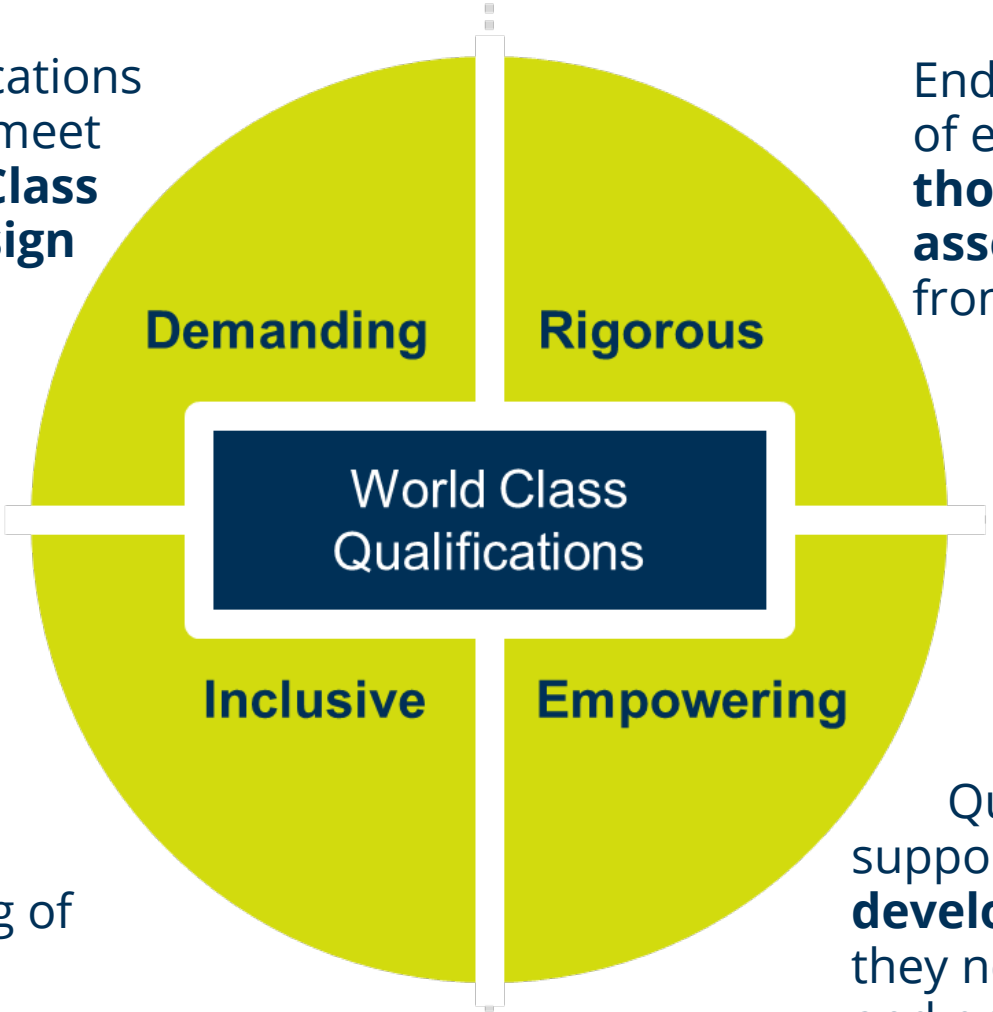
PEARSON EDEXCEL INTERNATIONAL GCSE (9-1)

Understanding assessment and improving delivery in International GCSE Maths A (Module 1)

First teaching in 2017, first assessment in 2018.

World-class qualifications

All Edexcel qualifications are developed to meet Pearson's **World Class Qualification design principles**



Endorsement of educational **thought-leaders and assessment experts** from across the globe

Developed using an understanding and benchmarking of **all educational systems**

Qualifications that support young people to **develop the capabilities** they need to **progress** and prosper in their lives

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Session Agenda

10:00 Introductions and protocols

10:05 What assessment objectives are:

. the assessment structure of Edexcel International GCSE papers.

explanation of terms by exemplars of typical questions Activity 1

10:30 How assessment objectives work. Activity 2, Activity 3

11:00 Introduction to Mathematical reasoning and problem solving Activity 4

11.30 Problem Solving in depth - Background and Exemplars Activity 5

12:00 Finish:

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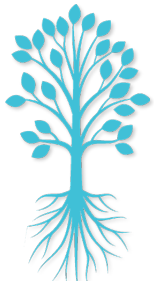
Aims and objectives

- Delegates will:

1. be introduced to the idea of assessment objectives: what are they and why they are used when writing examination papers,

2. analyse recent question papers and learn which types of question match the different assessment objectives,

3. understand the theoretical underpinning of assessment objectives applied to our International GCSE papers



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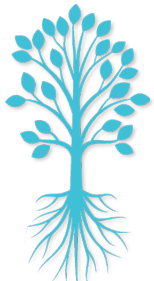
Polls to get to know the delegates.



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Structure of an Assessment

The purpose of an assessment is to measure one or more CONSTRUCTS.

An alternative name for a CONSTRUCT is a LATENT VARIABLE.

Constructs represent the underlying representations that a person has of his/her world.

In our case this is the world of mathematics.

Structure of an Assessment

A construct in mathematics can be thought of as a collection of objects together with rules for operating on them .

For example, the set of whole numbers and addition or the relation ‘is greater than’.

Constructs are closely related to CONCEPTS in mathematics.
They are abstractions that enable us to understand and interact with the real world.

Structure of an Assessment

Constructs are closely related to CONCEPTS in mathematics.
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Students who are ‘good’ at mathematics have :

Structure of an Assessment

Constructs are closely related to CONCEPTS in mathematics.
They are abstractions that enable us to understand and interact with the real world.

Students who are ‘good’ at mathematics have :

- a good knowledge of the underlying ‘objects’ of mathematics
- the ability to use rules for ‘interacting’ or transforming these objects
- the insight to use mathematical concepts to solve abstract problems
- the skill of being able to use mathematics when modelling the real world

Structure of an Assessment

The **key task** of an assessment in mathematics is to measure a student's ability in mathematics.

This means producing a mechanism which enables the student **to demonstrate** their ability to express these mathematical constructs.

Possible mechanisms by which this can be done include:

Discussion with the student / guided problem solving

Coursework or extended problem solving

Written examinations/ tests.

Structure of an Assessment

A written test seeks to measure student's ability (in mathematics) by requiring them to **demonstrate** their knowledge of mathematical facts and their ability to work with mathematical concepts.

In Edexcel examinations this means that the specification includes details of:

the mathematical facts and skills that have to be learned

Content

the way(s) in which the student will have to demonstrate what they have learned.

Assessment Objectives

Structure of an Assessment

Content

Facts

Techniques

Relationships

Assessment Objectives

Demonstrate knowledge of facts, techniques and relationships (**DO IT)**

Demonstrate application of facts, techniques and relationships to solve problems **(SOLVE IT)**

Demonstrate mathematical reasoning by using application of facts, techniques and relationships to solve problems **(SHOW IT)**

In outline this is the Edexcel International GCSE scheme.

Structure of an Assessment

Content	
Facts	$y^2 = y \times y$
Techniques	Use the formula to solve $x^2 + x - 7 = 0$
Relationships	If $x > y$ and $y > z$ then $x > z$

Structure of an Assessment

Content coverage
- sufficient for each separate assessment (samples from (nearly) all sections of the content list)
- complete coverage over a cycle of assessments

Assessment Objectives
- fixed from assessment to assessment
- same weightings from assessment to assessment (some leeway allowed)

Structure of the Edexcel Assessment

Assessment Objective	Demonstrate knowledge, understanding and skills in	Percentage
AO1	number and algebra: • numbers and the numbering system • calculations • solving numerical problems • equations, formulae and identities • sequences, functions and graphs.	60 ± 3
AO2	shape, space and measures: • geometry and trigonometry • vectors and transformation geometry.	25 ± 3
AO3	handling data: • statistics • probability.	15 ± 3

In outline this is the Edexcel International GCSE scheme.

Structure of the Edexcel Assessment

Sitting with these weightings are the higher order skills of:

- Mathematical problem solving
- Mathematical reasoning and argument

These are not ‘add-ons’ but are embedded in the 3AOs.

Structure of the Edexcel International GCSE assessment – all papers

All figures in the following table are expressed as marks out of 100.

	AO1	AO2	AO3	Problem Solving	Mathematical Reasoning
1F	60	25	15	25	15
2F	60	25	15	25	15
1H	60	25	15	30	20
2H	60	25	15	30	20

Specification 4MA1

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Structure of the Edexcel International GCSE assessment – all papers

All figures in the following table are expressed as percentages of the final maximum mark for the exam.

	AO1	AO2	AO3	Problem Solving	Mathematical Reasoning
1H	20	10	3	30	20
2H	40	20	6	30	20

Specification 4MB1 Paper 2 (max 100 marks) accounts for two thirds and paper 1 (max 100 marks) accounts for one third of the assessment

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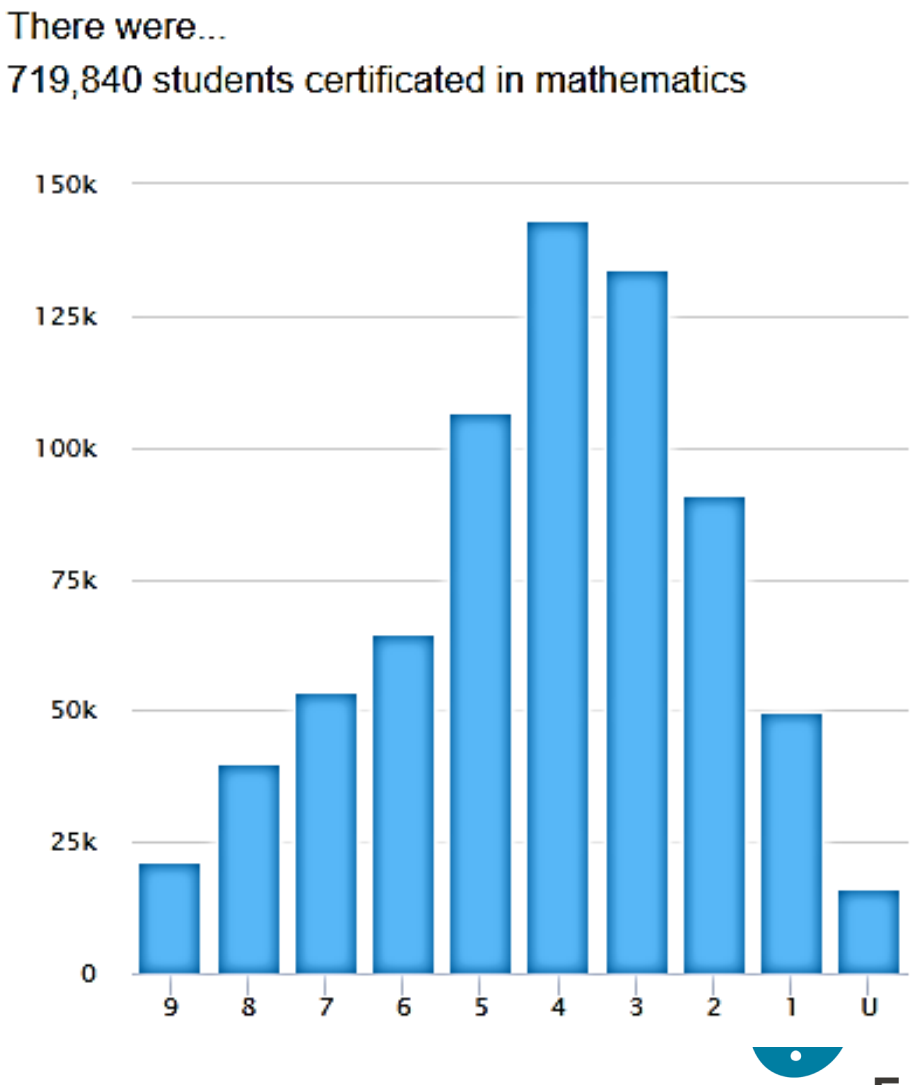
Structure of the Edexcel International GCSE assessment – all papers

Combinations of suitable content, assessment objectives and demand can lead to outcomes like this:

https://analytics.ofqual.gov.uk/apps/GCSE/9to1/



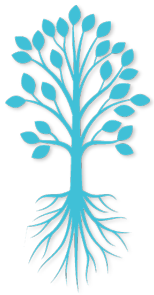
The assessment objectives for International GCSE are described in terms of content and mathematical processes

AO1 Demonstrate knowledge, understanding and skills in number and algebra:

- numbers and the numbering system
- calculations
- solving numerical problems
- equations, formulae and identities
- sequences, functions and graphs.

More number than algebra at F tier

More algebra than number at H tier



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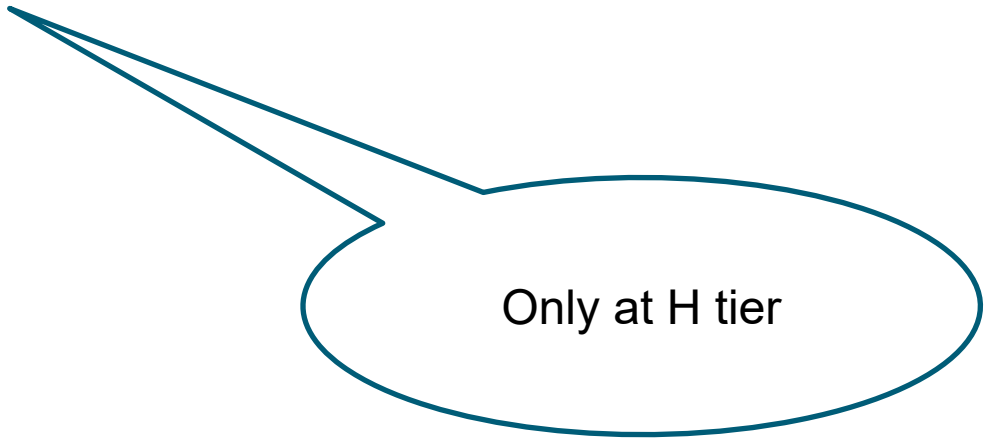
The assessment objectives for International GCSE are described in terms of content and mathematical processes

AO2 Demonstrate knowledge, understanding and skills in shape, space and measures:

- geometry and trigonometry
- transformation geometry
- vectors



The assessment objectives for International GCSE are described in terms of content and mathematical processes

AO3 Demonstrate knowledge, understanding and skills in

- statistics
- probability

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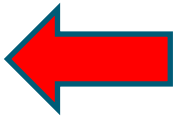
Some examples of ‘knowledge’

Knowledge - know facts and definitions.

Know (standard) processes

Some examples of ‘knowledge’

Knowledge - know facts

y^2 means $y \times y$  This is a definition

In the evaluation of $3 \times (6 + 4)$ the expression inside the brackets has to be worked out first.

The sum of the angles around a point is 360^o This is a fact

The range of a set of measurements is the difference between the largest and the smallest

This is a definition

Some examples of ‘knowledge’

Knowledge - processes 15% of \$60 → 60 ÷ 100 = 0.60 and 0.60 × 15 = 9

15% of \$60 → 15 ÷ 100 = 0.15 and 0.15 × 60 = 9

Solve $4y - 3 = 8 - y$

$4y + y = 8 + 3$

$5y = 11$

$y = 11/5$

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Some examples of ‘knowledge’

Knowledge - processes

Expand and simplify $(2y + 1)(y – 3)(y + 2)$

One approach is $(y – 3)(y + 2) = y^2 – y – 6$

$(2y + 1)(y^2 – y – 6) = 2y^3 – 2y^2 – 12y + y^2 – y – 6$

$2y^3 – y^2 – 13y – 6$

Some examples of ‘knowledge’

Knowledge - processes

Work out the size of the internal angle of a regular decagon

One approach is $360 \div 10 = 36$
followed by $180 - 44 = 144$

Of course the direct approach is also possible.

Some examples of ‘knowledge’

Knowledge - processes

The mean height of the 12 girls in a class is 160 cm
The mean height of the 18 boys in the class is 170 cm

Total height of all the girls is 12 × 160 = 1920 cm
Total height of all the boys is 18 × 170 = 3060 cm
Total height of all the students = 3060 + 1920 = 4980 cm

Total number of students = 12 + 18 = 30

Mean height of all the students = 4980 ÷ 30 = 166 cm

Some examples of ‘knowledge’

Knowledge - processes

The mean height of the 12 girls in a class is 160 cm
The mean height of the 18 boys in the class is 170 cm

Quote and use $\dfrac{ma+nb}{m+n}$

AO1, AO2 and AO3 questions

Activity 1

Look at the examples of student responses to questions in the 2020 4MA1 exam.

Use the mark scheme to mark the responses – the marks should tally with the success that the student has had with satisfying the assessment objective.

Once you have marked recorded the marks fill in the polls which will be shared anonymously.

Demonstrating ‘knowledge’ in exams when a modern calculator is allowed

Functionality of many inexpensive calculators

Demonstrating ‘knowledge’ in exams when a modern calculator is allowed

Functionality of many inexpensive calculators

Can carry out operations with fractions

Can write a number as a product of its prime factors

Can solve simultaneous equations when written in ‘usual’ form.

Can solve quadratic equations when written in ‘usual’ form

Can carry out operations with surds including rationalising the denominator

Can draw algebraic graphs

Demonstrating ‘knowledge’ in exams when a calculator is NOT allowed on a question

At International GCSE these are usually signalled by

‘Show’

‘Use algebra to’

‘You must show your working’

‘Show full algebraic working’

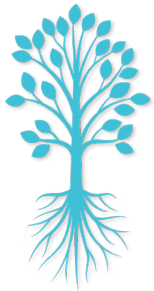
Demonstrating ‘knowledge’ in exams when a modern calculator is allowed

E.g. June 2FR 2019

Show that $5\frac{2}{3} - 2\frac{3}{4} = 2\frac{11}{12}$

E.g. June 1 FR and 1HR 2019

Write 720 as a product of its prime factors.
Show your working clearly.



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Demonstrating ‘knowledge’ in exams when a modern calculator is allowed

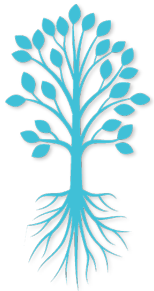
E.g. June 2FR 2019

Show that $5\frac{2}{3} - 2\frac{3}{4} = 2\frac{11}{12}$

(1) $\frac{17}{3} - \frac{11}{4}$

(2) $\frac{68}{12} - \frac{33}{12}$

(3) $\frac{35}{12} = 2\frac{11}{12}$



Demonstrating ‘knowledge’ in exams when a modern calculator is allowed

Solve the simultaneous equations

$$x + 2y = -0.5$$

$$3x - y = 16$$

Show clear algebraic working.

Solve the simultaneous equations

$$2x^2 + 3y^2 = 5$$

$$y = 2x + 1$$

Show clear algebraic working.

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Demonstrating ‘knowledge’ in exams when a modern calculator is allowed

Activity 2

Demonstrating ‘knowledge’ when solving a quadratic equation by using the formula or by completing the square.

- Complete the record sheet for the 6 student attempts.
- Does the attempt display knowledge of the process?

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Demonstrating ‘knowledge’ in exams when a modern calculator is allowed

Activity 2

Demonstrating ‘knowledge’ when solving a quadratic equation by using the formula or by completing the square.

- The philosophy is to reward application of the process(es)
- Accurate substitution
- Correct order of working out in a correct expression
- Correct roots BUT ONLY IF there is evidence of correct processes

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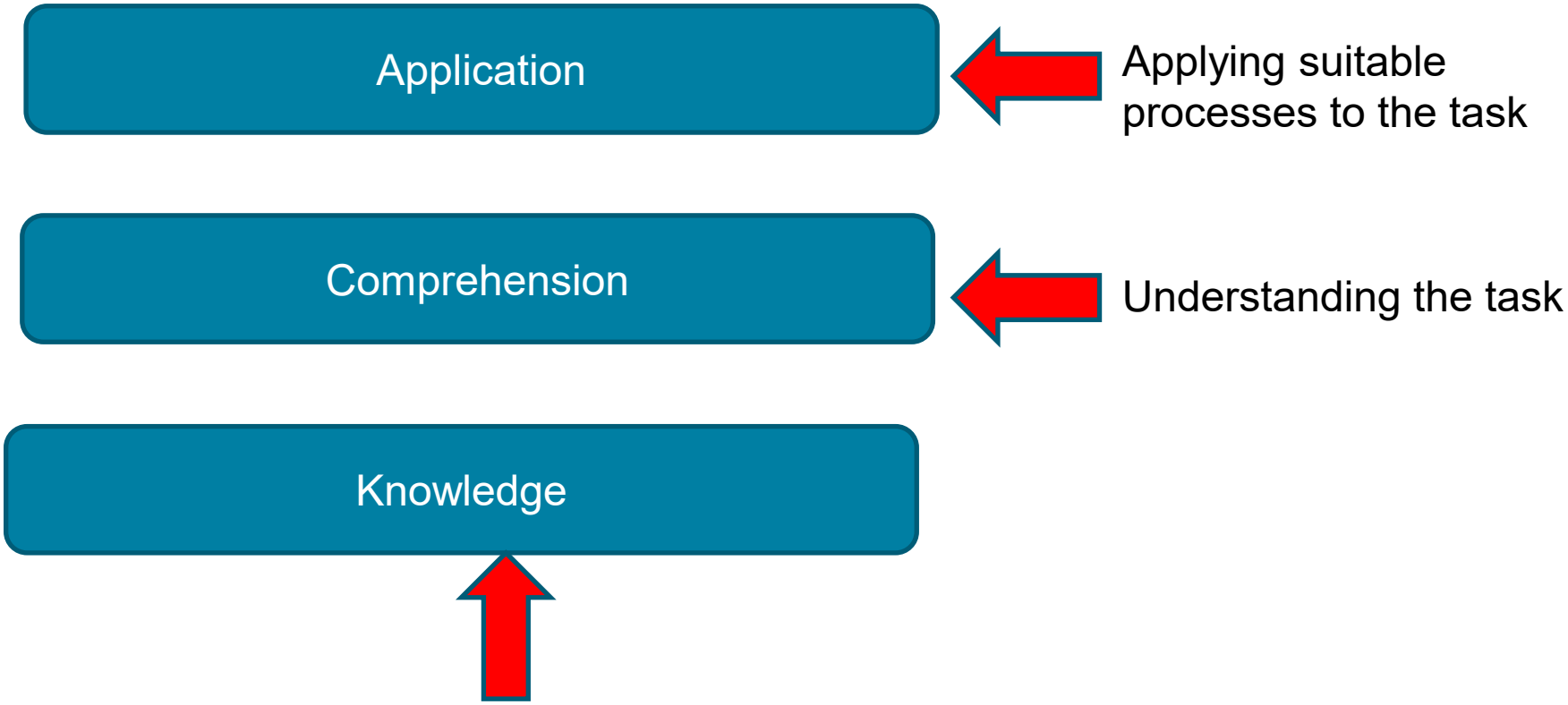
The theoretical underpinning of the assessment objectives for International GCSE



The theoretical underpinning of the assessment objectives for International GCSE

Knowledge

Remembering facts and processes for a task

observation and recall of information
knowledge of major ideas
mastery of subject matter

The theoretical underpinning of the assessment objectives for International GCSE

Knowledge

Remembering facts and processes for a task

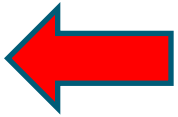
list, define, tell, describe, identify, show, label, collect, examine, tabulate, quote, name, who, when, where, etc.

These are general instruction words.
More specifically for maths we have……

Name, write down, simplify, solve

The theoretical underpinning of the assessment objectives for International GCSE

Comprehension

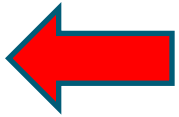


Understanding the task

understanding information
grasp meaning
translate knowledge into new context
interpret facts, compare, contrast
order, group, infer causes
predict consequences

The theoretical underpinning of the assessment objectives for International GCSE

Comprehension



Understanding the task

summarise, describe, interpret, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend

These are general instruction words. More specifically for maths we have……

Find!

The theoretical underpinning of the assessment objectives for International GCSE

Application

Applying suitable processes to the task

use information
use methods, concepts, theories in new situations
solve problems using required skills or knowledge

The theoretical underpinning of the assessment objectives for International GCSE

Application

Applying suitable processes to the task

apply, demonstrate, calculate, complete, illustrate, show, solve, examine, modify, relate, change, classify, experiment, discover

These are general instruction words. More specifically for maths we have……

Find!

The theoretical underpinning of the assessment objectives for International GCSE

Activity 3

Make a record of the demand words used in the two examination papers 4MA1/1FR and 4MA1/1HR (both Jan 2019)
(4MA1/1FR has already been done for you)

Write down any comments/ observations on your results.

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The theoretical underpinning of the assessment objectives for International GCSE

Activity 3

Make a record of the demand words used in the two examination papers 4MA1/1FR and 4MA1/1HR (both Jan 2019)

There appear to be a greater variety of command words at F

Both F and H have ‘Find’ and ‘Work out’ as the most frequent demand words

There are more ‘Work out’ than ‘Find’ at F tier
This reverses at H tier

Mathematical reasoning and problem solving in International GCSE mathematics

Mathematical reasoning -

make deductions
draw conclusions
present arguments and proofs
interpret information accurately
communicate results clearly

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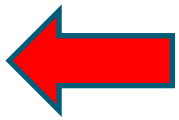
Mathematical reasoning and problem solving in Int GCSE mathematics

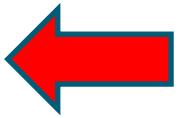
Problem solving -

translate a situation into suitable mathematical form –
then –
carry out a suitable (possibly sequence of) mathematical process(es)
then –
state the answer



There is some overlap between this and reasoning

Evaluation



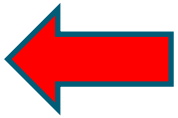
Not really present in examinations

Synthesis

Present arguments and proofs, make deductions and draw conclusions from mathematical information.

Analysis

Evaluation



Not really present in examinations

Synthesis

Translating a problem in a mathematical or non-mathematical context into a process or a series of mathematical processes and solve the problem.

Analysis

Problem solving in International GCSE mathematics

Some further comments on what are the properties of a mathematical problem. A mathematical problem:

Problem solving in International GCSE mathematics

Some further comments on what are the properties of a mathematical problem. A mathematical problem:

requires use of techniques from more than one content area

requires a succession of processes – but not just a standard set such as with simultaneous equations

is unfamiliar so there is no **obvious** standard method of solution

is in an unfamiliar context

requires translation to a form which allows suitable mathematical processes to be used to solve the problem.

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Problem solving in International GCSE mathematics

Some further comments on what are the properties of a mathematical problem.

So a question such as

Solve $2x + y = 6$

$2x^2 + y^2 = 66$

….would **NOT** normally be considered a mathematical problem, even though many students will find it difficult.

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Problem solving in International GCSE mathematics

Activity 4 Some examples – not problem solving

Write down, based on your own knowledge 3 questions suitable for F tier which you think are **not** examples of problem solving.
(but may not necessarily be done well)

Use Chat to answer

Then do the same for H tier

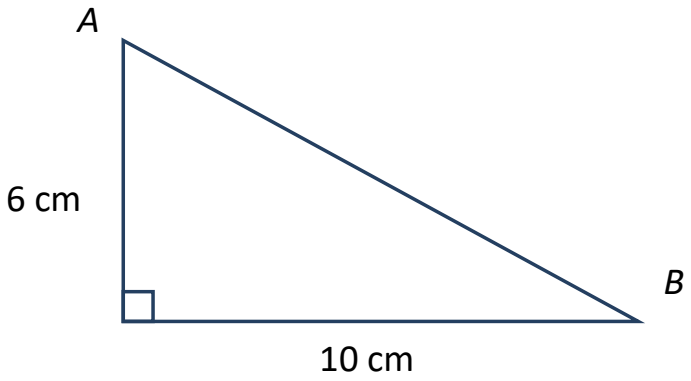
Problem solving in International GCSE mathematics

Activity 4 Some examples – not problem solving

A Solve $3(x – 4) = x + 8$ Show full algebraic working

B $A = \{3, 5,6, 8\}$, $B = \{2, 6, 7, 8\}$ List the members of the set $A \cap B$

C



Work out the length of *AB*.

Give your answer in cm correct to 2 decimal places.

D The table gives information about the time some students spent on doing homework each week.
Calculate an estimate of the mean.

Problem solving in International GCSE mathematics

Activity 4 Some examples – not problem solving

D The table below gives information about the times some students spent doing homework.

Time (t) hours	Frequency
$0 < t \leq 2$	2
$2 < t \leq 4$	5
$4 < t \leq 6$	12
$6 < t \leq 8$	15
$8 < t \leq 10$	18
$10 < t \leq 12$	6

Work out an estimate for the mean.

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Problem solving in International GCSE mathematics

Activity 4 Some examples – not problem solving

E Expand $(2x + 1)(x - 3)(2x + 5)$

F Rationalise the denominator of $\frac{\sqrt{2}}{2-\sqrt{2}}$

Give your answer in its simplest form.

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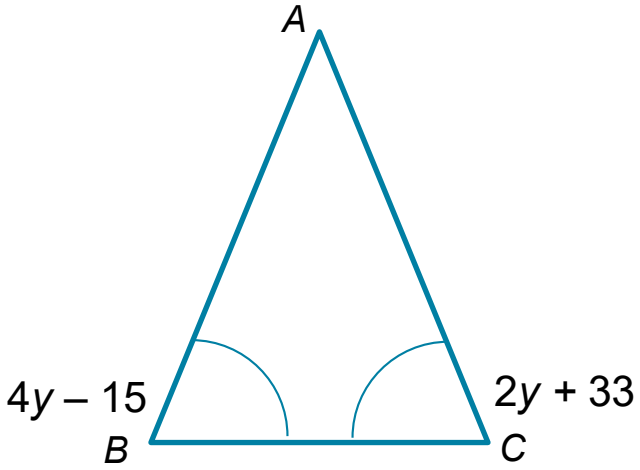
Problem solving in International GCSE mathematics

Translate a situation into suitable mathematical form



Triangle *ABC* is isosceles with *AB* = *AC*
Find the size of angle *BAC*

Base angles of an isosceles triangle are equal
Set up an equation.
Solve the equation
Work out angles *B* and *C*

$4y - 15 = 2y + 33$

Problem solving in International GCSE mathematics

Chen buys 120 watches for $50 each.
He sells 60% of the watches for $80 each.
He sells half the remaining watches for $60 each.
Any watches he still has left he sells for $50 each

Work out the percentage profit.

Problem solving in International GCSE mathematics

Chen buys 120 watches for $50 each.
He sells 60% of the watches for $80 each.
He sells half the remaining watches for $60 each.
Any watches he still has left he sells for $50 each

Work out the percentage profit.

Work out the income from the first 60%
Work out the income from the remainder
Work out the percentage profit

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Problem solving in International GCSE mathematics

Find the sum of all the multiples of 3 which are less than 1000

Problem solving in International GCSE mathematics

Find the sum of all the multiples of 3 which are less than 1000

First task – recognise this is a Q about arithmetic series
Second task – work out how many terms
Third task – work out the sum of the arithmetic series

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Problem solving in International GCSE mathematics

Activity 5

There are 5 questions from two January papers.
Work through the questions:

Make a decision of whether each question is a problem or not.

If it is a problem, decide on what aspects of the question makes it a problem.

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Problem solving in Int GCSE mathematics

Activity 5

There are 5 questions from two Jan papers.

Make a decision of whether each question is a problem or not
If it is a problem, decide on what aspects of the question makes it a problem.

A This had all 5 marks set against problem solving.

B This had none of the 6 marks set against problem solving; the question was very standard. The different approaches were different orderings in the calculations.

Problem solving in Int GCSE mathematics

Activity 5

There are 5 questions from two Jan papers.

Make a decision of whether each question is a problem or not
If it is a problem, decide on what aspects of the question makes it a problem.

C This had all 3 marks set against AO1 only. No problem solving marks

D 3 problem solving marks and 3 reasoning marks set against AO2

E 5 problem solving marks set against AO1 and AO2

Module_2

In module_1 we looked at AO1, AO2 and AO3, their theoretical justification and some examples of student's work

We also looked at what is a mathematical problem and some of the processes involved when students have to answer it.

In module_2 we shall be looking in detail at how questions assess mathematical reasoning with examples of students work from 4MA1 and 4MB1

We will also consider practical ways of teaching problem solving and mathematical reasoning

Lastly, we shall look at the support available to teachers at our centres

Contact your dedicated Subject Advisor

Subject Advisor details

Your subject advisor is **Graham Cumming**
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ALWAYS LEARNING