

**GCE**

**Mathematics A**

**H240/01: Pure Mathematics**

A Level

**Mark Scheme for June 2026**

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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## Preparation For Marking

### 1. RM Assessor

- Access and complete the on-screen marking training packages: OCR Examiner Training (RMA3).
- Read the mark scheme and question paper for this component or unit.
- The mark scheme and question paper are available in RM Assessor or on your Component Page if you use the Training Platform for standardisation.
- Log in to RM Assessor and mark the **required number** of practice scripts and the **required number** of standardisation scripts.

## Marking

### 2. General Guidance

- Mark strictly to the mark scheme.
- Marks awarded must relate directly to the marking criteria.
- If you are in any doubt about applying the mark scheme, consult your Team Leader by phone, email or via the RM Assessor messaging system.
- It is **essential** that you meet the RM Assessor 50% and 100% batch deadlines. For traditional marking this will be 40% and 100%. If you experience problems, contact your Team Leader without delay.
- Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there, then add the annotation '**SEEN**' to confirm that the work has been seen and mark any responses using the annotations in Section 11.
- The RM Assessor **comments box** is used by your Team Leader to explain the marking of the practice responses. Use these comments when checking your practice responses. **Do not use the comments box for any other reason.**

- **Before the end of the marking period** send a brief report on the performance of candidates to your Team Leader via email. The report should contain notes on strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

### 3. No Response and Crossed-out Answers

Using the No Response (NR) option. Only mark as NR if:

- the answer space is blank
- there is only a comment not related to the question (e.g., 'can't do', 'don't know')
- there is only a mark (e.g., a dash, a question mark) which is not an attempt at the question.

Note: Enter 0 marks for an attempt that earns no credit (including copying out the question). Do **not** use NR.

#### **Crossed-out answers**

If a candidate has crossed out an answer and written a clear alternative, do **not** mark the crossed-out answer.

If a candidate has crossed out an answer and **not** written a clear alternative, mark the crossed-out answer if it is readable.

## 4. Annotations available in RM Assessor

| Annotation   | Meaning                       |
|--------------|-------------------------------|
| √and □       | Benefit of doubt              |
| BOD          | Follow through                |
| FT           | Ignore subsequent working     |
| ISW          | Method mark awarded 0, 1      |
| M0,M1        | Accuracy mark awarded 0, 1    |
| A0,A1        | Independent mark awarded 0, 1 |
| B0,B1        | Special case                  |
| SC           | Omission sign                 |
| ^            | Misread                       |
| MR           | Blank Page                    |
| BP           |                               |
| Seen         |                               |
| Highlighting |                               |

**5. Abbreviations, annotations and conventions used in the mark scheme (including subject-specific conventions).**

| <b>Abbreviation / Annotation</b> | <b>Meaning</b>                                                                                      |
|----------------------------------|-----------------------------------------------------------------------------------------------------|
| dep*                             | Mark dependent on a previous mark, indicated by *. The * may be omitted if only one previous M mark |
| cao                              | Correct answer only                                                                                 |
| oe                               | Or equivalent                                                                                       |
| rot                              | Rounded or truncated                                                                                |
| soi                              | Seen or implied                                                                                     |
| www                              | Without wrong working                                                                               |
| AG                               | Answer given                                                                                        |
| awrt                             | Anything which rounds to                                                                            |
| BC                               | By Calculator                                                                                       |
| DR                               | This question included the instruction: In this question you must show detailed reasoning.          |

## 6. Subject-specific Marking Instructions

### Introduction

Your first task is to familiarise yourself with:

- the specification, especially the assessment objectives
- the question paper and any inserts or resource booklets
- the mark scheme, including annotation requirements
- the administrative procedures related to the marking process.

The administrative procedures are set out in the OCR booklet **Instructions for Examiners**.

If you are examining for the first time, please read **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

All relevant training materials are accessed from the Training Platform.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

- a. Annotations must be used during your marking. For a response awarded zero (or full) marks a single appropriate annotation (cross, tick, M0 or ^) is sufficient, but not required.

For responses that are not awarded either 0 or full marks, you must make it clear how you have arrived at the mark you have awarded and all responses must have enough annotation for a reviewer to decide if the mark awarded is correct without having to mark it independently.

It is vital that you annotate standardisation scripts fully to show how the marks have been awarded.

If a candidate uses the answer space for one question to answer another, for example using the space for 8(b) to answer 8(a), then give benefit of doubt unless it is ambiguous for which part it is intended.

- b. An element of professional judgement is required in the marking of any written paper. Remember that the mark scheme is designed to assist in marking incorrect solutions. Correct solutions leading to correct answers are awarded full marks but work must not always be judged on the answer alone, and answers that are given in the question, especially, must be validly obtained; key steps in the working must always be looked at and anything unfamiliar must be investigated thoroughly. Correct but unfamiliar or unexpected methods are often signalled by a correct result following an apparently incorrect method. Such work must be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, escalate the question to your Team Leader who will decide on a course of action with the Principal Examiner.

If you are in any doubt whatsoever you should contact your Team Leader.

- c. The following types of marks are available.

### **M**

A suitable method has been selected and applied in a manner which shows that the method is essentially understood. Method marks are not usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, e.g. by substituting the relevant quantities into the formula. In some cases the nature of the errors allowed for the award of an M mark may be specified.

A method mark may usually be implied by a correct answer unless the question includes the DR statement, the command words “Determine” or “Show that”, or some other indication that the method must be given explicitly.

### **A**

Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated Method mark is earned (or implied). Therefore M0 A1 cannot ever be awarded.

### **B**

Mark for a correct result or statement independent of Method marks.

Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored. Sometimes this is reinforced in the mark scheme by the abbreviation isw. However, this would not apply to a case where a candidate passes through the correct answer as part of a wrong argument.

- d. When a part of a question has two or more 'method' steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. (The notation 'dep\*' is used to indicate that a particular mark is dependent on an earlier, asterisked, mark in the scheme.) Of course, in practice it may happen that when a candidate has once gone wrong in a part of a question, the work from there on is worthless so that no more marks can sensibly be given. On the other hand, when two or more steps are successfully run together by the candidate, the earlier marks are implied and full credit must be given.
- e. The abbreviation FT implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A and B marks are given for correct work only – differences in notation are of course permitted. A (accuracy) marks are not given for answers obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage of a solution, there may be various alternatives that are equally acceptable. In such cases, what is acceptable will be detailed in the mark scheme. If this is not the case please, escalate the question to your Team Leader who will decide on a course of action with the Principal Examiner.

Sometimes the answer to one part of a question is used in a later part of the same question. In this case, A marks will often be 'follow through'. In such cases you must ensure that you refer back to the answer of the previous part question even if this is not shown within the image zone. You may find it easier to mark follow through questions candidate-by-candidate rather than question-by-question.

- f. We are usually quite flexible about the accuracy to which the final answer is expressed; over-specification is usually only penalised where the scheme explicitly says so.
- When a value is **given** in the paper only accept an answer correct to at least as many significant figures as the given value.
  - When a value is **not given** in the paper accept any answer that agrees with the correct value to **3 s.f.** unless a different level of accuracy has been asked for in the question, or the mark scheme specifies an acceptable range.

Candidates using a value of 9.81 or 10 for  $g$  should usually be penalised for any final accuracy marks which do not agree to the value found with 9.8 which is given in the rubric.

- g. Rules for replaced work and multiple attempts:

- If one attempt is clearly indicated as the one to mark, or only one is left uncrossed out, then mark that attempt and ignore the others.
  - If more than one attempt is left not crossed out, then mark the last attempt unless it only repeats part of the first attempt or is substantially less complete.
  - If a candidate crosses out all of their attempts, the assessor should attempt to mark the crossed out answer(s) as above and award marks appropriately.
- h. For a genuine misreading (of numbers or symbols) which is such that the object and the difficulty of the question remain unaltered, mark according to the scheme but following through from the candidate's data. A penalty is then applied; 1 mark is generally appropriate, though this may differ for some units. This is achieved by withholding one A or B mark in the question. Marks designated as CAO may be awarded as long as there are no other errors.  
If a candidate corrects the misread in a later part, do not continue to follow through. Note that a miscopy of the candidate's own working is not a misread but an accuracy error.
- i. If a calculator is used, some answers may be obtained with little or no working visible. Allow full marks for correct answers, provided that there is nothing in the wording of the question specifying that analytical methods are required such as the bold "In this question you must show detailed reasoning", or the command words "Show" or "Determine". Where an answer is wrong but there is some evidence of method, allow appropriate method marks. Wrong answers with no supporting method score zero. If in doubt, consult your Team Leader.
- j. If in any case the scheme operates with considerable unfairness consult your Team Leader.

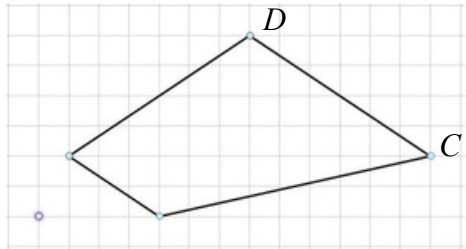
| Question |     |      | Answer                                                           | Marks                                          | AO                           | Guidance                                                                                                                                                                            |                                                                                                                                                                                                   |
|----------|-----|------|------------------------------------------------------------------|------------------------------------------------|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1        | (a) | (i)  | $(x-3)^2$<br>$\dots + 2$                                         | <b>B1</b><br><b>B1FT</b><br><br><b>[2]</b>     | <b>1.1</b><br><b>1.1</b>     | For '3' (Allow $a = 3$ )<br>For '2' (Allow $b = 2$ )                                                                                                                                | <b>ISW</b> if $(x-3)^2$ seen but then $a = -3$ stated<br><b>FT</b> on their $a$ ie $11 - a^2$ ; most typically (but not exclusively) this will be from $(x+3)^2$                                  |
| 1        | (a) | (ii) | $x = 3$                                                          | <b>B1FT</b><br><br><b>[1]</b>                  | <b>1.1</b>                   | Correct equation<br><b>FT</b> their (i)                                                                                                                                             | Must include $x = \dots$<br><b>B0</b> if any other equation given eg $x = 3$ , $y = 2$                                                                                                            |
| 1        | (b) | (i)  | $(2p-1)^2 - 4p^2$<br><br>$= 4p^2 - 4p + 1 - 4p^2$<br>$= -4p + 1$ | <b>M1</b><br><br><b>A1</b><br><br><b>[2]</b>   | <b>1.1</b><br><br><b>1.1</b> | Attempt $b^2 - 4ac$<br><br>Obtain correct discriminant, in simplified form                                                                                                          | Implied by correct answer<br>Allow <b>M1 BOD</b> if within a square root, but <b>M0</b> if within a full quadratic formula, unless later recovered and isolated<br>Condone '='                    |
| 1        | (b) | (ii) | $-4p + 1 = 0$<br><br>$p = \frac{1}{4}$                           | <b>M1</b><br><br><b>A1FT</b><br><br><b>[2]</b> | <b>1.1</b><br><br><b>1.1</b> | Equate their discriminant (in terms of $p$ only) to 0<br>Implied by correct value for $p$<br>Obtain correct value for $p$<br><b>FT</b> their (b)(i) as long it is a linear equation | Could also attempt 'perfect square' form, but must go as far as equating their constant term to 0<br><br>Any equivalent eg 0.25<br>Allow correct answer coming from equating the square root to 0 |

## H240/01 Mark Scheme

June 2026

| Question |     |      | Answer                                                            | Marks         | AO         | Guidance                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|----------|-----|------|-------------------------------------------------------------------|---------------|------------|------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2        | (a) | (i)  | digit sum of 11 is $1 + 1 = 2$                                    | <b>M1</b>     | <b>1.1</b> | Find digitsum for at least one prime number between 10 and 20                                                                            | No need for any comment                                                                                                                                                                                                                                                                                                                                                                                                                           |
|          |     |      | 13: $1 + 3 = 4$<br>17: $1 + 7 = 8$<br>19: $1 + 9 = 10$            | <b>A1*</b>    | <b>2.1</b> | Find digit sums for <b>all</b> prime numbers between 10 and 20                                                                           | Condone any additional eg 15: $1 + 5 = 6$<br>Allow <b>BOD</b> if not explicitly stated which number is being considered                                                                                                                                                                                                                                                                                                                           |
|          |     |      | which are even numbers                                            | <b>A1dep*</b> | <b>2.4</b> | Conclude appropriately                                                                                                                   | Comment needed, even if just showing that all numbers can be written as $2 \times *$<br>Condone just 'true'<br><b>A0</b> if any additional numbers included eg non-primes / primes outside 10 to 20                                                                                                                                                                                                                                               |
|          |     |      |                                                                   | [3]           |            |                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 2        | (a) | (ii) | eg 23: $2 + 3 = 5$ , which is not even                            | <b>B1</b>     | <b>2.3</b> | State both counterexample and reason<br>Either the sum or the evaluation must be seen<br>eg for 23, we need at least one of $2 + 3$ or 5 | Could state either 'not even' or 'odd'<br>Accept 'not multiple of 2' or 'not divisible by 2', but <b>B0</b> for just 'not true'<br>Allow <b>BOD</b> if any additional numbers are included eg non-prime or those that have an even digit sum, as long as they draw attention to the counterexample                                                                                                                                                |
|          |     |      |                                                                   | [1]           |            |                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 2        | (b) |      | $(2n+5)^2 - (2n+3)^2$<br>$= (4n^2 + 20n + 25) - (4n^2 + 12n + 9)$ | <b>M1</b>     | <b>2.1</b> | Expand to obtain two 3 term quadratics, both with at least two terms correct                                                             | Condone 'invisible' brackets eg <b>M1</b> for $4n^2 + 20n + 25 - 4n^2 + 12n + 9$<br>Could be 4 terms eg $4n^2 + 10n + 10n + 25$<br>Could be implied by going from expanded quadratics straight to $8(n+2)$<br>Allow <b>BOD A1</b> if following an earlier slip<br>Identify common factor (condone just writing it as $8(n+2)$ ) or justify term by term (ie 8 and 16 are both multiples of 8)<br>Allow <b>BOD A1</b> if following an earlier slip |
|          |     |      | $= 8n + 16$                                                       | <b>A1*</b>    | <b>1.1</b> | Correct simplified expression ie like terms collected, from correct expansions                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|          |     |      | $= 8(n+2)$<br>(hence both are multiples of 8)                     | <b>A1dep*</b> | <b>2.4</b> | Show that this is a multiple of 8                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

| Question |     |  | Answer                                                                                                                                                                                                                                                                                                                                                                                                          | Marks      | AO                                                                                                                                 | Guidance                                                                                                                                                                                                                                                                                                                                         |                                                           |
|----------|-----|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| 2        | (b) |  | <b>Alternative method</b><br><b>Considering both odd and even</b><br><br>even: $n = 2p$<br>$(4p + 5)^2 - (4p + 3)^2$<br>$= (16p^2 + 40p + 25) - (16p^2 + 24p + 9)$<br><br>odd: $n = 2p + 1$<br>$(4p + 7)^2 - (4p + 5)^2$<br>$= (16p^2 + 56p + 49) - (16p^2 + 40p + 25)$<br><br>$= 16p + 16$ (for $n$ even)<br>$= 16p + 24$ (for $n$ odd)<br>$= 8(2p + 2)$<br>$= 8(2p + 3)$<br><br>hence both are multiples of 8 | <b>M1</b>  | <b>2.1</b>                                                                                                                         | Condone using $2n$ and $2n + 1$<br><br>Expand <b>both</b> odd and even expressions to obtain two 3 term quadratics, both with at least two terms correct                                                                                                                                                                                         | Condone ‘invisible’ brackets<br>Could use odd as $2p - 1$ |
|          |     |  | <b>A1*</b>                                                                                                                                                                                                                                                                                                                                                                                                      | <b>1.1</b> | <b>Both</b> simplified expressions correct ie like terms collected, from correct expansions<br>Explain why each is a multiple of 8 | Could be implied by going from expanded quadratics straight to factorised form)<br>Allow <b>BOD A1</b> if following an earlier slip<br>Identify common factors (it is sufficient to just write as $8(2p + 2)$ and $8(2p + 3)$ or justify term by term (ie 16 and 24 are both multiples of 8)<br>Allow <b>BOD A1</b> if following an earlier slip |                                                           |
|          |     |  | <b>A1dep*</b>                                                                                                                                                                                                                                                                                                                                                                                                   | <b>2.4</b> |                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                  |                                                           |
|          |     |  |                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>[3]</b> |                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                  |                                                           |

| Question |     |      | Answer                                                                                                                                                 | Marks | AO  | Guidance                                                                                                                                                                                |                                                                                                                                                                                                                                                 |
|----------|-----|------|--------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3        | (a) |      |                                                                       | B1    | 1.1 | Point C marked and labelled                                                                                                                                                             | No need for line segments – just mark position of C using overlay (slight variations due to scanning)                                                                                                                                           |
|          |     |      |                                                                                                                                                        | B1    | 1.1 | Point D marked and labelled                                                                                                                                                             | No need for line segments – just mark position of D using overlay (slight variations due to scanning)                                                                                                                                           |
|          |     |      |                                                                                                                                                        | [2]   |     |                                                                                                                                                                                         | SC B1 for both points correctly marked, but no labels or labels reversed                                                                                                                                                                        |
| 3        | (b) | (i)  | $\vec{AB} = \mathbf{b} - \mathbf{a}$<br>$\vec{DC} = (\mathbf{a} + 3\mathbf{b}) - (3\mathbf{a} + \mathbf{b})$<br>$\vec{DC} = 2\mathbf{b} - 2\mathbf{a}$ | B1    | 1.1 | Correct expression for $\vec{AB}$                                                                                                                                                       | Ignore any numerical vectors                                                                                                                                                                                                                    |
|          |     |      |                                                                                                                                                        | M1    | 1.1 | Attempt expression for $\vec{DC}$<br>Implied by correct simplified vector                                                                                                               | Or attempt $\vec{CD}$ ie $\pm[(\mathbf{a} + 3\mathbf{b}) - (3\mathbf{a} + \mathbf{b})]$<br>Brackets soi<br>M1 could be implied by answer of $2\mathbf{a} - 2\mathbf{b}$                                                                         |
|          |     |      |                                                                                                                                                        | A1    | 1.1 | Correct simplified expression for $\vec{DC}$                                                                                                                                            | Ignore any numerical vectors                                                                                                                                                                                                                    |
|          | (b) | (ii) | $\vec{DC} = 2(\mathbf{b} - \mathbf{a}) = 2\vec{AB}$<br>hence a pair of parallel sides<br>(so ABCD is a trapezium)                                      | B1    | 2.4 | Clearly state or demonstrate that one is a multiple of the other to correctly confirm that $\vec{AB}$ and $\vec{DC}$ are <b>parallel</b><br>Must have correct $\vec{AB}$ and $\vec{DC}$ | <b>Parallel</b> must be seen in explanation<br>It is not sufficient to simply say that the 2 relevant sides are parallel with no evidence<br>Ignore any other statements unless contradictory<br>Ignore any attempts to compare other two sides |
|          |     |      |                                                                                                                                                        | [1]   |     |                                                                                                                                                                                         |                                                                                                                                                                                                                                                 |

| Question |     | Answer                                                                                                                                                                                                               | Marks                                                                             | AO                                                                                                                                                                                                                                                                                                                            | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  |
|----------|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| 4        | (a) | <p><b>DR</b></p> $2x+1 = \ln \frac{7}{5}$<br>$x = \frac{1}{2} (\ln \frac{7}{5} - 1) = -0.332$                                                                                                                        | <p><b>M1</b></p><br><p><b>A1</b></p><br><p>[2]</p>                                | <p><b>2.1</b></p> <p>Dividing by 5 then taking logs of both sides to obtain a linear equation</p><br><p><b>1.1</b></p> <p>Accept any exact answer, or a decimal equivalent<br/>If more than 3sf used then accept <math>[-0.3315, -0.332]</math></p>                                                                           | <p>Could be logs to any base but must also drop power eg <math>(2x+1)\lg(e) = \lg(1.4)</math><br/>Condone invisible brackets as long as later implied<br/>If taking logs of the original equation the LHS must be a sum eg <math>\ln 5 + (2x+1)</math><br/><b>ISW</b> once correct answer has been seen<br/>Exact answer could be unsimplified (and could include eg <math>\lg(e)</math>)<br/>May see <math>\ln 7 - \ln 5</math> in place of <math>\ln \frac{7}{5}</math><br/><b>DR</b> so some method must be seen to gain any credit</p>                                 |  |
| 4        | (b) | <p><b>DR</b></p> $3\log_{10} x = \log_{10} x^3$<br>$\log_{10} (2x^3 + 27) - \log_{10} x^3 = \log_{10} \frac{2x^3 + 27}{x^3}$<br>$\frac{2x^3 + 27}{x^3} = 10$<br>$x^3 = \frac{27}{8}$<br>$x = \sqrt[3]{\frac{27}{8}}$ | <p><b>B1</b></p><br><p><b>M1*</b></p><br><p><b>M1dep*</b></p><br><p><b>A1</b></p> | <p><b>3.1a</b></p> <p>Use the power law correctly on <math>3\log_{10} x</math></p><br><p><b>2.1</b></p> <p>Correctly combine at least two correct log terms</p><br><p><b>1.1</b></p> <p>Correctly remove logs to obtain correct equation</p><br><p><b>1.1</b></p> <p>Obtain <math>x = \sqrt[3]{\frac{27}{8}} = 1.5</math></p> | <p>Seen anywhere in solution, and possibly in an incorrect equation<br/>Condone no explicit base</p><br><p>Most likely to rearrange to get both log terms on one side of the equation and then combine but could also use <math>1 = \log_{10} 10</math> and combine with other log term(s)<br/>Condone no explicit base</p><br><p>Dependent on correct combination of logs</p><br><p><b>A0</b> if cube root has not been evaluated eg <math>\sqrt{3.375}</math></p><br><p><b>DR</b> so some method required; if answer only then allow <b>SC B1</b> for correct answer</p> |  |

| Question |  |  | Answer                                                                                                                                                                                                                                                                            | Marks                                                             | AO | Guidance                                                                                                                                                                                                       |                                                                                                                                                                                                                                                     |
|----------|--|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          |  |  | <b>Alternative method</b><br><b>Removing <math>\log_{10}</math> as first step</b><br>$2x^3 + 27 = 10^{1+3\log x}$<br>$2x^3 + 27 = 10^{1+\log^3 x}$<br><br>$2x^3 + 27 = 10^1 \times 10^{\log^3 x}$<br><br>$2x^3 + 27 = 10x^3$<br><br>$x^3 = \frac{27}{8}$<br><br>$x = \frac{3}{2}$ | <b>B1</b><br><br><b>M1*</b><br><br><b>M1dep*</b><br><br><b>A1</b> |    | Use the powerlaw correctly on $3\log_{10} x$<br><br>Correctly split $10^{1+\log^3 x}$ or $10^{1+3\log x}$<br>Correctly remove logs to obtain correct equation<br><br>Obtain $x = \sqrt[3]{\frac{27}{8}} = 1.5$ | Seen anywhere in solution, and possibly in an incorrect equation<br>Condone no explicit base<br><br>Must be product not sum<br><br>Dependent on correct splitting of indices<br><br><b>A0</b> if cube root has not been evaluated eg $\sqrt{3.375}$ |
|          |  |  |                                                                                                                                                                                                                                                                                   | <b>[4]</b>                                                        |    |                                                                                                                                                                                                                | <b>DR</b> so some method required; if answer only then allow <b>SC B1</b> for correct answer                                                                                                                                                        |

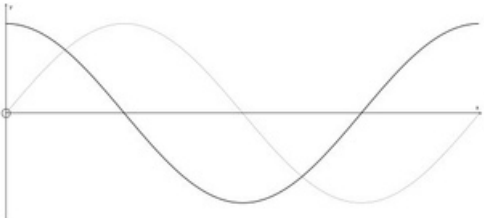
| Question |  |  | Answer                                  | Marks      | AO          | Guidance                                                                                                                                                                                           |                                                                                                                                                                                         |
|----------|--|--|-----------------------------------------|------------|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5        |  |  | $32 = 16a + 2b$                         | <b>B1</b>  | <b>3.1a</b> | Use $x = 4$ , $y = 32$ to obtain a correct equation, possibly unsimplified<br>May be in terms of just $a$ or just $b$ if the derivative has already been substituted in<br>Attempt differentiation | Seen anywhere in solution<br>Allow for unsimplified equation, even if error then occurs                                                                                                 |
|          |  |  | $\frac{dy}{dx} = 2ax + b \frac{1}{x^2}$ | <b>M1</b>  | <b>1.1a</b> |                                                                                                                                                                                                    | To obtain derivative of the form $px + qx^{-0.5}$                                                                                                                                       |
|          |  |  |                                         | <b>A1</b>  | <b>1.1</b>  | Obtain correct derivative, possibly unsimplified                                                                                                                                                   |                                                                                                                                                                                         |
|          |  |  | $22 = 8a + \frac{1}{4}b$                | <b>M1</b>  | <b>3.1a</b> | Use $x = 4$ , $\frac{dy}{dx} = 22$ in their derivative                                                                                                                                             | Not dependent on previous <b>M1</b> but must clearly be using an attempt at differentiation ie at least one power reduced by 1                                                          |
|          |  |  |                                         | <b>A1</b>  | <b>1.1</b>  | Obtain correct equation, possibly unsimplified                                                                                                                                                     | Allow <b>BOD</b> if $\sqrt{4}$ initially becomes $\pm 2$ , resulting in a second incorrect equation<br>Possibly <b>BC</b> , so no method needed when solving the simultaneous equations |
|          |  |  | $a = 3, b = -8$                         | <b>A1</b>  | <b>1.1</b>  | Obtain correct values for $a$ and $b$ www                                                                                                                                                          | <b>A0</b> if there is a second set of values for $a$ and $b$ , from $\sqrt{4}$ being $\pm 2$                                                                                            |
|          |  |  |                                         | <b>[6]</b> |             |                                                                                                                                                                                                    |                                                                                                                                                                                         |

| Question |     |                                                                    | Answer                                                                                                        | Marks | AO                                                        | Guidance                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------|-----|--------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|-------|-----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6        | (a) | (i)                                                                | $\int (x^3 - 16x)dx = \frac{1}{4}x^4 - 8x^2$                                                                  | M1    | 1.1                                                       | Attempt integration                                                                                                                                                                                                                        | Obtain $ax^4 + bx^2$                                                                                                                                                                                                                                                                                                                                                                                                                         |
|          |     |                                                                    |                                                                                                               | A1    | 1.1                                                       | Implied by correct answer<br>Obtain correct integral                                                                                                                                                                                       | May also have + $c$                                                                                                                                                                                                                                                                                                                                                                                                                          |
|          |     | $[x^4 - 8x^2]_0^k$<br>$= (k^4 - 8k^2) - (0 - 0)$<br>$= k^4 - 8k^2$ | A1                                                                                                            | 1.1   | Use given limits to obtain correct answer in terms of $k$ | Correct order, and subtraction (condone use of 0 not being explicit)<br>A0 if + $c$ still present                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|          |     |                                                                    |                                                                                                               | [3]   |                                                           |                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 6        | (a) | (ii)                                                               | $[x^4 - 8x^2]_{-k}^k$<br>$= (k^4 - 8k^2) - ((-k)^4 - 8(-k)^2)$<br>$= (k^4 - 8k^2) - (k^4 - 8k^2)$<br>$= 0$ AG | B1FT  | 2.1                                                       | Replace lower limit with $-k$ to obtain given answer<br>FT their (i) answer, as long as there are two terms both with even powers                                                                                                          | Need to see $-k$ being used correctly, so brackets around $-k$ are needed<br>Must see $\frac{1}{4}(-k)^4 - 8(-k)^2$ becoming $\frac{1}{4}k^4 - 8k^2$ before given answer of 0 is stated                                                                                                                                                                                                                                                      |
|          |     |                                                                    |                                                                                                               | [1]   |                                                           |                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 6        | (b) |                                                                    | Equal areas above and below the $x$ -axis (between $x = -k$ and $x = k$ , for all $k$ )                       | B1    | 2.2a                                                      | Any sensible statement that refers to equal areas (soi to be both above and below the $x$ -axis); condone reference to 'negative' area<br>Could refer to the symmetry of the curve<br>No need to mention limits, as it is true for all $k$ | Must go both above and below the $x$ -axis is not sufficient<br>Accept 'odd function', but this is not on the specification so also allow a description of an odd function eg referring to <b>rotational</b> symmetry around the origin oe<br>Accept $f(x) = -f(-x)$ oe<br>Condone additional incorrect statements as long as not directly contradictory<br>A sketch alone is not sufficient, but could be used to support their explanation |
|          |     |                                                                    |                                                                                                               | [1]   |                                                           |                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                              |

| Question |     | Answer                                                                                  | Marks                   | AO          | Guidance                                                                                            |                                                                                                                                           |
|----------|-----|-----------------------------------------------------------------------------------------|-------------------------|-------------|-----------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| 6        | (c) | $x^3 - 16x = x(x+4)(x-4)$<br>so points of intersection with $x$ -axis are<br>$-4, 0, 4$ | <b>B1</b>               | <b>3.1a</b> | Identify limits as 0 (soi) and at least one of $-4$ and $4$<br>Implied by answer of $\pm 64$<br>www | Possibly <b>BC</b>                                                                                                                        |
|          |     | $\int_0^4 (x^3 - 16x) dx = -64$<br>or $\int_4^0 (x^3 - 16x) dx = 64$                    | <b>M1</b>               | <b>1.1a</b> | Attempt integral / area between 0 and either of their $\pm 4$<br>Implied by answer of $\pm 64$      | Limits used in either order, and no need to see explicit use of 0<br>Could also see modulus being used (or implied)<br>Possibly <b>BC</b> |
|          |     | Hence total area is 128                                                                 | <b>A1</b><br><b>[3]</b> | <b>1.1</b>  | Obtain total area of 128 www                                                                        | <b>A0</b> for $-128$                                                                                                                      |

| Question |     | Answer                                                                                                                                          | Marks         | AO          | Guidance                                                                                                                                                                            |                                                                                                                                                                                                                                                                                     |
|----------|-----|-------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7        | (a) | constant term needs $(x^2)2 \times (x^{-1})^4$                                                                                                  | <b>B1*</b>    | <b>3.1a</b> | Attempt required term                                                                                                                                                               | Possibly within an expansion that also attempts other terms, in which case powers of $x$ must be seen to be intended to cancel out at some point in the solution ie this term becomes constant (and no others do) or the same single power of $x$ seen in numerator and denominator |
|          |     | coeff is ${}^6C_2 \times 3^2 \times 2^4$                                                                                                        | <b>M1dep*</b> | <b>1.1</b>  | Attempt correct coefficient<br>May still have $x$ present as well<br>‘C2 may be implied by 15 used                                                                                  | Or use ${}^6C_4$<br>Possibly within fuller expansion<br>Ignore any other terms attempted                                                                                                                                                                                            |
|          |     | $15 \times 9 \times 16 = 2160$ <b>AG</b>                                                                                                        | <b>A1</b>     | <b>2.1</b>  | Obtain given answer                                                                                                                                                                 | If part of a fuller expansion then the constant term must be identified (eg underlined or isolated)                                                                                                                                                                                 |
|          |     | <b>Alternative method</b><br><b>Taking a factor outside the bracket</b><br>eg<br>constant term in $(1 + \frac{3x^3}{x})^6$ would need $(x^3)^2$ | <b>B1*</b>    |             | <b>This MS should be applied to any attempt at using a factor</b><br>Attempt required term<br>Powers of $x$ must be seen to be intended to cancel out at some point in the solution | Possibly within an expansion that also attempts other terms, but then <b>this</b> term must become constant<br>The power of $x$ in the factor <b>must</b> be correct, but condone incorrect coeff eg $\frac{2}{16}$                                                                 |
|          |     | coeff is ${}^6C_2 \times 2^6 \times (\frac{3}{x})^2$                                                                                            | <b>M1dep*</b> |             | Attempt correct coefficient<br>May still have $x$ present as well<br>‘C2 may be implied by 15 used                                                                                  | Or use ${}^6C_4$<br>Possibly within fuller expansion<br>Ignore any other terms attempted                                                                                                                                                                                            |
|          |     | $15 \times 64 \times 2.25 = 2160$ <b>AG</b>                                                                                                     | <b>A1</b>     |             | Obtain given answer                                                                                                                                                                 | If part of a fuller expansion then the constant term must be identified                                                                                                                                                                                                             |
|          |     |                                                                                                                                                 | <b>[3]</b>    |             |                                                                                                                                                                                     | If powers of $x$ are never considered then <b>SC B1</b> for $15 \times 9 \times 16 = 2160$ (the coefficient has been found, but this term has not been justified as a constant term)                                                                                                |

| Question |     | Answer                                                                                                                                                                                                                                  | Marks         | AO          | Guidance                                                                                                                                                        |                                                                                                                                                                                                                                                                     |
|----------|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7        | (b) | constant term needs $(\sqrt{x})^4 \times (x^{-1})^2$                                                                                                                                                                                    | <b>B1*</b>    | <b>3.1a</b> | Attempt required term                                                                                                                                           | Possibly within an expansion that also attempts other terms, in which case powers of $x$ must be seen to be intended to cancel out at some point in the solution ie this term becomes constant (and no others do) or same power of $x$ in numerator and denominator |
|          |     | coeff is ${}^6C_4 \times 5^2$                                                                                                                                                                                                           | <b>M1dep*</b> | <b>1.1</b>  | Attempt correct coefficient<br>May still have $x$ present as well<br>Implied by correct answer<br>Obtain 375 www                                                | Or use ${}^6C_2$<br>Possibly within fuller expansion<br>Ignore any other terms attempted                                                                                                                                                                            |
|          |     | $15 \times 25 = 375$                                                                                                                                                                                                                    | <b>A1</b>     | <b>1.1</b>  | Answer only gets full marks                                                                                                                                     | If in a fuller expansion then no need to isolate as long as no other constant terms                                                                                                                                                                                 |
|          |     | <b>Alternative method</b><br><b>Taking a factor outside the bracket</b><br>eg<br>constant term in $(1 + \frac{1}{5}x^{1.5})^6$<br>wuldneed $\frac{1}{5} \times (\frac{1}{5})^4$<br>coeff is ${}^6C_4 \times 5^6 \times (\frac{1}{5})^4$ | <b>B1*</b>    |             | <b>This MS should be applied to any attempt at using a factor</b><br>Attempt required term<br>Powers of $x$ must cancel out at some point in the solution (soi) | Possibly within an expansion that also attempts other terms, but then <b>this</b> term must become constant                                                                                                                                                         |
|          |     |                                                                                                                                                                                                                                         | <b>M1dep*</b> |             | Attempt correct coefficient<br>May still have $x$ present as well<br>Implied by correct answer<br>Obtain 375 www                                                | Or use ${}^6C_2$<br>Possibly within fuller expansion<br>Ignore any other terms attempted                                                                                                                                                                            |
|          |     | $15 \times 15625 \times 0.0016 = 375$                                                                                                                                                                                                   | <b>A1</b>     |             | Answer only gets full marks                                                                                                                                     | If in a fuller expansion then no need to isolate as long as no other constant terms                                                                                                                                                                                 |
|          |     |                                                                                                                                                                                                                                         | <b>[3]</b>    |             |                                                                                                                                                                 |                                                                                                                                                                                                                                                                     |
| 7        | (c) | Other products will also give a constant term eg $x^3 \times x^{-3}$ (and will not cancel out as all terms will be positive)                                                                                                            | <b>B1</b>     | <b>2.4</b>  | Condone just 'there will be other constant terms' with no further explanation                                                                                   | Condone incorrect terms if an example is given, as long as it demonstrates cancelling                                                                                                                                                                               |
|          |     |                                                                                                                                                                                                                                         | <b>[1]</b>    |             |                                                                                                                                                                 |                                                                                                                                                                                                                                                                     |

| Question |     |      | Answer                                                                            | Marks                       | AO                 | Guidance                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------|-----|------|-----------------------------------------------------------------------------------|-----------------------------|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 8        | (a) | (i)  | $(3\pi, -3)$                                                                      | B1<br>B1<br>[2]             | 3.1a<br>1.1        | $x$ -coordinate of $3\pi$<br>$y$ -coordinate of $-3$                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 8        | (a) | (ii) | $a = 3$<br><br>$b = \frac{1}{2}$                                                  | B1<br><br>B1<br><br>[2]     | 1.1<br><br>2.2a    | Correct value for $a$<br><br>Correct value for $b$                                                                                                                                                                                                                                                                                   | Could be embedded in the equation of the curve, but only credit this if not contradicted by $a = \dots$ in the <b>AB</b><br><br>Could be embedded in the equation of the curve, but only credit this if not contradicted by $b = \dots$ in the <b>AB</b>                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 8        | (b) | (i)  |  | B1<br><br><br>B1<br><br>[2] | 1.1<br><br><br>1.1 | One complete cos curve attempted over the same domain (ignore any cos graph outside the domain of the sin graph)<br>Ignore amplitude<br>Intended maximum points on (or close to) the $y$ -axis and at the end of the domain of $x$ (but condone a non-zero gradient at these points)<br><br>Same amplitude attempted (ignore period) | Allow <b>BOD</b> for small fluctuations in $x_{\max}/x_{\min}/$ intersection with $x$ -axis, as long as intention is clear – use overlay to judge intent (it can be moved and dragged onto the axes in the script)<br>Allow a curve that goes beyond the given domain of $x$ , as long as one full period of the cos graph is intended to coincide with the given sin graph<br>For tolerance, use two dashes on the overlay as a guide<br><br>Allow <b>BOD</b> for small fluctuations in amplitude, as long as intention is clear – use overlay to judge intent<br>Must be from recognisable attempt at a positive cos curve<br>For tolerance, use two dashes on the overlay as a guide |

| Question |     |      | Answer                                         | Marks      | AO          | Guidance                                                                                                                                                             |
|----------|-----|------|------------------------------------------------|------------|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 8        | (b) | (ii) | $p\sin qx = p\cos qx$<br>$\tan qx = 1$         | <b>B1</b>  | <b>3.1a</b> | Obtain $\tan qx = 1$ oe<br>If no equation seen then <b>B1</b> can be implied by $qx = -\pi$ or $\frac{5}{4}\pi$<br>(or $qx = 45^\circ$ or $225^\circ$ ) <sup>4</sup> |
|          |     |      | $qx = \frac{1}{4}\pi$<br>$x = \frac{1}{4q}\pi$ | <b>B1</b>  | <b>1.1</b>  | Obtain correct first solution                                                                                                                                        |
|          |     |      | $qx = \frac{5}{4}\pi$                          | <b>M1</b>  | <b>3.1a</b> | Attempt second value for $qx$<br>(could be implied by value for $x$ )<br>If solving $\tan qx = k$ , then need $k \neq 0$                                             |
|          |     |      | $x = \frac{5}{4q}\pi$                          | <b>A1</b>  | <b>1.1</b>  | Obtain correct second solution<br><b>A0</b> if additional solutions in $[0, \frac{2}{q}\pi]$                                                                         |
|          |     |      |                                                | <b>[4]</b> |             |                                                                                                                                                                      |

**BOD** if  $\frac{\cos qx}{\sin qx} = 1$  then appears as  $\tan qx = 1$  on the next line, as no incorrect statement seen  
Equally condone other similar statements where no error is seen eg  $\sin^2 qx - \cos^2 qx = 0$  becoming  $\cos 2qx = 0$   
If using harmonic form then condone no / incorrect  $R$  (as irrelevant to solution)  
Could use a longer method (eg initially squaring both sides) but this must result in a correct equation in a single trig function (with no powers) eg  $\sin qx = \sqrt[2]{2}$   
Allow in degrees ie  $x = \frac{45}{q}$   
Condone answers both in degrees and radians  
Allow working in degrees, but only if consistent with first value for  $qx$  (ie add 180 if in degrees or add  $\pi$  if in radians)  
Or  $\sin qx$  or  $\cos qx = k$ , with  $-1 < k < 1$  and  $k \neq 0$   
Must now be in radians only, but accept any equivalent form eg  $\frac{1.25\pi}{q}$   
**A0** if answers both in degrees and radians  
Whilst the command word is ‘determine’ some solutions may just use points of intersection of  $\sin x$  and  $\cos x$  along with transformations; if no method is seen then allow **B2** per correct answer, but with no partial credit

| Question |     |  | Answer                                                                                                                                                                             | Marks                                                                     | AO                                                                               | Guidance                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----------|-----|--|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 9        | (a) |  | 35 seals                                                                                                                                                                           | <b>B1</b><br><b>[1]</b>                                                   | <b>3.4</b>                                                                       | State 35                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 9        | (b) |  | $P_{10} = 61.53$ So<br>increase is $= P_{10} - P_0$<br>$61.53 - 35 = 26.53$<br>$\approx 26$                                                                                        | <b>M1</b><br><br><b>A1</b><br><b>[2]</b>                                  | <b>3.4</b><br><br><b>1.1</b>                                                     | Attempt the difference between $P_{10}$ and their $P_0$<br><br>Obtain either 26 or 27                                                                                                                                     | Implied by answer of $\pm 26, \pm 26.5 \dots$ or $\pm 27$<br><br>Must be an integer value, following subtraction in correct order                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 9        | (c) |  | $\frac{dP}{dt} = 5 - 2.175e^{0.015t}$<br><br>$5 - 2.175e^{0.015t} = 0$<br>$e^{0.015t} = \frac{200}{87}$<br>$0.015t = 0.8324 \dots$<br><br>$t = 55.49 \dots$<br><br>$P = 124$ seals | <b>M1</b><br><br><b>A1</b><br><b>M1</b><br><br><b>A1</b><br><br><b>A1</b> | <b>1.1</b><br><br><b>1.1</b><br><b>3.1a</b><br><br><b>1.1</b><br><br><b>3.2a</b> | Attempt differentiation<br><br>Correct derivative<br>Equate their attempted derivative to 0 (soi) and attempt to rearrange at least as far as $0.015t = c$<br><br>Obtain a correct value for $t$<br><br>Obtain 124 or 125 | Obtain derivative of form $5 + ke^{0.015t}$<br>Condone a slip in the index eg now $0.15t$ as long as it is a slip and not an attempt to 'reduce the power by 1'<br><br>As far as a linear equation in $t$ , using correct order of operations<br>Could follow <b>M0</b><br>Allow slip(s) in derivative when equating to 0, eg $0.015t$ becoming $0.15t$<br>Could be 55 or 56, or decimal, or in exact form with log(s) still present<br><b>From <math>55 \leq t \leq 56</math></b><br>Final answer must be an integer<br><b>NB</b> it is possible to use $0.015t$ to find $P$ , so the $t$ value may never be seen; a correct value for $P$ would imply the penultimate<br><b>A1</b> |

## H240/01 Mark Scheme

## June 2026

| Question |     |  | Answer                                                                                            | Marks                                         | AO   | Guidance                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                             |
|----------|-----|--|---------------------------------------------------------------------------------------------------|-----------------------------------------------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          |     |  |                                                                                                   | [5]                                           |      |                                                                                                                                                                                                                                                 | 'Determine using calculus' so SC B1 for answer only of 124 or 125                                                                                                                                                                                                           |
| 9        | (d) |  | Predicts seal population is eventually 0<br>(ie dies out)<br>The number of seals will be negative | B1<br><br><br><br><br><br><br><br><br><br>[1] | 3.5a | Sensible consideration of long term behaviour<br>A 'negative' number of seals is what the model does predict<br>Just need to refer to the prediction and not the possible reasons for it, nor how good the model is for the long term behaviour | Condone incorrect value of $t$ in explanation (should be $\approx 106$ )<br>Stating that the number of seals will decrease is not sufficient; part (c) has already identified that there is a maximum value<br>Condone $P \rightarrow -\infty$<br>B1 BOD for $P$ tends to 0 |

| Question |     | Answer                                                                                                                                                                                         | Marks      | AO          | Guidance                                                                                                                     |                                                                                                                                                                                                         |
|----------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-------------|------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10       | (a) | $u'v = \frac{3}{x}(4x-1) \quad v'u = 4(3\ln x + 1)$<br><br>$\frac{dy}{dx} = \frac{\frac{3}{x}(4x-1) - 4(3\ln x + 1)}{(4x-1)^2}$                                                                | <b>B1</b>  | <b>1.1a</b> | $\frac{3}{x}(4x-1)$ or $4(3\ln x + 1)$<br><small>seen</small>                                                                | At least one product correct (possibly expanded)                                                                                                                                                        |
|          |     |                                                                                                                                                                                                | <b>M1</b>  | <b>1.1</b>  | Attempt use of quotient rule; correct structure ie correct order (and subtraction) in numerator and $v^2$ in the denominator | Allow <b>BOD</b> for missing bracket(s), as long as intention is clear                                                                                                                                  |
|          |     |                                                                                                                                                                                                | <b>A1</b>  | <b>1.1</b>  | Obtain correct derivative, possibly unsimplified                                                                             | <b>ISW</b> an incorrect attempt to simplify<br>Must be fully correct, including brackets, for <b>A1</b> (no back credit from part (b))<br>If implicit differentiation is attempted then consult your TL |
|          |     | <b>Alternative method</b><br><b>Using the product rule</b><br>$u = (4x - 1)^{-1}$ gives $u' = -4(4x - 1)^{-2}$<br><br>$\frac{dy}{dx} = -4(4x - 1)^{-2}(3\ln x + 1) + \frac{3}{x}(4x - 1)^{-1}$ | <b>B1</b>  |             | Correct differentiation of $(4x - 1)^{-1}$                                                                                   | Either seen explicitly or as part of product rule (if latter, then must be convincing)                                                                                                                  |
|          |     |                                                                                                                                                                                                | <b>M1</b>  |             | Attempt use of the product rule; correct structure                                                                           | Allow <b>BOD</b> for missing bracket(s), as long as intention is clear                                                                                                                                  |
|          |     |                                                                                                                                                                                                | <b>A1</b>  |             | Obtain correct derivative, possibly unsimplified<br>Could be negative indices or fractions                                   | <b>ISW</b> an incorrect attempt to simplify<br>Must be fully correct, including brackets, for <b>A1</b> (no back credit from part (b))                                                                  |
|          |     |                                                                                                                                                                                                | <b>[3]</b> |             |                                                                                                                              |                                                                                                                                                                                                         |

| Question |     |  | Answer                                          | Marks  | AO  | Guidance                                                                                                               |                                                                                                                                                                                                                       |
|----------|-----|--|-------------------------------------------------|--------|-----|------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10       | (b) |  | $\frac{x(4x-1)-4(3\ln x+1)}{(4x-1)^2} = 0$      | M1*    | 1.1 | Equate attempt at their derivative to 0<br>May no longer be the derivative credited in (a), eg if ISW had been applied | Could be implied by simply equating their numerator to 0 oe, if quotient rule was used<br><br>Couldse e $\frac{8-\frac{3}{x}12\ln x}{(4x-1)^2}$ or $\frac{8x-3-12x\ln x}{(4x-1)^2}$ if already simplified in part (a) |
|          |     |  | $12x - 3 - 12x\ln x - 4x = 0$                   | M1dep* | 1.1 | Attempt to rearrange ie clear any fractions from their derivative                                                      | Evidence for clearing fractions could have been seen in part (a)                                                                                                                                                      |
|          |     |  | $8x-3=12\ln x$<br>$x = \frac{8x-3}{12\ln x}$ AG | A1     | 2.1 | Rearrange to given answer<br>www                                                                                       | A0 if derivative was no longer correct when equated to 0                                                                                                                                                              |
|          |     |  |                                                 | [3]    |     |                                                                                                                        |                                                                                                                                                                                                                       |

| Question |     | Answer                                                                                                                                                | Marks      | AO          | Guidance                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                            |
|----------|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-------------|------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10       | (c) | $x - \frac{8x-3}{12\ln x}$ $1.6 - \frac{8 \times 1.6 - 3}{12\ln 1.6}$ $1.7 - \frac{8 \times 1.7 - 3}{12\ln 1.7}$                                      | <b>M1</b>  | <b>1.1</b>  | Gather terms on one side first, and attempt to use <b>both</b> $x = 1.6$ and $x = 1.7$                     | soi<br>Subtraction could be either way around<br>Condone using $x = 1.6$ and $1.7$ in <b>correct</b> dy (full expression or just numerator oe) instead of the given equation, possibly rearranged, with full credit available<br>Could be 0.138 and $-0.035$ if order of subtraction was reversed<br>Condone rounding or truncating<br>Conclusion needed<br>Condone rounding or truncating |
|          |     | $x = 1.6$ gives $-0.1375\dots$<br>$x = 1.7$ gives $0.0353\dots$                                                                                       | <b>A1</b>  | <b>2.1</b>  | Obtain at least one correct value – minimum of 1sf                                                         |                                                                                                                                                                                                                                                                                                                                                                                            |
|          |     | $-0.1375\dots < 0$<br>$0.0353\dots > 0$<br>Change of sign (hence $1.6 < \text{root} < 1.7$ )                                                          | <b>A1</b>  | <b>2.2a</b> | Obtain both correct values and conclude correctly<br>Just need to mention change of sign                   |                                                                                                                                                                                                                                                                                                                                                                                            |
|          |     | <b>Alternative method (using <math>x = F(x)</math>)</b><br>$F(1.6) = 1.7375\dots$ and compare to $1.6$<br>$F(1.7) = 1.6646\dots$ and compare to $1.7$ | <b>M1</b>  |             | Attempt <b>both</b> $F(1.6)$ <b>and</b> $F(1.7)$ , <b>and</b> compare to $x$ values                        | <b>M0</b> if simply evaluating $F(x)$ and not considering $x$ as well                                                                                                                                                                                                                                                                                                                      |
|          |     | $1.6 < 1.7375\dots$<br>$1.7 > 1.6646\dots$                                                                                                            | <b>A1</b>  |             | Obtain at least one correct value of $F(1.6)$ or $F(1.7)$ in comparison of $x$ and $F(x)$ – minimum of 2dp | Condone any inequality signs, but must be attempting to use both sides of the equation<br>Condone rounding or truncating<br>Conclusion needed<br>Condone rounding or truncating                                                                                                                                                                                                            |
|          |     | Change of (inequality) sign (hence $1.6 < \text{root} < 1.7$ )                                                                                        | <b>A1</b>  |             | Obtain both correct comparisons and conclude correctly<br>Just need to mention change of sign              |                                                                                                                                                                                                                                                                                                                                                                                            |
|          |     |                                                                                                                                                       | <b>[3]</b> |             |                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                            |

| Question |     |      | Answer                                                     | Marks     | AO          | Guidance                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                             |
|----------|-----|------|------------------------------------------------------------|-----------|-------------|--------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10       | (d) | (i)  | $x_2 = 1.697\dots$                                         | <b>B1</b> | <b>1.1</b>  | Correctfirst iterate                                                                                                                 | At least 3sf<br>Allow rounded (hence 1.70) or truncated (hence 1.69)                                                                                                                                                                                                                                                                                        |
|          |     |      | 1.666..., 1.686..., 1.673..., 1.681..., 1.676..., 1.679... | <b>M1</b> | <b>1.1</b>  | Correct iterative process; at least <b>3 further values</b> stated (at least 3sf)                                                    | <b>M</b> mark so condone incorrect values as long as correct process is being attempted                                                                                                                                                                                                                                                                     |
|          |     |      | $x = 1.68$                                                 | <b>A1</b> | <b>1.1</b>  | Obtain 1.68                                                                                                                          | <b>A0</b> for eg $x_8 = 1.68$ (implies8 <sup>th</sup> iterate and not root)<br>Process self corrects so <b>B0M1A1</b> possible; or <b>B1M1A1</b> if the error is in a term other than $x_2$<br>Condone answers given to more than 3sf as long as it agrees with the root ie 1.678152166... (and no need to see further explicit iterations to justify this) |
|          |     |      |                                                            | [3]       |             |                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                             |
| 10       | (d) | (ii) | $P$ is (1.68, 0.447)                                       | <b>B1</b> | <b>2.2a</b> | Correct coordinates of $P$<br>Condone if no iteration seen                                                                           | Condone $x = 1.68$ , $y = 0.447$<br>Must be exactly 3sf                                                                                                                                                                                                                                                                                                     |
|          |     |      |                                                            | [1]       |             |                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                             |
| 10       | (e) |      | Cobweb                                                     | <b>B1</b> | <b>1.2</b>  | Correct term used                                                                                                                    | Must state ‘cobweb’ as per specification, Not dependent on previous <b>B</b> mark, even if ‘staircase’ was stated<br>Idea that the iterates go up and down (no need to explicitly mention the root) Could use informal language eg alternating / oscillating / back and forth Could also consider gradient at root ie $F'(1.68) = -0.64 < 0$ www            |
|          |     |      | As iterates are both above and below the root              | <b>B1</b> | <b>2.4</b>  | Correct explanation<br>Not spiralling / circling etc, as this is describing the cobweb diagram and not the behaviour of the iterates |                                                                                                                                                                                                                                                                                                                                                             |
|          |     |      |                                                            |           |             |                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                             |

| Question |     | Answer                                                                                                                                                                                                                               | Marks                                                                                 | AO                                                                        | Guidance                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|----------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 11       | (a) | <p><b>DR</b></p> $\tan\theta + \cot\theta = \frac{\sin\theta \cos\theta}{\sin^2\theta + \cos^2\theta}$ $= \frac{1}{\cos\theta \sin\theta}$ $= \frac{1}{\frac{1}{2}\sin 2\theta}$ $= 2\operatorname{cosec} 2\theta \quad \mathbf{AG}$ | <p><b>M1</b></p> <p><b>M1</b></p> <p><b>M1</b></p> <p><b>A1</b></p> <p><b>[4]</b></p> | <p><b>3.1a</b></p> <p><b>3.1a</b></p> <p><b>1.1</b></p> <p><b>2.1</b></p> | <p>Use identities for <math>\tan\theta</math> and <math>\cot\theta</math> and attempt to combine fractions into a single fraction</p> <p>Use at least one identity correctly</p> <p>Use a second identity correctly</p> <p>Obtain given answer</p> | <p>Allow <b>BOD</b> if order reversed when considering <math>\tan\theta + \cot\theta</math></p> <p>Could instead split into two fractions if starting with right-hand side (or using a proof that ‘meets in the middle’)</p> <p>ie <b>use of</b> <math>\sin^2\theta + \cos^2\theta = 1</math>, or equivalent Pythagorean identity, in a proof and not just stated</p> <p>2nd and 3<sup>rd</sup> <b>M marks</b> could be seen in either order, and possibly in a single step</p> <p>ie <b>use of</b> <math>\cos\theta \sin\theta = \frac{1}{2}\sin 2\theta</math> and not just stated</p> <p>Obtain given answer convincingly</p> <p>Condone missing <math>\theta</math> within proof, as long as present in final answer</p> <p><b>M</b> marks could be seen in any order, depending on the method used</p> <p>Starting with the LHS, the RHS or attempting a proof that ‘meets in the middle’ are all acceptable methods</p> <p>Attempting to manipulate the given identity can gain <b>M</b> marks up until the point where any term(s) change sides; after that there is no further credit</p> |

| Question |     | Answer                                                                                                                                                                                                                                                                                         | Marks                                                                                 | AO                                                                       | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|----------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|--------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 11       | (b) | <p><b>DR</b></p> $\frac{2}{\sin 2\theta} = 4$ $\frac{1}{\sin 2\theta} = 2$ $\sin 2\theta = \frac{1}{2}$ $2\theta = 30^\circ$ $\theta = 15^\circ$ <p><math>2\theta = 30^\circ, 150^\circ, 390^\circ, 510^\circ</math></p> <p><math>\theta = 15^\circ, 75^\circ, 195^\circ, 255^\circ</math></p> | <p><b>B1</b></p> <p><b>M1</b></p> <p><b>A1</b></p> <p><b>A1</b></p> <p><b>[4]</b></p> | <p><b>3.1a</b></p> <p><b>1.1</b></p> <p><b>1.1</b></p> <p><b>2.1</b></p> | <p>Obtain <math>\sin 2\theta = \frac{1}{2}</math> oe; any correct equation (possibly with <math>\sin 2\theta</math> in the denominator)</p> <p>Attempt to find at least one solution, using correct order of operations<br/>Equation <b>must</b> involve <math>k\theta</math>, where <math>k \neq 1</math></p> <p>Obtain at least two correct solutions</p> <p>Obtain all 4 correct solutions, and no others in given range<br/><b>NB</b> solution space is over 2 pages so <b>MUST</b> check both – needs <b>SEEN</b> on pg 13</p> <p>Obtain correct equation in a single trig ratio, with like terms gathered, and no powers</p> <p>eg <math>\text{inv sin}</math> and then divide by 2<br/>Could be <math>\text{inv cos}</math> or <math>\text{inv tan}</math>, depending on equation being solved, and could be dividing by <math>k</math> and not 2</p> <p>Condone solutions in radians<br/>Must come from solving algebraically and not <b>BC</b> eg correct solutions from <math>\sin \theta \cos \theta = 0.25</math> is <b>M0</b>, and hence <b>A0</b><br/>Must now be in degrees</p> <p><b>DR</b> so method needed; no credit for answer(s) only</p> <p><b>NB</b><br/>The command word is ‘hence’ so there should be an attempt to use the result from part (a), though <b>B0 M1</b> is possible if the equation was never correct.<br/>If there is never an attempt to use the part (a) result, but another algebraic method is instead attempted (eg quadratic in <math>\tan \theta</math> or disguised quadratic in <math>\sin \theta</math> or <math>\cos \theta</math>) then apply <b>SC B1</b> for 2 correct solutions or <b>B2</b> for all 4 correct and no extras</p> |

|    |     |                                                                                                                                                                                                                                                      |                                                                           |                                                         |                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                             |
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| 11 | (c) | <p><b>DR</b></p> $\tan\frac{\theta}{2} + \cot\frac{\theta}{2} = \frac{1}{2}\operatorname{cosec}\theta$ $\sin 2\theta(2\operatorname{cosec}\theta) = 3$ $2\sin\theta\cos\theta \frac{2}{\sin\theta} = 3$ $4\cos\theta = 3$ $\cos\theta = \frac{3}{4}$ | <p><b>B1*</b></p> <p><b>M1dep*</b></p> <p><b>A1</b></p> <p><b>[3]</b></p> | <p><b>3.1a</b></p> <p><b>3.1a</b></p> <p><b>1.1</b></p> | <p>State or use correct identity from part (a)</p> <p>Valid attempt to rewrite in terms of <math>\sin \theta</math> and/or <math>\cos \theta</math> only</p> <p>Simplify to obtain correct value for <math>\cos \theta</math></p> | <p>If used in the given equation, condone errors elsewhere as long as this identity is correct</p> <p>Using correct identities</p> <p><b>A0</b> if additional solutions<br/> <b>ISW</b> any value given for <math>\theta</math><br/>         Must have worked exactly throughout, so<br/> <b>A0</b> if <math>41.4^\circ</math> seen as part of solution</p> |
|----|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|---------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

| Question | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Marks                                                                                                       | AO                                                                                                           | Guidance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
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| 12       | <p><b>Initially differentiating <math>\sin 3x</math></b></p> <p><math>\int (e^{2x} \sin 3x) dx</math></p> <p><math>= \frac{1}{2} e^{2x} \sin 3x - \int \frac{3}{2} e^{2x} \cos 3x dx</math></p> <p><math>\int e^{2x} \cos 3x dx</math></p> <p><math>= \frac{1}{2} e^{2x} \cos 3x - \int -\frac{3}{2} e^{2x} \sin 3x dx</math></p> <p><math>\int (e^{2x} \sin 3x) dx</math></p> <p><math>= \frac{1}{2} e^{2x} \sin 3x - e^{\frac{2x}{4}} \cos 3x</math></p> <p><math>- \int e^{\frac{2x}{4}} \sin 3x dx</math></p> <p><math>\frac{13}{4} \int (e^{2x} \sin 3x) dx</math></p> <p><math>= e^{\frac{1x}{2}} \sin 3x - e^{\frac{2x}{4}} \cos 3x</math></p> | <p><b>M1*</b></p> <p><b>A1</b></p> <p><b>M1*</b></p> <p><b>A1</b></p> <p><b>A1</b></p> <p><b>M1dep*</b></p> | <p><b>1.1</b></p> <p><b>2.1</b></p> <p><b>1.1</b></p> <p><b>2.1</b></p> <p><b>2.1</b></p> <p><b>3.1a</b></p> | <p>Attempt integration by parts once</p> <p>Obtain correct expression</p> <p>Attempt integration by parts again on integrand</p> <p>Parts must be consistent with first stage, so <b>M0</b> if now differentiating <math>e^{2x}</math></p> <p>Not dependent on previous <b>M1</b></p> <p>Fully correct expression for integration of <math>\int e^{2x} \cos 3x dx</math>, which could be embedded within a full integration</p> <p>Obtain fully correct expression, with brackets removed and fractions combined</p> <p>Attempt to gather like terms</p> <p>Dependent on <b>M1 M1</b></p> <p><b>Condone missing dx signs throughout</b></p> <p>Obtain <math>\pm \frac{1}{2} e^{2x} \sin 3x \pm \int \frac{3}{2} e^{2x} \cos 3x dx</math></p> <p>Condone any sign errors, but coefficients must be correct</p> <p>LHS not required</p> <p>Only need to consider <math>\int e^{2x} \cos 3x dx</math></p> <p>Obtain <math>\pm \frac{1}{2} e^{2x} \cos 3x \pm \int \frac{3}{2} e^{2x} \sin 3x dx</math></p> <p>Condone any sign errors, but coefficients must be correct</p> <p>If using <math>\int \frac{3}{2} e^{2x} \cos 3x dx</math> then coefficients must be commensurate</p> <p>Could be embedded within a fuller expression</p> <p>LHS not required</p> <p>Could still have double negative signs and/or brackets</p> <p>LHS not required</p> <p>Could be implied by subsequent working</p> <p>Need to have had <math>\int (e^{2x} \sin 3x) dx</math> on both sides, and not equal coefficients</p> <p>Could use eg I for <math>\int (e^{2x} \sin 3x) dx</math></p> <p>Could instead attempt the sum to infinity of a GP, with <math>r = -\frac{9}{4}</math> (allow <b>M1 M1 BOD</b> despite <math>-\frac{9}{4} &lt; -1</math>)</p> |

| Question |  |  | Answer                                                                                                                                                                                                                                                          | Marks      | AO         | Guidance                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                   |
|----------|--|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          |  |  | $\int(e^{2x}\sin 3x)dx$<br><br>$= \frac{4}{13}e^{\frac{2x}{2}}(\sin 3x - \frac{\cos 3x}{4})$<br><br>$\int(e^{2x}\sin 3x)dx$<br><br>$= \frac{1}{13}e^{2x}(2\sin 3x - 3\cos 3x) + c$                                                                              | <b>M1</b>  | <b>2.1</b> | Attempt to rearrange to required form, having gathered like terms (ie dep <b>M1 M1 M1</b> )                                                                                        | ie divide by their coefficient of $\int(e^{2x}\sin 3x)dx$ (soi) and take out common factor of $e^{2x}$                                                                                                                                                                                                                            |
|          |  |  |                                                                                                                                                                                                                                                                 | <b>A1</b>  | <b>2.1</b> | Obtain correct values for $A$ and $B$ , possibly embedded in a correct answer<br>Condone no explicit $+ c$                                                                         | <b>A0</b> if from the sum to infinity as $-\frac{9}{4} < -1$                                                                                                                                                                                                                                                                      |
|          |  |  |                                                                                                                                                                                                                                                                 |            |            | <b>NB</b> solution space is over 2 pages so <b>MUST</b> check both – needs <b>SEEN</b> on pg15                                                                                     | Allow partial credit for those who differentiate given answer and equate:<br><b>SC B1</b> for $A = 2$ and/or <b>B1</b> for $B = -3$                                                                                                                                                                                               |
|          |  |  | <p><b>Initially differentiating <math>e^{2x}</math></b></p> $\int(e^{2x}\sin 3x)dx$<br><br>$= -e^{\frac{2x}{3}}\cos 3x - \int -e^{\frac{2x}{3}}\cos 3x dx$<br><br>$\int e^{2x}\cos 3x dx$<br><br>$= \frac{1}{3}e^{2x}\sin 3x - \int e^{\frac{2x}{3}}\sin 3x dx$ | <b>M1*</b> |            | Attempt integration by parts once                                                                                                                                                  | <b>Condone missing dx signs throughout</b><br>Obtain $\pm \frac{1}{3}e^{2x}\cos 3x \pm \int^2 e^{\frac{2x}{3}}\cos 3x dx$<br>Condone any sign errors, but coefficients must be correct                                                                                                                                            |
|          |  |  |                                                                                                                                                                                                                                                                 | <b>A1</b>  |            | Obtain correct expression<br>Condone the ‘double negative’                                                                                                                         | LHS not required                                                                                                                                                                                                                                                                                                                  |
|          |  |  |                                                                                                                                                                                                                                                                 | <b>M1*</b> |            | Attempt integration by parts again on integrand<br>Parts must be consistent with first stage, so <b>M0</b> if now differentiating $\cos 3x$<br>Not dependent on previous <b>M1</b> | Only need to consider $\int e^{2x}\cos 3x dx$<br>Obtain $\pm \frac{1}{3}e^{2x}\sin 3x \pm \int^2 -e^{\frac{2x}{3}}\sin 3x dx$<br>Condone any sign errors, but coefficients must be correct<br>If using $\int^2 e^{\frac{2x}{3}}\cos 3x dx$ then coefficients must be commensurate<br>Could be embedded within a fuller expression |
|          |  |  |                                                                                                                                                                                                                                                                 | <b>A1</b>  |            | Fully correct expression for integration of $\int e^{2x}\cos 3x dx$ , which could be embedded within a full integration                                                            | LHS not required<br>Could still have double negative signs and/or brackets                                                                                                                                                                                                                                                        |

| Question |  |  | Answer                                                                                                                              | Marks         | AO         | Guidance                                                                                                   |                                                                                                                                                                                                                                              |
|----------|--|--|-------------------------------------------------------------------------------------------------------------------------------------|---------------|------------|------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|          |  |  | $\int(e^{2x}\sin 3x)dx$<br>$= -e^{\frac{1}{3}2x}\cos 3x + \frac{2}{9}e^{\frac{2}{3}x}\sin 3x$<br>$-\int e^{\frac{2}{3}x}\sin 3x dx$ | <b>A1</b>     |            | Obtain fully correct expression, with brackets removed and fractions combined                              | LHS not required<br>Could be implied by subsequent working                                                                                                                                                                                   |
|          |  |  | $\frac{13}{9}\int(e^{2x}\sin 3x)dx$<br>$= -e^{\frac{2}{3}x}\cos 3x + e^{\frac{2}{9}x}\sin 3x$                                       | <b>M1dep*</b> |            | Attempt to gather like terms<br>Dependent on <b>M1 M1</b>                                                  | Need to have had $\int(e^{2x}\sin 3x)dx$ on both sides, and not equal coeffs<br>Could use eg I for $\int(e^{2x}\sin 3x)dx$<br>Could instead attempt the sum to infinity of a GP, with $r = -\frac{4}{9}$ (which could gain <b>M1 M1 A1</b> ) |
|          |  |  | $\int(e^{2x}\sin 3x)dx$<br>$= \frac{9}{13}e^{2x}(-\cos 3x + \sin \frac{2}{9}3x)$                                                    | <b>M1</b>     | <b>2.1</b> | Attempt to rearrange to required form, having gathered like terms (ie dep <b>M1 M1 M1</b> )                | ie divide by their coefficient of $\int(e^{2x}\sin 3x)dx$ (soi) and take out common factor of $e^{2x}$                                                                                                                                       |
|          |  |  | $\int(e^{2x}\sin 3x)dx$<br>$= \frac{1}{13}e^{2x}(2\sin 3x - 3\cos 3x) + c$                                                          | <b>A1</b>     | <b>2.1</b> | Obtain correct values for $A$ and $B$ , possibly embedded in a correct answer<br>Condone no explicit $+ c$ |                                                                                                                                                                                                                                              |
|          |  |  |                                                                                                                                     | <b>[8]</b>    |            |                                                                                                            | Allow partial credit for those who differentiate given answer and equate:<br><b>SC B1</b> for $A = 2$ and/or <b>B1</b> for $B = -3$                                                                                                          |

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