Question	Answer	Marks	Partial Marks	Guidance
1	Solve the equation $10^{2x+1} - 80(10^x) = -70$.			
1	$10^{2x}.10 - 80(10^x) = -70$	**6**	**M1**	For splitting
	Let u = 10^x		**M1**	For substitution
	$u^2 - 8u + 7 = 0$		**M1**	For quadratic equation. Accept $10u^2 - 80u + 70 = 0$ [**M2** for $(10^x)^2 - 8(10^x) + 7 = 0$ *if there is no subsitution used*]
	$(u-7)(u-1) = 0$ $u = 7$ or $u = 1$		**M1**	For u or 10^x values
	$x = \lg 7$ or $x = 0$ $x = 0.845$ (3 sf) or $x = 0$		**A2**	Accept 0.84509804. Reject lg 7

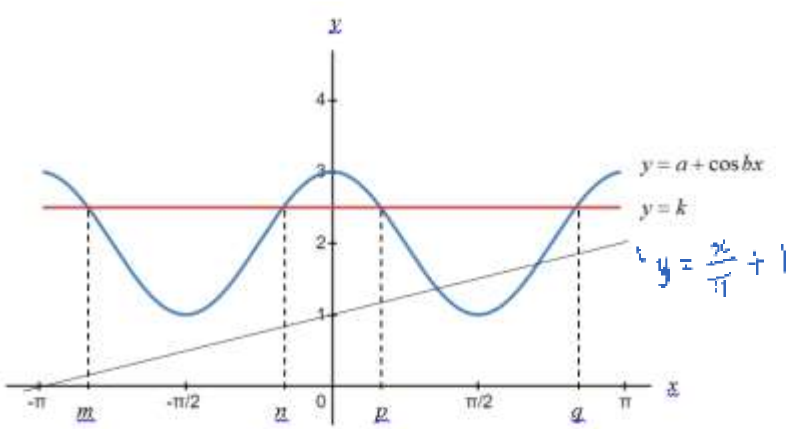
Question	Answer	Marks	Partial Marks	Guidance
2	$f(x) = x^2 - 5x + 7$			
2(i)	$b^2 - 5b + 7 = c^2 - 5c + 7$	**3**	**M1**	f(b) = f(c) or f(b)– f(c) = 0 or f(c) – f(b)=0
	$(b-c)(b+c) = 5(b-c)$		**M1**	For factorisation
	Since $b \neq c$, $b - c \neq 0$ Therefore $b + c = 5$ (shown)		**A1**	For conclusion
2(ii)	$b = 5 - c$ $4(5-c)(c) = 21$	**4**	**M1**	For substitution
	$(2c-3)(2c-7) = 0$		**M1**	
	$c = 1.5$ or $c = 3.5$ $b = 3.5$ or $b = 1.5$		**M1**	Reject pre-mature rejection of values

	Since $b > c$, $b = 3.5$ and $c = 1.5$		**A1**	Accept fractions

Question	Answer	Marks	Partial Marks	Guidance
3(i)	$\left(3-\frac{x}{2}\right)^8$ $= 3^8 + (8\ 1)3^7\left(-\frac{x}{2}\right)^1 + (8\ 2)3^6\left(-\frac{x}{2}\right)^2 + (8\ 3)3^5\left(-\frac{x}{2}\right)^3 + \cdots$	**3**	**M1**	For expansion
	$= 6561 - 8748x + 5103x^2 - 1701x^3 + \cdots$		**A2**	For 4 terms [**A1** for 2-3 terms; A0 if 0-1 term correct.]
3(ii)	$\left(x-\frac{5}{x}\right)^2\left(3-\frac{x}{2}\right)^8$ $= \left(x^2 - 10 + \frac{25}{x^2}\right)(6561 - 8748x + 5103x^2 - 1701x^3 + \cdots)$	**3**	**M1**	Expansion of $\left(x-\frac{5}{x}\right)^2 = x^2 - 10 + \frac{25}{x^2}$
	$= \ldots + 87480x - 42525x + \ldots$ $= \ldots + 44955x + \ldots$		**M1**√	√ For overall expansion if expansion of $\left(x-\frac{5}{x}\right)^2$
	Coefficient of x = 44955		**A1**	Reject 44955x

Question	Answer	Marks	Partial Marks	Guidance
4(i)	$M = 24e^{-kt}$ When $t = 0$, $M = 24\ g$ When $t = 35$, $M = 12\ g$	**3**	**M1**	For M = 12 g
	$e^{-k(35)} = \frac{1}{2}$ or $e^{k(35)} = 2$ $-35\ k = ln\frac{1}{2}$ or $35\ k = ln\ 2$		**M1**	For isolating e or taking ln
	$k = 0.0198042 = 0.0198$ (3 s f)		**A1**	Reject $k = -\frac{1}{35}\ ln\frac{1}{2}$ or $\frac{1}{35}\ ln\ ln\ 2$ or0.020 Accept 0.01980

4(ii)	$M = 24e^{-0.0198042(365)}$	**2**	**M1√**	Accept t = 366 days , √ **for k**
	= 0.017414028 = 0.0174 g (3 s f)		**A1**	
Question	Answer	Marks	Partial Marks	Guidance
5	$y = \frac{3x}{2x-3},\ x \neq 1.5$			
5(i)	$\frac{dy}{dx} = \frac{(2x-3)(3) - 3x(2)}{(2x-3)^2}$	**5**	**M1**	For Quotient or Product Rule applied correctly
	$= \frac{-9}{(2x-3)^2} = \frac{-9}{4}$		**M1√**	√ for equating $\frac{dy}{dx}$ to gradient of tangent
	x = 2.5 or x = 0.5		**A1√**	√ for both x values
	y = 3.75 or y = -0.75		**A1√**	√ for both y values
	Points are (2.5, 3.75) and (0.5, -0.75)		**A1**	For both points
5(ii)	$\frac{dy}{dx} = \frac{-9}{(2x-3)^2}$	**2**		
	Since $(2x-3)^2 > 0, x \neq 1.5$ $\frac{-9}{(2x-3)^2} < 0$		**M1**	Reject using one/two values of x to show $\frac{dy}{dx} < 0.$
	Curve is a <u>decreasing</u> function as $\frac{dy}{dx} < 0.$		**A1√**	√ For correct conclusion $\frac{dy}{dx} < 0$ *or implied knowledge* $\frac{dy}{dx} < 0$.

Question	Answer	Marks	Partial Marks	Guidance
6(i)	$a = 2$	**2**	**B1**	
	$b = 2$		**B1**	
6(ii)	$m = -\pi + p$	**1**	**B1**	
6(iii)	$k < 1, k > 3$	**1**	**B1**	
6(iv)	$x - \pi \cos\cos bx = \pi a - \pi$ $\frac{x}{\pi} + 1 = a + \cos\cos bx$	**3**	**M1**	
	By adding/drawing the straight line $y = \frac{x}{\pi} + 1$ 		**A1√**	√ for correctly plotted the line
	Number of solutions = 2		**A1√**	√ implied from the graph

Question	Answer	Marks	Partial Marks	Guidance
7(i)	$y = e^x(\cos x - \sin x)$ $\frac{dy}{dx} = e^x(-sin\ x - cos\ x) + (cos\ cos\ x - sin\ x)\ e^x$	**2**	**M1**	For either one term correct
	$= -2e^x\ sin\ sin\ x$ (shown)		**A1**	
7(ii)	$\int_0^{\frac{\pi}{3}} e^x\ sin\ sin\ x\ \ dx = -\frac{1}{2}[e^x(cos\ cos\ x - sin\ x)]_0^{\frac{\pi}{3}}$	**4**	**M1**	
	$= -\frac{1}{2}[e^{\frac{\pi}{3}}(cos\ cos\ \frac{\pi}{3} - sin\ \frac{\pi}{3}) - e^0(cos\ cos\ 0 - sin\ sin\ 0\ )\ ]$		**M1√**	√ for substitution of boundary values
	$= -\frac{1}{2}[e^{\frac{\pi}{3}}\left(\frac{1}{2} - \frac{\sqrt{3}}{2}\right) - (1)]$			
	$= \left(\frac{\sqrt{3}-1}{4}\right)e^{\frac{\pi}{3}} + \frac{1}{2}$			
	$a = 1,\ b = \frac{1}{2}$		**A2**	Answers given correctly

Question	Answer	Marks	Partial Marks	Guidance
8	$y=\frac{x^2}{9}+\frac{x}{6}+k$			
8(i)	$\frac{dy}{dx}=\frac{2x}{9}+\frac{1}{6}$	**6**	**M1**	
	At $x=6,\ \frac{dy}{dx}=\frac{3}{2}$		**M1√**	√ for correct substitution of $x=6\ into\ \frac{dy}{dx}$
	Gradient of normal = $-\frac{2}{3}$		**M1√**	√
	$equation\ of\ normal: y=-\frac{2}{3}x+11$		**M1√**	√ for equation of normal
	Substitute $x=6,\ y=5+k$: OR $5+k=-\frac{2}{3}(6)+11$ $\quad$ $\frac{6^2}{9}+\frac{6}{6}+k=-\frac{2}{3}(6)+11$		**M1√**	
	$k=2$ (shown)		**A1**	
8(ii)	Shaded area = $\int_0^6 [(-\frac{2}{3}x+11)-\left(\frac{x^2}{9}+\frac{x}{6}+2\right)]\,dx$	**4**	**M1√**	√ for applying equation of normal
	$=\left[-\frac{x^3}{27}-\frac{5x^2}{12}+9x\right]_0^6$		**M1√**	√ for correct integration
	$=(-8-15+54)-(0)$		**M1√**	√ for correct substitution of limits
	= 31 sq units		**A1**	
OR	Area of trapezium = $\frac{1}{2}(7+11)(6)=54\ sq\ units$		**M1**	
	Area under graph = $\int_0^6 \left(\frac{x^2}{9}+\frac{x}{6}+2\right)\,dx$ $=\left[\frac{x^3}{27}+\frac{x^2}{12}+2x\right]_0^6$		**M1**	For integration

	$= (23) - (0)$		**M1**	For substitution of limits
	Shaded area = 54 – 23 = 31 sq units		**A1**	
Question	Answer	Marks	Partial Marks	Guidance
9(i)	$SP = 5\cos\cos\theta$ $SQ = 12\sin\sin\theta$	**4**	**M1** **M1**	
	$\tan\tan\theta = \frac{5}{12}$		**M1**	
	$\theta = 22.61986° = 22.6°\ (1\ d\ p)$		**A1**	Reject 22.62
9(ii)	PQ = $12\sin\sin\theta - 5\cos\cos\theta$	**4**	**M1√**	√ for PQ = SQ - SP
	R = 13 α = 22.61986°		**M1√** **M1√**	√ for $applying\ \sqrt{a^2 + b^2}$ √ for $applying\ tan^{-1} = \frac{b}{a}$
	PQ = $13\sin\sin(\theta - 22.6°)$		**A1**	
9(iii)	Range: $22.6° < \theta < 90°$	**1**	**B1√**	√ Realises range is between part (i) θ value and 90°.

Question	Answer		Marks	Partial Marks	Guidance
10	$v = t^2 - 6t + 5$				
10(i)	$displacement = \int (t^2 - 6t + 5)\, dt$ $= \frac{t^3}{3} - \frac{6t^2}{2} + 5t + c$		**2**	**M1**	
	When $t = 0$, displacement = 0 => $c = 0$				
	Displacement = $\frac{t^3}{3} - 3t^2 + 5t$			**A1**	
10(ii)	At A and B, $v = 0$ => $t = 1$ and $t = 5$		**4**	**M1**	*For values of t*
	At $t = 1$, displacement = $2\frac{1}{3}\ cm$ At $t = 5$, displacement = $-8\frac{1}{3}\ cm$	$AB = \int_1^5 (t^2 - 6t + 5)\, dt$ $= -10\frac{2}{3}\ cm$		**M1√** **M1√**	√ for *applying* $t = 1$ √ for *applying* $t = 5$ [**M1** for correct integration and **M1**substitution of limits]
	AB = $10\frac{2}{3}$ cm			**A1**	Accept 10.7 cm; reject $-10\frac{2}{3}\ cm$
10(iii)	Average speed = $\frac{10\frac{2}{3}}{4}$		**2**	**M1√**	√ for applying AB in part (ii)
	= 2.67 cm/s			**A1**	Accept $2\frac{2}{3}$
10(iv)	$acceleration = \frac{dv}{dt} = 2t - 6$		**4**	**M1**	
	$t = 3$			**M1**	
	OC = 3 cm			**M1√**	√ For applying t value when acceleration=0
	OB = $8\frac{1}{3}$ cm	OC < $\frac{1}{2}OB$		**A1√**	Correct conclusion with comparison

Question	Answer	Marks	Partial Marks	Guidance
	BC = $5\frac{1}{3}$ cm > OC Therefore, C is nearer to O			Reject if no comparison between OC, BC and/or $\frac{1}{2}OB$ is made.
Question	**Answer**	**Marks**	**Partial Marks**	**Guidance**
11	$x^2 + y^2 - 10x - 12y + 52 = 0$			
11(i)	Centre (5,6), radius = 3 units	**3**	**M1** **A1A1**	Any correct method Correct answers given
11(ii)	radius =3, centre (5,6) and y = 6 is a horizontal line 5-3 = 2 $x = 2$ is a vertical line and is a tangent to the circle at (2,6).	**2**	**M1** **A1**	Any correct explanation implying tangent perpendicular to radius Accept proof of discriminant = 0
11(iii)	Centre (-1,6)	**2**	**M1**	
	$(x+1)^2 + (y-6)^2 = 9$		**A1**	Accept General Form

Question	Answer	Marks	Partial Marks	Guidance
12(i)	$x + y = 20$ $y = 20 - x$	**3**	**M1**	For y in terms of x
	$Area = xy - \pi(\frac{1}{2}x)^2$		**M1**	For Area = Rectangle - Circle
	$= 20x - (\frac{4+\pi}{4})x^2\ (shown)$		**A1**	
12(ii)	$\frac{dA}{dx} = 20 - \left(\frac{4+\pi}{4}\right)(2x)$	**3**	**M1**	For correct differentiation
	$Stationary\ value \Rightarrow \frac{dA}{dx} = 0$ $\frac{dA}{dx} = 20 - \left(\frac{4+\pi}{4}\right)(2x) = 0$		**M1√**	√ for $\frac{dA}{dx} = 0$, sets to 0 and solves

	$$x = \frac{40}{4+\pi} = 5.60099 = 5.60$$		**A1**	Reject 5.6
Question	Answer	Marks	Partial Marks	Guidance
12(iii)	$$\frac{d^2A}{dx^2} = -\frac{(4+\pi)}{2}$$	**2**	**M1√**	√ Correct differentiation Accept 1st Derivative Test with clear presentation
	$\frac{d^2A}{dx^2} = -\frac{(4+\pi)}{2} < 0 \rightarrow A \text{ or stationery value is a maximum}$ The landscape designer might be delighted as he could optimise/make full use of the length/dimension of the fencing to obtain a maximum area for his flower beds.		**A1√**	√ For correct conclusion Reject *x* is maximum and making area maximum.