



Assessing pupils' progress in mathematics at Key Stage 3: Standards File

Pupil V



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Pupil V – Year 9 – Secure level 7

Assessing pupils' progress in mathematics at Key Stage 3

Assessment summary

Pupil V's attainment across mathematics is judged to be secure level 7. His performance is strongest in handling data, and within level 7 across the other attainment targets.

Using the Standards Files

- The current Standards Files are based on work planned and assessed in relation to the 1999 National Curriculum programme of study. A new set of Standards Files based on the 2008 National Curriculum are currently in production, but the current set will provide useful guidance on making APP assessments against national standards in the transition period as the new programmes of study are introduced.
- The commentaries in the Standards Files are provided for guidance and reference, and are much more extensive than any teacher would be expected to make when carrying out APP assessments. It is also important to remember that APP encourages and enables a broader overview of current learning, and that there is no need to collect special portfolios of pupils' work. Evidence from pupils' written and oral work, backed up by brief teacher's notes where necessary, is all that is required.
- The evidence base presented in each Standards File is necessarily partial, as it would of course be impractical to reproduce all of each pupil's work. Examples of each pupil's work have been selected to provide evidence to support judgements against APP criteria. This evidence should be considered in conjunction with the teacher's notes, which will provide a broader context and further justification for the assessments that are made.

Assessment focus

Numbers and the number system; Calculating

Context

Classwork: At the beginning of a unit on numbers and the number system pupils completed a range of questions on adding, subtracting, multiplying and dividing fractions.

10/1/07
Eze E

1) $1\frac{5}{6} + 4\frac{1}{2}$
 $\frac{11}{6} + \frac{4\frac{1}{2}}{2} = \frac{11}{6} + \frac{27}{6}$
 $= \frac{38}{6} = 6\frac{2}{6}$

2) $2\frac{2}{5} + 3\frac{1}{4}$
 $\frac{14}{5} + \frac{13}{4} = \frac{56}{20} + \frac{32.5}{20}$
 $= \frac{88.5}{20} = 5\frac{17}{20}$

3) $5\frac{5}{6} + 2\frac{2}{3}$
 $\frac{35}{6} + \frac{8}{3} = \frac{35}{6} + \frac{16}{6}$
 $= \frac{51}{6} = 8\frac{1}{2}$

4) $2\frac{2}{9} + 1\frac{1}{4}$
 $\frac{26}{9} + \frac{5}{4} = \frac{104}{36} + \frac{45}{36}$
 $= \frac{149}{36} = 4\frac{5}{36}$

5) $4\frac{2}{3} + 3\frac{3}{5}$
 $\frac{14}{3} + \frac{18}{5} = \frac{70}{15} + \frac{54}{15}$
 $= \frac{124}{15} = 8\frac{4}{15}$

6) $5\frac{1}{2} + 2\frac{2}{7}$
 $\frac{11}{2} + \frac{16}{7} = \frac{77}{14} + \frac{32}{14}$
 $= \frac{109}{14} = 7\frac{7}{14}$

8) $\frac{4}{3} \times \frac{1}{3} = \frac{4}{9}$ ✓
 9) $\frac{2}{7} \times \frac{5}{7} = \frac{10}{49}$ ✓
 10) $\frac{2}{3} \times \frac{7}{7} = \frac{14}{21}$ ✓
 11) $\frac{4}{8} \times \frac{2}{3} = \frac{8}{24} = \frac{1}{3}$ ✓
 12) $\frac{5}{6} \times \frac{1}{3} = \frac{5}{18}$ ✓

Teacher's notes

- converts between mixed numbers and improper fractions
- finds common denominators
- adds, subtracts, multiplies and divides fractions

Next steps

- experiment with different methods and develop efficient methods for calculating with fractions
- use similar methods to simplify expressions involving algebraic fractions

Assessment focus

Algebra

Context

Homework: In a unit on algebraic manipulation, pupils multiplied linear terms together to form quadratic expressions. They were also asked to identify any special cases.

Handwritten work on a whiteboard titled "multiplying brackets".

eg1) $(x+7)(x+4) = x^2 + 4x + 7x + 28$
 $= x^2 + 11x + 28$ ✓

obj; To be able to multiply brackets together to form a quadratic expression

eg2) $(x-3)(x+4) = x^2 + 4x - 3x - 12$
 $= x^2 + x - 12$

eg3) $(x+7)(x-9) = x^2 - 9x + 7x - 63$
 $= x^2 - 2x - 63$ ✓

eg4) $(x-3)(x-5) = x^2 - 5x - 3x + 15$
 $= x^2 - 8x + 15$ ✓

eg5) $(x+3)^2 = (x+3)(x+3) = x^2 + 3x + 3x + 9$
 $= x^2 + 6x + 9$ ✓

eg6) $(x+5)(x-5) = x^2 + 5x - 5x - 25$ ← "difference of two squares"
 $= x^2 - 25$

Teacher's notes

- finds the product of two linear expressions
- simplifies the resulting quadratic expressions
- identifies the difference of two squares as a special case

Next steps

- justify alternative methods (e.g. by relating this method to a multiplication grid)
- recognise patterns and relationships between linear expressions, coefficient of x and the constant term
- multiply expressions where the coefficient of x is not equal to 1
- explore links between algebraic and graphical representations of quadratic expressions
- extend to solving quadratic equations

Assessment focus

Algebra

Context

Classwork: A series of lessons on using formulae from mathematics and other subjects. These exercises required pupils to substitute into formulae and solve the resulting equations.

Handwritten student work on grid paper showing algebraic calculations:

$$i) C = 20 + \frac{1}{2}m$$

$$44 = 20 + \frac{1}{2}m$$

$$m = 48 \text{ miles}$$

$$ii) 82 = 20 + \frac{1}{2}m$$

$$m = 124 \text{ miles}$$

$$c) 228 = 20 + \frac{1}{2}m$$

$$m = 400 \text{ miles}$$

$$d) 32 = 20 + \frac{1}{2}m$$

$$m = 24 \text{ miles}$$

$$E) 160 = 20 + \frac{1}{2}m$$

$$m = 180 \text{ miles}$$

Ex 5g

$$1a) S = 0 \times 2 + \frac{1}{2} \times 10 \times 2^2$$

$$S = 0 + \frac{1}{2} \times 10 \times 4$$

$$S = 0 + 20$$

$$S = 20 \checkmark$$

$$b) S = 10 \times 5 + \frac{1}{2} \times 10 \times 5^2$$

$$S = 50 + 125$$

$$S = 175 \checkmark$$

Teacher's notes

- substitutes values and calculates correctly
- calculates accurately using mental methods and a calculator as appropriate
- solves equations

Next steps

- use equations of motion to solve a range of problems
- use formulae involving powers and more complex calculations
- use units consistently
- link equations with graphical representations

What the teacher knows about Pupil V's attainment in number and algebra

Pupil V has a good understanding of ratio and proportion in a range of contexts including ratios expressed using different units. He uses fractions and decimals to calculate quantities in problems on proportionality. He uses simple decimal equivalents to calculate percentage increase and decrease and to calculate the original amount prior to a proportional change, for example, when calculating the original price of an item costing £15 after a 15% reduction he calculated $15 \div 0.85$.

Pupil V uses mental, written and calculator methods when substituting into formulae and calculating in other areas of mathematics. He has a good grasp of methods for adding, subtracting, multiplying and dividing fractions. He simplifies calculations using common factors and multiples. He understands that dividing by numbers less than one increases the size of the original number. With decimals he used an example of multiples of 0.5 to explain 'Two 0.5s make one and so when you divide it's bigger'. His explanation with fractions referred to the relationship between dividing by a fraction and multiplying by its reciprocal, which is greater than one when the fraction is between zero and one.

Pupil V uses a calculator appropriately, recognising that rounding too soon if there is more than one step in a calculation can result in accuracy errors.

Pupil V manipulates algebraic expressions using a range of methods. When shown a dissection of a rectangle showing the difference of the two squares he proved that the statement is true for all positive numbers. Pupil V solves simultaneous equations algebraically when it is straightforward to eliminate or equate one variable.

Pupil V makes good use of a graphing calculator. He uses a range of functions including 'trace' and 'zoom' to explore properties of functions and find intersection points. He has plotted simple quadratic and cubic graphs and is beginning to understand the effects of the coefficients on the shape of a curve.

When investigating quadratic sequences Pupil V recognised that the second difference is constant and went on to work out that the coefficient of x -squared is half the second difference. He finds n th terms using a difference method because he understands the underlying patterns. Working on the 'maxbox' problem, for example, he generated a function and maximised the volume by linking together work on sequences and skills on the graphing calculator.

Summarising Pupil V's attainment in number and algebra

Pupil V's attainment in number and algebra is best described as secure level 7. To progress further and give evidence for high level 7, Pupil V should demonstrate understanding of problems that extend proportional thinking beyond direct, linear relationships. He needs to use estimation and approximation more consistently to support and check calculations and extend calculator skills, for instance use of the memory. In algebra, he should explore further the links with numerical and graphical representations, for example when multiplying linear expressions. He needs to continue developing and refining methods for solving simultaneous equations.

Assessment focus

Numbers and the number system; Shape, space and measures

Context

Classwork: In a unit on proportionality pupils were given opportunities to make links between geometry and number. The introductory activity was to identify and use similarity and scale factors given dimensions of a painting and a corresponding photograph.

scale and scale drawing

obj: To find the scale factors used in scale drawings and write as a representative fraction

Calculating scale factor.

$\text{Height} = 90\text{cm}$
 $\text{Photo} = 10\text{cm}$
 $\therefore \text{scale} = 1 : \frac{90}{10} = 1 : 9$

$\text{Height} = 42$
 $\text{Photo} = 7$
 $\therefore \text{scale} = 1 : \frac{42}{7} = 1 : 6$

$\text{Height} = 84$
 $\text{Photo} = 7$
 $\therefore \text{scale} = 1 : \frac{84}{7} = 1 : 12$

$\text{Height} = 65$
 $\text{Photo} = 5$
 $\therefore \text{scale} = 1 : \frac{65}{5} = 1 : 13$
 $\therefore \text{width} = 52\text{cm}$

$0.75 \div 3 = 0.25$

Teacher's notes

- Identifies similar shapes
- Calculates scale factors from measurements
- Uses similarity and ratios to calculate unknown dimensions

Next steps

- Develop more efficient methods based on understanding of multiplicative relationships
- Investigate angles in similar shapes
- Explore the relationship between scale factors for length, area and volume

Assessment focus

Shape, space and measures; Using and applying mathematics

Context

Classwork: Towards the end of a unit on geometrical reasoning pupils selected the appropriate methods to use to solve a range of multi-step problems.

$C^2 = A^2 + B^2$
 $169 = a^2 + 25$
 $a^2 = 169 - 25$
 $a^2 = 144$
 $a = \sqrt{144}$
 $a = 12$
 $E, F = 3$

Teacher's notes

- Selects appropriate methods and communicates clearly
- Solves multi-step problems requiring Pythagoras' theorem
- Calculates accurately using mental and calculator methods

Next steps

- Consolidate accuracy and use of conventional notation (e.g. EF not E,F)
- Use Pythagoras in a wider range of problems
- Begin to use trigonometric ratios

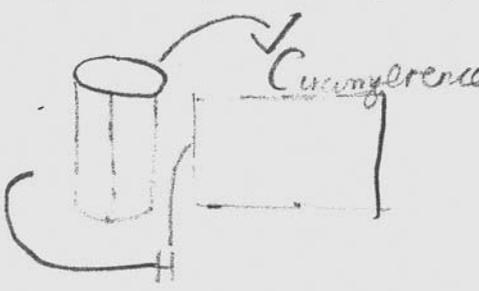
Assessment focus

Shape, space and measures

Context

Classwork: At the beginning of a unit on mensuration of shapes pupils worked in pairs to calculate the surface area of right prisms and cylinders.

calculating the surface area of a cylinder



eg, A tin is 8 cm high
and has a radius of
5 cm. calculate.

① $C = \pi \times d$
 $C = \pi \times 10 \text{ cm}$
 $C = 31.4 \text{ cm}$

② area of rectangle = 8×31.4
 $= 251.2 \text{ cm}^2$

③ area of circle = $\pi \times r^2$
 $= 3.14 \times 25 = 78.5$

④ area of both circles = $78.5 \times 2 =$
 $= 157 \text{ cm}^2$

Teacher's notes

- Uses 2-D representations of 3-D shapes
- Uses the formula for circumference and area of a circle
- Calculates surface areas of compound shapes

Next steps

- Derive a formula for the surface area of a prism and cylinder.
- Consider a range of situations in geometric and algebraic form
- Develop more accurate and efficient calculator methods, using the π key, and avoiding premature rounding

What the teacher knows about Pupil V's attainment in shape, space and measures

Pupil V uses Pythagoras' theorem to solve problems in two and three dimensions. He draws on a wide range of geometrical knowledge to solve multi-step problems in different shape contexts, for example areas and surface areas of plane shapes and solids. When working in three dimensions he visualises the situation and draws 2-D projections to help solve the problem. In the unit on mensuration of shapes, Pupil V independently reasoned that the length of the curved side of the rectangle was equal to the circumference of the circle and used this to derive a formula for finding the surface area of any cylinder.

Pupil V understands scale factors and similarity. He links his knowledge of enlargement to real situations. He worked with a small group to investigate the proportions of metric paper sizes and confirmed by measurement that all the standard sizes are enlargements of each other.

Pupil V uses units accurately. In the unit using formulae from other subjects he explained why metres per second and miles per hour are both units for speed by referring to the standard formula. He also understands other compound measures such as density and links them with the concept of direct proportion.

Summarising Pupil V's attainment in shape, space and measures

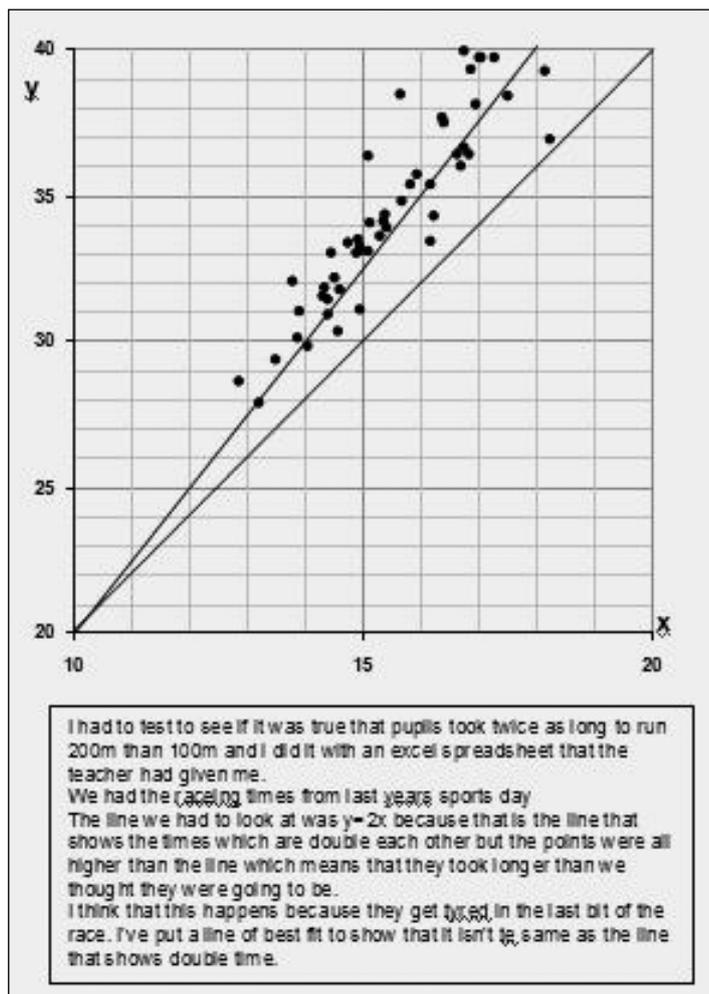
Pupil V's teacher judges his attainment in shape, space and measures to be secure level 7. To make further progress within the level he should explore the locus of a point that moves according to a given rule and extend this to relate to work on constructions. He needs to enlarge 2-D shapes from a centre of enlargement. He should also work on a range of problems involving accuracy of measurement and begin to link this to the idea of upper and lower bounds.

Assessment focus

Using and applying mathematics; Handling data

Context

Classwork: In a unit on statistical problem solving, pupils were asked to test the hypothesis that the times to run a 200m race are double the times to run 100m. They used real data from a sports day and a spreadsheet program to plot and analyse their results.



Teacher's notes

- Processes and represents the data using ICT
- Draws line of best fit by eye and using algebraic functions ($y = 2x$, $y = 2.5x + c$)
- Interprets graphs and diagrams
- Communicates results and discusses how data relates to a problem

Next steps

- Derive parameters for the line of best fit from the data set
- Explore the trend line function on the spreadsheet
- Suggest a hypothesis to test using another data set

Assessment focus

Handling data

Context

Classwork: In a unit on probability pupils were shown how to use the random and integer functions and the *countif* statement in the spreadsheet program to simulate the throwing of a dice. They were asked to compare theoretical and experimental distributions of the outcomes.

Throws	10	20	30	40	50	100	1000
Number of 6	2	3	3	7	8	18	173
relative frequency	0.20000	0.15000	0.10000	0.17500	0.16000	0.18000	0.17300
	5	5	1	2	5	1	1
	5	4	4	1	2	5	3
	1	4	5	1	5	4	6
	1	3	6	2	3	2	6
	1	5	2	1	2	2	2
	5	6	3	4	4	6	5
	6	3	2	4	4	1	5
	1	1	5	2	5	5	4
	6	2	2	5	4	3	3
	2	4	2	2	1	1	5
		3	3	1	2	6	6
		4	5	6	6	4	6
		6	1	1	2	1	6
		1	1	4	1	1	2
		4	2	4	5	1	3
		6	3	4	2	6	6
		5	3	4	6	3	5
		1	2	1	2	5	2
		2	6	4	5	6	5
		2	6	1	2	1	3
			4	4	2	6	5
			1	6	6	5	3
			1	2	5	3	4
			3	3	1	4	5
			1	2	4	1	1

Throwing the dice 1000 times gives a result that is more often closer to the real probability of 0.166666666666.... This is because you are doing the experiment more times. If you threw the dice twice you could get two sixes really easily but that doesn't mean that your certain of getting two sixes.

Teacher's notes

- Generates data using ICT
- Processes the data to calculate relative frequencies of the outcome 'six'
- Uses relative frequency to compare outcomes
- Comments on results and relates them to the original problem

Next steps

- Explore the relative frequency of all outcomes
- Use bar charts to represent the distributions

What the teacher knows about Pupil V's attainment in handling data

Pupil V plans surveys carefully, avoiding bias by choosing samples across the largest available population. He uses a range of data diagrams and statistics to compare data sets, using the whole distribution when appropriate.

Pupil V transfers his algebraic skills to the context of data handling. When using the sports day data he explained that the points above the line $y = 2x$ would represent runners that had longer times in the 200m than the hypothesis predicted. He said that the line of best fit was steeper than $y = 2x$ and would have an equation similar to $y = 2.5x + c$.

Pupil V uses ICT to progress a statistical enquiry. For instance, he compared the distance jumped by Year 7 and Year 9 pupils using the data from the sports day. This involved grouping the data and finding estimates of the mean and median distances.

Pupil V understands the use of the probability scale and that the probabilities of mutually exclusive events sum to one. He uses percentages, fractions and decimals efficiently and accurately while solving probability problems. He understands that increasing the number of trials results in a better estimate of the theoretical probability. For example, in the dice throw simulation he commented that there was less variation in the relative frequency of the 1000 throw experiment than those with fewer throws and that this was to be expected.

Summarising Pupil V's attainment in handling data

Pupil V's attainment in handling data is best described as secure level 7. To consolidate this further he should develop methods for calculating probabilities of compound events. He also needs more opportunities to suggest problems to investigate and to justify the choice of statistical representation.

What the teacher knows about Pupil V's attainment in using and applying mathematics

Pupil V makes links between new problems and situations he has come across before. He selects an appropriate approach to tackle a problem. For instance, he has used knowledge of functions to plot lines of best fit in statistics. He has generated his own formulae to find the surface area of a cylinder.

Pupil V gives reasons for his choice of presentations. He gives convincing oral explanations to answer probing questions. For example, when investigating the optimum volume in 'Max Box' he explained how to create a function for the volume. He also explained how to use the graph of the function to find the maximum volume.

Pupil V justifies generalisations by referring to the structure of the situation. When calculating the total surface area of cylinders he explained that, 'It's always got two circles so it must be two pi r-squared'. When discussing results with his teacher or peers, Pupil V tends to rely on experimental evidence to justify a result. For instance in the 'maxbox' problem he repeated the same set of calculations and procedures for different starting squares.

Summarising Pupil V's attainment in using and applying mathematics

Pupil V's teacher judges his attainment in using and applying mathematics to be secure level 7. His reasoning and oral communication are particularly strong. To make further progress within the level he needs opportunities to develop his written communication further. He should also apply his mathematics to prove why certain rules are always true. For example, he could be given a jumbled-up proof of Pythagoras' theorem using similar triangles and put them in order.

Pupil name.....Class/group.....Date.....

	Using and applying mathematics	Numbers and the number system	Calculating	Algebra	Shape, space and measure	Handling data
Level 7	<ul style="list-style-type: none"> solve increasingly demanding problems and evaluate solutions; explore connections in mathematics across a range of contexts; number, algebra, shape, space and measures; and handling data; refine or extend the mathematics used to generate fuller solutions give reasons for choice of presentation, explaining selected features and showing insight into the problems structure justify generalisations, arguments or solutions appreciate the difference between mathematical explanation and experimental evidence 	<ul style="list-style-type: none"> understand and use proportionality 	<ul style="list-style-type: none"> calculate the result of any proportional change using multiplicative methods understand the effects of multiplying and dividing by numbers between 0 and 1; add, subtract, multiply and divide fractions make and justify estimates and approximations of calculations; estimate numbers to one significant figure and multiplying and dividing mentally use a calculator efficiently and appropriately to perform complex calculations with numbers of any size, knowing not to round during intermediate steps of a calculation 	<ul style="list-style-type: none"> square a linear expression, and expand and simplify the product of two linear expressions of the form $(x + a)(x + b)$ and simplify the corresponding quadratic expression use algebraic and graphical methods to solve simultaneous linear equations in two variables solve inequalities in one variable and represent the solution set on a number line use formulae from mathematics and other subjects; substitute numbers into expressions and formulae derive a formula and, in simple cases, change its subject find the next term and nth term of quadratic sequences and functions and explore their properties plot graphs of simple quadratic and cubic functions, e.g. $y = x^2$, $y = 3x^2$, $y = 4x - x^2$ 	<ul style="list-style-type: none"> understand and apply Pythagoras' theorem when solving problems in 2-D calculate lengths, areas and volumes in plane shapes and right prisms enlarge 2-D shapes, given a centre of enlargement and a fractional scale factor, on paper and using ICT; recognise the similarity of the resulting shapes find the locus of a point that moves according to a given rule, both by reasoning and using ICT recognise that measurements given to the nearest whole unit may be inaccurate by up to one-half of the unit in either direction understand and use measures of speed (and other compound measures such as density or pressure) to solve problems 	<ul style="list-style-type: none"> suggest a problem to explore using statistical methods, frame questions and raise conjectures; identify possible sources of bias and plan how to minimise it select, construct and modify, on paper and using ICT suitable graphical representation to progress an enquiry including frequency polygons and lines of best fit on scatter graphs estimate the mean, median and range of a set of grouped data and determine the modal class, selecting the statistic most appropriate to the line of enquiry compare two or more distributions and make inferences, using the shape of the distributions and measures of average and range understand relative frequency as an estimate of probability and use this to compare outcomes of an experiment examine critically the results of a statistical enquiry, and justify the choice of statistical representation in written presentation
Level 6	<ul style="list-style-type: none"> solve problems and carry through substantial tasks by breaking them into smaller, more manageable tasks, using a range of efficient techniques, methods and resources, including ICT; give solutions to an appropriate degree of accuracy interpret, discuss and synthesise information presented in a variety of mathematical forms present a concise, reasoned argument, using symbols, diagrams, graphs and related explanatory texts use logical argument to establish the truth of a statement 	<ul style="list-style-type: none"> use the equivalence of fractions, decimals and percentages to compare proportions 	<ul style="list-style-type: none"> calculate percentages and find the outcome of a given percentage increase or decrease divide a quantity into two or more parts in a given ratio and solve problems involving ratio and direct proportion use proportional reasoning to solve a problem, choosing the correct numbers to take as 100%, or as a whole add and subtract fractions by writing them with a common denominator; calculate fractions of quantities (fraction answers); multiply and divide an integer by a fraction 	<ul style="list-style-type: none"> use systematic trial and improvement methods and ICT tools to find approximate solutions to equations such as $x^2 + x = 20$ construct and solve linear equations with integer coefficients, using an appropriate method generate terms of a sequence using term-to-term and position-to-term definitions of the sequence, on paper and using ICT; write an expression to describe the nth term of an arithmetic sequence. plot the graphs of linear functions, where y is given explicitly in terms of x; recognise that equations of the form $y = mx + c$ correspond to straight-line graphs construct functions arising from real-life problems and plot their corresponding graphs; interpret graphs arising from real situations 	<ul style="list-style-type: none"> classify quadrilaterals by their geometric properties solve geometrical problems using properties of angles, of parallel and intersecting lines, and of triangles and other polygons identify alternate and corresponding angles; understand a proof that the sum of the angles of a triangle is 180° and of a quadrilateral is 360° devise instructions for a computer to generate and transform shapes and paths visualise and use 2-D representations of 3-D objects enlarge 2-D shapes, given a centre of enlargement and a positive whole-number scale factor know that translations, rotations and reflections preserve length and angle and map objects onto congruent images use straight edge and compasses to do standard constructions deduce and use formulae for the area of a triangle and parallelogram, and the volume of a cuboid; calculate volumes and surface areas of cuboids know and use the formulae for the circumference and area of a circle 	<ul style="list-style-type: none"> design a survey or experiment to capture the necessary data from one or more sources; design, trial and, if necessary, refine data collection sheets; construct tables for large discrete and continuous sets of raw data, choosing suitable class intervals; design and use two-way tables select, construct and modify, on paper and using ICT: <ul style="list-style-type: none"> pie charts for categorical data bar charts and frequency diagrams for discrete and continuous data simple time graphs for time series scatter graphs and identify which are most useful in the context of the problem find and record all possible mutually exclusive outcomes for single events and two successive events in a systematic way know that the sum of probabilities of all mutually exclusive outcomes is 1 and use this when solving problems communicate interpretations and results of a statistical survey using selected tables, graphs and diagrams in support
BL	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
IE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Key: BL-Below Level IE-Insufficient Evidence

Overall assessment (tick one box only)

Low 6

Secure 6

High 6

Low 7

Secure 7

High 7

Audience: Secondary mathematics subject leaders

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