Question			Answer	Marks	Guidance
1			$\frac{2x}{x+1}-\frac{1}{x-1}=1$		
			$\Rightarrow \quad 2x(x-1)-(x+1)=(x+1)(x-1)$	M1	mult throughout by (x + 1)(x – 1) or combining fractions and mult up oe (can retain denominator throughout). Condone a single computational error provided that there is no conceptual error. Do not condone omission of brackets unless it is clear from subsequent work that they were assumed.
			$\Rightarrow \quad 2x^2-3x-1=x^2-1$	A1	any fully correct multiplied out form (including say, if 1's correctly cancelled) soi
			$\Rightarrow \quad x^2-3x=0=x(x-3)$	DM1	dependent on first M1.For any method leading to both solutions. Collecting like terms and forming quadratic (= 0) and attempting to solve *(provided that it is a quadratic and $b^2-4ac\geq 0$).Using either correct quadratic equation formula (can be error when substituting), factorising (giving correct x^2 and constant terms when factors multiplied out), completing the square oe soi.*
			$\Rightarrow \quad x=0$ or 3	A1	for both solutions www.
				[4]	**SC** B1 for x = 0 (or x = 3) without any working **SC** B2 for x = 0 (or x = 3) without above algebra but showing that they satisfy equation **SC** M1A1M0 SCB1 for first two stages followed by stating x = 0 **SC** M1A1M0 SCB1 for first two stages and cancelling x to obtain x = 3 only.

Question			r	Marks	Guidance
2			$\frac{x+1}{x^2(2x-1)} = \frac{A}{x} + \frac{B}{x^2} + \frac{C}{2x-1} = \frac{Ax(2x-1)+B(2x-1)+Cx^2}{x^2(2x-1)}$	B1	correct partial fractions
			$\Rightarrow \quad x+1 = Ax(2x-1)+B(2x-1)+Cx^2$	M1	Using a correct method to find a coefficient (equating numerators and substituting oe or using cover-up) Condone omission of brackets only if brackets are implied by subsequent work. Must go as far as finding a coefficient. Not dependent on B1
			$x = 0$, $1 = -B \Rightarrow B = -1$	A1	$B = -1$ www
			$x = ½$, $1½ = C/4 \Rightarrow C = 6$	A1	$C = 6$ www
			x^2 coeffs: $0 = 2A + C \Rightarrow A = -3$	A1	$A = -3$ www
			$\Rightarrow \quad \frac{x+1}{x^2(2x-1)} = -\frac{3}{x} - \frac{1}{x^2} + \frac{6}{2x-1}$		isw for incorrect assembly of partial fractions following correct A,B,C
					SC $\frac{A}{x^2} + \frac{B}{2x-1}$ can get 2/5 max from B0 M1 A1 (for B=6) SC $\frac{Ax+B}{x^2} + \frac{C}{2x-1}$ can get B1 M1 A1 (C=6) and can continue for full marks if the first fraction is then split. SC $\frac{A}{x} + \frac{B}{x^2} + \frac{C+Dx}{2x-1}$ can get B1 M1 A1 A1 A1 (C=6, D=0)
				[5]	

3 $\frac{3x+2}{x(x^2+1)} = \frac{A}{x} + \frac{Bx+C}{(x^2+1)}$		
$\Rightarrow$ $3x + 2 = A(x^2 + 1) + (Bx + C)x$	M1	correct partial fractions
$x = 0 \Rightarrow 2 = A$	M1	
coefft of x^2 : $0 = A + B \Rightarrow B = -2$	B1	
coefft of x: $3 = C$	M1	equating coefficients
	A1	at least one of B,C correct
$\Rightarrow$ $\frac{3x+2}{x(x^2+1)} = \frac{2}{x} + \frac{3-2x}{(x^2+1)}$	A1	
	[6]	

4 $\frac{4}{x(x^2+4)} = \frac{A}{x} + \frac{Bx+C}{x^2+4}$	M1	correct partial fractions
$= \frac{A(x^2+4)+(Bx+C)x}{x(x^2+4)}$		
$\Rightarrow$ $4 = A(x^2+4)+(Bx+C)x$	M1	
$x = 0 \Rightarrow 4 = 4A \Rightarrow A = 1$	B1	A=1
coefft of x^2: $0 = A + B \Rightarrow B = -1$	DM1	Substitution or equating coeffts
coeffts of x: $0 = C$	A1	B= –1
$\Rightarrow$ $\frac{4}{x(x^2+4)} = \frac{1}{x} - \frac{x}{x^2+4}$	A1	C= 0
	[6]	

5 $\frac{2x}{x-2} - \frac{4x}{x+1} = 3$		
$\Rightarrow$ $2x(x + 1) - 4x(x - 2) = 3(x - 2)(x + 1)$	M1	Clearing fractions
$\Rightarrow$ $2x^2 + 2x - 4x^2 + 8x = 3x^2 - 3x - 6$	M1	expanding brackets
$\Rightarrow$ $0 = 5x^2 - 13x - 6$	A1	oe
$= (5x + 2)(x - 3)$		
$\Rightarrow$ $x = -2/5$ or 3.	M1	factorising or formula
	A1 cao	
	[5]	

Question			Answer	Marks	Guidance
6	**(i)**		$\frac{x}{(1+x)(1-2x)} = \frac{A}{1+x} + \frac{B}{1-2x}$		
			$\Rightarrow \quad x = A(1-2x) + B(1+x)$	M1	expressing in partial fractions of correct form (at any stage) and attempting to use cover up, substitution or equating coefficients Condone a single sign error for M1 only.
			$x = ½ \Rightarrow ½ = B(1 + ½) \Rightarrow B = 1/3$	A1	www cao
			$x = -1 \Rightarrow -1 = 3A \Rightarrow A = -1/3$	A1	www cao (accept A/(1+x) +B/(1-2x) , A = −1/3, B = 1/3 as sufficient for full marks without needing to reassemble fractions with numerical numerators)
				[3]	

Question			Answer	Marks	Guidance
6	(ii)		$\frac{x}{(1+x)(1-2x)} = \frac{-1/3}{1+x} + \frac{1/3}{1-2x}$		
			$= \frac{1}{3}\left[(1-2x)^{-1} - (1+x)^{-1}\right]$	M1	correct binomial coefficients throughout for first three terms of
			$= \frac{1}{3}[1 + (-1)(-2x) + \frac{(-1)(-2)}{2}(-2x)^2 + ... - (1 + (-1)x + \frac{(-1)(-2)}{2}x^2 + ...)]$		**either** $(1-2x)^{-1}$ or $(1+x)^{-1}$ oe ie 1,(−1),(−1)(−2)/2 , not nCr form. Or correct simplified coefficients seen.
			$= \frac{1}{3}[1 + 2x + 4x^2 + ... - (1 - x + x^2 + ...)]$	A1 A1	$1 + 2x + 4x^2$ $1 - x + x^2$ (or 1/3/-1/3 of each expression, ft their A/B) If $k(1-x+x^2)$ (A1) not clearly stated separately, condone absence of inner brackets (ie $1+2x+4x^2$<u>$-1-x+x^2$)</u> **only if** subsequently it is clear that brackets were assumed, otherwise A1A0. [ie $-1-x+x^2$ is A0 unless it is followed by the correct answer] Ignore any subsequent incorrect terms
			$= \frac{1}{3}(3x + 3x^2 + ...) = x + x^2 + ...$ so $a = 1$ and $b = 1$	A1	or from expansion of $x(1-2x)^{-1}(1+x)^{-1}$ www cao
			OR $x(1-x-2x^2) = x(1-(x+2x^2))$ $= x(1 + x + 2x^2 + (-1)(-2)(x + 2x^2)^2/2 + \text{.........})$	M1	correct binomial coefficients throughout for $(1-(x+2x^2))$ oe (ie 1,-1), at least as far as necessary terms $(1+x)$ (NB third term of expansion unnecessary and can be ignored)
			$= x(1 + x + 2x^2 + x^2 \text{.........})$	A2	$x(1+x)$ www
			$= x + x^2\text{.....}$ so $a = 1$ and $b = 1$	A1	ww cao
			Valid for $-\frac{1}{2} < x < \frac{1}{2}$ or $\lvert x\rvert < \frac{1}{2}$	B1	independent of expansion. Must combine as one overall range. condone ≤ s (although incorrect) or a combination. Condone also, say $-\frac{1}{2} < \lvert x\rvert < \frac{1}{2}$ but not $x < \frac{1}{2}$ or $-1 < 2x < 1$ or $-\frac{1}{2} > x > \frac{1}{2}$
				[5]	

7(i) $v = \int 10e^{-\frac{1}{2}t}\,dt$ $= -20e^{-\frac{1}{2}t} + c$ when $t = 0$, $v = 0$ $\Rightarrow$ $0 = -20 + c$ $\Rightarrow$ $c = 20$ so $v = 20 - 20e^{-\frac{1}{2}t}$	M1 A1 M1 A1 [4]	separate variables and intend to integrate $-20e^{-\frac{1}{2}t}$ finding c cao
(ii) As $t \to \infty$ $e^{-1/2\,t} \to 0$ $\Rightarrow$ $v \to 20$ So long term speed is 20 m s^{-1}	M1 A1 [2]	 ft (for their $c>0$, found)
(iii) $\frac{1}{(w-4)(w+5)} = \frac{A}{w-4} + \frac{B}{w+5}$ $= \frac{A(w+5)+B(w-4)}{(w-4)(w+5)}$ $\Rightarrow$ $1 \equiv A(w+5) + B(w-4)$ $w = 4$: $1 = 9A \Rightarrow A = 1/9$ $w = -5$: $1 = -9B \Rightarrow B = -1/9$ $\Rightarrow \frac{1}{(w-4)(w+5)} = \frac{1/9}{w-4} - \frac{1/9}{w+5}$ $= \frac{1}{9(w-4)} - \frac{1}{9(w+5)}$	M1 M1 A1 A1 [4]	 cover up, substitution or equating coeffs 1/9 −1/9
(iv) $\frac{dw}{dt} = -\frac{1}{2}(w-4)(w+5)$ $\Rightarrow$ $\int \frac{dw}{(w-4)(w+5)} = \int -\frac{1}{2}\,dt$ $\Rightarrow \int [\frac{1}{9(w-4)} - \frac{1}{9(w+5)}]dw = \int -\frac{1}{2}\,dt$ $\Rightarrow \frac{1}{9}\ln(w-4) - \frac{1}{9}\ln(w+5) = -\frac{1}{2}t + c$ $\Rightarrow \frac{1}{9}\ln\frac{w-4}{w+5} = -\frac{1}{2}t + c$ When $t = 0$, $w = 10 \Rightarrow c = \frac{1}{9}\ln\frac{6}{15} = \frac{1}{9}\ln\frac{2}{5}$ $\Rightarrow \ln\frac{w-4}{w+5} = -\frac{9}{2}t + \ln\frac{2}{5}$ $\Rightarrow \frac{w-4}{w+5} = e^{-\frac{9}{2}t + \ln\frac{2}{5}} = \frac{2}{5}e^{-\frac{9}{2}t} = 0.4e^{-4.5t}$ *	 M1 M1 A1ft M1 M1 E1 [6]	 separating variables substituting their partial fractions integrating correctly (condone absence of c) correctly evaluating c (at any stage) combining lns (at any stage) www
(v) As $t \to \infty$ $e^{-4.5\,t} \to 0$ $\Rightarrow$ $w - 4 \to 0$ So long term speed is 4 m s^{-1}.	M1 A1 [2]	