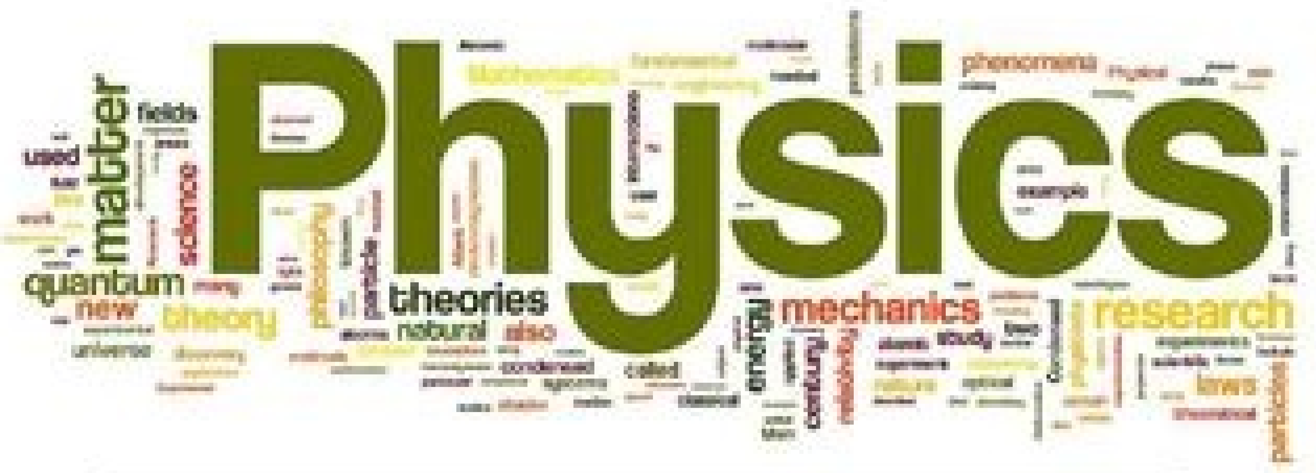
A level physics aqa equation sheet



WJEC Triple Award
Year 11
Revision Guide

speed = $\frac{\text{distance}}{\text{time}}$	
acceleration [or deceleration] = $\frac{\text{change in velocity}}{\text{time}}$	$a = \frac{\Delta v}{t}$
acceleration = gradient of a velocity-time graph	
distance travelled = area under a velocity-time graph	
resultant force = mass × acceleration	$F = ma$
weight = mass × gravitational field strength	$W = mg$
work = force × distance	$W = Fd$
kinetic energy = $\frac{\text{mass x velocity}^2}{2}$	$KE = \frac{1}{2}mv^2$
change in potential energy = mass × gravitational field strength × change in height	$PE = mgh$
force = spring constant × extension	$F = kx$
work done in stretching = area under a force-extension graph	$W = \frac{1}{2}Fx$
momentum = mass × velocity	$p = mv$
force = $\frac{\text{change in momentum}}{\text{time}}$	$F = \frac{\Delta p}{t}$
u = initial velocity v = final velocity t = time a = acceleration x = displacement	$v = u + at$ $x = \frac{u+v}{2}t$ $x = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2ax$
moment = force × distance	$M = Fd$

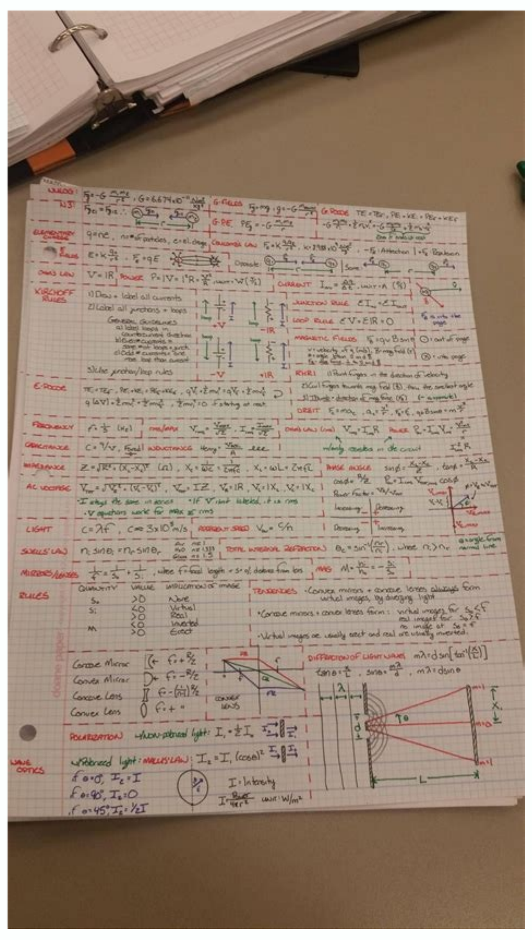
Strategies to decrease percentage uncertainty

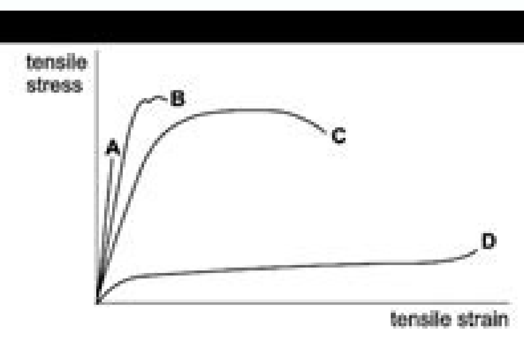
$$\text{Reading \% Uncertainty} = \frac{\text{Precision (Uncertainty)}}{\text{Reading}} \times 100\%$$

- **To reduce the reading percentage uncertainty you can:**
  (i) Increase the precision of your measuring instrument (Reduce uncertainty)
  (ii) Increase the value of the readings taken.

$$\text{\% Uncertain ty in mean} = \frac{\text{Uncertaint y}}{\text{Mean Value}} \times 100\%$$

- **To reduce the percentage uncertainty in the calculated mean:**
  (i) Take more repeat readings.
  (ii) Increase the precision of your measuring instrument *(Reduce uncertainty)*
  (iii) Increase the value of the readings taken. *(Results in bigger mean)*



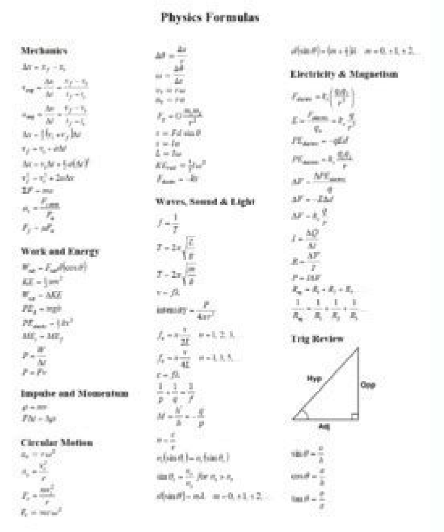


0 3 . 1 State what is meant by tensile stress and tensile strain.

[2 marks]

tensile stress is the force acting to extend the material divided by the cross-sectional area of the material.

tensile strain is the extension of the material divided by its original



Last updated11 June 2018Designed for students, I created this resource during A Levels to include all A Level Physics formulae not given in the formula sheet. Some of the formulae included in this document are not directly stated in the new specification but were used in the old specification (pre 2015) so may be useful in applied questions: Contains formulae for: Year 1 Particles and Radiation Waves Mechanics Materials Electricity Year 2 Circular Motion Simple Harmonic Motion Thermal Physics Gravitational Fields Electric Fields Capacitance Magnetic Fields Nuclear Physics Optional Topic Medical Physics Creative Commons "Sharealike"Select overall rating(no rating)Your rating is required to reflect your happiness.Write a reviewUpdate existing reviewIt's good to leave some feedback.Something went wrong, please try again later.Thanks, very usefulEmpty reply does not make any sense for the end userCould you make a turning points slide please?Empty reply does not make any sense for the end userThis is a brilliant resource, thanks for sharing! May try to adapt for OCR B if I find the timeEmpty reply does not make any sense for the end userThank you, this is brilliant.Empty reply does not make any sense for the end userEmpty reply does not make any sense for the end userReport this resourceto let us know if it violates our terms and conditions. Our customer service team will review your report and will be in touch. Cheatography ScalarA quantity without direction. Length/Distance, Speed, Mass, Temperature, Time, EnergyVectorA quantity with both direction and magnitude Displacement, Velocity, Force (inc. Weight), Acceleration, MomentumEquilibriumWhen all forces acting on an object are balanced and cancel each other out. There is no resultant forceFree-body DiagramA diagram of all the forces acting on a body, but not the forces it exerts on other things. The arrows indicate magnitude and direction.Principle of MomentsFor a body to be in equilibrium, the sum of the clockwise moments equals the sum of the anticlockwise moments.MomentThe product of the size of the force and the perpendicular distance between the turning point and the line of action of the force.CoupleA pair of forces with equal size which act parallel to each other but in opposite direction. E.g. turning a car's steering wheel.Centre of MassThe single point from which the body's weight acts through. The object will always balance around this point. To calculate for uniform objects: Σmx = Mx̄SUVAT (Constant Acceleration)v = u + at s = 1/2 (u+v)tv2 = u2 + 2ass = ut + 1/2 at2s = vt - 1/2 at2Displacement-Time GraphDisplacement (y) against Time (x). Gradient = Velocity Acceleration = ΔgradientVelocity-Time GraphVelocity (y) against Time (x) Gradient = Acceleration ΔGradient = ΔAcceleration Area = Displacement Variable Acceleration Differentiate x v a Δa IntegrateAcceleration-Time GraphAcceleration (y) against Time (x). Gradient = ΔAcceleration 0 Gradient = No acceleration constant velocity. Constant Gradient = constant acceleration Area = Velocity NB: Remember to treat area below the time axis as negative!Newtons 1st LawThe velocity of an object will not change unless a resultant force acts on it.Newtons 2nd LawF = ma The acceleration of an object is ∝ to the resultant force acting upon it. (for objects with a constant mass) Points to remember: • Resultant Force is vector sum of all the forces • Unit = N • Ensure mass is in kg • Acceleration is in the same direction as resultant force.Newtons 3rd LawIf object A exerts a force on object B, then object B exerts an equal but opposite force on object AFreefallWhen there is only gravity acting upon an object. i.e. motion with an acceleration of g (9.81ms-2) The same SUVAT equations apply, however, u = 0 and a = g {{ng}} NB: 'direction' of motion, dictates the sign of gProjectile MotionAn object given an initial velocity, then left to move freely under g. There is separate horizontal and vertical motion with time being the only common attribute. Both motion follows SUVAT equations but horizontal motion has no acceleration.FrictionForce that opposes motion. When in a fluid (liquid or gas) it is drag, drag depends on: • Viscosity of the fluid • Speed of object • Shape of the object For all frictional forces • Force is in the opposite direction to motion • Can never increase speed or induce motion• They convert kinetic energy heat.LiftUpwards force on a object in a fluidTerminal SpeedWhen frictional forces equal the driving force. For a falling object, when drag equals the force due to their mass.MomentumThe product of the mass and velocity of an object. Momentum in any collision is conserved (when no external forces are involved)Inelastic CollisionNot all of the kinetic energy is conserved. Momentum however is conserved.Elastic CollisionKinetic energy is conserved i.e. no energy is dissipated as heat or other energy forms.ImpulseAn extension of N2L. Impulse is the product of force and time and is equal to the momentum of that body. FΔt = Δ(mv) Also equal to the area under a force-time graph.Work DoneThe energy transferred from one form to another. W = Fd Work Done = The force causing motion x distance movedPowerThe rate of work done over time P = ΔW/Δt P = Fv derived from combining P and W = FsForce-Displacement GraphArea = Work DoneConservation of EnergyEnergy cannot be created nor destroyed, only converted from one form to another, but the total energy of a closed system will not change.Efficiencyuseful output/input in terms of energy or power. Densityρ = m/V A property all materials have and is independent of both shape and size.Limit of ProportionalityThe point where Hooke's law no longer applies. On a force-extension graph, the limit of proportionality is where the line is no longer straightHooke's LawF = kΔL The force is proportional to the extension of a stretched wire. k is the stiffness constant a measure of how hard it is to stretchElastic LimitThe point on a force-extension graph where the line begins to curve. Beyond this point, permanent deformation occurs where the wire will no longer return to its original shape.Force-Extension GraphStraight section Gradient = k Loading and unloading plot a loop, if a stretch is elastic, the curve starts and finishes in the same position (the origin). If plastic deformation occurs, the unloading line has the same gradient (k) but crosses the x axis at a different point Area = Elastic Strain Energy The area between the loading and unloading line (after plastic deformation) is equal to the work done in deforming the materialTensile StressThe ratio of forced applied and cross-sectional area. stress = F/ATensile StrainThe ratio of extension to original length, it has no units and is just a ratio. strain = ΔL/LYoungs ModulusThe ratio of tensile stress and tensile strain E = FL/AΔL The YM of a material is the constant value up to the limit of proportionality,Stress-Strain GraphStress (y) against Strain (x). Gradient = Young's Modulus Area = strain energy per unit volumeYield PointThe point on a stress-strain graph where the material stretches without any extra load.BrittlenessWhen a material breaks after a certain about of force is applied. The line simply stops on a stress-strain graph. The same thing applies on a force-extension graph, the line just stops. KelvinA temperature scale that is in terms of an atoms movements. °C K + 273Absolute ZeroThe lowest theoretical temperature of anything 0 K = -273°CInternal EnergyThe internal energy of a body is the sum of the randomly distributed kinetic and potential energies of all its particlesClosed SystemA system where no matter or energy is transferred in or out of the systemHeat TransferHeat is always transferred from a hot area/substance to a cold area/substance.Specific Heat CapacityThe amount of energy required to heat up 1kg of the material by 1°C/1 K ΔQ = mcΔT Energy Change is equal to the product of the mass, specific heat capacity and the change in temperature.Specific Latent HeatThe specific latent heat of fusion (Solid) / vaporisation (gas) is the quantity of thermal energy needed/will be lost to change the state of 1kg of the substance. Q = ml where m is the mass and l the latent heat. When a substance changes state, there is a period where the temperature of the material is constant, as the internal energy rises, this is due to the latent heat.Boyle's LawAt a constant temperature, pV is constant. i.e. p1V1 = p2V2 On a p-V plot, the higher the line, the higher the temperature.Charles' LawAt a constant pressure: V is directly proportional to its absolute temperature TV1/T1 = V2/T2Pressure LawAt a constant volume: p is directly proportional to its absolute temperature. p1/T1 = p2/T2 Molecular Massthe sum of the masses of all the atoms that make up the molecule.Relative Molecular MassThe sum of the relative atomic masses of all the atoms.Avogadro ConstantThe number of atoms in exactly 12g of carbon isotope 126C. NA = 6.02 x1023 mol-1Molar MassThe mass of a material containing NA moleculesIdeal Gas EquationspV = nRT n = number of moles R = molar gas constant pV = NkTN = number of moleculesk = Boltzmann constant A way of remembering which n is which. Moles will be small, therefore small n. Number of molecules will be large so, big N.Kinetic TheoryThe pressure exerted by an ideal gas can be derived by considering the gas as individual particles. pV = 1/3 x Nm(Crms)2 Crms is the root mean square speed. Assumptions • All molecules in the gas are identical • Gas contains a large number of molecules• The volume of the molecules is negligible when compared to the volume of the container/gas as a whole.Brownian MotionRandom motion of particles suspended in a fluid helped provide evidence that the movement of the particles was due to the collisions of the fast randomly-moving particles, which supported the model of kinetic theory.Average Kinetic Energy1/2 x m(Crms)2 = 3/2 x nRT/N 1/2 x m(Crms)2 = 3/2 x RT/NA Proton & NeutronsThe 2 Baryons that make up the nucleus of an atom. Comprised of 3 quarks. Protons have a relative charge: +1, neutrons: 0. Both have a relative mass of 1 (1.67 x10-27 kg).ElectronA fundamental lepton, with a charge of -1. Cannot be broken down into other subatomic particles. Relative mass of 1/2000 (9.11x10-31 kg)Nuclide Notation AZXThe general notation of elements.Proton Number (Z)The number of protons in an atom. Defines the element. For a neutral atom, proton no. also == the electron numberNucleon Number (A)AKA Mass Number - number of total nucleons (protons + neutrons)Specific ChargeThe ratio of a particles charge to its mass. Specific meaning per kg. S.C. = Charge (Q) / Mass (kg)IsotopeAtoms with the same number of protons but a different number of neutrons. Affects the stability of a atomStrong Nuclear ForceA strong force that holds atoms together at small distances, strong enough to overcome the electrostatic repulsion of the protons. Distances Repulsive: n2Total Internal ReflectionWhen all light is completely reflected back into a medium at a boundary with another medium instead of being refracted. Occurs when θi > θcritOptical FibreA very thin flexible tube of glass/plastic fibre in which light signals are carried across long distances and around corners by applying TIR. The fibres are surrounded by a cladding with a high refractive index and a core of a lower refractive index. The light is refracted where the mediums meet and travels along the fibre.Signal AbsorbtionWhen some of the signals energy is absorbed by the material of the fibre. The final amplitude is reduced.Signal DispersionWhen the final pulse is broader than expected, which can cause information loss as it may overlap with another signal.Modal DispersionLight entering at different angles and taking different paths, resulting in signals arriving in the wrong order Single-mode fibre is used to prevent this - light is only allowed to folllow a very narrow path.Material DispersionDifferent amounts of dispersion depending on wavelength. Monochromatic light prevents this. Rutherford ScatteringAn experiment that proved the current model of the atom that it is mostly empty space.Rutherford set up an experiment, with an alpha emitter pointed at gold foil. He observed the deflection of the particles and it showed that atoms have a concentrated mass at the centre and are mostly empty space, which disproved the plum-pudding model which was accepted previously.It showed that: • Atoms = mostly empty space• Nucleus has a large positive charge, as some of the +ve charged alpha particles are repelled and deflected• Nucleus must be tiny due to few particles being deflected by an angle > 90°• Mass must be concentrated in the nucleusDistance of Closest ApproachEk = Eelec = Qnucleusqalpha/4πε0r where r is the distance of closest approachElectron Diffractionλ≈hc/E where the first minimum occurs at: sinθ ≈ 1.22λ/2RNuclear RadiusR = R0A1/3Alpha Decay (α)Charge(rel): +2Mass(u): 4Penetration: lowIonising: highSpeed: slowAffected by mag. field: yStopped by: paper/~10cm airUsed for: Smoke alarms if the particles cant reach the detector, the smoke must be stopping themBeta Decay(β^±)Charge(rel): ±1Mass(u): n/aPenetration: midIonising: weakSpeed: fastAffected by mag. field: yStopped by: ~3mm of aluminiumUsed for: PET Scanners, In production of metals the levels penetrating through the metal can be used to control the thickness.Gamma Decay(γ)Charge(rel): 0Mass(u): 0Penetration: lowIonising: very weakSpeed: c (speed of light)Affected by mag. field: nStopped by: several cm of lead. Used for: PET Scanners produced through annihilation, cancer treatment.Background RadiationThe low level of radiation that always exists. Must be taken into account when measuring radiation.Sources of Background Rad.• The Air Radioactive radon gas released from rocks• Ground/Buildings Nearly all rock contains radioactive materials• Cosmic Radiation nuclear radiation from particle collisions due to cosmic rays• Living things living things are made of carbon, some of which is radioactive carbon-14• Man-Made Radiation from industrial/medical sourcesIntensityI = k/x2 Intensity (Wm-2) = constant of proportionality (W)/distance from source (m)Radioactive DecayIt both spontaneous and random. Spontaneous: Decay is not affected by external factorsRandom: It cannot be predicted when the next decay occursDecay ConstantThe probability of a specific nucleus decaying per unit time. It is a measure of how quickly a isotope will decay.Activity (Bq)The number of nuclei that will decay each second.A = λN where λ is the decay constant, and N is the number of unstable nuclei in the sampleIt can also be written as:ΔN/Δt = -λN (ΔN is always a decreasing number hence the neg sign)A = A0e-λt A0 is the activity at t=0Number of unstable Nuclei (N)N = N0e-λt where N0 is the original number of the unstable nucleiN = nNAwhere n is the number of moles and NA is Avogadro's constantHalf-Life (T1/2)The average time the isotope takes for the number of nuclei to halve. T1/2 = ln2/λ (Derived from N = N0e-λt)Uses of Radiation• Carbon Dating Using the amount of C-14 left in the organic material. Problems are that the material may have been contaminated, high background count, uncertainty in c-14 in the past and sample size may be too small• Medical Diagnosis Tracers that emit radiation to track things in the bodyInstabilityNuclei are unstable when:• Too many/not enough neutrons• Too many nucleons• Too much energy If they nuclei lies on the N=Z line they are generally stable. If they lie above, they undergo β- decay, if they lie below, the undergo β+ decay. If they have a Z number of over ~82 (Protons) they undergo α decay.Mass DefectThe mass of a nucleus is less than the mass of its constituents. This energy difference is the mass defect and is lost to energy as E = mc2, energy and mass are equivalent.Binding EnergyIf you were to pull a nucleus apart, this binding energy would be the energy required to do so, equal to the energy released when the nucleus formed.Average Binding EnergyAverage Binding energy per nucleon = Binding Energy/Nucleon numberNuclear FissionWhen large unstable nuclei randomly split into smaller more stable nuclei. Energy is released as the smaller nuclei have a higher avg. binding energy per nucleonNuclear FusionWhen 2 smaller nuclei combine to form a larger nuclei. A lot of energy is released because the new heavier nucleus has a higher avg. binding energy (if the 2 original nuclei are light enough). This is the energy that keeps stars burningNuclear Fission Reactors• Control Rods Usually made of carbon, they are lowered and raised to control the rate of fission. The amount of fuel required to produce one fission per fission is the critical mass. Any less (sub-critical) then the reaction will eventually fizzle out. Any more, and the reactor could go into meltdown, which is why control rods are used.• Moderator Fuel rods are placed in the moderator, this slows down/absorbs neutrons to control the rate. The choice of moderator needs to slow down the neutrons enough to slow down neutrons enough to keep the rate of fission steady. It slows down neutrons through elastic collisions, a moderator with a similar nucleon-mass to the neutrons. • Coolant is sent around the reactor to remove heat produced by the fissio. The material is either liquid or gas at room temp. Often it is the same water (heavy-water) as the moderator and can be used to make steam and turn turbines. • Shielding Reactors are surrounded by thick concrete, which shields and protects from radiation escaping and anyone working there.• Emergency Shut-down All reactors have an emergency shutdown where the control rods are completely lowered into the reactor, thus absorbing all the neutrons produced and slowing the reaction down as quickly as possible. • Waste Unused uranium only produces α so can be easily contained. Spent uranium however emit β & γ radiation. Once removed from the reactor they are cooled and ten stored in sealed containers until the activity is at a low enough level. RadianObjects in circular motion travel through angles, mostly measured in radians. Rads to Deg: Angle in deg x π/180Angular SpeedThe angle an object rotates through per second. ω = θ/t = v/r = 2π/T = 2πfFrequencyThe number of revolutions per second. f = 1/TTime PeriodThe time taken for a complete revolution. Centripetal AccelerationObjects travelling in a circle are accelerating as their velocity is changing constantly. The acceleration is always acting towards the centre of the circle. a = v2/r = ω2rCentripetal ForceIs the resolved force which is always directed towards the centre of the circle. F = mv2/r = mω2rSimple Harmonic MotionAn object undergoing SHM is oscillating to and fro, either side of an equilibrium position. It is defined as An oscillation in which the acceleration of an object is directly proportional to its displacement, which is always directed towards the equilibrium positionDisplacement (x)Displacement varies as a cosine/sine wave with a maximum value of A (Amplitude)x = Acos(ωt)Velocity (v)Is the gradient of the displacement time graph. Its maximum value is ωAv = ±ω x sqrt(A2 x2)vmax = ωAAcceleration (a)Is the gradient of the velocity time graph. Its maximum value is ω2Aa = ω2xMass-Spring SystemA mass on a spring is a simple harmonic oscillator. When the mass is pulled/pushed from the equilibrium position, there is a force directed back towards the equilibrium position. F = kΔL where k is the spring constant and ΔL is the displacement. The Time period for a M-S System is given by:T = 2π x sqrt(m/k)PendulumA pendulum is an example of a Simple Harmonic Oscillator. The time period for a pendulum is given by:T = 2π x sqrt(l/g)Free VibrationFree vibrations involve no transfer of energy to/from the surroundings. If a mass-spring system is stretched, it will oscillate at its natural frequency fn.Forced VibrationForced Vibration occurs when there is an external driving force. A system can be forced to vibrate by a periodic external force. This is called the driving frequency, fd.fd > fn The oscillator will not be able to keep up and will end up out of control. i.e. completely out of phase.ResonanceAs fd → fn, the system gains more and more energy from the driving force, thus the amplitude rapidly increases. The system is now considered to be resonating. At resonance, the phase difference between the driver and the oscillator is 90°.DampingAny oscillating system loses energy to its surroundings damping. System are also deliberately damped to stop them oscillating or minimise resonance.Light Damping Take a long time for oscillation to stop, the amplitude is decreased slowly. Displacement-Time Graph: sharp peak.Heavy Damping The amplitude decreases rapidly, and oscillation takes much less time to stop.Displacement-Time Graph: flat peak.Critical Damping Oscillation is stopped in the shortest amount of time possible.Over Damping Systems with even heavier damping, they take longer to reach equilibrium than a critically damped system. physics alevel aqa keyterms ;> 21 Pages //media.cheatography.com/storage/thumb/0lliec_a-level-physics-key-terms.750.jpg Your Download Will Begin Automatically in 5 Seconds.Close

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