M14/5/MATME/SP1/ENG/TZ1/XX/M

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MARKSCHEME

May 2014

MATHEMATICS

Standard Level

Paper 1

17 pages

Instructions to Examiners

All examiners must read these instructions carefully, as there are some changes since M13.

Abbreviations

M Marks awarded for attempting to use a correct **Method**; working must be seen.

(M) Marks awarded for **Method**; may be implied by **correct** subsequent working.

A Marks awarded for an **Answer** or for **Accuracy**; often dependent on preceding ***M*** marks.

(A) Marks awarded for an **Answer** or for **Accuracy**; may be implied by **correct** subsequent working.

R Marks awarded for clear **Reasoning**.

N Marks awarded for **correct** answers if **no** working shown.

AG Answer given in the question and so no marks are awarded.

Using the markscheme

1 General

Mark according to scoris instructions and the document "**Mathematics SL: Guidance for e-marking May 2014**". It is **essential** that you read this document before you start marking. In particular, please note the following. Marks must be recorded using the annotation stamps, using the new scoris tool. Please check that you are entering marks for the right question.

- If a part is **completely correct**, (and gains all the "must be seen" marks), use the ticks with numbers to stamp full marks. Do **not** use the ticks with numbers for anything else.
- If a part is completely wrong, stamp ***A0*** by the final answer.
- If a part gains anything else, all the working **must** have annotations stamped to show what marks are awarded. This includes any zero marks.

All the marks will be added and recorded by scoris.

2 Method and Answer/Accuracy marks

- Do **not** automatically award full marks for a correct answer; all working **must** be checked, and marks awarded according to the markscheme.
- It is generally not possible to award ***M0*** followed by ***A1***, as ***A*** mark(s) depend on the preceding ***M*** mark(s), if any. An exception to this rule is when work for ***M1*** is missing, as opposed to incorrect (see point 4).
- Where ***M*** and ***A*** marks are noted on the same line, *eg* ***M1A1***, this usually means ***M1*** for an **attempt** to use an appropriate method (*eg* substitution into a formula) and ***A1*** for using the **correct** values.
- Where there are two or more ***A*** marks on the same line, they may be awarded independently; so if the first value is incorrect, but the next two are correct, award ***A0A1A1***.
- Where the markscheme specifies ***(M2)***, ***N3***, *etc*., do **not** split the marks, unless there is a note.
- Once a correct answer to a question or part-question is seen, ignore further working.

- Most ***M*** marks are for a **valid** method, ie a method which can lead to the answer: it must indicate some form of progress towards the answer.

3 *N* marks

*If **no** working shown, award **N** marks for **correct** answers – this includes acceptable answers (see accuracy booklet). In this case, ignore mark breakdown (**M**, **A**, **R**).*

- Do **not** award a mixture of ***N*** and other marks.
- There may be fewer ***N*** marks available than the total of ***M***, ***A*** and ***R*** marks; this is deliberate as it penalizes candidates for not following the instruction to show their working.
- There may not be a direct relationship between the ***N*** marks and the implied marks. There are times when all the marks are implied, but the ***N*** marks are not the full marks: this indicates that we want to see some of the working, without specifying what.
- For consistency within the markscheme, ***N*** marks are noted for every part, even when these match the mark breakdown.
- If a candidate has incorrect working, which somehow results in a correct answer, do **not** award the ***N*** marks for this correct answer. However, if the candidate has indicated (usually by crossing out) that the working is to be ignored, award the ***N*** marks for the correct answer.

4 Implied and must be seen marks

*Implied marks appear in **brackets** eg **(M1)**.*

- Implied marks can only be awarded if the work is seen or if implied in subsequent working (a correct final answer does not necessarily mean that the implied marks are all awarded). There are questions where some working is required, but as it is accepted that not everyone will write the same steps, all the marks are implied, but the ***N*** marks are not the full marks for the question.
- Normally the correct work is seen in the next line.
- Where there is an (***M1***) followed by ***A1*** for each correct answer, if no working shown, one correct answer is sufficient evidence to award the (***M1***).

*Must be seen marks appear without **brackets** eg **M1**.*

- Must be seen marks can only be awarded if the work is seen.
- If a must be seen mark is not awarded because work is missing (as opposed to ***M0*** or ***A0*** for incorrect work) all subsequent marks may be awarded if appropriate.

5 Follow through marks (only applied after an error is made)

*Follow through (**FT**) marks are awarded where an incorrect answer (final or intermediate) from one **part** of a question is used correctly in **subsequent** part(s) or subpart(s). Usually, to award **FT** marks, **there must be working present** and not just a final answer based on an incorrect answer to a previous part. However, if the only marks awarded in a subpart are for the **final** answer, then **FT** marks should be awarded if appropriate. Examiners are expected to check student work in order to award **FT** marks where appropriate.*

- Within a question part, once an **error** is made, no further ***A*** marks can be awarded for work which uses the error, but ***M*** and ***R*** marks may be awarded if appropriate. (However, as noted above, if an ***A*** mark is not awarded because work is missing, all subsequent marks may be awarded if appropriate).
- Exceptions to this rule will be explicitly noted on the markscheme.
- If the question becomes much simpler because of an error then use discretion to award fewer ***FT*** marks.
- If the error leads to an inappropriate value (*eg* probability greater than 1, use of $r > 1$ for the sum of an infinite GP, $\sin\theta = 1.5$, non integer value where integer required), do not award the mark(s) for the final answer(s).
- The markscheme may use the word "**their**" in a description, to indicate that candidates may be using an incorrect value.
- If a candidate makes an error in one part, but gets the correct answer(s) to subsequent part(s), award marks as appropriate, unless the question says hence. It is often possible to use a different approach in subsequent parts that does not depend on the answer to previous parts.
- In a "show that" question, if an error in a previous subpart leads to not showing the required answer, do not award the final ***A1***. Note that if the error occurs within the same subpart, the ***FT*** rules may result in further loss of marks.
- Where there are anticipated common errors, the ***FT*** answers are often noted on the markscheme, to help examiners. It should be stressed that these are not the only ***FT*** answers accepted, neither should ***N*** marks be awarded for these answers.

6 Mis-read

*If a candidate incorrectly copies information from the question, this is a mis-read (**MR**). A candidate should be penalized only once for a particular mis-read. Use the **MR** stamp to indicate that this is a misread. Do not award the first mark in the question, even if this is an **M** mark, but award all others (if appropriate) so that the candidate only loses one mark for the misread.*

- If the question becomes much simpler because of the ***MR***, then use discretion to award fewer marks.
- If the ***MR*** leads to an inappropriate value (*eg* probability greater than 1, use of $r > 1$ for the sum of an infinite GP, $\sin\theta = 1.5$, non integer value where integer required), do not award the mark(s) for the final answer(s).
- Miscopying of candidates' own work does **not** constitute a misread, it is an error.

7 Discretionary marks *(d)*
An examiner uses discretion to award a mark on the rare occasions when the markscheme does not cover the work seen. In such cases the annotation DM should be used and a brief ***note*** *written next to the mark explaining this decision.*

8 Alternative methods
Candidates will sometimes use methods other than those in the markscheme. Unless the question specifies a method, other correct methods should be marked in line with the markscheme. If in doubt, contact your team leader for advice.

- Alternative methods for complete parts are indicated by **METHOD 1**, **METHOD 2**, *etc*.
- Alternative solutions for parts of questions are indicated by **EITHER** . . . **OR**. Where possible, alignment will also be used to assist examiners in identifying where these alternatives start and finish.

9 Alternative forms
Unless the question specifies otherwise, ***accept*** *equivalent forms.*

- As this is an international examination, accept all alternative forms of **notation**.
- In the markscheme, equivalent **numerical** and **algebraic** forms will generally be written in brackets immediately following the answer.
- In the markscheme, **simplified** answers, (which candidates often do not write in examinations), will generally appear in brackets. Marks should be awarded for either the form preceding the bracket or the form in brackets (if it is seen).

10 Accuracy of Answers

If the level of accuracy is specified in the question, a mark will be allocated for giving the final answer to the required accuracy. When this is not specified in the question, all numerical answers should be given exactly or correct to three significant figures

Candidates should NO LONGER be penalized for an accuracy error ***(AP)****. Examiners should award marks according to the rules given in these instructions and the markscheme. Accuracy is not the same as correctness – an incorrect value does not achieve relevant* ***A*** *marks. It is only final answers which may lose marks for accuracy errors, not intermediate values. Please check work carefully for* ***FT****. Further information on which answers are accepted is given in a separate booklet, along with examples. It is* ***essential*** *that you read this carefully.*

Do not accept unfinished numerical final answers such as 3/0.1 (unless otherwise stated). As a rule, numerical answers with more than one part (such as fractions) should be given using integers (*eg* 6/8). Calculations which lead to integers should be completed, with the exception of fractions which are not whole numbers.

Clarification of intermediate values accuracy instructions

Intermediate values do not need to be given to the correct three significant figures. But, if candidates work with rounded values, this could lead to an incorrect answer, in which case award ***A0*** for the final answer. However, do not penalise inaccurate intermediate values that lead to an acceptable final answer.

11 Calculators

No calculator is allowed. The use of any calculator on paper 1 is malpractice, and will result in no grade awarded. If you see work that suggests a candidate has used any calculator, please follow the procedures for malpractice. Examples: finding an angle, given a trig ratio of 0.4235.

12 Style

The markscheme aims to present answers using good communication, eg if the question asks to find the value of k, the markscheme will say $k = 3$*, but the marks will be for the correct value 3 – there is usually no need for the "* $k =$ *". In these cases, it is also usually acceptable to have another variable, as long as there is no ambiguity in the question, eg if the question asks to find the value of p and of q, then the student answer needs to be clear. Generally, the only situation where the full answer is required is in a question which asks for equations – in this case the markscheme will say "must be an equation".*

The markscheme often uses words to describe what the marks are for, followed by examples, using the eg notation. These examples are not exhaustive, and examiners should check what candidates have written, to see if they satisfy the description. Where these marks are ***M*** *marks, the examples may include ones using poor notation, to indicate what is acceptable. A valid method is one which will allow candidate to proceed to the next step eg if a quadratic function is given in factorised form, and the question asks for the zeroes, then multiplying the factors does not necessarily help to find the zeros, and would not on its own count as a valid method.*

13 Candidate work

If a candidate has drawn a line through work on their examination script, or in some other way crossed out their work, do not award any marks for that work.

Candidates are meant to write their answers to Section A on the question paper (QP), and Section B on answer booklets. Sometimes, they need more room for Section A, and use the booklet (and often comment to this effect on the QP), or write outside the box. That is fine, and this work should be marked.

The instructions tell candidates not to write on Section B of the QP. Thus they may well have done some rough work here which they assume will be ignored. If they have solutions on the answer booklets, there is no need to look at the QP. However, if there are whole questions or whole part solutions missing on answer booklets, please check to make sure that they are not on the QP, and if they are, mark those whole questions or whole part solutions that have not been written on answer booklets

14. Diagrams

The notes on how to allocate marks for sketches usually refer to passing through particular points or having certain features. These marks can only be awarded if the sketch is approximately the correct shape. All values given will be an approximate guide to where these points/features occur. In some questions, the first ***A1*** is for the shape, in others, the marks are only for the points and/or features. In both cases, unless the shape is approximately correct, no marks can be awarded (unless otherwise stated). However, if the graph is based on previous calculations, ***FT*** marks should be awarded if appropriate.

SECTION A

1. (a) $h = 2, k = 3$ *A1A1* *N2*

[2 marks]

(b) attempt to substitute $(1, 7)$ in any order into **their** $f(x)$ *(M1)*

eg $7 = a(1-2)^2 + 3$, $7 = a(1-3)^2 + 2$, $1 = a(7-2)^2 + 3$

correct equation *(A1)*

eg $7 = a + 3$

$a = 4$ *A1* *N2*

[3 marks]

Total [5 marks]

2. (a) attempt to find d *(M1)*

eg $\frac{16-10}{2}$, $10 - 2d = 16 - 4d$, $2d = 6$, $d = 6$

$d = 3$ *A1* *N2*

[2 marks]

(b) correct approach *(A1)*

eg $10 = u_1 + 2 \times 3, 10 - 3 - 3$

$u_1 = 4$ *A1* *N2*

[2 marks]

(c) correct substitution into sum or term formula *(A1)*

eg $\frac{20}{2}\left(2 \times 4 + 19 \times 3\right)$, $u_{20} = 4 + 19 \times 3$

correct simplification *(A1)*

eg $8 + 57$, $4 + 61$

$S_{20} = 650$ *A1* *N2*

[3 marks]

Total [7 marks]

3. (a) substituting for $(f(x))^2$ (may be seen in integral) *A1*

eg $(x^2)^2$, x^4

correct integration, $\int x^4 \, dx = \frac{1}{5}x^5$ *(A1)*

substituting limits into **their integrated** function and subtracting (in any order) *(M1)*

eg $\frac{2^5}{5} - \frac{1}{5}$, $\frac{1}{5}(1-4)$

$\int_1^2 (f(x))^2 \, dx = \frac{31}{5}$ $(= 6.2)$ *A1* *N2*

[4 marks]

(b) attempt to substitute limits or function into formula involving f^2 *(M1)*

eg $\int_1^2 (f(x))^2 \, dx$, $\pi \int x^4 dx$

$\frac{31}{5}\pi$ $(= 6.2\pi)$ *A1* *N2*

[2 marks]

Total [6 marks]

4. (a) (i) $\log_3 27 = 3$ *A1* *N1*

(ii) $\log_8 \frac{1}{8} = -1$ *A1* *N1*

(iii) $\log_{16} 4 = \frac{1}{2}$ *A1* *N1*

[3 marks]

(b) correct equation with **their** three values *(A1)*

eg $\frac{3}{2} = \log_4 x$, $3 + (-1) - \frac{1}{2} = \log_4 x$

correct working involving powers *(A1)*

eg $x = 4^{\frac{3}{2}}$, $4^{\frac{3}{2}} = 4^{\log_4 x}$

$x = 8$ *A1* *N2*

[3 marks]

Total [6 marks]

5. recognize need for intersection of Y and F ***(R1)***
eg $\mathrm{P}(Y \cap F)$, 0.3×0.4

valid approach to find $\mathrm{P}(Y \cap F)$ ***(M1)***
eg $\mathrm{P}(Y) + \mathrm{P}(F) - \mathrm{P}(Y \cup F)$, Venn diagram

correct working (may be seen in Venn diagram) ***(A1)***
eg $0.4 + 0.3 - 0.6$

$\mathrm{P}(Y \cap F) = 0.1$ ***A1***

recognize need for complement of $Y \cap F$ ***(M1)***
eg $1 - \mathrm{P}(Y \cap F)$, $1 - 0.1$

$\mathrm{P}\left((Y \cap F)'\right) = 0.9$ ***A1*** ***N3***

[6 marks]

6. correct integration (ignore absence of limits and "+C") ***(A1)***
eg $\frac{\sin(2x)}{2}$, $\int_{\pi}^{a} \cos 2x = \left[\frac{1}{2}\sin(2x)\right]_{\pi}^{a}$

substituting limits into **their** integrated function and subtracting (in any order) ***(M1)***
eg $\frac{1}{2}\sin(2a) - \frac{1}{2}\sin(2\pi)$, $\sin(2\pi) - \sin(2a)$

$\sin(2\pi) = 0$ ***(A1)***

setting **their** result from an integrated function equal to $\frac{1}{2}$ ***M1***

eg $\frac{1}{2}\sin 2a = \frac{1}{2}$, $\sin(2a) = 1$

recognizing $\sin^{-1} 1 = \frac{\pi}{2}$ ***(A1)***

eg $2a = \frac{\pi}{2}$, $a = \frac{\pi}{4}$

correct value ***(A1)***

eg $\frac{\pi}{2} + 2\pi, 2a = \frac{5\pi}{2}$, $a = \frac{\pi}{4} + \pi$

$a = \frac{5\pi}{4}$ ***A1*** ***N3***

[7 marks]

7. (a) $f'(x) = 3px^2 + 2px + q$ ***A2*** ***N2***

Note: Award ***A1*** if only 1 error.

[2 marks]

(b) evidence of discriminant (must be seen explicitly, not in quadratic formula) ***(M1)***

eg $b^2 - 4ac$

correct substitution into discriminant (may be seen in inequality) ***A1***

eg $(2p)^2 - 4 \times 3p \times q$, $4p^2 - 12pq$

$f'(x) \geq 0$ then f' has two equal roots or no roots ***(R1)***

recognizing discriminant less or equal than zero ***R1***

eg $\Delta \leq 0, 4p^2 - 12pq \leq 0$

correct working that clearly leads to the required answer ***A1***

eg $p^2 - 3pq \leq 0$, $4p^2 \leq 12pq$

$p^2 \leq 3pq$ ***AG*** ***N0***

[5 marks]

Total [7 marks]

SECTION B

8. (a) correct approach ***A1***

eg $\begin{pmatrix}1\\1\\5\end{pmatrix}-\begin{pmatrix}2\\1\\4\end{pmatrix}$, $\text{AO}+\text{OB}$, $\boldsymbol{b}-\boldsymbol{a}$

$\overrightarrow{\text{AB}}=\begin{pmatrix}-1\\0\\1\end{pmatrix}$ ***AG*** ***N0***

[1 mark]

(b) (i) correct vector (or any multiple) ***A1*** ***N1***

eg $\boldsymbol{d}=\begin{pmatrix}-1\\0\\1\end{pmatrix}$

(ii) **any** correct equation in the form $\boldsymbol{r}=\boldsymbol{a}+t\boldsymbol{b}$ (accept any parameter for t)

where $\boldsymbol{a}$ is $\begin{pmatrix}2\\1\\4\end{pmatrix}$ or $\begin{pmatrix}1\\1\\5\end{pmatrix}$, and $\boldsymbol{b}$ is a scalar multiple of $\begin{pmatrix}-1\\0\\1\end{pmatrix}$ ***A2*** ***N2***

eg $\boldsymbol{r}=\begin{pmatrix}1\\1\\5\end{pmatrix}+t\begin{pmatrix}-1\\0\\1\end{pmatrix}$, $\begin{pmatrix}x\\y\\z\end{pmatrix}=\begin{pmatrix}2-s\\1\\4+s\end{pmatrix}$

Note: Award ***A1*** for $\boldsymbol{a}+t\boldsymbol{b}$, ***A1*** for $L_1=\boldsymbol{a}+t\boldsymbol{b}$, ***A0*** for $\boldsymbol{r}=\boldsymbol{b}+t\boldsymbol{a}$.

[3 marks]

continued ...

Question 8 continued

(c) valid approach ***(M1)***

eg $r_1 = r_2$, $\begin{pmatrix} 2 \\ 1 \\ 4 \end{pmatrix} + t\begin{pmatrix} -1 \\ 0 \\ 1 \end{pmatrix} = \begin{pmatrix} 4 \\ 7 \\ -4 \end{pmatrix} + s\begin{pmatrix} 0 \\ -1 \\ 1 \end{pmatrix}$

one correct equation in one parameter ***A1***

eg $2 - t = 4, 1 = 7 - s, 1 - t = 4$

attempt to solve ***(M1)***

eg $2 - 4 = t, s = 7 - 1, t = 1 - 4$

one correct parameter ***A1***

eg $t = -2, s = 6, t = -3$,

attempt to substitute **their** parameter into vector equation ***(M1)***

eg $\begin{pmatrix} 4 \\ 7 \\ -4 \end{pmatrix} + 6\begin{pmatrix} 0 \\ -1 \\ 1 \end{pmatrix}$

$\mathrm{P}(4, 1, 2)$ (accept position vector) ***A1 N2***

[6 marks]

(d) (i) correct direction vector for L_2 ***A1 N1***

eg $\begin{pmatrix} 0 \\ -1 \\ 1 \end{pmatrix}, \begin{pmatrix} 0 \\ 2 \\ -2 \end{pmatrix}$

(ii) correct scalar product and magnitudes for **their** direction vectors ***(A1)(A1)(A1)***

scalar product $= 0 \times -1 + -1 \times 0 + 1 \times 1 \ (= 1)$

magnitudes $= \sqrt{0^2 + (-1)^2 + 1^2}, \sqrt{-1^2 + 0^2 + 1^2} \ \left(\sqrt{2}, \sqrt{2}\right)$

attempt to substitute **their** values into formula ***M1***

eg $\dfrac{0+0+1}{\left(\sqrt{0^2+(-1)^2+1^2}\right)\times\left(\sqrt{-1^2+0^2+1^2}\right)}, \dfrac{1}{\sqrt{2}\times\sqrt{2}}$

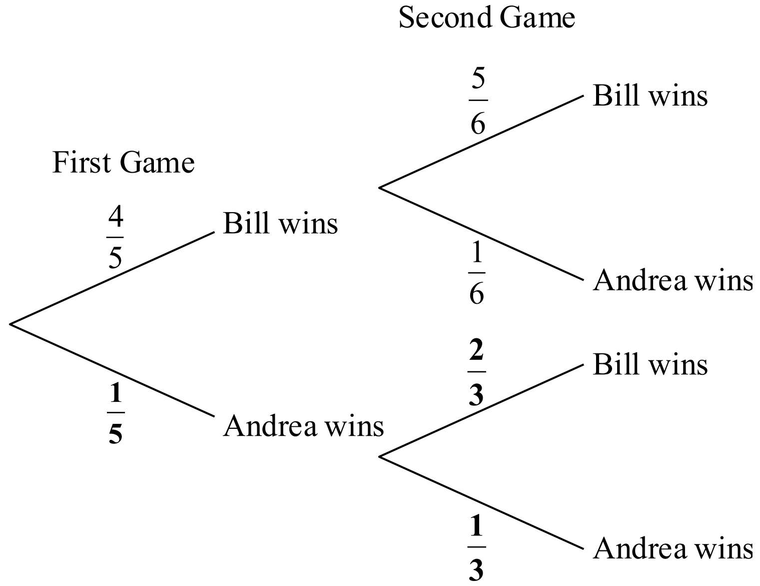
correct value for cosine, $\dfrac{1}{2}$ ***A1***

angle is $\dfrac{\pi}{3}\ (= 60^\circ)$ ***A1 N1***

[7 marks]

Total [17 marks]

9. (a)



A1A1A1 *N3*

Note: Award ***A1*** for each correct **bold** probability.

[3 marks]

(b) multiplying along the branches (may be seen on diagram) *(M1)*

eg $\frac{4}{5}\times\frac{1}{6}$

$\frac{4}{30}\left(\frac{2}{15}\right)$ *A1* *N2*

[2 marks]

(c) **METHOD 1**

multiplying along the branches (may be seen on diagram) *(M1)*

eg $\frac{4}{5}\times\frac{5}{6},\ \frac{4}{5}\times\frac{1}{6},\ \frac{1}{5}\times\frac{2}{3}$

adding their probabilities of three mutually exclusive paths *(M1)*

eg $\frac{4}{5}\times\frac{5}{6}+\frac{4}{5}\times\frac{1}{6}+\frac{1}{5}\times\frac{2}{3},\ \frac{4}{5}+\frac{1}{5}\times\frac{2}{3}$

correct simplification *(A1)*

eg $\frac{20}{30}+\frac{4}{30}+\frac{2}{15},\ \frac{2}{3}+\frac{2}{15}+\frac{2}{15}$

$\frac{28}{30}\left(=\frac{14}{15}\right)$ *A1* *N3*

continued …

Question 9 continued

METHOD 2

recognizing "Bill wins at least one" is complement of "Andrea wins 2" ***(R1)***
eg finding P (Andrea wins 2)

P (Andrea wins both) $= \frac{1}{5} \times \frac{1}{3}$ ***(A1)***

evidence of complement ***(M1)***
eg $1 - p,\ 1 - \frac{1}{15}$

$\frac{14}{15}$ ***A1*** ***N3***

[4 marks]

(d) P (B wins both) $= \frac{4}{5} \times \frac{5}{6} \left(= \frac{2}{3} \right)$ ***A1***

evidence of recognizing conditional probability ***(R1)***
eg $\mathrm{P}(A \mid B)$, P (Bill wins both |Bill wins at least one), tree diagram

correct substitution ***(A2)***
eg $\dfrac{\frac{4}{5} \times \frac{5}{6}}{\frac{14}{15}}$

$\frac{20}{28} \left(= \frac{5}{7} \right)$ ***A1*** ***N3***

[5 marks]

Total [14 marks]

10. (a) valid method for finding side length ***(M1)***

eg $8^2+8^2=c^2$, $45-45-90$ side ratios, $8\sqrt{2}$, $\frac{1}{2}s^2=16$, $x^2+x^2=8^2$

correct working for area ***(A1)***

eg $\frac{1}{2}\times4\times4$

n	1	2	3
x_n	8	$\mathbf{\sqrt{32}}$	4
A_n	32	16	**8**

A1A1 ***N2N2***

[4 marks]

(b) **METHOD 1**

recognize geometric progression for A_n ***(R1)***

eg $u_n=u_1r^{n-1}$

$r=\frac{1}{2}$ ***(A1)***

correct working ***(A1)***

eg $32\left(\frac{1}{2}\right)^5$; 4, 2, 1, $\frac{1}{2}$, $\frac{1}{4}$, …

$A_6=1$ ***A1*** ***N3***

METHOD 2

attempt to find x_6 ***(M1)***

eg $8\left(\frac{1}{\sqrt{2}}\right)^5$, $2\sqrt{2}$, 2, $\sqrt{2}$, 1, …

$x_6=\sqrt{2}$ ***(A1)***

correct working ***(A1)***

eg $\frac{1}{2}\left(\sqrt{2}\right)^2$

$A_6=1$ ***A1*** ***N3***

[4 marks]

continued …

Question 10 continued

(c) **METHOD 1**

recognize infinite geometric series ***(R1)***

eg $S_n = \dfrac{a}{1-r}$, $|r| < 1$

area of first triangle in terms of k ***(A1)***

eg $\dfrac{1}{2}\left(\dfrac{k}{2}\right)^2$

attempt to substitute into sum of infinite geometric series (must have *k*) ***(M1)***

eg $\dfrac{\frac{1}{2}\left(\frac{k}{2}\right)^2}{1-\frac{1}{2}}$, $\dfrac{k}{1-\frac{1}{2}}$

correct equation ***A1***

eg $\dfrac{\frac{1}{2}\left(\frac{k}{2}\right)^2}{1-\frac{1}{2}} = k$, $k = \dfrac{\frac{k^2}{8}}{\frac{1}{2}}$

correct working ***(A1)***

eg $k^2 = 4k$

valid attempt to solve **their** quadratic ***(M1)***

eg $k(k-4)$, $k = 4$ or $k = 0$

$k = 4$ ***A1*** ***N2***

METHOD 2

recognizing that there are four sets of infinitely shaded regions with equal area ***R1***

area of original square is k^2 ***(A1)***

so total shaded area is $\dfrac{k^2}{4}$ ***(A1)***

correct equation $\dfrac{k^2}{4} = k$ ***A1***

$k^2 = 4k$ ***(A1)***

valid attempt to solve **their** quadratic ***(M1)***

eg $k(k-4)$, $k = 4$ or $k = 0$

$k = 4$ ***A1*** ***N2***

[7 marks]

Total [15 marks]