GCSE EXAMINERS' REPORTS

MATHEMATICS
GCSE

SUMMER 2023

Introduction

Our Principal examiners' reports offer valuable feedback on the recent assessment series. They are written by our Principal Examiners and Principal Moderators after the completion of marking and moderation, and detail how candidates have performed.

This report offers an overall summary of candidates' performance, including the assessment objectives/skills/topics/themes being tested, and highlights the characteristics of successful performance and where performance could be improved. It goes on to look in detail at each question/section of each unit, pinpointing aspects that proved challenging to some candidates and suggesting some reasons as to why that might be.[i]

The information found in this report can provide invaluable insight for practitioners to support their teaching and learning activity. We would also encourage practitioners to share this document – in its entirety or in part – with their learners to help with exam preparation, to understand how to avoid pitfalls and to add to their revision toolbox.

Further support

Document	Description	Link
Professional Learning / CPD	WJEC offers an extensive annual programme of online and face-to-face Professional Learning events. Access interactive feedback, review example candidate responses, gain practical ideas for the classroom and put questions to our dedicated team by registering for one of our events here.	https://www.wjec.co.uk/home/professional-learning/
Past papers	Access the bank of past papers for this qualification, including the most recent assessments. Please note that we do not make past papers available on the public website until 6 months after the examination.	www.wjecservices.co.uk or on the WJEC subject page
Grade boundary information	Grade boundaries are the minimum number of marks needed to achieve each grade. For unitised specifications grade boundaries are expressed on a Uniform Mark Scale (UMS). UMS grade boundaries remain the same every year as the range of UMS mark percentages allocated to a particular grade does not change. UMS grade boundaries are published at overall subject and unit level. For linear specifications, a single grade is awarded for the overall subject, rather than for each unit that contributes towards the overall grade. Grade boundaries are published on results day.	For unitised specifications click here: Results, Grade Boundaries and PRS (wjec.co.uk)

Exam Results Analysis	WJEC provides information to examination centres via the WJEC secure website. This is restricted to centre staff only. Access is granted to centre staff by the Examinations Officer at the centre.	www.wjecservices.co.uk
Classroom Resources	Access our extensive range of FREE classroom resources, including blended learning materials, exam walk-throughs and knowledge organisers to support teaching and learning.	https://resources.wjec.co.uk/
Bank of Professional Learning materials	Access our bank of Professional Learning materials from previous events from our secure website and additional pre-recorded materials available in the public domain.	www.wjecservices.co.uk or on the WJEC subject page.

Subject Officer's Executive Summary

The examination papers in GCSE Mathematics were generally of a similar standard to previous examination series. As is always the case, some questions were more demanding in some topics than in previous series, whereas others were less demanding. What was noticeable this summer was that, despite there being Advance Information for each unit, the performance of the candidates was relatively weak, when compared with examination series prior to the pandemic. It is clear that many candidates in year 11 this year have been severely impacted by the pandemic, and there are gaps in their knowledge and understanding, which then cause problems with more demanding topics and skills.

There are some areas of the subject content that are not well-understood year on year. This year was no exception. Topics such as bearings, converting metric and Imperial units, many algebra topics, writing numbers as fractions or percentages of other numbers, and perimeter, area and volume have a great need for improvement. Other topics that are specific to units and/or tiers are listed in the individual unit reports.

Similarly, there are skills that are also lacking across tiers, such as non-calculator methods, e.g. multiplying and dividing large numbers.

What is also evident is how little time many candidates spent learning facts and rules in preparation for these examinations. These include metric to Imperial conversions, formulae for perimeter, area and volume of shapes, and angle facts.

There was also evidence of candidates not using the calculators to their full potential on the calculator-allowed papers. There is a difference between showing your working and using non-calculator methods to carry out calculations. Candidates should remind themselves of this difference before taking these examinations.

Candidates are also reluctant to annotate diagrams to help them answer questions, e.g. marking missing lengths on diagrams in perimeter, area and volume questions.

There are some topics and skills that show some improvement compared with previous series or are generally well-answered by the candidates entered at each tier. These topics are listed at the start of the question analysis in the report for each unit.

In the table below, we have included some examples of topics that we have identified as being most in need of improvement. These are in addition to the topics listed in the Mathematics – Numeracy report. Those listed in that report (fractions, decimals and percentages; perimeter, area and volume; conversion of units) are also appropriate for GCSE Mathematics. It is also worth noting that there are many examples of algebraic topics that need improvement. You'll find many more resources on our resources website (see previous section).

Areas for improvement	Classroom resources	Brief description of resource
Linear equations	Mathematics - Educational Resources - WJEC solving-linear-equations-wjec.pdf	Algebra – knowledge organisers Knowledge organiser
	Linear equations and inequalities - Blended Learning	Blended learning lessons
Bearings (Angles)	Mathematics - Educational Resources - WJEC angles-wjec.pdf	Geometry and Measures – knowledge organisers Knowledge organiser
	Angles - Blended Learning	Blended learning lessons
Constructions	Mathematics - Educational Resources - WJEC constructions-wjec.pdf	Geometry and Measures – knowledge organisers Knowledge organiser
	Construction, loci, 2-D representations, coordinates - Blended Learning	Blended learning lessons

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Summer 2023

UNIT 1 FOUNDATION TIER

Overview of the Unit

This unit tested the content of the full specification, but an Advanced Information Notice was released to centres prior to the series, and this gave details of the topics that would be assessed in Unit 1.

The demand of the questions was comparable to those asked in previous papers and the paper was a suitable and fair test for the candidates at Foundation level. Later questions in the paper proved more challenging than the earlier ones, as is expected. Numerical inaccuracies caused candidates to lose marks, as did unsupported answers, which were incorrect.

Many candidates found some questions in the later part of the paper difficult to answer, particularly if there was a long explanation introducing it.

This paper was comparable in standard with those set in previous years.

Comments on individual questions/sections

When a question or part-question is not listed, there are no areas to highlight.

The following topics were generally well-understood or well-answered.

- Identifying place value.
- Reflecting a shape in a line.
- Plotting coordinates.
- Working out the perimeter of a rectangle.

Some candidates found operations using whole numbers difficult, particularly if multiplication tables were involved. (Questions 1(c), 1(e))

In Question 1(c), candidates who knew the standard way of setting out the calculation to divide 504 by 8 were usually more successful than those who didn't. Alternative methods were used including writing out all the multiples of 8 up to 504. Some candidates weren't sure how to deal with the 0 in the middle of 504.

In Question 1(e), candidates frequently knew the correct method to multiply 93 by 7 but did not know the necessary multiplication tables accurately.

Areas for improvement include:
- Multiplication tables.
- Method for multiplying two-digit numbers by one-digit numbers.
- Method for dividing a three-digit number by a one-digit number.

Some candidates found it difficult to draw or measure angles sufficiently accurately (Question 3) and to use parallel line facts (Question 17).

In Question 3(a), the angle to be measured is obtuse, consequently it had to be greater than 90°. Many wrongly gave the supplementary angle of 43° as their answer. Others gave their answer outside the acceptable range of 137°± 2°.
Learning the range of degrees for each type of angle should help candidates to recognise which side of the protractor to read the angle.

In Question 3(b), understanding that a line perpendicular to a given line must be drawn at 90° to the line made this a question about drawing an angle accurately. Many candidates found it difficult to draw their angle sufficiently accurately. Others drew horizontal lines.

In Question 17, knowledge of parallel lines theorems was needed to find to find the values of *a, b* and *c:* alternate angles, interior angles and then opposite angles at a vertex. There was a follow-through mark awarded if the value of *c* was given equal to the value of *b*, even if this was incorrect.

Areas for improvement include:
- Using a protractor to measure angles.
- The definitions of acute and obtuse angles and to be able to recognise what these should look like.
- The difference between perpendicular and parallel lines.
- Learning theorems for parallel lines and opposite angles at a vertex.

Some candidates found working with fractions, percentages, decimals and ratios difficult. (Questions 4(c), 11, 19)

In Question 4(c), to calculate 40% of 120, the most common successful method was to work out 10% of 120 = 12, and then to multiply 12 by 4. Incorrect methods included guessing that as 40% is a bit less than 50%, then the required answer is a bit less than half of 120, maybe 55 or 50. No marks were awarded for any of these answers using guesswork.

In Question 11, the three given quantities had to be expressed in the same form for direct comparison: fractions, percentages or decimals. Many didn't do this and seemed to just choose the ascending order randomly.

In Question 19(a), to express 48 as a percentage of 400, candidates needed to work out 48/400 and multiply that answer by 100. Very many candidates wrongly worked out 48% of 400.

In Question 19(b), to share £45 in the ratio 8 : 1, the number 45 needed to be divided by 8 + 1 = 9. Very many candidates wrongly divided 45 by 8. The answer to this is not an exact whole number and should have been an indication that an error might have been made.

In Question 19(c), some candidates worked out $½^3$ correctly as 1/8 but a frequent wrong answer was 1/6. A common subsequent wrong answer was 1 – 1/8 = 0/8.

Areas for improvement include:
- Finding a percentage of an amount.
- Converting fractions, percentages and decimals into the same form.
- Expressing a number as a percentage of another number.
- Evaluating powers of numbers.
- Subtracting a fraction from a whole number.

Some candidates found working with algebra difficult. (Questions 8, 13, 15)

In both parts of Question 8, some candidates thought they needed to substitute a number for the letters given in the questions. In 8(b) particularly, $20 - k$ was very frequently followed by the number 19. Many did not seem happy to leave the answer to include both a letter and a number. So the mark gained by correctly writing $20 – k$ was immediately lost by following it by a number.

In Question 13(a), many candidates reached $3x = 27$ but were unable to continue to find $x = 9$. Embedded answers ($3 × 9 – 10 = 17$) were accepted for full marks. However, there was a significant number who were unable to solve this type of equation correctly.

To answer Question 13(b), it was necessary to work out $6f + 2f = 8f$ and $– 4g – 9g = – 13g$. Then these had to be written together as the single expression $8f – 13g$ to be awarded B2. An answer of $8f + – 13g$ was awarded only B1. However, despite working out one of these, frequently candidates weren't able to work out the other one. Both parts caused difficulty for different candidates.
Many candidates did not seem to know that the sign immediately preceding a number or a letter is the sign for that number or letter.

The algebraic understanding demanded in Question 15 was very challenging for most candidates. As in Question 8, very many thought that a number only was required for the answer, omitting the letter n entirely from their answer. Those who did work out the expression for Nigel's age frequently left out the brackets and consequently were awarded 2 marks for $2 × n – 7$, instead of 3 marks.

Areas for improvement include:
- Forming expressions which include both letters and numbers.

Questions involving equivalence of units (Questions 5, 14)

Candidates did not appear secure in their knowledge of the conversion facts between different types of metric units as well as converting metric units to Imperial units. The most successful answer was Question 5(b), where 700 cm was converted to 7 m. The most challenging was changing 100 litres to pints. Candidates should be encouraged to learn the facts and then use the answer lines provided to use the fact that 1 litre ≈ 1·75 pints.

Areas for improvement include:
- Learning the equivalences between metric units of length, mass, capacity, area and volume.
- Learning the approximate equivalences 8 km ≈ 5 miles, 1 kg ≈ 2·2 lb, 1 litre ≈ 1·75 pints.

Individual questions which need commenting upon.

Question 6
This was the OCW question.
Candidates were generally able to make a good attempt at working out the total length of the rods though some needed to read the question more carefully as they worked with the wrong number of each rod.
For the OC mark, they needed to show clearly what they were doing by labelling their statements, in particular identifying which of Rod A or Rod B was being referred to. They needed to write a simple conclusion in words, e.g. Total length = 23 cm.
For the W mark, working needed to be seen in correct mathematical form, e.g.

3 × 5 + 4 × 2 = 15 + 8.This mark was lost if work such as 3 × 5 = 15 + 4 × 2 = 8 = 23 was seen. Units needed to be included in the final answer.

Question 7
The probability question described a bag containing 20 pieces of fruit. The probability scale was marked in tenths of which the third one represented apples. Some candidates stated that 0·3 apples were in the bag. Thinking that it was unlikely that there would be a fraction of an apple in a bag might have prompted them to realise that they needed to work out 0·3 × 20 to find the actual number of apples in the bag.

Question 9
In this question the candidates needed to draw a net of the given box, which had no lid. Very many drew a 3-dimensional diagram of the box instead of the net. If a net was drawn, occasionally the wrong dimensions of the rectangles were used.

Areas for improvement include:
- Learning how to draw a net of a cuboid

Question 10
Not all candidates remembered the correct order in which to plot the coordinates. Some reversed the coordinates in the given points and consequently lost 1 mark. The question asked for the perimeter of the drawn rectangle to be worked out. To do this, the lengths of the sides of the rectangle need working out and should be stated in the answer as 1 mark was awarded for them. Some confused perimeter with area and could gain the mark for the lengths of the sides of the rectangle only if they were clearly stated.

Areas for improvement include:
- Learning the correct order of coordinates.
- Learning the definitions of perimeter and area.
- Write down all the information that has been calculated for working out the answer.

Question 12
In this problem, candidates needed to think in a reverse direction from usual. The area of the rectangle was given as 80 cm^2 and its length and width needed to be calculated when the length was 5 times the width. Trial and improvement by testing pairs of values would have been a useful method at this level.

Question 16
To find the total of four numbers with a mean of 7, as needed in Question 16(a), the calculation 4 × 7 = 28 had to be done.
In Question 16(b), from part (a) the total of the set of four numbers to be found needed to be 28 with the extra condition that the range of these numbers was 6. Many candidates found it difficult to find a set of four numbers which satisfied both conditions. A follow-through mark was allowed for finding four numbers with the same total as their answer for (a).

Areas for improvement include:
- Knowing how to find the total of numbers with a given mean.
- Learning the definition of the range of a set of numbers.

Question 18
This was a challenging question for very many candidates who were unable to decide how to begin answering this question.
The possible results needed to be written out in a structured way:

E.g.	1+1	1+2	1+3	1+4
	2+1	2+2	2+3	2+4
	3+1	3+2	3+3	3+4

From this, the winning scores of 6 or more could be identified and labelled.
Few of those candidates who did attempt to answer this question were able to identify the winning scores and then to proceed to work out how many winning scores could be expected when the game was played 60 times. There were some follow-through marks available from their combinations, their number of winning scores and their probability.
A very common error was to multiply together the two numbers given in the question, i.e. 60×6 was seen and sometimes evaluated as 120 and sometimes as 360.

Areas for improvement include:

- Working out a strategy to answer a question which has a number of steps.
- Writing out all the possible outcomes of an experiment in a systematic way.
- Estimating the number of successes of an experiment.

Question 20
This question involved an anticlockwise rotation of 90° about the origin.
The correct answer was rarely seen. There were clockwise rotations of 90° about the origin or candidates drew a rotation in every quadrant. Even if a correct anticlockwise rotation was drawn, the shape was frequently drawn a square or two across from where it should be.
Tracing paper should be available, and candidates should be encouraged to use it.

Areas for improvement include:

- Learning the difference between clockwise and anticlockwise rotations
- Practising using tracing paper to help draw rotations.

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Summer 2023

UNIT 1 INTERMEDIATE TIER

Overview of the Unit

This unit tested the content of the full specification, but an Advance Information Notice was released to centres prior to the series, giving details of the topics that would be assessed on Unit 1.

Overall, the questions were comparable with those asked on previous papers that have been sat, and the paper was a suitable and fair test for the candidates at the Intermediate level. Some questions proved more challenging than others, whilst some candidates lost marks because of incorrect numerical evaluations or giving unsupported incorrect answers.

Comments on individual questions/sections

When a question or part-question is not listed, there are no areas to highlight.

The following topic areas were generally well-understood or well-answered:

- Finding a share of an amount from a given a ratio (Qn9b).
- Solving simple linear equations (Qn3a).
- Collecting like terms (Qn3b).
- Finding the total of a set numbers, given the mean (Qn6a).
- Finding a set of numbers that satisfy a set of criteria including the mean and range (Qn6b).
- Finding the nth term of a sequence (Qn13b).
- Expressing a decimal < 0 in standard form (Qn19a).

Some candidates found working with fractions, decimals and percentages difficult. (Questions 1, 9(a)(c), 10, 17, 20(a)).

In Question 1, correct working had to be shown in order to be awarded all three marks. To allow for a full comparison, candidates were required to have all three values in an equivalent form. Sight of one correct conversion was awarded 1 mark.
Errors were seen when trying to convert 9% into a decimal, which was usually written as 0·9.
Candidates should be reminded to show $\frac{40}{100}$ as 40% if comparing all the values as percentages.
Follow through marks were available where candidates had been awarded B1 and then correctly ordered their values in ascending order.
A few candidates worked with common amounts (e.g. 9% of 100, 0·3 × 100 and $\frac{2}{5}$ × 100).

Various different methods were seen in Questions 9(a) and 20(a), where candidates were asked to express one number as a percentage of another. In Question 9(a), some misunderstood the question and attempted to find 48% of 400, rather than express 48 as a percentage of 400. In Question 20(a), poor notation was used to express $\frac{36}{360}$.

In Question 9(c), many showed a correct method of $1 - \frac{1}{8}$ but then gave an answer of $\frac{0}{8}$ or left the answer as $\frac{1}{8}$.

Varying methods were also seen by candidates dealing with repeated fractional changes in Question 10. Some candidates decided to work with percentages, which usually resulted in errors. A number of candidates found ¼ of 512 but then did not realise they needed to subtract from 512. A Special Case mark (SC1) was gained by many candidates for sight of 128. Unfortunately, a significant number did not gain any marks as they could not find ¼ of 512 successfully.

Question 17(a) was generally well answered, however, more candidates gained M1A1 for identifying the 0·3 on the first branch, than those gaining the B1 for the 0·96. Errors included reading 0·04 as 0·4 and then having 0·6 on all 3 branches. In Question 17(b), arithmetical errors when multiplying decimals were often seen. Usually place value errors were evident, resulting in a final answer of 0·1 or 100% or 1 (from 25 × 4).

Areas for improvement include:

- Converting between fractions, decimals, and percentages, especially those less than 10%.
- Expressing one number as a percentage of another.
- Subtracting fractions.
- Multiplying decimals.
- Finding a fraction or percentage of a quantity.

Some candidates found working with topics involving algebra difficult. (Questions 3, 5, 13abc)

Although Question 3 was generally well answered, candidates should be reminded that when solving linear equations, a final answer or an answer on follow through leads to a whole number answer, it must be shown as a whole number. Otherwise a fraction is accepted. Embedded answers were accepted, but not if followed by a contradictory answer. Although, again well answered, poor notation was seen in Question 3(b). 2 marks were awarded only if an expression was seen.

Poor notation was also seen in Question 5, where many candidates gained 2 marks for an answer of $2 \times n - 7$, where brackets were omitted. Many candidates found forming an expression from the information in the question challenging and used numbers instead.

Question 13(a) involved knowing and applying the rules of indices. m^{12} was the most commonly seen incorrect response in part (i), from multiplying the indices, and m^3 was the most commonly seen incorrect response in part (ii) from dividing the indices.
In Question 13(b), some just continued with the sequence, either adding the next term, 32, to the sequence or writing 'adding 7'. Poor notation was evident again, with final answers of $n7 - 3$, $n \times 7 - 3$ and $7 \times n - 3$ seen.
Candidates were required to list all of the integers that satisfied the inequality in Question 13(c). Few candidates managed to engage with solving the inequality and which values to include. Common incorrect answers included 14,15,16,17,18 or decimals, e.g. 6·5, 7…. where candidates missed or did not understand the meaning of the term integers.

Areas for improvement include:

- Use more formal methods of solving linear equations rather than using trial and error methods.

- Avoid presenting embedded answers in questions such as those in 3(a).
- Practise forming expressions using the correct notation and using brackets where appropriate.
- Practise solving linear inequalities and understand the meaning of the inequality symbols in this context.
- Learn the meaning of the term integer.

A lack of knowledge or application of the facts, formulae and definitions that need to be learned was evident in some questions. (Questions 2, 4, 7, 15, 20)

Candidates need to learn the formula to find the area of a rectangle. Many candidates were able to find the two values that satisfied both criteria listed in Question 2. However, some candidates did not engage with the criteria that the length of the rectangle was 5 times its width. Many gained 1 mark for stating a length and width whose product was 80.

It was evident that many candidates did not know that 1kg $\approx$ 2·2 lb and 1 litre $\approx$ 1·75 pints, as was required in Question 4. A lack of knowledge or understanding of the rules of angles in parallel lines was also apparent in Question 7, as was the formula for finding the circumference of a circle or semi-circle in Question 15 and Circle Theorems in Question 20.

The lack of knowledge or application of these facts, formulae and definitions that needed to be learned resulted in some candidates not being to access a number of marks.

Areas for improvement include:

- Learn the formula for finding the area of a rectangle and circumference of a circle.
- Read the question carefully to check that the answer satisfies all criteria given.
- Learn all the conversions listed the specification.
- Learn all the Circle Theorems listed the specification.

A number of arithmetical errors were made by candidates in some questions. (Question 12, 19c)

In a number of questions, candidates were aware of how to tackle the question, but lost marks due to arithmetical errors. In Question 12, most candidates knew the method for starting to find the prime factors of 675. However, as 675 was not an even, some had difficulty with dividing 675 or 135 by 5 or 3.
In Question 19(c), a question on standard form, some candidates firstly changed the values into numbers but then errors appeared when trying to add 23 000 and 5000. Candidates were awarded 1 mark if they wrote their answer correctly in standard form, following one place value error in either 23 000 or 5000.

Areas for improvement include:

- Check all answers for arithmetical errors.
- Practise adding, subtracting, multiplying, and dividing whole numbers, decimals, fractions, and negative numbers.

Other individual questions that need mentioning are below:

Question 8
Some candidates found the lack of structure in the question challenging.
Those candidates that listed all the possible combinations and then went on to identify the winning combinations were usually more successful. Some candidates misread the question and did not include the winning score of 7. Some candidates gave their final answer as a fraction. A number of follow through marks were available here from their combinations, their number of winning scores and their probability.
Generally, presentation was poor, with a lack of labelling or explanation, and inappropriate mathematical form.

Areas for improvement include:

- Identifying all the outcomes of a combination of two experiments using tabulation or other diagrammatic representations of compound events.
- Estimating the number of successes.
- Candidates should be made aware of what is taken into consideration when awarding the OC and W marks. Responses should be structured with explanations that are clear and logical to the reader. Explanations should be given at the point in the solution when they are presented. A series of calculations, followed at the bottom of the page with a detailed explanation, is not what is expected in order to gain an OC mark.
  Those who divide their page into two vertical halves headed 'Calculations' and 'Explanation', should ensure that the explanations on the right are in line with the calculations on the left-hand side.

Question 11(b)(i) &(ii)
This question was surprisingly poorly answered. It was evident that the majority of candidates are not aware of vector column notation for translations. Very few correct answers were seen in part (ii), where the majority of candidates had no concept of a reverse translation. Incorrect notation was also seen with answers without brackets or written as a fraction.

Areas for improvement include:

- Practise translating shapes where the description of translation is written in words and as column vectors.
- Practise writing the column vector that will reverse a translation.

Question 14
All parts of this question were very poorly answered. Rarely were completely correct answers seen in all parts, with candidates drawing arcs by hand and obviously not using a pair of compasses. In some cases, it was obvious a protractor had been used with retrospective arcs. Where candidates were on the right track, more often than not, not all construction arcs were seen. Candidates must show their 'initial arcs' to show where the point of the pair of compasses are placed before drawing intersecting arcs.

Areas for improvement include:

- Practise using a pair of compasses.
- Practise constructing angles of 60°, 30°, 90° and 45, bisecting a given line and angle.
- Practise constructing the perpendicular from a point to a line.

Question 15
Although candidates should have been expecting Pythagoras' Theorem to appear on Unit 1, following the publication of the Advance Notice Information, the correct method to find the length of the hypotenuse was rarely seen. Of the few candidates that did engage with using π, some worked with the circumference of a whole circle or found the area of the whole circle or semi-circle. Other common errors included using the radius instead of the diameter or including the 6cm when calculating the perimeter.

Areas for improvement include:
- Using Pythagoras' Theorem in 2-D shapes with or without a calculator (simple cases).
- Calculating the perimeter and area of a circle, semicircle, and composite shapes.

Question 16
Many candidates at the intermediate tier find questions dealing with bounds to be challenging.
In many cases, candidates did not realise that to find the least possible sum of these two time periods, 5 minutes needed to be subtracted from each time period first, or 10 minutes needed to be subtracted from the total time.

Areas for improvement include practising:
- Finding the upper and lower bounds of numbers expressed to a given degree of accuracy.
- Calculating the upper and lower bounds in the addition and subtraction of numbers expressed to a given degree of accuracy.

Question 18
Dimensions is another concept intermediate tier candidates found challenging. It was rare to award 3 marks for identifying what the formula could be used for. There were no noticeable patterns of incorrect answers. Those who undertook some written work usually did better.

Areas for improvement include:
- Distinguishing between formulae for length, area and volume by considering dimensions.

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Summer 2023

UNIT 1 HIGHER TIER

Overview of the Unit

Like in Summer 2022, the number of candidates entered was relatively high. Due to the effects of the Covid pandemic, centres and candidates were provided with Advance Information, giving details of the relevant parts of the specification; the paper nevertheless provided a fair test at this tier. As is always the case, candidates' performances reflected the increased demand as they progressed through the paper. Very few questions were not attempted, indicating that the entries were mostly appropriate for this tier.

Comments on individual questions/sections

The following topic areas were generally well-understood or well-answered:

- Expressing a number as a product of primes
- Using the rules of indices in algebra
- Finding the *n*th term of a linear sequence
- Solving a linear inequality
- Calculating using bounds
- Using a tree diagram
- Expressing and using numbers in standard form.

Some candidates found working with fractions, decimals and percentages difficult. (Questions 7, 10(a), 11(b), 15).

Question 7(a) was usually done well, but a few wrote 0·6 (or 0·06) rather than 0·96 on the 'No fire drill' branches of the tree diagram. Most knew to multiply the relevant probabilities in part (b), but there were very frequent place value errors in so doing, often resulting in an incorrect answer of 0·1, or even 1·00 or 100% (since 25 × 4 = 100).

Question 10(a) was often well-answered, even though some candidates stopped after having found the angle of 36˚. However, inaccurate use of notation was sometimes seen in trying to find 10% e.g. 36 / 360 = 10.

In Question 11(b), even when the correct substitutions were made, not all were able to simplify their answers e.g. some gave 32 / 128 as 4 or 0·4 or were unable to simplify 32 / 0·8.

In Question 15, having interpreted the context, many candidates could not correctly undertake the necessary calculations involving fractions.

Areas for improvement include:

- Adding, subtracting and multiplying decimals, paying particular attention to place value.
- Writing a complete method to express one number as a percentage of another.
- Multiplying and adding fractions.

Some candidates found working with topics involving algebra difficult. (Questions 3, 11, 13, 14)

Whilst plenty of secure algebra skills were seen in Question 3, there were occasional slips in notation, such as writing $n7$ instead of $7n$.

In Question 11(a), many candidates found the correct formula for inverse proportion, although some were penalised for stopping after finding the constant of 32 (without specifically stating the required final expression).
In part (b), marks were followed through if the constant had been wrongly evaluated in the equation for inverse proportion.
There were no marks available for those who used direct proportion throughout the question (since their work was not of equivalent difficulty).

There was a mixed response to all parts of this Question 13. In part (a), many candidates failed to involve ½ in the area of the triangle, in which case it was not possible to derive the required quadratic equation. (An alternative valid solution involved doubling the area of the triangle in order to consider the corresponding rectangle.) Some misinterpreted part (a) by proceeding to solve the equation, often simply repeating this work in part (b)(i).
For part (b)(i), many were able to correctly solve the quadratic equation by factorising, although some sign errors occurred within the brackets; candidates should be encouraged to check their factorisations by expanding their brackets. Those who used the quadratic formula tended to be less successful, particularly as they needed to know (without a calculator) that $\sqrt{256} = 16$.
Not many achieved the mark in part (b)(i); of those who did, they were usually able to justify their choice of answer.

In Question 14, while plenty found the correct value of 2·5, errors in part (a)(i) were often caused by not realising that 1 / 0·5 = 2 as part of the calculation.
Given that this was a relatively unfamiliar function, there were many excellent graphs produced in part (a)(ii). Some, however, did not realise (as they may have done for a quadratic function) that a smooth curve was required, and used a ruler to join their points.
It was common to state only one answer in part (b), even when the graph clearly provided two.

Areas for improvement include:
- Using correct notation when forming expressions.
- Learning the standard method for finding a proportional relationship.
- Solving quadratic equations by factorising.
- Sketching curves for non-linear functions.

A lack of knowledge or application of the facts, formulae and definitions that need to be learned was evident in some questions. (Questions 5, 10(b))

The majority found Question 5 accessible, usually applying Pythagoras' Theorem correctly to find AC = 10 cm. However, the arc length caused more difficulty, with some confusion between radius and diameter, or even between circumference and area. Some made the arithmetic potentially more difficult by multiplying the circumference by 180/360 rather than immediately recognising the arc as belonging to a semi-circle. Another notable common error was the inclusion of 6 cm as part of the perimeter. For the OCW requirement, many candidates understood the necessity of labelling their steps e.g. 'length AC', 'arc length', 'perimeter'. There was occasional misuse of the '=' sign within number work
(e.g. '6 × 3·14 = 18·84 / 2 = 9·42') or the required units were incorrect or missing.

In Question 10, even having correctly used the fact that 'the tangent and radius are perpendicular' in part (a), candidates were let down in part (b) by not using appropriate terminology.

Areas for improvement include:

- Learning the formula for finding the circumference of a circle and understanding when to use this rather than using the formula for the area of a circle.
- Formally stating and understanding how to use Circle Theorems.

Other individual questions that need mentioning are below:

Question 1
The response in part (a) was surprisingly disappointing, with relatively few candidates able to correctly translate the given shape. Some made an error in one direction only (most often horizontal) while others undertook a completely different transformation, such as a rotation or reflection.
In part (b), plenty did know how to construct a vector for the reverse translation (even if they had not translated correctly in part (a)), but many were penalised for incorrect notation (such as writing their pair of numbers without brackets, or as a fraction or as coordinates).

Areas for improvement include:

- Translating shapes where the translation is defined by a column vector.
- Writing column vectors that describe a specific translation and its reverse.

Question 2
The majority were able to find the correct product of primes in part (a), with occasional slips in arithmetic. Despite 675 clearly being an odd number, some candidates nevertheless presented 2 as a factor. Others incorrectly included 9 as part of their final answer.
Part (b) was far less successful; some candidates had an idea that either 2 or 5 should be involved, but only a few produced 10 (from 2 × 5).

Areas for improvement include:

- Knowing that an odd number can never have '2' as a prime factor.
- Recognising prime and non-prime numbers.

Question 4
Only a minority of candidates were able to undertake all three constructions. Within the good solutions seen, a variety of valid methods were used, particularly for parts (b) and (c). Too often, candidates did not show all necessary arcs, indicating that they had not 'constructed' the required lines. In other cases, some of the arcs seen were clearly added retrospectively or had the wrong orientation, or a ruler appeared to have been used to measure distances. Occasionally, irrelevant other constructions were seen, such as the perpendicular bisector of a line. Some candidates drew all the necessary arcs then omitted to draw the required line.

Areas for improvement include:

- Using standard construction methods, using a pair of compasses.
- Being aware of the need to show sufficient (but not spurious) construction arcs as evidence of a correct method.

Question 6
Many fully correct solutions were seen here. Otherwise, errors included subtracting 10 minutes from each time, or not considering lower bounds at all. Some candidates recognised the need to subtract 5 minutes from the given times, but subtracted from both the hours and the minutes as if they were separate measurements.

There was an occasional misinterpretation of the question as requiring a time difference, resulting in a subtraction instead of addition. Others sometimes misread one of the times in the question e.g. writing 4 hours 10 minutes instead of 4 hours 40 minutes.

Areas for improvement include:

- Identifying and using upper and lower bounds of numbers which are given to a specified degree of accuracy.

Question 8
Only a few candidates achieved all 3 marks in this question on dimensions, and there was no particular pattern of incorrect answers. Those who undertook some associated written work tended to be most successful.

Areas for improvement include:

- Understanding dimensions and distinguishing between formulae for length, area and volume.

Question 9
All parts of this question on standard form were usually well done, with just occasional errors in place value. A few tried to multiply rather than add the numbers in part (c).

Areas for improvement include:

- Knowing when and how to add, subtract, multiply or divide numbers in standard form.

Question 12
Here, common errors in finding the volumes included: mis-quoting the formulae (which are printed at the start of the paper); using 6 cm as the radius of the sphere; giving 3^3 to be 9; being unable to find 4/3 of 27; replacing 4/3 and 1/3 with 1·3 and 0·3 respectively. A significant proportion of candidates used 3·14 for π in finding the volumes, which made the arithmetic unnecessarily difficult, and the subsequent work on ratio also very much more challenging.
In simplifying the ratio, while there were plenty of successful solutions, a surprising number left π in their answer (sometimes finishing with 3π:25π) or failed to fully simplify their ratio of integers.
More able candidates realised that the volumes did not need to be explicitly evaluated, and wrote the related calculations as ratios, proceeding from there to clear fractions and eliminate π.

Areas for improvement include:

- Using formulae for volumes of 3D shapes.
- Recognising when it is appropriate (and more efficient) to work in terms of π.
- Fully simplifying a ratio.

Question 15
In part (a), plenty of candidates considered two possibilities (BBB or YYY) and accurately presented and added the required products of fractions. It was a concern, however, that some did not know when or how to multiply or add fractions. Others produced two separate probabilities without then proceeding to add them.
Part (b) was less successful, with candidates often failing to consider the three possible orderings (BYY, YBY, YYB). Those who embarked on the more challenging method of 1 – P(0 or 2 or 3 blue) were usually unsuccessful due to not accounting for all of the possibilities.

Areas for improvement include:

- Including all possibilities when calculating probabilities.
- Developing fluency in calculating with fractions.

Question 16

(a) Relatively few gained both marks in this question. Many of the answers offered involved incorrect symmetries e.g. 270 ± 62. If they had one or both correct answers, candidates were unfortunately penalised if they also included incorrect values (beyond two attempts).

(b) Candidates were helped here by having a copy of the graph of y = sin$x$ printed on the opposite page, although some drew y = cos$x$ or drew multiple cycles (of sine or cosine or even tangent). In part (i), many showed a clear intention to reflect in the x-axis, but some omitted to indicate the relevant y-values of 1 and -1. Part (ii) was generally less successful, with the graph of y = 2 sin$x$ often sketched. Some candidates needed to take more care with the positioning of the maximum and minimum points.

Areas for improvement include:

- Understanding and using the properties of trigonometric graphs.
- Knowing the effects of transformations on graphs.

Question 17

(a) The majority of candidates found four terms by multiplying the brackets. A good number then collected terms to correctly obtain the final answer. Common errors, however, included writing √24 for 4√6, or losing the final mark for incorrect subsequent working, e.g. stating – 2 + 3√6 to be 1√6 or stating 3√6 – 2 to be 3√4.

(b) Not many candidates gained all 3 marks in this part of the question. From those who did, the most common trio of numbers was 9, 8, 64. Very rarely, a candidate realised that 64 (or 729 or 1 000 000) was a possible valid answer for all three parts.

Areas for improvement include:

- Developing fluency in manipulating surds.
- Identifying rational and irrational numbers.

MATHEMATICS

GCSE

Summer 2023

UNIT 2 FOUNDATION TIER

Overview of the Unit

This unit tested the content of the full specification, but an Advance Information Notice was released to centres prior to the series, giving details of the topics that would be assessed on Unit 2.

Overall, the questions were comparable with those asked on previous papers that have been sat, and the paper was a suitable and fair test for the candidates at the Foundation level. Some questions proved more challenging than others, particularly those common with the Intermediate tier paper, whilst some candidates lost marks due to incorrect numerical evaluations.

Comments on individual questions/sections

When a question or part-question is not listed, there are no areas to highlight.

The following topic areas were generally well-understood or well-answered:

- Finding the sum/difference of two numbers (Question 1)
- Describing the chance of an event occurring (Question 2)
- Describing the rule of a sequence (Question 8a)
- Solving simple questions (Question 8b)

In some questions, candidates used their calculators inefficiently.

A calculator-allowed paper gives opportunities to assess calculator use. Although non-calculator methods can lead to correct responses, they often increase the difficulty of the question and can lead to candidates making unnecessary errors. Candidates should be encouraged to use a calculator where possible on Unit 2, whilst remembering to show workings to gain method marks.

In Questions 1 and 9, some candidates used non-calculator methods to evaluate each of the calculations. Some of these candidates made numerical errors, suggesting that calculators weren't used to check answers either once they were obtained.

Areas for improvement include:

- Practise using a calculator to calculate and to check answers.
- Show all workings.

A lack of knowledge or application of the facts and definitions that need to be learned was evident in some questions. (Questions 4c, 7b, 12b)

Many candidates lost marks in questions throughout the paper as they did not know essential facts or definitions.

Few candidates were able to identify a parallelogram as the shape in Question 4(c), with a significant proportion of candidates not attempting the question.

In Question 7(b), few candidates were able to identify the name of the quadrilateral with rotational symmetry of order four, with over half the candidates not attempting the question.

Question 12(b) required candidates to identify three prime numbers from the list of eight numbers. A minority of candidates were able to identify all three primes for 2 marks, but some were awarded 1 mark for identifying two of the three primes.

Areas for improvement include:
- Learning the names of 2D and 3D shapes.
- Learning the properties of 2D shapes, including symmetrical properties.
- Learning prime numbers and strategies to help identify larger primes.

Some candidates found working with angles difficult. (Questions 11, 15, 18)

The first part of Question 11 was well-answered, with many candidates demonstrating knowledge that the interior angles in a quadrilateral sum to 360°. The second part was answered less well, with some candidates aware that the interior angles in a triangle sum to 180°, but not knowing the properties of an isosceles triangle.

In Question 15, candidates needed to accurately draw a pie chart. Before drawing the pie chart, candidates needed to calculate the size of each sector, but few were able to do this correctly.

In the first part of Question 18, candidates were asked to find the bearings of two points, whilst the second part asked candidates to use bearings to identify which two points were the closest. Both parts were answered poorly by candidates, with correct responses rarely seen.

Areas for improvement include:
- Understanding the angle properties of an isosceles triangle.
- Showing all working when constructing pie charts.
- Understanding all aspects of bearings, including interpreting and drawing bearings.

Some candidates found working with topics involving negative numbers difficult. (Questions 14a, 14b)

In Question 14(a), candidates had to find the next two terms in a sequence by adding six on to –8 and then onto –2. Some candidates found this challenging, with incorrect responses of –14 and –20 often seen.

Few fully correct answers were seen in Question 14(b), where candidates needed to substitute two values into a formula. Many candidates evaluated 3 × 9·3 or 2 × –13·6 correctly and were awarded 1 mark. Some had an incorrect final answer of 55·1, resulting from using +27·2, rather than –27·2. No marks were awarded for sight of 27·2g or –27·2h.

Areas for improvement include:
- Practising finding the next terms in sequences with negative numbers.
- Practising substituting negative numbers into formulae.

Some candidates found working with topics involving fraction of an amount difficult (Questions 3b, 10)

In Question 3(b), a significant number of candidates were able to correctly shade 1/5 of the rectangle, with candidates often shading 5 boxes, instead of 4.

In Question 10, candidates needed to calculate 2/5 of 10, but many were unable to do this.

Areas for improvement include:
- Practising calculating the fraction of an amount.

Other individual questions that need mentioning are below:

Question 5
Some candidates identified 20 as the median of the list of numbers, neglecting to firstly write the numbers in ascending or descending order before selecting the middle number.

Areas for improvement include:
- Practising calculating the median.

Question 16

Some candidates showed awareness of the formula to calculate average speed. However, few candidates were able to write 1 hour 15 minutes as 1.25 hours so that it could be used in the formula, with many writing it as 1.15 hours.

Areas for improvement include:
- Practising writing time in hours.

Question 17
Few candidates were able to successfully find the volume of both the cuboid and cube. Many incorrect methods were seen to find the volume, including finding the sum of the three lengths (4, 5 and 20).
Many candidates did not realise that the length, width and height of the cube was 3 cm. An incorrect method to find the volume of the cube, which was frequently seen, was 3 × 3 or 3 × 6, or simply stating that the volume was 3 cm^3.
Follow through marks were available if either volume was correctly evaluated, or 4 × 5 × 20 and 3 × 3 × 3 were seen. The final mark was awarded for correctly interpreting their answer, even if no previous marks had been awarded, but many candidates rounded their answer up instead of truncating it.

Areas for improvement include:
- Calculating the volume of cubes and cuboids.

Question 19
In part (a), few candidates placed 18 and 5 in the correct positions on the Venn diagram. Some candidates wrote 4 and 1 instead of 5, and the History total was often 43 instead of 25. Many thought the 25 was for History only.
In part (b), very few correct responses were seen. Some candidates gave a fraction with 43 as its denominator and were awarded 1 mark.

Areas for improvement include:

- Understanding and using Venn diagrams to solve problems.
- Interpreting each section of the Venn and understand what it represents in the context of the question.

MATHEMATICS

GCSE

Summer 2023

UNIT 2 INTERMEDIATE TIER

Overview of the Unit

This unit tested the content of the full specification, but an Advance Information Notice was released to centres prior to the series, giving details of the topics that would be assessed on Unit 2.

Overall, the questions were comparable with those asked on previous papers that have been sat, and the paper was a suitable and fair test for the candidates at the Intermediate level. Some questions proved more challenging than others, whilst some candidates lost marks because of incorrect numerical evaluations or giving unsupported incorrect answers.

Comments on individual questions/sections

When a question or part-question is not listed, there are no areas to highlight.

The following topic areas were generally well-understood or well-answered:

- Finding values using a set of criteria or clues given (Qn3).
- Continuing a sequence of numbers (Qn4a).
- Ordering probabilities (Qn5b).
- Extracting a common factor (Qn11c).
- Knowing that the total probability of all the possible outcomes of an experiment is 1 (Qn12a).

In some questions, candidates used their calculators inefficiently.

A calculator paper is designed to assess the use of the calculator. Although non-calculator methods can yield correct responses, they often increase the difficulty of the question and result in unnecessary errors. Candidates should be encouraged to use a calculator as much as possible on Unit 2, but they must remember to show workings where appropriate.

In Question 14(a), a common answer seen was 8·02, where candidates did not use the facilities of the calculator to plan or evaluate the expression correctly. Decimal places were used regularly rather than significant figures. Incorrect use of the facilities of the calculator was also seen in Questions 13 and 15, with some candidates, in Question 15 typing tan (47 × 13·1) into the calculator resulting in an answer of 3·9.

On some occasions, dots were placed on digits within answers, for example $0.\dot{0}43$ in Question 14(b). Candidates need to understand the correct notation when decimals are recurring and be careful when reading calculator displays.

Areas for improvement include:

- Practising using a calculator to calculate or to check answers.
- Showing all workings.
- Understanding the notation for recurring decimals.

Some candidates found working with angles difficult. (Questions 1, 5, 7, 9, 15)

Although both parts of Question 1 were well answered, arithmetical errors were seen in part (a), were candidates used non-calculator methods to add the angles and subtract from 360. As mentioned above, candidates should be encouraged to use a calculator to find calculate their answers on Unit 2 questions, or at least to use it as a check. In part (b), some candidates thought that the sum of the interior angles of a triangle was 360°.
The method mark in both parts was awarded for a complete method and not only for finding 254° in (a) and 102° in (b).
Embedded answers were accepted, but not if followed by a contradictory answer.

Interpreting (including measuring angles) and drawing pie charts is a skill that can be assessed on both the GCSE Mathematics and GCSE Mathematics – Numeracy qualifications. In Question 5, many candidates used various different methods to calculate the correct angle for Red (72°) and Green (108°). However, in some cases, inaccurate use of a protractor meant that their angles were out of tolerance. Some lines were not straight and again resulted in the angles being out of tolerance.
Candidates should be encouraged to always show their working and angles when asked to construct a pie chart, as part marks can then be awarded.

Some candidates worked with interior angles rather than exterior angles in Question 7. Sometimes, 24° was shown along with 156°. In this case, 1 mark was awarded.

Bearings continue to prove extremely challenging to candidates, especially when using bearings that are greater than 180°. In Question 9, few correct answers were given, with 55° usually given instead of 055°. Those that utilised the space to draw a sketch, usually were more successful. Common incorrect answers were P and Q, where the two smallest angles were given.

Candidates who were familiar with using trigonometric relationships in right-angled triangles did manage to gain some marks in Question 15. It appeared, however, that many candidates had not covered this part of the specification.
A few candidates adopted a ‘round the houses’ multi-step approach in both parts which, although correct, was not necessary. This approach has more potential of possible arithmetical errors arising, and marks are not awarded for a partial method.
In part (b), candidates needed to appreciate that either angle *DBE* was 47°, or angle *BED* was 43°. Marks were awarded then for using a correct method to find the length *DE*, using the appropriate angle. Follow through marks were available in this question.

Areas for improvement include:

- Understanding that the sum of the interior angles of a triangle is 180°.
- Showing all working when constructing pie charts.
- Learning the methods of finding interior and exterior angles of regular polygons.
- Understanding all aspects of bearings, including interpreting and drawing.
- Using trigonometric relationships in right-angled triangles where more than one triangle is drawn.

A lack of knowledge or application of the facts, formulae and definitions that need to be learned was evident in some questions. (Questions 2ab, 6, 14bc, 18)

Many candidates lost marks in questions as they did not know certain terminology, facts or formulae. In Question 2(a), $\frac{1}{8}$ was usually given as a recurring decimal. 51 and 39 were commonly given as prime numbers in Question 2(b), and the square root of 23 was given rather than the reciprocal in Question 14(b). In Question 14(c), candidates mixed the terms multiple and factor and regularly gave 2 as Lowest Common Multiple (LCM) and 30 or 150 were given as the Highest Common Factor (HCF).

In Question 6, candidates needed to learn the formula which connects average speed, distance and time.
A mark was given for use of the appropriate $\frac{distance}{time}$ formula. For this first mark, any indication of the appropriate time could be given. Calculations such as $\frac{45}{1.15}$ or $\frac{45}{1\ hour\ 15\ mins}$ or $\frac{45}{75}$ were awarded the first mark.
For the second method mark, the time needed to be in a correct format.
Candidates found expressing hours and minutes as a decimal fraction of an hour challenging.

Knowledge of the formulae of the area of a semicircle and trapezium were needed in order to solve the multi-step problem in Question 18. Some candidates worked with the area of the full circle; however, many candidates did not engage with any formula involving π at all.
In some cases, 7cm was derived from incorrect method or workings. No marks were awarded for the radius in these cases.
The final M1A1 marks were available, on follow through, for those candidates that used their radius and diameter correctly to find the area of the trapezium.
Some candidates split the trapezium into a rectangle and two triangles. This method was more laborious but nonetheless correct.

Areas for improvement include:

- Learning the formula for finding the area of various shapes, including semi-circles and trapeziums.
- Learning the definitions of the terminology listed the specification.
- Learning the formula for average speed, distance and time.
- Practising expressing hours and minutes as a decimal fraction of an hour.

Some candidates found working with topics involving algebra difficult. (Questions 4b, 11ab, 13, 17)

In Question 4(b), a significant number of candidates evaluated 3 × 9·3 and 2 × –13·6 correctly and gained 1 mark, for one or even both evaluations seen. Many had an incorrect final answer of 55·1, resulting from using +27·2, rather than –27·2.
No marks were awarded for sight of $27{\cdot}2g$ or $-27{\cdot}2h$.

Very few correct answers were seen in Question 11(a). The addition of expanding a bracket within a linear equation with letters on both sides, proved particularly challenging for candidates.
A common error, which was seen regularly, was to write a first step as $12(x - 2) = 3x + 8$.
Follow through marks were available if candidates continued to solve their equation correctly before an additional error was made.
In other cases, several errors, usually more than 2, appeared on the first line, therefore no marks were awarded.
Where no marks were awarded, if either $5x - 10$ or $12x - 24$ was seen, a SC (Special Case) mark was awarded.

In Question 11(b), the first mark in the marking scheme was given for correctly isolating the $2f$ (or $-2f$) term. The second mark was awarded for correctly dealing with the 2 (or -2).
This could be a follow through from their $\pm 2f = \pm 13 \pm h$.

Candidates who gave $-f$ rather than $(+)f$ as their subject did not gain the final mark.
Candidates who gave a final answer with '$f =$' missing did not gain the final mark as in this case there is no formula.
Many candidates displayed poor algebraic notation.

It was pleasing that a number of candidates set out their evaluations for Question 13 logically and usually in a table.
A number of candidates did not substitute the values of x correctly into the expression, which led to incorrect evaluations.
The marking scheme allowed:
1 mark (B1) for any correct substitution and evaluation.
1 mark (B1) for two correct evaluations using x in the range $2{\cdot}55 \leq x \leq 2{\cdot}75$, but, crucially, one answer has to be less than 0 and one answer has to be greater than 0.
1 method mark (M1), that has to be seen, for two correct evaluations using x in the range $2{\cdot}55 \leq x \leq 2{\cdot}65$, but again crucially, one answer has to be less than 0 and one answer has to be greater than 0. If this is not shown, then no further marks were permitted.
1 mark (A1) for a final correct answer BUT only if the previous M1 mark awarded.

Some candidates substituted $x = 2{\cdot}6$ and $x = 2{\cdot}7$ into the expression and then simply looked at which evaluation was the closest to 0.
This does not gain a method mark (M1) nor the final mark (A1) even if 2·6 is given as an answer.
Others not only lost the final A1 mark, but wasted valuable time by giving an answer to a greater degree of accuracy than was asked for.

In Question 17, several different methods were used by candidates to solve the simultaneous equations. If these methods were valid and algebraic (as the question specified) then marks could be awarded.
The most common method was to eliminate one variable by trying to equate either the x or y coefficients. Some only multiplied the terms in x, only the terms in y, or only the terms on the left-hand side. Furthermore, if candidates did achieve two correct equations with equal coefficients for either the terms in x or y, a significant number of candidates did not know whether to add or subtract to eliminate one variable. In some cases, the requirement to subtract a negative value ('minus a minus') did lead to arithmetical errors.
The question required the candidates to solve the simultaneous equations using an algebraic method. As this was on a calculator paper, no marks were awarded to those who used a form of 'trial and improvement' method to find the value of x and the value of y.

Areas for improvement include:
- Working with negative numbers whether it is substituting negative values into formulae or solving linear equations.
- Solving linear equations which include brackets and letters on both sides.
- Including all steps when finding solutions using the trial and improvement method.
- Solving simultaneous equations that include large numbers, negative numbers and decimals.

When a question or part-question is not listed, there are no areas to highlight.

The following topic areas were generally well-understood or well-answered:
- Finding values using a set of criteria or clues given (Qn3).
- Continuing a sequence of numbers (Qn4a).

- Ordering probabilities (Qn5b).
- Extracting a common factor (Qn11c).
- Knowing that the total probability of all the possible outcomes of an experiment is 1 (Qn12a).

Other individual questions that need mentioning are below:

Question 2(c)
Many candidates gave 27 as a final answer from 81 ÷ 3.

Areas for improvement include:
- Using index notation.

Question 8
Many candidates successfully found the volume of both the cuboid and cube and then correctly found the correct number of cubes by truncating the answer resulting from volume of cuboid ÷ volume of cube.
Many incorrect methods were seen to find the volume. These including 4 + 5 + 20 or finding the surface area.
Many candidates did not realise that the length, width and height of the cube was 3cm. A common incorrect method to find the volume of the cube was 3 × 3 or 3 × 6, or simply stating that the volume was $3cm^3$.
Follow through marks were available where either volume was correctly evaluated, or 4 × 5 × 20 and 3 × 3 × 3 were seen. The final mark was awarded for interpreting their answer, even if no previous marks had been awarded, and knowing whether to round down or up as appropriate. Various methods were seen to find the complete number of cubes. Generally volume of cuboid ÷ volume of cube, was seen, but some candidates used repeated addition or multiplication to find the number of complete cubes.

Candidates should present their response in a structured way and use appropriate labels to be awarded the OC mark. All workings should be shown, and the correct mathematical form was required for the W mark.

Areas for improvement include:
- Learning the formulae for finding the volume of a cuboid or cube and know which units should be given.
- Interpreting the display on a calculator and know whether to round up or down as appropriate.
- Be aware of what is taken into consideration when awarding the OC and W marks. Responses should be structured with explanations that are clear and logical to the reader. Explanations should be given at the point in the solution when they are presented. A series of calculations followed at the bottom of the page with a detailed explanation is not what is expected in order to gain an OC mark. Those who divide their page into two vertical halves headed ‘Calculations’ and ‘Explanation’ should ensure that the explanations on the right are in line with the calculations on the left-hand side.

Question 10
In part (a), many candidates placed 18 and 5 in the correct positions on the Venn diagram, although sometimes 4 and 1 were written instead of 5.
Most often the History total was 43 not 25 as given. Many thought the 25 was for History only.
In part (b), many candidates found a correct probability following through from their Venn diagram or were awarded 1 mark from a correct numerator or 43 as a denominator. Candidates should check that all sections of the Venn diagram are completed.

Areas for improvement include:

- Understanding and using Venn diagrams to solve problems.
- Interpreting each section of the Venn and understand what it represents in the context of the question.

Question 16(b)
Some candidates were awarded 1 mark for sight of 83% or equivalent. Candidates, on the whole, find it difficult to comprehend the concept of 'reverse percentages'. Instead of equating 3569 to 83% of the original number, most candidates found 83% of 3569, or found 17% of 3569.

Areas for improvement include:

- Finding the original quantity given the result of a proportional change.

MATHEMATICS

GCSE

Summer 2023

UNIT 2 HIGHER TIER

Overview of the Unit

This unit tested the content of the full specification, but an Advance Information Notice was released to centres prior to the series, giving details of the topics that would be assessed on Unit 2.

Overall, the questions were comparable with those asked on previous papers that have been sat, and the paper was a suitable and fair test for the candidates at the Higher level. Candidates generally performed better over the first half of the paper, and they also performed well on some of the standard Unit 2 topics. Some questions proved more challenging than others however, especially the non-standard AO3 type problem-solving and multi-stage questions. There were some novel questions bridging different topics together and many candidates struggled to give full, correct solutions even though those individual parts themselves were relatively straightforward. Robust algebraic skills were also lacking for many candidates. Misconceptions were commonplace in the response to non-standard questions. It is also worth noting that incorrect numerical evaluations, premature rounding or unsupported incorrect answers were still evident. Many candidates failed to retain accurate intervening answers in multi-step calculations.

Comments on individual questions/sections

When a question or part-question is not listed, there are no areas to highlight.

The following topic areas were generally well-understood or well-answered:

- Extracting a common factor,
- Knowing that the total probability of all the possible outcomes of an experiment is 1 and expectation,
- Trial and improvement to solve equations to an approximate answer,
- Calculating the Lowest Common Multiple and Highest Common factor,
- Solving a pair of simultaneous equations,
- Right-angled trigonometry,
- Working out the arc length of a sector
- Knowing when to use the sine and cosine rule.

In some questions, candidates used their calculators inefficiently.

A calculator paper is designed to assess the use of the calculator. Although non-calculator methods can yield correct responses, they often increase the difficulty of the question and result in unnecessary errors. Candidates should be encouraged to use a calculator as much as possible on Unit 2, but they must remember to show workings where appropriate. Candidates must also try and keep values in the calculator in intervening steps within a multi-step calculation to avoid premature approximation.

On some occasions, dots were placed on digits within answers, for example $0.\dot{0}43$ in Question 4(b). Candidates need to understand the correct notation when decimals are recurring and be careful when reading calculator displays.

Areas for improvement include:

- Practise using a calculator to calculate or to check answers.
- Show all workings.
- Understand the notation for recurring decimals.

Some candidates rounded values too prematurely in multi-step calculations leading to final inaccurate answers or gave only inaccurate whole number answers. (Questions 14 and 16)

In Question 14, some candidates rounded the √968 (the length of the diagonal of one of the faces of the cube) to the nearest whole number 31cm. Then, in conjunction with finding the diagonal of the cube ($31^2 + 22^2$) resulted in an inaccurate final answer of 38.01cm. The candidates should have kept √968 to at least 1 decimal place of 31.1cm.
In Question 16, a rounded whole number answer was condoned for an angle derived correctly or incorrectly which was then used as a follow through to calculate angle BAD. However, if only a whole number answer was given for angle BAD, the candidate lost the final accuracy A1 mark. A more accurate answer had to be shown first.

Areas for improvement include:

- Do not round answers prematurely in intervening steps of multi-step calculations.
- Always give final answers to an appropriate degree of accuracy, unless specified to a precise degree by the question.

Some candidates found working with algebra difficult. (Questions 1ab, 5, 11, 12 and 15)

The addition of expanding a bracket and a single term on the left-hand side of an equation introduced misconceptions to many candidates in Questions 1(a) and 1(b).
A very common error was adding 7 + 5 to give $12(x – 2) = 3x + 8$. Follow through marks were available if candidates continued to solve their equation correctly before an additional error was made. Alternatively, many treated the left-hand side as two brackets, $(7 + 5)(x - 2)$, which ultimately led to the same incorrect answer.
In other cases, several errors, usually more than two, appeared on the first line and therefore no marks were awarded.
Where no marks were awarded, if either $5x – 10$ or $12x – 24$ was seen, a SC (Special Case) mark was awarded.

In Question 1(b), the first mark in the marking scheme was given for correctly isolating the $2f$ (or $-2f$) term. The second mark was awarded for correctly dealing with the 2 (or -2).
This could be a follow through from their $\pm 2f = \pm 13 \pm h$.
The common error was inaccurately dealing with negative terms when rearranging the equation.

Candidates who gave $-f$ rather than $(+)f$ as their subject did not gain the final mark.
The majority of candidates did not omit '$f =$' in their answer and also used the fraction line for division.

Although Question 5 was well answered, the common error to highlight was the incorrect addition or subtraction of negative terms when eliminating one of the variables.
This question required the candidates to solve the simultaneous equations using an algebraic method. As this was on a calculator paper, no marks were awarded to those who used a form of 'trial and improvement' method to find the value of x and the value of y or if they just gave the two unsupported correct answers.

Question 11 exposed a few misconceptions. In this question, x was asked to be the subject of the formula. Therefore some candidates only factorised the x from the left-hand side instead of the x^2 and therefore the bracket also had an x term in it.
A number of candidates did not realise that factorising was involved. They divided the equation by the coefficient a but did not do it to the second x term. Therefore the left-hand side simplified to $x^2 + x^2$ and then subsequently $2x^2$. At this point, correctly dividing by 2 and then taking the square root was worthy of the final two B1 marks. However, writing down the correct FT answer from incorrect work gained no marks.
Occasionally, a perfect answer was presented including the $\pm$ sign.

In Question 12(a), many candidates factorised the quadratic expression correctly into two brackets, e.g. $(4x + 6)(2x - 3)$ which gained B2. The candidates who first factorised out the 2 to leave $2(4x^2 - 9)$ were more likely to proceed to $2(2x - 3)(2x + 3)$ as they realised the quadratic was in the form of the difference of two squares. However, the majority of candidates who offered $2(4x^2 - 9)$ did not go any further.

Although in Question 12(b) the wording began with 'Hence…', a significant number of candidates simply solved the equation in 12(b), without using the response from 12(a). Follow through marks were also available from the bracketed expression in 12(a). However, this mark was only available if two distinct roots were offered. Many candidates who directly solved $8x^2 - 18 = 0$ only gave the answer of $x = \frac{3}{2}$, forgetting the second root of $x = -\frac{3}{2}$.

In Question 12(c), the candidates had to use the roots from 12(b) to sketch a positive quadratic curve showing the x and y axis intersections, i.e. (−1·5,0), (1·5,0) and (0,−18). This question also began with 'Hence…'. Therefore, if two roots were offered in 12(b), the candidates could sketch a positive or negative quadratic curve with those follow through roots as the x axis intersections. This gained a B1. A B1 was also offered for sketching a positive quadratic curve with the minimum of −18 indicated on the y axis.
The question was not answered well. Many candidates did not know the shape of a quadratic. If they attempted to sketch a quadratic curve, some had concave and/or convex curved ends which was condoned for B1, but not B2. A significant number of candidates also did not realise that the roots in 12(b) were the x axis intersections. This clearly posed problems for the candidate if 12(b) was not answered, or only one root was offered. The most common partially correct answer was a positive quadratic curve with −18 indicated as a minimum.

Question 15 asked the candidate to rearrange an equation involving algebraic fractions with linear denominators and then solve it using the quadratic formula. Candidates appeared to struggle more with the first part. Many candidates knew to multiply the two denominators correctly to gain B1. It was also evident that many candidates understood that the denominators had to be cleared before rearranging the equation to obtain a quadratic equation equated to zero. However, only a few candidates knew how to rearrange correctly.

Many different errors were made. However, a common error was equating the expanded denominator to 1 and then rearranging it, resulting in $3x^2 - 13x + 13 = 0$. This was from incorrectly adding the fractions together using the cross-multiplication technique.
The other correct method sometimes seen was multiplying the whole equation by the lowest common denominator, in this case $(x - 2)(3x - 7)$ to clear the denominators.
If there was a derived quadratic equation equated to zero offered by the candidate, then many candidates did use the quadratic formula successfully. However, the usual pitfalls were evident, namely:

- incorrectly dealing with the $-b$ and b^2 term since b was negative,
- not showing the substitution into the formula (this meant zero marks M0A0A0 for this part),
- using the quadratic formula on an equation not set to zero,
- not rounding to two decimals places,
- using the quadratic formula on a quadratic which was not an equation (e.g. the quadratic was the denominator of a fraction).

Areas for improvement include:

- Working with negative numbers whether it is substituting negative values into formulae or equations.
- Solving linear equations which include brackets and letters on both sides.
- Including all steps when finding solutions using the trial and improvement method.
- Solving simultaneous equations that include large numbers, negative numbers and decimals.
- Solving equations involving algebraic fractions.

Other individual questions that need mentioning are below:

Question 4b
A number of candidates either left this question not attempted or did not know what reciprocal meant. Finding the square root of 23 was a common error seen.

Area for improvement include:

- Understand and use the definition of a reciprocal.

Question 7b
Candidates had been given a lead in to this part of the question, by introducing a multiplier in part (a). Even though the majority of candidates did gain a mark for the sight of 0.83 or 83%, many did then go on to add 17% of 3569 to the given value in order to attempt to find the original amount.

Areas for improvement include:

- Finding the original quantity given the result of a proportional change.

Question 8
A significant number of candidates failed to halve the formula for the area of a circle in order to calculate the radius of the semicircle. Then, if they had gained the correct radius or not, a good number of candidates either failed to double the radius to identify the length CD, or more often having doubled the radius for the length CD, continued to use this doubled amount for the height of the trapezium.

Areas for improvement include:

- Working out the area of a semi-circle
- Applying the area of a trapezium correctly and using problem-solving skills to tackle different types of questions.

Question 9
Many candidates appreciated that a negative enlargement was a transformation to the opposite side of the centre of enlargement from the object. However, the common misconceptions that arose from this were: placing it in the wrong place, using an incorrect negative scale factor (-1/2 was common), or that the shape was reflected and not inverted.

Areas for improvement include:
- Understanding the differences between positive, negative and fractional enlargements.
- Be aware that the centre of enlargement can be an invariant point if it is on the shape itself.

Question 10
Question 10(a) was a multistep AO3 question which did not perform as well as expected. Many candidates could work out either the external angle (72°) or the internal angle (108°) of the regular pentagon, but then failed to calculate the reflex angle CDE (252°) which was required to work out the arc length of the sector. However, many candidates did know the formula for the sector arc length and did gain an M1 mark if they used it with a derived angle. There was no follow through accuracy mark if the derived angle was not reflex.
Question 10(b) was not answered well either. The majority of candidates only gave the answer of 61 which is the linear scale factor. Some candidates knew to square this number but only wrote down 61^2 instead of actually evaluating it.

Areas for improvement include:
- Remembering that basic angle facts (in this case angles around a point) may be used in more complex, higher tier questions.
- Understanding the connection between the linear and area scale factor of similar shapes.

Question 13
Surprisingly, in Question 13(a), many higher tier candidates did not know which were the prime numbers. Some included 1, whilst others omitted the 2, and some did both. Otherwise, the probability element of the question was understood well.
In Question 13(b) many candidates, who did gain an M1 mark, knew to correctly evaluate or imply within a calculation 1−P(1,1,1). It was the permutations of getting a score of 4 and the associated probabilities that caused the greatest issue. A common error seen was writing P(1,1,2) as 1/4 x 1/5 x 2/6 even though P(2) also equalled 1/6. There were many ways that allowed a candidate to gain M1, and because of the errors seen, it was difficult to decide if a candidate's work was worthy of this M1 mark or not. Candidates need to show clearly what they are calculating, so that if they do not gain the full marks, then at least they can gain part marks.

Areas for improvement include:
- Be aware of the different type of numbers, e.g. the prime numbers. Prime numbers must be known for different topics such as prime factorisation.
- Understand the number of permutations that can occur for multiple events.

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[i] ***Please note that where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.***