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Examiners' report

A LEVEL

MATHEMATICS A

OCR Level 3 Advanced GCE in Mathematics A

H240

For first teaching in 2017

H240/01 Summer 2025 series

Version 1

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate responses is also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from Teach Cambridge.

Paper 1 series overview

H240/01 is a two hour paper that consists of 100 marks. It can test any of the Pure Mathematics topics on the GCE Pure Mathematics A specification, which can also be tested on the first half of H240/02 and H240/03.

To be successful on this paper, candidates should be familiar with the entire specification including any GCSE pre-knowledge (such as mensuration in non-right-angled triangles). They should be aware of the formulae given at the start of the question paper, and be able to apply them reliably (e.g. the binomial expansion). Equally they should appreciate which formulae will, and will not, be provided and be able to accurately recall any of the latter.

Centres should make sure that candidates fully appreciate the necessary detail expected when a 'command word' is used in a question. This does not necessarily preclude the use of a calculator (such as solving trigonometric equations), but does require that method and reasoning should be shown. If a question involves a given answer then it is essential that sufficient detail is shown in a solution, so as to be convincing.

If questions are set in context then candidates should also address the context in their answer, paying close attention to the question posed. On this paper Question 5 required consideration of the given model when applying it to specific situations, but too often candidates gave standard, learnt, responses as opposed to answering the actual question posed. Candidates should also make sure that their handwriting is legible to allow credit to be given; it was pleasing to note that some candidates applied strategies such as writing in block capitals or non-joined up handwriting when giving explanations which was helpful in allowing examiners to clearly identify where credit should be given.

Candidates must use mathematical language and notation correctly, including set notation if required. They should show clear method in their solutions, such as explicit substitution of values, to allow partial credit to be given to a solution that is not fully correct.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• responded appropriately to the command words in a question, fully appreciating their meaning • appreciated the link between different parts of a question • showed clear method to allow partial credit to be given when a solution was not fully correct • ensured that answers to 'worded' questions included sufficient detail, and were also legible • considered the accuracy of their final answer when using rounded values in their method.	• were not able to apply standard techniques to routine questions • lacked familiarity with formulae given at the start of the question paper • did not consider how parts of a question may be linked together, even when the command word of 'hence' was used • tried to apply more complex strategies to straightforward AS topics, including those already encountered at GCSE • lacked clarity in any explanations given in modelling questions • did not provide sufficient detail when structuring their solutions, which meant that part-marks were unlikely to be awarded.

Question 1 (a)

1 Express each of the following in the form px^q, where p and q are constants.

(a) $\dfrac{2}{\sqrt[4]{x}}$ **[1]**

This proved to be a straightforward start to the paper, with the vast majority of candidates stating a correct expression.

Question 1 (b)

(b) $(5x\sqrt{x})^3$ **[2]**

This was also very well answered. The more successful approach was to first write the expression in brackets in index form, and then cube this, whereas others first expanded the brackets and then attempted to combine terms. Candidates nearly always obtained the correct power of *x*, but some forgot to also cube the 5.

Question 1 (c)

(c) $\sqrt{2x^3} \times \sqrt{8x^5}$ **[2]**

This was another routine question on manipulating surds. The more successful candidates first combined the two expressions as a single surd before simplifying, and this inevitably resulted in the correct answer. Candidates who attempted to initially simplify the two surds separately tended to be less successful.

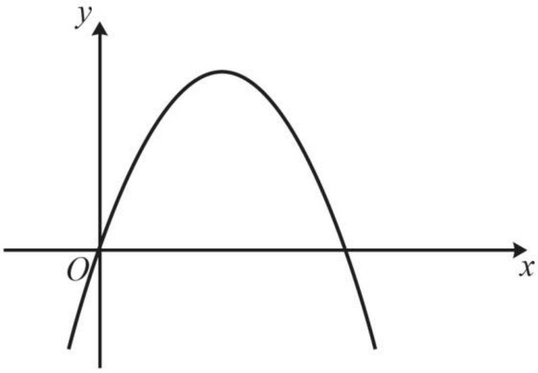
Question 1 (d)

(d) $x^5(27x^6)^{\frac{1}{3}}$ **[3]**

This final part of the question was also very well answered, with nearly all of the candidates gaining full credit. Candidates who made an initial error when attempting the cube root of $27x^6$ were still able to gain partial credit, as long as there was sufficient detail of each step shown in their method.

Question 2 (a)

2



The diagram shows the curve $y = ax(x-b)$, where a and b are constants and $b > 0$.

(a) Given that the curve has a stationary point at $x = 3$, state the value of b. **[1]**

It was expected that candidates would use the symmetry of a quadratic curve to be able to write down the correct value for *b*, hence the command word 'state' and the limited space in the Printed Answer Booklet. While some candidates did indeed do so, many more embarked on a method involving the use of calculus, with varying degrees of success.

Question 2 (b)

(b) Given also that the stationary point at $x = 3$ is a maximum, state what can be deduced about the value of a. **[1]**

By contrast, in this part of the question many candidates were able to state a correct deduction about the value of *a*, but some did still consider the second derivative before correctly concluding.

Question 2 (c)

(c) Find the y-coordinate of the stationary point, giving your answer in terms of a. **[1]**

Many candidates were able to make a good attempt at this question, but some answers were subsequently spoilt by changing the sign on their final answer in the mistaken belief that -9*a* was negative which did not match the given diagram.

Question 2 (d)

(d) State the range of values of x for which the curve is increasing. **[1]**

Most candidates were familiar with the term 'increasing' function, and could state a correct inequality. The use of incorrect set notation was condoned, as long as the intention was clear.

Question 3 (a) (i)

3 **(a)** A sequence has terms $u_1, u_2, u_3, \ldots$ defined by $u_1 = 3$ and $u_{n+1} = u_n^{\ 2} - 5$ for $n \geqslant 1$.

(i) Find the values of u_2, u_3 and u_4. **[2]**

This question was very well answered, with very few candidates not gaining both of the marks available.

Question 3 (a) (ii)

(ii) Describe the behaviour of the sequence. **[1]**

Most candidates could identify that it was an increasing (or diverging) sequence, but it was quite common to see an additional, incorrect, statement such as 'geometric' which was penalised.

Question 3 (b)

(b) The second, third and fourth terms of a geometric progression are 12, 8 and $\frac{16}{3}$.

Determine the sum to infinity of this geometric progression. **[3]**

This question was also very well answered, with mostly fully correct solutions seen. The most common error was to correctly find the common ratio, but then use 12 as the first term when attempting the sum to infinity.

Question 4 (a)

4 The position vector of the point A is $0.5\mathbf{i} - 0.5\mathbf{j}$.

(a) Determine whether $0.5\mathbf{i} - 0.5\mathbf{j}$ is a unit vector. **[2]**

Candidates seemed familiar with the command word 'determine' and usually provided sufficient detail in their solution. Most candidates were able to correctly find the magnitude of the given vector and then conclude appropriately. To gain full credit candidates were expected to explicitly compare the correct magnitude of the given vector to 1, which some omitted to do.

Question 4 (b)

(b) Find the direction of $0.5\mathbf{i} - 0.5\mathbf{j}$, giving your answer in degrees. **[2]**

Most candidates gained 1 mark for calculating a relevant angle, most typically 45°. However many candidates did not seem familiar with the definition of the 'direction' of a vector as given in the specification. Giving the answer as a bearing from the vertical axis was one of the more common misunderstandings, as was giving a negative angle as opposed to the (0°, 360°) convention.

Misconception

Pure Maths specification reference 1.10c Magnitude and direction of vectors states that '*Learners should know that the modulus of a vector is its magnitude and the direction of a vector is given by the angle the vector makes with a horizontal line parallel to the positive x-axis. The direction of a vector will be taken to be in the interval [0,360º).*'

The convention for measuring direction clockwise from North should only be used in questions set in that context, whilst measuring direction above or below a stated reference line will be appropriate in kinematics or statics problems set in Mechanics questions.

Question 4 (c)

The position vector of the point B is $3.5\mathbf{i}+c\mathbf{j}$, where c is a constant.

(c) Given that $|\overrightarrow{AB}|=5$, determine the possible values of c. **[3]**

Most candidates were able to set up and solve a quadratic equation to obtain the two correct values for *c*, although more informal methods involving a *y* difference of 4 were also seen. Some candidates were clearly attempting the correct distance equation but made a sign error when considering *c* – (– 0.5).

Misconception

A number of candidates did not seem familiar with key terminology, definitions and notation such as 'unit vector', 'direction' of a vector and the notation for the magnitude of a vector.

Question 5 (a)

5 Scientists are comparing h, the average height of a child in cm, with t, the age of the child in years. They suggest the model $h=at+b$ for $t \geqslant 2$, where a and b are constants.

They find that the average height of a 2 year old child is 87 cm and the average height of a 5 year old child is 108 cm.

(a) Find the values of a and b that are consistent with the scientists' findings. **[4]**

This question was exceptionally well answered, with candidates being able to accurately set up and solve two simultaneous equations based on the given model.

Question 5 (b) (i)

(b) **(i)** Sam is 4 years old.

Use the model to predict Sam's height. **[2]**

Candidates were then able to use their model to predict Sam's height, with lack of units being condoned.

Question 5 (b) (ii)

(ii) Comment on the accuracy of this prediction. **[1]**

Candidates were expected to suggest a reason as to why this model for average height may not be accurate when predicting the height of an individual. Explanations that gained credit included reference to Sam not necessarily being of average height, with various reasons given, or identifying that having an age of 4 ignores the number of days since their 4th birthday and height will not remain the same until their 5th birthday. The most common error was to focus on interpolation being accurate as opposed to the potential issues with using an 'average' model to predict a single height. As with all of the explanation questions on this paper, the handwriting of some candidates made it difficult to discern their intent.

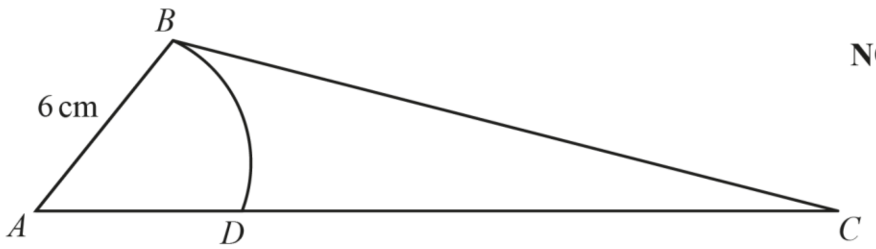
Question 5 (c)

(c) Suggest **one** possible limitation of this model when predicting the average height of a 12 year old child. **[1]**

While the previous question focused on using the given model to predict the height of an individual, this question was expecting candidates to consider why the given linear model may no longer be appropriate. The better explanations identified that increase in average height was unlikely to continue (due to puberty) or that extrapolation from the last recorded data of a 5 year old would be unreliable. Some candidates did not appreciate that it was the general model for average height that could possibly be limited and instead referred to a single child not fitting the model due to circumstances, which was not allowed.

Question 6 (a)

6



NOT TO SCALE

The diagram shows a triangle ABC. The arc BD is part of a circle with centre A and radius 6 cm.

The area of the sector ABD is $14.4\,\text{cm}^2$.

(a) Show that angle BAD is 0.8 radians. **[1]**

This part of the question was generally very well answered with most candidates gaining the 1 mark available. Most candidates stated a correct equation which they then solved to find the required angle. As it was a single mark question, verification was also condoned. Candidates who obtained the expected 0.8 radians via use of decimals (either angles in degrees or percentage of a circle) were penalised, as these methods cannot justify the angle as being exactly 0.8 as opposed to a rounded answer.

Question 6 (b)

The area of the triangle ABC is **three** times the area of the sector ABD.

(b) Find the length AC. **[2]**

Once again, this question was very well answered with a significant majority of candidates gaining both of the marks available. The question was expected to be a straightforward test of using the formula for the area of a non-right-angled triangle (which is a GCSE topic). As such, it was surprising to see a number of candidates attempt to split the area into right-angled triangles. While long-winded, this approach could still gain full credit if done correctly.

Question 6 (c)

(c) Find the perimeter of the region *BCD*. **[5]**

Most candidates could identify a valid strategy to answer this multi-step problem and then make a good attempt at finding the requested perimeter. While a number of candidates appreciated the need to work accurately throughout the question, before rounding their final answer, many used 3sf for the separate lengths and thus lost the accuracy required for the final answer. Some candidates used the chord *BD* rather than the arc *BD* which did not gain the method mark for the attempt at the perimeter. Candidates should also be aware that method marks can only be awarded for an explicit method; a minority of candidates stated a correct generic Cosine Rule when attempting the length *BC* but never showed the values being used; an incorrect answer cannot imply a correct method unless further detail is shown.

Exemplar 1

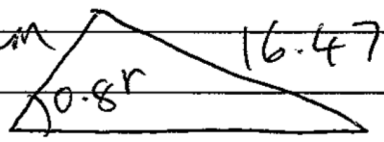
6(c)

Arc length = $r\theta$

$6(0.8) = 4.8$cm

$20.074 - 6 =$

co-sine rule 14.074cm



20.074

$a^2 = (6)^2 + (20.074)^2 - 2(6)(20.074) \times \cos(0.8)$

$a^2 = 271.13719$

$a = 16.47$

BCD

~~16.47~~ $14.074 + 4.8 + 16.47$

$= 35.344$cm

This is a well-structured solution, which clearly identifies which lengths are being attempted and works to a sufficient degree of accuracy throughout.

Question 7 (a)

7 In this question you must show detailed reasoning.

A curve has parametric equations $x = t^3 + t^2$, $y = t^2 + 2t$ for all real values of t.

The curve passes through the point P with coordinates (2, 3).

(a) Show that the equation of the tangent to the curve at the point P can be written as $5y = 4x + 7$. **[5]**

This part of the question was very well answered, with the majority of candidates gaining full credit. They were able to accurately use parametric differentiation to find an expression for the derivative. Candidates were then able to find the correct *t*-value using a variety of different approaches, and most also justified why any other *t*-values found were not valid. In 'show that' questions it is important that candidates show sufficient method so as to be convincing, especially when the answer is given. Most candidates did show explicit method of using the correct *t*-value in the correct derivative to obtain the correct gradient However some candidates attempted to work backwards from the given answer and they generally struggled to a provide any evidence that could gain credit. When attempting the equation of a tangent, candidates should be using a numerical gradient which did not always happen.

Question 7 (b)

(b) Determine the coordinates of the point where the tangent to the curve at P meets the curve again. **[4]**

It was expected that candidates would attempt to solve the equations of the tangent and the curve simultaneously to obtain an equation in *t* only, and many were able to do so. It was then expected that candidates would recognise that the tangent should have a repeated root at $t = 1$, and use this to solve the cubic equation to find the other *t*-value. Candidates should appreciate that method needs to be shown, as the command word used was 'determine' along with a 'detailed reasoning' instruction for the entire question. Many candidates were indeed able to show a convincing method, through repeated division by $(t – 1)$, inspection or an equivalent method, all of which tended to be effective. A number of candidates seemingly solved the cubic equation on their calculator instead. Some candidates simply stated the *t*-values whereas others did try to work backwards to produce the required factors but this was rarely successful due to the calculator not identifying a repeated root. Having found the other *t*-value, through whatever method used, candidates were then usually able to give the correct coordinates in an exact form although a few did instead give a rounded decimal value. A surprisingly common error was to equate the gradient of the curve, in terms of *t*, to the gradient of the tangent i.e. attempting to find other points on the curve that would have tangents parallel to the one already found. A minority of candidates attempted to first find a Cartesian equation for the curve, either in this part of the question or continuing with an equation attempted in part (a). This was rarely successful, and candidates should consider the most effective and efficient method when attempting a question. While some previous questions on parametric equations may have requested the Cartesian equation, this is usually the final part of the question as opposed to the starting point.

OCR support

Some candidates did not seem familiar with the command wards, such as 'detailed reasoning', 'show that' and 'determine'. These are detailed section 2. of the specification, and OCR have also produced a command word poster for display in the classroom.

Question 8 (a)

8 **(a)** Find the first **three** terms in the expansion of $(2+x)^{-3}$ in ascending powers of x. **[4]**

Most candidates were able to make a good attempt at this routine question, with many gaining full credit. The most successful solutions made effective use of brackets so as to avoid sign errors and make sure that the index was applied to the 0.5 when attempting the third term. The most common error was not correctly dealing with the required multiplier of 2^{-3}, some candidates did have the correct value but then forgot to then apply it when attempting the final answer whereas others omitted the index and simply multiplied by 2 instead. Some candidates attempted to use Maclaurin's expansion from first principles. This approach could gain full credit, but attempts rarely did so as the relevant formula is not given at the start of this paper. Candidates who are also studying Further Mathematics should always attempt to use the method most fitting to the paper being taken.

Question 8 (b)

(b) Hence find the first **three** terms in the expansion of $\dfrac{\sqrt{1+4x}}{(2+x)^3}$ in ascending powers of x. **[4]**

Most candidates appreciated the need to first find the expansion of $(1 + 4x)^{0.5}$ and obtained a correct expression. The command word 'hence' should indicate to candidates that they needed to use their result from the previous part of the question and most attempted to do so thus gaining at least 3 of the 4 marks available. Candidates generally showed sufficient detail when finding the product of their two expressions, which allowed the method mark to be given even if an error had previously occurred.

Exemplar 2

8(b)

$$(1+4x)^{\frac{1}{2}} = 1+2x+\frac{-\frac{1}{4}x^2\times 4}{2}$$

$$= \left(1+2x-\frac{x^2}{2}\right)\left(\frac{1}{8}-\frac{3}{16}x+\frac{3}{8}x^2\right)$$

$$\cancel{= \frac{1}{8}+\frac{1}{4}x-\frac{3}{16}x+\frac{3}{16}x^2-\frac{x^2}{16}}$$

$$\cancel{= \frac{1}{8}+\frac{1}{16}x+\frac{1}{8}x^2}$$

$$\frac{1}{8}+\frac{1}{4}x-\frac{3}{16}x+\frac{3}{8}x^2-\frac{1}{16}x^2-\frac{6}{16}x^2$$

$$= \frac{1}{8}+\frac{1}{16}x-\frac{1}{16}x^2\ldots\ldots$$

The candidate gains the method mark for attempting to expand $(1 + 4x)^{0.5}$ but not using brackets results in the coefficient of the quadratic term being incorrect. The expansion from part (a) is also incorrect but, when attempting the product of their two expansions, the candidate shows sufficient detail to allow the second method mark to also be awarded. Had the penultimate line not been shown the method mark would not have been awarded, as an incorrect final answer cannot imply a correct method.

Question 8 (c)

(c) Determine the range of values of x for which the expansion in part **(b)** is valid, giving a reason for your answer. **[2]**

This final part of the question was less well answered, with fully correct solutions being in the minority. To gain the first mark candidates had to state the conditions for each of the two expansions to be valid, yet many were unable to do so despite conditions on *ax* being condoned for this mark. Candidates should be aware that this is listed in the formulae at the start of the paper, and appreciate how to use it. To gain the second mark, candidates were expected to identify the correct range of values as well as giving a convincing reason for their choice. Some candidates were able to explain about the need to use the tighter condition (sometimes referring to a subset or a nested interval), but other explanations lacked clarity or no explanation at all was given for their choice.

Assessment for learning

Students need to be familiar with which formulae will be given at the start of the question paper, and which will not be given. It will be helpful to students if they are given a copy of the list of formulae at the start of the course, which they can refer to regularly to gain familiarity.

Question 9 (a)

9 (a) Express $3\cos 2x + 4\sin 2x$ in the form $R\cos(2x-\alpha)$, where $R > 0$ and $0° < \alpha < 90°$. **[3]**

Most candidates showed a clear method, expanding the given harmonic form, equating coefficients and obtaining a correct expression. Some candidates simply wrote down values for R and tanα; while the former was usually correct, the latter did vary as to whether the values of 3 and 4 were correctly placed in the expected fraction. In this examination session, the correct value of tanα being found from cosα = 3, sinα = 4 (i.e. R being omitted) was condoned for the method mark where no defined command word had been employed, but candidates should not be employing methods that are mathematically invalid.

Question 9 (b)

(b) In this question you must show detailed reasoning.

Solve the equation $\frac{3\cos 2x + 4\sin 2x + 6}{3\cos 2x + 4\sin 2x - 1} = 4$ for $0° < x < 360°$. **[7]**

Many candidates used the harmonic form from the first part of the question to obtain a simplified equation that could then be solved to gain at least 6 of the marks available. Only the most astute candidates gained full credit for also including the smallest angle of 2.47°, as this was often either not attempted at all or not given to a sufficient degree of accuracy. This was a 'detailed reasoning' question, so candidates were expected to show convincing method to support their solution; simply using the calculator to quote the four expected values with no other working was not accepted. A surprising number of candidates did not recognise the connection with the previous part of the question and instead attempted to use double angle formulae and trigonometric identities. While some initial credit was often awarded, those attempting this method rarely made any further progress.

Question 10 (a) (i)

10 The graph of $y = e^x$ can be transformed to the graph of $y = e^{2x-1}$ by a stretch parallel to the x-axis **followed by** a translation.

(a) (i) State the scale factor of the stretch. **[1]**

Most candidates were able to gain this mark by stating the correct scale factor.

Question 10 (a) (ii)

(ii) Give full details of the translation. **[2]**

One mark was available for identifying the correct direction of the translation, using the expected mathematical terminology; this could also be implied by stating a vector for the translation with a *y* component of 0. Most candidates were able to gain this mark, usually through their vector statement, as long as this was not contradicted by their worded statement (e.g. stating that the translation was 'vertical' but giving a vector with a *y* component of 0 is ambiguous and thus B0). Identifying the magnitude of 0.5 proved to be more challenging, and only the most able candidates gained both of the marks available.

Question 10 (b)

Alternatively the graph of $y = \mathrm{e}^{x}$ can be transformed to the graph of $y = \mathrm{e}^{2x-1}$ by a stretch parallel to the x-axis and a stretch parallel to the y-axis.

(b) State the scale factor of the stretch parallel to the y-axis. **[1]**

This part of the question proved to be more challenging, with just less than half of the candidates gaining the mark available. Those who were successful appreciated the need to rewrite the given equation in the form $y = ae^{bx}$, so as to address the information given in the question, and could then identify the magnitude of the stretch in the y-direction, giving the answer in an exact form.

Question 10 (c)

The point P lies on the curve $y = \mathrm{e}^{2x-1}$ and has x-coordinate of $\frac{1}{2}$.

(c) Show that the tangent to the curve $y = \mathrm{e}^{2x-1}$ at P has equation $y = 2x$. **[4]**

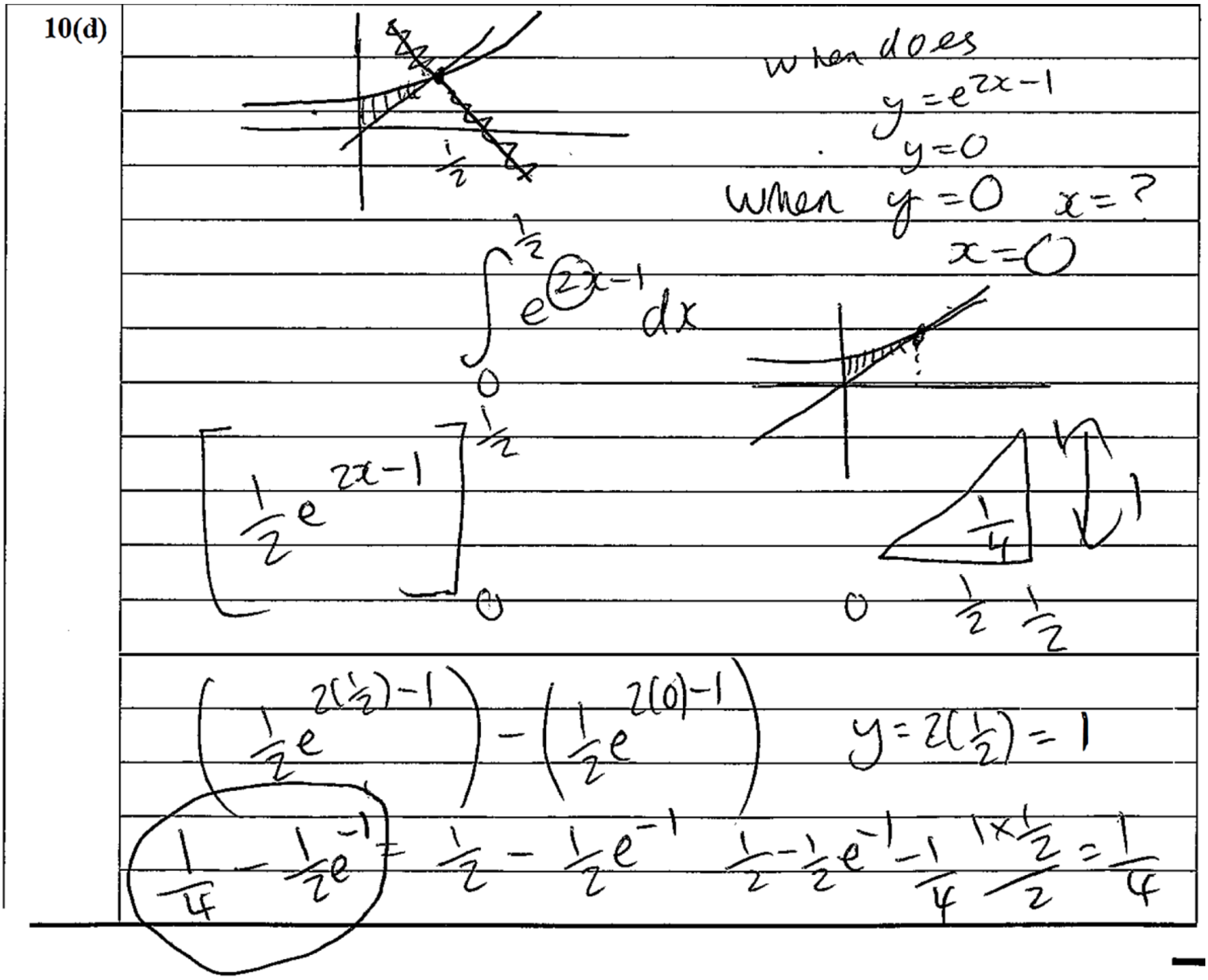
Nearly all of the candidates were able to find the correct y-value, but some then simply stated that $y = 2x$ based on the now known (x, y) value with no further consideration of the question posed. However the majority of candidates could then correctly state the derivative of the given equation, and most then evaluated this at $x = 0.5$ and proceeded to find the given equation convincingly. As with previous questions involving the equation of a straight line some candidates still attempted to use an algebraic gradient when attempting the tangent, so equations such as $y = (2e^{2x-1})x + 0$, resulting in $y = 2x$, were penalised even if the gradient had previously been shown to be 2. When attempting the equation of a straight line (e.g. a tangent or normal) candidates should be using a numerical (as opposed to variable) value for the gradient.

Question 10 (d)

(d) Find the **exact** area enclosed by the curve $y = \mathrm{e}^{2x-1}$, the tangent to the curve at P and the y-axis. **[4]**

Most candidates were able to correctly integrate the given equation, and many could then apply the correct limits of 0.5 and 0, while still working exactly. To gain the third mark candidates needed to attempt a correct method to find the required area, and the most successful attempts made good use of a diagram. The most common errors were to assume that the area being requested was simply the area between the curve and the x-axis, or to quote decimal values from the calculator as opposed to working exactly. Some candidates attempted to integrate with respect to y instead, but this was rarely successful.

Exemplar 3



The candidate makes good use of diagrams to devise an appropriate strategy to find the requested area, working exactly throughout and simplifying the final answer.

Assessment for learning

When using previous question papers in lessons, teachers could highlight any command words used in a question and have an explicit class discussion about what the mark scheme will expect to see.

Question 11 (a)

11 A student is attempting to prove that $\sqrt{5}$ is irrational.
The first three lines of their proof are shown below.

Assume that $\sqrt{5}$ is rational, so it can be written as $\sqrt{5} = \frac{a}{b}$.	**Line 1**
Squaring both sides gives $5 = \frac{a^2}{b^2}$. Hence $a^2 = 5b^2$.	**Line 2**
Hence a must be a multiple of 5, so $a = 5k$, for some integer k.	**Line 3**

(a) State any conditions required on **Line 1**. **[2]**

Candidates were usually able to identify the condition that *a* and *b* had no common factors (or were coprime or HCF was 1). Stating that $^a/_b$ could not 'be further simplified' was accepted but stating that '$^a/_b$ had no common factors' was not. The second mark proved to be more challenging; the expected condition was that *a* and *b* were positive integers but 'both integers with *b* ≠ 0' was also accepted; while 'integers' (or even ''whole numbers') was often seen the exclusion on *b* was not.

Question 11 (b)

(b) Explain why **Line 2** means that *a* must be a multiple of 5. **[2]**

Many candidates were able to gain 1 mark for identifying, with a reason, that a^2 was a multiple of 5. However, only a small proportion of candidates were able to explain why this meant that *a* was also a multiple of 5. See the appendix notes for Question 11 (b) for the B1dep*. The most common error was for candidates to go straight to a conclusion about *a* without first considering a^2, some of these explanations were convincing but the majority were not. A number of candidates referred to odd and even numbers, suggested that they were well versed in the proof of √2 being irrational but were not sure how to apply this to other questions, nor explaining their reasoning for each step.

Question 11 (c)

(c) Complete the proof to show that $\sqrt{5}$ is irrational. **[3]**

While some candidates decided to ignore the statement in **Line 3** most did attempt to use the hint provided, although not making effective use of brackets did result in a few cases of an incorrect $5k^2 = 5b^2$ being seen. Once the first mark had been gained, candidates usually also gained the second mark for stating that b must be a multiple of 5. The final mark in this part of the question required candidates to reference the common factors, the contradiction (which also required B1 for no common factors in part (a) to have been given) and the conclusion that $\sqrt{5}$ was hence irrational. Many candidates were able to provide a complete and convincing proof, but more struggled to do so despite this being a standard specification item.

Question 12 (a)

12 (a) Express $\dfrac{2+4x}{x(1+x)(1-x)}$ in partial fractions. **[4]**

Nearly all of the candidates were able to make a good attempt at this question, with the majority gaining full credit. The errors seen tended to be sign slips as opposed to not knowing how to attempt the required process.

Question 12 (b)

The gradient of a curve is given by $\frac{dy}{dx} = \frac{2+4x}{x(1+x)(1-x)\tan y}$ and the curve passes through the point $\left(\frac{1}{2}, \frac{1}{4}\pi\right)$.

(b) Show that the equation of the curve can be written in the form $\cos y = f(x)$, where $f(x)$ is fully simplified. **[7]**

This question proved to be a suitably challenging final question, with only those candidates that had successfully completed the majority of the paper gaining full credit here. To gain the first mark candidates needed to identify that this was a differential equation with separable variables and attempt to do so; no credit was given for any integration attempts on an equation that still involved both x and y terms. Once variables had been separated, integrating $\tan y$ is a standard specification statement (1.08h) yet this was not always done correctly; sign errors were common, as was finding the derivative and not the integral of $\tan y$. Candidates nearly always realised the need to use their partial fractions from the first part of the question, and could attempt integration of these, but there were often sign errors when integrating the fraction with the denominator of $(1 - x)$. Further credit could still be gained for correctly combining all of their terms and removing logarithms; while many candidates could correctly combine the algebraic terms it was a common error to see the constant term still as $+c$ even once logs had been removed. Of the candidates who had made reasonable progress with this question, most were able to attempt the required method but made slips in their working.

Misconception

?

A number of candidates assumed that a fraction with a linear denominator, $ax + b$, will always integrate to $+\ln|ax + b|$ without considering the value of a. In this question, the most common error was to have the incorrect sign when integrating the fraction with the denominator of $1 - x$.

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