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# Pre Paper 3H Question Bank Answers
# November 2017

GCSE Mathematics (AQA style)

Higher Tier

This set of answers is not a conventional marking scheme; while it gives a basic allocation of marks, its main purpose it to help students understand how to do each question and how they can avoid making mistakes. As such, its format is rather different from that of a normal mark scheme. Included with each answer is the statement from the specification to which it applies (where "basic foundation content" is in normal type, "additional foundation content" is in underlined type, and "higher content" is in **bold type**); content in *italics* is taken from the 'notes' sections of the specification. **All** content can be assessed on Higher tier question papers.

The following guidance is adapted from that issued by AQA

**Types of mark**

**M** Method marks are awarded for a correct method which could lead to a correct answer.

**A** Accuracy marks are awarded when following on from a correct method. It is not necessary to always see the method. This can be implied.

**B** Marks awarded independent of method.

**Working out**

Usually, if the question asks students to show working, marks are not awarded to students who show no working. As a general principle, where the questions does not ask students to show working, a correct answer is awarded full marks. However, if the answer is incorrect, students can still obtain method marks, assuming that they show some valid working out. **An incorrect answer with no working out is always awarded zero.**

**Premature approximation**

Rounding off too early can lead to inaccuracy in the final answer. This is normally penalised by 1 mark.

**Multiple choice questions**

| Q | Answer | Mark | Comments |
|---|---|---|---|
| **M1** | **N15** round numbers and measures to an appropriate degree of accuracy (eg to a specified number of decimal places or significant figures) use inequality notation to specify simple error intervals due to truncation or rounding | | |
| | $29.5 \leq x < 30.5$ | B1 | |
| **M2** | **R6** express a multiplicative relationship between two quantities as a ratio or a fraction | | |
| | 3 : 1 | B1 | |
| **M3** | **R8** relate ratios to fractions and to linear functions | | |
| | $\frac{4}{7}$ | B1 | |
| **M4** | **R9** interpret percentages and percentage changes as a fraction or a decimal, and interpret these multiplicatively | | |
| | 48 × 1.08 | B1 | |
| **M5** | **G3** understand and use alternate and corresponding angles on parallel lines; *colloquial terms such as Z angles are not acceptable and should not be used* | | |
| | alternate | B1 | |
| **M6** | **G7** identify, describe and construct congruent and similar shapes, including on coordinate axes, by considering rotation, reflection, translation and enlargement **including negative scale factors** | | |
| | *B* | B1 | |
| **M7** | **G9** identify and apply circle definitions and properties, including: centre, radius, chord, diameter, circumference tangent, arc, sector and segment | | |
| | segment | B1 | |
| **M8** | **G12** identify properties of the faces, surfaces, edges and vertices of: cubes, cuboids, prisms, cylinders, pyramids, cones and spheres | | |
| | 15 | B1 | |
| **M9** | **G13** interpret plans and elevations of 3D shapes | | |
| | 5 | B1 | |
| **M10** | **G24** describe translations as 2D vectors | | |
| | $\begin{pmatrix} 3 \\ -4 \end{pmatrix}$ | B1 | |
| **M11** | **G25** use vectors to construct geometric arguments and proofs | | |
| | **a − b** | B1 | |

| Q | Answer | Mark | Comments |
|---|---|---|---|
| **M12** | **P5** understand that empirical unbiased samples tend towards theoretical probability distributions, with increasing sample size | | |
| | $\frac{140}{400}$ | B1 | |
| **M13** | **P9 calculate and interpret conditional probabilities through representation using expected frequencies with two-way tables, tree diagrams and Venn diagrams** | | |
| | $\frac{5}{18}$ | B1 | |
| **M14** | **S4** interpret, analyse and compare the distributions of data sets from univariate empirical distributions through appropriate measures of central tendency (median, mean, mode and modal class) and spread (range, including consideration of outliers) | | |
| | $7\frac{1}{2}$ | B1 | |
| **M15** | **S4** *students should know and understand the terms: primary data, secondary data, discrete data and continuous data* | | |
| | primary | B1 | |

**Number**

| Q | Answer | Mark | Comments |
|---|---|---|---|
| **1 (a)** | **N3** use conventional notation for priority of operations, including brackets, powers, roots and reciprocals | | |
| | 16.68 ÷ 8.34 | M1 | Must see that the denominator is evaluated first. |
| | 2 | A1 | |
| **1 (b)** | **N3** use conventional notation for priority of operations, including brackets, powers, roots and reciprocals | | |
| | Trevor calculated 16.68 ÷ 2.78, then added 5.56 afterwards. Order of operations was wrong. | B1 | Any explanation **must** include some numerical calculation(s). |
| **2 (a)** | **N5** apply systematic listing strategies **including use of the product rule for counting** | | |
| | 24 arrangements of wagons | M1 | Attempts to find this by multiplying; 1 × 2 × 3 × 4 = 24 |
| | Multiplies the number of arrangements of wagons by the number of locomotives | M1 | (your 24) × 3 |
| | 72 | A1 | |
| **2 (b)** | **P7** construct theoretical possibility spaces for single and combined experiments with equally likely outcomes and use these to calculate theoretical probabilities | | |
| | 24 arrangements of wagons **or** 72 trains | M1 | Denominator = 24 **or** 72 |
| | $\frac{2}{24}$ **or** $\frac{6}{72}$ | A1 | Complete fraction. Accept decimal (0.08333…) or percentage ($8\frac{1}{3}$ %) equivalents, but **not** a ratio.<br>May be simplified to $\frac{1}{12}$, but not required here. |
| **3 (a)** | **N11** identify and work with fractions in ratio problems | | |
| | **R8** relate ratios to fractions and to linear functions | | |
| | 3 : 7 | B1 | |
| **3 (b)** | **N11** identify and work with fractions in ratio problems | | |
| | **Either** uses $\frac{3}{10}$ of 80 to find number of tiles with vowels, **or** uses correctly chosen ratio from **(a)** to do this | M1 | 80 ÷ 10 × 3 = 24, or equivalent. No follow through if incorrect ratio from **(a)** is used. |
| | 24 × 4 = 96 | M1 | You could set up an equation to use the consonants to do this; something like $\frac{7}{10} \times 80 + x = \frac{3}{4} \times (80 + x)$, the solution to which is 16, but really the vowels are easier! |
| | 16 | A1 | |

| Q | Answer | Mark | Comments |
|---|---|---|---|
| **4 (a)** | **N13** use standard units of mass, length, time, money and other measures (including standard compound measures) using decimal quantities where appropriate | | |
| | 80 ÷ 5 × 8<br>**or** 80 × 1.6<br>**or** 130 ÷ 8 × 5<br>**or** 130 ÷ 1.6 | M1 | |
| | 80 mph = 128 kph<br>**or** 130 kph = 81.25 mph | A1 | When comparing numbers, you must state the units on each (so "80 = 128" would not do). |
| | "Janet is not breaking the speed limit" box ticked | B1 | |
| **4 (b)** | **N16** apply and interpret limits of accuracy **including upper and lower bounds** | | |
| | 110 ÷ 8 × 5<br>**or** 110 ÷ 1.6 | M1 | |
| | 110 kph = 68.75 mph | A1 | |
| | 68 mph | A1 | 68.75 mph would display as 69 mph; if her speed was displayed as 69 mph she could be travelling at more than 68.75 mph/110 kph. |
| **5** | **N16** apply and interpret limits of accuracy **including upper and lower bounds** | | |
| | Any sight of a lower or upper bound for 10cm | M1 | Where a measurement is given "to the nearest…" there is likely to be an error interval or a bound to follow. Here **M1** is given for 9.5cm or 10.5cm. |
| | $1000cm^3 \div (9.5cm \times 9.5cm)$ | M1 | |
| | 11.1cm (1 decimal place) | A1 | |

**Algebra**

| Q | Answer | Mark | Comments |
|---|---|---|---|
| **6 (a)** | **A2** substitute numerical values into formulae and expressions, including scientific formulae | | |
| | $-6 \times 5 + \frac{1}{2} \times 4 \times 25$ | M1 | Choice of $s = ut + \frac{1}{2}at^2$ is implied by calculation; to start picking up marks, some substitution must be seen. You would be allowed a minor mistake in the working for **M1**. |
| | 20 | A1 | |
| **6 (b)** | substitute numerical values into formulae and expressions, including scientific formulae | | |
| | Substitution into $v^2 = u^2 + 2as$ to get $121 = u^2 + 2 \times 4 \times 9$ **or** rearranges to get $u^2 = v^2 - 2as$ | M1 | |
| | Reaches $u^2 = 49$ | M1 | |
| | $u = 7$ or $u = -7$ | A1 | Either value accepted; only one needed. |
| **7** | **A4** simplify and manipulate algebraic expressions (including those involving surds) by expanding products of two binomials | | |
| | $2x^2 + 7x - 6x - 21$ | M1 | At least three of the four terms must be correct for **M1**. |
| | $2x^2 + x - 21$ | A1 | Remember that $1x$ should be simplified to $x$. |
| **8** | **A4 simplify and manipulate algebraic expressions (including those involving surds and algebraic fractions) by expanding products of two or more binomials** | | |
| | $(2x^2 + x - 21)(x + 2)$ **or** $(2x + 7)(x^2 - x - 6)$ | M1 | These are two likely methods, but any valid method to expand the three brackets would be awarded **M1**. You would be allowed a couple of minor errors if your main method was good (any errors would be likely to cost you at least one of the **A** marks later). |
| | $2x^3 + 5x^2 - 19x - 42$ | A2 | **A2** if all four terms are correct; **A1** if three of the four terms are correct. |
| **9** | **A4** simplify and manipulate algebraic expressions (including those involving surds) by simplifying expressions involving sums, products and powers, including the laws of indices | | |
| | $\sqrt{\frac{4x^4}{y^2}}$ **or** $\sqrt{4x^4y^{-2}}$ | M1 | Simplify the fraction inside the square root first. Allow one error for **M1**. |
| | $\frac{2x^2}{y}$ **or** $2x^2y^{-1}$ | A2 | Take the square root of each term; **A2** if all three terms, including the 2, are correct; **A1** if two of the three terms are correct. |

| Q | Answer | Mark | Comments |
|---|---|---|---|
| **10 (a)** | **A5** rearrange formulae to change the subject | | |
| | Moves 5 to right hand side | M1 | Must see $\frac{a}{3} = b - 5$ |
| | $a = 3(b - 5)$ **or** $a = 3b - 15$ | A1 | Must have "$a$ =" |
| **10 (b)** | **A5** rearrange formulae to change the subject | | |
| | $p(2q - 7) = q + 3$ | M1 | Multiplies to eliminate fraction |
| | $q(2p - 1) = 3 + 7p$ | M1 | Terms in $q$ separated and factorised |
| | $q = \frac{3 + 7p}{2p - 1}$ | A1 | Must have "$q$ =". You could also have got $q = \frac{-3 - 7p}{1 - 2p}$ if you do the rearrangement in a slightly different way. |
| **11 (a)** | **A6** know the difference between an equation and an identity | | |
| | $2a = 8$ | M1 | |
| | 4 | A1 | |
| **11 (b)** | **A6** know the difference between an equation and an identity | | |
| | "your $a$" $- 1 = b$<br>**or** "your $a$"$x - x = bx$ | M1 | |
| | 5 | A1 | Tolerate $5x$ |
| **12 (a)** | **A6** argue mathematically to show algebraic expressions are equivalent, and use algebra to support and construct arguments **to include proofs** | | |
| | $n + (n + 2) + (n + 4)$ **or**<br>$2n + (2n + 2) + (2n + 4)$ | M1 | Brackets not essential here. Any letter could be used. Could also use, for example, $n$ (**or** $2n$) to represent the middle of the three numbers, giving<br>$(n - 2) + n + (n + 2) = 3n$<br>**or** $(2n - 2) + 2n + (2n + 2) = 6n$ |
| | $3n + 6$ **or** $6n + 6$ | M1 | |
| | Clear conclusion | B1 | Must follow completely correct working. If $3n + 6$, or $3n$, is used, you **must** state that it is a multiple of 6 because $n$ is even (note that, if $n$ is odd, $3n + 6$ and $3n$ are not multiples of 6). |
| **12 (b)** | **A6** argue mathematically to show algebraic expressions are equivalent, and use algebra to support and construct arguments **to include proofs** | | |
| | $n^2 + (n + 2)^2 + (n + 4)^2$ **or**<br>$2n^2 + (2n + 2)^2 + (2n + 4)^2$ | M1 | Brackets are essential here. Any letter could be used. Could also use, for example, $n$ (**or** $2n$) to represent the middle of the three numbers, giving<br>$(n - 2)^2 + n^2 + (n + 2)^2 = 3n^2 + 8$<br>**or** $(2n - 2)^2 + (2n)^2 + (2n + 2)^2 = 12n^2 + 8$ |
| | $3n^2 + 12n + 20$ **or**<br>$12n^2 + 24n + 20$ | M1 | |
| | Clear conclusion | B1 | Must follow completely correct working. |

| Q | Answer | Mark | Comments |
|---|---|---|---|
| **13 (a)** | **A7** where appropriate, interpret simple expressions as functions with inputs and outputs ***understanding and use of f(x), fg(x) and $f^{-1}(x)$ notation is expected at Higher tier*** | | |
| | $x^2 + 1 = 10$ | M1 | |
| | 3 and −3 | A1 | Both must appear. |
| **13 (b)** | **A7 interpret the reverse process as the 'inverse function'** | | |
| | Any valid method | M1 | |
| | $\sqrt{x-1}$ | A1 | Note the "order of operations" here; $\sqrt{x}$ − 1 is **A0**. |
| **13 (c)** | **A7 interpret the reverse process as the 'inverse function'** | | |
| | $gf(x) = (x + 5)^2 + 1$ | B1 | |
| | $fg(x) = x^2 + 1 + 5$ | B1 | |
| | Correct subtraction of your $gf(x) - fg(x)$ | M1 | |
| | Reaches $10(x + 2)$ | A1 | Must follow completely correct working. |
| **14 (a)** | **A9** find the equation of the line through two given points, or through one point with a given gradient | | |
| | Gradient of $PQ$ is $\frac{1}{2}$. | M1 | |
| | $y = \frac{1}{2}x + 1$<br>**or** $2y = x + 2$ | A2 | $y = mx + c$ (where m is the gradient found previously, c is any positive number) **A1**<br>$y = mx + 1$ (where m is any positive number) **A1**<br>$y = \frac{1}{2}x + c$ (where c is any positive number) **A1** |
| **14 (b)** | **A9** use the form $y = mx + c$ to identify parallel lines | | |
| | $y = \frac{1}{2}x - 3$<br>**or** $2y = x - 6$ | M1 | $y = mx + c$ (where m is the gradient used in **(a)**, c is any negative number) **M1**<br>$y = mx - 3$ (where m is any positive number) **M1**<br>$y = \frac{1}{2}x + c$ (where c is any negative number) **M1** |
| | | A1 | Correct answer. |

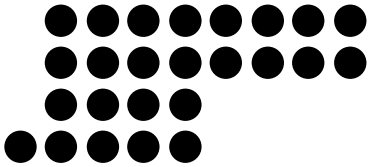
| Q | Answer | Mark | Comments |
|---|---|---|---|
| **15 (a)** | **A9** find the equation of the line through two given points, or through one point with a given gradient | | |
| | Gradient of $PQ$ is $-\frac{3}{2}$ **or** $-1\frac{1}{2}$. | M1 | |
| | $y = -\frac{3}{2}x + 2$ **or** $y = -1\frac{1}{2}x + 2$ **or** $2y = -3x + 4$ | A2 | $y = mx + c$ (where m is the gradient found previously, c is any positive number) **A1**<br>$y = mx + 2$ (where m is any positive number) **A1**<br>$y = -\frac{3}{2}x + c$ (where c is any positive number) **A1**<br>$y = -1\frac{1}{2}x + c$ (where c is any positive number) **A1** |
| | $3x + 2y - 4 = 0$ **or** $-3x - 2y + 4 = 0$ **or** $4 - 3x - 2y = 0$ | A1 | Allow follow through from answer awarded **A1** above. |
| **15 (b)** | **A9 use the form $y = mx + c$ to identify perpendicular lines** | | |
| | Gradient of perpendicular is $\frac{-1}{\text{your gradient in (a)}}$ | M1 | |
| | $y = \frac{2}{3}x - 1$ **or** $3y = 2x - 3$ **or** $3y - 2x + 3 = 0$ | M1 | $y = mx + c$ (where m is $\frac{-1}{\text{your gradient in (a)}}$, c is any negative number) **M1**<br>$y = mx - 1$ (where m is any positive number) **M1**<br>$y = \frac{2}{3}x + c$ (where c is any positive number) **M1** |
| | | A1 | Correct answer. |
| **16 (a)** | **A12** recognise, sketch and interpret graphs of linear functions and quadratic functions including simple cubic functions and the reciprocal function $y = \frac{1}{x}$ with $x \neq 0$ | | |
| | 3.2 | B1 | $3.2 = 32 \div 10$ |
| **16 (b)** | **A12** recognise, sketch and interpret graphs of linear functions and quadratic functions including simple cubic functions and the reciprocal function $y = \frac{1}{x}$ with $x \neq 0$ | | |
| | Any valid method | M1 | Could be trial and improvement, but you must show every stage of your working out for **M1**.<br>Best method, however, starts with $2x = \frac{32}{x}$ for **M1**. |
| | Either $x = 4$ or $y = 8$ seen | M1 | $2x = \frac{32}{x}$ continues to $2x^2 = 32$, $x^2 = 16$, $x = 4$ |
| | (4 , 8) | A1 | |

| Q | Answer | Mark | Comments |
|---|---|---|---|
| **17 (a)** | **A12** recognise, sketch and interpret graphs of linear functions and quadratic functions **including exponential functions $y = k^x$ for positive values of $k$** | | |
| | $a \times b^0 = 3$ **or** $a \times 1 = 3$ | M1 | |
| | 3 | A1 | |
| **17 (b)** | **A12** recognise, sketch and interpret graphs of linear functions and quadratic functions **including exponential functions $y = k^x$ for positive values of $k$** | | |
| | $3 \times b^4 = 48$ **or** $b^4 = 16$ | M1 | |
| | 2 | A1 | |
| **17 (c)** | **A12** recognise, sketch and interpret graphs of linear functions and quadratic functions **including exponential functions $y = k^x$ for positive values of $k$** | | |
| | $3 \times 2^5$ | M1 | |
| | 96 | A1 | |

| Q | Answer | Mark | Comments |
|---|---|---|---|
| **18 (a)** | **A14** plot and interpret graphs, and graphs of non-standard functions in real contexts, to find approximate solutions to problems such as simple kinematic problems involving distance, speed and acceleration | | |
| | **Both of** "The cyclist is slowing down after 20 seconds", "The cyclist's maximum speed is 14 metres per second" **ticked** | B1 | Would accept any clear indication (eg T or F for true and false, etc) - but then why don't you just tick the boxes, like you were told to… ? |
| | **and** "The cyclist is moving backwards after 20 seconds.", "The cyclist's average speed is more than 12 metres per second" **left blank** | | |
| **18 (b)** | **A15 calculate or estimate gradients of graphs and areas under graphs (including quadratic and other nonlinear graphs), and interpret results in cases such as distance-time graphs, velocity-time graphs and graphs in financial contexts** | | |
| | Recognises that area under curve gives distance covered | B1 | May be implied – could be a statement, or. any attempt to find an area. |
| | $\frac{1}{2} \times 10 \times 11$<br>$+ \frac{1}{2} \times 10 \times (11 + 14)$<br>$+ \frac{1}{2} \times 10 \times (14 + 12)$<br>$+ \frac{1}{2} \times 10 \times (12 + 11)$ | M1 | Should see division into triangle/trapezia and at least one correct area calculation. All velocities used should be correct<br><br>Can award marks for other estimates if methods are correct (eg a triangle from 0 seconds to 20 seconds and a trapezium from 20 seconds to 40 seconds). |
| | 425 | A1 | If a triangle from 0 seconds to 20 seconds and a trapezium from 20 seconds to 40 seconds is used, result will be 390. |
| **18 (c)** | **A15 calculate or estimate gradients of graphs and areas under graphs (including quadratic and other nonlinear graphs), and interpret results in cases such as distance-time graphs, velocity-time graphs and graphs in financial contexts** | | |
| | Straight lines at tops of all triangles and trapezia are under the curve, or similar. | B1 | |
| | "Underestimate" box ticked. | B1 | Cannot award second mark without a valid reason. |
| **18 (d)** | **R15** interpret the gradient at a point on a curve as the instantaneous rate of change<br>apply the concepts of average and instantaneous rate of change (gradients of chords and tangents) in numerical, algebraic and graphical contexts | | |
| | Links gradient to acceleration | B1 | Expect to see a right angled triangle drawn to a tangent at 10 seconds. |
| | Measurements obtained from triangle and divided. | M1 | Tolerate misreads if intention/method is clear here. |
| | 0.7 $m/s^2$ | A1 | Both measurements on triangle must be correct (±1 km/s and ± 1 second). Allow ±0.2 $m/s^2$ (so 5 $m/s^2$ to 9 $m/s^2$). |

| Q | Answer | Mark | Comments |
|---|---|---|---|
| **19 (a)** | **A17** solve linear equations in one unknown algebraically | | |
| | Multiplies by 5 | M1 | Must see $2x + 3 = 35$ or better ($2x + 3 = 7 \times 5$ is not enough) |
| | 16 | A1 | |
| **19 (b)** | **A4** simplify and manipulate algebraic expressions by multiplying a single term over a bracket | | |
| | **A17** solve linear equations in one unknown algebraically *including use of brackets* | | |
| | Expands brackets | M1 | Must see $4y + 8 = 26$ |
| | 4.5 or $4\frac{1}{2}$ | A1 | |
| **19 (c)** | **A17** solve linear equations in one unknown algebraically including those with the unknown on both sides of the equation | | |
| | Attempts to put terms in $z$ together | M1 | $3z + 3z = 5 - 17$. Allow one error (for example $17 - 5$), but not if the result would cancel out terms in $z$ (for example $3z - 3z$) |
| | Reaches $6z = -12$ | M1 | Care with minus signs; this should follow completely correct working and award of first **M1**. |
| | −2 | A1 | Do not award if this is "fluked" from incorrect working. |
| **19 (d)** | **A17** solve linear equations in one unknown algebraically including those with the unknown on both sides of the equation | | |
| | Attempts to put terms in $x$ together | M1 | Should see at least $\frac{x}{2} - \frac{x}{3}$ (may be reversed, for example if rearrangement puts $x$ on right hand side). |
| | Reaches $\frac{x}{6} = -\frac{7}{3}$ | M1 | or equivalent. |
| | −14 | A1 | |
| **20** | **A4 factorising quadratic expressions of the form $ax^2 + bx + c$** | | |
| | **A18** solve quadratic equations algebraically by factorising **including those that require rearrangement** | | |
| | $3x^2 - x - 2 = 0$ | M1 | Must see "=0" |
| | $(3x + 2)(x - 1) = 0$ | B1 | |
| | $-\frac{2}{3}$ | A1 | Award **A1 A0** for two correct solutions obtained from incorrect factorisation. |
| | 1 | A1 | |

| Q | Answer | Mark | Comments |
|---|---|---|---|
| **21** | **A18** solve quadratic equations algebraically **by completing the square and by using the quadratic formula** | | |
| | $\frac{6 \pm \sqrt{36 - 4 \times 1 \times (-4)}}{2 \times 1}$ | M1 | Correct attempt to use quadratic formula; must see +6 at start, for −(−6), and positive value inside the square root |
| | **or** correct method of use of completed square form found in part **(b)** | | **or**, if completing the square chosen, must see $x$ − "your 3" = ± square root of "your 13" (if 13 is not correct, must be a positive number).<br>Note that the ± (or similar) is required. |
| | 6.61 | A1 | If only one correct answer is present, without correct working, award **M0 A1 A0**. |
| **22** | **A19** solve two simultaneous equations in two variables (linear/linear) algebraically | | |
| | Correct method to obtain $x$ or $y$ | M1 | Could use elimination or substitution. A likely first step is to double the second equation (to match terms in $y$), then find $x$ from $10x - 3x = 24 - 3$ |
| | $x = 3$ | A1 | |
| | $y = -1\frac{1}{2}$ or $y = -1.5$ | A1 | |
| **23** | **A19** solve two simultaneous equations in two variables **including linear/quadratic** | | |
| | Obtains single quadratic equation in $x$ or $y$. | M1 | Either $x^2 + (5 - 2x)^2 = 25$ or $\left(\frac{5-y}{2}\right)^2 + y^2 = 25$ |
| | Reaches $5x^2 - 20x = 0$ or $5y^2 - 10y - 75 = 0$ | M1 | Must have "= 0". Either could be divided by 5. |
| | Solves quadratic to obtain any one of $x = 0$, $x = 4$, $y = -3$ or $y = 5$. | A1 | |
| | Substitutes into **linear** equation to find other unknown. | M1 | Either value found for $x$ substituted into $y = 5 - 2x$<br>or value found for $y$ substituted into $x = \frac{5-y}{2}$ |
| | $x = 0$, $y = 5$ | A1 | You **must** give the values of $x$ and $y$ correctly paired for full marks here. Something like "$x = 0$, $x = 5$, $y = 4$ and $y = -3$" would only be good for **A1 A0**. |
| | $x = 4$, $y = -3$ | A1 | |
| **24** | **A20 find approximate solutions to equations numerically using iteration, *including the use of suffix notation in recursive formulae*** | | |
| | $x_2$ = 1.91293… | M1 | 2 substituted to obtain first iterate. |
| | $x_3$ = 1.88066…<br>$x_4$ = 1.86842…<br>$x_5$ = 1.86373…<br>$x_6$ = 1.86193… | M1 | Obtains correct values for $x_5$ and $x_6$ and makes clear that, being equal to three decimal places, second decimal place will remain unchanged. |
| | 1.86 | A1 | Must be correctly rounded |

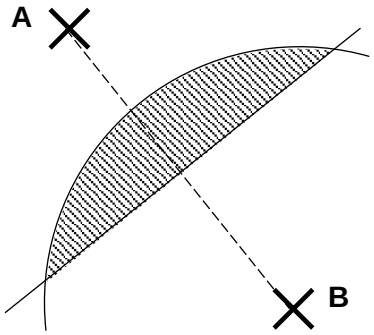
| Q | Answer | Mark | Comments |
|---|---|---|---|
| **25** | **A22 solve linear inequalities in one or two variable(s); *in graphical work the convention of a dashed line for a strict inequality and a solid line for an included inequality will be required*** | | |
| | 3 | B1 | |
| **26** | **A22 solve quadratic inequalities in one variable** | | |
| | $(x + 5)(x - 6) > 0$ | M1 | |
| | $x > 6$ or $6 < x$ | A1 | Both must appear as separate inequalities. Do not allow any marks for $-5 > x > 6$ (note that $-5 > 6$ is false). Special case marks; $-5 < x < 6$ **A1 A0**; any (otherwise correct) substitution of ≥ for > or ≤ for <, allow **A1 A0**. |
| | $x < -5$ or $-5 > x$ | A1 | |
| **27 (a)** | **A23** generate terms of a sequence from either a term-to-term or a position-to-term rule | | |
| |  | A1 | |
| **27 (b)** | **A23** generate terms of a sequence from either a term-to-term or a position-to-term rule | | |
| | Any reference to increasing by 6 from term to term. | M1 | Best as a multiplication, eg 6 × 10 + 1 or 6 × 9 + 7 |
| | 61 | A1 | |
| **27 (c)** | **A6** use algebra to support and construct arguments | | |
| | **A23** generate terms of a sequence from either a term-to-term or a position-to-term rule | | |
| | All terms in sequence are odd | B1 | Could see $6 \times n + 1 = 200$ at this stage; $n = 33\frac{1}{6}$ implies that there is not an integer that gives a pattern with 200 dots in it. |
| | "Gemma is wrong" box ticked | B1 | Cannot award second mark without a valid reason. |
| **27 (d)** | **A25** deduce expressions to calculate the *n*th terms of linear sequences | | |
| | $6n + 1$ | M1 | $6n$ + c (with any value for c) or just $6n$ seen anywhere. |
| | | A1 | |

| Q | Answer | Mark | Comments |
|---|---|---|---|
| **28 (a)** | **A24** recognise and use sequences of triangular, square and cube numbers and simple arithmetic progressions including Fibonacci-type sequences | | |
| | 8 cm | M1 | |
| **28 (b)** | **A24** recognise and use sequences of triangular, square and cube numbers and simple arithmetic progressions including Fibonacci-type sequences | | |
| | Creates Fibonacci type sequence, starting with 2, 3, 5, or starting from 8 cm length of **Rectangle 4** to give 8, 13, 21… | M1 | |
| | 55 cm | A1 | |
| **29 (a)** | **A25** deduce expressions to calculate the $n$th term of linear sequences **including quadratic sequences** | | |
| | Any valid working out | M1 | Check for calculation or valid method seen on the isometric grid |
| | 70 | A1 | |
| **29 (b)** | **A25** deduce expressions to calculate the $n$th term of linear sequences **including quadratic sequences** | | |
| | Recognises quadratic sequence | B1 | Could be $n^2$ seen anywhere, or appropriate comment based on differences between terms (eg "second difference is constant") leading to use of "quadratic". |
| | $2n^2$ seen anywhere. | M1 | |
| | $2n^2 + 4n$ | A1 | |
| **29 (c)** | **A18** solve quadratic equations algebraically by factorising | | |
| | **A25** deduce expressions to calculate the $n$th term of linear sequences **including quadratic sequences** | | |
| | Reaches $n^2 + 2n - 720 = 0$ | M1 | |
| | Any method to solve equation. | M1 | $(n + 20)(n - 18) = 0$ easiest, but formula, etc, acceptable. |
| | 18 | A1 | Condone lack of comment about the unusable negative solution. |

**Ratio**

| Q | Answer | Mark | Comments |
|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| **30** | **R1** change freely between related standard units (eg time, length, area, volume/capacity, mass) and compound units (eg speed, rates of pay, prices) in numerical and algebraic contexts compound units (eg density, pressure) | | | |
| | **R11** use compound units such as density and pressure | | | |
| | Volume of sphere = 0.00214466… $cm^3$ | M1 | Care; diameter is 0.16 cm, so the radius is 0.08 cm | Alternatively, you could find the volume of $\frac{1}{2}$ kg of lead (= 44.2478… $cm^3$) and divide by volume of one sphere. |
| | "0.00214466…" × 11.3 to find mass of sphere. | M1 | Mass = volume × density | |
| | Mass of sphere = 0.02423… g | A1 | | |
| | 500 ÷ "0.02423…" | M1 | $\frac{1}{2}$ kg = 500 g. | |
| | 20 600 | A1 | Any reasonable rounding of 20 631.60… | |

| | | | |
|---|---|---|---|
| **31 (a)** | **G2** use the standard ruler and compass constructions (perpendicular bisector of a line segment, constructing a perpendicular to a given line from/at a given point, bisecting a given angle); use these to construct given figures and solve loci problems | | |
| |  | B1 | Bisector of **AB** constructed using ruler and compasses. (Leave arcs in place; this is your "working out".) |
| | | B1 | Circle (or arc) drawn with centre **B** and radius 6.5 cm. |
| | | B1 | Correct region shaded. |

| | | | |
|---|---|---|---|
| **31 (b)** | **R2** use scale factors, scale diagrams and maps | | |
| | 1 km = 100 000 cm seen | B1 | |
| | 1 : 2 000 000 | A1 | Must be simplified, with no units present. |

| Q | Answer | Mark | Comments |
|---|---|---|---|
| **32 (a)** | **R5** divide a given quantity into two parts in a given part : part or part : whole ratio | | |
| | 12 parts = 180° | M1 | Must see 180 ÷ 12 |
| | 105° | A1 | 7 × 15° |
| **32 (b)** | **R5** divide a given quantity into two parts in a given part : part or part : whole ratio; apply ratio to real contexts and problems (such as those involving conversion, comparison, scaling, mixing, concentrations) | | |
| | 240 ÷ 3 = 80<br>440 ÷ 4 = 110<br>(may see 90 ÷ 1 = 90) | M1 | |
| | 1 part = 80 people | M1 | |
| | 240 men<br>320 women<br>80 children | A2 | **A1** for either 320 women or 80 children; all three correct required for **A2**. |
| **33 (a)** | **R9** solve problems involving percentage change, including percentage increase/decrease and original value problems, and simple interest including in financial mathematics | | |
| | Correct method to find 14% of 650 | M1 | $\frac{14}{100} \times 650$ **or** $0.14 \times 650$ **or** $1.14 \times 650$ (this last one will give you the total for Tuesday straight away).<br>You have a calculator, so don't take lots of time working out 10%, 5%, 1%, etc… |
| | 741 | A1 | |
| **33 (b)** | **R9** express one quantity as a percentage of another | | |
| | Correct method to find percentage of bricks. | M1 | $\frac{650 + \text{"your 741"}}{2\,000} \times 100$ (then subtract from 100%).<br>**or** $\frac{2000 - (650 + \text{"your 741"})}{2\,000} \times 100$ |
| | 30.45% | A1 | |
| **33 (c)** | **R9** work with percentages greater than 100%; solve problems involving percentage change, including percentage increase/decrease and original value problems, and simple interest including in financial mathematics | | |
| | Equates 104% to £572. | M1 | No marks for any method in which 4% of £572 is found. |
| | £550 | A1 | |

| Q | Answer | Mark | Comments |
|---|---|---|---|
| **34** | **R6** apply ratio to real contexts and problems (such as those involving conversion, comparison, scaling, mixing, concentrations) *including better value or best-buy problems* | | |
| | **R11** use compound units such as speed, rates of pay, unit pricing *including making comparisons* | | |
| | **Either** 1.79 ÷ 0.4 = 3.58<br>2.60 ÷ 0.75 = 3.4666…<br>and 6.99 ÷ 2 = 3.495<br>**or** 500 ÷ 1.79 = 279.32…<br>750 ÷ 2.60 = 288.46…<br>and 2000 ÷ 6.99 = 286.12…<br>**(other variants possible)** | M1 | **Either** divide the price by the quantity (to find the cost of 1 litre or 1 ml) **or** divide the quantity by the price (to find the quantity per £1 or 1p). There are several alternatives (g or kg, £1 or 1p); two are given here. |
| | | A1 | All divisions must be correct for the second mark. |
| | Large | B1 | As well as ticking the box, write down your conclusion from the calculations. Of course, ticking a box (even the correct one) with no working out will get you no marks. |

| | | | |
|---|---|---|---|
| **35 (a)** | **R12** compare lengths, areas and volumes using ratio notation scale factors; make links to similarity (including trigonometric ratios) | | |
| | Finds scale factor | M1 | 6 ÷ 2.5 = 2.4 |
| | 3 × "your 2.4" | M1 | |
| | 7.2 cm | A1 | |

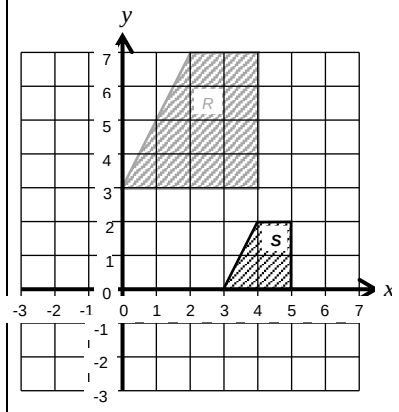
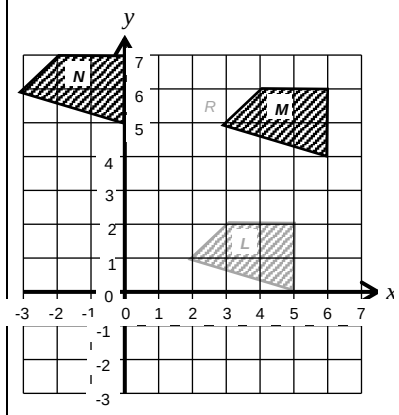
| | | | |
|---|---|---|---|
| **35 (b)** | **R12** compare lengths, areas and volumes using ratio notation scale factors; make links to similarity (including trigonometric ratios) | | |
| | 10.8 ÷ "your 2.4" from **(a)** | M1 | |
| | 4.5 cm | A1 | |

| | | | |
|---|---|---|---|
| **36 (a)** | **R13 construct and interpret equations that describe direct and inverse proportion** | | |
| | Valid statement of inverse proportion between $F$ and $d^2$ or between $\sqrt{F}$ and $d$. | B1 | $Fd^2 = k$ **or** $F = \frac{k}{d^2}$ **or** $d^2 = \frac{k}{F}$ **or** $d = \frac{k}{\sqrt{F}}$ |
| | $F = 180 \div 4^2$ | M1 | 180 from $20 \times 3^2$ (if $d = \frac{k}{\sqrt{F}}$ used, this will be $\sqrt{180}$ ). |
| | 11.25 or $11\frac{1}{4}$ | A1 | |

| | | | |
|---|---|---|---|
| **36 (b)** | **R13 construct and interpret equations that describe direct and inverse proportion** | | |
| | $d^2 = \frac{180}{5}$ | M1 | Allow follow through for **M1 A0** from incorrect 180. |
| | 6 | A1 | |

| Q | Answer | Mark | Comments |
|---|---|---|---|
| **37 (a)** | **A14** plot and interpret graphs, and graphs of non-standard functions in real contexts, to find approximate solutions to problems such as simple kinematic problems involving distance, speed and acceleration | | |
| | 1.2 km | B1 | |
| **37 (b)** | **R14** interpret the gradient of a straight-line graph as a rate of change | | |
| | Identifies *BC*. | B1 | May be implied |
| | 0.7 km travelled in 30 sec | B1 | |
| | $\frac{0.7}{30}$ km per second<br>**or** 0.7 km × 120 | M1 | |
| | 84 kph | A1 | |
| **38 (a)** | **R16** set up, solve and interpret the answers in growth and decay problems, including compound interest | | |
| | Correct method to find 8% of 450 ml. | M1 | $\frac{8}{100}$ × 450 **or** 0.08 × 450 **or** 1.08 × 450 (this last one will give you the total for 2 June straight away). |
| | Finds 8% "compounded" increases for three days. | M1 | $\frac{8}{100}$ × 486, and $\frac{8}{100}$ × 524.88<br>**or** 0.08 × 486 and 0.08 × 524.88<br>**or** 1.08 × 1.08 × 1.08 × 450 **or** $1.08^3$ × 450 (either of the last two will give you the total for 4 June straight away). |
| | 567 (566.8704) | A1 | |
| **38 (b)** | **R16** set up, solve and interpret the answers in growth and decay problems, including compound interest **and work with general iterative processes** | | |
| | Sets up iterative method | M1 | By far the best method here is a "multiplier", using 1.08 to increase the volume by 8%. |
| | Obtains 9 days just below double, 10 days just above. | M1 | $1.08^9$ × 450 = 899.552…<br>$1.08^{10}$ × 450 = 971.516…<br>Note; this can be done without using the 450 ml;<br>$1.08^9$ = 1.9990… < 2, $1.08^{10}$ = 2.1589… > 2 |
| | 10 June | A1 | |

**Geometry**

| Q | Answer | Mark | Comments |
|---|---|---|---|
| **39 (a)** | **G7** identify, describe and construct congruent and similar shapes, including on coordinate axes, by considering rotation, reflection, translation and enlargement | | |
| | Rotation | B1 | Not "turn". |
| | 90° anticlockwise<br>**or** 270° clockwise<br>**and** centre (1 , 2) | B1 | Angle/direction **and** centre needed for this mark. |
| **39 (b)** | **G7** identify, describe and construct congruent and similar shapes, including on coordinate axes, by considering rotation, reflection, translation and enlargement <u>including fractional scale factors</u> | | |
| |  | B1 | **Either** any enlargement scale factor $\frac{1}{2}$<br>**or** any enlargement centre (6 , −3). |
| | | B1 | Shape *S*; check all vertices correct. |
| **40** | **G7** identify, describe and construct congruent and similar shapes, including on coordinate axes, by considering rotation, reflection, translation and enlargement | | |
| | **G8 describe the changes and invariance achieved by combinations of rotations, reflections and translations *including using column vector notation for translations*** | | |
| |  | B1 | Any translation of *L* |
| | | B1 | Shape *M*; check all vertices correct. |
| | | B1 | Shape *M* (may be incorrect) correctly translated $\begin{pmatrix} -6 \\ 1 \end{pmatrix}$. |
| | | B1 | Shape *N* correctly translated from correct *M*;<br>check all vertices correct. |
| | Translation | B1 | |
| | using vector $\begin{pmatrix} -5 \\ 5 \end{pmatrix}$ | B1 | Must use correct vector notation (do not use statements like "5 left, 5 up", etc). |

| Q | Answer | Mark | Comments |
|---|---|---|---|
| **41 (a)** | **G10 apply and prove the standard circle theorems concerning angles, radii, tangents and chords, and use them to prove related results** | | |
| | Angle *CAB* = $82° - \frac{180° - 132°}{2}$ | M1 | |
| | Angle *CAB* = angle *PCB* using alternate segment theorem | B1 | |
| | 58° | A1 | |
| **41 (b)** | **G10 apply and prove the standard circle theorems concerning angles, radii, tangents and chords, and use them to prove related results** | | |
| | Angle *ABC* = 180° − 132° using cyclic quadrilateral | B1 | |
| | Angle *BCA* = 180° − 48° − 58° (triangle); Angle *RCQ* = angle *BCA* (vertically opposite) | B1 | **or** you could use the alternate segment theorem to find angle *ACS* (equal to angle *ABC*), then subtract this and angle *PCB* from 180° to find angle *BCA*. |
| | 74° | A1 | |
| **42** | **G17** know the formulae: circumference of a circle = $2\pi r = \pi d$; area of a circle = $\pi r^2$; calculate perimeters of 2D shapes, including circles, areas of circles and composite shapes | | |
| | Finds area of circle using $\pi \times \text{radius}^2$ | M1 | $\pi \times 1.5^2 = 7.06858…$<br>Must see radius = 1.5 m used. |
| | Correct method to find area of grass | M1 | 8 × 11 − 2 × "your 7.06858…" = 73.862…<br>Allow some mistakes (for example only taking away the area of one pond) if method/intention is clear. |
| | 73.862… $m^2$ | A1 | |
| | £55.92 | A1 | Eight bags needed (although 73.862… rounds to 70, buying only seven bags would not be enough).<br>No follow through here from incorrect area of grass. |
| **43** | **G17** surface area and volume of spheres, pyramids, cones and composite solids | | |
| | **G10 apply and prove the standard circle theorems concerning angles, radii, tangents and chords, and use them to prove related results** | | |
| | **G20** know the formula for Pythagoras' theorem, $a^2 + b^2 = c^2$ and apply to find angles and lengths in right-angled triangles in two dimensional figures | | |
| | Angle *PQR* is 90° | B1 | Circle theorem; angle in semicircle is 90° |
| | Uses Pythagoras to find length of *PR* | M1 | $PR^2 = 4.5^2 + 2.8^2$; *PR* = 5.3 cm |
| | Finds area of circle using $\pi \times \text{radius}^2$ | M1 | $\pi \times 2.65^2$<br>Must see radius = 2.65 cm used. |
| | 22.1 (22.0618…) | A1 | |

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|---|---|---|---|
| **44** | **R1** change freely between related standard units (eg time, length, area, volume/capacity, mass) and compound units (eg speed, rates of pay, prices) in numerical contexts, compound units (eg density, pressure | | |
| | **R15 apply the concepts of average and instantaneous rate of change (gradients of chords and tangents) in numerical, algebraic and graphical contexts** | | |
| | **G17** surface area and volume of spheres, pyramids, cones and composite solids *including frustums* | | |
| | **Either** volume of large cone $= \frac{1}{3} \times \pi \times 15^2 \times 24$ **or** volume of large cone $= \frac{1}{3} \times \pi \times 10^2 \times 16$ | M1 | |
| | "your $\frac{1}{3} \times \pi \times 15^2 \times 24$" − "your $\frac{1}{3} \times \pi \times 10^2 \times 16$" | M1 | |
| | 3979.35… $cm^3$ | A1 | |
| | "your 3979.35… $cm^3$" ÷ 0.5 $cm^3$ per second (= 7958.70… seconds) | M1 | Remember to use the full decimal you obtained for the volume. Could do "your 3979.35… $cm^3$" ÷ 30 $cm^3$ per minute (= 132.6… minutes) |
| | Valid method to find time after 6:00 pm | M1 | |
| | 8:12 pm | A1 | Accept 8:13 pm (from 12.645… minutes after 8:00 pm) |

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|---|---|---|---|
| **45 (a)** | **G19** apply the concepts of congruence and similarity, including the relationships between lengths in similar figures **including the relationships between lengths, areas and volumes in similar figures** | | |
| | Uses cube roots to find ratio of lengths, **or** scale factor | M1 | Ratio of lengths is $\sqrt[3]{60} : \sqrt[3]{50}$, or scale factor is $\frac{\sqrt[3]{60}}{\sqrt[3]{50}} = 1.063\ldots$, or $\frac{\sqrt[3]{50}}{\sqrt[3]{60}} = 0.941\ldots$ |
| | Uses ratio, or multiplication or division with scale factor, to find length. | M1 | 12 ÷ 1.063… or 12 × 0.941… |
| | 11.3 cm (11.2924…) | A1 | |

| | | | |
|---|---|---|---|
| **45 (b)** | **G19** apply the concepts of congruence and similarity, including the relationships between lengths in similar figures **including the relationships between lengths, areas and volumes in similar figures** | | |
| | Uses square of ratio of lengths, or of scale factor. | M1 | Ratio of areas is $\left(\sqrt[3]{60}\right)^2 : \left(\sqrt[3]{50}\right)^2$, or multiplier of areas is $(1.063\ldots)^2$, or $(0.941\ldots)^2$. Allow follow through from incorrect scale factor found in part **(a)** for this **M1**. |
| | Uses ratio, or multiplication or division with multiplier of areas. | M1 | 120 ÷ $(1.063\ldots)^2$ or 120 × $(0.941\ldots)^2$ Allow follow through from incorrect scale factor found in part **(a)** for this **M1**. |
| | 106 $cm^2$ (106.2658…) | A1 | |

| Q | Answer | Mark | Comments |
|---|---|---|---|
| **46 (a)** | **G20** know the formula for Pythagoras' theorem, $a^2 + b^2 = c^2$ and apply to find angles and lengths in right-angled triangles in two dimensional figures | | |
| | Uses Pythagoras for *DE* | M1 | Must see $DE^2 = 12^2 - 8.5^2$, or at least $12^2 = DE^2 + 8.5^2$, with numbers substituted into the formula; just writing $a^2 + b^2 = c^2$ or similar isn't enough for a mark. You can use a symbol like $x$ for *DE* if you prefer. |
| | *DE* = 8.470537… | M1 | Uses square root to get *DE*; must see $\sqrt{71.75}$. |
| | 8.47 cm | A1 | The final 0 must be present for 1 decimal place. |
| **46 (b)** | **G20** know the trigonometric ratios $\sin x = \frac{\text{opposite}}{\text{hypotenuse}}$, $\cos x = \frac{\text{adjacent}}{\text{hypotenuse}}$ and $\tan x = \frac{\text{opposite}}{\text{adjacent}}$ and apply them to find angles and lengths in right-angled triangles in two dimensional figures | | |
| | $\cos x = \frac{4.2}{5.1}$ | M1 | Not enough just to identify "trigonometry" here; you must use the correct trigonometric ratio (sin, cos or tan) and make a fraction with the numbers. |
| | $x = 34.6°$ | A1 | |
| **47** | **G16** know and apply formulae to calculate: area of triangles, parallelograms, trapezia | | |
| | **G20** know the trigonometric ratios $\sin x = \frac{\text{opposite}}{\text{hypotenuse}}$, $\cos x = \frac{\text{adjacent}}{\text{hypotenuse}}$ and $\tan x = \frac{\text{opposite}}{\text{adjacent}}$ and apply them to find angles and lengths in right-angled triangles in two dimensional figures | | |
| | Uses trigonometry to find width of symbol (or half width of symbol). | M1 | Must see 75 × cos28° |
| | Width of symbol is 132.442139… cm (half width of symbol is 66.221069… cm) | A1 | Do not round off before finding area. |
| | Finds area of parallelogram | M1 | 66.221069… cm × 40 cm × 2, or you could find the combined area using 132.442139… cm × 40 cm. |
| | 5300 $cm^2$ (5297.68555…) | A1 | |

| Q | Answer | Mark | Comments |
|---|---|---|---|
| **48 (a)** | **G22 know and apply the sine rule $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$, and cosine rule $a^2 = b^2 + c^2 - 2bc\cos A$ to find unknown lengths and angles** | | |
| | Uses sine rule | M1 | Look for $\frac{25}{\sin x°} = \frac{31}{\sin 68°}$; for **M1** allow minor errors. Must see some attempt at substitution (not just statement of sine rule formula). |
| | $\sin x° = \frac{25 \times \sin 68°}{31}$ | M1 | Completely correct |
| | 48.4° | A1 | |
| **48 (b)** | **G22 know and apply the sine rule $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$, and cosine rule $a^2 = b^2 + c^2 - 2bc\cos A$ to find unknown lengths and angles** | | |
| | Uses cosine rule | M1 | Look for $AB^2 = 3.9^2 + 4.6^2 - 2 \times 3.9 \times 4.6 \times \cos 61°$; for **M1** allow minor errors. Must see some attempt at substitution (not just statement of cosine rule formula). |
| | $AB^2 = 18.9750…$ | M1 | Completely correct |
| | 4.36 cm | A1 | |
| **48 (c)** | **G22 know and apply the sine rule $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$, and cosine rule $a^2 = b^2 + c^2 - 2bc\cos A$ to find unknown lengths and angles** | | |
| | Uses cosine rule | M1 | Look for $8^2 = 7^2 + 5.5^2 - 2 \times 7 \times 5.5 \times \cos R°$; for **M1** allow minor errors. Must see some attempt at substitution (not just statement of cosine rule formula). Again, allow **M1** if largely correct expression is seen for angle *P* or angle *Q*. |
| | $\cos R = \frac{8^2 - 7^2 - 5.5^2}{-2 \times 7 \times 5.5}$ | M1 | or equivalent, completely correct. This time must be for angle *R*, not *P* or *Q*. |
| | 78.6° | A1 | |

| Q | Answer | Mark | Comments |
|---|---|---|---|
| **49** | **G23 know and apply Area = $\frac{1}{2}ab\sin C$ to calculate the area, sides or angles of any triangle** | | |
| | Uses area of triangle = $\frac{1}{2}ab\sin C$ | M1 | Look for $20 = \frac{1}{2} \times 6 \times 8 \times \sin(180° - x)$ or<br>$20 = \frac{1}{2} \times 6 \times 8 \times \sin$(included angle)<br>for **M1** allow minor errors (for example 40 = …, or sin$x$)<br>Must see some attempt at substitution (not just statement of area = $\frac{1}{2}ab\sin C$ formula). |
| | sin(included angle) = $\frac{20}{\frac{1}{2} \times 6 \times 8}$ | M1 | Completely correct |
| | Included angle = 56.4426… | A1 | If $20 = \frac{1}{2} \times 6 \times 8 \times \sin(180° - x)$ used previously, may not need to see the 56.4426… |
| | $x$ = 123.6° | A1 | |

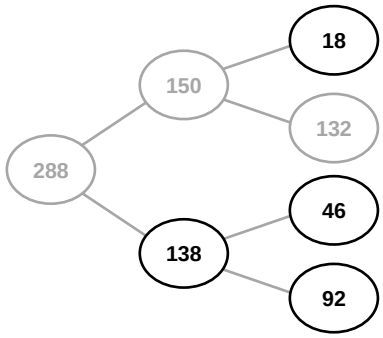
| | | | |
|---|---|---|---|
| **50 (a)** | **G25 use vectors to construct geometric arguments and proofs** | | |
| | Any valid method | M1 | At least one of $\frac{1}{2}\mathbf{a}$ or $\frac{1}{2}\mathbf{b}$ seen. |
| | $\frac{1}{2}\mathbf{a} + \frac{1}{2}\mathbf{b}$, or $\frac{1}{2}(\mathbf{a} + \mathbf{b})$ | A1 | |

| | | | |
|---|---|---|---|
| **50 (b)** | **R12** compare lengths, areas and volumes using ratio notation, scale factors; make links to similarity (including trigonometric ratios) | | |
| | Any valid method | M1 | Using triangles *AMQ* and *NRQ* (*QM* = 2*RQ*)<br>Using triangles *NOR* and *BOM* (*OM* = 2*OR*) |
| | 2 : 1 | A1 | |

| | | | |
|---|---|---|---|
| **50 (c)** | **G25 use vectors to construct geometric arguments and proofs** | | |
| | $\overrightarrow{OQ} = \frac{2}{3}\overrightarrow{OM}$ | M1 | Look for $\frac{2}{3}$ × ("your $\frac{1}{2}\mathbf{a} + \frac{1}{2}\mathbf{b}$") from part **(a)**) or similar.<br>Also allow follow through, for **M1**, from incorrect ratio in **(b)**. |
| | $\frac{1}{3}\mathbf{a} + \frac{1}{3}\mathbf{b}$, or $\frac{1}{3}(\mathbf{a} + \mathbf{b})$ | A1 | |

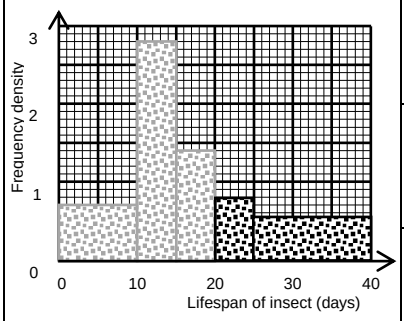
| | | | |
|---|---|---|---|
| **50 (d)** | **G25 use vectors to construct geometric arguments and proofs** | | |
| | $\overrightarrow{QA} = \overrightarrow{QO} + \overrightarrow{OA}$<br>or $\overrightarrow{QA} = \overrightarrow{QM} + \overrightarrow{MA}$ | M1 | Other |
| | $\frac{2}{3}\mathbf{a} - \frac{1}{3}\mathbf{b}$ or $\frac{1}{3}(2\mathbf{a} - \mathbf{b})$ | A1 | |

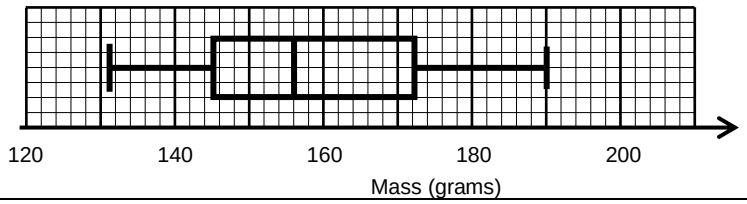
**Probability**

| Q | Answer | Mark | Comments |
|---|---|---|---|
| **51 (a)** | **P1** record, describe and analyse the frequency of outcomes of probability experiments using tables and frequency trees | | |
| |  | B1 | 18 and 138 seen |
| | | M1 | Attempts to divide 288 in ratio 2 : 7 |
| | | A1 | 64 students wear glasses<br>224 students don't wear glasses (may be implied) |
| | | B1 | 46 and 92 seen |
| **51 (b)** | **R4** use ratio notation, including reduction to simplest form | | |
| | 46 : 92 | B1 | |
| | 1 : 2 | A1 | |
| **52 (a)** | **P3** relate relative expected frequencies to theoretical probability, using appropriate language and the 0 to 1 probability scale | | |
| | 40 ÷ 0.2 or 40 × 5 | M1 | |
| | 200 | A1 | |
| **52 (b)** | **P4** apply the property that the probabilities of an exhaustive set of outcomes sum to 1; apply the property that the probabilities of an exhaustive set of mutually exclusive events sum to 1 | | |
| | 1 − (0.2 + 0.44) | M1 | |
| | Divides 0.36 so that one number is 3 times the other. | M1 | 0.27 and 0.09. Could use a ratio of 3 : 1 |
| | 0.27 **or** $\frac{27}{100}$ **or** 27% | A1 | …but not "27 out of 100", or any kind of ratio. |

| Q | Answer | Mark | Comments |
|---|---|---|---|
| **53 (a)** | **P8** calculate the probability of independent and dependent combined events, including using tree diagrams and other representations, and know the underlying assumptions | | |
| | 0.3 seen on at least one branch for “Steve wins” | B1 | |
| | All “Dennis wins” branches have 0.7 **and** all “Steve wins” branches have 0.3. | B1 | |
| **53 (b)** | **P8** calculate the probability of independent and dependent combined events, including using tree diagrams and other representations, and know the underlying assumptions *including knowing when to add and when to multiply two or more probabilities* | | |
| | 0.3 × 0.7 **or** 0.7 × 0.3 | M1 | |
| | 0.42 | A1 | Both alternatives added and correct |
| **53 (c)** | **P8** calculate the probability of independent and dependent combined events, including using tree diagrams and other representations, and know the underlying assumptions *including knowing when to add and when to multiply two or more probabilities* | | |
| | 0.3 × 0.3 × 0.3 | M1 | |
| | 0.027 | A1 | |

**Statistics**

| Q | Answer | Mark | Comments |
|---|---|---|---|
| **54 (a)** | **S3 construct and interpret diagrams for grouped discrete data and continuous data, ie histograms with equal and unequal class intervals and cumulative frequency graphs, and know their appropriate use** | | |
| | **Both of**<br>"70 insects had a lifespan of less than 10 days"<br>"Twice as many insects had a lifespan of between 10 and 15 days as had a lifespan of between 15 and 20 days"<br>**ticked** | B1 | Would accept any clear indication (eg T or F for true and false, etc) - but why not just tick the two boxes, like you were told to? |
| | **both of**<br>"28 insects had a lifespan of between 10 and 15 days"<br>"Twice as many insects had a lifespan of between 15 and 20 days as had a lifespan of less than 10 days"<br>**left blank** | | |
| **54 (b)** | **S3 construct and interpret diagrams for grouped discrete data and continuous data, ie histograms with equal and unequal class intervals and cumulative frequency graphs, and know their appropriate use** | | |
| |  | M1 | Either "280 insects less than 20 days" or "120 insects over 20 days" seen |
| | | A1 | Correct bar for 40 insects between 20 and 25 days (frequency density = 8) |
| | | A1 | Correct bar for 80 insects over 25 days<br>(frequency density = 5.33… or $5\frac{1}{3}$) |
| **54 (c)** | **S3 construct and interpret diagrams for grouped discrete data and continuous data, ie histograms with equal and unequal class intervals and cumulative frequency graphs, and know their appropriate use** | | |
| | Attempts to find 200th (maybe with 201st) insect | M1 | Must see at least 12.5 days < median < 15 days |
| | Completely correct method | M1 | $10 + \frac{130}{140} \times (15 - 10)$ or $15 - \frac{10}{140} \times (15 - 10)$ |
| | 14.6 ($14\frac{9}{14}$, 14.642857…) | A1 | |

| Q | Answer | Mark | Comments |
|---|---|---|---|
| **55 (a)** | **S4** interpret, analyse and compare the distributions of data sets from univariate empirical distributions through appropriate graphical representation involving discrete, continuous and grouped data **including box plots** and appropriate measures of central tendency (median, mean, mode and modal class) and spread (range, including consideration of outliers), **including quartiles and inter-quartile range** | | |
| | All five pieces of data correctly plotted | B2 |  |
| | Median plus **either** maximum and minimum **or** lower and upper quartiles | B1 | |

| Q | Answer | Mark | Comments | |
|---|---|---|---|---|
| **55 (b)** | **S4** interpret, analyse and compare the distributions of data sets from univariate empirical distributions through appropriate graphical representation involving discrete, continuous and grouped data **including box plots** and appropriate measures of central tendency (median, mean, mode and modal class) and spread (range, including consideration of outliers), **including quartiles and inter-quartile range** | | | |
| | On average, the potatoes in the crate are smaller | B1 | 148 grams < 156 grams. | Use numerical values to compare these, but you **must** relate the numbers to the masses of the potatoes in your comparison. |
| | The masses of the potatoes in the crate are more consistent | B1 | Use interquartile range, not range, to make this comparison.<br>20 grams < 27 grams | |

| Q | Answer | Mark | Comments |
|---|---|---|---|
| **56 (a)** | **S6** use and interpret scatter graphs of bivariate data; recognise correlation *students should know and understand the terms: positive correlation, negative correlation, no correlation, weak correlation and strong correlation* | | |
| | Greater age corresponds with greater mass | B1 | |

| Q | Answer | Mark | Comments |
|---|---|---|---|
| **56 (b)** | **S6** use and interpret scatter graphs of bivariate data; recognise correlation; know that it does not indicate causation draw estimated lines of best fit make predictions, interpolate and extrapolate apparent trends whilst knowing the dangers of so doing | | |
| | Line of best fit | M1 | The question says “Show clearly how you obtain your estimate”; you must draw the lines on the diagram that allow you to do this. |
| | 8 grams to 10 grams | A1 | **M0 A1** if this is correct with no annotation on diagram |

| Q | Answer | Mark | Comments |
|---|---|---|---|
| **56 (c)** | **S6** use and interpret scatter graphs of bivariate data; recognise correlation; know that it does not indicate causation draw estimated lines of best fit make predictions, interpolate and extrapolate apparent trends whilst knowing the dangers of so doing | | |
| | Any valid reason | B1 | 365 days much bigger than 40 days, so line would be more inaccurate away from the original data;<br>Lambs would not grow indefinitely. |

| Q | Answer | Mark | Comments |
|---|---|---|---|
| **57** | **S4** interpret, analyse and compare the distributions of data sets from univariate empirical distributions through appropriate measures of central tendency (median, mean, mode and modal class) and spread (range, including consideration of outliers) | | |
| | Correct method attempted | M1 | $0 \times 12 + 1 \times 17 + 2 \times 8 + 3 \times 3 = 42$. One error allowed for **M1** if method used is correct. |
| | Divides answer by 40 | M1 | Allow follow through from incorrect value for 42. |
| | 1.05 | A1 | or equivalent (eg $1\frac{1}{20}$). |
| **58** | **S4** interpret, analyse and compare the distributions of data sets from univariate empirical distributions through appropriate measures of central tendency (median, mean, mode and modal class) and spread (range, including consideration of outliers) | | |
| | Mid values seen | B1 | Use the middle of each interval. Should be 195, 205, 215 and 225. |
| | $11 \times 195 + 17 \times 205 +$<br>$28 \times 215 + 4 \times 225$ | M1 | If your method is right, you will be let off a small mistake here. |
| | $12550 \div 60$ | M1 | Whatever you get for the total height must be divided by the number of basketball players. |
| | 209 cm | A1 | |

| Q | Answer | Mark | Comments |
|---|---|---|---|
| **74 (b)** | **N14** use standard units of mass, length, time, money and other measures (including standard compound measures) using decimal quantities where appropriate; *imperial/metric conversions will be given in the question* | | |
| | **S4** interpret, analyse and compare the distributions of data sets from univariate empirical distributions through appropriate measures of central tendency (median, mean, mode and modal class) and spread (range, including consideration of outliers) | | |
| | Finds interval containing the median | B1 | Median is interval 210 cm < $h$ ≤ 220 cm |
| | Converts 7 feet to cm | M1 | 7 × 30.4 = 212.8 cm |
| | “Scott could be right” ticked | A1 | Median is greater than 210 cm but could be less than 212.8 cm (so less than 7 feet). |