European Schools

Office of the Secretary-General
Pedagogical Development Unit

Ref.:2010-D-591-en-2

Orig.: EN

S4P6 MATHEMATICS SYLLABUS SECONDARY 4th YEAR

6 period/week course

APPROVED BY THE JOINT TEACHING COMMITTEE ON THE 4th AND 5TH OF FEBRUARY 2010 IN BRUSSELS

Entry into force in September 2010

ALGEBRA (for guidance: 80 periods)

TOPIC	KNOWLEDGE & SKILLS	USE OF TECHNOLOGY
Basic Calculations	*Pupils must be able to and/or understand:* - do basic calculations $(+, -, x \text{ and } /)$ over the sets $\mathbb{N}, \mathbb{Z}$ and $\mathbb{Q}$. - verify calculation rules and properties established in years 1, 2 & 3 and use them in simple algebraic expressions .	*Pupils must be able to and/or understand:* - basic handling of a calculator numbers: fractions, decimals - transform a fraction into a decimal and vice versa - manage approximate and exact mode calculation - calculate lcm and hcf - simplify, expand and factorise expressions - use a calculator for controlling results
Rational Numbers	*Pupils must be able to and/or understand:* - define a rational number - write terminating and recurring decimals as a fraction and vice versa	*Pupils must be able to and/or understand:* - appreciate the floating point
Square Roots and a new set of numbers	*Pupils must be able to and/or understand:* - solve $x^2 = a$ $(a \in \mathbb{R}^+)$ by trial and error (with a calculator) - give the definition of $\sqrt{a}$ - know that squaring and square rooting are inverse operations - know and be able to use the following identities: $\sqrt{a}\sqrt{b} = \sqrt{ab}$; $\frac{\sqrt{a}}{\sqrt{b}} = \sqrt{\frac{a}{b}}$ for $a \in \mathbb{R}^+, b \in \mathbb{R}^+$ $\sqrt{n^2 m} = n\sqrt{m}$ for $n \in \mathbb{N}$, $m \in \mathbb{N}$ e.g. $\sqrt{12} = 2\sqrt{3}$ $\sqrt{a^2} = \lvert a \rvert$ for $a \in \mathbb{Q}$	*Pupils must be able to and/or understand:* - solve by trial $x^2 = a$; $a \in \mathbb{R}^+$ - show the properties of square roots - calculate the square root of a number

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	- know the square roots of perfect squares (between 1 and 400) by heart - calculate more difficult expressions like: $\left(3\sqrt{2}+\sqrt{12}\right)^2$; $\left(\sqrt{2}+3\sqrt{5}\right)\left(-1+\sqrt{2}\right)$ - rationalise the denominator and also give the conditions of existence of these rules - enclose a root between 2 decimals - prove that $\sqrt{2}$ is an irrational number (without a calculator) - understand that $\sqrt{2} \notin \mathbb{Q}$ and recognise other irrational numbers	- simplify expressions involving square roots - approximate a number in the decimal form - approximate a number as a fraction
Real numbers	*Pupils must be able to and/or understand:* - define the set of real numbers as the union of rational and irrational numbers - realise that $\mathbb{N} \subset \mathbb{Z} \subset \mathbb{Q} \subset \mathbb{R}$ - understand that the rules of calculation for $\mathbb{Q}$ are also valid in $\mathbb{R}$ - understand that each point of a number line corresponds to one and only one real number and vice-versa - know that all arithmetic rules in $\mathbb{Q}$ apply in $\mathbb{R}$	*Pupils must be able to and/or understand:* - correctly evaluate a numerical result displayed by the calculator - know the displaying modes - distinguish between approximate and exact values
Powers and Algebraic Expressions	*Pupils must be able to and/or understand:* - know the definitions and the formulae concerning powers where the indices are positive - define a^{-n} for $n \in \mathbb{N}$ - extend the formulae for positive indices to negative indices	*Pupils must be able to and/or understand:*

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	- simplify algebraic expressions like: $\frac{21a^2b}{7ab^2}$, $3a^{-2}b \times 18a^2b$ - express a number in scientific notation and include rounding - perform calculations with numbers in scientific notation	- simplify expressions - introduce a number written in scientific notation. - use a memory storage facility to calculate numerical values using numbers written in scientific notation.
Linear dependency and proportionality: 1st degree functions and equations	*Pupils must be able to and/or understand:* - recognise that one value depends on another value and define a function accordingly - write the equation of and recognise a linear function $(y = mx + p)$ - transform an equation $ax + by = c$, $(b \neq 0)$ in the form $y = mx + p$ and the converse - recognise that the graphical representation of $ax + by = c$ (including when $b = 0$ or $a = 0$) is a straight line and the converse - understand the meaning of *m* and *p* - define geometrically *m* and *p* - find the equation of a line given: two points one point and *m* only the graph - find algebraically and geometrically the zero (root) of a linear function - recognise real problems which lead to such functions - form equations - solve linear equations - know that the equation $ax + by = c$, where *a* and *b* are non-zero, has an infinite number of solutions - give a geometric interpretation of such equations - recognise real and worded problems which lead to such equations and solve them.	*Pupils must be able to and/or understand:* - draw the graph of a linear function - operate the transformation $ax + by = c \Leftrightarrow y = mx + p$ - find the equation of a linear function given its graph - vary *m* and *p* - find the intersection point with the *x*-axis given the graph and given the equation of a linear function - plot a set of (x, y) values and the graph of a linear function. - solve equations - solve equations step by step and check solutions - verify results by use of a calculator

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Simultaneous equations of the type: $\begin{cases} ax + by = c \\ dx + ey = f \end{cases}$	*Pupils must be able to and/or understand:* - recognise real problems which lead to simultaneous equations - solve simultaneous equations geometrically - recognise from the equations and the geometrical representations that such a system has one, none or infinite number of solutions. - solve simultaneous equations by substitution and/or elimination methods - check solutions - form and solve simultaneous equations from real problems and worded problems.	*Pupils must be able to and/or understand:* - draw the graph of two linear functions - solve simultaneous equations - solve simultaneous equations step by step - check solutions - show by dynamical procedure that points having coordinates satisfying an equation $ax + by = c$ are aligned
First degree inequalities in one unknown and Linear Optimisation	*Pupils must be able to and/or understand:* - know that if $a < b$ then: $a + c < b + c$; and $ac < bc$ provided $c > 0$; and $ac > bc$ provided $c < 0$ - solve first degree inequalities - form simultaneous inequalities from real problems and worded problems - solve geometrically systems of inequalities of the type: $\begin{cases} ax + by \geq c \\ dx + ey \leq f \\ gx + hy \leq j \end{cases}$ - use first degree inequalities in one unknown in linear optimisation, apply to problems such as from economics.	*Pupils must be able to and/or understand:* - draw the graph of linear functions and verify the shaded region - draw the graph of linear functions and verify the solution region and optimal solution.
Quadratic dependency. 2nd degree functions and equations	*Pupils must be able to and/or understand:* - draw parabolas of the types: $y = ax^2$	*Pupils must be able to and/or understand:* - verify that their graphs have been successfully drawn.

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	- graphically compare $y=(x-p)^2$ and $y=(x-p)^2+q$ with $y=x^2$ - understand the graph of $y=a(x-p)^2$ and $y=a(x-p)^2+q$ - find the axis of symmetry and the coordinates of the vertex of a parabola, graphically and by using the form $y=a(x-p)^2+q$ - find the zeros of a quadratic function and interpret them geometrically - determine algebraically and geometrically the intersection of a straight line and a parabola - find the values of x when $f(x)<0$ and when $f(x)>0$	- investigate the effect of changing coefficients in functions of the form: $y=a(x-p)^2+q$ - verify algebraically and geometrically the intersection of a straight line and a parabola - confirm where $f(x)<0$ and $f(x)>0$
	- solve equations which can be reduced to first degree equations e.g. $(ax+b)(cx+d)=0$; $\frac{ax+b}{cx+d}=e$ - solve $x^2=a$, $(a\in\mathbb{R})$	- verify the solutions to a variety of quadratic equations
	- use factorisation to simplify an expression and solve an equation: include use of the results $(a\pm b)^2=a^2\pm 2ab+b^2$ and $(a+b)(a-b)=a^2-b^2$ - solve an equation by writing it in the form $(x+a)^2=b$ - know and apply the formula for the general solution of $ax^2+bx+c=0$ - understand the relation between the coefficients and the nature of the solutions of the general equation by using the discriminant b^2-4ac - solve problems leading to a quadratic equation including worded problems.	- factorise and solve equations

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Polynomials	*Pupils must be able to and/or understand:* - define a monomial - define a polynomial as a sum of monomials - add and multiply algebraic expressions with powers - simplify and order polynomial expressions. - substitute into polynomials expressions and evaluate - perform simple factorisations, including the result: $a^3 \pm 3a^2b + 3ab^2 \pm b^3 = (a \pm b)^3$	*Pupils must be able to and/or understand:* - calculate the numerical value of an algebraic expression by substituting given numerical values to the variables - simplify expressions involving powers - simplify algebraic expressions - factorise algebraic expressions - expand the expression $(a+b)^n$ and calculate coefficients of Pascal's triangle

STATISTICS (for guidance: 32 periods)

TOPIC	KNOWLEDGE & SKILLS	USE OF TECHNOLOGY
Collect, organise and analyse data	*Pupils must be able to and/or understand:* - recognise populations and samples in everyday life situations - recognise discrete and continuous data - determine frequencies from collected raw data - establish a table of frequencies - convert frequencies into percentages and the converse - establish the range of a set of data - form equal classes intervals - establish a table of cumulative frequencies - calculate the arithmetic mean and the median	*Pupils must be able to and/or understand:* - insert data into a spreadsheet - order data in a table of frequencies - use a calculator to convert frequencies into percentages and the converse - find the minimum and the maximum value of a numerical set of data - define and name a variable - calculate cumulative frequencies - calculate the arithmetic mean and the median
Data, population, sample	*Pupils must be able to and/or understand:* - define data: qualitative, quantitative, discrete and continuous - distinguish between population and sample - describe a sample in words - define a statistical variable	
Organisation of data	*Pupils must be able to and/or understand:* - divide data into classes and find: • the upper and lower class boundaries. • the class width • the mid point of each class - form a frequency distribution for grouped data of equal class width - form a cumulative frequency table	*Pupils must be able to and/or understand:* - find, for each class, the minimum and the maximum value, the class width and the mid point - calculate the arithmetic mean and the median

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Representation of data	*Pupils must be able to and/or understand:* - understand the appropriate statistical diagram for the type of data given - draw histograms for grouped data of equal class widths - draw cumulative frequency polygons - box and whisker diagrams	*Pupils must be able to and/or understand:* - represent data in bar charts and histograms, box and whisker
Analysis of data	*Pupils must be able to and/or understand:* - calculate and interpret from grouped frequency distributions and diagrams: • an estimate of the mean $\bar{x} = \frac{\sum fx}{\sum f}$, where x is the mid point • the modal class - calculate and interpret from a cumulative frequency table and cumulative frequency polygons: • an estimate of the median • the interquartile range (IQR)	*Pupils must be able to and/or understand:* - calculate an estimate of the arithmetic mean - calculate an estimate of the median - calculate the IQR
Interpretation and comparison of data	*Pupils must be able to and/or understand:* - decide which average best represents the distribution - compare and interpret distributions with respect to their: • means and medians • interquartile ranges • histograms and box and whisker plots	*Pupils must be able to and/or understand:* - show simultaneously histograms and box and whisker plots for two different distributions and compare them

GEOMETRY (for guidance: 80 periods)

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Study of circles	*Pupils must be able to and/or understand:* - give the definition of a circle and a disc - define ideas such as: sector of a disc ; arc of a circle ; chord ; angle at the centre of a circle ; angle in a segment of a circle ; tangent to a circle - explore with a calculator, prove and apply the following circle theorems: • angles subtended on the same arc are equal • angles in a semi-circle are right angles • angles with a tangent are right angles the angle at the centre is double the angle on the circumference - calculate the circumference of a circle and area of a disc - find the length of arcs and areas of sectors.	*Pupils must be able to and/or understand:* - observe dynamically the ratio value of a circumference to a diameter - find out by dynamical procedure some properties of circle theorems - verify by measuring angles - calculate the circumference of a circle - calculate the area of a disc - calculate the length of an arc - calculate the area of a sector
Similar triangles and Thales theorem	*Pupils must be able to and/or understand:* - recognise and use the properties of similar triangles - know that a parallel projection of a line onto a line preserves: - equality of lengths - ratio of lengths - prove and use the mid-point theorem (for a triangle) - recognise the converse of the intercept theorem - apply the intercept theorem to calculate lengths and to prove lines are parallel	*Pupils must be able to and/or understand:* - use constructions and measurements to verify lengths ratio and angles - use dynamical procedures to show the theorem using variables and sliders
Enlargements and	*Pupils must be able to and/or understand:*	*Pupils must be able to and/or understand:*

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similarities	- perform both positive and negative enlargements given the centre and the scale factor - find the image of a point, a line, a half-line - find the image of a line segment and find the ratio of lengths - find and use the invariant elements - given two figures one of which is an enlargement of the other, find the centre of enlargement and the scale factor - calculate the ratio of lengths, areas and volumes of similar figures	- draw simple enlargements - find out the scale factor using variables and sliders - verify invariants by measurements - use a calculator to explore the ratio of lengths, areas and volumes of similar figures.
Pythagoras' Theorem	*Pupils must be able to and/or understand:* - express and prove Pythagoras' Theorem and its converse - know that there are different ways to prove Pythagoras' Theorem - apply the Pythagoras' Theorem to problems in two dimensions - recognise real problems and apply the Pythagoras' Theorem	*Pupils must be able to and/or understand:* verify the theorem using - side length measurements - area measurements
Trigonometric ratios in right angled triangles	*Pupils must be able to and/or understand:* - find the trigonometric ratios (T.R.) of an acute angle - determine an angle knowing one of its T.R. - compare the T.R. of angle with those of its complementary angle: $\cos\theta = \sin\left(90^0 - \theta\right)$ - know that the T.R. of an angle varies - know the standard trigonometric ratios associated with right angled triangles - calculate the lengths of the sides and the angles of a right angled triangle	*Pupils must be able to and/or understand:* - use a calculator to verify the results and perform calculations. - use a calculator to investigate by dynamical way the ratios defining sin, cos and tan.

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	- simple cases (given two elements, find a third) - practical applications - know the fundamental results $\sin^2\theta + \cos^2\theta = 1$ $\tan\theta = \frac{\sin\theta}{\cos\theta}$	
Applied Trigonometry and Solid Geometry	*Pupils must be able to and/or understand:* - calculate lengths and angles in right-angled triangles and apply these results to plane sections of prisms, pyramids and cones - apply trigonometry to solve problems - determine the volume, sketch the nets and calculate surface areas for the following objects: cube, cuboid, triangular right prism, triangle and square based pyramids, cylinder, cone - sketch plane sections of objects and use these sections to calculate distances and angles - find the slant height given the height and the circumference of a cone	*Pupils must be able to and/or understand:* - use a calculator to verify the results and perform calculations.
Vectors in a plane (Direction Vectors)	*Pupils must be able to and/or understand:* - define a vector - construct a line segment representing a vector - know the connections between translations and free/direction vectors - define - a negative vector and a zero vector - the parallelism of vectors - the equality of vectors - the magnitude of a vector - prove and use the following property: $\overrightarrow{AB} = \overrightarrow{CD} \Leftrightarrow \overrightarrow{AC} = \overrightarrow{BD}$	*Pupils must be able to and/or understand:* - construct a vector - use translations with vectors

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Addition of vectors	*Pupils must be able to and/or understand:* - combine translations - add and subtract vectors - state and use the properties of the addition of vectors	*Pupils must be able to and/or understand:* - show the sum of vectors using a translation combination
Multiplying Vectors	*Pupils must be able to and/or understand:* - multiply a vector by a real number - state and use the properties of scalar multiplication - define parallel vectors	
Transformations and vectors	*Pupils must be able to and/or understand:* - show that parallel projections, translations, enlargements and rotations of 180° all map equal vectors onto equal vectors	*Pupils must be able to and/or understand:* - use a calculator to show transformations
Linear combination of vectors	*Pupils must be able to and/or understand:* - construct a vector which is a linear combination of two given vectors - express a vector as a linear combination of two given vectors	
Vectors at the origin of the coordinate system (Position vectors)	*Pupils must be able to and/or understand:* - define and represent a vector in a 2D coordinate system - add position vectors and use the addition properties - multiply a position vector by a real number and use the properties of scalar multiplication - construct a vector which is the linear combination of	

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	two given vectors - express a vector as a linear combination of two given vectors - find the coordinates of a vector in a given base	