Topics	What students need to learn:		
	Content		Guidance
2 **Algebra and functions**	2.1	**Understand and use the laws of indices for all rational exponents.**	$a^m \times a^n = a^{m+n}, a^m \div a^n = a^{m-n}, (a^m)^n = a^{mn}$ **The equivalence of** $a^{\frac{m}{n}}$ **and** $\sqrt[n]{a^m}$ **should be known.**
	2.2	**Use and manipulate surds, including rationalising the denominator.**	**Students should be able to simplify algebraic surds using the results** $\left(\sqrt{x}\right)^2 = x, \sqrt{xy} = \sqrt{x}\sqrt{y}$ **and** $\left(\sqrt{x}+\sqrt{y}\right)\left(\sqrt{x}-\sqrt{y}\right) = x - y$
	2.3	**Work with quadratic functions and their graphs.** **The discriminant of a quadratic function, including the conditions for real and repeated roots.** **Completing the square.** **Solution of quadratic equations** **including solving quadratic equations in a function of the unknown.**	**The notation** $\mathrm{f}(x)$ **may be used** **Need to know and to use** $b^2 - 4ac > 0,\ b^2 - 4ac = 0$ **and** $b^2 - 4ac < 0$ $ax^2 + bx + c = a\left(x + \frac{b}{2a}\right)^2 + \left(c - \frac{b^2}{4a}\right)$ **Solution of quadratic equations by factorisation, use of the formula, use of a calculator and completing the square.** **These functions could include powers of** x**, trigonometric functions of** x**, exponential and logarithmic functions of** x**.**
	2.4	**Solve simultaneous equations in two variables by elimination and by substitution, including one linear and one quadratic equation.**	**The quadratic may involve powers of** 2 **in one unknown or in both unknowns,** **e.g. solve** $y = 2x + 3,\ y = x^2 - 4x + 8$ **or** $2x - 3y = 6, x^2 - y^2 + 3x = 50$

Topics	What students need to learn:		
	Content		Guidance
2 **Algebra and functions** *continued*	2.5	**Solve linear and quadratic inequalities in a single variable and interpret such inequalities graphically,**	**e.g. solving** $ax + b > cx + d$, $px^2 + qx + r \geq 0$, $px^2 + qx + r < ax + b$ **and interpreting the third inequality as the range of x for which the curve $y = px^2 + qx + r$ is below the line with equation $y = ax + b$**
		including inequalities with brackets and fractions.	**These would be reducible to linear or quadratic inequalities** **e.g. $\frac{a}{x} < b$ becomes $ax < bx^2$**
		Express solutions through correct use of 'and' and 'or', or through set notation.	**So, e.g. $x < a$ or $x > b$ is equivalent to $\{x : x < a\} \cup \{x : x > b\}$ and $\{x : c < x\} \cap \{x : x < d\}$ is equivalent to $x > c$ and $x < d$**
		Represent linear and quadratic inequalities such as $y > x + 1$ and $y > ax^2 + bx + c$ graphically.	**Shading and use of dotted and solid line convention is required.**
	2.6	**Manipulate polynomials algebraically, including expanding brackets and collecting like terms, factorisation and simple algebraic division; use of the factor theorem.** Simplify rational expressions, including by factorising and cancelling, and algebraic division (by linear expressions only).	**Only division by $(ax + b)$ or $(ax - b)$ will be required. Students should know that if $f(x) = 0$ when $x = a$, then $(x - a)$ is a factor of $f(x)$.** **Students may be required to factorise cubic expressions such as $x^3 + 3x^2 - 4$ and $6x^3 + 11x^2 - x - 6$.** Denominators of rational expressions will be linear or quadratic, e.g. $\frac{1}{ax+b}, \frac{ax+b}{px^2+qx+r}, \frac{x^3+a^3}{x^2-a^2}$

Topics	What students need to learn:		
	Content		Guidance
2 **Algebra and functions** *continued*	2.7	**Understand and use graphs of functions; sketch curves defined by simple equations including polynomials** The modulus of a linear function. $y = \frac{a}{x}$ **and** $y = \frac{a}{x^2}$ **(including their vertical and horizontal asymptotes)** **Interpret algebraic solution of equations graphically; use intersection points of graphs to solve equations.** **Understand and use proportional relationships and their graphs.**	**Graph to include simple cubic and quartic functions,** **e.g. sketch the graph with equation** $y = x^2(2x-1)^2$ Students should be able to sketch the graphs of $y = \lvert ax + b \rvert$ They should be able to use their graph. For example, sketch the graph with equation $y = \lvert 2x - 1 \rvert$ and use the graph to solve the equation $\lvert 2x - 1 \rvert = x$ or the inequality $\lvert 2x - 1 \rvert > x$ **The asymptotes will be parallel to the axes e.g. the asymptotes of the curve with equation** $y = \frac{2}{x+a} + b$ **are the lines with equations** $y = b$ **and** $x = -a$ **Direct proportion between two variables.** **Express relationship between two variables using proportion "$\propto$" symbol or using equation involving constant** **e.g. the circumference of a semicircle is directly proportional to its diameter so** $C \propto d$ **or** $C = kd$ **and the graph of** C **against** d **is a straight line through the origin with gradient** k**.**

Topics	What students need to learn:		
	Content		Guidance
2 **Algebra and functions** *continued*	2.8	Understand and use composite functions; inverse functions and their graphs.	The concept of a function as a one-one or many-one mapping from $\mathbb{R}$ (or a subset of $\mathbb{R}$) to $\mathbb{R}$. The notation $\mathrm{f}: x \mapsto$ and $\mathrm{f}(x)$ will be used. Domain and range of functions. Students should know that fg will mean 'do g first, then f' and that if f^{-1} exists, then $\mathrm{f}^{-1}\mathrm{f}(x) = \mathrm{ff}^{-1}(x) = x$ They should also know that the graph of $y = \mathrm{f}^{-1}(x)$ is the image of the graph of $y = \mathrm{f}(x)$ after reflection in the line $y = x$
	2.9	**Understand the effect of simple transformations on the graph of $y = \mathrm{f}(x)$, including sketching associated graphs:** $y = a\mathrm{f}(x),\ \ y = \mathrm{f}(x) + a,$ $y = \mathrm{f}(x + a),\ y = \mathrm{f}(ax)$ and combinations of these transformations	Students should be able to find the graphs of $y = \lvert \mathrm{f}(x) \rvert$ and $y = \lvert \mathrm{f}(-x) \rvert$, given the graph of $y = \mathrm{f}(x)$. Students should be able to apply a combination of these transformations to any of the functions in the A Level specification (quadratics, cubics, quartics, reciprocal, $\frac{a}{x^2}$, $\lvert x \rvert$, $\sin x$, $\cos x$, $\tan x$, e^x and a^x) and sketch the resulting graph. Given the graph of $y = \mathrm{f}(x)$, students should be able to sketch the graph of, e.g. $y = 2\mathrm{f}(3x)$, or $y = \mathrm{f}(-x) + 1$, and should be able to sketch (for example) $y = 3 + \sin 2x$, $y = -\cos\left(x + \frac{\pi}{4}\right)$
	2.10	Decompose rational functions into partial fractions (denominators not more complicated than squared linear terms and with no more than 3 terms, numerators constant or linear).	Partial fractions to include denominators such as $(ax + b)(cx + d)(ex + f)$ and $(ax + b)(cx + d)^2$. Applications to integration, differentiation and series expansions.

Topics	What students need to learn:		
	Content		Guidance
2 **Algebra and functions** *continued*	2.11	Use of functions in modelling, including consideration of limitations and refinements of the models.	For example, use of trigonometric functions for modelling tides, hours of sunlight, etc. Use of exponential functions for growth and decay (see Paper 1, Section 6.7). Use of reciprocal function for inverse proportion (e.g. pressure and volume).