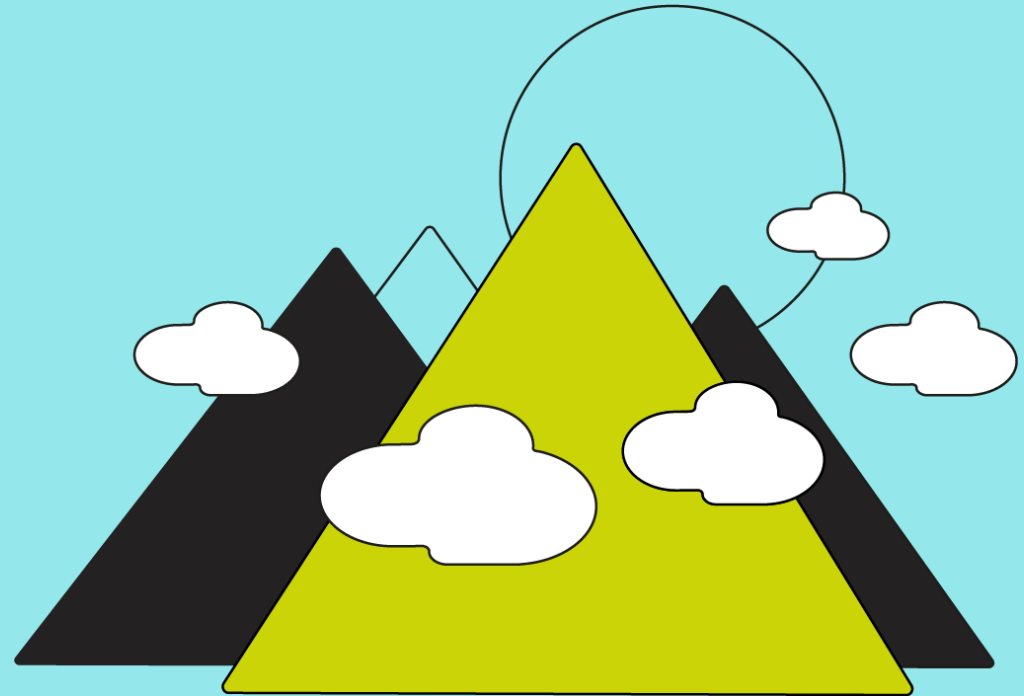


Pearson Edexcel AS and A level Maths:

Marking Guidance

Mark Heslop



Agenda

- General Marking Guidance
- A Level Pure
- A Level Statistics
- A Level Mechanics



Calculator Guidance

Calculators may always be used to check answers.

Students should write down any equations that they are solving, so these can be checked and credit given.

We will always include instructions in questions to indicate that the use of a calculator is **not** permitted. Phrases used to signal that calculators should **not** be used include:

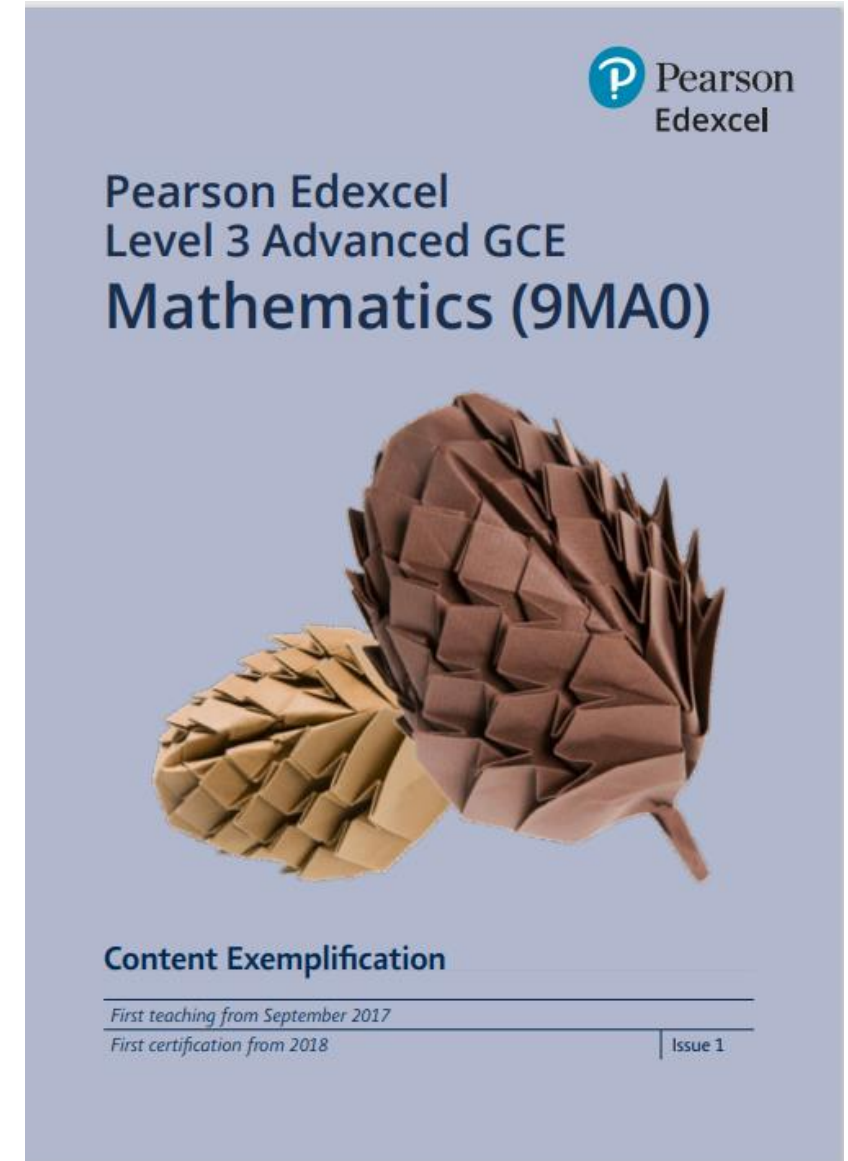
- Solutions relying entirely on calculator technology are not acceptable.
- Solutions based entirely on graphical or numerical methods are not acceptable.
- Numerical (calculator) integration/differentiation is not accepted in this question.
- Use algebraic integration/differentiation to ...
- Use algebra to ...
- Show that ...
- Prove that ...

Using a calculator in statistics

Students will need to be able to find probabilities for a binomial distribution using their calculators.

Students are expected to use a calculator to find probabilities for a Normal distribution.

When finding a critical region or using an inverse Normal, we cannot assume that all students will be able to do this using a calculator and so tables of values are provided. However, if students do have the facility to do this on their calculator then that is an acceptable method.



Please check the examination details below before entering your candidate information

Candidate surname

Centre Number

Candidate Number

Pearson Edexcel Level 1

Time 2 hours

Paper reference

Mathematics

Advanced

PAPER 1: Pure Mathematics 1

You must have:

Mathematical Formulae and Statistical Tables (G)

Candidates may use any calculator allowed by Pearson regulations. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided
– *there may be more space than you need.*
- You should show sufficient working to make your methods clear. ←
- Inexact answers should be given to three significant figures unless otherwise stated. ←

Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- There are 16 questions in this question paper. The total mark for this paper is 100.
- The marks for each question are shown in brackets
– *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

...ing ... lie.

- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.



Types of Marks

The Edexcel Mathematics mark schemes use the following types of marks.

- **M** marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- **A** marks: accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- **B** marks are unconditional accuracy marks (independent of M marks)

Marks should not be subdivided.

Mark Scheme Notes

These are some of the traditional marking abbreviations that will appear in the mark schemes.

- bod – benefit of doubt
- ft – follow through
- the symbol \surd will be used for correct ft
- cao – correct answer only
- cso – correct solution only. There must be no errors in this part of the question to obtain this mark.
- isw – ignore subsequent working
- awrt – answers which round to

Mark Scheme Notes

- SC: special case
- oe – or equivalent (and appropriate)
- dep – dependent
- indep – independent
- dp decimal places
- sf significant figures
- * The answer is printed on the paper
- □ The second mark is dependent on gaining the first mark

Mark Scheme Notes

- For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.
- Where a candidate has made multiple responses and indicates which response they wish to submit, examiners should mark this response. If there are several attempts at a question which have not been crossed out, examiners should mark the final answer which is the answer that is the most complete.
- Ignore wrong working or incorrect statements following a correct answer.
- Mark schemes will firstly show the solution judged to be the most common response expected from candidates. Where appropriate, alternative answers are provided in the notes. If examiners are not sure if an answer is acceptable, they will check the mark scheme to see if an alternative answer is given for the method used.

Mark Scheme Notes

Use of a formula

Where a method involves using a formula that has been learnt, the advice given in recent examiners' reports is that the formula should be quoted first.

Normal marking procedure is as follows:

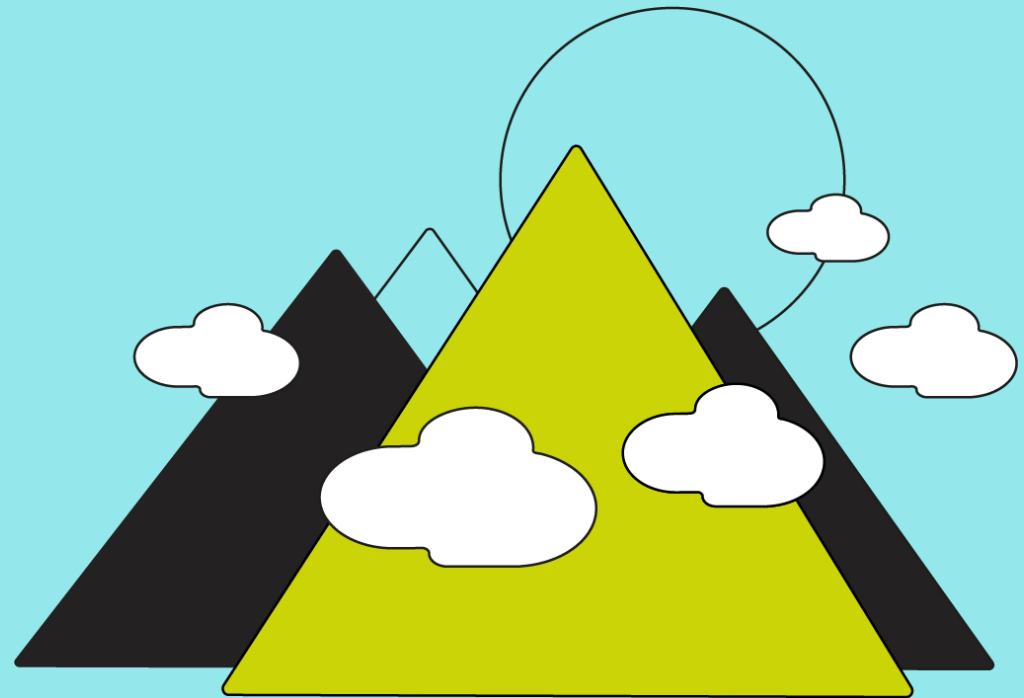
Method mark for quoting a correct formula and attempting to use it, even if there are small errors in the substitution of values.

Where the formula is not quoted, the method mark can be gained by implication from correct working with values but may be lost if there is any mistake in the working.

Exact answers

Examiners' reports have emphasised that where, for example, an exact answer is asked for, or working with surds is clearly required, marks will normally be lost if the candidate resorts to using rounded decimals.

Marking guidance: Pure



Mark Scheme Notes

General Principles for Further Pure Mathematics Marking

(But note that specific mark schemes may sometimes override these general principles)

Method mark for solving 3 term quadratic:

1. Factorisation

$(x^2 + bx + c) = (x + p)(x + q)$, where $|pq| = |c|$, leading to $x = \dots$

$(ax^2 + bx + c) = (mx + p)(nx + q)$, where $|pq| = |c|$ and $|mn| = |a|$, leading to $x = \dots$

2. Formula

Attempt to use the correct formula (with values for a , b and c)

3. Completing the square

Solving $x^2 + bx + c = 0$: $\left(x \pm \frac{b}{2}\right)^2 \pm q \pm c = 0$, $q \neq 0$, leading to $x = \dots$

Mark Scheme Notes

Method marks for differentiation and integration:

1. Differentiation

Power of at least one term decreased by 1. ($x^n \rightarrow x^{n-1}$)

2. Integration

Power of at least one term increased by 1. ($x^n \rightarrow x^{n+1}$)

Let's have a go!

$$f(x) = (x-4)(x^2 - 3x + k) - 42 \text{ where } k \text{ is a constant}$$

Given that $(x+2)$ is a factor of $f(x)$, find the value of k .

$$\begin{aligned} &(2-4)(2^2 - 3(2) + k) - 42 \\ &(-2)(4 - 6 + k) - 42 = 0 \\ &(-2)(-2 + k) - 42 = 0 \\ &4 - 2k - 42 = 0 \\ &-2k = 38 \\ &k = -19 \end{aligned}$$

Question	Scheme	Marks
2	Sets $f(-2) = 0 \Rightarrow (-2-4)((-2)^2 - 3 \times -2 + k) - 42 = 0$	M1
	$-6(k+10) = 42 \Rightarrow k = \dots$	M1
	$k = -17$	A1

M1: Attempts $f(-2) = 0$ leading to an equation in k . So $(-2-4)((-2)^2 - 3 \times -2 + k) - 42 = 0$ is fine

Condone slips but expect to see a first bracket of $(-2-4)$

"-42" must not be omitted but could appear as +42 with a sign slip.

There may have been attempts to expand $f(x) = (x-4)(x^2 - 3x + k) - 42$ before attempting to set $f(-2) = 0$. This is acceptable and condone slips/errors in the expansion, but the 42 must be present. FYI the expanded (and simplified) $f(x) = x^3 - 7x^2 + (12+k)x - 4k - 42$

M1: Solves a **linear** equation in k as a result of setting $f(\pm 2) = 0$.

The ± 42 must be there at some point when the substitution is made.

Allow minimal evidence here. A linear equation leading to a solution is fine.

If $f(x)$ is expanded then it is dependent upon being a cubic which contains a kx term and a '42'

A1: $k = -17$ correct answer following correct work but allow recovery from invisible brackets

Answers of $k = -17$ may appear with very little or no working, perhaps via trial and improvement. If so, then marks can only be allocated if evidence is shown.

$$\text{E.g. } k = -17 \Rightarrow f(x) = (x-4)(x^2 - 3x - 17) - 42$$

$$f(-2) = (-6) \times (-7) - 42 = 0. \text{ Hence } (x+2) \text{ is a factor.}$$

AS Level Maths 2020 Paper 1 Qu 6

- 6 (a) Find the first 4 terms, in ascending powers of x , in the binomial expansion of $(1 + kx)^{10}$

where k is a non-zero constant. Write each coefficient as simply as possible.

Given that in the expansion of $(1 + kx)^{10}$ the coefficient x^3 is 3 times the coefficient of x ,

- (b) find the possible values of k .

(3)

(3)

(Total for Question 6 is 6 marks)

Question	Scheme	Marks	AOs
6 (a)	$(1 + kx)^{10} = 1 + \binom{10}{1}(kx)^1 + \binom{10}{2}(kx)^2 + \binom{10}{3}(kx)^3 \dots$	M1 A1	1.1b 1.1b
	$= 1 + 10kx + 45k^2x^2 + 120k^3x^3 \dots$	A1	1.1b
		(3)	

M1: An attempt at the binomial expansion. This may be awarded for either the second or third term or fourth term. The coefficients may be of the form $^{10}C_1$, $\binom{10}{2}$ etc or eg $\frac{10 \times 9 \times 8}{3!}$

A1: A correct unsimplified binomial expansion. The coefficients must be numerical so cannot be of the form $^{10}C_1$, $\binom{10}{2}$. Coefficients of the form $\frac{10 \times 9 \times 8}{3!}$ are acceptable for this mark.

The bracketing must be correct on $(kx)^2$ but allow recovery

A1: $1 + 10kx + 45k^2x^2 + 120k^3x^3 \dots$ or $1 + 10(kx) + 45(kx)^2 + 120(kx)^3 \dots$

Allow if written as a list.

A Level Maths 2022 Paper 1 Qu 1

1. The point $P(-2, -5)$ lies on the curve with equation $y = f(x)$, $x \in \mathbb{R}$

Find the point to which P is mapped, when the curve with equation $y = f(x)$ is transformed to the curve with equation

(a) $y = f(x) + 2$

(b) $y = |f(x)|$

(c) $y = 3f(x - 2) + 2$

Question	Scheme	Marks	AOs
1 (a)	$(-2, -3)$	B1	1.1b
		(1)	
(b)	$(-2, 5)$	B1	1.1b
		(1)	
(c)	Either $x = 0$ or $y = -13$	M1	1.1b
	$(0, -13)$	A1	1.1b
		(2)	
(4 marks)			

Watch for answers in the body of the question and on sketch graphs. This is acceptable.

If coordinates are written by the question and in the main answer section the answer section takes precedence.

(a)

B1: Accept without brackets. May be written $x = -2, y = -3$

(b)

B1: Accept without brackets. May be written $x = -2, y = 5$

(c)

M1: For either coordinate. E.g. $(0, \dots)$ or $(\dots, -13)$

If they are building up their solution in stages e.g. $(-2, -5) \rightarrow (0, -5) \rightarrow (0, -15) \rightarrow (0, -13)$
only mark their final coordinate pair

A1: Correct coordinates. See above for building up solution in stages

Accept without brackets. May be written $x = 0, y = -13$

SC 10 for candidates who write $(-13, 0)$

A Level Maths 2022 Paper 1 Qu 5

5. The height, h metres, of a tree, t years after being planted, is modelled by the equation

$$h^2 = at + b \quad 0 \leq t < 25$$

where a and b are constants.

Given that

- the height of the tree was 2.60 m, exactly 2 years after being planted
- the height of the tree was 5.10 m, exactly 10 years after being planted

- (a) find a complete equation for the model, giving the values of a and b to 3 significant figures. (4)

Given that the height of the tree was 7 m, exactly 20 years after being planted

- (b) evaluate the model, giving reasons for your answer. (2)

Many went to a great deal of effort to solve the simultaneous equations using algebraic methods, whereas some just put the equations into a calculator and wrote down the values of the constants a and b .

Question	Scheme	Marks	AOs
5 (a)	Attempts to use $h^2 = at + b$ with either $t = 2, h = 2.6$ or $t = 10, h = 5.1$	M1	3.1b
	Correct equations $2a + b = 6.76$ $10a + b = 26.01$	A1	1.1b
	Solves simultaneously to find values for a and b	dM1	1.1b
	$h = 2.41t + 1.95$ cao	A1	3.3
		(4)	

$$\begin{aligned}
 a) \quad h^2 &= at + b \\
 \textcircled{1} \quad (2.6)^2 &= a(2) + b \\
 \textcircled{2} \quad (5.1)^2 &= a(10) + b \\
 \textcircled{3} \quad 6.76 &= 2a + b \\
 \textcircled{4} \quad 26.01 &= 10a + b \\
 \textcircled{2} - \textcircled{1} &= 19.25 = 8a \\
 a &= 19.25 / 8 = 2.40625 \approx 2.41 \\
 2(2.41) + b &= 6.76 \\
 b &= 1.95 \quad a = 2.41
 \end{aligned}$$

dM1: Solves simultaneously to find values for a and b . It is dependent upon the previous M
Don't be too concerned with the process here as calculators may be used.
Score if values of a and b are reached from a pair of simultaneous equations

A Level Maths 2022 Paper 1 Qu 6

6.

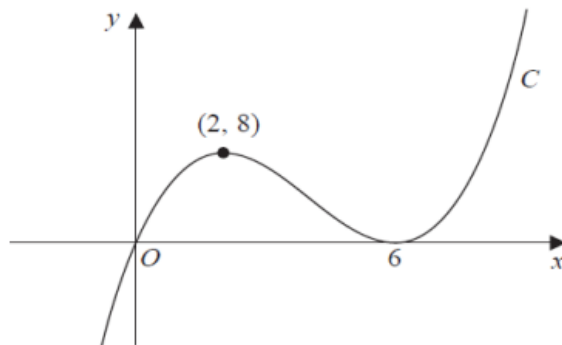


Figure 1

Figure 1 shows a sketch of a curve C with equation $y = f(x)$ where $f(x)$ is a cubic expression in x .

The curve

- passes through the origin
- has a maximum turning point at $(2, 8)$
- has a minimum turning point at $(6, 0)$

(a) Write down the set of values of x for which

$$f'(x) < 0$$

The line with equation $y = k$, where k is a constant, intersects C at only one point.

(b) Find the set of values of k , giving your answer in set notation.

(c) Find the equation of C . You may leave your answer in factorised form.

(b)

States either $k > 8$ or $k < 0$

M1

3.1a

States e.g. $\{k : k > 8\} \cup \{k : k < 0\}$

A1

2.5

(2)

b) $k: \{y > 8\} \cup \{y < 0\}$

B1: Deduces $2 < x < 6$ o.e. such as $x > 2, x < 6$ $x > 2$ and $x < 6$ $\{x : x > 2\} \cap \{x : x < 6\}$ $x \in (2, 6)$

Condone attempts in which set notation is incorrectly attempted but correct values can be seen or implied E.g. $\{x > 2\} \cap \{x < 6\}$ $\{x > 2, x < 6\}$. Allow just the open interval $(2, 6)$

Do not allow for incorrect inequalities such as e.g. $x > 2$ or $x < 6$, $\{x : x > 2\} \cup \{x : x < 6\}$ $x \in [2, 6]$

(1)

(2)

(3)

(Total for Question 6 is 6 marks)

A Level Maths 2022 Paper 1 Qu 10

A scientist is studying the number of bees and the number of wasps on an island.

The number of bees, measured in thousands, N_b , is modelled by the equation

$$N_b = 45 + 220 e^{0.05t}$$

where t is the number of years from the start of the study.

According to the model,

(a) find the number of bees at the start of the study,

(1)

(b) show that, exactly 10 years after the start of the study, the number of bees was increasing at a **rate** of approximately 18 thousand per year.

(3)

The number of wasps, measured in thousands, N_w , is modelled by the equation

$$N_w = 10 + 800 e^{-0.05t}$$

where t is the number of years from the start of the study.

When $t = T$, according to the models, there are an equal number of bees and wasps.

(c) Find the value of T to 2 decimal places.

(4)

(Total for Question 10 is 8 marks)

A Level Maths 2022 Paper 1 Qu 10

A scientist is studying the number of bees and the number of wasps on an island.

The number of bees, measured in thousands, N_b , is modelled by the equation

$$N_b = 45 + 220 e^{0.05t}$$

where t is the number of years from the start of the study.

According to the model,

(a) find the number of bees at the start of the study,

(b) show that, exactly 10 years after the start of the study, the number of bees was increasing at a **rate** of approximately 18 thousand per year.

Attempts $\frac{dN_b}{dt} = 11 e^{0.05t}$	M1
Substitutes $t = 10$ into their $\frac{dN_b}{dt}$	M1
$\frac{dN_b}{dt} = \text{awrt } 18.1$ which is approximately 18 thousand per year *	A1*

(3)

M1: Substitutes $t = 10$ into a changed function that was formed from an attempt at differentiation.

The left hand side must have implied differentiation. E.g. Rate = , N' , $\frac{dN_b}{dt}$, $\frac{dN}{dt}$ or even $\frac{dy}{dx}$

A1*: Full and complete proof that requires

- some correct lhs seen at some point. E.g. "Rate = , " $\frac{dN_b}{dt}$, $\frac{dN}{dt}$ but condone N' .
- an intermediate line/answer of either $11 e^{0.05 \times 10}$ or awrt 18.1 before a minimal conclusion which must be referencing the 18 000 or 18 thousand

A Level Maths 2022 Paper 1 Qu 10

The number of bees, measured in thousands, N_b , is modelled by the equation

$$N_b = 45 + 220 e^{0.05t}$$

The number of wasps, measured in thousands, N_w , is modelled by the equation

$$N_w = 10 + 800 e^{-0.05t}$$

where t is the number of years from the start of the study.

When $t = T$, according to the models, there are an equal number of bees and wasps.

(c) Find the value of T to 2 decimal places.

(4)

(c)	Sets $45 + 220e^{0.05t} = 10 + 800e^{-0.05t} \Rightarrow 220e^{0.05t} + 35 - 800e^{-0.05t} = 0$	M1	3.1b
	Correct quadratic equation $\Rightarrow 220(e^{0.05t})^2 + 35e^{0.05t} - 800 = 0$	A1	1.1b
	$e^{0.05t} = 1.829, (-1.988) \Rightarrow 0.05t = \ln(1.829)$	M1	2.1
	$T = 12.08$	A1	1.1b
		(4)	

A Level Maths 2022 Paper 1 Qu 10

(c) Find the value of T to 2 decimal places.

a) $45 + 220e^{0.05 \times 0} = 265000$ (4)

b) $\frac{dN_t}{dt} = 11e^{0.05t}$ $45 + 220e^{0.05 \times 10} = 407$
 407000
 $407000 - 256000 = 151000$
 $\frac{191000}{10} = 19100$ $\frac{151000}{10} = 15100$
 $15100 \approx 18000$

$10 + 800e^{-0.05t} = 45 + 220e^{0.05t}$

$800e^{-0.05t} - 220e^{0.05t} = 35$

Let $-45t = 11t = 35$
 $-54t = 35$

So, $t = 12.08$ years

(c)	Sets $45 + 220e^{0.05t} = 10 + 800e^{-0.05t} \Rightarrow 220e^{0.05t} + 35 - 800e^{-0.05t} = 0$	M1	3.1b
	Correct quadratic equation $\Rightarrow 220(e^{0.05t})^2 + 35e^{0.05t} - 800 = 0$	A1	1.1b
	$e^{0.05t} = 1.829, (-1.988) \Rightarrow 0.05t = \ln(1.829)$	M1	2.1
	$T = 12.08$	A1	1.1b
		(4)	

Answers with limited or no working in (b) and (c)

(b) A derivative in the correct form must be seen

(c) Candidates who state $45 + 220e^{0.05t} = 10 + 800e^{-0.05t}$ followed by awrt 12.08 (presumably from using num-solv on their calculators) can score SC 1100. Rubric on the front of the paper states that "Answers without working may not gain full credit" so we demand a method in this part.

A Level Maths 2022 Paper 1 Qu 11

11.

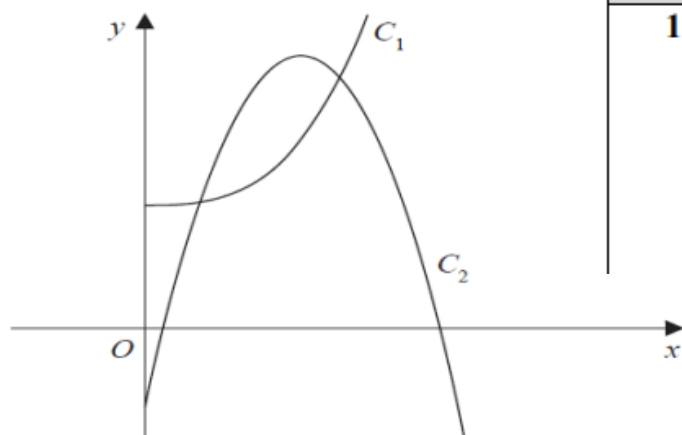


Figure 4

Figure 4 shows a sketch of part of the curve C_1 with equation

$$y = 2x^3 + 10 \quad x > 0$$

and part of the curve C_2 with equation

$$y = 42x - 15x^2 - 7 \quad x > 0$$

(a) Verify that the curves intersect at $x = \frac{1}{2}$

The curves intersect again at the point P

(b) Using algebra and showing all stages of working, find the exact x coordinate of P

(Total for Question 11 is 7 r

Question	Scheme	Marks	AOs
11 (a)	Substitutes $x = \frac{1}{2}$ into $y = 2x^3 + 10$ and $y = 42x - 15x^2 - 7$ and finds the y values for both	M1	1.1b
	Achieves $\frac{41}{4}$ o.e. for both and makes a valid conclusion. *	A1*	2.4
		(2)	

$$\begin{aligned}
 &a) 42x - 15x^2 - 7 = 2x^3 + 10 \\
 &2x^3 + 15x^2 - 42x + 17 = 0 \\
 &f\left(\frac{1}{2}\right) = 2\left(\frac{1}{2}\right)^3 + 15\left(\frac{1}{2}\right)^2 - 42\left(\frac{1}{2}\right) + 17 = 0 \\
 &\therefore (x - \frac{1}{2}) \text{ is a factor, so } \frac{1}{2} \text{ is an intersect.}
 \end{aligned}$$

A1*: Correct calculations must be seen with a minimal conclusion that curves intersect (at $x = \frac{1}{2}$).

$$\text{E.g. } 2\left(\frac{1}{2}\right)^3 + 10 = 10.25 \text{ and } 42\left(\frac{1}{2}\right) - 15\left(\frac{1}{2}\right)^2 - 7 = 10.25 \text{ so curves intersect.}$$

Acceptable alternatives are:

$$f(x) = 42x - 15x^2 - 7 - 2x^3 - 10, f\left(\frac{1}{2}\right) = 42\left(\frac{1}{2}\right) - 15\left(\frac{1}{2}\right)^2 - 7 - 2\left(\frac{1}{2}\right)^3 - 10 = 0 \Rightarrow \text{so curves intersect}$$

$$f(x) = 2x^3 + 15x^2 - 42x + 17 \Rightarrow \left(x - \frac{1}{2}\right)\left(2x^2 + 16x - 34\right) \text{ so } x = \frac{1}{2} \text{ is a root so curves intersect}$$

$$f(x) = 2x^3 + 15x^2 - 42x + 17 \Rightarrow (2x - 1)(x^2 + 8x - 17) \text{ so } (2x - 1) \text{ is a factor hence curves intersect}$$

A Level Maths 2022 Paper 2 Qu 1

1.

In this question you must show all stages of your working.

Solutions relying entirely on calculator technology are not acceptable.

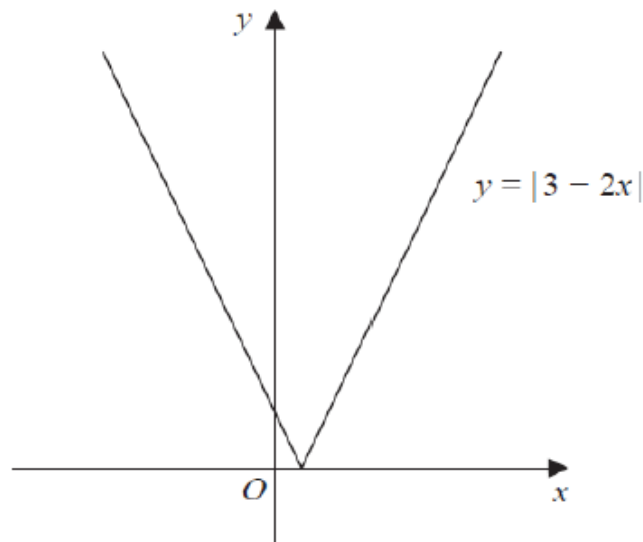


Figure 1

Figure 1 shows a sketch of the graph with equation $y = |3 - 2x|$

Solve

$$|3 - 2x| = 7 + x$$

(4)

(Total for Question 1 is 4 marks)

A Level Maths 2022 Paper 2 Qu 1

Solve

$$|3 - 2x| = 7 + x$$

(4)

(Total for Question 1 is 4 marks)

Question	Scheme	Marks	AOs
1	For an attempt to solve Either $3 - 2x = 7 + x \Rightarrow x = \dots$ or $2x - 3 = 7 + x \Rightarrow x = \dots$	M1	1.1b
	Either $x = -\frac{4}{3}$ or $x = 10$	A1	1.1b
	For an attempt to solve Both $3 - 2x = 7 + x \Rightarrow x = \dots$ and $2x - 3 = 7 + x \Rightarrow x = \dots$	dM1	1.1b
	For both $x = -\frac{4}{3}$ and $x = 10$ with no extra solutions	A1	1.1b
		(4)	

Is w if necessary e.g. ignore subsequent attempts to put the values in an inequality e.g. $-\frac{4}{3} < x < 10$

But if e.g. $x = -\frac{4}{3}$ is obtained and a candidate states $x = \left| -\frac{4}{3} \right|$ then score A0

A Level Maths 2022 Paper 2 Qu 1

$$\begin{array}{l}
 y = 7 + x \\
 \begin{array}{r}
 4 7 \\
 x \overline{) 0 7} \\
 \underline{- 7 0} \\
 0 0
 \end{array} \\
 3 - 2x = 7 + x \\
 -3x = 4 \\
 x = -\frac{4}{3} \quad y = 7 - \frac{4}{3} \quad y = \frac{17}{3} \\
 -3 + 2x = 7 + x \\
 x = 10 \quad y = 7 + 10 \\
 \quad y = 17
 \end{array}$$

	Scheme	Marks	AOs
1	For an attempt to solve Either $3 - 2x = 7 + x \Rightarrow x = \dots$ or $2x - 3 = 7 + x \Rightarrow x = \dots$	M1	1.1b
	Either $x = -\frac{4}{3}$ or $x = 10$	A1	1.1b
	For an attempt to solve Both $3 - 2x = 7 + x \Rightarrow x = \dots$ and $2x - 3 = 7 + x \Rightarrow x = \dots$	dM1	1.1b
	For both $x = -\frac{4}{3}$ and $x = 10$ with no extra solutions	A1	1.1b
		(4)	

Is w if necessary e.g. ignore subsequent attempts to put the values in an inequality e.g. $-\frac{4}{3} < x < 10$

But if e.g. $x = -\frac{4}{3}$ is obtained and a candidate states $x = \left| -\frac{4}{3} \right|$ then score A0

A Level Maths 2022 Paper 2 Qu 12

The function f is defined by

$$f(x) = \frac{e^{3x}}{4x^2 + k}$$

where k is a positive constant.

(a) Show that

$$f'(x) = (12x^2 - 8x + 3k) g(x)$$

where $g(x)$ is a function to be found.

Question	Scheme	Marks	AOs
12(a)	$f(x) = \frac{e^{3x}}{4x^2 + k} \Rightarrow f'(x) = \frac{(4x^2 + k)3e^{3x} - 8xe^{3x}}{(4x^2 + k)^2}$ <p>or</p> $f(x) = e^{3x}(4x^2 + k)^{-1} \Rightarrow f'(x) = 3e^{3x}(4x^2 + k)^{-1} - 8xe^{3x}(4x^2 + k)^{-2}$	M1 A1	1.1b 1.1b
	$f'(x) = \frac{(12x^2 - 8x + 3k)e^{3x}}{(4x^2 + k)^2}$	A1	2.1
		(3)	

(3)

A Level Maths 2022 Paper 2 Qu 12

M1: Attempts the quotient rule to obtain an expression of the form $\frac{\alpha(4x^2 + k)e^{3x} - \beta xe^{3x}}{(4x^2 + k)^2}, \alpha, \beta > 0$

condoning bracketing errors/omissions as long as the intention is clear.

If the quotient rule formula is quoted it must be correct.

Condone e.g. $f'(x) = \frac{(4x^2 + k)3e^{3x} - 8xe^{3x}}{(4x^2 + k)}$ provided an incorrect formula is not quoted.

A1: Correct differentiation in any form with correct bracketing.

A1: Obtains $f'(x) = (12x^2 - 8x + 3k)g(x)$ where $g(x) = \frac{e^{3x}}{(4x^2 + k)^2}$ or equivalent

Allow recovery from “invisible” brackets earlier and apply isw here once a correct answer is seen.

A Level Maths 2022 Paper 2 Qu 1

$$f(x) = \frac{e^{3x}}{4x^2 + k}$$

Let $f(x) = \frac{u}{v}$

$$u = e^{3x} \quad v = 4x^2 + k$$

$$\frac{du}{dx} = 3e^{3x} \quad \frac{dv}{dx} = 8x$$

$$\therefore f'(x) = \frac{4x^2 + k (3e^{3x}) - e^{3x} (8x)}{(4x^2 + k)^2}$$

$$= \frac{12x^2 e^{3x} + 3k e^{3x} - 8x e^{3x}}{(4x^2 + k)^2}$$

$$= \frac{e^{3x} (12x^2 - 8x + 3k)}{(4x^2 + k)^2}$$

$$= \frac{e^{3x}}{(4x^2 + k)^2} \times (12x^2 - 8x + 3k)$$

$$g(x) = \frac{e^{3x}}{(4x^2 + k)^2}$$

Question	Scheme	Marks	AOs
12(a)	$f(x) = \frac{e^{3x}}{4x^2 + k} \Rightarrow f'(x) = \frac{(4x^2 + k)3e^{3x} - 8xe^{3x}}{(4x^2 + k)^2}$	M1 A1	1.1b 1.1b
	or $f(x) = e^{3x} (4x^2 + k)^{-1} \Rightarrow f'(x) = 3e^{3x} (4x^2 + k)^{-1} - 8xe^{3x} (4x^2 + k)^{-2}$		
	$f'(x) = \frac{(12x^2 - 8x + 3k)e^{3x}}{(4x^2 + k)^2}$	A1	2.1
		(3)	

NOTES:

(a)

M1: Attempts the quotient rule to obtain an expression of the form $\frac{\alpha(4x^2 + k)e^{3x} - \beta xe^{3x}}{(4x^2 + k)^2}$, $\alpha, \beta \neq 0$

condoning bracketing errors/omissions as long as the intention is clear.
If the quotient rule formula is quoted it must be correct.

Condone e.g. $f'(x) = \frac{(4x^2 + k)3e^{3x} - 8xe^{3x}}{(4x^2 + k)^2}$ provided an incorrect formula is not quoted.

May also see product rule applied to $e^{3x} (4x^2 + k)^{-1}$ to obtain an expression of the form

$\alpha e^{3x} (4x^2 + k)^{-1} + \beta x e^{3x} (4x^2 + k)^{-2}$, $\alpha, \beta \neq 0$ condoning bracketing errors/omissions as long as the intention is clear. If the product rule formula is quoted it must be correct.

A1: Correct differentiation in any form with correct bracketing.

A1: Obtains $f'(x) = (12x^2 - 8x + 3k)g(x)$ where $g(x) = \frac{e^{3x}}{(4x^2 + k)^2}$ or equivalent

A Level Maths 2022 Paper 2 Qu 15

In this question you must show all stages of your working.

Solutions relying on calculator technology are not acceptable.

Given that the first three terms of a geometric series are

$$12 \cos \theta, 5 + 2 \sin \theta \quad \text{and} \quad 6 \tan \theta$$

(a) show that

$$4 \sin^2 \theta - 52 \sin \theta + 25 = 0 \quad (3)$$

Given that θ is an obtuse angle measured in radians,

(b) solve the equation in part (a) to find the exact value of θ (2)

(c) show that the sum to infinity of the series can be expressed in the form

$$k(1 - \sqrt{3})$$

where k is a constant to be found.

(5)

A Level Maths 2022 Paper 2 Qu 15

(b)	$4\sin^2 \theta - 52\sin \theta + 25 = 0 \Rightarrow \sin \theta = \frac{1}{2} \left(\frac{25}{2} \right)$	M1	1.1b
	$\theta = \frac{5\pi}{6}$	A1	1.2
		(2)	
(c)	Attempts a value for either a or r e.g. $a = 12 \cos \theta = 12 \times -\frac{\sqrt{3}}{2}$ or $r = \frac{5 + 2 \sin \theta}{12 \cos \theta} = \frac{5 + 2 \times \frac{1}{2}}{12 \times -\frac{\sqrt{3}}{2}}$	M1	3.1a
	" a " = $-6\sqrt{3}$ and " r " = $-\frac{1}{\sqrt{3}}$ o.e.	A1	1.1b
	Uses $S_{\infty} = \frac{a}{1-r} = \frac{-6\sqrt{3}}{1 + \frac{1}{\sqrt{3}}}$	dM1	2.1
	Rationalises denominator $S_{\infty} = \frac{-6\sqrt{3}}{1 + \frac{1}{\sqrt{3}}} = \frac{-18}{\sqrt{3} + 1} \times \frac{\sqrt{3} - 1}{\sqrt{3} - 1}$	ddM1	1.1b
	$(S_{\infty}) 9(1 - \sqrt{3})$	A1	2.1
		(5)	

A Level Maths 2022 Paper 2 Qu 15

(b)

M1: Attempts to solve $4\sin^2 \theta - 52\sin \theta + 25 = 0$. Must be clear they have found $\sin \theta$ and not e.g. just x from $4x^2 - 52x + 25 = 0$. Working does not need to be seen but see general guidance for solving a 3TQ if necessary. Note that the $\frac{25}{2}$ does not need to be seen.

A1: $\theta = \frac{5\pi}{6}$ and no other values unless they are rejected or the $\frac{5\pi}{6}$ clearly selected here and not in (c)

A Level Maths 2022 Paper 2 Qu 15

(c) Allow full marks in (c) if e.g. $\theta = \frac{\pi}{6}$ is their answer to (b) but $\theta = \frac{5\pi}{6}$ is used here.

or if e.g. $\theta = \frac{5\pi}{6}$ is their answer to (b) but $\theta = \frac{\pi}{6}$ is used here allow the M marks only.

M1: For attempting a value (exact or decimal) for either a or r using **their** θ

A1: Finds both $a = -6\sqrt{3}$ and $r = -\frac{1}{\sqrt{3}}$ which can be left unsimplified but $\sin \theta = \frac{1}{2}$, $\cos \theta = -\frac{\sqrt{3}}{2}$ and

$\tan \theta = -\frac{\sqrt{3}}{3}$ (if required) must have been used.

dM1: Uses both **values** of " a " and " r " with the equation $S_{\infty} = \frac{a}{1-r} = \frac{-6\sqrt{3}}{1+\frac{1}{\sqrt{3}}}$ to create an expression

involving surds where a and r have come from appropriate work and $|r| < 1$

Depends on the first method mark.

ddM1: Rationalises denominator. The denominator must be of the form $p \pm q\sqrt{3}$ oe e.g. $p + \frac{q}{\sqrt{3}}$

Depends on both previous method marks.

A Level Maths 2022 Paper 2 Qu 15

$$b. \sin \theta = \frac{1}{2} \quad \theta = \frac{1}{2}$$

$$\theta = \frac{1}{6}\pi \quad \text{or} \quad \frac{5}{6}\pi$$

$$a = -6\sqrt{3}$$

$$c. \frac{a}{1-r}$$

$$\frac{-6\sqrt{3}}{1-}$$

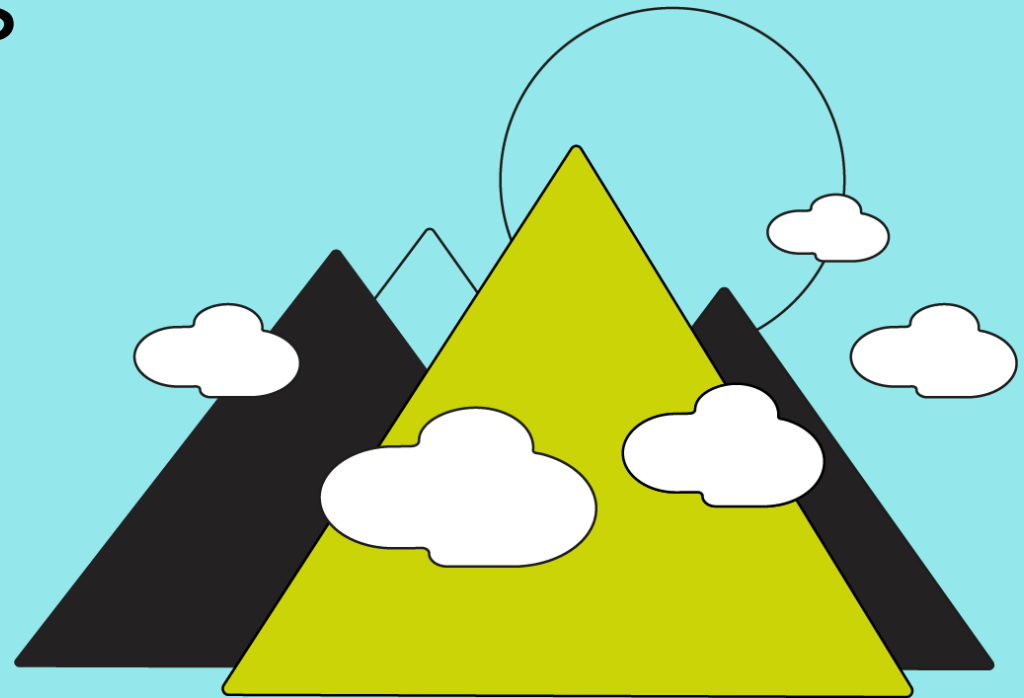
$$r = \frac{5 + 2\cos(\frac{5}{6}\pi)}{12 \times \cos(\frac{5}{6}\pi)} = \frac{3-5\sqrt{3}}{18}$$

$$\frac{-6\sqrt{3}}{1 - \frac{3-5\sqrt{3}}{18}}$$

$$= \frac{54 - 54\sqrt{3}}{5}$$

$$\frac{54}{5}(1 - \sqrt{3})$$

Marking guidance: Statistics



A Level Maths (Statistics) 2022 Qu 2

A manufacturer uses a machine to make metal rods.

The length of a metal rod, L cm, is normally distributed with

- a mean of 8 cm
- a standard deviation of x cm

Given that the proportion of metal rods less than 7.902 cm in length is 2.5%

(a) show that $x = 0.05$ to 2 decimal places.

(2)

(b) Calculate the proportion of metal rods that are between 7.94 cm and 8.09 cm in length.

(1)

The **cost** of producing a single metal rod is 20p

A metal rod

- where $L < 7.94$ is **sold** for scrap for 5p
- where $7.94 \leq L \leq 8.09$ is **sold** for 50p
- where $L > 8.09$ is shortened for an extra **cost** of 10p and then **sold** for 50p

(c) Calculate the expected profit per 500 of the metal rods.

Give your answer to the nearest pound.

(5)

A Level Maths (Statistics) 2022 Qu 2

Question	Scheme	Marks	AOs
2(a)	$[P(L < 7.902) = 0.025 \Rightarrow] \frac{7.902 - 8}{x} = -1.96 \text{ oe}$	M1	3.4
	$[x =] 0.05^*$	A1 cso*	1.1b
		(2)	
(b)	$P(7.94 \leq L \leq 8.09) = 0.8490...$ 0.849	awrt B1	1.1b
		(1)	
(c)	$[P(L < 7.94) =] 0.115069... \text{ (awrt 0.115) or } [P(L > 8.09) =] 0.03593...$ (awrt 0.036)	B1	1.1b
	$[P(L < 7.94) =] 0.115069... \text{ (awrt 0.115) \& } [P(L > 8.09) =] 0.03593...$ (awrt 0.036)	B1	1.1b
	Expected income per 500 rods = $\sum (\text{Income} \times \text{probability} \times 500)$ $(500 \times "0.849" \times 0.5) + (500 \times "0.1150..." \times 0.05) + (500 \times "0.03593..." \times 0.4)$ $\sum (\text{Income} \times \text{probability} \times 500) - 500 \times 0.2$ $= 500 \times "0.2446..."$ awrt [£]122	M1 M1d A1	3.4 3.1b 1.1b
		(5)	

A Level Maths (Statistics) 2022 Qu 2

Notes: (12 marks)		
(a)	M1	Using the normal distribution to set up equation. Allow σ for x and awrt ± 1.96
	A1*	cso For a correct expression for x followed by 0.05 or 0.05000... No incorrect working seen
(b)	B1	awrt 0.849
(c)	B1	awrt 0.115 (Implied by awrt 57.5 for number of rods) or awrt 0.036 (Implied by awrt 18 for number of rods)
	B1	awrt 0.115 (Implied by awrt 57.5 for number of rods) and awrt 0.036 (Implied by awrt 18 for number of rods)
	M1	Correct method to find the total income of 500 rods. Attempt at all 3 with at least two correct and no extras or Correct method to find sum of all three profits with at least two of 30, -15 or 20 correct. May work in pence but need to be consistent. Allow awrt 24.5 or 0.245
	M1d	Dep on previous method for finding profit for 500 rods. May work in pence but need to be consistent. Allow "0.2446..." \times 500 or "their income" for 500 rods – 500 \times 0.2 (accept 499 or 501)
	A1	All previous marks must be awarded for awrt 122 awrt 12200p NB if uses any integer values for numbers of rods then it is A0 other than for 18 for $L > 8.09$

A Level Maths (Statistics) 2022 Qu 2

$$a) X \sim N(8, \sigma^2)$$

$$P(X < 7.902) = 0.025$$

Using Inverse Normal,

$$Z = \frac{X - \mu}{\sigma} = \frac{7.902 - 8}{\sigma}$$

$$\text{And } Z = -1.96 = \frac{7.902 - 8}{\sigma}$$

$$\sigma = \frac{7.902 - 8}{-1.96} = 0.50 \text{ (2 d.p.)}$$

$$b) P(7.94 < X < 8.09) = 0.119 \text{ (3 s.f.)}$$
$$X \sim N(8, 0.5^2)$$

$$c) P(X < 7.94) = 0.452$$

$$d) P(7.94 \leq X \leq 8.09) = 0.119$$

$$P(X > 8.09) = 0.429$$

A Level Maths (Statistics) 2022 Qu 2

Transposed 0.452

$$500 \times 0.429 = 214.5 \text{ rods}$$

$$500 \times 0.119 = 59.5 \text{ rods}$$

$$500 \times 0.429 = 214.5 \text{ rods}$$

$$\text{Cost} = 500 \times 20 = 10000 \text{ p}$$

$$(212.5 \times 5) + (59.5 \times 50) + (214.5 \times 40)$$

$$= 12617.5 \text{ p}$$

$$12617.5 - 10000 = 2617.5 \text{ p}$$

$$= \text{£} 261.75$$

£262 (to the nearest pound)

Expected income per 500 rods = $\sum(\text{Income} \times \text{probability} \times 500)$		
$(500 \times "0.849" \times 0.5) + (500 \times "0.1150..." \times 0.05) + (500 \times "0.03593..." \times 0.4)$		
$\sum(\text{Income} \times \text{probability} \times 500) - 500 \times 0.2$	M1	3.4
$= 500 \times "0.2446..."$	M1d	3.1b
or $= "222.3" - 500 \times 0.2$		
$= \text{£}122.3...$	A1	1.1b
awrt [£]122		

A Level Maths (Statistics) 2022 Qu 2

NB The candidate's error in part (a) and failure to use a standard deviation of 0.05 has led to the loss of another 4 marks in parts (b) and (c).

Examiners will sometimes apply a misread rule if a student has misread a question and the error does not make the question much simpler.

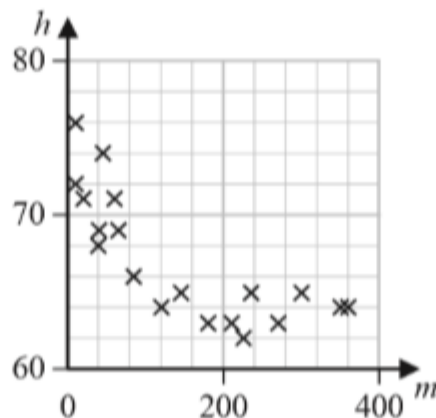
The examiners did not apply that rule here because it made a nonsense of the context. Students who had engaged with the context should realise that the proportion of rods sold for scrap was clearly too high and this should have caused them to check the value of the standard deviation given in the question.

A Level Maths (Statistics) 2022 Qu 6

6. Anna is investigating the relationship between exercise and resting heart rate. She takes a random sample of 19 people in her year at school and records for each person

- their resting heart rate, h beats per minute
- the number of minutes, m , spent exercising each week

Her results are shown on the scatter diagram.



(a) Interpret the nature of the relationship between h and m

Question	Scheme	Marks
6(a)	eg As the number of minutes <u>exercise</u> (m) increases the resting <u>heart rate</u> (h) decreases or the gradient of the curve is becoming flatter with increasing m : diminishing effect of each <u>additional minute</u> of <u>exercise</u>	B1
		(1)

(a)	B1	eg Idea as one increases the other decreases (in context). Allow use of m and h eg As m increases h decreases. Do not allow negative correlation with no context or $\rho < 0$ Allow there is a negative correlation/association/relationship/exponential between minutes <u>exercise</u> (m) and resting <u>heart rate</u> (h) oe
-----	----	---

a) a weak negative correlation

a) negative correlation

(1)

a) as m increases, h decreases, so they have a negative correlation.

A Level Maths (Statistics) 2022 Qu 6

Anna codes the data using the formulae

$$x = \log_{10} m$$

$$y = \log_{10} h$$

The product moment correlation coefficient between x and y is -0.897

(b) Test whether or not there is significant evidence of a negative correlation between x and y

You should

- state your hypotheses clearly
- use a 5% level of significance
- state the critical value used

(b)	$H_0 : \rho = 0$ $H_1 : \rho < 0$	B1	2.5
	Critical value -0.3887 (Allow \pm)	M1	1.1b
	There is evidence that the product moment correlation is less than 0/ there is a negative correlation	A1	2.2b

(a)	B1	eg Idea as one increases the other decreases (in context). Allow use of m and h eg As m increases h decreases. Do not allow negative correlation with no context or $\rho < 0$ Allow there is a negative correlation/association/relationship/exponential between minutes <u>exercise</u> (m) and resting <u>heart rate</u> (h) oe
(b)	B1	Both hypotheses correct in terms of ρ (allow p)
	M1	For the cv of -0.3887 or any cv such that $0.3 < cv < 0.5$
	A1	Independent of hypotheses. Correct conclusion that implies reject H_0 on basis of seeing -0.3887 or if they give $0.3887 < 0.897$ and which mentions “pmcc/correlation/relationship” and less than 0/ negative or $\rho < 0$ A contradictory statement scores A0 eg Accept H_0 therefore negative correlation

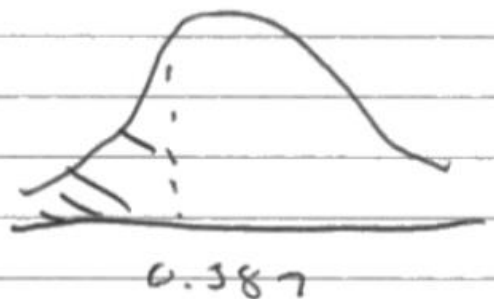
A Level Maths (Statistics) 2022 Qu 6

$$H_0: \rho = 0$$

$$H_1: \rho < 0$$

critical value

$$\text{at } 0.05 = 0.3887$$



(b)

$$H_0: \rho = 0 \quad H_1: \rho < 0$$

Critical value – 0.3887 (Allow \pm)

There is evidence that the product moment correlation is less than 0/ there is a negative correlation

B1

2.5

M1

1.1b

A1

2.2b

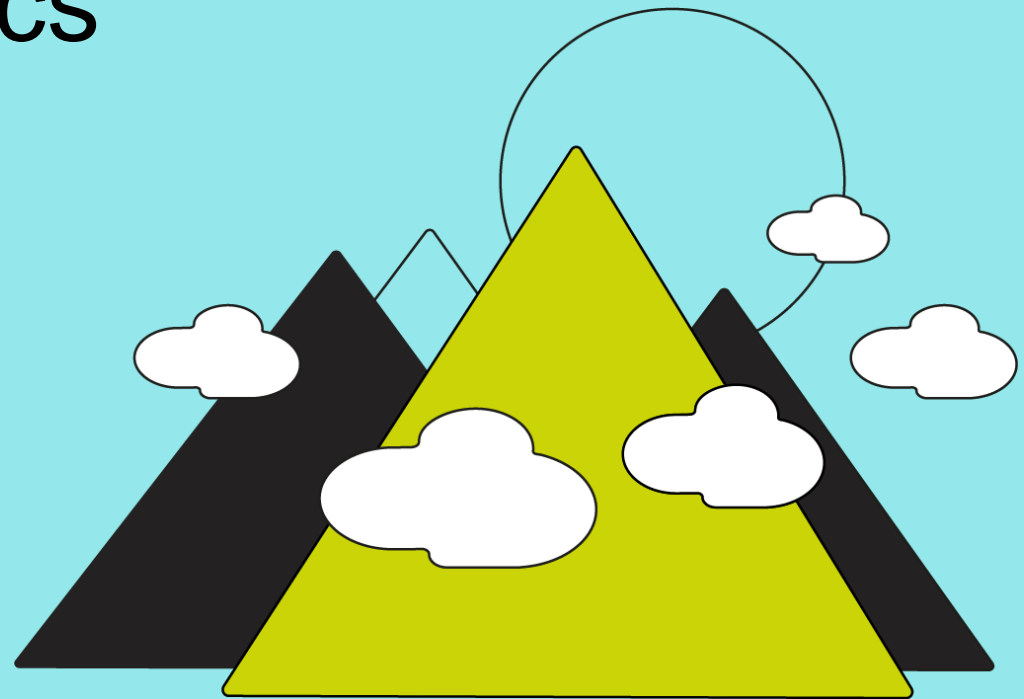
evidence to reject H_0 and
accept H_1 as it falls
within

A Level Maths (Statistics) 2022 Qu 6

b) $H_0: \rho = 0$ critical value = -0.3887
 $H_1: \rho < 0$ $-0.897 < -0.3887$, this value is significant
 Reject H_0 and accept H_1 , as there is
 sufficient evidence to suggest there is a
 negative correlation between x and y .
 $5\% \Rightarrow 0.05$
 $n = 19$

(b)	$H_0: \rho = 0$ $H_1: \rho < 0$	B1	2.5
	Critical value -0.3887 (Allow \pm)	M1	1.1b
	There is evidence that the product moment <u>correlation</u> is <u>less than 0/ there is a negative correlation</u>	A1	2.2b

Marking guidance: Mechanics



Please check the examination details below before

Candidate surname

Centre Number

Candidate Number

Pearson Edexcel Level 3 Certificate

Paper
reference

Mathematics

Advanced PAPER 32: Mechanics

You must have:

Mathematical Formulae and Statistical Tables

Candidates may use any calculator allowed by Pearson regulations. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled. ←
- Answer the questions in the spaces provided
– *there may be more space than you need.*
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- Unless otherwise indicated, whenever a value of g is required, take $g = 9.8 \text{ m s}^{-2}$ and give your answer to either 2 significant figures or 3 significant figures. ←

Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- The total mark for this part of the examination is 50. There are 5 questions.
- The marks for **each** question are shown in brackets
– *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

Mark Scheme Notes

- Any numerical answer which comes from use of $g = 9.8$ should be given to 2 or 3 SF.
- Use of $g = 9.81$ should be penalised once per (complete) question.
- N.B. Over-accuracy or under-accuracy of correct answers should only be penalised *once* per complete question. However, premature approximation should be penalised every time it occurs.
- Marks must be entered in the same order as they appear on the mark scheme.
- **In all cases, if the candidate clearly labels their working under a particular part of a question i.e. (a) or (b) or (c),.....then that working can only score marks for that part of the question.**
- Accept column vectors in all cases.
- Misreads – if a misread does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, bearing in mind that after a misread, the subsequent A marks affected are treated as A ft

Mark Scheme Notes

Mechanics Abbreviations

- M(A) Taking moments about A.
- N2L Newton's Second Law (Equation of Motion)
- NEL Newton's Experimental Law (Newton's Law of Impact)
- HL Hooke's Law
- SHM Simple harmonic motion
- PCLM Principle of conservation of linear momentum
- RHS, LHS Right hand side, left hand side.

Mark Scheme Notes

- Rules for M marks: correct no. of terms; dimensionally correct; all terms that need resolving (i.e. multiplied by \cos or \sin) are resolved.
- Omission or extra g in a resolution is an accuracy error not method error.
- Omission of mass from a resolution is a method error.
- Omission of a length from a moments equation is a method error.
- Omission of units or incorrect units is not (usually) counted as an accuracy error.
- DM indicates a dependent method mark i.e. one that can only be awarded if a previous specified method mark has been awarded

A Level Maths (Mechanics) 2022 Qu 4

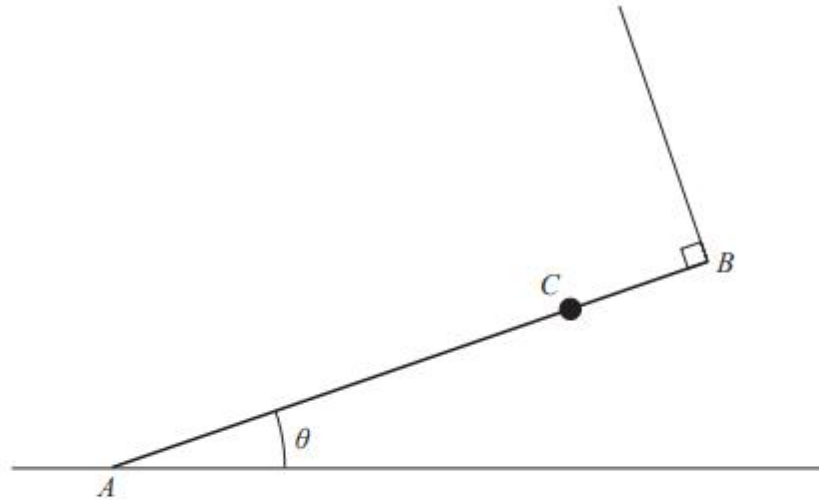


Figure 2

A uniform rod AB has mass M and length $2a$

A particle of mass $2M$ is attached to the rod at the point C , where $AC = 1.5a$

The rod rests with its end A on rough horizontal ground.

The rod is held in equilibrium at an angle θ to the ground by a light string that is attached to the end B of the rod.

The string is perpendicular to the rod, as shown in Figure 2.

- (a) Explain why the frictional force acting on the rod at A acts horizontally to the right on the diagram.

(1)

A Level Maths (Mechanics) 2022 Qu 4

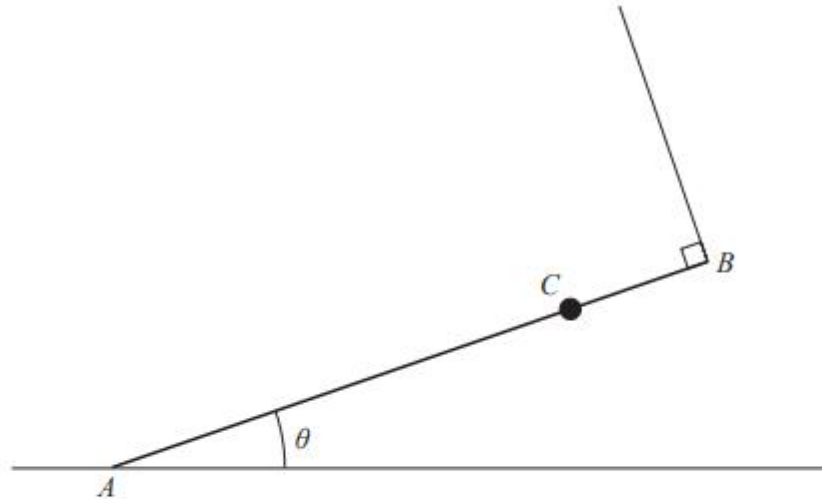


Figure 2

A uniform rod AB has mass M and length $2a$

A particle of mass $2M$ is attached to the rod at the point C , where $AC = 1.5a$

The rod rests with its end A on rough horizontal ground.

The rod is held in equilibrium at an angle θ to the ground by a light string that is attached to the end B of the rod.

The string is perpendicular to the rod, as shown in Figure 2.

The tension in the string is T

(b) Show that $T = 2Mg \cos \theta$

(3)

A Level Maths (Mechanics) 2022 Qu 4

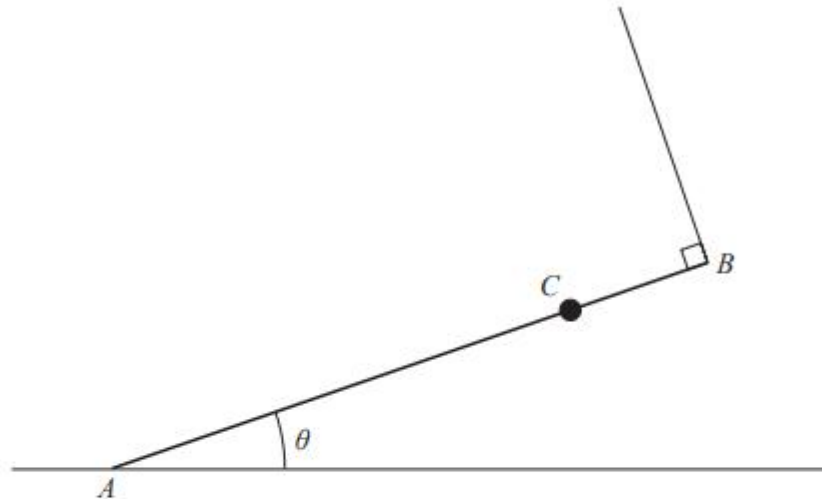


Figure 2

A uniform rod AB has mass M and length $2a$

A particle of mass $2M$ is attached to the rod at the point C , where $AC = 1.5a$

The rod rests with its end A on rough horizontal ground.

The rod is held in equilibrium at an angle θ to the ground by a light string that is attached to the end B of the rod.

The string is perpendicular to the rod, as shown in Figure 2.

Given that $\cos \theta = \frac{3}{5}$

(c) show that the magnitude of the vertical force exerted by the ground on the rod at A is $\frac{57Mg}{25}$

(3)

A Level Maths (Mechanics) 2022 Qu 4

Question	Scheme	Marks	AOs
4(a)	The horizontal component of T acts to the left and since the only other horizontal force is friction, it must act to the right oe	B1	2.4
		(1)	

Notes:

4a	B1	Any equivalent explanation
----	----	----------------------------

Acts to the right because the movement of rod is to the left (friction opposes movement to the left). Rod is only able to move to left.

A Level Maths (Mechanics) 2022 Qu 4

4(b)		Take moments about A or any other complete method to obtain an equation in T, M and θ only. (see possible equations below that they may use)	M1	3.1b
		$T.2a = Mga \cos \theta + 2Mg \times 1.5a \cos \theta$ (A0 if a 's missing)	A1	1.1b
		Other possible equations but F and R would need to be eliminated. (↖), $R \cos \theta + T = F \sin \theta + Mg \cos \theta + 2Mg \cos \theta$ (↗), $R \sin \theta + F \cos \theta = Mg \sin \theta + 2Mg \sin \theta$ (→), $F = T \sin \theta$ M(B), $R.2a \cos \theta = Mga \cos \theta + 2Mg \times 0.5a \cos \theta + F.2a \sin \theta$ M(G), $Fa \sin \theta + Ta = Ra \cos \theta + 2Mg \times 0.5a \cos \theta$ M(C), $R \times 1.5a \cos \theta = T \times 0.5a + Mg \times 0.5a \cos \theta + F \times 1.5a \sin \theta$		
		$T = 2Mg \cos \theta^*$	A1*	1.1b
			(3)	
4b	M1	Correct no. of terms, dimensionally correct, condone sin/cos confusion and sign errors		
	A1	Correct equation, trig does not need to be substituted (Allow: $T.2a = Mga \cos \theta + 3Mga \cos \theta$)		
	A1*	Given answer correctly obtained with <u>no wrong working seen</u> . Allow $2Mg \cos \theta = T$ But not $T = 2 \cos \theta Mg$		

A Level Maths (Mechanics) 2022 Qu 4

Take moments about A or any other complete method to obtain an equation in T, M and θ only. (see possible equations below that they may use)	M1
$T \cdot 2a = Mga \cos \theta + 2Mg \times 1.5a \cos \theta$ (A0 if a 's missing)	A1
Other possible equations but F and R would need to be eliminated. $(\nwarrow), R \cos \theta + T = F \sin \theta + Mg \cos \theta + 2Mg \cos \theta$ $(\nearrow), R \sin \theta + F \cos \theta = Mg \sin \theta + 2Mg \sin \theta$ $(\rightarrow), F = T \sin \theta$ $M(B), R \cdot 2a \cos \theta = Mga \cos \theta + 2Mg \times 0.5a \cos \theta + F \cdot 2a \sin \theta$ $M(G), Fa \sin \theta + Ta = Ra \cos \theta + 2Mg \times 0.5a \cos \theta$ $M(C), R \times 1.5a \cos \theta = T \times 0.5a + Mg \times 0.5a \cos \theta + F \times 1.5a \sin \theta$	
$T = 2Mg \cos \theta^*$	A1*
A1* Given answer correctly obtained with <u>no wrong working seen.</u> Allow $2Mg \cos \theta = T$ But not $T = 2 \cos \theta Mg$	

~~resolve forces:~~ Moments about A:

~~clockwise = anticlockwise~~

~~$\cos \theta Mg(a) = 2aT$~~

$\cos \theta Mg(a) + 2 \cos \theta Mg(1.5a) = 2aT$

so $\cos \theta Mg + 3 \cos \theta Mg = 2T$

$2T = 4 \cos \theta Mg$

$T = 2 \cos \theta Mg$

A Level Maths (Mechanics) 2022 Qu 4

4(c)		e.g. Resolve vertically	M1	3.4
		$(\uparrow), R + T \cos \theta = Mg + 2Mg$	A1	1.1b
		$R = \frac{57Mg}{25} *$	A1*	1.1b
4c	M1	For an equation in R, M, T and θ only Correct no. of terms, dimensionally correct, condone sin/cos confusion and sign errors, each term that needs to be resolved must be resolved		
	A1	Correct equation, T and trig do not need to be substituted		
	A1*	Given answer correctly obtained with <u>no wrong working seen</u>		

$$\begin{aligned}
 & R = Mg + 2Mg + \cos \theta T \\
 & R = Mg + 2Mg - 2 \cos^2 \theta Mg \\
 & R = 2Mg - 2 \left(\frac{9}{25} \right) Mg \\
 & R = Mg \left(2 - \frac{18}{25} \right) \\
 & R = \frac{57}{25} Mg
 \end{aligned}$$

A Level Maths (Mechanics) 2022 Qu 5

5.

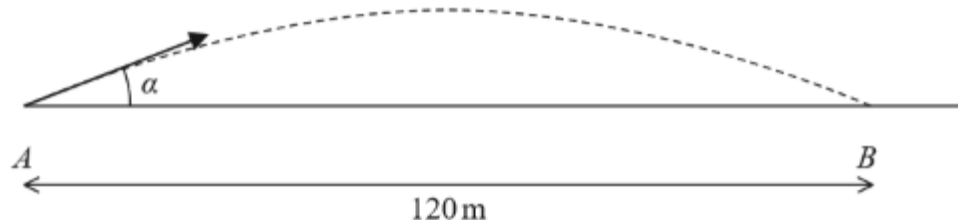


Figure 3

A golf ball is at rest at the point A on horizontal ground.

The ball is hit and initially moves at an angle α to the ground.

The ball first hits the ground at the point B , where $AB = 120\text{m}$, as shown in Figure 3.

The motion of the ball is modelled as that of a particle, moving freely under gravity, whose initial speed is $U\text{ms}^{-1}$

Using this model,

(a) show that $U^2 \sin \alpha \cos \alpha = 588$

Using horizontal motion		M1
Whole Motion		Half way
$U \cos \alpha \times t = 120$	OR	$U \cos \alpha \times t = 60$
Using vertical motion		M1
$U \sin \alpha \times t - \frac{1}{2}gt^2 = 0$	OR	$0 = U \sin \alpha - gt$
Attempt to solve problem by eliminating t		DM1
$U^2 \sin \alpha \cos \alpha = 588 *$		A1*

5a		N.B. Could score 2/6 for any one of the 4 given equations if there is no corresponding second equation or there is an attempt but it's incorrect.
	M1	Complete method to give equation in U , α and t only, condone sin/cos confusion and sign errors, each term that needs to be resolved must be resolved
	A1	Correct equation
	M1	Complete method to give equation in U , α and t only, condone sin/cos confusion and sign errors, each term that needs to be resolved must be resolved
	A1	Correct equation
	DM1	Eliminate t , dependent on first and second M1's
	A1*	Given answer correctly obtained, <u>with no wrong working seen</u> . Allow $588 = U^2 \sin \alpha \cos \alpha$ but nothing else

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Additional Support



UPCOMING EVENTS

- | | | | |
|-----|-------------------|-----------|--|
| JAN | 9:00 am - 9:30 am | 26 | GCSE Maths November 2022 Crossover Papers release |
| JAN | 4:00 pm - 5:30 pm | 26 | A level Maths: Marking guidance training (Free online event) |
| JAN | All day | 27 | A Level Statistics 9ST0 June 2022 shadow papers release date |
| FEB | All day | 3 | A Level Statistics 9ST0 June 2022 exemplars release date |
| FEB | All day | 10 | Updated A Level Maths Year 2 scheme of work with technology links |

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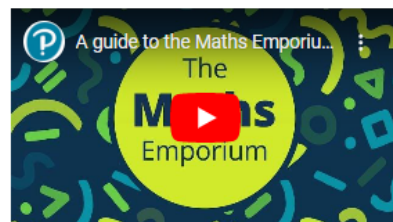
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[List](#)
[Month](#)
[Day](#)

[<](#)
[Today](#)
[UPCOMING](#)

January 2023

THU

26

January 26 @ 9:00 am - 9:30 am
GCSE Maths November 2022 Crossover Papers release

THU

26

January 26 @ 4:00 pm - 5:30 pm
A level Maths: Marking guidance training (Free online event)

In this FREE session will be providing guidance on the finer points of marking A level exams, using the 2022 exam series as the basis of the examples. We will be looking at the key principles behind the structure of the marks in the mark schemes and giving examples of borderline student responses.

FRI

27

January 27
A Level Statistics 9ST0 June 2022 shadow papers release date

Shadow papers for 9ST0 A Level Statistics June 2022 are being released on the Emporium

February 2023

FRI

3

February 3
A Level Statistics 9ST0 June 2022 exemplars release date

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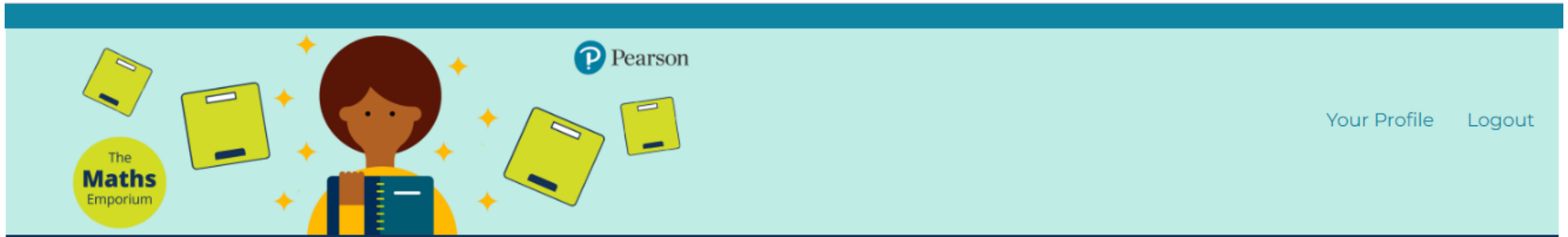
[List](#)
[Month](#)
[Day](#)

[<](#)
[This Month](#)
[JANUARY 2023](#)

MON	TUE	WED	THU	FRI	SAT	SUN
26	27	28	29	30	31	1
2	3 GCSE Maths Mock S...	4 Updated Teaching G...	5	6 BMA0, 9FMO, 9FMO...	7	8
9 Quick guide to Maths... 8:00 am - 12:00 pm Edexcel Award in Number and Measure Exam Day – ANM10 & ANM20 12:00 pm - 5:00 pm International A Level WMA11-01 Pure Mathematics 1 Exam Day	10 8:00 am - 12:00 pm International GCSE Exam Day 4MA1 Paper 1 & 4MB1 Paper 1 8:00 am - 12:00 pm International A Level VWED03-01 Mechanics 3 Exam Day	11 International A Level ...	12 GCSE Maths Novem... 8:00 am - 12:00 pm International A Level WMA13-01 Pure Mathematics 3 Exam Day 8:00 am - 12:00 pm Edexcel Award in Algebra Exam Day – AAL20 & AAL30 8:00 am - 12:00 pm International GCSE Exam Day – 4PM1 Paper 1	13 International A Level ...	14	15 Added answer sheet...
16 9FMO-4A Further Pur... BMA0 A level Maths ... New video: A level M...	17 8:00 am - 12:00 pm International GCSE Exam Day – 4MA1 Paper 2 & 4MB1 Paper	18 International A Level ...	19 International A Level ...	20 8:00 am - 12:00 pm International GCSE Exam Day – 4PM1 Paper 2	21	22

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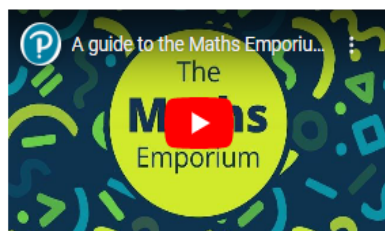
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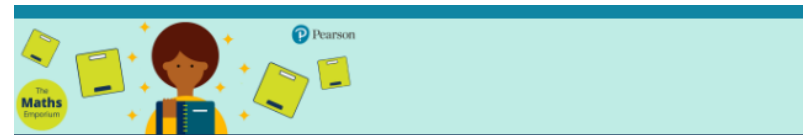


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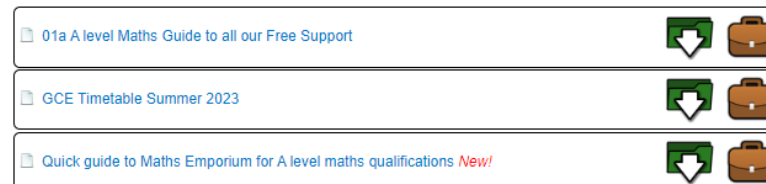
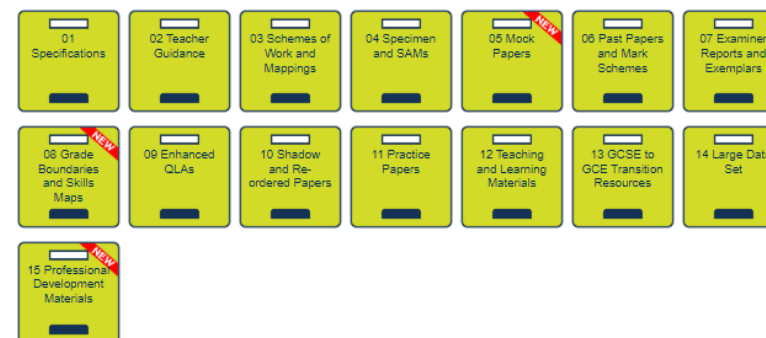
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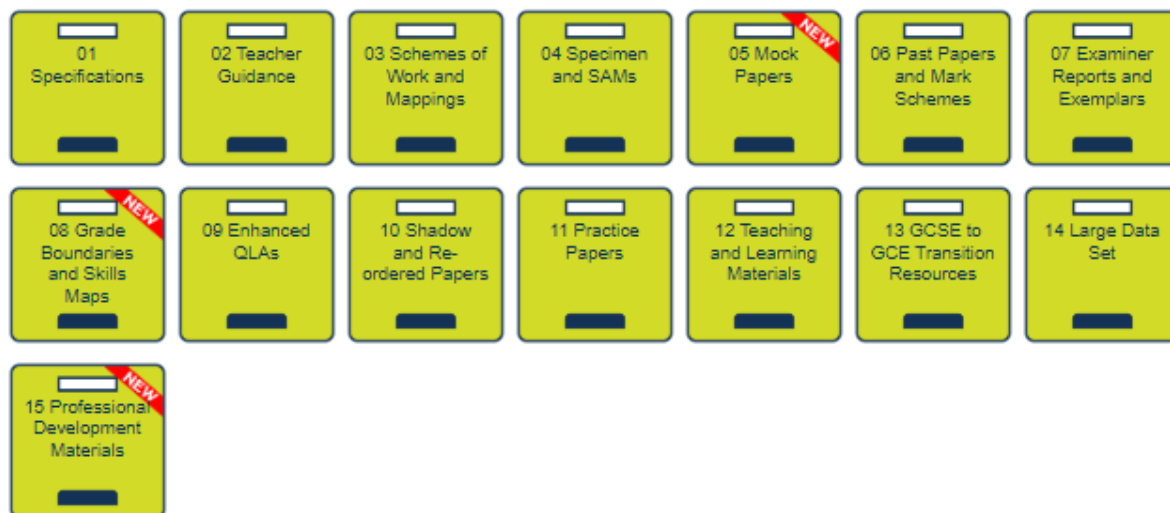
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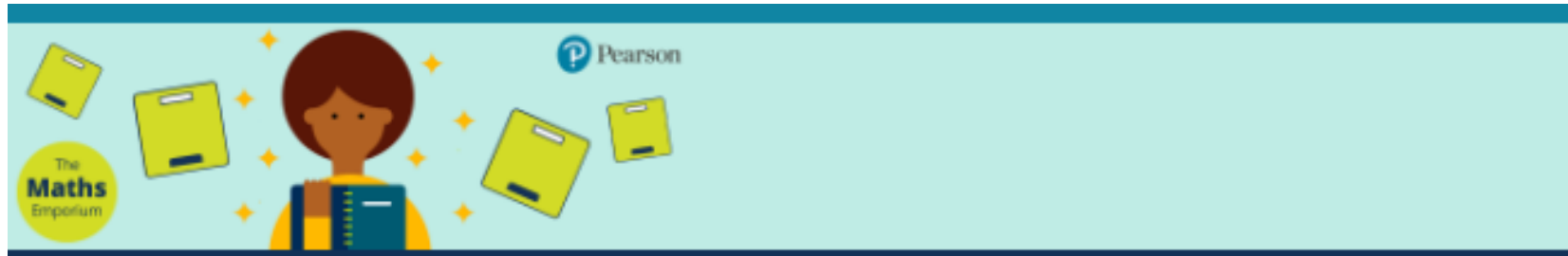
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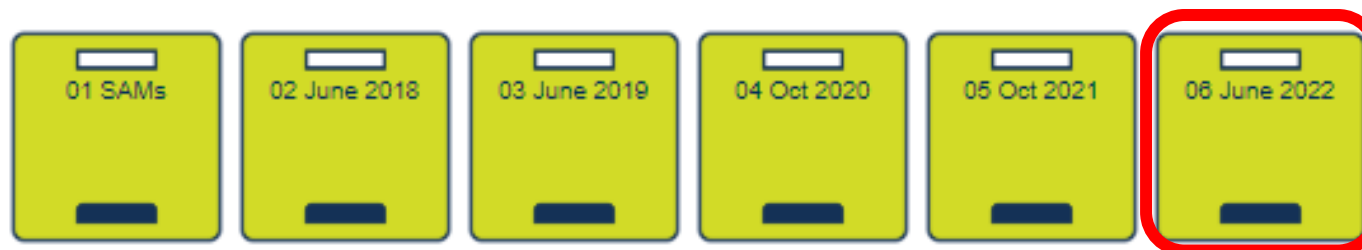
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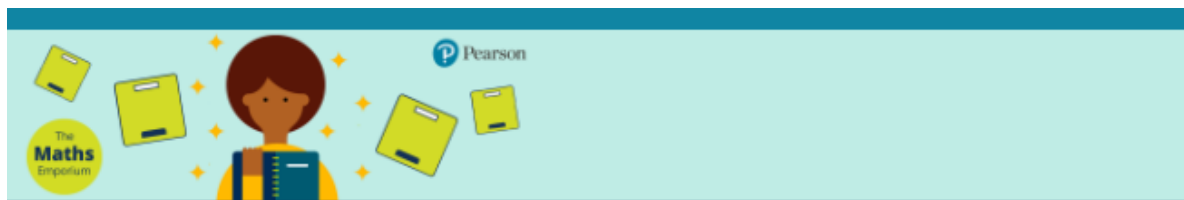


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Category: 07 Examiner Reports and Exemplars

Exemplars: Real student responses to questions in past papers and how the examining team follow the mark schemes to demonstrate how the students would be awarded marks on these questions.
































[Maths Emporium](#) > [GCE AS/A level Mathematics](#) > [07 Examiner Reports and Exemplars](#) > [06 June 2022](#)

Category: 06 June 2022

Examiner reports and exemplar responses with examiners commentaries on all questions from the June 2022 examination session for all 9MA0 papers.

 01a 8MA0 AS Mathematics Examiner Reports June 2022	 
 01b 9MA0 A level Mathematics Examiner Reports June 2022	 
 02a 9MA0-01 A Level Pure Mathematics 1 – June 2022 exemplars (pdf)	 
 02b 9MA0-02 A Level Pure Mathematics 2 – June 2022 exemplars (pdf)	 
 02c 9MA0-31 A Level Statistics – June 2022 exemplars (pdf)	 
 02d 9MA0-32 A Level Mechanics – June 2022 exemplars (pdf)	 
 03a 8MA0-01 AS Level Pure Mathematics – June 2022 exemplars (pdf)	 
 03b 8MA0-21 AS Level Statistics – June 2022 exemplars (pdf)	 
 03c 8MA0-22 AS Level Mechanics – June 2022 exemplars (pdf)	 

- Question: [1](#) [2](#) [3](#) [4](#) [5](#) [6](#) [7](#) [8](#) [9](#)
[10](#) [11](#) [12](#) [13](#) [14](#) [15](#) [16](#)

Question 2

- [Introduction](#) [Question](#) [Mark Scheme](#) [Examiner Comments](#)
[Performance](#) [Response A](#) [Response B](#) [Response C](#)

Question 2 - Introduction

Candidates should know that if $(x-a)$ is a factor, then $f(a) = 0$. This was the most direct way of finding the value of k in this question.

Question 2 - Question

2. $f(x) = (x-4)(x^2 - 3x + k) - 42$ where k is a constant
 Given that $(x+2)$ is a factor of $f(x)$, find the value of k .
 (3)
 (Total for Question 2 is 3 marks)

Question 2 - Mark Scheme

Question	Scheme	Marks	AOs
2	Sets $f(-2) = 0 \Rightarrow (-2-4)((-2)^2 - 3 \times -2 + k) - 42 = 0$	M1	3.1a
	$-6(k+10) = 42 \Rightarrow k = \dots$	M1	1.1b
	$k = -17$	A1	1.1b
		(3)	

Notes:

M1: Attempts $f(-2) = 0$ leading to an equation in k . So $(-2-4)((-2)^2 - 3 \times -2 + k) - 42 = 0$ is fine
 Condone slips but expect to see a first bracket of $(-2-4)$
 * -42 * must not be omitted but could appear as $+42$ with a sign slip.
 There may have been attempts to expand $f(x) = (x-4)(x^2 - 3x + k) - 42$ before attempting to set $f(-2) = 0$. This is acceptable and condone slips/errors in the expansion, but the 42 must be present. FYI the expanded (and simplified) $f(x) = x^3 - 7x^2 + (12+k)x - 4k - 42$
 M1: Solves a linear equation in k as a result of setting $f(\pm 2) = 0$.
 The ± 42 must be there at some point when the substitution is made.
 Allow minimal evidence here. A linear equation leading to a solution is fine.
 If $f(x)$ is expanded then it is dependent upon being a cubic which contains a kx term and a ' 42 '
 A1: $k = -17$ correct answer following correct work but allow recovery from invisible brackets

- Question: [1](#) [2](#) [3](#) [4](#) [5](#) [6](#) [7](#) [8](#) [9](#)
[10](#) [11](#) [12](#) [13](#) [14](#) [15](#) [16](#)

M1: For an attempt at factorising E.g. $x^3 - 7x^2 + (12+k)x - 4k - 42 = (x+2)(x^2 + bx + c)$ and attempting to set up three equations in b , c and k . E.g. $2+b=-7$, $2b+c=12+k$, $2c=-4k-42$
 The expanded $f(x)$ must be a cubic which contains both a kx term and a ' 42 '
 M1: Solves the equations set up from an allowable equation to find k . It is dependent via this route.
 A1: Completely correct with $k = -17$

Question 2 - Examiner Comments

This was a familiar and accessible question with most candidates scoring 2 or 3 marks. The most common and successful approach was via the use of the factor theorem. Following on from setting $f(-2) = 0$, most candidates were able to set up and solve the linear equation in k . Errors seen resulting in the loss of marks were:

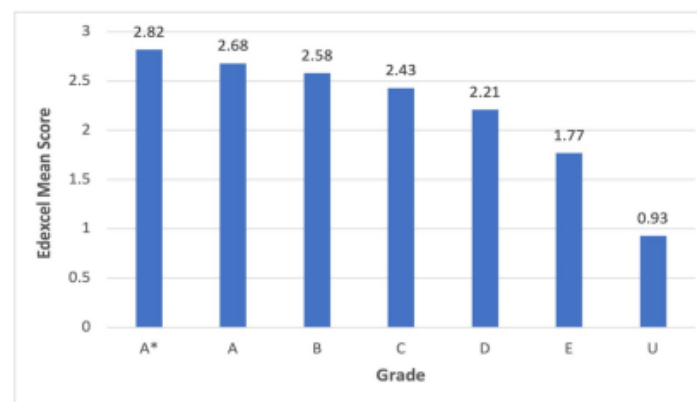
- having $(10k)$ not $(10+k)$ in the linear equation
- expanding $-6(10+k)$ to $\pm 60 \pm k$, or m
- setting $f(2) = 0$
- expanding the expression before sub

There was a small proportion of candidates who did not score many marks since the working left incomplete, or there was not a linear rem factorisation by inspection; only a handful of

- Question: [1](#) [2](#) [3](#) [4](#) [5](#) [6](#) [7](#) [8](#) [9](#)
[10](#) [11](#) [12](#) [13](#) [14](#) [15](#) [16](#)

Question 2 - Performance

Mean score	Max score	Mean %	Edexcel averages: mean scored by candidates achieving grade:							
			ALL	A*	A	B	C	D	E	U
2.50	3	83	2.50	2.82	2.68	2.58	2.43	2.21	1.77	0.93



- Question: 1 2 3 4 5 6 7 8 9
10 11 12 13 14 15 16

Question 2

- [Introduction](#) [Question](#) [Mark Scheme](#) [Examiner Comments](#)
[Performance](#) [Response A](#) [Response B](#) [Response C](#)

Question 2 - Introduction

Candidates should know that if $(x-a)$ is a factor, then $f(a) = 0$. This was the most direct way of finding the value of k in this question.

Question 2 - Question

2. $f(x) = (x-4)(x^2 - 3x + k) - 42$ where k is a constant
 Given that $(x+2)$ is a factor of $f(x)$, find the value of k .

(3)

(Total for Question 2 is 3 marks)

Question 2 - Mark Scheme

Question	Scheme	Marks	AOs
2	Sets $f(-2) = 0 \Rightarrow (-2-4)((-2)^2 - 3(-2) + k) - 42 = 0$	M1	3.1a
	$-6(k+10) = 42 \Rightarrow k = \dots$	M1	1.1b
	$k = -17$	A1	1.1b
		(3)	

(3 marks)

Notes:

M1: Attempts $f(-2) = 0$ leading to an equation in k . So $(-2-4)((-2)^2 - 3(-2) + k) - 42 = 0$ is fine

Condone slips but expect to see a first bracket of $(-2-4)$

-42 must not be omitted but could appear as +42 with a sign slip.

There may have been attempts to expand $f(x) = (x-4)(x^2 - 3x + k) - 42$ before attempting to set $f(-2) = 0$. This is acceptable and condone slips/errors in the expansion, but the 42 must be present. FYI the expanded (and simplified) $f(x) = x^3 - 7x^2 + (12+k)x - 4k - 42$

M1: Solves a linear equation in k as a result of setting $f(\pm 2) = 0$.

The ± 42 must be there at some point when the substitution is made.

Allow minimal evidence here. A linear equation leading to a solution is fine.

If $f(x)$ is expanded then it is dependent upon being a cubic which contains a kx term and a '42'

A1: $k = -17$ correct answer following correct work but allow recovery from invisible brackets

- Question: 1 2 3 4 5 6 7 8 9
10 11 12 13 14 15 16

Question 2 - Response C

$$f(x) = x^3 - 3x^2 + xk - 4x^2 + 12x - 4k - 42$$

$$= x^3 - 7x^2 + (12+k)x - (4k - 42)$$

$$\text{when } x = -2$$

$$f(x) = 0$$

$$(-2-4)((-2)^2 - 3(-2) + k) - 42 = 0$$

$$-6 \times (10+k) - 42 = 0$$

$$-60 - 6k - 42 = 0$$

$$-6k = 102$$

$$k = 17$$

2 / 3

M1: Uses an allowable method (setting $f(-2) = 0$) to form an equation in k

M1: Solves a linear equation in k formed using an allowable method

A0: Incorrect value for k

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