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Mark Scheme (Results)
January 2009

GCE

GCE Mathematics (6663/01)

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Question Number	Scheme	Marks
2	$(I=)\frac{12}{6}x^6-\frac{8}{4}x^4+3x+c$ $=2x^6-2x^4+3x+c$	M1 A1A1A1 **[4]**
	M1 for an attempt to integrate $x^n \to x^{n+1}$ (i.e. ax^6 or ax^4 or ax, where a is any non-zero constant). Also, this M mark can be scored for just the + c (seen at some stage), even if no other terms are correct. 1st A1 for $2x^6$ 2nd A1 for $-2x^4$ 3rd A1 for $3x + c$ (or $3x+k$, etc., any appropriate letter can be used as the constant) Allow $3x^1+c$, but <u>not</u> $\frac{3x^1}{1}+c$. Note that the A marks can be awarded at separate stages, e.g. $\frac{12}{6}x^6-2x^4+3x$ scores 2nd A1 $\frac{12}{6}x^6-2x^4+3x+c$ scores 3rd A1 $2x^6-2x^4+3x$ scores 1st A1 (even though the c has now been lost). Remember that all the A marks are dependent on the M mark. If applicable, isw (ignore subsequent working) after a correct answer is seen. Ignore wrong notation if the intention is clear, e.g. Answer $\int 2x^6-2x^4+3x+c\,\mathrm{d}x$.	

Question Number	Scheme	Marks
4	$\left(\mathrm{f}(x)=\right)\dfrac{3x^3}{3}-\dfrac{3x^{\frac{3}{2}}}{\frac{3}{2}}-7x\left(+c\right)$	M1
	$= \; x^3-2x^{\frac{3}{2}}-7x \quad (+c)$	A1A1
	$\mathrm{f}(4)=22 \quad \Rightarrow \quad 22=64-16-28+c$	M1
	$\boldsymbol{c=2}$	A1cso (5)
		[5]
	1st M1 for an attempt to integrate (x^3 or $x^{\frac{3}{2}}$ seen). The x term is insufficient for this mark and similarly the + c is insufficient. 1st A1 for $\frac{3}{3}x^3$ or $-\dfrac{3x^{\frac{3}{2}}}{\frac{3}{2}}$ (An unsimplified or simplified correct form) 2nd A1 for all three x terms correct and simplified… (the simplification may be seen later). The + c is not required for this mark. Allow $-7x^1$, but not $-\dfrac{7x^1}{1}$. 2nd M1 for an attempt to use $x = 4$ and $y = 22$ in a changed function (even if differentiated) to form an equation in c. 3rd A1 for $c = 2$ with no earlier incorrect work (a final expression for f(x) is not required).	

Question Number	Scheme	Marks
6 (a)	$2x^{3/2}$ or $p=\dfrac{3}{2}$ (<u>Not</u> $2x\sqrt{x}$)	B1
	$-x$ or $-x^1$ or $q=1$	B1 (2)
(b)	$\left(\dfrac{dy}{dx}=\right)$ $20x^3+2\times\dfrac{3}{2}x^{1/2}-1$	M1
	$=\underline{20x^3+3x^{\frac{1}{2}}-1}$	A1A1ftA1ft (4) **[6]**
(a) (b)	1st B1 for $p=1.5$ or exact equivalent 2nd B1 for $q=1$ M1 for an attempt to differentiate $x^n\to x^{n-1}$ (for any of the 4 terms) 1st A1 for $20x^3$ (the -3 must 'disappear') 2nd A1ft for $3x^{\frac{1}{2}}$ or $3\sqrt{x}$. Follow through their p but they must be differentiating $2x^p$, where p is a <u>fraction</u>, and the coefficient must be simplified if necessary. 3rd A1ft for -1 (<u>not</u> the unsimplified $-x^0$), or follow through for correct differentiation of their $-x^q$ (i.e. coefficient of x^q is -1). If ft is applied, the coefficient must be simplified if necessary. 'Simplified' coefficient means $\dfrac{a}{b}$ where a and b are integers with no common factors. Only a single + or − sign is allowed (e.g. − − must be replaced by +). If there is a 'restart' in part (b) it can be marked independently of part (a), but marks for part (a) cannot be scored for work seen in (b). <u>Multiplying</u> by $\sqrt{x}$: (assuming this is a restart) e.g. $y=5x^4\sqrt{x}-3\sqrt{x}+2x^2-x^{3/2}$ $\left(\dfrac{dy}{dx}=\right)\dfrac{45}{2}x^{7/2}-\dfrac{3}{2}x^{-1/2}+4x-\dfrac{3}{2}x^{1/2}$ scores M1 A0 A0 (p not a fraction) A1ft. <u>Extra term</u> included: This invalidates the final mark. e.g. $y=5x^4-3+2x^2-x^{3/2}-x^{1/2}$ $\left(\dfrac{dy}{dx}=\right)20x^3+4x-\dfrac{3}{2}x^{1/2}-\dfrac{1}{2}x^{-1/2}$ scores M1 A1 A0 (p not a fraction) A0. <u>Numerator and denominator differentiated separately</u>: For this, neither of the last two (ft) marks should be awarded. <u>Quotient/product rule</u>: Last two terms must be correct to score the last 2 marks. (If the M mark has not already been earned, it can be given for the quotient/product rule attempt.)	

Question Number	Scheme	Marks
11 (a)	$\left(\frac{dy}{dx}=\right) -4+8x^{-2}$ (4 or $8x^{-2}$ for M1… sign can be wrong)	M1A1
	$x=2 \Rightarrow \quad m=-4+2=-2$	M1
	$y=9-8-\frac{8}{2}=-3$ The first 4 marks could be earned in part (b)	B1
	Equation of tangent is: $y+3=-2(x-2) \rightarrow y=1-2x$ (*)	M1 A1cso (6)
(b)	Gradient of normal = $\frac{1}{2}$	B1ft
	Equation is: $\frac{y+3}{x-2}=\frac{1}{2}$ or better equivalent, e.g. $y=\frac{1}{2}x-4$	M1A1 (3)
(c)	$(A:)\ \frac{1}{2}$, $(B:)\ 8$	B1, B1
	Area of triangle is: $\frac{1}{2}(x_B \pm x_A)\times y_P$ with values for all of x_B, x_A and y_P	M1
	$\frac{1}{2}\left(8-\frac{1}{2}\right)\times 3 = \frac{45}{4}$ or 11.25	A1 (4) **[13]**
(a)	1st M1 for 4 or $8x^{-2}$ (ignore the signs). 1st A1 for both terms correct (including signs). 2nd M1 for substituting $x=2$ into their $\frac{dy}{dx}$ (must be different from their y) B1 for $y_P=-3$, but not if clearly found from the given equation of the <u>tangent</u>. 3rd M1 for attempt to find the equation of tangent at P, follow through their m and y_P. Apply general principles for straight line equations (see end of scheme). <u>NO DIFFERENTIATION ATTEMPTED</u>: Just assuming $m=-2$ at this stage is M0 2nd A1cso for correct work leading to printed answer (allow equivalents with $2x$, y, and 1 terms… such as $2x+y-1=0$).	
(b)	B1ft for correct use of the perpendicular gradient rule. Follow through their m, but if $m \neq -2$ there must be clear evidence that the m is thought to be the gradient of the tangent. M1 for an attempt to find normal at P using their changed gradient and their y_P. Apply general principles for straight line equations (see end of scheme). A1 for any correct form as specified above (correct answer only).	
(c)	1st B1 for $\frac{1}{2}$ and 2nd B1 for 8. M1 for a full method for the area of triangle ABP. Follow through their x_A, x_B and their y_P, but the mark is to be awarded 'generously', condoning sign errors.. The final answer must be positive for A1, with negatives in the working condoned. <u>Determinant</u>: Area = $\frac{1}{2}\begin{vmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{vmatrix} = \frac{1}{2}\begin{vmatrix} 2 & -3 & 1 \\ 0.5 & 0 & 1 \\ 8 & 0 & 1 \end{vmatrix} = ...$ (Attempt to multiply out required for M1) <u>Alternative</u>: $AP=\sqrt{(2-0.5)^2+(-3)^2}$, $BP=\sqrt{(2-8)^2+(-3)^2}$, Area = $\frac{1}{2}AP\times BP = ...$ M1 <u>Intersections with y-axis instead of x-axis</u>: Only the M mark is available B0 B0 M1 A0.	

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Question Number	Scheme	Marks
2	$y=(1+x)(4-x)=4+3x-x^2$ M: Expand, giving 3 (or 4) terms $\int\left(4+3x-x^2\right)\mathrm{d}x=4x+\frac{3x^2}{2}-\frac{x^3}{3}$ M: Attempt to integrate $=[..............]_{-1}^{4}=\left(16+24-\frac{64}{3}\right)-\left(-4+\frac{3}{2}+\frac{1}{3}\right)=\frac{125}{6}$ $\left(=20\frac{5}{6}\right)$	M1 M1 A1 M1 A1 (5) **[5]**
Notes	**M1** needs expansion, there may be a slip involving a sign or simple arithmetical error e.g. $1\times 4=5$, but there needs to be a 'constant' an 'x term' and an 'x^2 term'. The x terms do not need to be collected. (Need not be seen if next line correct) Attempt to integrate means that $x^n\to x^{n+1}$ for at least one of the terms, then **M1** is awarded (even 4 becoming 4x is sufficient) – one correct power sufficient. **A1** is for correct answer only, not follow through. But allow $2x^2-\frac{1}{2}x^2$ or any correct equivalent. Allow **+ *c***, and even allow an evaluated extra constant term. **M1**: Substitute limit 4 and limit –1 into a changed function (must be –1) and indicate subtraction (either way round). **A1** must be exact, not 20.83 or similar. If recurring indicated can have the mark. Negative area, even if subsequently positive loses the A mark.	
Special cases	(i) Uses calculator method: **M1** for expansion (if seen) **M1** for limits if answer correct, so 0 , 1 or 2 marks out of 5 is possible (Most likely **M0 M0 A0 M1 A0**) (ii) Uses trapezium rule : not exact, no calculus – 0/5 unless expansion mark **M1** gained. (iii) Using original method, but then change all signs after expansion is likely to lead to: **M1 M1 A0, M1 A0 i.e. 3/5**	

Question Number	Scheme	Marks
10 (a)	$2\pi rh + 2\pi r^2 = 800$	B1
	$h = \dfrac{400 - \pi r^2}{\pi r}$, $V = \pi r^2 \left(\dfrac{400 - \pi r^2}{\pi r} \right) = 400r - \pi r^3$ (*)	M1, M1 A1 (4)
(b)	$\dfrac{dV}{dr} = 400 - 3\pi r^2$	M1 A1
	$400 - 3\pi \ r^2 = 0$ $r^2 = ...,$ $r = \sqrt{\dfrac{400}{3\pi}}$ (= 6.5 (2 s.f.))	M1 A1
	$V = 400r - \pi r^3 = 1737 = \dfrac{800}{3}\sqrt{\dfrac{400}{3\pi}}$ (cm^3) (accept awrt 1737 or exact answer)	M1 A1 (6)
(c)	$\dfrac{d^2V}{dr^2} = -6\pi r$, Negative, $\therefore$ maximum (Parts (b) and (c) should be considered together when marking)	M1 A1 (2) **[12]**
<u>Other methods for part (c):</u>	<u>Either:</u>M: Find <u>value</u> of $\dfrac{dV}{dr}$ on each side of "$r = \sqrt{\dfrac{400}{3\pi}}$" and consider sign. A: Indicate sign change of positive to negative for $\dfrac{dV}{dr}$, and conclude max. <u>Or:</u> M: Find <u>value</u> of V on each side of "$r = \sqrt{\dfrac{400}{3\pi}}$" and compare with "1737". A: Indicate that both values are less than 1737 or 1737.25, and conclude max.	
Notes (a)	**B1:** For any correct form of this equation (may be unsimplified, may be implied by 1st M1) **M1 :** Making h the subject of their three or four term formula **M1:** Substituting expression for h into $\pi r^2 h$ (independent mark) Must now be expression in r only. **A1:** cso	
(b)	**M1:** At least one power of r decreased by 1 **A1:** cao **M1:** Setting $\dfrac{dV}{dr}$ =0 and finding a value for correct power of r for candidate **A1 :** This mark may be credited if the value of V is correct. Otherwise answers should round to 6.5 (allow ± 6.5)or be exact answer **M1:** Substitute a positive value of r to give V **A1:** 1737 or 1737.25….. or exact answer	

(c)	**M1:** needs complete method **e.g.**attempts differentiation (power reduced) of their first derivative and considers its sign **A1(first method)** should be $-6\pi r$ (do not need to substitute *r* and can condone wrong *r* if found in (b)) Need to conclude maximum or indicate by a tick that it is maximum. Throughout allow confused notation such as d*y*/d*x* for d*V*/d*r*
Alternative for (a)	$A = 2\pi r^2 + 2\pi rh$, $\frac{A}{2} \times r = \pi r^3 + \pi r^2 h$ is **M1** Equate to 400*r* **B1** Then $V = 400r - \pi r^3$ is **M1 A1**