MARK SCHEME NOTES

The following notes are intended to aid interpretation of mark schemes in general, but individual mark schemes may include marks awarded for specific reasons outside the scope of these notes.

Types of mark

M Method marks, awarded for a valid method applied to the problem.

A Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. For accuracy marks to be given, the associated Method mark must be earned or implied.

B Mark for a correct result or statement independent of Method marks.

When a part of a question has two or more 'method' steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. The notation '**dep**' is used to indicate that a particular M or B mark is dependent on an earlier mark in the scheme.

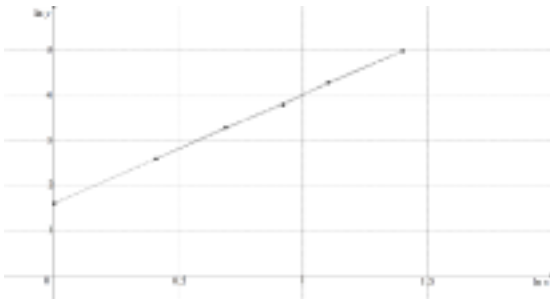
Abbreviations

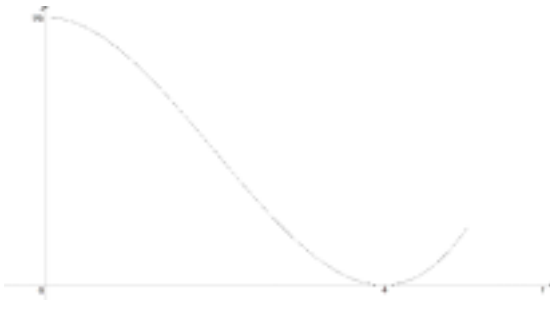
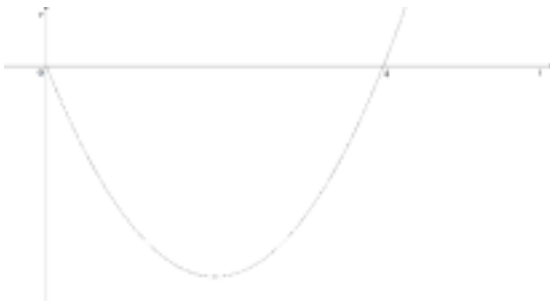
awrt answers which round to
cao correct answer only
dep dependent
FT follow through after error
isw ignore subsequent working
nfww not from wrong working
oe or equivalent
rot rounded or truncated
SC Special Case
soi seen or implied

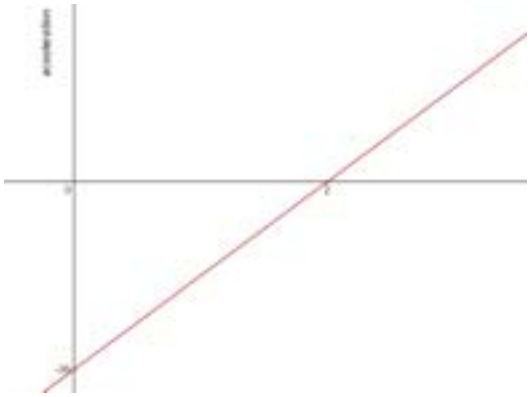
Question	Answer	Marks	Guidance
1(a)	2π	**B1**	
1(b)		**3**	**B1** for the correct shape, must be tending correctly towards the asymptotes **B1** for $(0,\ -3)$ **B1** for $\left(\frac{\pi}{2},\ 0\right)$
2(a)	$2\left(x+\frac{5}{4}\right)^2-\frac{1}{8}$ oe	**2**	**B1** for $2\left(x+\frac{5}{4}\right)^2$ **B1** for $-\frac{1}{8}$
2(b)	$\left(-\frac{5}{4},\ -\frac{1}{8}\right)$ oe	**2**	**B1 FT** for each on *their* (a).

Question	Answer	Marks	Guidance
2(c)	Use of *their* (a) or expansion to 3 term quadratic (= 0), to obtain two critical values.	**M1**	
	$-\frac{9}{4}$, $-\frac{1}{4}$	**A1**	For both critical values
	$-\frac{9}{4} < x < -\frac{1}{4}$	**A1**	
3(a)	$\lg\frac{500a^2}{b}$ oe	**3**	**B1** for $\lg a^2$, $-\lg 2b$ or $\lg 1000$ **B2** for $\lg\frac{a^2}{2b}$, $\lg 1000a^2$ or $\lg\frac{1000}{2b}$
3(b)	$\log_3 c = \frac{1}{\log_c 3}$	**B1**	
	$2(\log_c 3)^2 - 7\log_c 3 - 4 \ (=0)$ $(2\log_c 3 + 1)(\log_c 3 - 4) \ (=0)$ $\log_c 3 = -\frac{1}{2}$, $\log_c 3 = 4$	**M1**	Attempt to obtain a 3 term quadratic equation (= 0) and attempt to solve to obtain $\log_c 3 = ...$ Allow one sign error
	$c^{-\frac{1}{2}} = 3$ $c^4 = 3$	**M1**	**Dep** for attempt to solve at least one of *their* log equations
	$c = \frac{1}{9}$, $c = 3^{\frac{1}{4}}$ or exact equivalents	**2**	**A1** for each
	Alternative Method		
	$\log_c 3 = \frac{1}{\log_3 c}$	**B1**	
	$4(\log_3 c)^2 + 7\log_3 c - 2 \ (=0)$ $(4\log_3 c - 1)(\log_3 c + 2) \ (=0)$ $\log_3 c = \frac{1}{4}$, $\log_3 c = -2$	**M1**	Attempt to obtain a 3 term quadratic equation = 0 and attempt to solve to obtain $\log_3 c = ...$ Allow one sign error
	$c = 3^{\frac{1}{4}}$, c $= \frac{1}{9}$ or exact equivalents	**3**	**M1 dep** for attempt to solve at least one of *their* log equations. **A2** for both or **A1** for either

Question	Answer	Marks	Guidance
4	$5x^2-8x-4\ \ (=0)$ or $5y^2-36y-305\ \ (=0)$	**M1**	For attempt to eliminate one variable to obtain a 3 term quadratic equation (= 0). Allow one sign error.
	$x=-\frac{2}{5},\ x=2$ $y=-\frac{61}{5},\ y=-5$	**3**	**Dep M1** for attempt to solve *their* quadratic equation **A1** for any correct pair **A1** for a second correct pair.
	Mid-point $\left(\frac{4}{5},\ -\frac{43}{5}\right)$	**M1**	For attempt to find mid-point using *their* coordinates
	Gradient of perpendicular = $-\frac{1}{3}$	**B1**	
	$y+\frac{43}{5}=-\frac{1}{3}\left(x-\frac{4}{5}\right)$	**M1**	For attempt to find the equation of the perpendicular bisector using *their* perpendicular gradient and *their* midpoint. Allow alternative methods
	$a=-1$	**A1**	
5(a)	$x^{20}-40x^{16}+720x^{12}$	**3**	**B1** for each correct term
5(b)	$\left(x^4+4+\frac{4}{x^4}\right)$	**B1**	Allow unsimplified
	$\left(4\times their\ -40\right)+4+their720$ soi	**M1**	Must have 3 terms
	564	**A1**	
6(a)	$\frac{1}{2}r^2\theta=25$ $\theta=\frac{50}{r^2}$	**B1**	
	$P=2r+\frac{50}{r}$	**2**	**M1** for use of $P=2r+r\theta$ with attempt to eliminate θ

Question	Answer	Marks	Guidance
6(b)	$\frac{dP}{dr} = 2 - \frac{50}{r^2}$	**M1**	For attempt to differentiate *their P*, must be in terms of *r*.
	When $\frac{dP}{dr} = 0,\ r = 5$	**A1**	
	$\frac{d^2P}{dr^2} = \frac{100}{r^3}$ When $r = 5,\ \frac{d^2P}{dr^2}$ is positive so a minimum oe.	**B1**	Allow alternative valid methods
	Minimum $P = 20$	**A1**	
7(a)	<table><tr><td>ln *x*</td><td>0.41</td><td>0.69</td><td>0.92</td><td>1.1</td><td>1.4</td></tr><tr><td>ln *y*</td><td>2.6</td><td>3.3</td><td>3.8</td><td>4.3</td><td>5</td></tr></table> 	**3**	**M1** for attempt to find ln values of all and plotting the graph. **A1** for 4 correct points. **A0** for fewer than 4 correct points.
7(b)	$\ln y = \ln A + b \ln x$ soi	**B1**	Allow if seen in (a)
	Gradient = $b = 2.4$ Allow 2.3 to 2.5	**2**	**Dep M1** for attempt to find the gradient of *their* graph, must have **M1** in part(a) Must be using points on *their* graph.
	$\ln A = 1.6$ $A = 5$ Allow awrt 4.8 to awrt 5.5	**2**	**Dep M1** for attempt to find the intercept on the vertical axis and equate to ln *A*. must have **M1** in part (a).
7(c)	$x = 3.42$ Allow 3.2 to 3.5	**2**	**M1** for a correct attempt to find the estimate either using *their* graph or *their* equation.
8(a)	**b** – **a**	**B1**	

Question	Answer	Marks	Guidance
8(b)	$\frac{2}{5}\mathbf{a}+\frac{1}{2}\left(their\ \left(\mathbf{b}-\mathbf{a}\right)\right)$ soi oe	**M1**	
	$\frac{1}{2}\mathbf{b}-\frac{1}{10}\mathbf{a}$	**A1**	Allow unsimplified
8(c)	$\left(\lambda+1\right)\times\left(\frac{1}{2}\mathbf{b}-\frac{1}{10}\mathbf{a}\right)$ oe	**2**	**M1** for $\left(\lambda+1\right)\times their\left(\frac{1}{2}\mathbf{b}-\frac{1}{10}\mathbf{a}\right)$ **A1** allow unsimplified
8(d)	$-\frac{3}{5}\mathbf{a}+\left(\mu+1\right)\mathbf{b}$ oe	**2**	**B1** for each vector, allow unsimplified.
8(e)	$\left(\lambda+1\right)\times\left(\frac{1}{2}\mathbf{b}-\frac{1}{10}\mathbf{a}\right)=-\frac{3}{5}\mathbf{a}+\left(\mu+1\right)\mathbf{b}$ $\lambda=5$ $\mu=2$	**3**	**M1** for equating $\left(\lambda+1\right)\times their\left(\frac{1}{2}\mathbf{b}-\frac{1}{10}\mathbf{a}\right)$ and *their* $-\frac{3}{5}\mathbf{a}+\left(\mu+1\right)\mathbf{b}$ **and** then equating like vectors at least once. **A1** for each.
9(a)	$v=9t\left(t-4\right)$ oe	**2**	**M1** for correct attempt to differentiate, allow one arithmetic error.
	$t=0,\ t=4$	**2**	**Dep M1** for equating *their v* to zero and attempt to solve. **A1** for both.
9(b)		**3**	**B1** for correct cubic curve for given domain **B1** for $\left(0,\ 96\right)$ and no other intercept on the *y*-axis **B1** for touching at $\left(4,\ 0\right)$ and no other intercept on the *x*-axis
9(c)		**2**	**B1** for a correct quadratic curve for the given domain, starting from the origin. **B1** for $\left(4,\ 0\right)$ and no other *x*- intercept
9(d)(i)	$18t-36$	**B1**	

Question	Answer	Marks	Guidance
9(d)(ii)		**2**	**B1** for a correctly positioned straight line graph for the given domain. **Dep B1** for $(0,-36)$ and $(2,\ 0)$
10(a)	$\cos^4\theta-\sin^4\theta=$ $\left(\cos^2\theta-\sin^2\theta\right)\left(\cos^2\theta+\sin^2\theta\right)$ soi	**B1**	
	$\cos^2\theta-\sin^2\theta+1$	**M1**	Must show sufficient detail to show the given result.
	$2\cos^2\theta$	**A1**	
	Alternative 1		
	$\cos^4\theta-\left(1-\cos^2\theta\right)^2+1$	**(B1)**	
	$\cos^4\theta-\left(\cos^4\theta-2\cos^2\theta+1\right)+1$	**(M1)**	Must show sufficient detail to show the given result.
	$2\cos^2\theta$	**(A1)**	
	Alternative 2		
	$\left(1-\sin^2\theta\right)^2-\sin^2\theta+1$	**(B1)**	
	$\left(1-2\sin^2\theta+\sin^4\theta\right)-\sin^4\theta+1$ $2-2\sin^2\theta$	**(M1)**	Must show sufficient detail to show the given result.
	$2\cos^2\theta$	**(A1)**	
10(b)	$\cos\left(\frac{\phi}{3}\right)=(\pm)\frac{1}{2}$ soi	**B1**	
	$\phi=-2\pi,\ -\pi,\ \pi,\ 2\pi$	**4**	**M1** for obtaining one correct solution. **A1** for obtaining 2 correct solutions. **A1** for obtaining a third correct solution. **A1** for a fourth correct solution and no extras within the range.