMF (electromotive force) is the number of joules of energy supplied to each coulomb of charge as it passes through the source.
- E.g a supply of emf 12 V supplies 12 joules of energy to each coulomb of charge passing through the source.

Explain the term resistance.

- the opposition to the flow of charge.

Explain the term internal resistance.

- The opposition to the flow of charge as it passes through the source

Explain the term lost volts.

- Energy given up by each coulomb of charge as it passes through the source.

Explain the term open circuit.

- An incomplete circuit
- In an open circuit the resistance is infinitely high.
- A voltmeter across an open circuit will give a reading equal to the EMF.

Explain the term short circuit.

- In a short circuit the load resistance is zero or almost zero
- There is a large current
- Lost volts is a maximum

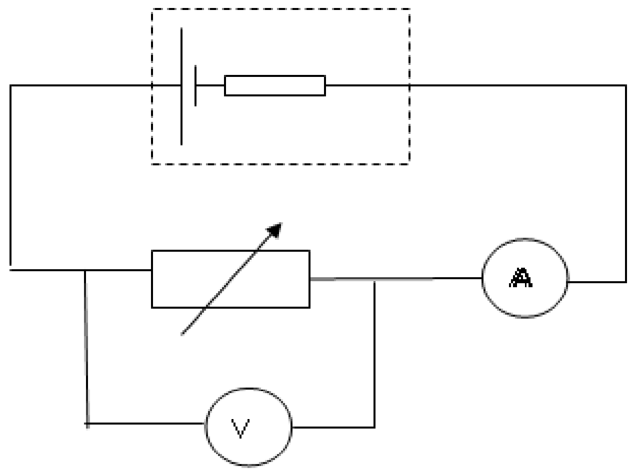
Explain the term terminal potential difference (tpd).

- **The terminal potential difference (p.d.) is the energy supplied per unit charge (voltage) available to the external circuit**
  - If there was no internal resistance, the terminal p.d. would be equal to the e.m.f.
  - If a cell has internal resistance, the terminal p.d. is always lower than the e.m.f.
  - If you have a load resistor R across the cell's terminals, then the terminal p.d. is also the potential difference across the load resistor

State why the EMF voltage is not available to the external circuit

- As a result of the lost volts, the voltage available from the supply is always less than or equal to the maximum available voltage when no current flows (the e.m.f.).
- The potential difference measured across the terminals of the supply is called the **terminal potential difference (the t.p.d.).** Effectively, this is the voltage which is available for the external circuit.

describe of an experiment to measure the EMF and internal resistance of a cell.



1. Measure voltage from Voltmeter and current from ammeter.
2. Adjust the resistance of the variable resistor
3. Repeat steps
4. Plot a graph of V against I,
5. y-intercept = EMF,
6. Gradient = -r

State what is meant by a capacitance of 1 Farad

- **a capacitor of 1 farad will store 1 coulomb of charge when the potential difference across it is 1 volt.**
- $C = \frac{Q}{V}$

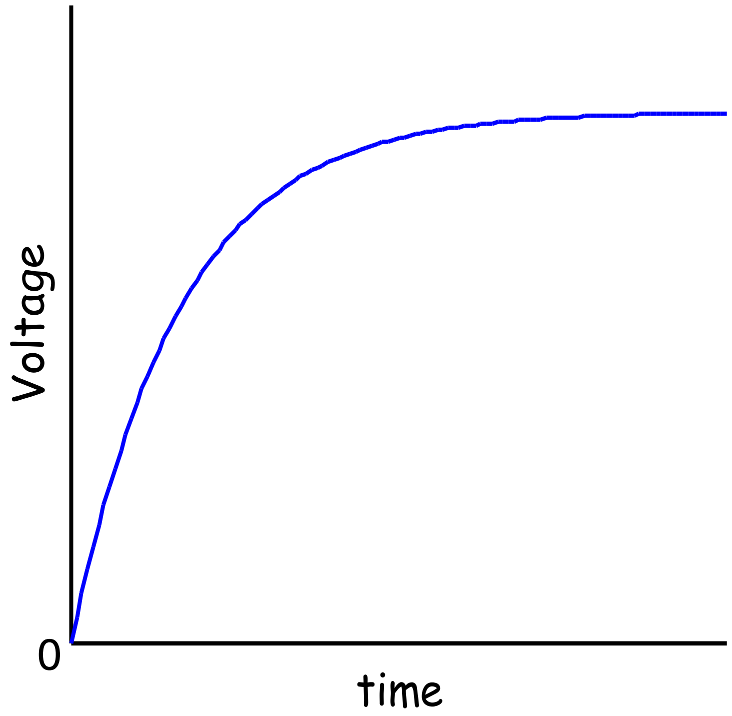
State how you can determine the energy stored on a capacitor from graph

- Energy is the area under a Q-V graph

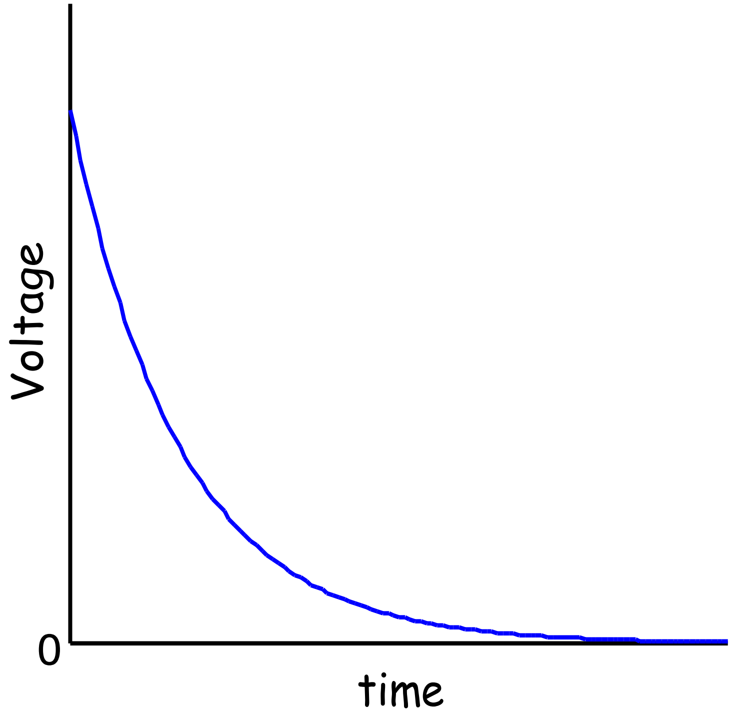
State how you can determine the capacitance from a graph

- For a QV graph, capacitance is the gradient of a Q (y axis), V (x-axis)
- If plotted the other way up capacitance = 1/gradient

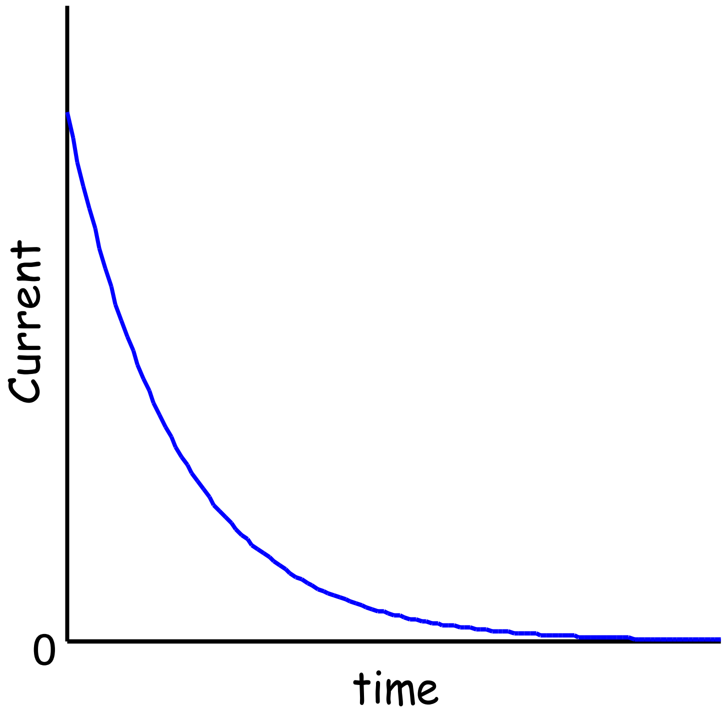
Sketch a graph of voltage against time for charging a capacitor



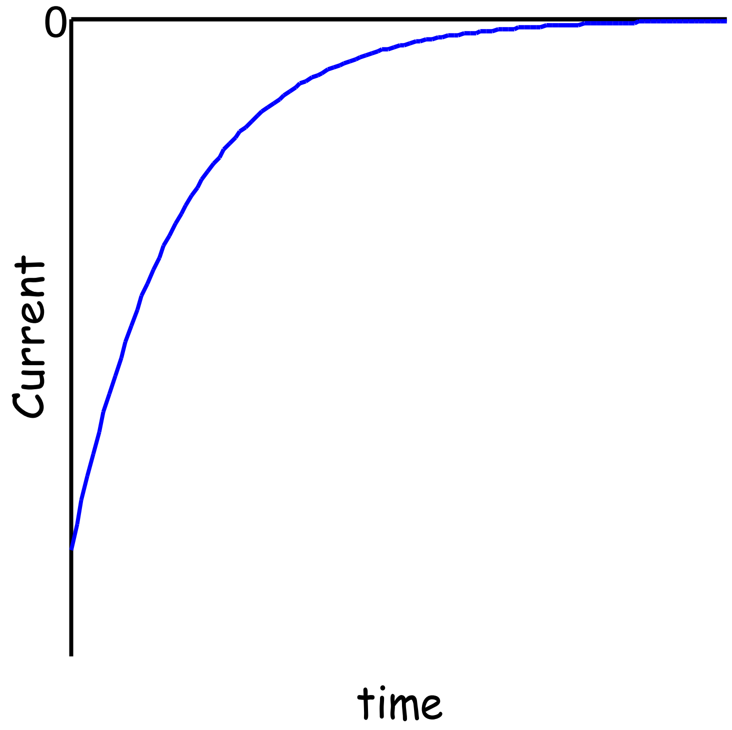
Sketch a graph of voltage against time for discharging a capacitor



Sketch a graph of current with time for charging a capacitor



Sketch a graph of current with time for discharging a capacitor



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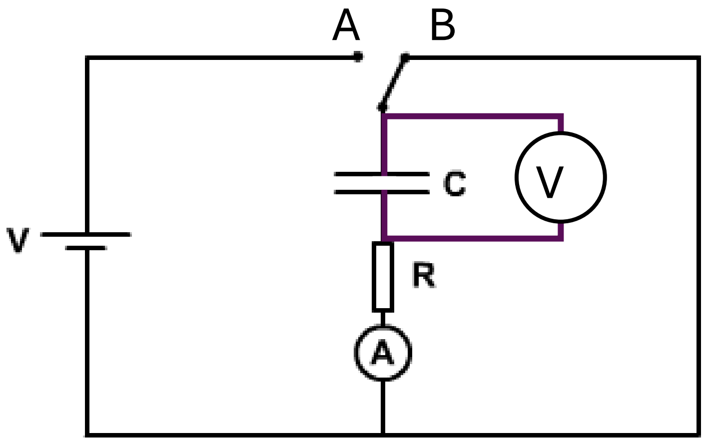
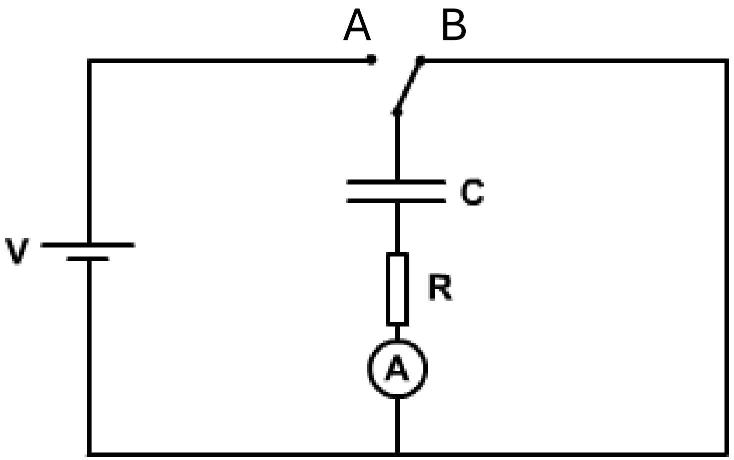
Describe an experiment to investigate the variation of current in a capacitor and voltage across a capacitor with time, for the charging and discharging of capacitors



1. Connect up the circuit.
2. Ensure the capacitor is fully discharged
3. Start clock and tmove switch to position A
4. Take regular values of V and I at set time intervals.
5. Rest clock and move switch to position B as clock restarted
6. Take regular values of V and I at set time intervals.
7. Plot graphs of V against t and I against t.

Describe an experiment to investigate the variation of current in a capacitor with time, for the charging and discharging of capacitors



1. Connect up the circuit.
2. Ensure the capacitor is fully discharged
3. Start clock as switch moved to position A
4. Take regular values of I at set time intervals.
5. Rest clock and move switch to position B as clock restarted
6. Take regular values of I at set time intervals.
7. Plot graphs of I against t.

(Take readings of current from the ammeter at regular time intervals)

State and explain the terms conduction band and valence band

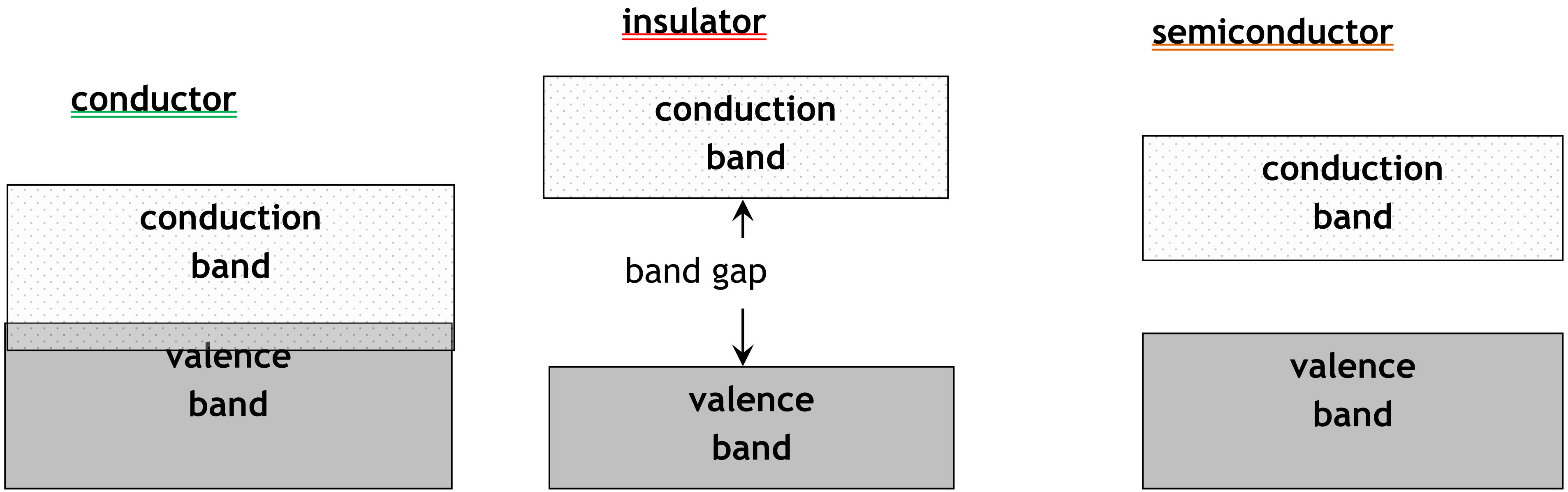
- **Conduction Band**: The conduction band is the energy band that contains the electrons that are free to move and conduct electricity. It is the higher energy band and is typically empty or partially filled with electrons.

- **Valence Band**: The valence band is the energy band that contains the valence electrons, which are the electrons in the outermost shell of an atom. It is the lower energy band and is typically filled with electrons.

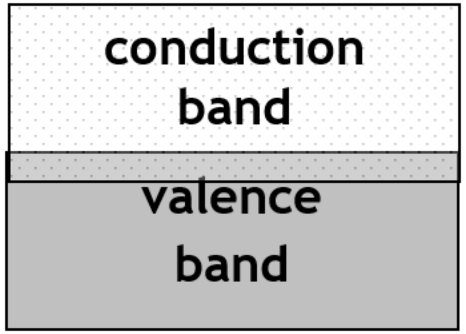
State how solids are categorised

- solids can be categorised into conductors, semiconductors or insulators by their band structure and their ability to conduct electricity.
- Every solid has its own characteristic energy band structure.
- For a solid to be conductive, both free electrons and accessible empty states must be available

Sketch a graph of the energy bands in conductors, insulators and semiconductors

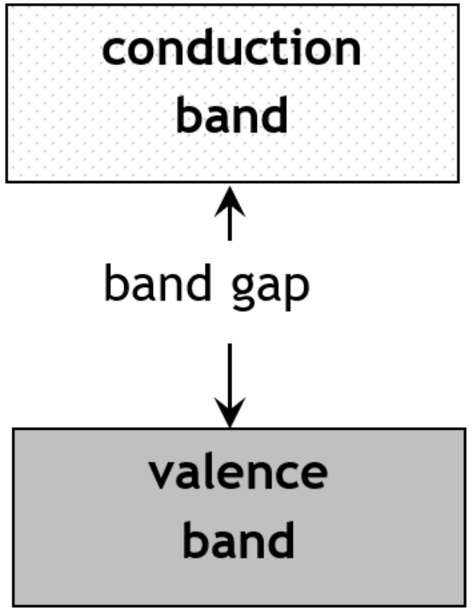


conductor



In a conductor,-e.g metals, the bands overlap and the conduction band contains electrons free to move. These electrons can move to produce the current when an e.m.f. is applied to the solid.

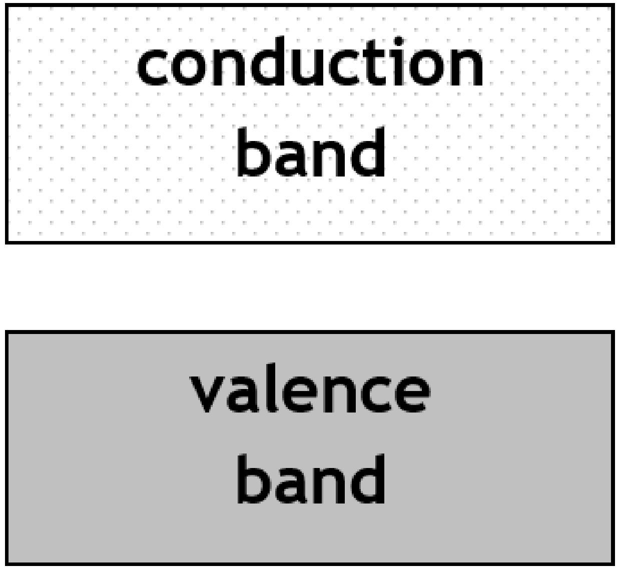
insulator



In an insulator, the highest occupied band (called the valence band) is full. The first unfilled band above the valence band is the conduction band. There is a large energy gap between the bands [**band gap**]. It is so large that electrons almost never cross the gap and the solid never conducts, and at room temperature there is not enough energy available to move electrons from the valence band into the conduction band where they would be able to contribute to conduction. There is no electrical conduction in an insulator.

If we supply enough energy the solid will conduct but often the large amount of energy ends up destroying the solid.

semiconductor



Semiconductors are like insulators in that the valence band is full. However the gap between the two bands is small and at room temperature some electrons have enough energy to jump the gap and move from the valence to the conduction band. An increase in temperature increases the conductivity of a semiconductor.

State where electrons are contained in atoms

- **Electrons in atoms are contained in energy levels.**
- **When the atoms come together to form solids, the electrons then become contained in energy bands separated by gaps**

State how the energy bands are filled in metals

- **One or more bands are partially filled**

- **Some metals have free electrons and partially filled valence bands, therefore they are highly conductive**

Explain the distribution of electrons in insulators

- The highest occupied band (called the valence band) is full.
- The first unfilled band above the valence band is the conduction band.
- For an insulator, the gap between the valence band and the conduction band is large and at room temperature there is not enough energy available to move electrons from the valence band into the conduction band where they would be able to contribute to conduction.
- There is no electrical conduction in an insulator.

Explain the distribution of electrons in semiconductors

- The gap between the valence band and conduction band is smaller than in an insulator
- At room temperature there is sufficient energy available to move some electrons from the valence band into the conduction band
- This allows some conduction to take place.

State the effect of temperature on semiconductors

- An increase in temperature increases the conductivity of a semiconductor.

State when doping occurs in semiconductors

- during manufacture, semiconductors may be doped with specific impurities

State how this affect conductivity

- Conductivity increases, resulting in two types of semiconductor: p-type and n-type (all are overall neutrally charged but have either excess or deficiency in charge carriers)

State how a p-n junction arises and state the effect

- **a semiconductor contains the two types of doping (p-type and n- type) in adjacent layers,**

- **There is an electric field in the p-n junction.**

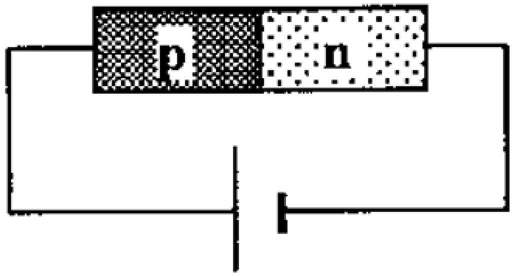
State devices that use one or more p-n junction. If possible state the bias

- LED - Forward Bias photoconductive
- Photodiodes Reverse bias
- Solar Cells No bias set up in photovoltaic mode
- Transistor (2 junctions eg pnp or npn) including MOSFET

State how to bias a p-n junction

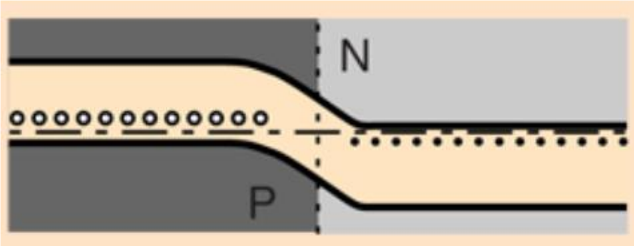
- an external voltage is applied across the junction

Sketch a diagram of forward bias



cell connected - positive end to p-type negative end to n-type

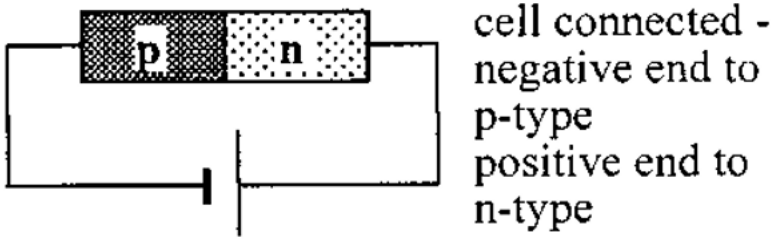
Forward-biased



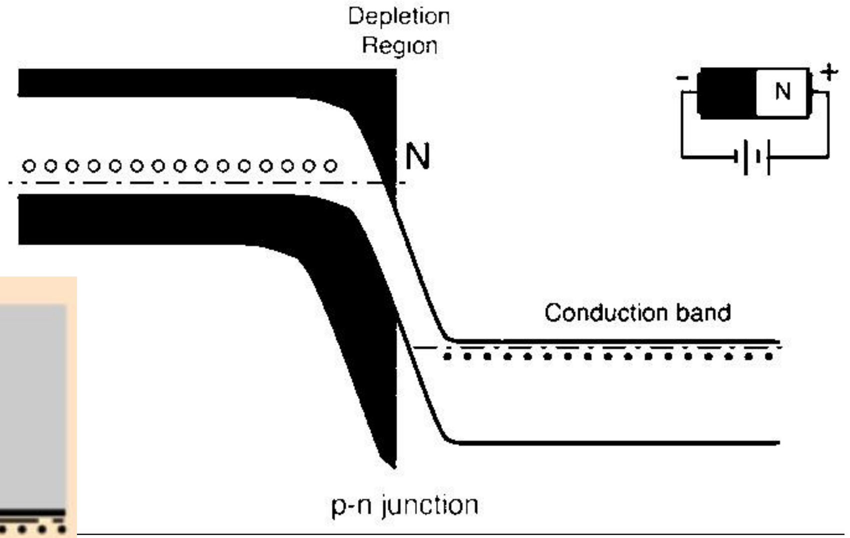
- In **forward bias** the diode is connected with the p-type connected to the positive supply terminal and the n-type connected to the negative.
- The electric field across the depletion layer decreases.
- The resistance to electron flow is reduced.

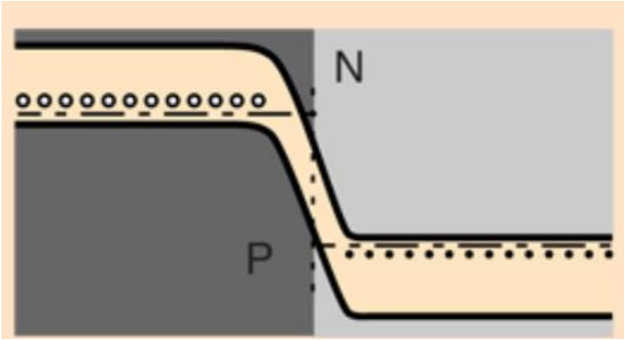
Sketch a diagram of reverse bias

- In **reverse bias** the diode is connected with the p-type connected to the negative supply terminal and the n-type connected to the positive.
- The electric field across the depletion layer increases.
- This acts as a barrier that stops electron flow.
- The valence band energy level in the p-type material is raised above the free electrons of the conduction band of the n-type. This is due to the combination of doping and electric field across the junction.



Reverse-biased





State how forward biasing affects the electric field

- **Forward bias reduces the electric field in the p-n junction.**

State how reverse biasing affects the electric field

- **reverse bias increases the electric field in the p-n junction.**

Explain how an LED works

- **LEDs are forward biased p-n junction diodes that emit photons.**
- **The forward bias potential difference across the junction causes electrons to move from the conduction band of the n-type semiconductor towards the conduction band of the p- type semiconductor.**
- **Photons are emitted when electrons 'fall' from the conduction band into the valence band either side of the junction**

Describe in detail the solar cell

- solar cells are p-n junctions that produce a potential difference is when photons are absorbed.
- Solar cells have no bias - this is known as the photovoltaic effect.
- The absorption of photons provides energy to ‘raise’ electrons from the valence band to the conduction band.
- The p-n junction causes the electrons in the conduction band to move towards the n-type semiconductor
- and a potential difference is produced across the solar cell.

Hope you found this helpful

Please pass on any feedback before you go back to the beginning and try again, and see if you can get any more correct answers.

Little and often is the name of the game