Question	Scheme	Marks	AOs
3 (a)	$\left\{y = x^2 + kx + 14 - 8(x-5)^{-1} \Rightarrow\right\} \dfrac{dy}{dx} = 2x + k + 8(x-5)^{-2}$	M1 A1	1.1b 1.1b
	$\left\{\text{At } x = 3, \dfrac{dy}{dx} = 0 \Rightarrow\right\} \dfrac{dy}{dx} = 2(3) + k + \dfrac{8}{(3-5)^2} = 0$	dM1	1.1b
	$\Rightarrow 6 + k + \dfrac{8}{4} = 0 \Rightarrow 6 + k + 2 = 0 \Rightarrow k = -8$ *	A1*	2.1
		(4)	
(b)	$\dfrac{d^2y}{dx^2} = 2 - 16(x-5)^{-2} = 2 - \dfrac{16}{(x-5)^3}$		
	When $x = 3$, $\dfrac{d^2y}{dx^2} = 2 - \dfrac{16}{(3-5)^3}$	M1	1.1b
	$\dfrac{d^2y}{dx^2} = 4 > 0 \Rightarrow$ {local} minimum {stationary point at P}	A1	2.1
		(2)	
(b) Alt 1	E.g. $x = 2.9$, $\dfrac{dy}{dx} = 2(2.9) - 8 + 8(2.9-5)^{-2} = -0.38594... < 0$	M1	1.1b
	$x = 3.1$, $\dfrac{dy}{dx} = 2(3.1) - 8 + 8(3.1-5)^{-2} = 0.41606... > 0$ $\Rightarrow$ {local} minimum {stationary point at P}	A1	2.1
		(2)	
(c)	**<u>Criteria 1</u>** (Accept any one of the two following points) • At $x = 7$, $\dfrac{d^2y}{dx^2} = 2 - \dfrac{16}{(7-5)^3} = 0$ • $\dfrac{d^2y}{dx^2} = 2 - \dfrac{16}{(x-5)^3} = 0 \Rightarrow (x-5)^3 = 8 \Rightarrow x = 2 + 5 \Rightarrow x = 7$		
	<u>Criteria 2</u> (Accept any one of the two following points) • At $x = 6.9$, $\dfrac{d^2y}{dx^2} = -0.33... < 0$ and at $x = 7.1$, $\dfrac{d^2y}{dx^2} = 0.27... > 0$ • $\dfrac{d^3y}{dx^3} = \dfrac{48}{(x-5)^3}$ and at $x = 7$, $\dfrac{d^3y}{dx^3} \left\{= \dfrac{48}{(7-5)^3} = 6\right\} \neq 0$		
	At least one of Criteria 1 or Criteria 2	M1	2.1
	Both Criteria 1 and Criteria 2 (with correct calculations) and concludes the curve has a {non-stationary} point of inflection at $x = 7$	A1	2.4
		(2)	
(d)	Sign change method is not valid because either • the curve is not defined at $x = 5$ • the curve is not continuous over the interval (4.5, 5.5)	B1	2.4
		(1)	
			(9 marks)

Question 3 Notes:	
(a)	
M1:	At least one of either $x^2 \to \pm Ax$ or $kx \to k$ or $-\dfrac{8}{(x-5)} \to \pm B(x-5)^{-2}$; $A, B \neq 0$
A1:	$\dfrac{dy}{dx} = 2x + k + 8(x-5)^{-2}$, which may be un-simplified or simplified
dM1	**dependent on the previous M mark**
	Complete strategy of substituting $x = 3$ into their equation for $\dfrac{dy}{dx}$ and setting $\dfrac{dy}{dx}$ equal to 0
A1*:	Correctly shows $k = -8$ with no errors in their working
(b)	
M1:	Evidence of substituting $x = 3$ into an expression for $\dfrac{d^2y}{dx^2}$ which is in the form $\pm\alpha \pm \beta(x-5)^{-3}$; $\alpha, \beta \neq 0$
A1:	For a correct calculation, a valid reason and a correct conclusion
(b) Alt 1	
M1:	Uses $\dfrac{dy}{dx}$ which is in the form $\pm\alpha x - 8 \pm \beta(x-5)^{-2}$; $\alpha, \beta \neq 0$ and finds values for $\dfrac{dy}{dx}$ either side of $x = 3$
A1:	For correct calculations, a valid reason and a correct conclusion
(c)	
M1:	See scheme
A1:	See scheme
(d)	
B1:	States that the sign change method is not valid together with an acceptable reason as indicated in the scheme