Diploma Programme
Programme du diplôme
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Markscheme

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Mathematical studies

Standard level

Paper 1

International Baccalaureate
Baccalauréat International
Bachillerato Internacional

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 RM Assessor 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, indicating a lack of mathematical understanding 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**. An exception to this may be in numerical answers, where a correct exact value is followed by an incorrect decimal.

Example:

	Correct answer seen	Further working seen	Action
1.	$8\sqrt{2}$	5.65685... *(incorrect decimal value)*	Award the final *(A1)* *(ignore the further working)*
2.	$(x-6)(x+1)$	$x=6$ and -1	Do **not** award the final *(A1)* *(see next example)*

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: $(x-6)(x+1)$ followed by $x = 6$ and -1, or just $6, -1$ in either working box or on answer line.	**(A1)** **(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 (*eg*, 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)** $= 2.83\ (2.83163\ldots)$ **(A1)(ft)**	(b) case (i) $x = 7\tan 41.8°$ $= 6.26$ ***but*** case (ii) 6.26	**(M1)** **(A1)(ft)** **(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 $\left(\text{for example } \dfrac{2}{3} \text{ if applicable}\right)$;

the full calculator display in the form $2.83163\ldots$ 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; $1'7$; $1 \cdot 7$; $1,7$.

Decimal numbers less than 1 may be written with or without a leading zero: 0.49 or $.49$.

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

Different forms of notation for set properties (*e.g.* complement): A'; $\overline{A}$; A^c; $U - A$; $(A$; $U \setminus A$.

Different forms of logic notation: $\neg p$; p'; $\tilde{p}$; $\overline{p}$; $\sim p$.
$$p \Rightarrow q\,;\ p \rightarrow q\,;\ q \Leftarrow p\,.$$

Significance level may be written as α .

(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 RM Assessor to the team leader.

As with previous sessions there will be no whole paper penalty marks for accuracy AP, financial accuracy FP and units UP. Instead these skills 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 answer** is seen to 4 sf or greater **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 summarized in the table below and illustrated in the examples which follow.

	If candidates final answer is given …					
	Exact or to 4 or more sf (and would **round to the correct 3 sf**)	**Correct to 3 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)**	**(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)**	(a) $\;\;BC = \sqrt{32^2 - 30^2}$ $11\,(cm)$	**(M1)** **(A1)** *(2 sf answer only seen, but correct)*
(b) $\;\;Area = \dfrac{1}{2} \times 30 \times 11.1355...$ **(M1)** *Award **(M1)** for correct substitution in area of triangle formula* $= 167(167.032...)(cm^2)$ **(A1)(ft)**	(b) case (i) $Area = \dfrac{1}{2} \times 30 \times 11$ $= 165\,(cm^2)$ case (ii) $= 165\,(cm^2)$	**(M1)** *(working shown)* **(A1)(ft)** **(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 $\dfrac{1}{4}$ can be written as decimals to fewer than 3 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 (*eg,* 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.

eg, 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 or two marks 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) $\dfrac{\left(\tan\left(2\times30\right)+1\right)\left(2\cos\left(30\right)-1\right)}{41^2-9^2}$ **(M1)**

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

$= 0.00125 \ \left(\dfrac{1}{800}\right)$ **(A1)**   **(C2)**

> **Note:** Using radians the answer is -0.000570502, award at most **(M1)(A0)**.

(b) (i)   0.0013   **(A1)(ft)**

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

   (ii)   0.001   **(A1)(ft)**   **(C2)**

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

(c) $\left|\dfrac{0.002-0.00125}{0.00125}\right|\times100$ **(M1)**

> **Notes:** Award **(M1)** for their correct substitution into the percentage error formula.
> Absolute value signs are not required.
> Their **unrounded** answer from part (a) must be used.
> Do **not** accept use of answers from part (b).

$= 60\,(\%)$ **(A1)(ft)**   **(C2)**

> **Notes:** The % sign is not required.
> The answer from radians is $450.568\,\%$, award **(M1)(A1)(ft)**.
> Follow through from part (a).

[6 marks]

2. (a)   2 3 3 4 4 5 5 5 6 7   *(M1)*

> **Note:** Award *(M1)* for correct ordered set.

   (Median =) 4.5   *(A1)*   *(C2)*

(b) $5-3$ *(M1)*

> **Note:** Award *(M1)* for correct quartiles seen.

   $= 2$ *(A1)*   *(C2)*

(c) $\dfrac{7}{10}$ (0.7, 70%)   *(A2)*   *(C2)*

[6 marks]

3. (a) $(3, 1)$ *(A1)(A1)*   *(C2)*

> **Note:** Accept $x = 3$, $y = 1$. Award *(A0)(A1)* if parentheses are missing.

(b) $\dfrac{2-0}{0-6}$ *(M1)*

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

   $= -\dfrac{1}{3}$ (−0.333333...)   *(A1)*   *(C2)*

> **Note:** Accept $-\dfrac{2}{6}$.

(c) $(y-2) = -\dfrac{1}{3}(x-3)$ *(M1)*

   OR

   $2 = -\dfrac{1}{3}(3) + c$ *(M1)*

> **Note:** Award *(M1)* for substitution of their gradient from part (b).

   $y = -\dfrac{1}{3}x + 3$ *(A1)(ft)*   *(C2)*

> **Note:** Follow through from part (b).
> The answer must be an equation in the form $y = mx + c$ for the
> *(A1)(ft)* to be awarded.

[6 marks]

4. (a) (i) -0.998 $(-0.997770...)$ **(A2)**

> **Note:** Award **(A0)(A1)** for 0.998 $(0.997770…)$.
> Award **(A1)(A0)** for -0.997.

(ii) $y = -0.470x + 81.7$ $(y = -0.469713...x + 81.7279...)$ **(A1)(A1)** **(C4)**

> **Note:** Award a maximum of **(A0)(A1)** if the answer is not an equation.

(b) $-0.469713...(28) + 81.7279$ **(M1)**

> **Note:** Award **(M1)** for correct substitution of 28 into their equation of regression line.

$= 68.6$ (mosquitoes) $(68.5759…)$ **(A1)(ft)** **(C2)**

> **Note:** Accept 68 or 69 or 68.5(4) from use of 3 sf values.
> Follow through from part (a)(ii).

[6 marks]

5. (a) $\dfrac{4}{3}\pi(6371)^3$ **(M1)**

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

$= 1.08 \times 10^{12} \ (1.08320...\times 10^{12})$ **(A2)**   **(C3)**

> **Notes:** Award **(A1)(A0)** for correct mantissa between 1 and 10, with incorrect index.
> Award **(A1)(A0)** for 1.08E12.
> Award **(A0)(A0)** for answers of the type: 108×10^{10}.

(b) $\dfrac{1.08320...\times 10^{12}}{2.1958 \times 10^{10}}$ **(M1)**

> **Note:** Award **(M1)** for dividing their answer to part (a) by 2.1958×10^{10}.

$= 49.3308...$ **(A1)(ft)**

> **Note:** Accept 49.1848… from use of 3 sf answer to part (a).

$= 49$ **(A1)**   **(C3)**

> **Notes:** Follow through from part (a).
> The final **(A1)** is awarded for their unrounded non-integer answer seen and given correct to the nearest integer.
> Do not award the final **(A1)** for a rounded answer of 0 or if it is incorrect by a large order of magnitude.

[6 marks]

6. (a) 800×1.55 **(M1)**

> **Note:** Award **(M1)** for multiplication by 1.55.

$= 1240$ **(A1)** **(C2)**

(b) $\dfrac{100 \times 1.92}{1.28}$ **(A1)(M1)(M1)**

> **Notes:** Award **(M1)** for multiplication by a GBP rate (1.92 or 2.05), **(M1)** for division by a USD rate (1.28 or 1.15), **(A1)** for two correct rates used.

$= 150$ **(A1)** **(C4)**

> **Note:** Award a maximum of **(A1)(ft)(M1)(M1)(A1)(ft)** for
> $\dfrac{100 \times 2.05}{1.15}$, if in part (a) a rate of 1.75 is used.
>
> Award a maximum of **(A1)(ft)(M1)(M1)(A1)(ft)** if division by an EUR rate is seen in part (a) and multiplication by 1.28 and division by 1.92 is seen in (b).

[6 marks]

7. (a) (i) $u_1 + d = 30$, $u_1 + 4d = 90$, $3d = 90 - 30$ (or equivalent) **(M1)**

> **Note:** Award **(M1)** for **one** correct equation.
> Accept a list of at least 5 correct terms.

$(d =) 20$ **(A1)**

(ii) $(u_1 =) 10$ **(A1)(ft)** **(C3)**

> **Note:** Follow through from (a)(i), irrespective of working shown if
> $u_1 = 30 - ($their $d)$ **OR** $u_1 = 90 - 4 \times ($their $d)$.

(b) $(u_7 =) 10(3^{(7-1)})$ **OR** $(u_7 =) 10 \times 3^6$ **(M1)(A1)(ft)**

> **Note:** Award **(M1)** for substituted geometric sequence formula,
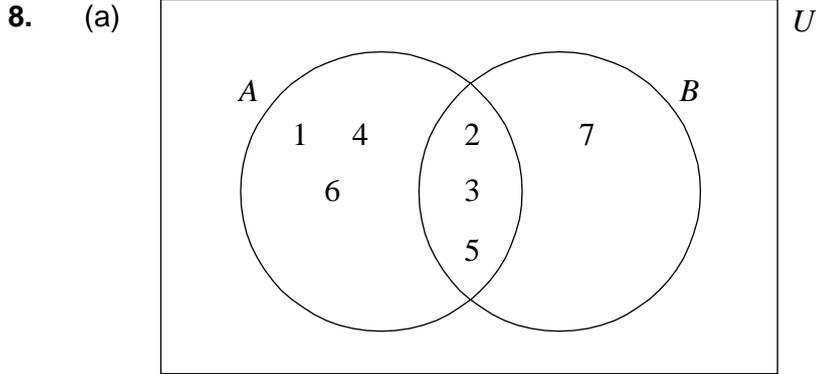> **(A1)(ft)** for their correct substitutions.

OR

10; 30; 90; 270; 810; 2430; 7290 **(M1)(A1)(ft)**

> **Note:** Award **(M1)** for a list of at least 5 consecutive terms of a geometric
> sequence, **(A1)(ft)** for terms corresponding to their answers in part (a).

$= 7290$ **(A1)(ft)** **(C3)**

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

[6 marks]

8. (a)

(A1)(A1) (C2)

Note: Award **(A1)** for 2, 3, 5 in intersection, **(A1)** for 1, 4, 6, 7 correctly placed.

(b) 1 **(M1)(A1)**(ft) (C2)

Notes: Award **(M1)(A0)** for listing the elements of their set $B \cap A'$; shading the correct region on diagram; or an answer of 1/7 with a correct Venn diagram. Follow through from part (a).

(c) Correct, from $(2, 2)$ $(3, 3)$ and $(5, 5)$ on sample space

OR

Correct, from a labelled tree diagram

OR

Correct, from a sample space diagram

OR

Correct, from $3 \times \dfrac{1}{4} \times \dfrac{1}{6}$ (or equivalent) **(A1)**(ft)**(R1)** (C2)

Notes: Do not award **(A1)**(ft)**(R0)**. Award **(R1)** for a consistent reason with their part (a). Follow through from part (a).

[6 marks]

9. (a) $AC^2 = 8^2 + 6^2$ *(M1)*

> **Note:** Award *(M1)* for correct substitution into Pythagoras, or recognition of Pythagorean triple.

$AC = 10$ *(A1)*

> **Note:** Award *(A2)* for $AC = 10$ **OR** $AM = 5$ with no working seen.

$VM^2 = 13^2 - 5^2$ *(M1)*

> **Note:** Award *(M1)* for correct second use of Pythagoras, using the result from the first use of Pythagoras.

$VM = 12$ (cm) *(A1)* *(C4)*

> **Notes:** Accept alternative methods and apply the markscheme as follows: Award *(M1)(A1)* for first correct use of Pythagoras with lengths from the question, *(M1)* for a correct second use of Pythagoras, consistent with the method chosen, *(A1)* for correct height.

(b) $\dfrac{1}{3} \times 8 \times 6 \times 12$ *(M1)*

> **Note:** Award *(M1)* for their correct substitutions into volume formula.

$= 192 \, \text{cm}^3$ *(A1)(ft)* *(C2)*

> **Notes:** Follow through from part (a), only if working seen.

[6 marks]

10. (a) $5000\left(1+\dfrac{4.5}{12\times100}\right)^{12\times7}$ *(M1)(A1)*

> **Note:** Award *(M1)* for substitution into compound interest formula, *(A1)* for correct substitutions.

OR

$N = 7$
$I\% = 4.5$
$PV = (\pm)\,5000$
$P/Y = 1$
$C/Y = 12$ *(A1)(M1)*

> **Note:** Award *(A1)* for $C/Y = 12$ seen, *(M1)* for all other correct entries.

OR

$N = 84$
$I\% = 4.5$
$PV = (\pm)\,5000$
$P/Y = 12$
$C/Y = 12$ *(A1)(M1)*

> **Note:** Award *(A1)* for $C/Y = 12$ seen, *(M1)* for all other correct entries.

$= 6847.26$ (euros)   *(A1)*   *(C3)*

> **Note:** Answer must be correct to 2 decimal places for the final *(A1)* to be awarded.

(b) $14000 = 7000\left(1+\dfrac{r}{100}\right)^{10}$ *(M1)(A1)*

> **Notes:** Award *(M1)* for substitution into compound interest formula equated to 14000 or equivalent.
> Award *(A1)* for correct substitutions.

OR

$N = 10$
$PV = \pm7000$
$FV = \mp14000$
$P/Y = 1$
$C/Y = 1$ *(A1)(M1)*

> **Note:** Award *(A1)* for $C/Y = 1$ seen, *(M1)* for other correct entries.
> PV and FV must have opposite signs.

$r = 7.18\%$ $(7.17734...\%,\ 0.0718)$ *(A1)*   *(C3)*

> **Note:** Do not penalize if % sign is missing.   Do not accept 0.0718%.

[6 marks]

11. (a) 0.9   *(A1)*   *(C1)*

     (b) 0.75×0.05 *(M1)*

           $= 0.0375 \left(\dfrac{3}{80}, \ 3.75\ \% \right)$ *(A1)*   *(C2)*

     (c) $\dfrac{0.75 \times 0.05}{0.75 \times 0.05 + 0.25 \times 0.1}$ *(M1)(M1)*

> **Note:** Award *(M1)* for their correct numerator, *(M1)* for their correct
> denominator, *ie*, $\left(\dfrac{\text{their (b)}}{\text{their (b)} + 0.25 \times 0.1} \right)$.
>
> Do not award *(M1)* for *their* 0.0375 or 0.0625 if not a correct
> part of a fraction.

           $= 0.6 \left(\dfrac{3}{5}, \ 60\ \% \right)$ *(A1)(ft)*   *(C3)*

> **Note:** Follow through from part (b).

                                                                 [6 marks]

12. (a) $180 = 150m + c$ (or equivalent)   *(A1)*   *(C1)*

     (b) $181.5 = 210m + c$ (or equivalent)   *(A1)*   *(C1)*

     (c) $m = 0.025, \ c = 176.25$ *(A1)(A1)(ft)*

> **Note:** Follow through from part (a) and part (b), irrespective of
> working shown.

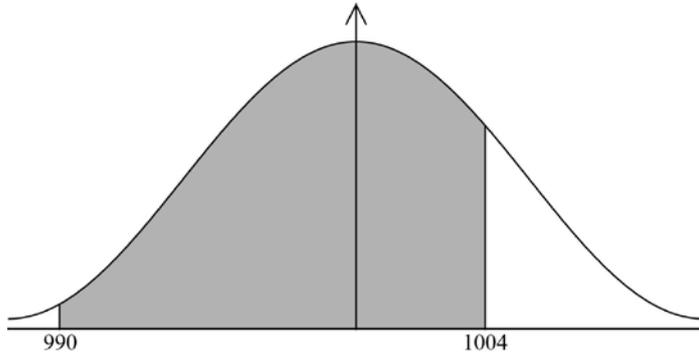 $L = 0.025 (40) + 176.25$ *(M1)*

> **Note:** Award *(M1)* for substitution of their *m*, their *c* and 40 into equation.

        $L = 177\ (177.25)\ (\text{mm})$ *(A1)(ft)*   *(C4)*

> **Note:** Follow through, within **part (c)**, from their *m* and *c* only if
> working shown.

                                                                 [6 marks]
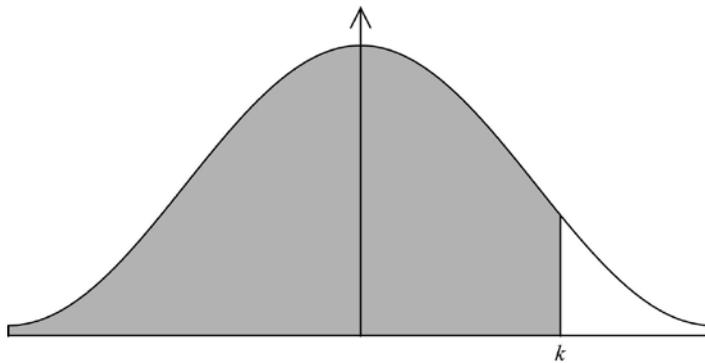
13.   (a)

(M1)

> **Note:** Award *(M1)* for approximate curve with 990 and 1004 in correct place.

     0.835 (0.835135…, 83.5%)   *(A1)*   *(C2)*

(b)

(M1)

> **Note:** Award *(M1)* for approximate curve with k placed to the right of the mean.
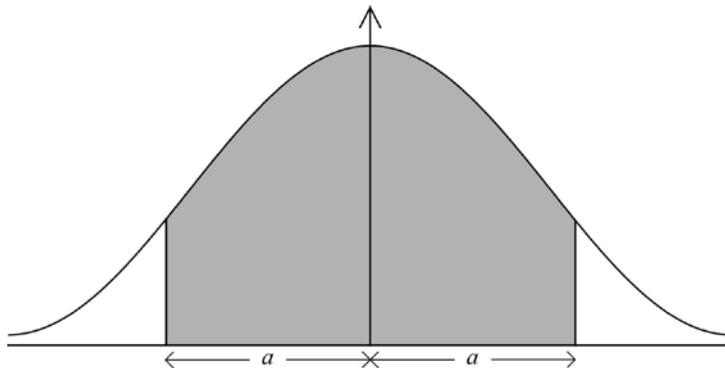
     1010 (1006.57...)   *(A1)*   *(C2)*

> **Note:** Award full marks **only** for 1010, 1007 or an answer with more than 4 sf resulting from **correct** rounding of 1006.57… .

(c)

(M1)

> **Note:** Award *(M1)* for some indication of symmetry on diagram.

Question 13 continued

OR

$$P(W < 1000 - a) = 0.05 \quad \textbf{OR} \quad P(W > 1000 + a) = 0.05 \qquad \textbf{(M1)}$$

> **Note:** Award **(M1)** for probability with single inequality resulting from symmetry of diagram.

$$(a =) \ 6.58 \ (6.57941...) \qquad \textbf{(A1)} \qquad \textbf{(C2)}$$

[6 marks]

14. (a) $0 = p(6)(q - 6)$ **(M1)**
     $q = 6$ **(A1)**

     OR

$$f(x) = -px^2 + pqx$$
$$3 = \frac{-pq}{-2p} \qquad \textbf{(M1)}$$
$$q = 6 \qquad \textbf{(A1)}$$

     OR

$$f(x) = -px^2 + pqx$$
$$f'(x) = pq - 2px \qquad \textbf{(M1)}$$
$$pq - 2p(3) = 0$$
$$q = 6 \qquad \textbf{(A1)} \qquad \textbf{(C2)}$$

(b) $27 = p(3)(6 - 3)$ **(M1)**

> **Note:** Award **(M1)** for correct substitution of the vertex $(3, 27)$ **and** *their q* into $f(x) = px(q - x)$ or equivalent.

     $p = 3$ **(A1)(ft)**   **(C2)**

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

(c) $y \leq 27 \ \left(f(x) \leq 27 \right)$ **(A1)(A1)**   **(C2)**

> **Notes:** Award **(A1)** for $y \leq$ (or $f(x) \leq$), **(A1)** for 27 as part of an inequality.
> Accept alternative notation: $(-\infty, 27]$, $]-\infty, 27]$.
> Award **(A0)(A1)** for $[27, -\infty)$.
> Award **(A0)(A0)** for $(-\infty, \infty)$.

[6 marks]

15. (a) $72 = 12x + 4h$ (or equivalent) **(M1)**

> **Note:** Award **(M1)** for a correct equation obtained from the total length of the edges.

$V = 2x^2(18 - 3x)$ **(A1)**

$(a =)\ 36$ **(A1)** **(C3)**

(b) $\dfrac{\mathrm{d}V}{\mathrm{d}x} = 72x - 18x^2$ **(A1)**

$72x - 18x^2 = 0$ **OR** $\dfrac{\mathrm{d}V}{\mathrm{d}x} = 0$ **(M1)**

> **Notes:** Award **(A1)** for $-18x^2$ seen. Award **(M1)** for equating derivative to zero.

$(x =)\ 4$ **(A1)(ft)** **(C3)**

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

OR

Sketch of V with visible maximum **(M1)**

Sketch with $x \geq 0$, $V \geq 0$ and indication of maximum (e.g. coordinates) **(A1)(ft)**

$(x =)\ 4$ **(A1)(ft)** **(C3)**

> **Notes:** Follow through from part (a).
> Award **(M1)(A1)(A0)** for (4, 192).
> Award **(C3)** for $x = 4$, $y = 192$.

[6 marks]