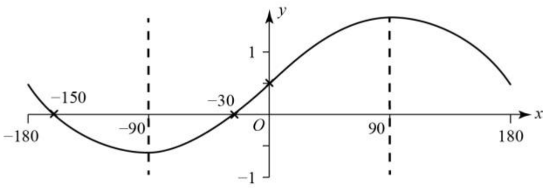
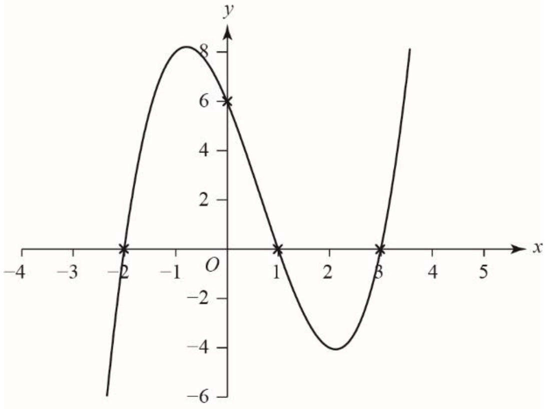
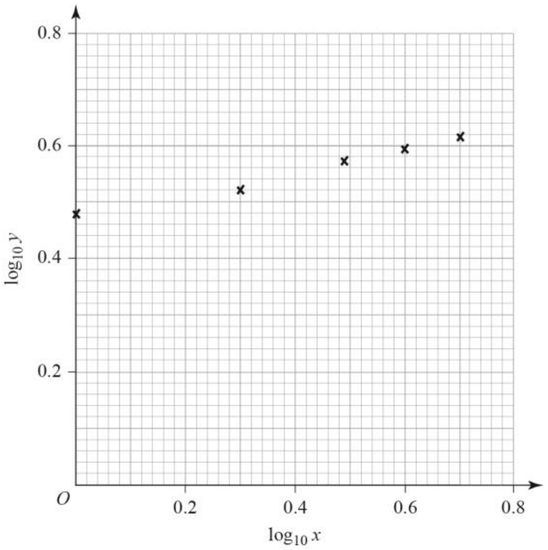
Q	Answer	Mark	Comments
1	Gradient = $-\frac{1}{2}$	B1	
	$y-7=-\frac{1}{2}\left(x-4\right)$	M1	Substituting "their" value for the gradient into the equation $y-y_1=m(x-x_1)$
	$y=-\frac{1}{2}x+9$	A1	Equation correct, in this or equivalent form
2	Stretch;	B1	
	Parallel to *y*-axis;	B1	Accept 'vertical stretch'
	Scale factor 2	B1	
3 a	$2^x=\left(2^3\right)^{3x-1}$	B1	
	$x=3(3x-1)$	M1	Attempt at an equation in *x* using index laws or taking logs on both sides
	$x=\frac{3}{8}$	A1	
b	$\log\left(\frac{x\times x^2}{x^{\frac{1}{2}}}\right)$ **or** $\log x+2\log x-\frac{1}{2}\log x$	M1	Apply either $\log a+\log b-\log c=\log\left(\frac{ab}{c}\right)$ **or** $\log a^k=k\log a$ for each term
	$\log\left(x^{\frac{5}{2}}\right)$ **or** $\frac{5}{2}\log x$	M1	Use laws of indices **or** Collect up like terms (this scores both M1 & A1 marks)
	$\frac{5}{2}\log x$	A1	Apply $\log a^k=k\log a$ and express as single logarithm in $\log x$

4	Gradient PR × Gradient QR $= -1$	M1	Use of $m_1 \times m_2 = -1$ for perpendicular lines
	$\frac{4}{8} \times \frac{3-k}{2} = -1 \Rightarrow k = 7$	A1	
	PQ is the diameter of the circle, since angle subtended at circumference is 90°		
	Centre of circle is at midpoint of PQ: (2, 3)	B1	Correct deduction; leading to correct method to find radius
	$r^2 = (5-2)^2 + (7-3)^2$		
	$r = 5$	M1	Correctly calculating the radius
	Area of circle: $\pi r^2 = 25\pi$	A1	Accept decimal form
5	$\frac{\mathrm{d}y}{\mathrm{d}x} = 2x - 3$	M1 A1	Attempt at differentiating equation of C Correct expression obtained for derivative
	At $x = 2$, $m = 2(2) - 3 = 1$	M1	Use of derivative to find gradient of tangent at $x = 2$
	$y = 0$ at $x = 2$ $y = x - 2$	B1 A1	Evaluate y at $x = 2$
6	$(1 - \cos^2 x) - 3\cos x + 2 = 0$	M1	Use of identity
	$\cos^2 x + 3\cos x - 3 = 0$	A1	Three term quadratic in cos x
	$\cos x = \frac{-3 \pm \sqrt{3^2 - 4(1)(-3)}}{2} = \frac{-3 \pm \sqrt{21}}{2}$	M1 A1	
	$\cos x = 0.7913$ or –3.7913 (reject)	A1	
	x = 37.7° or 322.3°	A1	
7 a	$1^8 + {}^8C_1(1)^7(2x)^1 + {}^8C_2(1)^6(2x)^2 + {}^8C_3(1)^5(2x)^3$	M1	Uses binomial theorem to expand bracket
	$1 + 16x + 112x^2 + 448x^3$	A1 A1	$1 + 16x$ Completely correct
b	$1 + 16(0.01) + 112(0.01)^2 + 448(0.01)^3$	B1 M1	Selects $x = 0.01$ Substitute "their" chosen value of x into **a**
	1.171648	A1	

8 **a** **b**	$p-6=14$ so $p=20$ $q-5=-7$ so $q=-2$ $\lvert AB\rvert=\sqrt{14^2+(-7)^2}=\sqrt{245}$ $\theta=\tan^{-1}\left(-\frac{7}{14}\right)=-26.6°$	B1 B1 M1 A1 M1 A1
9	$\frac{1-\cos\theta}{\sin\theta}\times\frac{1+\cos\theta}{1+\cos\theta}$ $\equiv\frac{1-\cos^2\theta}{\sin\theta(1+\cos\theta)}$ $\equiv\frac{\sin^2\theta}{\sin\theta(1+\cos\theta)}$ $\equiv\frac{\sin\theta}{1+\cos\theta}$ **Alternatively:** $\frac{1-\cos\theta}{\sin\theta}\times\frac{\sin\theta}{\sin\theta}$ $\equiv\frac{(1-\cos\theta)\sin\theta}{\sin^2\theta}$ $\equiv\frac{(1-\cos\theta)\sin\theta}{(1-\cos^2\theta)}$ $\equiv\frac{(1-\cos\theta)\sin\theta}{(1-\cos\theta)(1+\cos\theta)}$ $\equiv\frac{\sin\theta}{1+\cos\theta}$	M1 Attempt at product M1 Use of $\sin^2\theta=1-\cos^2\theta$ A1 R1 A completely correct argument which is clear and easy to follow M1 Attempt at product M1 Use of $\sin^2\theta=1-\cos^2\theta$ A1 R1 A completely correct argument which is clear and easy to follow
10	$(-4k)^2-4(1)(2k)>0$ $16k^2-8k>0$ $8k(2k-1)>0$ $k=0$ or $\frac{1}{2}$ $k<0,\ k>\frac{1}{2}$	M1 States that discriminant > 0 for real and distinct roots M1 Attempt to solve A1 Critical values stated A1 Correct regions identified (both required) Accept $k<0$ **or** $k>\frac{1}{2}$ but not '**and**'

11 a		B1	Correct shape of graph
		B1	Coordinates of max/min points and axes interceptions all marked correctly
b	two solutions	B1	
	the graph of $y = 0.5 + \sin x$ cuts the line $y = 1$ twice when $-180° \leq x \leq 180°$	B1	Explanation
12 a	$\text{f}(1) = 1 - 2 - 5 + 6 = 0$	M1	Use of Factor Theorem with $x = 1$
		A1	Expression evaluated to show $\text{f}(1) = 0$
		(OR	M1 A1 Long division and explanation that no remainder $\Rightarrow (x-1)$ is a factor)
	$\begin{array}{r} x^2 - x - 6 \\ (x-1)\overline{\smash{)}x^3 - 2x^2 - 5x + 6} \end{array}$	M1	Long division **or** inspection **or** comparing coefficients **or** further application of the factor theorem
	$\text{f}(x) = (x-1)(x^2 - x - 6)$	M1	Express as product of linear factor and three-term quadratic
	$\text{f}(x) = (x-1)(x-3)(x+2)$	A1	Correct factors
	$x = 3$ or $x = -2$		
b		B1	Correct shape of graph
		B1	Co-ordinates of axes intersections marked
c	$\frac{\text{d}y}{\text{d}x} = 3x^2 - 4x - 5$	M1	Use of $\frac{\text{d}y}{\text{d}x}$ with one of these terms correct
		A1	All correct and nothing extra
	$3x^2 - 4x - 5 = 0$	M1	Equating “their” $\frac{\text{d}y}{\text{d}x}$ to 0
	$x = \frac{-(-4) \pm \sqrt{(-4)^2 - 4(3)(-5)}}{3(2)} = \frac{4 \pm \sqrt{76}}{6}$	M1	Use of quadratic formula **or** completing

			the square
	$x=\dfrac{2\pm\sqrt{19}}{3}$	A1	
13 a	$\mathrm{f}\left(x\right)=\int \mathrm{f}'\left(x\right)\,\mathrm{d}x=\int x^{\frac{1}{2}}-3x^{2}+1\,\mathrm{d}x$	M1	Attempt at integrating $\mathrm{f}'\left(x\right)$
	$\mathrm{f}\left(x\right)=\dfrac{2}{3}x^{\frac{3}{2}}-x^{3}+x+c$	A1 A1 B1	Two terms correct All three terms correct Inclusion of $+\,c$
b	$2=\dfrac{2}{3}\times 1^{\frac{2}{3}}-1^{3}+1+c$	M1	Correct substitution of $\left(1,\ 2\right)$
	$c=\dfrac{4}{3}$	A1	
	$q=\dfrac{2}{3}\times 4^{\frac{3}{2}}-4^{3}+4+\dfrac{4}{3}=-53\dfrac{1}{3}$	M1 A1	
14 a		M1	Points plotted correctly
	3.346	A1	
	$\left(\log 2,\ \log 3.346\right)$ doesn't follow a straight line relationship with the other points	B1	Explanation of why 3.346 is incorrect
b	$\log y=\log a+b\log x$	M1	Use of correct log relationship
	$\log a=0.48$ so $a=3.0$ (2 s.f.)	A1	
	$b=\dfrac{\log 4.139-\log 3}{\log 5-\log 1}=0.20$ (2 s.f.)	M1	Calculation of gradient. Accept ± 0.01
	$y=3.0\times x^{0.20}$	A1	*a* and *b* given to 2 s.f. Award mark for correct follow thro of acceptable gradient value calculated above

15	$AC^2 = 125^2 + 158^2 - 2\times 125\times 158\times \cos 80°$	M1	Use of cosine rule with correct lengths
	$AC = 183.66\text{ m}$	A1	
	$\dfrac{\sin 31°}{110} = \dfrac{\sin CBA}{(\text{"their" AC})}$	M1	Use of sine rule to find *CBA*
	Angle $CBA = 59.3°$	A1	
	Angle $BCA = 180 - 31 - 59.3 = 89.7°$	A1	
	$\text{Area} = \frac{1}{2}AD\times DC\times \sin ADC$ $+\frac{1}{2}AC\times BC\times \sin BCA$	M1	Use of $\text{Area} = \frac{1}{2}ab\sin C$ for both triangles
	$= \frac{1}{2}\times 125\times 158\times \sin 80°$ $+\frac{1}{2}\times(\text{"their" } AC)\times 110\times \sin(\text{"their"} BCA)$ $= 9725 + 10\,101$	M1	Correct substitution
	$= 19\,826\text{ m}^2$	A1	
16	$\frac{1}{2}\times 5\times 9\times \sin\alpha = 10$	M1	Uses $\text{Area} = \frac{1}{2}ab\sin C$ for half of kite
	$\sin\alpha = \frac{4}{9}$	A1	Finds value of $\sin\alpha$
	For acute α, $\sin\alpha = \frac{4}{9} \Rightarrow \cos\alpha = \frac{\sqrt{65}}{9}$	M1	Attempt to find $\cos\alpha$
	But, since α is the largest interior angle in the kite, it must be obtuse.	R1	Logical reasoning explained to deduce that α is obtuse
	Therefore $\cos\alpha = -\frac{\sqrt{65}}{9}$	R1	Conclusion with reference to obtuse α
17	If n is odd, it is of the form $n = 2m+1$	B1	Correct form for n
	$n^2 + n = (2m+1)^2 + (2m+1)$ $= 4m^2 + 6m + 2$ $= 2(2m^2 + 3m + 1)$	M1	Attempt to expand using “their” n. At least two terms correct.
	which is a multiple of two and hence $n^2 + n$ is even.	R1	Full reasoning must be given

18	Philomena has cancelled through by *x*. She cannot do this as *x* may take the value 0. Instead, she should factorise *x*. $x(x-3)=0$ so $x=0$ or $x=3$	R1 B1
19	$\mathrm{f}'(x)<0$ for all values of $x \Rightarrow \mathrm{f}(x)$ is a decreasing function $\mathrm{f}'(x)=-5+4x-3x^2$ $\mathrm{f}'(x)=-3\left(x-\frac{2}{3}\right)^2-9$ Since $\left(x-\frac{2}{3}\right)^2>0$ for all *x*, so $\mathrm{f}'(x)<0$ for all *x* Hence, $\mathrm{f}(x)$ is a decreasing function	R1 Condition for decreasing stated M1 Finds $\mathrm{f}'(x)$; at least two terms correct A1 All terms correct M1 Method to show $\mathrm{f}'(x)<0$ A1 Correctly deduces $\mathrm{f}'(x)<0$ R1 Complete rigorous proof with no errors