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MARKSCHEME

November 2013

MATHEMATICAL STUDIES

Standard Level

Paper 1

Paper 1 Markscheme
Instructions to Examiners

Notes: **If in doubt about these instructions or any other marking issues, contact your team leader for clarification.**

The number of marks for each question is 6.

1   Abbreviations

The markscheme may make use of the following abbreviations:

M   Marks awarded for **Method**

A   Marks awarded for an **Answer** or for **Accuracy**

C   Marks awarded for **Correct** answers (irrespective of working shown)

R   Marks awarded for clear **Reasoning**

ft   Marks that can be awarded as **follow through** from previous results in the question

2   Method of Marking

(a)   All marking must be done in scoris using the mathematical studies annotations and in accordance with the current document for guidance in e-marking Mathematical Studies SL. It is essential that you read this document before you start marking.

(b)   If the candidate has full marks on a question use the *C6* annotation, if the candidate has made an attempt but scores zero marks use *C0*. If there is no attempt use the No response button. If a candidate does not score full or zero marks then full annotations **MUST** be shown.

(c)   In this paper, if the **correct answer is seen on the answer line the** maximum mark is awarded. **There is no need to check the working!** Award *C* marks and move on.

(d)   If the answer does not appear on the answer line, but the correct answer is seen in the working box with no subsequent working, award the maximum mark.

(e)   If the **answer is wrong**, marks should be awarded for the working according to the markscheme.

(f)   Working crossed out by the candidate should not be awarded any marks. Where candidates have written two solutions to a question, only the first solution should be marked.

(g)   A correct answer in the working box transcribed inaccurately to the answer line can receive full marks.

(h)   If correct working results in a correct answer **in the working box** but then further working is developed, full marks should **not** be awarded. In most such cases it will be a single final answer mark that is lost, however, a statement on the answer line should always be taken as the candidate's final decision on the answer **as long as it is unambiguous**.
Accuracy of numerical answers is an exception to this rule – see Section 5.

Example: Factorise $x^2 - 5x - 6$

Markscheme	Candidates' Scripts		Marking
$(x-6)(x+1)$ *(A1)(A1)*	(i)	Answer line: $(x+6)(x+1)$	*(A0)(A1)*
	(ii)	Working box: $(x-6)(x+1)$	*(A1)*
		followed by $x = 6$ and -1, or just $6, -1$	
		in either working box or on answer line.	*(A0)*

3   Follow through (ft) Marks

Errors made at any step of a solution affect all working that follows. To limit the severity of the penalty, **follow through (ft)** marks can be awarded. Markschemes will indicate where it is appropriate to apply follow through in a question with **'(ft)'**.

(a)   Follow through applies only from one part of a question to a subsequent part of the question. Follow through does not apply within the same part.

(b)   If an answer resulting from follow through is extremely unrealistic (*e.g.* negative distances or incorrect by large order of magnitude) then the final *A* mark should not be awarded.

(c)   If a question is transformed by an error into a **different**, **much simpler question** then follow through may not apply.

(d)   To award follow through marks for a question part, **there must be working present for that part**. An isolated follow through answer, without working is regarded as incorrect and receives no marks **even if it is approximately correct**.

(e)   The exception to the above would be in a question which is testing the candidate's use of the GDC, where working will not be expected. **The markscheme will clearly indicate where this applies.**

(f)   Inadvertent use of radians will be penalised the first time it occurs. The markscheme will give clear instructions to ensure that only one mark per paper can be lost for the use of radians.

Example: Finding angles and lengths using trigonometry

Markscheme		Candidates' Scripts		Marking
(a)	$\dfrac{\sin A}{3} = \dfrac{\sin 30}{4}$ *(M1)(A1)*	(a)	$\dfrac{\sin A}{4} = \dfrac{\sin 30}{3}$	*(M1)(A0)*
				(use of sine rule but with wrong values)
	$A = 22.0°\ (22.0243\ldots)$ *(A1)*		$A = 41.8°$	*(A0)*
				*(**Note:** the 2nd (A1) here was not marked* **(ft)** *and cannot be awarded because there was an earlier error in the **same** question part.)*
(b)	$x = 7\tan(22.0243\ldots°)$ *(M1)*	(b)	case (i) $x = 7\tan 41.8°$	*(M1)*
	$= 2.83\,(2.83163\ldots)$ *(A1)***(ft)**		$= 6.26$	*(A1)***(ft)**
		but	case (ii) 6.26	*(C0)*
				since no working shown

4   **Using the Markscheme**

(a)   *A* marks are **dependent** on the preceding *M* mark being awarded, it is **not** possible to award *(M0)(A1)*. Once an *(M0)* has been awarded, all subsequent *A* marks are lost in that part of the question, even if calculations are performed correctly, until the next *M* mark.
The only exception will be for an answer where the accuracy is specified in the question – see section 5.

(b)   *A* marks are **dependent** on the *R* mark being awarded, it is **not** possible to award *(A1)(R0)*. Hence the *(A1)* is not awarded for a correct answer if no reason or the wrong reason is given.

(c)   **Alternative methods** may not always be included. Thus, if an answer is wrong then the working must be carefully analysed in order that marks are awarded for a different method consistent with the markscheme.
Where alternative methods for complete questions are included in the markscheme, they are indicated by '**OR**' *etc*.

(d)   Unless the question specifies otherwise, accept **equivalent forms**. For example: $\dfrac{\sin\theta}{\cos\theta}$ for $\tan\theta$.

On the markscheme, these equivalent numerical or algebraic forms will sometimes be written in brackets after the required answer.
Where numerical answers are required as the final answer to a part of a question in the markscheme, the scheme will show, in order:
the 3 significant figure answer worked through from full calculator display;
the exact value (for example $\sqrt{3}$ if applicable);
the full calculator display in the form 2.83163… as in the example above.
Where answers are given to 3 significant figures and are then used in subsequent parts of the question leading to a **different** 3 significant figure answer, these solutions will also be given.

(e)   As this is an international examination, all valid **alternative forms of notation** should be accepted. Some examples of these are:

Decimal points: 1.7; 1'7; 1·7; 1,7 .

Different descriptions of an interval: $3 < x < 5$; (3, 5);] 3, 5 [.

Different forms of notation for set properties (*e.g.* complement): A'; $\bar{A}$; A^c; $U - A$;(A ;$U \setminus A$.
Different forms of logic notation: $\neg p$; p'; $\tilde{p}$; $\bar{p}$; $\sim p$.
$$p \Rightarrow q;\ p \rightarrow q;\ q \Leftarrow p\,.$$

(f)   Discretionary marks: There will be very rare occasions where the markscheme does not cover the work seen. In such cases the annotation DM should be used to indicate where an examiner has used discretion. Discretion should be used sparingly and if there is doubt an exception should be raised through scoris to the team leader.

As from Nov 11 the AP, FP and UP penalties will no longer apply. Accuracy and units will be assessed in particular questions and the marks applied according to the rules given in sections 5, 6 and 7 below.

5   Accuracy of Answers

Incorrect accuracy should be penalized once only in each question according to the rules below.

Unless otherwise stated in the question, all numerical answers should be given exactly or correct to 3 significant figures.

1.   If the candidate's unrounded answer is seen and would round to the required 3 sf answer, then award *(A1)* and ignore subsequent rounding.
Note: The unrounded answer may appear in either the working box or on the final answer line.

2.   If the candidate's unrounded answer is **not** seen then award *(A1)* if the answer given is **correctly** rounded to 2 or more significant figures, otherwise *(A0)*.
Note: If the candidate's unrounded answer is **not** seen and the answer is given correct to 1 sf (correct or not), the answer will be considered wrong and will not count as incorrect accuracy. If this answer is used in subsequent parts, then working must be shown for further marks to be awarded.

3.   If a correct 2 sf answer is used in subsequent parts, then working **must** be shown for further marks to be awarded. (This treatment is the same as for following through from an incorrect answer.)

These 3 points (see numbers in superscript) have been summarised in the table below and illustrated in the examples which follow.

	If candidates final answer is given …				
	Exact or correct to 3 or more sf	**Incorrect to 3 sf**	Correct to 2 sf [3]	Incorrect to 2 sf	Correct or incorrect to 1 sf
Unrounded answer seen[1]	Award the final *(A1)* irrespective of correct or incorrect rounding				
Unrounded answer not seen[2]	*(A1)*	*(A0)*	*(A1)*	*(A0)*	*(A0)*
Treatment of subsequent parts	As per MS	Treat as follow through, only if working is seen.[3]			

Examples:

Markscheme	Candidates' Scripts	Marking
9.43 (9.43398…) *(A1)*	(i) 9.43398… is seen in the working box followed by 9; 9.4; 9.43; 9.434 *etc.* (correctly rounded)	*(A1)*
	(ii) 9.43398… is seen in the working box followed by 9.433; 9.44 *etc.* (incorrectly rounded)	*(A1)*
	(iii) 9.4	*(A1)*
	(iv) 9	*(A0)* *(correct to 1 sf)*
	(v) 9.3	*(A0)* *(incorrectly rounded to 2 sf)*
	(vi) 9.44	*(A0)* *(incorrectly rounded to 3 sf)*

Markscheme	Candidates' Scripts	Marking
7.44 (7.43798…) *(A1)*	(i) 7.43798… is seen in the working box followed by 7; 7.4; 7.44; 7.438 *etc.* (correctly rounded)	*(A1)*
	(ii) 7.43798… is seen in the working box followed by 7.437; 7.43 *etc.* (incorrectly rounded)	*(A1)*
	(iii) 7.4	*(A1)*
	(iv) 7	*(A0)* *(correct to 1 sf)*
	(v) 7.5	*(A0)* *(incorrectly rounded to 2 sf)*
	(vi) 7.43	*(A0)* *(incorrectly rounded to 3 sf)*

Example: ABC is a right angled triangle with angle $ABC = 90°$, $AC = 32$ cm and $AB = 30$ cm. Find (a) the length of BC, (b) The area of triangle ABC.

Markscheme	Candidates' Scripts	Marking
(a) $BC = \sqrt{32^2 - 30^2}$ **(M1)** *Award **(M1)** for correct substitution in Pythagoras' formula* $= 11.1 \left(\sqrt{124}, 11.1355...\right)$(cm) **(A1)** (b) $Area = \frac{1}{2} \times 30 \times 11.1355...$ **(M1)** *Award **(M1)** for correct substitution in area of triangle formula* $= 167(167.032...)(\text{cm}^2)$ **(A1)(ft)**	(a) $BC = \sqrt{32^2 - 30^2}$ **(M1)** 11 (cm) **(A1)** *(2 sf answer only seen, but correct)* (b) case (i) $Area = \frac{1}{2} \times 30 \times 11$ **(M1)** *(working shown)* $= 165\,(\text{cm}^2)$ **(A1)(ft)** case (ii) $= 165\,(\text{cm}^2)$ **(M0)(A0)(ft)** *(No working shown, the answer 11 is treated as a ft, so no marks awarded here)*	

Rounding of an exact answer to 3 significant figures **should be accepted if performed correctly**. Exact answers such as $\frac{1}{4}$ can be written as decimals to fewer than three significant figures if the result is still exact. Reduction of a fraction to its lowest terms is **not** essential, however where an answer simplifies to an integer this is expected.

Ratios of π and answers taking the form of square roots of integers or any rational power of an integer (*e.g.* $\sqrt{13}, 2^{\frac{2}{3}}, \sqrt[4]{5}$,) may be accepted as exact answers. All other powers (*e.g.* of non-integers) and values of transcendental functions such as sine and cosine must be evaluated.

If the level of accuracy is specified in the question, a mark will be allocated for giving the answer to the required accuracy. In **all** such cases the final mark is not awarded if the rounding does not follow the instructions given in the question. A mark for specified accuracy can be regarded as a **(ft)** mark regardless of an immediately preceding *(M0)*.

Certain answers obtained from the GDC are worth 2 marks and working will not be seen. In these cases only one mark should be lost for accuracy.

e.g. Chi-squared, correlation coefficient, mean

Markscheme	Candidates' Scripts	Marking
Chi-squared	(a) 7.7	*(A2)*
7.68 (7.67543…) *(A2)*	(b) 7.67	*(A1)*
	(c) 7.6	*(A1)*
	(d) 8	*(A0)*
	(e) 7	*(A0)*
	(e) 7.66	*(A0)*

Regression line

Markscheme	Candidates' Scripts	Marking
$y = 0.888x + 13.5$ *(A2)* ($y = 0.887686…x + 13.4895…$) If an answer is not in the form of an equation award at most *(A1)(A0)*.	(a) $y = 0.89x + 13$	*(A2)* *(both accepted)*
	(b) $y = 0.88x + 13$	*(A1)* *(one rounding error)*
	(c) $y = 0.88x + 14$	*(A1)* *(rounding error repeated)*
	(d) (i) $y = 0.9x + 13$	
	(ii) $y = 0.8x + 13$	*(A1)* *(1 sf not accepted)*
	(e) $0.88x + 14$	*(A0)* *(two rounding errors and not an equation)*

Maximum/minimum/points of intersection

Markscheme	Candidates' Scripts	Marking
(2.06, 4.49) *(A1)(A1)* (2.06020…, 4.49253…)	(a) (2.1, 4.5)	*(A1)(A1)* *(both accepted)*
	(b) (2.0, 4.4)	*(A1)* *(same rounding error twice)*
	(c) (2.06, 4.4)	*(A1)* *(one rounding error)*
	(d) (2, 4.4)	*(A0)* *(1sf not accepted, one rounding error)*

6 Level of accuracy in finance questions

The accuracy level required for answers will be specified in all questions involving money. This will usually be either whole units or two decimal places. The first answer not given to the specified level of accuracy will not be awarded the final *A* mark. The markscheme will give clear instructions to ensure that only one mark per paper can be lost for incorrect accuracy in a financial question.

Example: A financial question demands accuracy correct to 2 dp.

Markscheme	Candidates' Scripts	Marking
$231.62 (231.6189) *(A1)*	(i) 231.6	*(A0)*
	(ii) 232	*(A0)* *(Correct rounding to incorrect level)*
	(iii) 231.61	*(A0)*
	(iv) 232.00	*(A0)* *(Parts (iii) and (iv) are both incorrect rounding to correct level)*

7 Units in answers

There will be specific questions for which the units are required and this will be indicated clearly in the markscheme. The first correct answer with no units or incorrect units will not be awarded the final *A* mark. The markscheme will give clear instructions to ensure that only one mark per paper can be lost for lack of units or incorrect units.

The units are considered only when the numerical answer is awarded *(A1)* under the accuracy rules given in Section 5.

Markscheme	Candidates' Scripts	Marking
(a) $37000 \, \text{m}^2$ *(A1)*	(a) $36000 \, \text{m}^2$	*(A0)* *(Incorrect answer so units not considered)*
(b) $3200 \, \text{m}^3$ *(A1)*	(b) $3200 \, \text{m}^2$	*(A0)* *(Incorrect units)*

If no method is shown and the answer is correct but with incorrect or missing units award the C marks with a one mark penalty.

8 Graphic Display Calculators

Candidates will often obtain solutions directly from their calculators. They must use mathematical notation, not calculator notation. No method marks can be awarded for incorrect answers supported only by calculator notation. The comment "I used my GDC" cannot receive a method mark.

1.   (a)   discrete   *(A1)*   *(C1)*

(b)   0   *(A1)*   *(C1)*

(c)   (i)   1.47 (1.46666...)   *(A2)*

> **Note:** Award *(M1)* for $\dfrac{176}{120}$ seen.
>
> Accept 1 **or** 2 as a final answer if 1.4666… or 1.47 seen.

(ii)   1.5   *(A1)*

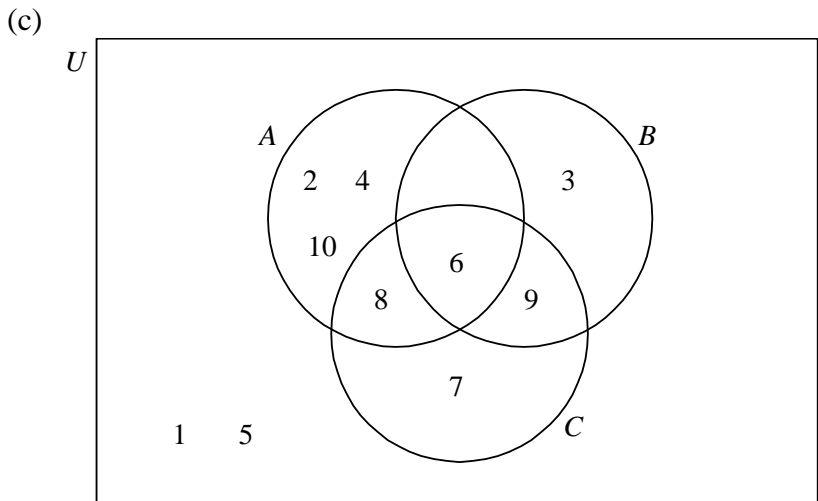(iii)   1.25 (1.25122...)   *(A1)*   *(C4)*

[6 marks]

2.   (a)   2, 4, 6, 8, 10   *(A1)*   *(C1)*

> **Note:** Do not penalize the use of {   }.

(b)   3, 6, 9   *(A1)*   *(C1)*

> **Note:** Do not penalize the use of {   }.
> Follow through from part (a) only if their U is listed.

(c)

(A1)(ft)*(A1)*(ft)*(A1)*(ft)*(A1)*(ft)*   *(C4)*

> **Notes:** Award *(A1)*(ft) for the correct placement of 6.
> Award *(A1)*(ft) for the correct placement of 8 and 9 and the empty region.
> Award *(A1)*(ft) for the correct placement of 2, 4, 3, 7, and 10.
> Award *(A1)*(ft) for the correct placement of 1 and 5.
> If an element is in more than one region, award *(A0)* for that element.
> Follow through from their answers to parts (a) and (b).

[6 marks]

3. (a) If I do not have a bowl of soup then I have an ice cream. *(A1)(A1)* *(C2)*

Notes: Award *(A1)* for If… then…
Award *(A1)* for correct statements in correct order.

(b)

p	q	$\neg p$	$\neg p \Rightarrow q$
T	T	**F**	**T**
T	F	**F**	**T**
F	T	**T**	**T**
F	F	**T**	**F**

(A1)(A1)(ft) *(C2)*

Note: Follow through from third column to fourth column.

(c) $q \Rightarrow \neg p$ *(A1)(A1)* *(C2)*

Notes: Award *(A1)* for $\Rightarrow$.
Award *(A1)* for q and $\neg p$ in correct order.
Accept $\neg p \Leftarrow q$.

[6 marks]

4. (a) $Q_2 = 119$ km *(M1)(A1)* *(C2)*

Note: Award *(M1)* for indication on graph of correct position of median.

(b) $Q_1 = 114$ and $Q_3 = 123$ *(A1)*

Note: Award *(A1)* for correct quartiles seen.

9 *(A1)* *(C2)*

(c) $240 - 220$ *(M1)*

Note: Award *(M1)* for 220 seen.

$= 20$ *(A1)* *(C2)*

[6 marks]

5. (a) $(AB^2) = 20^2 - 12^2$ *(M1)*

> **Note:** Award *(M1)* for correctly substituted Pythagoras formula.

$AB = 16 \text{ cm}$ *(A1)* *(C2)*

(b) $\dfrac{DB}{12} = 0.6$ *(M1)*

> **Note:** Award *(M1)* for correct substitution in tangent ratio or equivalent
> *ie* seeing 12×0.6.

$DB = 7.2 \text{ cm}$ *(A1)* *(C2)*

> **Note:** Award *(M1)(A0)* for using $\tan 31$ to get an answer of 7.21.
> Award *(M1)(A0)* for $\dfrac{12}{\sin 59} = \dfrac{DB}{\sin 31}$ to get an answer of
> 7.2103… or any other incorrect answer.

(c) $\dfrac{1}{2} \times 12 \times (16 - 7.2)$ *(M1)*

> **Note:** Award *(M1)* for their correct substitution in triangle area formula.

OR

$\dfrac{1}{2} \times 12 \times 16 - \dfrac{1}{2} \times 12 \times 7.2$ *(M1)*

> **Note:** Award *(M1)* for subtraction of their two correct area formulas.

$= 52.8 \text{ cm}^2$ *(A1)*(ft) *(C2)*

> **Notes:** Follow through from parts (a) and (b).
> Accept alternative methods.

[6 marks]

6. (a) $145 + (5-1)d = 113$ *(M1)*

> **Note:** Award *(M1)* for correctly substituted AP formula.

   OR

   $\dfrac{113-145}{4}$ *(M1)*

   $= -8$ *(A1)*   *(C2)*

(b) $145 + (n-1) \times -8 = -7$ *(M1)*

> **Note:** Award *(M1)* for their correctly substituted AP formula.
> If a list is used award *(M1)* for their correct values down to −7.

   $n = 20$ *(A1)*(ft)   *(C2)*

> **Note:** Follow through from their part (a).

(c) $S_{20} = \dfrac{20}{2}\left(2 \times 145 + (20-1) \times -8\right)$ *(M1)*

> **Note:** Award *(M1)* for their correctly substituted sum of an AP formula.
> If a list is used award *(M1)* for their correct terms up to 1380

   $= 1380$ *(A1)*(ft)

> **Note:** Follow through from their part (a).

   OR

   $S_{20} = \dfrac{20}{2}\left(145 + (-7)\right)$ *(M1)*

> **Note:** Award *(M1)* for correctly substituted sum of an AP formula.

   $= 1380$ *(A1)*   *(C2)*

> **Note:** If candidates have listed the terms correctly and given the common
> difference as 8, award *(M1)(A0)* for part (a), *(M1)(A0)* for an answer
> of −18 or 18 for part (b) and *(M1)(A1)*(ft) for an answer of 4420 in
> part (c) with working seen.

[6 marks]

7.   (a)

$\dfrac{3}{5}$ Bus

$\dfrac{2}{3}$ Buys a magazine

$\dfrac{1}{3}$ Does not buy a magazine

$\dfrac{2}{5}$ Train

$\dfrac{3}{4}$ Buys a magazine

$\dfrac{1}{4}$ Does not buy a magazine

(A1)(A1)(A1)   *(C3)*
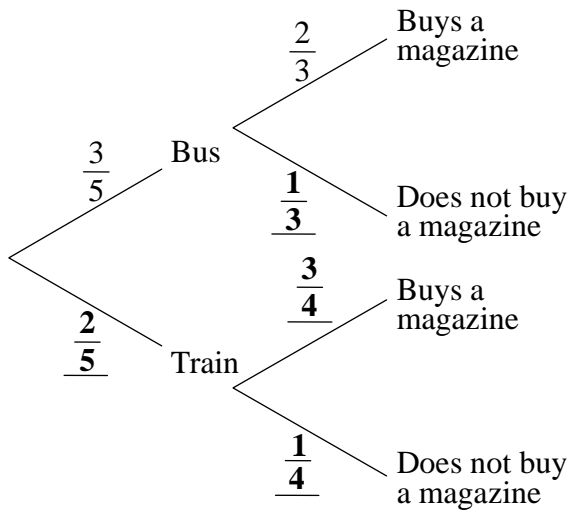
> **Note:** Award *(A1)* for each correct pair of branches.

(b) $\dfrac{3}{5} \times \dfrac{2}{3} + \dfrac{2}{5} \times \dfrac{3}{4}$ *(A1)*(ft)*(M1)*

> **Notes:** Award *(A1)*(ft) for two consistent products from tree diagram, *(M1)* for addition of their products.
> Follow through from their tree diagram provided all probabilities are between 0 and 1.

$\dfrac{7}{10}\ \left(0.7,\,70\%,\,\dfrac{42}{60}\right)$ *(A1)*(ft)   *(C3)*

[6 marks]

8. (a) The (preferred) swimming style is independent of gender　　　　*(A1)*　　*(C1)*

> **Notes:** Accept "not associated".　Do not accept "not related",
> "not correlated" or "not influenced".

(b) 3　　　　*(A1)*　　*(C1)*

(c) $\chi^2_{calc} = 16.4\,(16.4285\ldots)$　　　　*(A2)*　　*(C2)*

(d) Do not accept the Null Hypothesis (Reject the Null Hypothesis).
$\chi^2_{calc} > \chi^2_{crit}$ **OR** $16.4 > 7.815$　　　　*(R1)(A1)*(ft)

　　OR

Do not accept the Null Hypothesis (Reject the Null Hypothesis).
p-value of $9.26148\ldots \times 10^{-4} < 0.05$　　　　*(R1)(A1)*(ft)　*(C2)*

> **Notes:** Follow through from their answer to part (c).
> Accept "(preferred) swimming style is not independent (dependent) of gender" as the conclusion.
> Do not award *(R0)(A1)*.
> If using the p-value the value must be seen.

[6 marks]

9. (a) $2x^4 - x$　　　　*(A1)(A1)*　　*(C2)*

> **Note:** Award *(A1)* for $2x^4$, *(A1)* for $-x$.

(b) $8x^3 - 1$　　　　*(A1)*(ft)*(A1)*(ft)　*(C2)*

> **Note:** Award *(A1)*(ft) for $8x^3$, *(A1)*(ft) for -1.　Follow through from their part (a).
> Award at most *(A1)(A0)* if extra terms are seen.

(c) $8x^3 - 1 = 0$　　　　*(M1)*
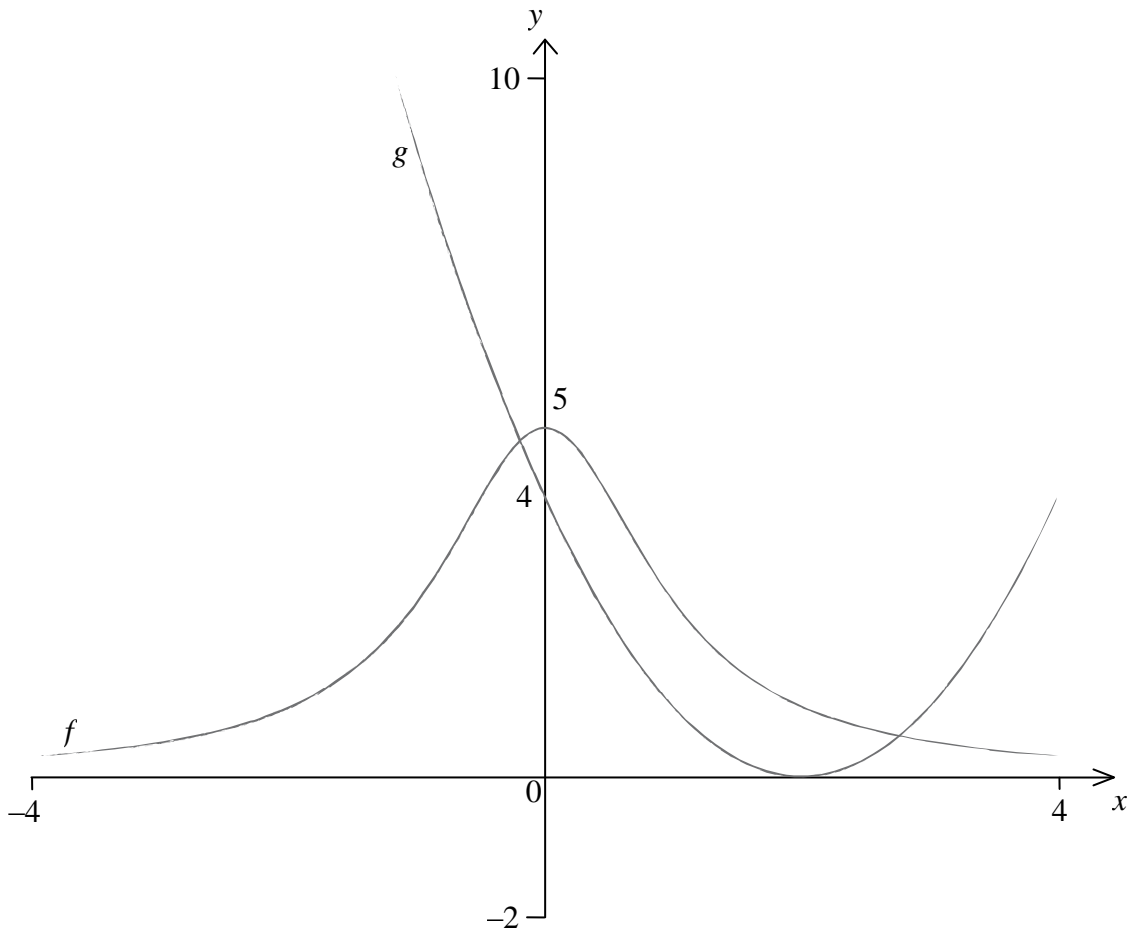
> **Note:** Award *(M1)* for equating their part (b) to zero.

$(x =) \dfrac{1}{2}\,(0.5)$　　　　*(A1)*(ft)　*(C2)*

> **Notes:** Follow through from part (b).
> 0.499 is the answer from the use of trace on the GDC; award *(A0)(A0)*.
> For an answer of $(0.5, -0.375)$, award *(M1)(A0)*.

[6 marks]

10. (a)

$f(x)$: a smooth curve symmetrical about y-axis, $f(x) > 0$ *(A1)*

Note: If the graph crosses the x-axis award *(A0)*.

Intercept at their numbered $y = 5$ *(A1)*

Note: Accept clear scale marks instead of a number.

$g(x)$: a smooth parabola with axis of symmetry at about $x = 2$ (the
2 does not need to be numbered) and $g(x) \geq 0$ *(A1)*

Note: Right hand side must not be higher than the
maximum of $f(x)$ at $x = 4$.
Accept the quadratic correctly drawn beyond
$x = 4$.

Intercept at their numbered $y = 4$ *(A1)*   *(C4)*

Note: Accept clear scale marks instead of a number.

Question 10 continued

(b)   −0.195, 2.76   (−0.194808..., 2.761377...)   **(A1)(ft)(A1)(ft)**   **(C2)**

> **Note:** Award **(A0)(A1)(ft)** if both coordinates are given.
>
> Follow through only if $f(x) = \dfrac{5}{x^2} + 1$ is sketched; the solutions are −0.841, 3.22 (−0.840913..., 3.217747...)

[6 marks]

11. (a) $512 \left(\dfrac{1}{2} \right)^5$ **(M1)(A1)**

> **Note:** Award **(M1)** for substituted geometric progression formula, **(A1)** for correct substitution.
> If a list is used, award **(M1)** for a list of at least six terms, beginning with 512 and **(A1)** for first six terms correct.

16   **(A1)**   **(C3)**

(b) $S_9 = 256 \left(\dfrac{1 - \left(\dfrac{1}{2} \right)^9}{1 - \dfrac{1}{2}} \right)$ **OR** $\dfrac{(2^9 - 1)}{2 - 1}$ **(M1)(A1)**

> **Note:** Award **(M1)** for substituted sum of a GP formula, **(A1)** for correct substitution.
> If a list is used, award **(A1)** for at least 9 correct terms, including 1, and **(M1)** for their 9 terms, including 1, added together.

511   **(A1)**   **(C3)**

[6 marks]

12. (a) $a(1)^2 + b = -9$ *(A1)*

$a(3)^2 + b = 119$ *(A1)* *(C2)*

> **Note:** Accept equivalent forms of the equations.

(b) (i) $a = 16$ *(A1)(ft)*

(ii) $b = -25$ *(A1)(ft)* *(C2)*

> **Note:** Follow through from part (a) irrespective of whether working is seen.
> If working is seen follow through from part (i) to part (ii).

(c) $16c^2 - 25 = 171$ *(M1)*

> **Note:** Award *(M1)* for correct quadratic with their a and b substituted.

$c = 3.5$ *(A1)(ft)* *(C2)*

> **Note:** Accept x instead of c.
> Follow through from part (b).
> Award *(A1)* only, for an answer of ± 3.5 with or without working.

[6 marks]

13. (a) $8 \times 66 \times 12 \times 20 - 80\,000$ *(M1)(M1)*

> **Note:** Award *(M1)* for multiplication of correct 4 terms, *(M1)* for subtraction of 80 000 seen.

   ($) 46 720   *(A1)*   *(C3)*

> **Note:** Accept 46 700
> Award at most *(M1)(A1)(A0)* for an answer of ($)126720 seen **with** working.
> Award at most *(A1)(A0)(A0)* for an answer of ($)126720 seen **without** working.

(b) $\dfrac{500}{116.11} \times 10\,000$ *(M1)*

> **Note:** Award *(M1)* for division by 116.11.

   43 062.6…   *(A1)*
   ($)43 000   *(A1)(ft)*   *(C3)*

> **Notes:** The final *(A1)(ft)* is for the rounding **down** of their answer.
> Award *(M1)(A1)(A0)* for an answer of ($)43 100 **with** working seen.
> Award *(A2)(A0)* for an answer of ($)43 100 **without** working seen.

                                                                              [6 marks]

14. (a)   (i)   3   *(A1)*

      (ii)   180°   *(A1)*   *(C2)*

   (b)   (i) $a = 2$ *(A1)*

      (ii) $b = 1$ *(A1)*

      (iii) $c = -1$ *(A1)*   *(C3)*

   (c)   5   *(A1)*   *(C1)*

                                                                              [6 marks]

15. (a) $200 \times (1.9)^{0.85 \times 6}$ *(M1)*

> **Note:** Award *(M1)* for correct substitution into given formula.

   $= 5280$ *(A1)*   *(C2)*

> **Note:** Accept 5281 or 5300 but no other answer.

   (b) $1\,000\,000 < 200 \times (1.9)^{0.85t}$ *(M1)(M1)*

> **Note:** Award *(M1)* for setting up the inequality (accept an equation),
> and *(M1)* for $1\,000\,000$ seen in the inequality or equation.

   $t = 15.6$ $(15.6113\ldots)$ *(A1)*
   16 hours   *(A1)***(ft)**   *(C4)*

> **Note:** The final *(A1)***(ft)** is for rounding **up** their answer to the nearest hour.
> Award *(C3)* for an answer of 15.6 with no working.
> Accept 1 000 001 in an equation.

[6 marks]