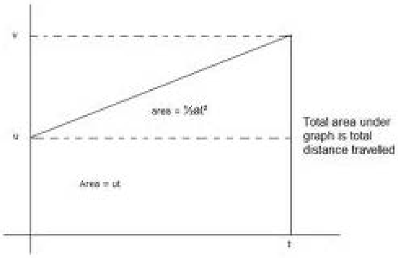
Definitions:

define scalar and vector quantities and give examples;	**Scalar:** Magnitude without direction Examples: Length, area, volume, distance, speed, mass, density, pressure, temperature, energy, work, power, electrical potential, charge, time **Vector:** A quantity that has (both) magnitude / size and direction Examples: Displacement, velocity, acceleration, momentum, force (lift, drag, thrust, weight), field(s), a.c. voltage, current (when calculating fields only)
define *displacement*, *instantaneous speed*, *average speed*, *velocity and acceleration*;	Displacement = (net) distance moved in a particular direction. Instantaneous speed = speed measured between two point a very small time apart Average speed = distance covered / time taken Velocity = speed in a given direction Acceleration is the gradient of a velocity vs time graph. (= change in velocity / time taken)
define the *newton*;	The (net) force which gives a mass of 1kg an acceleration of 1 ms^{-2}.
define and apply the *torque of a couple*;	one of forces × perpendicular distance (between forces) (Not force x perpendicular distance)
define and apply the *moment of force*;	moment = force x perpendicular distance from pivot / axis / point
define *thinking distance, braking distance* and *stopping distance*;	Thinking distance: The distance travelled (by the car) from when the driver sees a problem and the brakes are applied Braking distance: The distance travelled (by the car) whilst the brakes are applied and the car stops (wtte) Stopping distance: Thinking distance + braking distance
define *work done* by a force;	work done = force x distance moved / travelled in the direction of the force
define the *joule*;	Energy required to move a weight of 1N (through) a distance of 1 m
define *power* as the rate of work done;	power = work (done)/time or power = energy/time or power = rate of work done
define the *watt*;	Power required to move 1N through a distance of 1m in 1 sec (Rate of doing work)
define and use the terms *stress*, *strain*, *Young modulus* and *ultimate tensile strength* (*breaking stress*);	Stress = force/(cross-sectional) area Strain = extension/original length Young modulus = stress/strain / Young modulus is equal to the gradient from stress-strain graph (in the linear region) Ultimate tensile strength = Maximum stress material can withstand (before fracture)
define the terms *elastic deformation* and *plastic deformation* of a material;	Elastic: extension (or compression) ☐ (as long as elastic limit is not exceeded)

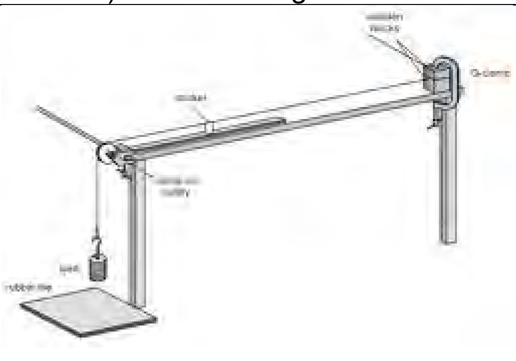
	Plastic: Material does not return to original length / shape/ size (is permanently deformed / longer) when the force / stress is removed
Define density	Density = mass/volume or mass per (unit) volume

Derive and apply:

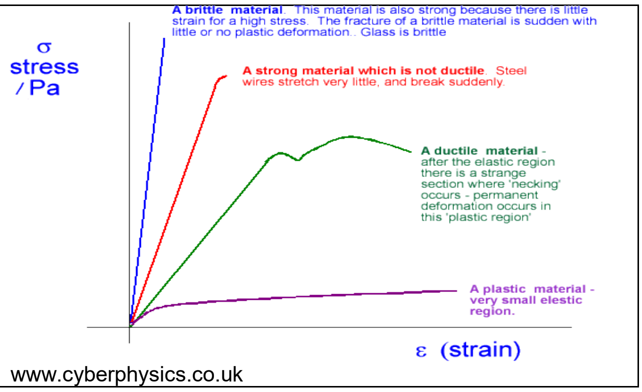
derive the equations of motion for constant acceleration in a straight line from a velocity against time graph;	 www.thestudentroom.co.uk Area of triangle = ½ (v-u) t [(v-u) = at] = ½ a t^2 Area of rectangle = ut add the two together
apply the definition of work done to derive the equation for the change in gravitational potential energy;	Work done = force x distance Force = mass x acceleration Weight = mass x gravitational field strength G.P.E. = m x g x h
apply graphical methods to represent displacement, speed, velocity and acceleration	
apply the equations for constant acceleration in a straight line, including the motion of bodies falling in the Earth's uniform gravitational field without air resistance	
apply the equations of constant acceleration to describe and explain the motion of an object due to a uniform velocity in one direction and a constant acceleration in a perpendicular direction	You can talk about 'large' deceleration/acceleration but not 'quick'
apply the equations for constant acceleration and $F = ma$ to analyse the motion of objects	
apply the principle of moments to solve problems, including the human forearm	Clockwise moment = anticlockwise moment
apply the idea that work done is equal to the transfer of energy to solve problems	
select and apply the equation for kinetic energy $E_k = ½ mv^2$	
select and apply the equation for the change in gravitational potential energy near the Earth's surface $E_p = mgh$	
apply the principle of conservation of energy to determine the speed of an object falling in the Earth's gravitational field	
select and apply the relationship for efficiency *Efficiency = total input energy* ×100% *useful output energy*	
select and apply the equation $F = kx$, where k is the force constant of the spring or the wire	

Describe:

describe an experiment to determine the acceleration of free fall *g* using a falling body;	Measurements: Height (distance) Time (of fall) Instruments: Stop watch/timer/clock/video Ruler/tape (measure) Calculation: $g = 2s/t^2$ or g = 2 gradient of . s-t^2 graph g is an estimate: air resistance / drag parallax (landing time) starting/stopping the clock ((v+u)/t = s/t, v=u+at, u=0) ($s=ut+1/2at^2$ (ut=0), $s = at^2/2$, $a(g)=2s/t^2$)
describe the motion of bodies falling in a uniform gravitational field with drag;	Acceleration: Terminal velocity: Net / total / resultant force (on drop) is zero 'upward force = downward force' / 'weight = drag' / 'weight balances drag'
describe a simple experiment to determine the centre of gravity of an object;	Suspend object from a point and then) mark a vertical line on the object Plumb line / 'pendulum' (used to find the vertical line) Hang from another point / place (and draw another vertical line) (wtte) Where the lines intersect gives position of centre of gravity (wtte)
describe the factors that affect thinking distance and braking distance;	speed, mass, condition of tyres/tread, condition of brakes, condition of road (surface), gradient of road For each factor, correct description of how braking distance is affected : Greater speed means greater distance OR distance ∝ $speed^2$ Greater mass means greater distance OR distance ∝ mass Worn tyres / brakes implies less friction therefore greater distance Bald tyres Wet / slippery / icy road means less friction therefore greater distance Uphill means shorter distance
describe and explain how air bags, seat belts and crumple zones in cars reduce impact forces in accidents;	Prevent collision with steering wheel / windscreen /dashboard Time for stopping is more / distance for stopping is more / seat belt 'stretches' Smaller deceleration / acceleration (of person) Reference to K.E.=Fs or ½ mv^2=Fs
describe how air bags work, including the triggering mechanism;	Large deceleration / rapid decrease in speed (triggers the air bag)

	Prevent collision with steering wheel / windscreen / dashboard
describe how the trilateration technique is used in GPS	(Several) <u>satellites</u> used Distance from (each) satellite is determined. Time taken for signal to travel from satellite to car/'delay' time for signal is determined. Distance = c x 'delay' time Position / distance is determined using *c* / speed of e.m waves / radio waves / microwaves and delay time Trilateration is used to locate the position of the car OR position of car is where circles/spheres cross/intersect.
describe examples of energy in different forms, its conversion and conservation, and apply the principle of energy conservation to simple examples;	
describe how deformation is caused by a force in one dimension and can be tensile or compressive;	
describe the behaviour of springs and wires in terms of force, extension, elastic limit, Hooke's law and the force constant (ie force per unit extension or compression);	Measurement: original / initial length (**Not**: final length) extension / initial <u>and</u> final lengths, weight / mass Equipment: Micrometer / vernier (calliper) (for the diameter of the wire) Ruler / (metre) rule / tape measure (for measuring the original length / extension) Travelling microscope (for measuring extension) Scales / balance (for measuring the mass & *mg* equation is used or for measuring weight) / Newton meter (for the weight of hanging masses) / 'known' weights used
describe an experiment to determine the Young modulus of a metal in the form of a wire;	 www.thestudentroom.co.uk

describe the shapes of the stress against strain graphs for typical materials



Determine:

determine velocity from the gradient of a displacement against time graph;
determine displacement from the area under a velocity against time graph
determine acceleration from the gradient of a velocity against time graph.
determine the acceleration of an object in the presence of drag;
determine the area under a force against extension (or compression) graph to find the work done by the force;

Use:

use correctly the named units listed in this specification as appropriate;	
use correctly the following prefixes and their symbols to indicate decimal sub-multiples or multiples of units: pico (p), nano (n), micro (ì), milli (m), centi (c), kilo (k), mega (M), giga (G), tera (T);	10^{12} tera T 1 000 000 000 000 10^{9} giga G 1 000 000 000 10^{6} mega M 1 000 000 10^{3} kilo k 1 000 10^{-2} centi c 0.01 10^{-3} milli m 0.001 10^{-6} micro µ 0.000 001 10^{-9} nano n 0.000 000 001 10^{-12} pico p 0.000 000 000 001
draw and use a vector triangle to determine the resultant of two coplanar vectors such as displacement, velocity and force	
select and use the relationships average speed = distance / time acceleration = change in velocity / time to solve problems	
Select and use the equations of motion for constant acceleration in a straight line: $v = u + at$, $s = ½ (u + v)t$ $s = ut + ½ at^2$ $v^2 = u^2 + 2as$	
select and use the relationship: weight = mass ×acceleration of free fall ($W = mg$);	
use and explain the term *terminal velocity*.	
draw and use a triangle of forces to represent the equilibrium of three forces acting at a point in an object;	*For equilibrium of an object the sum of clockwise moments about a point = sum of anticlockwise moments about the same point*.’

select and use the equation for density: ρ = m / V
select and use the equation for pressure p = F/ A where F is the force normal to the area A
select and use the equations for elastic potential energy $E = ½ Fx$ and $E = ½kx^2$

Explain:

explain that some physical quantities consist of a numerical magnitude and a unit	
explain how experiments carried out by Galileo overturned Aristotle's ideas of motion	'heavy' and 'light' objects / different weights / different masses dropped (from leaning tower of Pisa) / rolled down incline plane Objects have the same <u>acceleration</u> (of free fall) Objects hit ground at same time
explain that an object travelling in a fluid experiences a resistive or a frictional force known as drag	Drag/air resistance/air friction (makes the time longer) drag is proportional to speed^2
explain that a couple is a pair of forces that tends to produce rotation only	A pair of <u>equal</u> and <u>opposite</u> force
explain that both the net force and net moment on an extended object in equilibrium is zero	

Recall and state:

recall that according to the special theory of relativity, *F* = *ma* cannot be used for a particle travelling at very high speeds because its mass increases	
state the factors that affect the magnitude of the drag force	Area Speed/velocity (surface) texture/aerodynamic (shape) Viscosity (of air)/temperature/density
state that the weight of an object is the gravitational force acting on the object	
state that the *centre of gravity* of an object is a point where the entire weight of an object appears to act	
state the principle of conservation of energy	Energy cannot be created or destroyed; it can only be transferred/transformed into other forms or The (total) energy of a system remains constant or (total) initial energy = (total) final energy
state that the efficiency of a device is always less than 100% because of heat losses	
State Hooke's Law	Extension is proportional to force (applied) (as long as the elastic limit is not exceeded)

Mathematical requirements:

Make suitable estimates of physical quantities included within this specification
calculate the resultant of two perpendicular vectors such as displacement, velocity and force
resolve a vector such as displacement, velocity and force into two perpendicular components
Solve problems using the relationship: net force = mass × acceleration ($F = ma$) appreciating that acceleration and the net force are always in the same direction
analyse and solve problems using the terms thinking distance, braking distance and stopping distance
calculate the work done by a force using $W = Fx$ and $W = Fx \cos \theta$
analyse problems where there is an exchange between gravitational potential energy and kinetic energy
calculate power when solving problems
interpret and construct Sankey diagrams