Question	Answer	Marks	Guidance
9(a)	State or imply the form $\frac{A}{1-x}+\frac{B}{2+3x}+\frac{C}{(2+3x)^2}$	**B1**	
	Use a correct method for finding a coefficient	**M1**	
	Obtain one of $A=1$, $B=-1$, $C=6$	**A1**	
	Obtain a second value	**A1**	
	Obtain the third value	**A1**	In the form $\frac{A}{1-x}+\frac{Dx+E}{(2+3x)^2}$, where $A=1$, $D=-3$ and $E=4$ can score B1 M1 A1 A1 A1 as above.
		5	
9(b)	Use a correct method to find the first two terms of the expansion of $(1-x)^{-1}$, $(2+3x)^{-1}$, $\left(1+\frac{3}{2}x\right)^{-1}$, $(2+3x)^{-2}$ or $\left(1+\frac{3}{2}x\right)^{-2}$	**M1**	Symbolic coefficients are not sufficient for the M1 $A\left[\frac{1+(-1)(-x)+(-1)(-2)(-x)^2}{2\ldots}\right]$ $A=1$ $\frac{B}{2}\left[\frac{1+(-1)\left(\frac{3x}{2}\right)+(-1)(-2)\left(\frac{3x}{2}\right)^2}{2\ldots}\right]$ $B=1$ $\frac{C}{4}\left[\frac{1+(-2)\left(\frac{3x}{2}\right)+(-2)(-3)\left(\frac{3x}{2}\right)^2}{2\ldots}\right]$ $C=6$
	Obtain correct un-simplified expansions up to the term in of each partial fraction	**A1 FT** + **A1 FT** + **A1 FT**	$(1+x+x^2)+\left(-\frac{1}{2}+\left(\frac{3}{4}\right)x-\left(\frac{9}{8}\right)x^2\right)$ $+\left(\frac{6}{4}-\left(\frac{18}{4}\right)x+\left(\frac{81}{8}\right)x^2\right)$ [The FT is on A, B, C] $\left(1-\frac{1}{2}+\frac{6}{4}\right)+\left(1+\frac{3}{4}-\frac{18}{4}\right)x+\left(1-\frac{9}{8}+\frac{81}{8}\right)x^2$
	Obtain final answer $2-\frac{11}{4}x+10x^2$, or equivalent	**A1**	Allow unsimplified fractions $\frac{(Dx+E)}{4}\left[\frac{1+(-2)\left(\frac{3x}{2}\right)+(-2)(-3)\left(\frac{3x}{2}\right)^2}{2\ldots}\right]$ $D=-3$, $E=4$ The FT is on A, D, E.
		5	

9(a)	$k=-1$	B1
		(1)
(b)(i)	$f(0)=\lvert 2-4\ln(0+1)\rvert = 2-0=2$	B1
(ii)	$0=2-4\ln(x+1)\Rightarrow \ln(x+1)=\frac{1}{2}\Rightarrow x=e^{p}+q$	M1
	$x=e^{\frac{1}{2}}-1$	A1
		(3)
(c)	$2-4\ln(x+1)=3\Rightarrow \ln(x+1)=\ldots$ or $-2+4\ln(x+1)=3\Rightarrow \ln(x+1)=\ldots$	M1
	$2-4\ln(x+1)=3\Rightarrow x=\ldots$ and $-2+4\ln(x+1)=3\Rightarrow x=\ldots$	dM1
	CVs $e^{-\frac{1}{4}}-1,\ e^{\frac{5}{4}}-1$	A1
	$\text{"}-1\text{"}<x<e^{-\frac{1}{4}}-1$ or $x>e^{\frac{5}{4}}-1$	ddM1A1ft
		(5)
		(9 marks)

Question	Answer	Marks	Guidance
9(b)	Use a correct method to find the first two terms of the expansion $(2-x)^{-1}=2^{-1}+(-1)\,2^{-2}(-x)+[(-1)(-2)2^{-3}(-x)^2/2!]$, $\left(1+\frac{3x^2}{2}\right)^{-1}=1-\frac{3x^2}{2}$ or $\left(1-\frac{x}{2}\right)^{-1}=1-\left(\frac{-x}{2}\right)$	**M1**	Symbolic coefficients are not sufficient for the M1.
	$\frac{Ax+B}{2}\left[1+(-1)\frac{3x^2}{2}\ldots\right]$ $A=-2$ $B=3$ $\frac{C}{2}\left[1+(-1)\left(\frac{-x}{2}\right)+\frac{(-1)(-2)}{2}\left(\frac{-x}{2}\right)^2+\frac{(-1)(-2)(-3)}{6}\left(\frac{-x}{2}\right)^3\ldots\right]$ $C=5$	**A1 FT**	Obtain correct un-simplified expansions up to the term in x^3 of each partial fraction.
	$=\frac{3-2x}{2}\left(1-\frac{3x^2}{2}\right)+\frac{5}{2}\left(1+\frac{x}{2}+\frac{x^2}{4}+\frac{x^3}{8}\right)$ $=\left(\frac{3}{2}+\frac{5}{2}\right)+\left(-1+\frac{5}{4}\right)x+\left(-\frac{9}{4}+\frac{5}{8}\right)x^2+\left(\frac{3}{2}+\frac{5}{16}\right)x^3$	**A1 FT**	Unsimplified $(2-x)^{-1}$ expanded correctly, error in simplifying before their C is involved in the expression, allow A1FT when their C is introduced. The FT is on A, B, C.
	Multiply expansion of $\left(1+\frac{3x^2}{2}\right)^{-1}$ (must reach $1\pm\frac{3x^2}{2}$) by $Ax+B$, where $AB\neq 0$, up to the term in x^3. Allow if used $Cx+D$ ($Ax+B$ miscopied).	**M1**	Allow either ± 2 or $\pm 2^{-1}$ outside bracket or missing. Allow one error in actual multiplication to acquire the 4 terms [all terms needed]. Ignore errors in higher powers.

Question	Answer	Marks	Guidance
9(b)	Obtain final answer $4+\frac{1}{4}x-\frac{13}{8}x^2+\frac{29}{16}x^3$, or equivalent [If final answer has been multiplied throughout, e.g. by 16 then A0 at the end]	**A1**	Maclaurin's Series: $f(0)=4$ B1 $f'(0)=1/4$ B1. $f''(0)=-13/4$ and $f'''(0)=87/8$ B1. $4+\frac{1}{4}x-\frac{\frac{13}{4}x^2}{2}+\frac{\frac{87}{8}x^3}{6}$ or equivalent M1 A1. If $1+\frac{1}{4}x-\frac{\frac{13}{4}x^2}{2}+\frac{\frac{87}{8}x^3}{6}$ then M0 A0 unless their f(0) actually is 1.
		5	
9(c)	State answer $\lvert x\rvert<\sqrt{\frac{2}{3}}$ or $-\sqrt{\frac{2}{3}}<x<\sqrt{\frac{2}{3}}$ clear conclusion required	**B1**	Or exact equivalent. Strict inequality.
		1	

Question	Answer	Marks	Guidance
10(a)	State or imply the form $\frac{A}{1+2x}+\frac{B}{3-x}+\frac{C}{(3-x)^2}$	B1	Alternative form: $\frac{A}{1+2x}+\frac{Dx+E}{(3-x)^2}$.
	Use a correct method to find a constant	M1	Incorrect format for partial fractions: Allow M1 and a possible A1 if obtain one of these correct values. Max 2/5 Allow M1 even if multiply up by $(1+2x)(3-x)^3$.
	Obtain one of $A=2$, $B=2$ and $C=-3$	A1	Alternative form: obtain one of $A=2$, $D=-2$ and $E=3$.
	Obtain a second value	A1	
	Obtain the third value	A1	Do not need to substitute values back into original form.
		5	If $\frac{A}{1+2x}+\frac{B}{3-x}+\frac{Cx+D}{(3-x)^2}$ B0 but M1 A1 for *A*, A1 for *B* and A1 for *C* and *D*. If $C=0$ then recovers B1 from above.

Question	Answer	Marks	Guidance
10(b)	Use a correct method to obtain the first two terms of one of the unsimplified expansions $(1+2x)^{-1}, \left(1-\frac{1}{3}x\right)^{-1}, \left(1-\frac{1}{3}x\right)^{-2}$ $(3-x)^{-1}$, $(3-x)^{-2}$	M1	$(1+2x)^{-1}=1+(-1)(2x)+\ldots$ $\left(1-\frac{1}{3}x\right)^{-1}=1+(-1)(-x/3)+\ldots$ $\left(1-\frac{1}{3}x\right)^{-2}=1+(-2)(-x/3)+\ldots$ $(3-x)^{-1}=3^{-1}+(-1)3^{-2}(-x)\ldots$ $(3-x)^{-2}=3^{-2}+(-2)3^{-3}(-x)+\ldots$
	Obtain the correct unsimplified expansions up to the term in x^2 for each partial fraction If correct, should be working with $\frac{2}{1+2x}+\frac{2}{3-x}-\frac{3}{(3-x)^2}$ or $\frac{2}{1+2x}+\frac{-2x+3}{(3-x)^2}$	A1 FT A1 FT A1 FT	Follow through on *their A*, *B*, *C* $A(1+(-1)(2x)+((-1)(-2)/2)(2x)^2+\ldots)$ $\frac{B}{3}(1+(-1)(-x/3)+((-1)(-2)/2)(-x/3)^2+\ldots)$ $\frac{C}{3^2}(1+(-2)(-x/3)+((-2)(-3)/2)(-x/3)^2+\ldots)$. Must be *their* coefficients from **(a)** but may be unsimplified expansions for FT marks. If correct, expect to see $2(1-2x+(2x)^2)$ or $2-4x+8x^2$ $\frac{2}{3}\left(1+\frac{x}{3}+\left(\frac{x}{3}\right)^2\right)$ or $\frac{2}{3}+\frac{2}{9}x+\frac{2}{27}x^2$ $-\frac{1}{3}\left(1+\frac{2x}{3}+(3)\left(\frac{x}{3}\right)^2\right)$ or $-\frac{1}{3}-\frac{2}{9}x-\frac{x^2}{9}$.
	Obtain final answer $\frac{7}{3}-4x+\frac{215}{27}x^2$	A1	Accept $2\frac{1}{3}-4x+7\frac{26}{27}x^2$. No ISW.

8 (a)	52 b.p.m.	B1
		(1)
(b)	32 b.p.m.	B1
		(1)
(c)	$\frac{dH}{dt} = -8\,e^{-0.2t} + 18\,e^{-0.9t}$	M1, A1
	Sets $-8\,e^{-0.2t} + 18\,e^{-0.9t} = 0 \Rightarrow 4e^{0.7t} = 9$	dM1
	$\Rightarrow 0.7t = \ln\frac{9}{4} \Rightarrow t = \ldots$	M1
	$T = 1.158$ (minutes)	A1
		(5)
(d)	$37 = 32 + 40\,e^{-0.2t} - 20\,e^{-0.9t} \Rightarrow e^{-0.2t} = \frac{1+4\,e^{-0.9t}}{8}$	M1
	$\Rightarrow e^{0.2t} = \frac{8}{1+4\,e^{-0.9t}} \Rightarrow t = 5\ln\left(\frac{8}{1+4\,e^{-0.9t}}\right)$	A1*
		(2)
(e)	$t_2 = 5\ln\left(\frac{8}{1+4e^{-0.9\times 10}}\right) = \ldots.$	M1
	$(t_2) =$ awrt 10.3947	A1
	(M)= 10.3955	A 1
		(3)
		Total 12

8(c)	$\lvert x\rvert < \frac{a}{2}$	**B1**	Or $-\frac{a}{2} < x < \frac{a}{2}$. Mark final answer. Must make a clear statement.
		1	

7(a)	$y = e^{-x^2}\sin 3x \Rightarrow \frac{dy}{dx} = 3e^{-x^2}\cos 3x - 2xe^{-x^2}\sin 3x$	M1A1
	$3e^{-x^2}\cos 3x - 2xe^{-x^2}\sin 3x = 0 \Rightarrow 3\cos 3x - 2x\sin 3x = 0$ $\Rightarrow 3\cos 3x = 2x\sin 3x \Rightarrow \tan 3x = \frac{3}{2x}$	dM1
	$x = \frac{1}{3}\arctan\left(\frac{3}{2x}\right)$ *	A1*
		(4)
(b)(i)	$x_1 = 0.4 \Rightarrow x_2 = \frac{1}{3}\arctan\left(\frac{3}{2\times 0.4}\right)$	M1
	$(x_2 =)0.4367$	A1
(ii)	$(x_4 =)0.4307$	A1
		(3)

Question	Answer	Marks	Guidance
1	State correct first two terms $1 + 2x$	B1	
	State a correct unsimplified version of the x^2 or x^3 term	M1	Symbolic binomial coefficients are not sufficient for the M mark.
	Obtain the next term $-x^2$	A1	
	Obtain the final term $\frac{4}{3}x^3$	A1	
		4	

Question	Answer	Marks	Guidance
7(a)	State or imply the form $\frac{A}{x-2}+\frac{Bx+C}{2x^2+3}$	B1	If $1-\frac{A}{x-2}+\frac{Bx+C}{2x^2+3}$ or $\frac{A}{x-2}+\frac{C}{2x^2+3}$ B0 then M1 A1 (for $A = 3$) still possible.
	Use a correct method for finding a constant	M1	
	Obtain one of $A = 3$, $B = -1$ and $C = 6$	A1	Allow all A marks obtained even if method would give errors if equations solved in a different order.
	Obtain a second value	A1	
	Obtain the third value	A1	
		5	

Question	Answer	Marks	Guidance
7(b)	Use correct method to find the first two terms of the expansion of $(x-2)^{-1}$, $\left(1-\frac{1}{2}x\right)^{-1}$, $\left(2x^2+3\right)^{-1}$ or $\left(1+\frac{2}{3}x^2\right)^{-1}$	M1	Symbolic binomial coefficients not sufficient for the M1.
	Obtain correct unsimplified expansions, up to the term in x^2, of each partial fraction	A1 FT A1 FT	The FT is on A, B and C. $-\frac{A}{2}\left[1-\left(-\frac{x}{2}\right)+\frac{(-1)(-2)}{2}\left(-\frac{x}{2}\right)^2+\ldots\right]$ $\frac{Bx+C}{3}\left[1-\frac{2x^2}{3}+\ldots\right]$
	Extract the coefficient 3 correctly from $\left(2x^2+3\right)^{-1}$ with expansion to $1\pm\frac{2}{3}x^2$ then multiply by $Bx + C$ up to the terms in x^2, where $BC \neq 0$	M1	$\frac{C}{3}+\frac{Bx}{3}\pm\frac{C}{3}\left(\frac{2}{3}\right)x^2$ or $\frac{1}{3}\left(C+Bx\pm C\left(\frac{2}{3}\right)x^2\right)$ Allow a slip in multiplication for M1. Allow miscopies in B and C from **7(a)**.
	Obtain final answer $\frac{1}{2}-\frac{13}{12}x-\frac{41}{24}x^2$	A1	Do not ISW.
		5	

Question	Answer	Marks	Guidance
2	State a correct unsimplified term in x or x^2 of the expansion of either $(1+2x)^{\frac{1}{2}}$ or $(1-2x)^{-\frac{1}{2}}$	B1	
	State correct unsimplified expansion of $(1+2x)^{\frac{1}{2}}$ up to the term in x^2	B1	
	State correct unsimplified expansion of $(1-2x)^{-\frac{1}{2}}$ up to the term in x^2	B1	
	Obtain sufficient terms of the product of the expansions	M1	
	Obtain final answer $1+2x+2x^2$	A1	