Pearson Edexcel

# Examiners' Report
# Principal Examiner Feedback

## Summer 2025

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In Mathematics (9MA0)
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## General Comments

Overall, this paper gave learners good access to the available marks and a good opportunity to show their understanding of the specification. Learners also benefitted from being able to show what they could do using the many restart points in other questions, notably in questions 4, 6, 10, 11 and 15. There were some challenging problem solving questions which gave learners the opportunity to decide how they wanted to approach the problem, and in some cases that led to a variety of different methods being seen, particularly in questions 7, 12(d), 14 and 15(a).

It is worth highlighting that learners need to show full working to solve quadratic or higher order equations when calculator warnings are present, for example in questions 8(c) and 15(a). There was some overreliance on calculator technology, as evident in question 1 where a simple factorisation seemed to cause unnecessary challenge for more learners. Notation for the range of a function has improved since previous series, with greater consistency seen in question 12(b).

## Question 1

The first question on the paper required learners to factorise a routine cubic expression, of which $x$ was a factor. Designed to be a friendly and straightforward opener, a large number did not factorise the $2x$ as the first step, hence did not gain the mark. In many cases, either the 2 or the $x$ (or both) were divided out and forgotten about (leading to an incorrect answer) or left in the final answer as either $(2x – 4)$ or $(2x – 20)$ (leading to an incomplete answer). Some learners overcomplicated the question, attempting to use the factor theorem or use algebraic division to take $(x – 2)$ or $(x – 10)$ out as a factor.

A significant number appeared unable to distinguish between factorising an expression and solving an equation, with many presenting "$x = 0, 2, 10$" or similar as their final answer. By itself this was not worthy of any credit. Many seemed to rely on calculators to obtain roots and jumped straight to the incorrect factorisation $x(x – 2)(x – 10)$, which also scored no marks on its own.

There were, however, many concise solutions to this question, with responses gaining all 3 marks in two lines of working.

## Question 2

This routine question on indefinite integration was completed very well in almost all responses, with the majority demonstrating familiarity and confidence in dealing with this type of question. It was rare that this question was not attempted, and for many it proved to be a confidence boosting start to the paper.

Learners were mostly efficient in their methods, with the majority knowing the steps for integration and applying them successfully. Of those achieving full marks, many did not need a working step but proceeding directly to the correct answer. The common errors were mostly small, such as omitting the constant of integration ($+c$) or making arithmetic mistakes when simplifying fractions, particularly when dividing by $\frac{3}{2}$. These errors were often due to confusion during the simplification process.

A small number of responses mistakenly differentiated rather than integrated, which led to significant errors. This was a rare issue but still notable. Several responses that achieved a correct answer then went on to do further, often incorrect work with their integrated function, such as multiplying by 5 or setting it equal to 0 and attempting to solve. While this was not mathematically correct, subsequent work was ignored to ensure they were not penalised for these errors. Some responses seen confused the integral notation, either retaining the integral symbol and d$x$ in their answer or including square brackets as if they were expecting to substitute in values, but again, this was condoned.

## Question 3

The vast majority of learners found this question, which involved an understanding of indices and logarithms, to be accessible.

Most were able to take logarithms with the same base of each side and apply the power law to both sides in one step. It was common in responses to take natural logarithms or logarithms to base 10; sometimes logarithms to base 3 or, on rarer occasions, base 7 were used. Usually, this was followed by correct division to achieve $\frac{x}{y}$ as the subject and gaining the accuracy mark. A few divided incorrectly and obtained the reciprocal of the correct answer and so lost the A mark. Some proceeded from a correct answer with incorrect logarithm work, such as to $\ln\left(\frac{7}{3}\right)$ or $\ln(7-3)$, and did not gain the accuracy mark.

A number of concise responses attempted to take logarithms of base 3 and achieved $\frac{x}{y} = \log_3 7$, gaining both marks.

On rare occasions, responses took logarithms of base 3 and logarithms of base 7 of the original equation separately to produce $x = \log_3 7^y$ and $y = \log_7 3^x$ and simply divided from here. Having not dealt with the powers appropriately, they left $x$ and $y$ variables on both sides of the equation and so scored no marks. Others took the same approach but did deal with the powers to produce $x = y\log_3 7$ and $y = x\log_7 3$ but did not recognise how to combine the equations to achieve $\frac{x}{y}$ as the subject by square rooting.

Many learners appeared unclear about what “exact value” means and following a correct answer provided a decimal approximation. However, such responses were condoned.

## Question 4

This was a fairly routine question involving the use of the cosine rule and area formulae in radians to find the area of a region.

In part (a), most responses successfully used the cosine rule directly to find the relevant angle *ABC*. A small number attempted the cosine rule but used sine instead of cosine in the formula and so were not awarded both marks due to an incorrect formula. Some responses found other angles in triangle *ABD* first and used a combination of sine and cosine rules to find angle *ABC*; but those that attempted this were often less successful due to errors in their working.

Responses occasionally did not gain the marks through lack of detail in the working required for a "show that" question. Some did not substitute values for *a*, *b* and *c* into the cosine rule, instead just quoting the formula before stating the given answer. Others who started correctly with $6.4^2 = 8^2 + 13^2 - 2(8)(13)\cos ABC$ sometimes did not give an appropriate intermediate line such as cos *ABC* = 0.923 before stating the given answer.

Incorrect approaches involved finding the length of arc *AC* using the given angle 0.394 and then dividing the arc length by 8 to achieve the required angle. A very small number of responses worked on the incorrect assumption that triangle *ABD* was right angled. On rare occasions, learners worked in degrees and converted to radians, usually successfully, while a small number made no attempt at part (a) but used the given answer for part (b).

The majority of learners successfully attempted part (b), most commonly by finding the area of triangle *ABD*, using the formula $\frac{1}{2}ab\sin\theta$ and subtracting the area of sector *ABC* using $\frac{1}{2}r^2\theta$. A small proportion calculated angle *DAB* and used it to find the area of triangle *ABD* but most used the given angle *ABC*.

Of those that did not gain full marks for this part, it was common that responses gained the first method mark for correctly finding either the area of the triangle or the area of the sector. However, many could not remember the other relevant formula needed and so could not go on to gain further credit, or mistakes were made in substituting values leading to the accuracy mark not being awarded. Other errors arose from using an incorrect formula for the area of the sector, including not squaring *r*, omitting the $\frac{1}{2}$ or using the arc length formula instead.

## Question 5

This question involved a simple parametric equation, and learners generally performed very well across all three parts. The structure of the question offered a steady progression through substitution, rearranging and then differentiating, with each part building on the previous one. This allowed learners to approach each part confidently, with the majority performing well in parts (a) and (b), even if they did encounter difficulties with part (c).

In part (a), substituting $t = -5$ and $t = 2x + 1$ followed by $x = -3$ were both popular approaches. Errors were rare and typically due to simple computation mistakes, such as incorrectly evaluating the expression $5(-5 + 2)^4$.

Part (b) was also generally answered well, with most responses successfully converting the parametric form into Cartesian form. Where there were errors, they were in writing $t$ as a function of $x$, e.g. $t = 2x - 1$, while others made a mistake with $2x + 1 + 2$ inside the bracket. A reasonable number found the correct expression for $y$, then expanded the brackets, even though many did not go on to use their expansion in part (c).

Part (c) was the most variable in terms of performance. Learners who applied the chain rule to differentiate the Cartesian equation generally did well. Those who attempted parametric differentiation were more prone to errors, especially in dividing derivatives in the wrong order $\left(\frac{\mathrm{d}x}{\mathrm{d}t} \div \frac{\mathrm{d}y}{\mathrm{d}t}\right)$ or multiplying by $\frac{1}{2}$ instead of dividing by $\frac{1}{2}$ or substituting $x = -3$ instead of the correct $t$ value. Responses that tried to expand their cartesian equation from (b) tended to make errors in accuracy in their expansion. Quite a few responses did not recognise that $x$ was a simple linear function of $t$ and used approaches such as the quotient rule, often incorrectly. A very small number did not link the idea of finding the gradient to differentiation at all and instead attempted to use a linear method such as $y = mx + c$, which gained no credit.

## Question 6

This question tested learners' knowledge and understanding of small angle approximations, with learners finding the algebra in part (a) the most demanding aspect.

Most attempts began with a substitution of the small angle approximation for cos2*x,* and stronger responses proceeded efficiently to the given answer with good algebra seen.

A common error was not including brackets around the 2*x*. In some cases, these invisible brackets were recovered; in other cases, the omission led to $1-\left(1-x^2\right)^2$; but in both cases a maximum score of M1A0* was available. Another common error was to expand the binomial correctly, but to omit the brackets when subtracting from 1, resulting in sign errors.

In some cases, the squared sign on the outside of the bracket was omitted completely and this resulted in no marks being scored as they had materially simplified the algebra.

Many responses tried to use identities prior to using small angle approximations, making the question significantly more complicated. In some cases, these approaches did not meet the demand of the question "use the small angle approximation for $\cos\theta$".

More successful responses in part (b), made good use of the restart opportunity available here. Most used the small angle approximations and the given answer to part (a) correctly. After substitution into both the numerator and denominator, it was only a very small minority who were not successful. Some, for example, tried to add $\frac{x}{3}$ and $\frac{x}{2}$ together, rather than multiply, while others did not deal with the embedded fractions correctly, often dividing by 6 and obtaining the incorrect $\frac{2}{3}-\frac{2}{3}x^2$.

Part (c) was answered well by most learners. However, many did not appear to understand "given that $x$ is very small" or did not know how to use this information. There was one dominant misconception, even among those who had been successful in the previous parts of the question, namely that "very small" meant that the expression obtained as an answer to part (b) approached 0. This resulted in many learners setting $24-24x^2=0$ and solving to obtain $x=\pm 1$.

For both B marks follow-through was allowed on their answer to part (b). Most learners did succeed in deducing that the answer to part (c) was their constant term from part (b), and this was sufficient for the first B1 mark. However, a lot of responses did not adequately explain this, so the dB1 mark was frequently not awarded.

The most common form of correct answer was to discuss the behaviour of $bx^2$ as $x$ tended towards zero, for example "as $x\to 0, -24x^2\to 0$ so $24-24x^2\to 24$".

A significant minority missed the word “hence” and, as a result, some attempted to substitute 0 or a very small value into the expression $\dfrac{1-\cos^2(2x)}{\sin\left(\frac{x}{3}\right)\tan\left(\frac{x}{2}\right)}$, which scored no marks.

## Question 7

This question, which required learners to find the constants in a partial fraction identity, provided good differentiation between learners due to slightly more difficult nature of this question compared to similar problems from previous series.

A large variety of methods were seen in this question. The most common approaches used one of two main methods: algebraic division or multiplying through to set up an identity without any fractions. The most successful method tended to be to multiply by the denominator to make a single identity then use substitution and/or comparing coefficients to find the missing values. Some responses did not multiply their $Ax$ and $B$ by the denominator this led to finding correct values for constants $C$ and $D$ through substitution (e.g., using $x = -1$ and $x = 3$), but, since the underlying method was flawed, marks could not be awarded. Slips in writing out the full identity were often seen but condoned provided the intention was clear.

Whilst algebraic division was a successful method for some, errors were common in the division or dealing with the remainder, either calculating it incorrectly or not knowing how to use it to form an identity involving $C$ and $D$. Some confused the quotient and the remainder when finding the final constants and others set their partial fractions equal to the original expression rather than their remainder. Those who did use the correct set up for partial fractions generally substituted correctly to score all 4 marks.

Attempting algebraic division in two stages (dividing by each linear factor in turn) was much rarer, and often led to a maximum of two marks being scored, as responses used the remainders correctly to find $C$ and $D$.

Some responses expanded all their expressions after multiplying the identity by the denominator and then compared coefficients of powers of $x$ and were successful overall. This method, while slightly longer, proved more accurate than algebraic division. Notably, few responses spotted that certain constants (like $A$) could be quickly deduced, suggesting an area for improvement in identifying shortcuts or patterns. There were responses that successfully managed to use elimination and comparing coefficients interchangeably and demonstrated very good fluency and understanding of working with partial fractions.

## Question 8

This question, involving the factor theorem and differentiation, was attempted by the vast majority of learners, with nearly all engaging with all three parts. Parts (a) and (b) were generally well-answered. Part (c), however, proved more challenging, with a significant proportion of learners relying on calculator-based methods despite the question clearly stating that these were not acceptable.

In part (a), most responses correctly differentiated the function and substituted $x = -\frac{1}{4}$ to solve for $a$, showing sufficient working and generally securing all four marks. The most common cause of a mark not being awarded was because any prior working to $a + 4 = 0$ was not shown, a step which could have been easily deduced from the given answer $a = -4$. Occasionally responses also found the second derivative, which was not required and sometimes introduced errors. The majority, however, followed a clear algebraic method and presented each stage of their working logically. Only a minority used the alternative verification approach, but the work was equivalent and generally well completed, with the required conclusion only occasionally omitted.

Part (b) was usually answered correctly, as it required only a straightforward substitution into the original equation using the value given in part (a). Although only one mark was available, many responses showed clear working, while others simply stated the correct answer, both approaches were credited. A few responses gave the answer only as a decimal approximation, which did not gain the mark.

Part (c) was the most challenging part of the question but was well supported by a clear diagram that helped to improve learners' ability to solve the problem. A good range of marks were seen for this part of the question, and it differentiated well between the varying understanding of learners across the cohort.

While many learners correctly identified that the number of real solutions to the equation $f(x) = k$ depended on the location of $k$ relative to the turning points of the curve, a substantial number relied on calculator methods to find the critical values of $k$, rather than using written methods as instructed. There were many responses where the required quadratic of $x^2 - 4$ (or maybe $4x^2 - 16$) was never seen, the cubic was either followed directly by $x = -\frac{1}{4}$, 2, $-2$, or $(4x + 1)(x - 2)(x + 2)$. These responses scored M0A0 and could only receive limited credit under the special case. Those who did attempt the algebra often reached the correct values but struggled with set notation. A common error when writing the final answer was using the union of two intervals instead of an intersection, while some used inclusive inequalities instead of strict inequalities and others made no attempt to use set notation. Despite this, many understood the underlying concept and were able to identify the correct range for $k$, even if it was not expressed with the required detail.

## Question 9

This question assessed understanding of exponential modelling and differentiation. Performance across the question was generally very good, but common errors in dealing with exponential equations and differentiating exponential models persist.

In part (a), learners were required to substitute $t = 3$ into the given model for $N$. Many were successful in this part. Some responses gave the answer as an unrounded decimal and scored A0, while others appeared to misunderstand the "total number of this type of car sold" and found the sum of the values of $N$ for $t = 1$, 2 and 3, scoring M1A0.

Part (b) required setting $N = 2000$, rearrangement of the resulting equation using rules of logarithms correctly to achieve a value of $T$. The question required sufficient working to be shown and had the warning that solutions should not rely entirely on calculator technology. While most solutions showed intermediate working leading to the correct answer of $T = 12.22$, there were attempts where the equation was immediately followed by a solution. This was not sufficient and could only achieve a maximum of one mark out of three. Errors seen included taking logarithms to different bases on each side, rounding the final answer incorrectly and seeing logarithms of negative numbers due to an earlier error.

Part (c) was the least well answered part of the question with learners often not realising that differentiation was required to find the rate of increase. Finding two values of $N$ using the gradient of a straight-line formula was seen. Another common error was to substitute $t = 3$ first and then try to differentiate which gained no credit. The final answer did not require units to be given but occasionally incorrect time periods were referred to, thus changing the rate, which scored A0.

In part (d), reference to changing the constant of 5000 to 6500 was the most straightforward answer. Some learners misunderstood what was being asked and instead commented on the limiting behaviour of the original model and/or deduced the model to be unsuitable if the limit was required to be 6500, rather than refining the model with this limiting behaviour.

## Question 10

This question, which involved setting up and solving a differential equation using separation of variables, proved to discriminate across the cohort, with a wide range in quality of responses seen. The restart opportunities provided were well used, allowing many learners to access later parts of the question even if they had struggled in earlier parts.

Part (a) was generally well answered with most responses demonstrating good understanding of the problem. Responses generally deduced an expression for $\frac{\mathrm{d}V}{\mathrm{d}t}$ and went on to score full marks for multiplying through by 20. The few responses that did not score on this part often tried to incorporate a connected rates of change type approach and some deriving an expression for $V = 0.45t - 0.3VT$ and attempted to differentiate it, usually incorrectly.

In part (b), some learners recognised the need to separate the variables and were able to do this successfully. A significant number placed the 20 incorrectly and others struggled to separate correctly into the reciprocal form which limited access to further marks.

Those who separated the variables were generally able to score the method mark for the integration at the beginning of the process. Common mistakes were omitting the $-\frac{1}{6}$, not including the minus sign or multiplying by –6. Most learners included a constant of integration, and most learners recognised the need to use the given initial conditions to find it - those who made it this far generally made the correct substitution of $V = 0.25$ and $t = 0$ and obtained a value for the constant. The final mark proved challenging for many, with errors in rearranging their equation to the given form being particularly common. Many struggled with the logarithm work, not applying sum/product or difference/quotient rules correctly, often taking e to the power of individual terms rather than the whole expression on each side of the equation.

In part (c), it was pleasing that learners generally considered the behaviour of the curve as $t$ tended to infinity. The use of appropriate notation was generally good and often lead to full marks for the justification. A large number of responses set their equation equal to 2 and attempted to solve it, interpreting the fact that there were no solutions as meaning that the tank would not become full. If a response gained the M1 mark, the A1ft mark was achieved with a high success rate, suggesting the practical problem that was being modelled was generally well understood by learners.

Many learners who did not have a successful approach to part (b) were able to engage sufficiently with the problem and access the marks in part (c) using the given answer part (a). Those attempting the problem in this way did so by considering flow rates into and out of the tank either when the volume in the tank was 2 or by identifying that the flow rate was negative once the volume reached 1.5 (or some intermediate value).

## Question 11

This modelling question required learners to construct and interpret a linear demand model, derive a profit function, solve a quadratic inequality, identify the optimal selling price, and assess the suitability of a model against real data. Overall, performance was mixed across the different parts of the question.

Part (a) proved to be the most accessible part of the question and was generally well handled demonstrating a sound understanding of linear modelling. The majority were able to formulate an appropriate equation for the model in the form $y = mx + c$, correctly identifying the constants $m$ and $c$. Only a small number of responses encountered difficulties, primarily due to confusion between $x$ and $y$ coordinates when calculating the gradient.

Part (b) proved to be much more challenging. Learners who made an otherwise strong attempt sometimes omitted the −8000 term or made errors while expanding the brackets. Those who reached the correct expression connecting variable and fixed costs without initially dividing by 1000 generally recognised the need to do so, since the final answer was provided, and divided by 1000 at the end to match the printed equation. Common errors for those that attempted this part were missing the fixed cost, incorrect expressions for revenue or cost and failure to divide by 1000 accurately.

A few responses tried to verify the formula for the given data but often fell short of a full method by only testing the given two values and not forming a conclusion.

Part (c) allowed many learners to make the most of the restart opportunity, with the majority attempting this part. Most recognised that they needed to solve the equation by setting $P$ equal to zero and most did so by directly calculating values of $x$ using their calculators. As this was a question involving money, responses did not gain the accuracy mark for not rounding their answers to two decimal places as required. Among those who gave a decimal answer, many did not earn the A mark either because they rounded to one decimal place or used an incorrect inequality, misinterpreting when the profit would be positive in the vicinity of their critical values, with a common incorrect answer being $13.19 < x < 51.81$.

In part (d), many learners did not earn the mark due to the omission of the pound sign or failure to round their answer to two decimal places. It would be advisable for learners to pay closer attention to the word 'price' in the question, as it implies that both the correct unit and an answer given to two decimal places are required.

Part (e) was generally well answered and the vast majority of responses correctly substituted 35 and obtained a profit of £22,000. Those who did not gain the final mark typically did not acknowledge that £22,000 is close to £21,750 or only mentioned this in their conclusion. Some appeared to expect the output of the model to match the real value exactly. This part effectively distinguished between those who understood the purpose of model validation and those who performed substitution without interpretation.

## Question 12

This question, assessing understanding of modulus functions, composite functions and the range, was accessible to almost all learners. Generally, responses scored well on the first two parts but did not find a simple strategy for the last part.

In part (a), the modulus idea was understood by most learners who knew to substitute $x = 1$ and $x = -1$ into f($x$) achieving the correct answers $3$ and $11$. A number of responses did not gain the accuracy mark by either stating that $a = 3, 11$ or $x = 3, 11$. Some found incorrect additional solutions, often –13 and –21 (thinking that $|x - 3|$ could be positive or negative), or giving a range of values such as $3 < \mathrm{f}(a) < 11$ and as a result did not gain the accuracy mark. A number of responses found values of $a$ by solving a variety of equations. Many overlooked the modulus signs and treated the function as $\mathrm{f(x)} = 4(x – 3) – 5$.

In part (b), some responses found the minimum value of the function directly from $2(-5)+17$ but a significant number found an expression for gf($x$) first $2\left(4|x-3|-5\right)+17$. Of these, some knew to either replace $(x-3)$ with 0, or $x$ with 3 leading to a minimum value of 7, but a significant number did not know how to proceed from the function gf($x$).

Having found the correct minimum value, many learners gave the correct answer

$\mathrm{gf}(x) \geq 7$, but a number incorrectly gave the answer as $x \geq 7$ or $\mathrm{f}(x) \geq 7$. A few learners gave their answer in ‘set’ notation and these learners generally scored both marks for this part. Some learners used graphical transformations to arrive at their range, the majority of which got to the final answer, scoring full marks.

Learners found part (c) difficult, and many scored few marks as a result. This part is not dissimilar to questions from previous series but the idea of there being no solutions clearly caused greater difficulties for some. Those who were most successful approached the question thinking graphically, drawing on the given graph a line from the origin to the vertex, finding the gradient, then realising the gradient was between this value and –4 (inclusive of –4). Often the strict inequality for –4 was given and did not gain the final mark, but on the whole this approach was quick and successful. Other responses showed one of the more difficult routes to finding the upper limit for $k$ and invariably had processing errors at some stage.

Finally, many responses considered that a discriminant had to be involved because the question mentioned there being “no solutions”, however for most this ended up with them trying to find the discriminant of expressions that were not quadratic.

## Question 13

This question, which required an understanding of transformation and periodicity of trigonometric functions, gave learners the opportunity to think carefully and demonstrate a strong understanding of the topic.

Part (i) was generally well answered with many responses evidencing use of graphs to help deduce that $n$ was 3. The most common incorrect answer was $n = \frac{1}{3}$, even though the question specified that $n$ was a natural number. Learners would be well advised to pay careful attention to the constraints placed on unknowns in all questions.

In part (ii), a good number of responses demonstrated that there were 30 solutions to the equation, although fewer were able to communicate their reasoning well enough. A significant minority arrived incorrectly at 30 by mistakenly assuming that there were 15 solutions to $\sin(nx) = k$ and 15 solutions to $\sin(nx) = -k$, or sometimes 18 and 12 solutions respectively (the correct number of solutions being 16 and 14 respectively). Such responses scored one of the two available marks. An uncommon but elegant approach was to rewrite the quadratic in $\sin 3x$ as a linear equation in $\cos 6x$, making it easier to explain why there are 30 solutions in the given interval. Another was to identify $\frac{2}{3}$ as the period of $\sin^2 3x$ and then scale up accordingly, which demonstrated an excellent understanding of periodicity. A small number did not realise that $n$ was still equal to 3 in part (ii), and gave an answer in terms of $n$.

A common incorrect approach involved the misapprehension that squaring $\sin x$ would also square the number of solutions, leading to an incorrect answer of 36. Many did not take the negative solutions into account and simplify multiplied 6 by 2.5 to obtain the incorrect answer of 15. More learners would have benefited from a well-drawn and labelled graph to support their thinking and reasoning.

## Question 14

This question about vectors proved to be a good differentiator between learners. Many were only able to make progress in part (a), whilst learners who had a good knowledge of the techniques required progressed through part (b) as well. Most learners made some progress, but also found this question to be challenging. Throughout, responses saw varied methods, and many made effective use of the given diagram to help answer the question. In general, those that wrote the route down using good vector notation fared better than those who did not in both parts of the question.

In part (a), most successful responses attempted to use $\overrightarrow{AD}$ or $\overrightarrow{DA}$, often finding an equation such as $-4\mathbf{a}+k\mathbf{b}=\lambda(15\mathbf{a}-5\mathbf{b})+2\mathbf{a}+3\mathbf{b}$ or $\overrightarrow{AD}=6\mathbf{a}+(3-k)\mathbf{b}$ gaining the first mark. Some responses worked with the components of **a** and **b** from the start, rather than writing down expressions with vectors, but often produced correct work. A common mistake, however, was to incorrectly use $\overrightarrow{AD}=\overrightarrow{AB}+\overrightarrow{DB}$ and responses doing this made no progress in part (a). Those who had made a successful start were then often able to equate the **a** and **b** components of their expression to produce two simultaneous equations and used the **a** component to establish a value of their parameter $\lambda$, and the **b** component to find $k$. Others simply compared $6\mathbf{a}+(3-k)\mathbf{b}$ and $15\mathbf{a}-5\mathbf{b}$ by inspection and were able to find the correct scale factor between them using it to find $k$ with sufficient working. Regardless of the method used, some learners with incorrect work often wrote down the given answer, $k = 5$, without realising that their work did not lead to this value.

Learners found part (b) of the question significantly harder. Many responses earned the first mark for identifying that $\overrightarrow{BN}=\frac{1}{5}\overrightarrow{BC}$, and this was often the only mark scored in this question. A common error, however, was to misinterpret the ratio $BN : NC$, and to incorrectly use $\overrightarrow{BN}=\frac{1}{4}\overrightarrow{BC}$. Most learners who made progress found two expressions for one of the vectors $\pm\overrightarrow{BX}$, $\pm\overrightarrow{AX}$, $\pm\overrightarrow{NX}$ or $\pm\overrightarrow{DX}$, one using a multiple of $\overrightarrow{AN}$ and one using a multiple of $\overrightarrow{DB}$. Where responses found a second vector with a different parameter, they were typically successful in solving simultaneous equations and identifying the correct ratio. Common errors included: only finding one expression or using the same vector ($\overrightarrow{AN}$ or $\overrightarrow{DB}$) in both of their expressions or using the same parameter in both expressions. There were other strategies employed, but invariably they had the same issues as the strategy covered in the main scheme.

A neat approach was to establish that triangles $AXD$ and $NXB$ were similar and since $AD = 2BN$ it followed immediately that $BX : XD = 1 : 2$. There were some responses that attempted to use a similar strategy, but often the work was not detailed enough, simply stating that $AD$ and $BN$ were parallel without further justification that they understood the triangles were similar.

## Question 15

The final question, which involved differentiation, integration by substitution and trigonometric identities, provided challenge in dealing with the algebra but, given its layout, proved accessible. The majority of learners attempted at least part of this question with some success due to the restart opportunities available.

In part (a), learners were generally able to apply the quotient rule correctly, with a smaller number attempting to apply the product rule. A few responses attempted a substitution, usually $u = 1 + x^2$, and this need approach often resulted in a succinct and concise solution. Sign slips were quite common, while failing to square the denominator when applying the quotient rule was also seen fairly frequently. This was probably a reflection of the fact that the denominator in the question was already squared so required a bit of extra thought and was easily missed. These errors sometimes meant that they could not make progress due to the form that they achieved.

Simplifying the expression and finding the correct coordinate proved quite challenging. Responses often defaulted to unnecessary algebra, such as expanding brackets, when the expression could have been simplified more directly. The number of terms in the expression seemed to be a barrier for many learners. Of those who reached a 3-term hidden quadratic in $x^2$, a significant number turned to the calculator for a solution despite the question stating that solutions relying on calculator technology were not acceptable. Of the responses that obtained a value of $x$, the vast majority were able to identify that $x = -\sqrt{3}$ was the correct value to use and then go on to find a correct, corresponding value of $y$. There were some, however, that found a value for $x$ but stopped there, not attempting to find a value for $y$.

In part (b), learners generally made a good start and seemed to be confident with the method of substitution. Most were able to score the first two B marks and the first M mark for an attempt at a complete substitution. For those that did not achieve the first M mark, it was almost always due to not dealing with the d$x$. However, the simplification to the required form using the trigonometric identities proved more challenging for many. Although there were many very neat and succinct solutions using various effective approaches, some responses expanded brackets unnecessarily, applied multiple trigonometric identities or worked with cumbersome fractions until they achieved something close to the required form. A small but noticeable number used degrees.

Part (c) proved to be more accessible for many learners, with many making an attempt after struggling with the earlier sections. Those who attempted this part often successful, regardless of their performance in parts (a) and (b). Common errors were with the coefficient, usually given as $-\frac{1}{2}$ or 2, or when substituting the limits. Some tried to use double angle formulae to change the form of the integrand and therefore did not make progress with this part of the question, not realising that the given form in part (b) was designed to help them complete the integration. Despite the question asking the candidate to show all stages of their working, some responses did not show the substitution and so did not gain the last two marks.

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