1	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
	Makes an attempt to factor all the quadratics on the left-hand side of the identity.	**M1**	2.2a	5th Simplify algebraic fractions.
	Correctly factors each expression on the left-hand side of the identity: $\frac{(x-6)(x+6)}{(x-5)(x-6)}\times\frac{(5-x)(5+x)}{Ax^2+Bx+C}\times\frac{(3x-1)(2x+3)}{(3x-1)(x+6)}$	**A1**	2.2a	
	Successfully cancels common factors: $\frac{(-1)(5+x)(2x+3)}{Ax^2+Bx+C}\equiv\frac{x+5}{(-1)(x-6)}$	**M1**	1.1b	
	States that $Ax^2+Bx+C\equiv(2x+3)(x-6)$	**M1**	1.1b	
	States or implies that $A = 2$, $B = -9$ and $C = -18$	**A1**	1.1b	
				(5 marks)

Notes

Alternative method

Makes an attempt to substitute $x = 0$ (**M1**)

Finds $C = -18$ (**A1**)

Substitutes $x = 1$ to give $A + B = -7$ (**M1**)

Substitutes $x = -1$ to give $A - B = 11$ (**M1**)

Solves to get $A = 2$, $B = -9$ and $C = -18$ (**A1**)

2	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
(a)	Begins the proof by assuming the opposite is true. 'Assumption: there exists a number n such that n^2 is even and n is odd.'	B1	3.1	7th Complete proofs using proof by contradiction.
	Defines an odd number (choice of variable is not important) and successfully calculates n^2 Let $2k + 1$ be an odd number. $n^2 = (2k+1)^2 = 4k^2 + 4k + 1$	M1	2.2a	
	Factors the expression and concludes that this number must be odd. $4k^2 + 4k + 1 = 2\left(2k^2 + 2k\right) + 1$, so n^2 is odd.	M1	1.1b	
	Makes a valid conclusion. This contradicts the assumption n^2 is even. Therefore if n^2 is even, n must be even.	B1	2.4	
		(4)		

(b)	Begins the proof by assuming the opposite is true. 'Assumption: $\sqrt{2}$ is a rational number.'	**B1**	3.1	7th Complete proofs using proof by contradiction.
	Defines the rational number: $\sqrt{2} = \frac{a}{b}$ for some integers a and b, where a and b have no common factors.	**M1**	2.2a	
	Squares both sides and concludes that a is even: $\sqrt{2} = \frac{a}{b} \Rightarrow 2 = \frac{a^2}{b^2} \Rightarrow a^2 = 2b^2$ From part **a**: a^2 is even implies that a is even.	**M1**	1.1b	
	Further states that if a is even, then $a = 2c$. Choice of variable is not important.	**M1**	1.1b	
	Makes a substitution and works through to find $b^2 = 2c^2$, concluding that b is also even. $a^2 = 2b^2 \Rightarrow (2c)^2 = 2b^2 \Rightarrow 4c^2 = 2b^2 \Rightarrow b^2 = 2c^2$ From part **a**: b^2 is even implies that b is even.	**M1**	1.1b	
	Makes a valid conclusion. If a and b are even, then they have a common factor of 2, which contradicts the statement that a and b have no common factors. Therefore $\sqrt{2}$ is an irrational number.	**B1**	2.4	
		(6)		
				(10 marks)

Notes

3	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
(a)	Correctly states that $(1+ax)^{-2} = 1+(-2)(ax)+\frac{(-2)(-3)(ax)^2}{2}+\frac{(-2)(-3)(-4)(ax)^3}{6}+...$	**M1**	2.2a	6th Understand the binomial theorem for rational n.
	Simplifies to obtain $(1+ax)^{-2} = 1-2ax+3a^2x^2-4a^3x^3 \ldots$	**M1**	1.1b	
	Deduces that $3a^2 = 75$	**M1**	2.2a	
	Solves to find $a = \pm 5$	**A1**	1.1b	
		(4)		
(b)	$a = 5 \Rightarrow -4(125)x^3 = -500x^3$. Award mark for –500 seen.	**A1**	1.1b	6th Understand the binomial theorem for rational n.
	$a = -5 \Rightarrow -4(-125)x^3 = 500x^3$. Award mark for 500 seen.	**A1**	1.1b	
		(2)		
				(6 marks)

Notes

4	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
(a)	States $f'(x)=\lim_{h\to 0}\frac{f(x+h)-f(x)}{x+h-x}$	M1	3.1b	5th Differentiate simple trigonometric functions.
	Makes correct substitutions: $f'(x)=\lim_{h\to 0}\frac{\sin(x+h)-\sin x}{h}$	M1	1.1b	
	Uses the appropriate trigonometric addition formula to write $f'(x)=\lim_{h\to 0}\frac{\sin x\cos h+\cos x\sin h-\sin x}{h}$	M1	2.2a	
	Groups the terms appropriately $f'(x)=\lim_{h\to 0}\left(\left(\frac{\cos h-1}{h}\right)\sin x+\left(\frac{\sin h}{h}\right)\cos x\right)$	A1	2.2a	
		(4)		
(b)	Explains that as $h\to 0$, $\frac{\cos h-1}{h}\to 0$ and $\frac{\sin h}{h}\to 1$	M1	3.2b	5th Differentiate simple trigonometric functions.
	Concludes that this leaves $0\times\sin x+1\times\cos x$ So if $f(x)=\sin x$, $f'(x)=\cos x$	A1	3.2b	
		(2)		
				(6 marks)

Notes

5	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
	Makes an attempt to find $\int (10-2x)^4 \, dx$. Raising the power by 1 would constitute an attempt.	**M1**	1.1b	6th Integrate using the reverse chain rule.
	Correctly states $\int (10-2x)^4 \, dx = -\frac{1}{10}(10-2x)^5$	**A1**	2.2a	
	States $-\frac{1}{10}(2)^5 + \frac{1}{10}(10-2a)^5 = \frac{211}{10}$	**M1 ft**	1.1b	
	Makes an attempt to solve this equation. For example, $\frac{1}{10}(10-2a)^5 = \frac{243}{10}$ or $(10-2a)^5 = 243$ is seen.	**M1 ft**	1.1b	
	Solves to find $a = \frac{7}{2}$	**A1 ft**	1.1b	
				(5 marks)

Notes

Student does not need to state '+C' in an answer unless it is the final answer to an indefinite integral.

Award ft marks for a correct answer using an incorrect initial answer.

6	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
(a)	Rearranges $x^4 - 8x^2 + 2 = 0$ to find $x^2 = \frac{x^4 + 2}{8}$	M1	1.1b	5th Understand the concept of roots of equations.
	States $x = \sqrt{\frac{x^4 + 2}{8}}$ and therefore $a = \frac{1}{8}$ and $b = \frac{1}{4}$ or states $x = \sqrt{\frac{1}{8}x^4 + \frac{1}{4}}$	A1	1.1b	
		(2)		
(b)	Attempts to use iterative procedure to find subsequent values.	M1	1.1b	6th Solve equations approximately using the method of iteration.
	Correctly finds: $x_1 = 0.9396$ $x_2 = 0.5894$ $x_3 = 0.5149$ $x_4 = 0.5087$	A1	1.1b	
		(2)		
(c)	Demonstrates an understanding that the two values of f(x) to be calculated are for $x = –2.7815$ and $x = –2.7825$.	M1*	2.2a	5th Use a change of sign to locate roots.
	Finds $\mathrm{f}(-2.7815) = -0.0367...$ and $\mathrm{f}(-2.7825) = (+)0.00485...$	M1	1.1b	
	Change of sign and continuous function in the interval $\left[-2.7825, -2.7815\right] \Rightarrow$ root	A1	2.4	
		(3)		
				(7 marks)

Notes

(b) Award M1 if finds at least one correct answer.

(c) Any two numbers that produce a change of sign, where one is greater than –2.782 and one is less than –2.782, and both numbers round to –2.782 to 3 decimal places, are acceptable. Minimum required is that answer states there is a sign change in the interval and that this implies a root in the given interval.

7	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
(a)	Makes an attempt to find $\text{fg}(x)$. For example, writing $\text{fg}(x) = e^{2\ln(x+1)} + 4$	**M1**	2.2a	5th Find composite functions.
	Uses the law of logarithms to write $\text{fg}(x) = e^{\ln(x+1)^2} + 4$	**M1**	1.1b	
	States that $\text{fg}(x) = (x+1)^2 + 4$	**A1**	1.1b	
	States that the range is $y > 4$ or $\text{fg}(x) > 4$	**B1**	3.2b	
		(4)		
(b)	States that $(x+1)^2 + 4 = 85$	**M1**	1.1b	5th Find the domain and range of composite functions.
	Makes an attempt to solve for x, including attempting to take the square root of both sides of the equation. For example, $x+1 = \pm 9$	**M1**	1.1b	
	States that $x = 8$. Does not need to state that $x \neq -10$, but do not award the mark if $x = -10$ is stated.	**A1**	3.2b	
		(3)		
				(7 marks)

Notes

8	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
(a)	Forms a pair of simultaneous equations, using the given values $a+3d=98$ $a+10d=56$	M1	2.2a	4th Understand simple arithmetic sequences.
	Correctly solves to find $d=-6$	A1	1.1b	
	Finds $a=116$	A1	1.1b	
	Uses $a_n=a+(n-1)d$ to find $a_{20}=116+19\times(-6)=2$	A1	1.1b	
		(4)		
(b)	Uses the sum of an arithmetic series to form the equation $\frac{n}{2}\left[232+(n-1)(-6)\right]=78$	M1 ft	2.2a	5th Understand simple arithmetic series.
	Successfully multiplies out the brackets and simplifies. Fully simplified quadratic of $3n^2-119n+78=0$ is seen or $6n^2-238n+156=0$ is seen.	M1 ft	1.1b	
	Correctly factorises: $(3n-2)(n-39)=0$	M1 ft	1.1b	
	States that $n=39$ is the correct answer.	A1	1.1b	
		(4)		
				(8 marks)

Notes

(a) Can use elimination or substitution to solve the simultaneous equations.

(b) Award method marks for a correct attempt to solve the equation using their incorrect values from part **a**.

9	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
	States that $\sin\theta = \frac{BD}{1}$ and concludes that $BD = \sin\theta$	**M1**	3.1	6th Prove $\sec^2 x = 1 + \tan^2 x$ and $\text{cosec}^2 x = 1 + \cot^2 x$.
	States that $\cos\theta = \frac{AD}{1}$ and concludes that $AD = \cos\theta$	**M1**	3.1	
	States that $\angle DBC = \theta$	**M1**	2.2a	
	States that $\tan\theta = \frac{DC}{\sin\theta}$ and concludes that $DC = \frac{\sin^2\theta}{\cos\theta}$ oe.	**M1**	3.1	
	States that $\cos\theta = \frac{\sin\theta}{BC}$ and concludes that $BC = \tan\theta$ oe.	**M1**	3.1	
	Recognises the need to use Pythagoras' theorem. For example, $AB^2 + BC^2 = AC^2$	**M1**	2.2a	
	Makes substitutions and begins to manipulate the equation: $1+\tan^2\theta = \left(\frac{\cos\theta}{1} + \frac{\sin^2\theta}{\cos\theta}\right)^2$ $1+\tan^2\theta = \left(\frac{\cos^2\theta + \sin^2\theta}{\cos\theta}\right)^2$	**M1**	1.1b	
	Uses a clear algebraic progression to arrive at the final answer: $1+\tan^2\theta = \left(\frac{1}{\cos\theta}\right)^2$ $1+\tan^2\theta = \sec^2\theta$	**A1**	1.1b	
				(8 marks)

Notes

10	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
(a)	Makes an attempt to find the resultant force by adding the three force vectors together.	**M1**	3.1a	6th Solve contextualised problems in mechanics using 3D vectors.
	Finds $R = (6\mathbf{i} + 3\mathbf{j} + 3\mathbf{k})$ N	**A1**	1.1b	
		(2)		
(b)	States $F = ma$ or writes $(6\mathbf{i} + 3\mathbf{j} + 3\mathbf{k}) = 3(a)$	**M1**	3.1a	6th Solve contextualised problems in mechanics using 3D vectors.
	Finds $a = (2\mathbf{i} + \mathbf{j} + \mathbf{k})\text{ms}^{-2}$	**A1**	1.1b	
		(2)		
(c)	Demonstrates an attempt to find $\lvert a \rvert$ For example, $\lvert a \rvert = \sqrt{(2)^2 + (1)^2 + (1)^2}$	**M1**	3.1a	6th Solve contextualised problems in mechanics using 3D vectors.
	Finds $\lvert a \rvert = \sqrt{6}\text{ m s}^{-2}$	**A1**	1.1b	
		(2)		
(d)	States $s = ut + \frac{1}{2}at^2$	**M1**	3.1a	6th Solve contextualised problems in mechanics using 3D vectors.
	Makes an attempt to substitute values into the equation. $s = (0)(10) + \frac{1}{2}(\sqrt{6})(10)^2$	**M1 ft**	1.1b	
	Finds $s = 50\sqrt{6}$ m	**A1 ft**	1.1b	
		(3)		
				(9 marks)

Notes

(d) Award ft marks for a correct answer to part **d** using their incorrect answer from part **c**.

11	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
	Equating the coefficients of x^4: $A = 5$	**A1**	2.2a	6th Solve problems using the remainder theorem linked to improper algebraic fractions.
	Equating the coefficients of x^3: $B = -4$	**A1**	1.1b	
	Equating the coefficients of x^2: $2A + C = 17$, $C = 7$	**A1**	1.1b	
	Equating the coefficients of x: $2B + D = -5$, $D = 3$	**A1**	1.1b	
	Equating constant terms: $2C + E = 7$, $E = -7$	**A1**	1.1b	
				(5 marks)

Notes

12	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
(a)	States that $A(2x+3)+B(1-4x)\equiv 21-14x$	M1	1.1b	6th Decompose algebraic fractions into partial fractions − linear factors.
	Equates the various terms. Equating xs $2A-4B=-14$ Equating numbers $3A+B=21$	M1	1.1b	
	Multiplies or or both of the equations in an effort to equate one of the two variables.	M1	1.1b	
	Finds $A = 5$	A1	1.1b	
	Find $B = 6$	A1	1.1b	
		(5)		
(b)	Writes $\int_{-1}^{0}\left(\frac{5}{1-4x}+\frac{6}{2x+3}\right)dx$ as $\int_{-1}^{0}\left(5(1-4x)^{-1}+6(2x+3)^{-1}\right)dx$	M1 ft	2.2a	6th Integrate functions using the reverse chain rule.
	Makes an attempt to integrate the expression. Attempt would constitute the use of logarithms.	M1 ft	2.2a	
	Integrates the expression to find $\left[-\frac{5}{4}\ln(1-4x)+3\ln(2x+3)\right]_{-1}^{0}$	A1 ft	1.1b	
	Makes an attempt to substitute the limits $\left(-\frac{5}{4}\ln(1-4(0))+3\ln(2(0)+3)\right)$ $-\left(-\frac{5}{4}\ln(1-4(-1))+3\ln(2(-1)+3)\right)$	M1 ft	1.1b	
	Simplifies to find $\ln 27+\frac{5}{4}\ln 5$ o.e.	A1 ft	1.1b	
		(5)		
				(10 marks)

Notes

Award ft marks for a correct answer to part **b** using incorrect values from part **a**.

13	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
(a)	Shows or implies that if $y = 0$, $t = 1$	M1	1.1b	7th Solve coordinate geometry problems involving parametric equations.
	Finds the coordinates of P. $t=1 \Rightarrow x=3$ $P(3,0)$	A1	1.1b	
		(2)		
(b)	Attempts to find a cartesian equation of the curve. For example, $t = x - 2$ is substituted into $y=\dfrac{t-1}{t+2}$	M1	2.2a	7th Solve coordinate geometry problems involving parametric equations.
	Correctly finds the cartesian equation of the curve $y=\dfrac{x-3}{x}$ Accept any equivalent answer. For example, $y=1-\dfrac{3}{x}$	A1	1.1b	
		(2)		
(c)	Finds $\dfrac{\mathrm{d}y}{\mathrm{d}x}=3x^{-2}=\dfrac{3}{x^2}$	M1	2.2a	7th Solve coordinate geometry problems involving parametric equations.
	Substitutes $t = -1$ to find $x = 1$ and $\dfrac{\mathrm{d}y}{\mathrm{d}x}=\dfrac{3}{(1)^2}=3$	M1	1.1b	
	Finds the gradient of the normal $m_N=-\dfrac{1}{3}$	M1	1.1b	
	Substitutes $t = -1$ to find $x = 1$ and $y = -2$	A1	1.1b	
	Makes an attempt to find the equation of the normal. For example, $y+2=-\dfrac{1}{3}(x-1)$ is seen.	M1	1.1b	
	States fully correct answer $x+3y+5=0$	A1	1.1b	
		(6)		

(d)	Substitutes $x = t + 2$ and $y = \dfrac{t-1}{t+2}$ into $x + 3y + 5 = 0$ obtaining $t + 2 + 3\left(\dfrac{t-1}{t+2}\right) + 5 = 0$	**M1 ft**	2.2a	7th Solve coordinate geometry problems involving parametric equations.
	Manipulates and simplifies this equation to obtain $t^2 + 12t + 11 = 0$	**M1 ft**	1.1b	
	Factorises and solves to find $t = -1$ or $t = -11$	**M1 ft**	1.1b	
	Substitutes $t = -11$ to find $x = -9$ and $y = \dfrac{4}{3}$, i.e. $\left(-9, \dfrac{4}{3}\right)$	**A1 ft**	1.1b	
		(4)		
				(14 marks)

Notes

(c) Award ft marks for correct answer using incorrect values from part **b**.