AQA Further Maths AS-level

Mechanics

Formula Sheet

Provided in formula book

Not provided in formula book

Constant Acceleration

Motion in One Dimension

$s = ut + \frac{1}{2}at^2$
$s = vt - \frac{1}{2}at^2$
$v = u + at$
$s = \frac{1}{2}(u + v)t$
$v^2 = u^2 + 2as$

Motion in Multiple Dimensions

$\boldsymbol{s} = \boldsymbol{u}t + \frac{1}{2}\boldsymbol{a}t^2$
$\boldsymbol{s} = \boldsymbol{v}t - \frac{1}{2}\boldsymbol{a}t^2$
$\boldsymbol{v} = \boldsymbol{u} + \boldsymbol{a}t$
$\boldsymbol{s} = \frac{1}{2}(\boldsymbol{u} + \boldsymbol{v})t$

Dimensional Analysis

Quantity	Dimension	SI Unit
Time	T	second (s)
Mass	M	kilogram (kg)
Length/Displacement	L	metre (m)
Area/Volume	L^2 / L^3	m^2/m^3
Velocity	LT^{-1}	ms^{-1}
Acceleration	LT^{-2}	ms^{-2}
Force	MLT^{-2}	newton (N)
Kinetic Energy	ML^2T^{-2}	joule (J)
Work Done	ML^2T^{-2}	joule (J)
Moment	ML^2T^{-2}	newton metres (Nm)
Power	ML^2T^{-3}	watt (W)
Momentum	MLT^{-1}	$kgms^{-1}$
Impulse	MLT^{-1}	newton seconds (Ns)
Moment of Inertia	ML^2	kgm^2
Angular Velocity	T^{-1}	rad s^{-1}
Frequency	T^{-1}	hertz (Hz)
Periodic Time	T	second (s)
Angle	1/Dimensionless	degree/radian
Density	ML^{-3}	kgm^{-3}
Pressure	$ML^{-1}T^{-2}$	pascal (Pa)

Momentum and Collisions

Conservation of Linear Momentum

Momentum of an object of mass m moving at velocity v	$\text{momentum} = mv$
Momentum of an object of mass m moving with velocity vector $\begin{pmatrix} v_x \\ v_y \end{pmatrix}$	$\text{momentum} = m\begin{pmatrix} v_x \\ v_y \end{pmatrix}$
Conservation of momentum: Total momentum before collision = total momentum after collision	$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$
Impulse, I, of a constant force F acting for time t	$I = Ft$

Restitution and Newton's Experimental Law

Coefficient of restitution, e	$e = \dfrac{v_2 - v_1}{u_1 - u_2}, 0 \le e \le 1$
Coefficient of restitution for a perfectly elastic collision	$e = 1$
Velocity, v, after a collision with a fixed object at initial velocity u	$v = -eu$

Defining Impulse as a Change in Momentum

Impulse needed to change the velocity of mass m from u to v (a change in momentum)	$I = mv - mu$

Impulse for Variable Forces

Impulse of a variable force $F(t)$ acting for a time t where $t_1 \le t \le t_2$	$I = \int_{t_1}^{t_2} F(t)dt$

Work, Energy and Power

Definition of Work

Work done by a force acting in the direction of motion (unit: Joule, Newton Metre)	$\text{work done} = \text{force} \cdot \text{distance}$
Work done against/by gravity when raising/lowering a mass m through height h	$\text{work done} = mgh$

Gravitational Potential Energy

Gravitational potential energy (GPE) of an object of mass m at height h above ground level	$\text{GPE} = mgh$

Kinetic Energy

Kinetic energy of an object of mass m moving at a speed v	$\text{kinetic energy} = \frac{1}{2}mv^2$
Work done by a force on an object is equal to the change in its kinetic energy from moving with an initial velocity u to a final velocity v	$\text{work done} = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$
Conservation of mechanical energy	$\text{GPE} + \text{KE} = mgh + \frac{1}{2}mv^2 = \text{constant}$

Hooke's Law and the Modulus of Elasticity

Modulus of elasticity, λ, given by the ratio of the product of tension T and length l to the extension x	$\lambda = \frac{Tl}{x}$
Stiffness of an elastic string of length l and modulus of elasticity λ	$k = \frac{\lambda}{l}$
Hooke's law for an elastic spring or string of length l, modulus of elasticity λ, stiffness k, and extension x	$T = kx = \frac{\lambda x}{l}$
Work done extending an elastic spring or string from length x_1 to length x_2	$\frac{k}{2}(x_2^2 - x_1^2) = \frac{\lambda}{2l}(x_2^2 - x_1^2)$

Work Done by a Variable Force

Work done by a variable force $f(x)$ acting on an object, moving it from position x_1 to x_2	$\text{work done} = \int_{x_1}^{x_2} f(x)dx$

Elastic Potential Energy

Elastic potential energy (EPE) stored in a string extended, or compressed, by length x	$\frac{kx^2}{2} = \frac{\lambda x^2}{2l}$
Conservation of energy for an object acted on by only its own weight and the force in an elastic spring or string	$\text{GPE} + \text{EPE} + \text{KE} = \text{constant}$

Power

Average power of a constant force applied for a given time (Unit: Watts, W)	$\text{average power} = \frac{\text{work done}}{\text{time taken}}$
Power in terms of tractive force	$\text{Power} = \text{tractive force} \cdot \text{speed}$

Circular Motion

Angular Speed

Angular speed (rad s^{-1})	$\omega = \frac{d\theta}{dt}$

Kinematic Quantities in Circular Motion

Linear speed, v, of a particle moving in a circular path of radius r and with constant angular speed ω	$v = r\omega$
Angular speed in terms of linear speed	$\omega = \frac{v}{r}$
Centripetal acceleration, a	$a = v\omega = r\omega^2 = \frac{v^2}{r}$