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Mark Scheme (Results)

Summer 2015

Pearson Edexcel GCE in
Core Mathematics C1 (6663/01)

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

PEARSON EDEXCEL GCE MATHEMATICS

General Instructions for Marking

1. The total number of marks for the paper is 75

2. The Edexcel Mathematics mark schemes use the following types of marks:

- **M** marks: Method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- **B** marks are unconditional accuracy marks (independent of M marks)
- Marks should not be subdivided.

3. Abbreviations

   These are some of the traditional marking abbreviations that will appear in the mark schemes.

   - bod – benefit of doubt
   - ft – follow through
   - the symbol $\sqrt{}$ will be used for correct ft
   - cao – correct answer only
   - cso - correct solution only. There must be no errors in this part of the question to obtain this mark
   - isw – ignore subsequent working
   - awrt – answers which round to
   - SC: special case
   - oe – or equivalent (and appropriate)
   - d… or dep – dependent
   - indep – independent
   - dp decimal places
   - sf significant figures
   - $\ast$ The answer is printed on the paper or ag- answer given
   - $\sqsubset$ or d… The second mark is dependent on gaining the first mark

4. All A marks are 'correct answer only' (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but manifestly absurd answers should never be awarded A marks.

5. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.

6. If a candidate makes more than one attempt at any question:
   - If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
   - If either all attempts are crossed out or none are crossed out, mark all the attempts and score the highest single attempt.

7. Ignore wrong working or incorrect statements following a correct answer.

General Principles for Core Mathematics Marking

(But note that specific mark schemes may sometimes override these general principles).

Method mark for solving 3 term quadratic:

1. Factorisation

$(x^2 + bx + c) = (x + p)(x + q),\ \text{where}\ |pq| = |c|$, leading to x = …

$(ax^2 + bx + c) = (mx + p)(nx + q),\ \text{where}\ |pq| = |c|\ \text{and}\ |mn| = |a|$, leading to x = …

2. Formula

Attempt to use the correct formula (with values for a, b and c).

3. Completing the square

Solving $x^2 + bx + c = 0$: $\left(x \pm \frac{b}{2}\right)^2 \pm q \pm c = 0,\ \ q \neq 0$, leading to x = …

Solving $ax^2 + bx + c = 0$: $a\left(x \pm \frac{b}{2a}\right)^2 \pm p \pm \frac{c}{a} = 0,\ \ p \neq 0$, leading to x = …

Method marks for differentiation and integration:

1. Differentiation

Power of at least one term decreased by 1. ($x^n \rightarrow x^{n-1}$)

2. Integration

Power of at least one term increased by 1. ($x^n \rightarrow x^{n+1}$)

Use of a formula

Where a method involves using a formula that has been learnt, the advice given in recent examiners' reports is that the formula should be quoted first.

Normal marking procedure is as follows:

Method mark for quoting a correct formula and attempting to use it, even if there are small errors in the substitution of values.

Where the formula is not quoted, the method mark can be gained by implication from correct working with values, but may be lost if there is any mistake in the working.

Exact answers

Examiners' reports have emphasised that where, for example, an exact answer is asked for, or working with surds is clearly required, marks will normally be lost if the candidate resorts to using rounded decimals.

Question Number	Scheme		Marks
1.(a)	20	Sight of 20. (4×5 is not sufficient)	B1
			(1)
(b)	$\dfrac{\sqrt{2}}{2\sqrt{5}-3\sqrt{2}}\times\dfrac{2\sqrt{5}+3\sqrt{2}}{2\sqrt{5}+3\sqrt{2}}$	Multiplies top and bottom by a **correct** expression. This statement is sufficient. NB $2\sqrt{5}+3\sqrt{2}\equiv\sqrt{20}+\sqrt{18}$	M1
	(Allow to multiply top and bottom by $k(2\sqrt{5}+3\sqrt{2})$)		
	$=\dfrac{...}{2}$	Obtains a denominator of 2 or sight of $\left(2\sqrt{5}-3\sqrt{2}\right)\left(2\sqrt{5}+3\sqrt{2}\right)=2$ with no errors seen in this expansion. May be implied by $\dfrac{...}{2k}$	A1
	Note that M0A1 is not possible. The 2 must come from a correct method.		
	Note that if M1 is scored there is no need to consider the numerator. **e.g.** $\dfrac{2(MR?)}{2\sqrt{5}-3\sqrt{2}}\times\dfrac{2\sqrt{5}+3\sqrt{2}}{2\sqrt{5}+3\sqrt{2}}=\dfrac{...}{2}$ scores M1A1		
	Numerator = $\sqrt{2}(2\sqrt{5}\pm3\sqrt{2})=2\sqrt{10}\pm6$	An attempt to multiply the numerator by $\pm\left(2\sqrt{5}\pm3\sqrt{2}\right)$ and obtain an expression of the form $p+q\sqrt{10}$ where p and q are integers. This may be implied by e.g. $2\sqrt{10}+3\sqrt{4}$ or by their final answer.	M1
	(Allow attempt to multiply the numerator by $k(2\sqrt{5}\pm3\sqrt{2})$)		
	$\dfrac{\sqrt{2}}{2\sqrt{5}-3\sqrt{2}}=\dfrac{2\sqrt{10}+6}{2}=3+\sqrt{10}$	Cso. For the answer as written or $\sqrt{10}+3$ or a statement that a = 3 and b = 10. Score when first seen and ignore any subsequent attempt to 'simplify'. Allow $1\sqrt{10}$ for $\sqrt{10}$	A1
			(4)
			(5 marks)
	Alternative for (b)		
	$\dfrac{\sqrt{2}}{2\sqrt{5}-3\sqrt{2}}=\dfrac{1}{\sqrt{10}-3}$ or $\dfrac{2}{2\sqrt{10}-6}$	M1: Divides or multiplies top and bottom by $\sqrt{2}$ A1: $\dfrac{k}{k\left(\sqrt{10}-3\right)}$	M1A1
	$=\dfrac{1}{\sqrt{10}-3}\times\dfrac{\sqrt{10}+3}{\sqrt{10}+3}$	M1: Multiplies top and bottom by $\sqrt{10}+3$	M1
	$=3+\sqrt{10}$		A1
2.	$y-2x-4=0,\quad 4x^2+y^2+20x=0$		

<table>
<tr><th>Question Number</th><th colspan="2">Scheme</th><th>Marks</th></tr>
<tr><td></td><td>$y = 2x+4 \Rightarrow 4x^2 + (2x+4)^2 + 20x = 0$
or
$2x = y-4$ or $x = \frac{y-4}{2}$
$\Rightarrow (y-4)^2 + y^2 + 10(y-4) = 0$</td><td>Attempts to rearrange the linear equation to y =... or x =... or
$2x$ =... and attempts to **fully** substitute into the second equation.</td><td>M1</td></tr>
<tr><td></td><td>$8x^2 + 36x + 16 = 0$
or
$2y^2 + 2y - 24 = 0$</td><td>M1: Collects terms together to produce quadratic expression = 0. The '= 0' may be implied by later work.
A1: Correct three term quadratic equation in x or y. The '= 0' may be implied by later work.</td><td>M1 A1</td></tr>
<tr><td></td><td>$(4)(2x+1)(x+4) = 0 \Rightarrow x = ...$
or
$(2)(y+4)(y-3) = 0 \Rightarrow y = ...$</td><td>Attempt to factorise and solve or complete the square and solve or uses a correct quadratic formula **for a 3 term quadratic.**</td><td>M1</td></tr>
<tr><td></td><td>$x = -0.5, x = -4$
or
$y = -4, y = 3$</td><td>Correct answers for either both values of x or both values of y (possibly un-simplified)</td><td>A1 cso</td></tr>
<tr><td></td><td>Sub into $y = 2x+4$
or
Sub into $x = \frac{y-4}{2}$</td><td>Substitutes at least one of their values of x into a **correct** equation as far as y =... or substitutes at least one of their values of y into a **correct** equation as far as y =...</td><td>M1</td></tr>
<tr><td></td><td>$y = 3,\ y = -4$
and
$x = -4,\ x = -0.5$</td><td>Fully correct solutions and simplified.
Pairing not required.
If there are any extra values of x or y, score A0.</td><td>A1</td></tr>
<tr><td></td><td></td><td></td><td>(7 marks)</td></tr>
<tr><td></td><td colspan="2">**Special Case: Uses y = -2x - 4**</td><td></td></tr>
<tr><td></td><td>$y = 2x+4 \Rightarrow 4x^2 + (-2x-4)^2 + 20x = 0$</td><td></td><td>M1</td></tr>
<tr><td></td><td>$8x^2 + 36x + 16 = 0$</td><td></td><td>M1A1</td></tr>
<tr><td></td><td>$(4)(2x+1)(x+4) = 0 \Rightarrow x = ...$</td><td></td><td>M1</td></tr>
<tr><td></td><td>$x = -0.5, x = -4$</td><td></td><td>A0</td></tr>
<tr><td></td><td>Sub into $y = 2x+4$</td><td>Sub into $y = -2x-4$ is M0</td><td>M1</td></tr>
<tr><td></td><td>$y = 3,\ y = -4$
and
$x = -4,\ x = -0.5$</td><td></td><td>A0</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
</table>

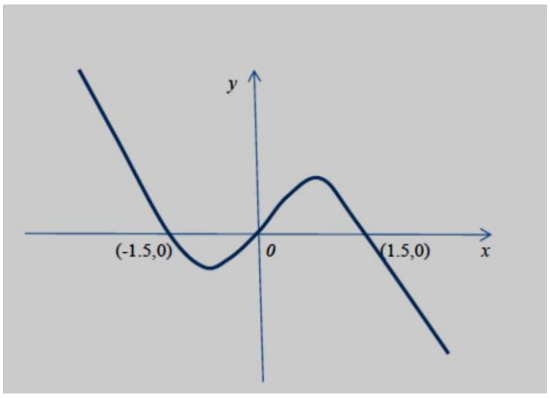
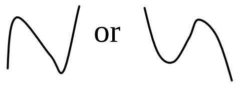
Question Number	Scheme		Marks
3.	$y = 4x^3 - \dfrac{5}{x^2}$		
(a)	$12x^2 + \dfrac{10}{x^3}$	M1: $x^n \to x^{n-1}$ e.g. Sight of x^2 or x^{-3} or $\dfrac{1}{x^3}$	M1A1A1
		A1: $3\times 4x^2$ or $-5\times -2x^{-3}$ (oe) (Ignore + c for this mark)	
		A1: $12x^2 + \dfrac{10}{x^3}$ or $12x^2 + 10x^{-3}$ <u>all on one line</u> and no + c	
	Apply ISW here and award marks when first seen.		
			(3)
(b)	$x^4 + \dfrac{5}{x} + c$ or $x^4 + 5x^{-1} + c$	M1: $x^n \to x^{n+1}$. e.g. Sight of x^4 or x^{-1} or $\dfrac{1}{x^1}$ **Do <u>not</u> award for integrating their answer to part (a)**	M1A1A1
		A1: $4\dfrac{x^4}{4}$ or $-5\times\dfrac{x^{-1}}{-1}$	
		A1: For fully correct and simplified answer with + c <u>all on one line</u>. Allow $x^4 + 5\times\dfrac{1}{x} + c$ Allow $1x^4$ for x^4	
	Apply ISW here and award marks when first seen. Ignore spurious integral signs for all marks.		
			(3)
			(6 marks)

Question Number	Scheme		Marks
4(i).(a)	$U_3 = 4$	cao	B1
			(1)
(b)	$\sum_{n=1}^{n=20} U_n = 4+4+4..........+4$ or 20×4	For realising that all 20 terms are 4 and that the sum is required. Possible ways are 4+4+4…..+4 or 20×4 or $\frac{1}{2}\times 20(2\times 4+19\times 0)$ or $\frac{1}{2}\times 20(4+4)$ (Use of a correct sum formula with n = 20, a = 4 and d = 0 or n = 20, a = 4 and l = 4)	M1
	= 80	cao	A1
	Correct answer with no working scores M1A1		
			(2)
(ii)(a)	$V_3 = 3k,\quad V_4 = 4k$	May score in (b) if clearly identified as V_3 and V_4	B1, B1
			(2)
(b)	$\sum_{n=1}^{n=5} V_n = k+2k+3k+4k+5k = 165$ or $\frac{1}{2}\times 5(2\times k+4\times k) = 165$ or $\frac{1}{2}\times 5(k+5k) = 165$	Attempts V_5, adds their V_1, V_2, V_3, V_4, V_5 AND sets equal to 165 or Use of a correct sum formula with $a = k$, $d = k$ and n = 5 or $a = k$, $l = 5k$ and n = 5 AND sets equal to 165	M1
	$15k = 165 \Rightarrow k = ..$	Attempts to solve their linear equation in k **having set the sum of their first 5 terms equal to 165.** Solving V_5 = 165 scores no marks.	M1
	$k = 11$	cao and cso	A1
			(3)
			(8 marks)

Question Number	Scheme		Marks
5(a)	$b^2-4ac<0 \Rightarrow$ e.g. $4^2-4(p-1)(p-5)<0$ or $0>4^2-4(p-1)(p-5)$ or $4^2<4(p-1)(p-5)$ or $4(p-1)(p-5)>4^2$	M1: Attempts to use b^2-4ac with at least two of a, b or c correct. May be in the quadratic formula. Could also be, for example, comparing or equating b^2 and $4ac$. Must be considering the given quadratic equation. Inequality sign not needed for this M1.There must be no x terms. A1: For a correct un-simplified **inequality** that is not the given answer	M1A1
	$4<p^2-6p+5$		
	$p^2-6p+1>0$	Correct solution with **no** errors that includes an expansion of $(p-1)(p-5)$	A1*
			(3)
(b)	$p^2-6p+1=0 \Rightarrow p=...$	For an attempt to solve $p^2-6p+1=0$ (**not <u>their</u> quadratic**) leading to 2 solutions for p (do not allow attempts to **factorise** – must be using the quadratic formula or completing the square)	M1
	$p=3\pm\sqrt{8}$	$p=3\pm2\sqrt{2}$ or any equivalent correct expressions e.g. $p=\dfrac{6\pm\sqrt{32}}{2}$ (May be implied by their inequalities) Discriminant must be a single number not e.g. 36 - 4	A1
	Allow the M1A1 to score anywhere for solving the given quadratic		
	$p<3-\sqrt{8}$ or $p>3+\sqrt{8}$	M1: Chooses outside region – **not dependent on the previous method mark** A1: $p<3-\sqrt{8}$, $p>3+\sqrt{8}$ or equivalent e.g. $p<\dfrac{6-\sqrt{32}}{2}$, $p>\dfrac{6+\sqrt{32}}{2}$ $\left(-\infty,\ 3-\sqrt{8}\right)\cup\left(3+\sqrt{8},\ \infty\right)$ Allow ",", "or" or a space between the answers but do **not** allow $p<3-\sqrt{8}$ **and** $p>3+\sqrt{8}$ (this scores M1A0) **Apply ISW if necessary.**	M1A1
A correct solution to the quadratic followed by $p>3\pm\sqrt{8}$ scores M1A1M0A0			
$3+\sqrt{8}<p<3-\sqrt{8}$ scores M1A0			
Allow candidates to use *x* rather than *p* but must be in terms of *p* for the final A1			
			(4)
			(7 marks)

Question Number	Scheme		Marks
6(a)	$(x^2+4)(x-3)=x^3-3x^2+4x-12$	Attempt to multiply out the numerator to get a cubic with 4 terms and at least 2 correct	M1
	$\dfrac{x^3-3x^2+4x-12}{2x}=\dfrac{x^2}{2}-\dfrac{3}{2}x+2-6x^{-1}$	M1: Attempt to divide each term by $2x$. The powers of x of at least two terms must follow from their expansion. Allow an attempt to multiply by $2x^{-1}$ A1: Correct expression. May be un-simplified but powers of x must be combined e.g. $\dfrac{x^2}{2}$ not $\dfrac{x^3}{2x}$	M1A1
	$\dfrac{dy}{dx}=x-\dfrac{3}{2}+\dfrac{6}{x^2}$ oe e.g. $\dfrac{2x^3-3x^2+12}{2x^2}$	ddM1: $x^n \to x^{n-1}$ or $2 \to 0$ **Dependent on both previous method marks.** A1: $x-\dfrac{3}{2}+\dfrac{6}{x^2}$ oe and **isw** Accept $1x$ or even $1x^1$ but not $\dfrac{2x}{2}$ and not x^0. If they lose the previous A1 because of an **incorrect constant only** then allow recovery here and in part (b) for a correct derivative.	ddM1A1
			(5)
	See appendix for alternatives using product/quotient rule		
(b)	At $x=-1,\ y=10$	Correct value for y	B1
	$\left(\dfrac{dy}{dx}=\right)-1-\dfrac{3}{2}+\dfrac{6}{1}=3.5$	M1: Substitutes $x = -1$ into their expression for dy/dx A1: 3.5 oe cso	M1A1
	$y-'10'='3.5'(x--1)$	Uses their **tangent** gradient **which must come from calculus** with $x=-1$ and their numerical y with a correct straight line method. If using $y = mx + c$, this mark is awarded for correctly establishing a value for c.	M1
	$2y-7x-27=0$	$\pm k(2y-7x-27)=0$ cso	A1
			(5)
			(10 marks)

Question Number	Scheme		Marks
7.(a)	$\left(4^x =\right) y^2$	Allow y^2 or $y \times y$ or "y squared" "$4^x =$" not required	B1
	Must be seen in part (a)		
			(1)
(b)	$8y^2 - 9y + 1 = (8y-1)(y-1) = 0 \Rightarrow y = ...$ or $(8(2^x)-1)((2^x)-1) = 0 \Rightarrow 2^x = ...$	For attempting to solve the given equation as a **3 term quadratic** in *y* or as a **3 term quadratic** in 2^x leading to a value of *y* or 2^x (Apply usual rules for solving the quadratic – see general guidance) Allow *x* (or any other letter) instead of *y* for this mark e.g. an attempt to solve $8x^2 - 9x + 1 = 0$	M1
	$2^x (\text{or } y) = \frac{1}{8},\ 1$	Both correct answers of $\frac{1}{8}$ (oe) and 1 for 2^x or *y* or their letter but **<u>not *x*</u>** unless $2^x (\text{or } y)$ is implied later	A1
	$x = -3 \quad x = 0$	M1: A correct attempt to find one **numerical value** of *x* from their $2^x (\text{or } y)$ **which must have come from a 3 term quadratic equation**. If logs are used then they must be evaluated. A1: Both $x = -3$ and/or $x = 0$ May be implied by e.g. $2^{-3} = \frac{1}{8}$ and $2^0 = 1$ **and no extra values.**	M1A1
			(4)
			(5 marks)

Question Number	Scheme		Marks
8(a)	$9x-4x^3 = x(9-4x^2)$ or $-x(4x^2-9)$	Takes out a common factor of x or $-x$ **correctly.**	B1
	$9-4x^2=(3+2x)(3-2x)$ or $4x^2-9=(2x-3)(2x+3)$	$9-4x^2=(\pm3\pm2x)(\pm3\pm2x)$ or $4x^2-9=(\pm2x\pm3)(\pm2x\pm3)$	M1
	$9x-4x^3=x(3+2x)(3-2x)$	Cao but allow equivalents e.g. $x(-3-2x)(-3+2x)$ or $-x(2x+3)(2x-3)$	A1
Note: $4x^3-9x=x(4x^2-9)=x(2x-3)(2x+3)$ so $9x-4x^3=x(3-2x)(2x+3)$ **would score full marks**			
	Note: Correct work leading to $9x\left(1-\frac{2}{3}x\right)\left(1+\frac{2}{3}x\right)$ **would score full marks**		
	Allow (x ± 0) or (-x ± 0) instead of x and -x		
			(3)
(b)		 or A cubic shape with one maximum and one minimum	M1
		Any line or curve drawn passing through (not touching) the origin	B1
		Must be the correct shape and in all four quadrants and pass through (-1.5, 0) and (1.5, 0) (Allow (0, -1.5) and (0, 1.5) or just -1.5 and 1.5 provided they are positioned correctly). **Must be on the diagram** (Allow $\sqrt{\frac{9}{4}}$ for 1.5)	A1
			(3)
(c)	$A=(-2, 14), \quad B=(1, 5)$	B1: y = 14 **or** y = 5 B1: y = 14 **and** y = 5	B1 B1
	These must be seen or used in (c)		
	$(AB=)\sqrt{(-2-1)^2+(14-5)^2}\left(=\sqrt{90}\right)$	**Correct** use of Pythagoras <u>including the square root.</u> Must be a correct expression for their A and B if a correct formula is not quoted	M1
	E.g. $AB=\sqrt{(-2+1)^2+(14-5)^2}$ **scores M0.** **However** $AB=\sqrt{(y_2-y_1)^2+(x_2-x_1)^2}=\sqrt{(-2+1)^2+(14-5)^2}$ **scores M1**		
	$(AB=)3\sqrt{10}$	cao	A1
			(4)
			(10 marks)
Special case: Use of $4x^3-9x$ for the curve gives (-2, -14) and (1, -5) in part (c). Allow this to score a maximum of B0B0M1A1 as a special case in part (c) as the length AB comes from equivalent work.			

<table>
<tr><th>Question Number</th><th colspan="2">Scheme</th><th>Marks</th></tr>
<tr><td>9.(a)</td><td>$32000 = 17000 + (k-1)\times 1500 \Rightarrow k = ...$</td><td>Use of 32000 with a <u>correct</u> formula in an attempt to find k. A correct formula could be implied by a correct answer.</td><td>M1</td></tr>
<tr><td></td><td>(k =) 11</td><td>Cso (Allow n = 11)</td><td>A1</td></tr>
<tr><td></td><td colspan="2">Accept correct answer only.</td><td></td></tr>
<tr><td></td><td colspan="2">32000 = 17000 + 1500k $\Rightarrow k = 10$ is M0A0 (wrong formula)
$\frac{32000-17000}{1500} = 10 \therefore k = 11$ is M1A1 (correct formula implied)</td><td></td></tr>
<tr><td></td><td colspan="2">Listing: All terms must be listed up to 32000 and 11 correctly identified.
A solution that scores 2 if fully correct and 0 otherwise.</td><td></td></tr>
<tr><td></td><td></td><td></td><td>(2)</td></tr>
<tr><td>(b)</td><td>M1:
$S = \frac{k}{2}(2\times 17000 + (k-1)\times 1500)$ or
$\frac{k}{2}(17000+32000)$
$S = \frac{k-1}{2}(2\times 17000 + (k-2)\times 1500)$ or
$\frac{k-1}{2}(17000+30500)$
A1:
$S = \frac{11}{2}(2\times 17000 + 10\times 1500)$ or $\frac{11}{2}(17000+32000)$
$S = \frac{10}{2}(2\times 17000 + 9\times 1500)$ or
$\frac{10}{2}(17000+30500)$
(= 269 500 or 237 500)</td><td>M1: Use of correct sum formula with their integer $n = k$ or $k - 1$ from part (a) where $3 < k < 20$ and a = 17000 and d = 1500. See below for special case for using n = 20.

A1: Any correct un-simplified numerical expression with n = 11 or n = 10</td><td>M1A1</td></tr>
<tr><td></td><td>$32000\times\alpha$</td><td>$32000\times\alpha$ where α is an integer and $3 < \alpha < 18$</td><td>M1</td></tr>
<tr><td></td><td>288 000 + 269 500 = 557 500
or
320 000 + 237 500 = 557 500</td><td>M1: Attempts to add their two values. It is dependent upon the two previous M's being scored and must be the sum of 20 terms i.e. $\alpha + k = 20$

A1: 557 500</td><td>ddM1A1</td></tr>
<tr><td></td><td colspan="2">Special Case: If they just find S_{20} (£625 000) in (b) score the first M1 otherwise apply the scheme.</td><td></td></tr>
<tr><td></td><td></td><td></td><td>(5)</td></tr>
<tr><td></td><td colspan="2"></td><td>(7 marks)</td></tr>
</table>

Listing:

n	1	2	3	4	5	6	7	8	9	10
u_n	17000	18500	20000	21500	23000	24500	26000	27500	29000	30500
n	11	12	13	14	15	16	17	18	19	20
u_n	32000	32000	32000	32000	32000	32000	32000	32000	32000	32000

Look for a sum before awarding marks. Award the M's as above then A2 for 557 500
If they sum the 'parts' separately then apply the scheme.

Question Number	Scheme		Marks
10(a)	$\text{f}(x) = x^{\frac{3}{2}} - \frac{9}{2}x^{\frac{1}{2}} + 2x(+c)$	M1: $x^n \to x^{n+1}$ A1: Two terms in x correct, simplification is not required in coefficients or powers A1: All terms in x correct. Simplification not required in coefficients or powers and + c is not required	M1A1A1
	Sub $x=4, y=9$ into $\text{f}(x) \Rightarrow c = ...$	M1: Sub x = 4, y = 9 into f (x) to obtain a value for c. If no + c then M0. Use of x = 9, y = 4 is M0.	M1
	$(\text{f}(x)=)x^{\frac{3}{2}} - \frac{9}{2}x^{\frac{1}{2}} + 2x + 2$	Accept equivalents **but must be simplified** e.g. $\text{f}(x) = x^{\frac{3}{2}} - 4.5\sqrt{x} + 2x + 2$ Must be all 'on one line' **and simplified.** Allow $x\sqrt{x}$ for $x^{\frac{3}{2}}$	A1
			(5)
(b)	Gradient of normal is $-\frac{1}{2} \Rightarrow$ Gradient of tangent = +2	M1: Gradient of $2y + x = 0$ is $\pm\frac{1}{2}(m) \Rightarrow \frac{\text{d}y}{\text{d}x} = -\frac{1}{\pm\frac{1}{2}}$ A1: Gradient of tangent = +2 (May be implied)	M1A1
	The A1 may be implied by $\frac{-1}{\frac{3\sqrt{x}}{2} - \frac{9}{4\sqrt{x}} + 2} = -\frac{1}{2}$		
	$\frac{3\sqrt{x}}{2} - \frac{9}{4\sqrt{x}} + 2 = 2 \Rightarrow \frac{3\sqrt{x}}{2} - \frac{9}{4\sqrt{x}} = 0$	Sets the given $\text{f}'(x)$ **or their** $\text{f}'(x)$ = their **changed** m and **not** their m where m has come from $2y + x = 0$	M1
	$\times 4\sqrt{x} \Rightarrow 6x - 9 = 0 \Rightarrow x = ..$	$\times 4\sqrt{x}$ or equivalent **correct algebraic** processing (**allow sign/arithmetic errors only**) and attempt to solve to obtain a value for x. If $\text{f}'(x) \neq 2$ they need to be solving a three term quadratic in $\sqrt{x}$ correctly and square to obtain a value for x. **Must be using the given** $\text{f}'(x)$ **for this mark.**	M1
	$x = 1.5$	$x = \frac{3}{2}$ (1.5) Accept equivalents e.g . $x = \frac{9}{6}$ **If any 'extra' values are not rejected, score A0.**	A1
			(5)
	Beware $\frac{-1}{\frac{3\sqrt{x}}{2} - \frac{9}{4\sqrt{x}} + 2} = -\frac{1}{2} \Rightarrow \frac{-2}{3\sqrt{x}} + \frac{4\sqrt{x}}{9} - \frac{1}{2} = -\frac{1}{2}$ etc. leads to the correct answer and could score M1A1M1M0(incorrect processing)A0		
			(10 marks)

Appendix

6(a)

Way 2 Quotient	$(x^2+4)(x-3)=x^3-3x^2+4x-12$	Attempt to multiply out the numerator to get a cubic with 4 terms and at least 2 correct	M1
	$\frac{\mathrm{d}y}{\mathrm{d}x}=\frac{2x\left(3x^2-6x+4\right)-2\left(x^3-3x^2+4x-12\right)}{(2x)^2}$	M1: Correct application of quotient rule A1: Correct derivative	M1A1
	$=\frac{4x^3}{4x^2}-\frac{6x^2}{4x^2}+\frac{24}{4x^2}=x-\frac{3}{2}+\frac{6}{x^2}$ oe e.g. $\frac{2x^3-3x^2+12}{2x^2}$	M1: Collects terms and divides by denominator. **Dependent on both previous method marks.** A1: $x-\frac{3}{2}+\frac{6}{x^2}$ oe and **isw** Accept $1x$ or even $1x^1$ but not $\frac{2x}{2}$ and not x^0.	ddM1A1
Way 3 Product	$y=\left(\frac{x}{2}+\frac{2}{x}\right)(x-3)$ or $\left(x^2+4\right)\left(\frac{1}{2}-\frac{3}{2x}\right)$	Divides one bracket by $2x$	M1
	$\frac{\mathrm{d}y}{\mathrm{d}x}=(x-3)\left(\frac{1}{2}-\frac{2}{x^2}\right)+\left(\frac{x}{2}+\frac{2}{x}\right)$ or $\frac{\mathrm{d}y}{\mathrm{d}x}=\left(x^2+4\right)\frac{3}{2x^2}+2x\left(\frac{1}{2}-\frac{3}{2x}\right)$	M1: Correct application of product rule A1: Correct derivative	M1A1
	$=\frac{3}{2}+\frac{6}{x^2}+x-3=x-\frac{3}{2}+\frac{6}{x^2}$ oe e.g. $\frac{2x^3-3x^2+12}{2x^2}$	M1: Expands and collects terms. **Dependent on both previous method marks.** A1: $x-\frac{3}{2}+\frac{6}{x^2}$ oe and **isw** Accept $1x$ or even $1x^1$ but not $\frac{2x}{2}$ and not x^0.	ddM1A1
Way 4 Product	$(x^2+4)(x-3)=x^3-3x^2+4x-12$	Attempt to multiply out the numerator to get a cubic with 4 terms and at least 2 correct	M1
	$\frac{\mathrm{d}y}{\mathrm{d}x}=\left(x^3-3x^2+4x-12\right)\times-\frac{1}{2}x^{-2}+\frac{1}{2}x^{-1}\left(3x^2-6x+4\right)$ M1: Correct application of product rule A1: Correct derivative		M1A1
	$\frac{\mathrm{d}y}{\mathrm{d}x}=-\frac{x}{2}+\frac{3}{2}-\frac{2}{x}+\frac{6}{x^2}+\frac{3x}{2}-3+\frac{2}{x}=x-\frac{3}{2}+\frac{6}{x^2}$ ddM1: Expands and collects terms **Dependent on both previous method marks.** A1: $x-\frac{3}{2}+\frac{6}{x^2}$ oe e.g. $\frac{2x^3-3x^2+12}{2x^2}$ and **isw**. Accept $1x$ or even $1x^1$ but not $\frac{2x}{2}$ and not x^0.		ddM1A1

<table>
<tr><td rowspan="5">Way 5</td><td>$y=\left(\frac{x}{2}+\frac{2}{x}\right)(x-3)$ or $(x^2+4)\left(\frac{1}{2}-\frac{3}{2x}\right)$</td><td>Divides one bracket by $2x$</td><td>M1</td></tr>
<tr><td rowspan="2">$=\frac{x^2}{2}-\frac{3}{2}x+2-6x^{-1}$</td><td>M1: Expands</td><td rowspan="2">M1A1</td></tr>
<tr><td>A1: Correct expression</td></tr>
<tr><td rowspan="2">$\frac{dy}{dx}=x-\frac{3}{2}+\frac{6}{x^2}$
oe e.g. $\frac{2x^3-3x^2+12}{2x^2}$</td><td>ddM1: $x^n \to x^{n-1}$ or $2 \to 0$
Dependent on both previous method marks.</td><td rowspan="2">ddM1A1</td></tr>
<tr><td>A1: $x-\frac{3}{2}+\frac{6}{x^2}$ oe and isw
Accept $1x$ or even $1x^1$ but not $\frac{2x}{2}$
If they lose the previous A1 because of an incorrect constant only then allow recovery here for a correct derivative.</td></tr>
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