A Level Physics Online

OCR B Physics – H557

Module 4: Understanding Processes

You should be able to demonstrate and show your understanding of:	Progress and understanding: 1	2	3	4
4.2 Space, Time and Motion				
Scalar – magnitude e.g. mass, temperature, time, speed, length, energy				
Vector – magnitude and direction e.g. force, acceleration, velocity, displacement, momentum				
$speed = \frac{distance}{time}$ $velocity, v = \frac{displacement}{time}$ $acc = \frac{\Delta v}{\Delta t}$				
Distance-Time Graphs: Stationary: Straight line with zero gradient Constant Speed: Straight line with constant non-zero gradient Decelerating: Curved line with decreasing gradient Accelerating: Curved line with increasing gradient Average speed: chord Instantaneous speed: tangent (large as possible to decrease % uncertainty) Speed: gradient				
Velocity-Time Graphs: Stationary: Straight line with zero gradient at y=0 (along x-axis) Constant Speed: Straight line with constant non-zero gradient Decelerating: Straight line with constant negative gradient Accelerating: Straight line with constant positive gradient Displacement: area (cannot calculate if the object has changed direction, may have returned to its start point) Acceleration: gradient (curved, non-uniform acceleration; linear, uniform acceleration)				
Vector Addition: through the angle is cos, away from the angle is sin. Add vectors tip to tail for the resultant vector. NW/NE is an angle of 45 degrees				
Relative Velocity: Minus the velocity of the other object from the velocity of your object (make sure to remember the sign of the velocities on both objects)				

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Remember that the relative velocity of an object to itself is zero				
Iterative Models: -Computers are used for iterative (repeated) calculations as the manual process is slow -The initial conditions are for when t=0 $s_{new} = s_{previous} + \Delta s \qquad v_{new} = v_{previous} + \Delta v$ -Improved using smaller time intervals -Results of the iteration presentation using a spreadsheet or graphically (using vectors) -Maximum velocity for a falling object is the terminal velocity -As an object falls, air resistance increases. To factor this in, $a = 9.8 - Kv^2$, where K is a constant that varies with the shape, size and density of the object (a bigger object means a greater value of K)				
Deriving Suvat/Constant Acceleration Equations: v=final velocity, u=initial velocity, a=acceleration, t=time, s=displacement				
$a = \frac{\Delta v}{\Delta t} = \frac{v-u}{t} \quad \rightarrow \quad at = v - u \quad \rightarrow \quad \boldsymbol{v = u + at}$				
$\bar{v} = \frac{u+v}{2}$ and $\bar{v} = \frac{s}{t}$ combined to give $\frac{s}{t} = \frac{u+v}{2} \quad \rightarrow \quad \boldsymbol{s = \left(\frac{u+v}{2}\right)t}$				
Substituting the first into the second equation $s = \left(\frac{u+u+at}{2}\right)t \quad \rightarrow \quad s = \left(u + \frac{1}{2}at\right)t \quad \rightarrow \quad \boldsymbol{s = ut + \frac{1}{2}at^2}$				
The fourth equation is $v^2=u^2+2as$ but the derivation of this isn't within the syllabus				
Calculating g: 1) Drop object 2) Measure t and distance to reach ground 3) Use suvat, solve for acceleration -Increase distance to decrease the percentage uncertainty -To improve, use light gates, data loggers or use a slow-motion camera with a timer behind the experiment				
Stopping Distances: -Stopping distance = thinking distance + breaking distance -To ensure no collision, the stopping distance must be less than the distance to the hazard -As speed increases, thinking distance increases in proportion -Breaking distance increases fourfold as the average speed doubles so it travels twice as far per second so the time to decelerate to rest doubles too -Human reaction time must consider conditions (icy road) and physical problems (car failure)				

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Newton's First Law: A body will continue moving in a straight line unless acted upon by a force. This is the concept of inertia, a body will have constant velocity, or stay at rest, unless an external force acts on it Newton's Second Law: $F \propto \frac{\Delta p}{\Delta t}$ where Δp per second produced by F, they are in the same direction as they are proportional $$F = \frac{\Delta p}{\Delta t} = \frac{m\Delta v}{\Delta t} = ma$$ Newton's Third Law: If a body A acts on body B with a force F_A, and body B acts on body A with a force F_B; then $F_A = -F_B$. Remember that the forces act on different objects				
Projectile Motion: In the horizontal direction, s=d/t can be used because there are no forces acting horizontally, so there is no acceleration. In the vertical direction acceleration is constant (g) so suvat is used. The path of a projectile (assuming no air resistance) follows the path of a parabola.				
Mass: The amount of matter in a body Weight: A force exerted due to the presence of mass, calculated by W=mg				
Momentum: $p = mv$ and conservation of p is $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ Inelastic collision - momentum is conserved Elastic collision - momentum and kinetic energy conserved				
Impulse: $I = \Delta p = Ft = mv - mu$ -Larger impulse means a longer time to act or a larger force -Crumple zones increase the time for the car to stop, there is the same Δp due to conservation of momentum so if t increases, F acting on the car must decrease -Seat belts gradually stretch; air bags gradually deflate so the time to stop increases if the car stops suddenly				
Work, W, (Units: J): Scalar. Work is done when an object is lifted. Depends on the size of the applied force against the weight and distance through which the force is moved $\Delta E = F\Delta s$ Work is the energy transfer when a force moves its point of application Energy, E, (Units: J): A measure of the capacity of a body or system for doing work				
Gravitational potential energy: $\Delta E = F\Delta s = mg\Delta h$ $E_p = mgh$				
Kinetic energy: $\Delta E = F\Delta s = ma\Delta s$ then using $v^2=u^2+2as$ with u=0, we get $as=0.5v^2$ $\Delta E = m\frac{1}{2}v^2$ $E_k = \frac{1}{2}mv^2$				
For a falling object; as the object falls, potential energy decreases, once at terminal velocity kinetic energy is constant. A resistive force is felt as it falls. By Newton's third, the object is exerting an equal force on the air as the air is on the object				

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Power, P, (Units: Js^{-1}): -Rate at which work is done/energy is transferred -For a falling object, power dissipation is the energy transferred to the surroundings (air) by heating them. The power dissipated by the GPE change of the object is equal to the energy transferred to the air in one second -If the displacement from a force is in the direction of the force itself; $P = \frac{Energy\ Transfer}{Time} = \frac{Work\ Done}{Time} = \frac{Fs}{t} = Fv$				