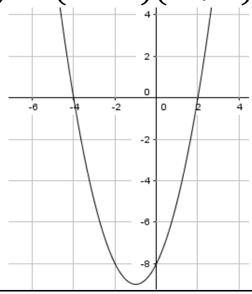
Quadratics Overview

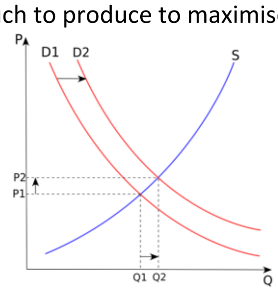
Terminology

Quadratic Expression	Quadratic Equation	Quadratic Graph
$ax^2 + bx + c$ (where a, b and c are numbers)	$ax^2 + bx + c = \mathbf{0}$ (where a, b and c are numbers)	$\boldsymbol{y} = ax^2 + bx + c$ (where a, b and c are numbers)
This is an **expression**, not an equation, so by choosing different **inputs** (x values), we can generate different **outputs**. For instance, the quadratic expression $x^2 - 4$ is equal to 21 when $x = 5$.	This is an **equation**, but unlike a simple linear equation that always has exactly one solution, a quadratic equation may have **two, one** or **no solutions**. For instance, the quadratic equation $x^2 - 4 = 0$ has two solutions: $x = 2$ and $x = -2$.	This is a **graph**, which represents the whole range of possible **output values** for any possible **input value**. For instance, the graph of the quadratic $y = x^2 - 4$ reaches a height of 21 ($y = 21$) at two points: $(5,21)$ and $(-5,21)$.
Eg: $1 - x^2$ $3x^2 - \frac{1}{2}x + 2$ $(x + 4)(x - 1)$ $(2x - 3)^2 + 5$	Eg: $2x^2 + 4x = 0$ $5 - x^2 = 3x + 2$ $(7 - x)(7 + x) = 8$ $0 = x\left(2x - \frac{1}{2}\right)$	Eg: $y = (x - 2)(x + 4)$ 

Formats

Standard	Factorised	Completed Square
$ax^2 + bx + c$ (where a, b and c are numbers)	$(Ax + B)(Cx + D)$ (where A, B, C and D are numbers)	$p(x + q)^2 + r$ (where p, q and r are numbers)
It is **always possible** to write a quadratic expression in this format. It is **useful for** solving equations using the formula.	It is **sometimes possible** to factorise a quadratic expression. It is **useful for** directly solving equations, or seeing where the graph would cross the x-axis.	It is **always possible** to complete the square with a quadratic expression. It is **useful for** finding the highest or lowest point of a quadratic curve, or for solving.
Eg: $2x^2 + 4x - 16$	Eg: $(2x - 4)(x + 4)$	Eg: $2(x + 1)^2 - 18$

Applications

Projectiles	Economics	Rocket Science
Whenever an object falls freely under gravity (Eg a ball or a bullet), it follows the curved path of a quadratic (known as a parabola) and quadratic equations are used to determine maximum height, hang time, range, etc. 	The supply-demand principle which governs the price of products means that the less of something you have to sell, the more people will pay for it. Quadratics allow businesses to solve the problem of how much to produce to maximise profit. 	The force of gravity is related to the distance from an object *squared*, so quadratics are used to interpret and predict the motion of objects in space. A satellite dish is also parabolic in shape since this focuses rays onto a fixed point. 

As with many mathematical concepts, quadratics are only the beginning – you won't find many physicists or engineers actually solving lists of quadratic equations in their day-to-day lives, but they will often construct them when analysing a situation, program spreadsheets to find solutions or optimal points, or – more often – deal with trickier concepts that rely on a thorough grasp of quadratics to master (such as cubic equations, higher order polynomials, calculus, etc).