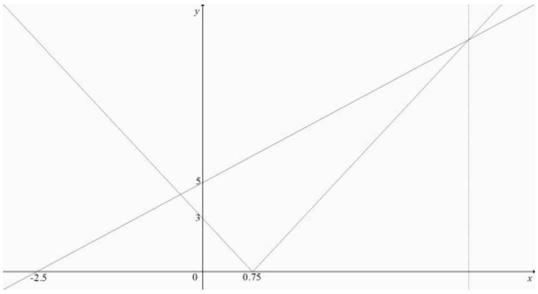
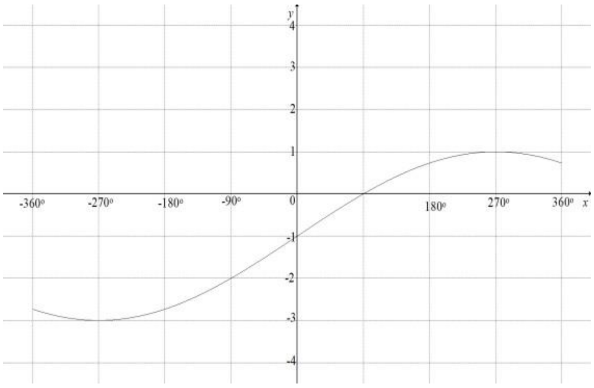
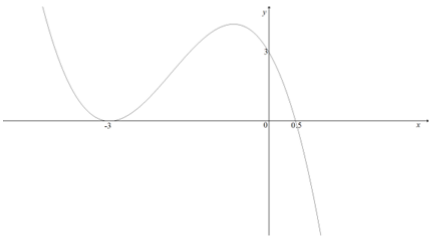
Question	Answer	Marks	Guidance
1(a)		3	**B1** for a V shaped graph with a vertex on the positive *x*-axis. **B1** for 0.75 and 3 marked correctly and **dependent** on first B1 **B1** for a straight line passing through −2.5 and 5 marked correctly, axis with a gradient such that there are two points of intersection. The second point of intersection may be implied.
1(b)	$4x-3<2x+5$ so $x<4$	**B1**	
	$2x+5>-4x+3$ so $x>-\frac{1}{3}$	**B1**	**nfww**
	$-\frac{1}{3}<x<4$	**B1**	Dependent on both B1 **SC2** for the values $-\frac{1}{3}$ and 4 without any or with wrong inequality signs **nfww**
	Alternative		
	$3x^2-11x-4<0$ or $=0$	**(M1)**	For squaring each side of the inequality and forming a 3-term quadratic. Allow multiples.
	$-\frac{1}{3}$, 4	**(A1)**	Critical values
	$-\frac{1}{3}<x<4$	**(A1)**	
2	Mid-point $\left(\frac{3}{2},-\frac{5}{6}\right)$	**B1**	Do not allow if unsimplified
	Gradient $=-\frac{1}{3}$	**B1**	Allow unsimplified
	$k+\frac{5}{6}=3\times\left(2-\frac{3}{2}\right)$ oe	**M1**	For attempt at perpendicular bisector **Must** be with *their* perpendicular gradient and *their* mid-point
	$k=\frac{2}{3}$	**A1**	

Question	Answer	Marks	Guidance
3		**4**	**B1** for a correct shape, starting in approximately correct places between –2 and -3 and finishing in approximately correct places between 0 and 1, having an amplitude of 2 and crossing the *x*-axis only once, on the positive *x*-axis. **B1** for a correct shape and $(0,\ -1)$ **B1** for a correct shape and a max and a min in approximately correct places. $\left(270^\circ, 1\right)$ and $\left(-270^\circ, -3\right)$ **B1** for a correct shape crosses at $\left(90^\circ, 0\right)$
4(a)	$\mathrm{P}\left(-\frac{1}{2}\right): -\frac{a}{8}+\frac{b}{4}-\frac{3}{2}+2=0$	**M1**	Allow one arithmetic error. **Must** be equated to 0 soi Allow unsimplified
	$\mathrm{P}(-1): -a+b-3+2=-6$	**M1**	Allow unsimplified **Must** be equated to -6 soi
	$-a+2b+4=0$ oe $-a+b+5=0$ oe	**A1**	For both allow unsimplified
	$a=6,\quad b=1$	**2**	**M1 dep** on at least one previous M1 for attempt to solve *their* simultaneous equations to find at least one of *their* unknowns. **A1** for both.
4(b)	$(2x+1)(3x^2-x+2)$	**2**	**M1** for correct attempt to obtain 2 terms of the quadratic for *their* P(*x*). Must divide by $(2x + 1)$ **A1** for correct quadratic $(3x^2-x+2)$
	For $3x^2-x+2$, the dicriminant is <0 so only one real root of $-\frac{1}{2}$ oe	**B1**	Must have a valid attempt to evaluate the discriminant.
5(a)(i)	30 240	**B1**	
5(a)(ii)	720	**B1**	the number of passwords with no symbols. Not part of a product
	29 520	**B1**	
5(a)(iii)	$(6\times5)\times6\times(4\times3)=2160$ oe	**2**	**B1** for (6×5) and (4×3) soi

Question	Answer	Marks	Guidance
5(b)	1 of each and 6 police officers = 20	**B1**	For ${}^4C_1 \times {}^5C_1 \times {}^6C_6$ must be evaluated, could be implied by a correct total
	2 of each and 4 police officers = 900	**B1**	For ${}^4C_2 \times {}^5C_2 \times {}^6C_4$ must be evaluated, could be implied by a correct total
	3 of each and 2 police officers = 600	**B1**	For ${}^4C_3 \times {}^5C_3 \times {}^6C_2$ must be evaluated, could be implied by a correct total
	4 of each and no police officers = 5	**B1**	For ${}^4C_4 \times {}^5C_4$ must be evaluated, could be implied by a correct total
	Total = 1525	**B1**	
6(a)	$\text{q}'(x) = -\frac{1}{3}(2(2x-1)(x+3)+2(x+3)^2)$ oe	**2**	**M1** for attempt to differentiate, allow one arithmetic slip. **A1** – allow unsimplified.
	$\left[\text{q}'(x) = -\frac{2}{3}\right](3x^2+11x+6)=0$ $x=-3$ and $x=-\frac{2}{3}$	**2**	**Dep M1** for equating *their* $\text{q}'(x)$ to zero and attempt to solve *their* 3-term quadratic to get two solutions for $x = \ldots$ **A1** for both x values correct **nfww**
6(b)		**3**	**B1** for correct cubic shape with maximum point in correct quadrant. **B1** for correct cubic shape touching at $(-3,\ 0)$ and passing through $(0.5, 0)$, intercepts must be marked. **B1** for correct cubic shape passing through $(0,\ 3)$ intercept must be marked.
6(c)	$k<0$	**B1**	Condone $y<0$
	$x=-\frac{2}{3},\ y=\frac{343}{81}$ or $y=4.23$	**M1**	For finding the value of y at *their* max point. If incorrect must see substitution of *their* $x=-\frac{2}{3}$ **nfww**
	$k>\frac{343}{81}$ or $k>4.23$	**A1**	Condone $y>\frac{343}{81}$ or $y>4.23$

Question	Answer	Marks	Guidance
7	$6\left(x^{\frac{1}{3}}\right)^2 - x^{\frac{1}{3}} - 2 = 0$ or $6m^2 - m - 2 = 0$ where $m = x^{\frac{1}{3}}$ oe	**B1**	
	$x^{\frac{1}{3}} = \frac{2}{3}$, $x^{\frac{1}{3}} = -\frac{1}{2}$ oe	**M1**	For attempt to solve 3-term quadratic equation in the form $6m^2 \pm m \pm 2 = 0$ and obtain $x^{\frac{1}{3}} =$.... or $m = ...$ from correct work only
	$x = \frac{8}{27}$, $x = -\frac{1}{8}$	**2**	**Dep M1** for dealing with the power of $\frac{1}{3}$ correctly at least once. **A1** for both
8	$(2x)^2 = 256x^{16}$ soi $n = 8$	**B1**	
	$\binom{8}{1}(2x^2)^7 \times \left(-\frac{1}{4x}\right) = ax^{13}$ oe leading to $a = -256$	**2**	**M1** for attempt at 2nd term with *their n* to find *a*, need to see one step to evaluate. Allow a sign error in simplifying but not missing in $-\frac{1}{4x}$
	$\binom{8}{2}(2x^2)^6\left(-\frac{1}{4x}\right)^2 = bx^c$ leading to $b = 112$	**2**	**M1** for attempt at 3rd term with *their n* to find *b*, need to see one step to evaluate. Allow a sign error but not missing in $\left(-\frac{1}{4x}\right)^2$
	$c = 10$	**B1**	Can be seen by observation.

Question	Answer	Marks	Guidance
9	$\left[\dfrac{dy}{dx}=\right]\dfrac{\frac{5}{3}(5x+2)^{-\frac{2}{3}}\times(x-1)^2-2(5x+2)^{\frac{1}{3}}(x-1)}{(x-1)^4}$ or $\left[\dfrac{dy}{dx}=\right]=\dfrac{5}{3}(5x+2)^{-\frac{2}{3}}\times(x-1)^{-2}+(5x+2)^{\frac{1}{3}}$ $\times-2\times(x-1)^{-3}$	3	**B1** for $\dfrac{5}{3}(5x+2)^{-\frac{2}{3}}$ **M1** for attempt at differentiation of a quotient or product. **A1** all other terms correct.
	$\dfrac{(5x+2)^{-\frac{2}{3}}}{3(x-1)^3}(5x-5-30x-12)$	M1	**Dep M1** for attempt to simplify by factorising $(5x+2)^{-\frac{2}{3}}$ or $(x-1)$ **nfww to the given form**, allow one arithmetic slip and/or one sign slip.
	$\dfrac{-(25x+17)}{3(x-1)^3(5x+2)^{\frac{2}{3}}}$	A1	Must be in correct form.

Question	Answer	Marks	Guidance
10	$40+20\theta=65$	*M1	
	$\theta=1.25$	A1	
	$\sin\left(\frac{their\ \theta}{2}\right)=\frac{\frac{1}{2}AB}{20}$ $AB=23.4$ or $\frac{1}{2}AB=11.7$	2	**Dep M1** for an attempt to find *AB* or $\frac{1}{2}AB$
	Either $\tan\left(\frac{their\ \theta}{2}\right)=\frac{\text{height of triangle } ACB}{their\ \frac{1}{2}AB}$ Height of triangle = 8.44 Area of triangle = 98.8	3	**DepM1** for a correct attempt to find the height of the triangle **M1** for attempt to find the area of the triangle using *their* height and *their AB* **A1** must be at least 3 significant figures.
	Or $\cos\left(\frac{their\ \theta}{2}\right)=\frac{their\ \frac{1}{2}AB}{AC}$ $AC=14.4$ Area of triangle $=\frac{1}{2}\times their\ AB\times their\ AC\times\sin\left(\frac{\theta}{2}\right)$ Area of triangle = 98.8	(3)	**DepM1** for a correct attempt to find *CA* **M1** for attempt to find the area of the triangle using the sine rule with *their CA*. **A1** must be at least 3 significant figures.
	Area of the segment $=\frac{1}{2}\times20^2\times(1.25-\sin1.25)$ Area of the segment = 60.2	B1	
	Area = 38.6	A1	

Question	Answer	Marks	Guidance
10	**Alternative 1**		
	$40+20\theta=65$	**(*M1)**	
	$\theta=1.25$	**(A1)**	
	$\tan\left(\frac{their\ \theta}{2}\right)=\frac{AC}{20}$ oe soi AC =14.43	**(2)**	**DepM1** for a correct attempt to find the AC
	Area of triangle ACO = $\frac{1}{2}\times20\times14.43=144.3$	**(2)**	**M1** for a correct attempt to find the area of the triangle using *their AC*
	Area of the sector = 250	**(B1)**	
	Area of half shaded region = (144.3 $-$ 125) $\times$ 2	**(M1)**	Dependent on a valid method for finding triangle ACO . Allow use of 144
	Area = 38.6	**(A1)**	
	Alternative 2		
	$40+20\theta=65$	**(*M1)**	
	$\theta=1.25$	**(A1)**	
	$\sin\left(\frac{their\ \theta}{2}\right)=\frac{\frac{1}{2}AB}{20}$ $AB=23.4$	**(2)**	**Dep M1** for an attempt to find AB or $\frac{1}{2}AB$
	$\tan\left(\frac{their\ \theta}{2}\right)=\frac{AC}{20}$ oe soi AC =14.43	**(2)**	**DepM1** for a correct attempt to find AC
	Shaded area $=14.4\times20-\frac{1}{2}\times20^2\times\frac{5}{4}$ Area = 38.6	**(3)**	**M1** for area of Kite **B1** for area of sector

Question	Answer	Marks	Guidance
10	**Alternative 3**		
	$40+20\theta=65$	**(*M1)**	
	$\theta=1.25$	**(A1)**	
	$\tan\left(\frac{their\ \theta}{2}\right)=\frac{AC}{20}$ oe soi $AC=14.43$	**(2)**	**DepM1** for a correct attempt to find *AC*
	Area of triangle *AOB* $=\frac{1}{2}\times 20^2\times\sin\ (their\ \theta)$ $=189.[7969...]$	**(M1)**	
	Area of triangle *ACB* $=\frac{1}{2}\times their\ AC\times their\ AB\times\sin\ \frac{\theta}{2}$ $=98.8$	**(M1)**	for a correct attempt to find the area of the triangle using *their AC* and *their AB*
	Area of the sector = 250	**(B1)**	
	Area of half shaded region = area of triangle *ACB* + area of triangle *AOB* – area of sector = 189.8 + 98.8 – 250	**(M1)**	
	Area = 38.6	**(A1)**	

Question	Answer	Marks	Guidance
10	**Alternative 4**		
	$40+20\theta=65$	**(*M1)**	
	$\theta=1.25$	**(A1)**	
	$\sin\left(\frac{their\ \theta}{2}\right)=\frac{\frac{1}{2}AB}{20}$ $AB=23.4$ or $\frac{1}{2}AB=11.7$	**(2)**	**Dep M1** for an attempt to find AB or $\frac{1}{2}AB$
	$\tan\left(\frac{their\ \theta}{2}\right)=\frac{\text{height of triangle } ACB}{their\ \frac{1}{2}AB}$ Height of triangle = 8.44	**(M1)**	**DepM1** for a correct attempt to find the height of the triangle
	Height of triangle ABO $=\sqrt{20^2-\left(\frac{1}{2}AB\right)^2}$ $=16.22$	**(M1)**	for a correct attempt to find to find the height of the triangle
	Area of the sector = 250	**(B1)**	
	Area of kite $=\frac{1}{2}\times 23.4\times(16.22+8.44)$ $=288.5$	**(M1)**	
	Area = 288.5 $-$250 =38.5	**(A1)**	
11(a)	$\overrightarrow{XY}=-\overrightarrow{OX}+\mathbf{a}+\frac{1}{3}\overrightarrow{AB}$ oe soi or $\overrightarrow{XY}=\overrightarrow{XB}-\frac{2}{3}\overrightarrow{AB}$ oe soi	**M1**	
	$\overrightarrow{XY}=-\frac{4}{5}\mathbf{b}+\mathbf{a}+\frac{1}{3}(\mathbf{b}-\mathbf{a})$ oe soi or $\overrightarrow{XY}=\frac{1}{5}\mathbf{b}+\frac{2}{3}(\mathbf{a}-\mathbf{b})$ oe soi	**M1**	For $\pm\frac{1}{3}(\mathbf{b}-\mathbf{a})$ or $\pm\frac{4}{5}\mathbf{b}$ For $\pm\frac{1}{5}\mathbf{b}$ or $\pm\frac{2}{3}(\mathbf{a}-\mathbf{b})$
	$\overrightarrow{XY}=\frac{2}{3}\mathbf{a}-\frac{7}{15}\mathbf{b}$ cao	**A1**	**AG**
11(b)	$\overrightarrow{YZ}=\lambda\left(\frac{2}{3}\mathbf{a}-\frac{7}{15}\mathbf{b}\right)$ cao	**B1**	

Question	Answer	Marks	Guidance
11(c)	$\overrightarrow{YZ} = \mu\mathbf{a} - \frac{1}{3}\overrightarrow{AB}$ oe soi	**M1**	
	$\overrightarrow{YZ} = \mu\mathbf{a} - \frac{1}{3}(\mathbf{b} - \mathbf{a})$ oe	**A1**	Allow unsimplified ISW from correct answer
11(d)	$\mu\mathbf{a} - \frac{1}{3}(\mathbf{b} - \mathbf{a}) = \lambda\left(\frac{2}{3}\mathbf{a} - \frac{7}{15}\mathbf{b}\right)$ soi	**M1**	For equating *their* (b) and *their* (c) **and** attempt to equate coefficients of **a** or **b** at least once.
	$\lambda = \frac{5}{7}$	**A1**	**nfww**
	$\mu = \frac{1}{7}$	**A1**	**nfww**
12	$\sin\left(\frac{2x}{3} - \frac{\pi}{3}\right) = \pm\frac{\sqrt{3}}{2}$ or $\tan\left(\frac{2x}{3} - \frac{\pi}{3}\right) = \pm\sqrt{3}$	**B1**	Allow if $\pm$ is missing
	$x = \pi, \frac{3\pi}{2}, \frac{5\pi}{2}, 3\pi$	**4**	**M1dep** on **B1** for obtaining $\frac{2x}{3} - \frac{\pi}{3} = \frac{\pi}{3}$ or any valid value **A1** for one correct solution **A1** for a 2nd correct solution **A1** for a 3rd and 4th correct solutions and no extras in the range