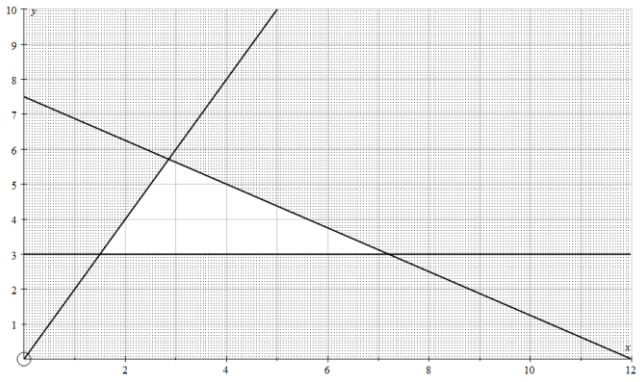
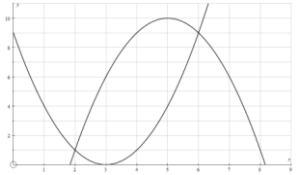
Question			Answer	Marks	Guidance	
9	(a)		$f(0) = -1,\ f(1) = 1$	**M1** **A1**	Substitution of both 0 and 1 Both correct	
				[2]		
	(b)		$x^3 + 2x^2 - x - 1 = 0 \Rightarrow x^2(x+2) = (x+1)$ $\Rightarrow x^2 = \frac{(x+1)}{(x+2)} \Rightarrow x = \sqrt{\frac{(x+1)}{(x+2)}}$ **AG**	**M1** **A1**	Factorising the first two terms; x^2 must be seen as a factor Ignore ±	Alternatively: start from given eqn Square both sides and multiply up M1 Correct algebra seen to give original equation A1
				[2]		
	(c)		0.8 0.801784 0.801926 0.801937 x_3 $(\Rightarrow \gamma) = 0.802$	**M1** **A1** **A1**	Use of formula x_1 correct to at least 4 dp or exact At least x_3 correct to at least 4 dp seen and answer correct to 3sf	Accept $\frac{3\sqrt{14}}{14}$ **oe** for x_1 Accept $x_3 = 0.802$ as final answer
				[3]		

Question			Answer	Marks	Guidance	
10	(a)		$x^2+(2x+k)^2=5$ $\Rightarrow x^2+4x^2+4kx+k^2-5=0$ $\Rightarrow 5x^2+4kx+(k^2-5)=0$ **AG**	**M1** **A1**	Substitute and attempt to simplify	
				[2]		
	(b)		For coincident roots, the terms under the square root sign sum to 0 $\Rightarrow 16k^2-20(k^2-5)=0$ $\Rightarrow -4k^2+100=0$ $\Rightarrow k=\pm 5$	**M1** **A1**	Evidence of understanding that tangent implies coincident roots	"Evidence" means some indication that roots are coincident
				[2]		

Question			Answer	Marks	Guidance	
11	(a)		$5x+8y \leqslant 60$ **oe**	**B1**		
				[1]		
	(b)		$y \geqslant 3$ $y \leqslant 2x$	**B1** **B1**		
				[2]		
	(c)			**B3,2,1** **B1**	B1 for each line. Ignore errors in (a) and (b) Ignore labels for lines on graph Correct shading	Check for time line goes through (4,5) Do not accept the shaded region being the triangle N.B. You might see lines on the graph that relate to (d) and (e) - ignore
				[4]		
	(d)		$(x + y =)$ 10 Time = 59 (hours)	**B1** **B1**	$x = 7$, $y = 3$ only is B0	
				[2]		
	(e)		 4 small and 5 large Profit = £412	**M1** **A1** **A1**	Sight of $(P =)28x+60y$ on grid Or listing at least two correct feasible points and calculating P for each point **soi** by £412	 SC no working seen but answer given, B1 B1 Allow B2 by implication from £412
				[3]		

Question			Answer	Marks	Guidance	
12	(a)		$10 = 10\times5 - 5^2 + k$ **oe** $\Rightarrow k = 10 - 25 = -15$ **AG**	**M1** **A1**	Substitute	Either substitute (5, 10) to obtain k or substitute $k = -15$ and show that it is satisfied by (5, 10)
				[2]		
	(b)		$\frac{dy}{dx} = 10 - 2x$ $= 0$ when $x = 5$	**M1** **A1** **A1**	Diffn and set = 0 or find = 0 from x = 5 Any demonstration to show maximum	All powers reduced by 1 – beware of division by x e.g. gradient either side of turning points or values either side or $\frac{d^2y}{dx^2} = -2 < 0$ stated meaning maximum
			Alternative method: $y = a \pm (x \pm b)^2$ $= \left(10 - (x-5)^2\right)$ $\Rightarrow$ Maximum value of 10 when $x = 5$ **Alternative method:** Statement that Quadratic function is symmetric Pair of symmetric coordinates either side of (5, 10) Gives maximum	**M1** **A1** **A1** **M1** **A1** **A1**	Completing the square	$a \neq -15$ and $b \neq 10$ e.g. at x =4, 6, y = 9 and 10 > 9
				[3]		
	(c)			**B1** **B1**	Upside down parabola Maximum (5, 10); Meets other curve at two points	
				[2]		

	(d)		(2, 1) and (6, 9)	**B1** **B1**	**FT** *their* graphs **FT** *their* graphs	Accept an algebraic method that may differ from their intersections in (c)
				[2]		
	(e)		$\text{Area} = \int_2^6 (y_1 - y_2)\,dx$	**M1**	Difference of curves	In either order
			$= \int_2^6 \left(16x - 2x^2 - 24\right)dx$	**A1**	Or – this function	A0 if divided by 2
			$= \left[8x^2 - \frac{2}{3}x^3 - 24x\right]_2^6$	**M1***	**Dep** Integrate; ignore limits	At least two powers increased by 1; beware multiplication by x
			$= \left(288 - 144 - 144\right) - \left(32 - \frac{16}{3} - 48\right)$	**M1***	**Dep** Apply limits by substitution of *their* intersections, subtract in correct order	
			$= 0 - \left(-\frac{64}{3}\right) = \pm\frac{64}{3}$	**A1**	Accept to 3sf or better	SC answer with no working B5
			Alternative method: $\text{Area} = \int_2^6 y_1\,dx - \int_2^6 y_2\,dx$	**M1**	Integrate both; ignore limits	
			$= \int_2^6 \left(10x - x^2 - 15\right)dx - \int_2^6 \left(x^2 - 6x + 9\right)dx$	**M1**	Apply limits in one integral by substitution of *their* intersections, subtract in correct order	
			$= \left[5x^2 - \frac{x^3}{3} - 15x\right]_2^6 - \left[\frac{x^3}{3} - 3x^2 + 9x\right]_2^6$			
			$= \left(\left(180 - 72 - 90\right) - \left(20 - \frac{8}{3} - 30\right)\right) - \left(\left(72 - 108 + 54\right) - \left(\frac{8}{3} - 12 + 18\right)\right)$	**A1**	For one value	
			$= \left(18 + \frac{38}{3}\right) - \left(18 - \frac{26}{3}\right)$	**M1***	**Dep on both** Subtract	
			$= \frac{92}{3} - \frac{28}{3} = \frac{64}{3}$	**A1**		
				[5]		

Question			Answer	Marks	Guidance	
13	(a)		$\frac{h}{300} = \tan 7 \Rightarrow h = 36.8....$	**M1** **A1**	Use tan ratio	Sine rule may be used
				[2]		
	(b)		$CB^2 = 400^2 + 300^2 - 2\times 300\times 400\times \cos 60$ $= 130000$ $\Rightarrow CB = 360.55.....$ elevation $= \tan^{-1}\left(\frac{their\ \ h}{their\ \ \text{CB}}\right)$ $= 5.83...$	**M1** **A1** **A1** **M1** **A1**	Find CB by correct cosine rule Correct substitutions Ignore any rounding Correct angle Correct to 3 sf	
				[5]		
	(c)		e.g $\frac{\sin B}{300} = \frac{\sin 60}{their\ CB}$ $\Rightarrow B = 46.1$ or $C = 73.9$ Bearing $= 180 + 60 + their\ B$ $= 286^0$	**M1** **A1** **A1** **M1** **A1**	Either sin rule or cosine rule to find angle at B or C Alternative methods ok Inserting correct values into chosen formula correctly awrt 46 or 74 Correct attempt to find bearing awrt 286	rearranging correctly either sin = or cos = Or using C
				[5]		

Question			Answer	Marks	Guidance	
14	(a)		$\frac{dv}{dt} = a$ (constant) $\Rightarrow v = c + at \Rightarrow v = 14 + at$ $\frac{ds}{dt} = v = 14 + at \Rightarrow s = c + 14t + \frac{1}{2}at^2 = 14t + \frac{1}{2}at^2$ $\Rightarrow 50 = 14t + \frac{1}{2}at^2$ and $9 = 14 + at \Rightarrow at = -5$ $\Rightarrow 50 = 14t - \frac{5}{2}t = \frac{23}{2}t \Rightarrow t = \frac{100}{23} \approx 4.35$ $\Rightarrow a = -\frac{23}{20} = -1.15$	M1 A1 A1		
			Alternative method: $u = 14,\ v = 9,\ s = 50$ Use of $v^2 = u^2 + 2as \Rightarrow 100a = 9^2 - 14^2$ $\Rightarrow a = -1.15$ Use of $v = u + at \Rightarrow t = \frac{5}{1.15} = 4.35$ **Alternative method:** $s =$ (Average velocity) $\times$ time $\Rightarrow 50 = \frac{9+14}{2}t \Rightarrow t = \frac{100}{23} = 4.35$ $\Rightarrow a = \frac{9-14}{4.35} = -1.15$	M1 A1 A1 M1 A1 A1	Use of at least one correct suvat formulae to get a or t www www Use of at least one correct suvat formulae to get a or t www www	Suvat formulae can be quoted without derivation Allow 1.15 if it is clear that a is the deceleration Correct suvat formula is $v^2 = u^2 + 2as,\ v = u + at, s = \frac{(u+v)}{2}t$
				[3]		

	(b)		$v = 14$	**B1**	Substitute $t = 10$	Or substitute $v = 14$ to give cubic in t and $t = 10$ shown to be a root The cubic is $t^3 - 15t^2 + 500 = 0$
				[1]		
	(c)		$v = \frac{1}{100}\left(15t^2 - t^3\right) + 9$ $\Rightarrow s = \frac{1}{100}\left(5t^3 - \frac{t^4}{4}\right) + 9t$ $\Rightarrow s = \frac{1}{100}\left(5000 - 2500\right) + 90$ $= 115$	**M1** **A1** **M1*** **A1**	Integrate - at least two powers increased by 1. Beware multiplying by t Ignore c **Dep** Substitute $t = 10$	M0 if 1/100 integrated Beware: suvat formulae will give 115
				[4]		
	(d)		$v = \frac{1}{100}\left(15t^2 - t^3\right) + 9$ $\Rightarrow a = \frac{1}{100}\left(30t - 3t^2\right)$ $\Rightarrow \frac{\mathrm{d}a}{\mathrm{d}t} = \frac{1}{100}\left(30 - 6t\right) = 0$ when $t = 5$ $\Rightarrow a = \frac{1}{100}\left(150 - 75\right) = 0.75$	**M1** **A1** **A1**	Differentiate twice	
			Alternative method: Differentiate once and use symmetry of quadratic or complete square Correct diffn and completed square or symmetry around 5 $a = 0.75$	**M1** **A1** **A1**	Symmetry must be stated	
				[3]		
	(e)		Distance between bumps = *their* 115 + 50 = 165 m	**B1**	**FT** their answer to (c)	
				[1]		

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