

APOLLO

Number and algebra SL

Mathematics: analysis and approaches

First assessment 2021

47 questions | mark schemes

2. (a) 3×10^4 OR 30000 (km) (accept $3 \cdot 10^4$)

A1

[1 mark]

(b) $\frac{4}{3}\pi(3 \times 10^4)^3$ OR $\frac{4}{3}\pi(30000)^3$

(A1)

$= \frac{4}{3}\pi \times 27 \times 10^{12} (= \pi(36 \times 10^{12}))$ OR $= \frac{4}{3}\pi \times 27000000000000$

(A1)

$= \pi(3.6 \times 10^{13}) (\text{km}^3)$ OR $a = 3.6, k = 13$

A1

[3 marks]

Total [4 marks]

3. METHOD 1 (finding u_1 first, from S_8)

$$4(u_1 + 8) = 8 \quad (A1)$$

$$u_1 = -6 \quad A1$$

$$u_1 + 7d = 8 \text{ OR } 4(2u_1 + 7d) = 8 \text{ (may be seen with their value of } u_1) \quad (A1)$$

attempt to substitute their u_1 (M1)

$$d = 2 \quad A1$$

METHOD 2 (solving simultaneously)

$$u_1 + 7d = 8 \quad (A1)$$

$$4(u_1 + 8) = 8 \text{ OR } 4(2u_1 + 7d) = 8 \text{ OR } u_1 = -3d \quad (A1)$$

attempt to solve linear or simultaneous equations (M1)

$$u_1 = -6, d = 2 \quad A1A1$$

[5 marks]

2. attempt to subtract squares of integers

(M1)

$$(n+1)^2 - n^2$$

EITHER

correct order of subtraction and correct expansion of $(n+1)^2$, seen anywhere

A1A1

$$= n^2 + 2n + 1 - n^2 (= 2n + 1)$$

OR

correct order of subtraction and correct factorization of difference of squares

A1A1

$$= (n+1-n)(n+1+n) (= 2n+1)$$

THEN

$$= n + n + 1 = \text{RHS}$$

A1

Note: Do not award final **A1** unless all previous working is correct.

which is the sum of n and $n+1$

AG

Note: If expansion and order of subtraction are correct, award full marks for candidates who find the sum of the integers as $2n+1$ and then show that the difference of the squares (subtracted in the correct order) is $2n+1$.

[4 marks]

4. EITHER

attempt to use the binomial expansion of $(x + k)^7$ **(M1)**

$${}^7C_0 x^7 k^0 + {}^7C_1 x^6 k^1 + {}^7C_2 x^5 k^2 + \dots \text{ (or } {}^7C_0 k^7 x^0 + {}^7C_1 k^5 x^1 + {}^7C_2 k^5 x^2 + \dots)$$

identifying the correct term ${}^7C_2 x^5 k^2$ (or ${}^7C_5 k^2 x^5$) **(A1)**

OR

attempt to use the general term ${}^7C_r x^r k^{7-r}$ (or ${}^7C_r k^r x^{7-r}$) **(M1)**

$$r = 2 \text{ (or } r = 5) \quad \text{ **(A1)**}$$

THEN

$${}^7C_2 = 21 \text{ (or } {}^7C_5 = 21) \text{ (seen anywhere)} \quad \text{ **(A1)**}$$

$$21x^5 k^2 = 63x^5 \text{ (} 21k^2 = 63, k^2 = 3) \quad \text{ **A1**}$$

$$k = \pm\sqrt{3} \quad \text{ **A1**}$$

Note: If working shown, award **M1A1A1A1A0** for $k = \sqrt{3}$.

[5 marks]

6. METHOD 1

product of a binomial coefficient, a power of 3 (and a power of x^2) seen **(M1)**

evidence of correct term chosen **(A1)**

$${}^{n+1}C_2 \times 3^{n+1-2} \times (x^2)^2 \left(= \frac{n(n+1)}{2} \times 3^{n-1} \times x^4 \right) \text{ OR } n-r=1$$

equating their coefficient to 20412 or their term to $20412x^4$ **(M1)**

EITHER

$${}^{n+1}C_2 \times 3^{n-1} = 20412 \quad \textbf{(A1)}$$

OR

$${}^{r+2}C_r \times 3^r = 20412 \Rightarrow r = 6 \quad \textbf{(A1)}$$

THEN

$$n = 7 \quad \textbf{A1}$$

METHOD 2

$$3^{n+1} \left(1 + \frac{x^2}{3} \right)^{n+1}$$

product of a binomial coefficient, and a power of $\frac{x^2}{3}$ OR $\frac{1}{3}$ seen **(M1)**

evidence of correct term chosen **(A1)**

$$3^{n+1} \times \frac{n(n+1)}{2!} \times \left(\frac{x^2}{3} \right)^2 \left(= \frac{3^{n-1}}{2} n(n+1)x^4 \right)$$

equating their coefficient to 20412 or their term to $20412x^4$ **(M1)**

$$3^{n-1} \times \frac{n(n+1)}{2} = 20412 \quad \textbf{(A1)}$$

$$n = 7 \quad \textbf{A1}$$

Total [5 marks]

Section B

7. (a) (i) **EITHER**

$$9000 \times \left(1 + \frac{7}{100}\right)^5 \quad (\text{A1})$$

$$12622.965... \quad (\text{A1})$$

OR

$$n = 5$$

$$I\% = 7$$

$$PV = \mp 9000$$

$$P/Y = 1$$

$$C/Y = 1$$

(A1)

$$\pm 12622.965...$$

(A1)

THEN

$$(\$) 12600 \quad \text{A1}$$

(ii) **EITHER**

$$9000 \left(1 + \frac{7}{100}\right)^x = 20000 \quad (\text{A1})$$

OR

$$I\% = 7$$

$$PV = \mp 9000$$

$$FV = \pm 20000$$

$$P/Y = 1$$

$$C/Y = 1$$

(A1)

THEN

$$= 12 \text{ (years)} \quad \text{A1}$$

[5 marks]

(b) METHOD 1

attempt to substitute into compound interest formula (condone absence of compounding periods)

(M1)

$$9000 \left(1 + \frac{r}{100 \times 12} \right)^{12 \times 10} = 20000$$

$$8.01170\dots$$

(A1)

$$r = 8.02\%$$

A1**METHOD 2**

$$n = 10$$

$$PV = \pm 9000$$

$$FV = \mp 20000$$

$$P/Y = 1$$

$$C/Y = 12$$

$$r = 8.01170\dots$$

(M1)(A1)

Note: Award **M1** for an attempt to use a financial app in their technology, award **A1** for $(r =) 8.01170\dots$

$$r = 8.02\%$$

A1**(c) (i) recognising geometric series (seen anywhere)****(M1)**

$$r = \frac{4500}{9000} \left(= \frac{1}{2} \right)$$

(A1)**EITHER**

considering S_{∞}

(M1)

$$\frac{9000}{1 - 0.5} (= 18000)$$

A1

correct reasoning that $18000 < 20000$

R1

Note: Accept $S_\infty < 20000$ only if S_∞ has been calculated.

OR

considering S_n for a large value of n , $n \geq 80$

(M1)

Note: Award **M1** only if the candidate gives a valid reason for choosing a value of n , where $50 \leq n < 80$.

correct value of S_n for their n

A1

valid reason why Chris will not reach the target, which involves their choice of n , their value of S_n and Chris' age OR using two large values of n to recognize asymptotic behaviour of S_n as $n \rightarrow \infty$.

R1

Note: Do not award the **R** mark without the preceding **A** mark.

THEN

Therefore, Chris will never reach the target.

AG

(ii) recognising geometric sum

M1

$$\frac{u_1(1-0.5^5)}{0.5} = 20000$$

(A1)

10322.58...

(\$) 10323

A1

[8 marks]
Total [16 marks]

3. (a) attempt to use $u_1 + (n-1)d = 0$ (M1)

$$60 - 2.5(k-1) = 0$$

$$k = 25$$

A1

[2 marks]

- (b) **METHOD 1**

attempting to express S_n in terms of n (M1)

use of a graph or a table to attempt to find the maximum sum (M1)

$$= 750$$

A1

METHOD 2

EITHER

recognizing maximum occurs at $n = 25$ (M1)

$$S_{25} = \frac{25}{2}(60 + 0), S_{25} = \frac{25}{2}(2 \times 60 + 24 \times -2.5)$$

(A1)

OR

attempting to calculate S_{24} (M1)

$$S_{24} = \frac{24}{2}(2 \times 60 + 23 \times -2.5)$$

(A1)

THEN

$$= 750$$

A1

[3 marks]**Total [5 marks]**

8. (a) $f\left(\frac{2}{3}\right) = 4$ OR $a^{\frac{2}{3}} = 4$ (M1)

$a = 4^{\frac{3}{2}}$ OR $a = (2^2)^{\frac{3}{2}}$ OR $a^2 = 64$ OR $\sqrt[3]{a} = 2$ A1

$a = 8$ AG

[2 marks]

(b) $f^{-1}(x) = \log_8 x$ A1

Note: Accept $f^{-1}(x) = \log_a x$.

Accept any equivalent expression for f^{-1} e.g. $f^{-1}(x) = \frac{\ln x}{\ln 8}$.

[1 mark]

(c) correct substitution (A1)

$\log_8 \sqrt{32}$ OR $8^x = 32^{\frac{1}{2}}$

correct working involving log/index law (A1)

$\frac{1}{2} \log_8 32$ OR $\frac{5}{2} \log_8 2$ OR $\log_8 2 = \frac{1}{3}$ OR $\log_2 2^{\frac{5}{2}}$ OR $\log_2 8 = 3$ OR $\frac{\ln 2^{\frac{5}{2}}}{\ln 2^3}$ OR $2^{3x} = 2^{\frac{5}{2}}$

$f^{-1}(\sqrt{32}) = \frac{5}{6}$ A1

[3 marks]
continued...

Question 8 continued.

(d) (i) **METHOD 1**

equating a pair of differences

(M1)

$$u_2 - u_1 = u_4 - u_3 (= u_3 - u_2)$$

$$\log_8 p - \log_8 27 = \log_8 125 - \log_8 q$$

$$\log_8 125 - \log_8 q = \log_8 q - \log_8 p$$

$$\log_8 \left(\frac{p}{27} \right) = \log_8 \left(\frac{125}{q} \right), \log_8 \left(\frac{125}{q} \right) = \log_8 \left(\frac{q}{p} \right)$$

A1A1

$$\frac{p}{27} = \frac{125}{q} \text{ and } \frac{125}{q} = \frac{q}{p}$$

A1

27, p , q and 125 are in geometric sequence

AG

Note: If candidate assumes the sequence is geometric, award no marks for part (i). If $r = \frac{5}{3}$ has been found, this will be awarded marks in part (ii).

METHOD 2

expressing a pair of consecutive terms, in terms of d

(M1)

$$p = 8^d \times 27 \text{ and } q = 8^{2d} \times 27 \text{ OR } q = 8^{2d} \times 27 \text{ and } 125 = 8^{3d} \times 27$$

two correct pairs of consecutive terms, in terms of d

A1

$$\frac{8^d \times 27}{27} = \frac{8^{2d} \times 27}{8^d \times 27} = \frac{8^{3d} \times 27}{8^{2d} \times 27} \text{ (must include 3 ratios)}$$

A1

all simplify to 8^d

A1

27, p , q and 125 are in geometric sequence

AG

continued...

Question 8 continued.

(ii) **METHOD 1 (geometric, finding r)**

$$u_4 = u_1 r^3 \text{ OR } 125 = 27(r)^3 \quad (M1)$$

$$r = \frac{5}{3} \text{ (seen anywhere)} \quad A1$$

$$p = 27r \text{ OR } \frac{125}{q} = \frac{5}{3} \quad (M1)$$

$$p = 45, q = 75 \quad A1A1$$

METHOD 2 (arithmetic)

$$u_4 = u_1 + 3d \text{ OR } \log_8 125 = \log_8 27 + 3d \quad (M1)$$

$$d = \log_8 \left(\frac{5}{3} \right) \text{ (seen anywhere)} \quad A1$$

$$\log_8 p = \log_8 27 + \log_8 \left(\frac{5}{3} \right) \text{ OR } \log_8 q = \log_8 27 + 2 \log_8 \left(\frac{5}{3} \right) \quad (M1)$$

$$p = 45, q = 75 \quad A1A1$$

METHOD 3 (geometric using proportion)

recognizing proportion (M1)

$$pq = 125 \times 27 \text{ OR } q^2 = 125p \text{ OR } p^2 = 27q$$

two correct proportion equations A1

attempt to eliminate either p or q (M1)

$$q^2 = 125 \times \frac{125 \times 27}{q} \text{ OR } p^2 = 27 \times \frac{125 \times 27}{p}$$

$$p = 45, q = 75 \quad A1A1$$

[9 marks]

Total [15 marks]

Special note: In this question if candidates use the word 'gradient' in their reasoning. e.g. gradient is positive, it must be clear whether this is the gradient of f or the gradient of f' to earn the **R** mark.

6. (a) $u_1 = S_1 = \frac{2}{3} \times \frac{7}{8}$ (M1)

$$= \frac{14}{24} \left(= \frac{7}{12} = 0.583333... \right) \quad \text{A1}$$

[2 marks]

(b) $r = \frac{7}{8} (= 0.875)$ (A1)

substituting their values for u_1 and r into $S_\infty = \frac{u_1}{1-r}$ (M1)

$$= \frac{14}{3} (= 4.66666...) \quad \text{A1}$$

[3 marks]

(c) attempt to substitute their values into the inequality or formula for S_n (M1)

$$\frac{14}{3} - \sum_{r=1}^n \frac{2}{3} \left(\frac{7}{8} \right)^r < 0.001 \quad \text{OR} \quad S_n = \frac{\frac{7}{12} \left(1 - \left(\frac{7}{8} \right)^n \right)}{\left(1 - \frac{7}{8} \right)}$$

attempt to solve their inequality using a table, graph or logarithms

(must be exponential) (M1)

Note: Award (M0) if the candidate attempts to solve $S_\infty - u_n < 0.001$.

correct critical value or at least one correct crossover value (A1)

$$63.2675... \text{ OR } S_\infty - S_{63} = 0.001036... \text{ OR } S_\infty - S_{64} = 0.000906...$$

$$\text{OR } S_\infty - S_{63} - 0.001 = 0.0000363683... \text{ OR } S_\infty - S_{64} - 0.001 = -0.0000931777...$$

least value is $n = 64$ A1

[4 marks]

Total [9 marks]

Section B

3. (a) attempting to expand the LHS (M1)

$$\text{LHS} = (4n^2 - 4n + 1) + (4n^2 + 4n + 1)$$

$$= 8n^2 + 2 (= \text{RHS})$$
A1
AG
[2 marks]
- (b) **METHOD 1**
- recognition that $2n-1$ and $2n+1$ represent two consecutive odd integers (for $n \in \mathbb{Z}$) R1

$$8n^2 + 2 = 2(4n^2 + 1)$$
A1
valid reason eg divisible by 2 (2 is a factor) R1
so the sum of the squares of any two consecutive odd integers is even AG
[3 marks]
- METHOD 2**
- recognition, eg that n and $n+2$ represent two consecutive odd integers (for $n \in \mathbb{Z}$) R1

$$n^2 + (n+2)^2 = 2(n^2 + 2n + 2)$$
A1
valid reason eg divisible by 2 (2 is a factor) R1
so the sum of the squares of any two consecutive odd integers is even AG
[3 marks]
- Total [5 marks]**

3. (a) $\left(1 + \frac{5.5}{4 \times 100}\right)^{4n}$ (M1)(A1)
 1.056 A1
 [3 marks]

continued...

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SPEC/5/MATAA/SP2/ENG/TZ0/XX/M

Question 3 continued

(b) EITHER

$$2P = P \times \left(1 + \frac{5.5}{100 \times 4}\right)^{4n} \quad \text{OR} \quad 2P = P \times (\text{their } (a))^m \quad (M1)(A1)$$

Note: Award (M1) for substitution into loan payment formula. Award (A1) for correct substitution.

OR

$$PV = \pm 1$$

$$FV = \mp 2$$

$$I\% = 5.5$$

$$P/Y = 4$$

$$C/Y = 4$$

$$n = 50.756\dots$$

(M1)(A1)

OR

$$PV = \pm 1$$

$$FV = \mp 2$$

$$I\% = 100(\text{their } (a) - 1)$$

$$P/Y = 1$$

$$C/Y = 1$$

(M1)(A1)

THEN

$$\Rightarrow 12.7 \text{ years}$$

Laurie will have double the amount she invested during 2032

A1

[3 marks]

Total [6 marks]

8. (a) (i) **EITHER**

attempt to use a ratio from consecutive terms

M1

$$\frac{p \ln x}{\ln x} = \frac{\frac{1}{3} \ln x}{p \ln x} \quad \text{OR} \quad \frac{1}{3} \ln x = (\ln x) r^2 \quad \text{OR} \quad p \ln x = \ln x \left(\frac{1}{3p} \right)$$

Note: Candidates may use $\ln x^1 + \ln x^p + \ln x^{\frac{1}{3}} + \dots$ and consider the powers of x in geometric sequence.

Award **M1** for $\frac{p}{1} = \frac{\frac{1}{3}}{p}$.

OR

$$r = p \quad \text{and} \quad r^2 = \frac{1}{3}$$

M1**THEN**

$$p^2 = \frac{1}{3} \quad \text{OR} \quad r = \pm \frac{1}{\sqrt{3}}$$

A1

$$p = \pm \frac{1}{\sqrt{3}}$$

AG

Note: Award **M0A0** for $r^2 = \frac{1}{3}$ or $p^2 = \frac{1}{3}$ with no other working seen.

$$(ii) \quad \frac{\ln x}{1 - \frac{1}{\sqrt{3}}} \quad (= 3 + \sqrt{3})$$

(A1)

$$\ln x = 3 - \frac{3}{\sqrt{3}} + \sqrt{3} - \frac{\sqrt{3}}{\sqrt{3}} \quad \text{OR} \quad \ln x = 3 - \sqrt{3} + \sqrt{3} - 1 \quad (\Rightarrow \ln x = 2)$$

A1

$$x = e^2$$

A1**[5 marks]**

continued...

Question 8 continued

(b) (i) **METHOD 1**attempt to find a difference from consecutive terms or from u_2 **M1**

correct equation

A1

$$p \ln x - \ln x = \frac{1}{3} \ln x - p \ln x \quad \text{OR} \quad \frac{1}{3} \ln x = \ln x + 2(p \ln x - \ln x)$$

Note: Candidates may use $\ln x^1 + \ln x^p + \ln x^{\frac{1}{3}} + \dots$ and consider the powers of x in arithmetic sequence.

Award **M1A1** for $p - 1 = \frac{1}{3} - p$.

$$2p \ln x = \frac{4}{3} \ln x \quad \left(\Rightarrow 2p = \frac{4}{3} \right)$$

A1

$$p = \frac{2}{3}$$

AG**METHOD 2**attempt to use arithmetic mean $u_2 = \frac{u_1 + u_3}{2}$ **M1**

$$p \ln x = \frac{\ln x + \frac{1}{3} \ln x}{2}$$

A1

$$2p \ln x = \frac{4}{3} \ln x \quad \left(\Rightarrow 2p = \frac{4}{3} \right)$$

A1

$$p = \frac{2}{3}$$

AG

continued...

*Question 8 continued***METHOD 3**attempt to find difference using u_3 **M1**

$$\frac{1}{3} \ln x = \ln x + 2d \quad \left(\Rightarrow d = -\frac{1}{3} \ln x \right)$$

$$u_2 = \ln x + \frac{1}{2} \left(\frac{1}{3} \ln x - \ln x \right) \quad \text{OR} \quad p \ln x - \ln x = -\frac{1}{3} \ln x$$

A1

$$p \ln x = \frac{2}{3} \ln x$$

A1

$$p = \frac{2}{3}$$

AG

$$(ii) \quad d = -\frac{1}{3} \ln x$$

A1*continued...*

Question 8 continued

(iii) **METHOD 1**

$$S_n = \frac{n}{2} \left[2 \ln x + (n-1) \times \left(-\frac{1}{3} \ln x \right) \right]$$

attempt to substitute into S_n and equate to $-3 \ln x$ **(M1)**

$$\frac{n}{2} \left[2 \ln x + (n-1) \times \left(-\frac{1}{3} \ln x \right) \right] = -3 \ln x$$

correct working with S_n (seen anywhere)**(A1)**

$$\frac{n}{2} \left[2 \ln x - \frac{n}{3} \ln x + \frac{1}{3} \ln x \right] \text{ OR } n \ln x - \frac{n(n-1)}{6} \ln x \text{ OR}$$

$$\frac{n}{2} \left(\ln x + \left(\frac{4-n}{3} \right) \ln x \right)$$

correct equation without $\ln x$ **A1**

$$\frac{n}{2} \left(\frac{7}{3} - \frac{n}{3} \right) = -3 \text{ OR } n - \frac{n(n-1)}{6} = -3 \text{ or equivalent}$$

Note: Award as above if the series $1 + p + \frac{1}{3} + \dots$ is considered leading to

$$\frac{n}{2} \left(\frac{7}{3} - \frac{n}{3} \right) = -3.$$

attempt to form a quadratic = 0

(M1)

$$n^2 - 7n - 18 = 0$$

attempt to solve their quadratic

(M1)

$$(n-9)(n+2) = 0$$

$$n = 9$$

A1

continued...

*Question 8 continued***METHOD 2**

listing the first 7 terms of the sequence **(A1)**

$$\ln x + \frac{2}{3} \ln x + \frac{1}{3} \ln x + 0 - \frac{1}{3} \ln x - \frac{2}{3} \ln x - \ln x + \dots$$

recognizing first 7 terms sum to 0 **M1**

8th term is $-\frac{4}{3} \ln x$ **(A1)**

9th term is $-\frac{5}{3} \ln x$ **(A1)**

sum of 8th and 9th terms $= -3 \ln x$ **(A1)**

$n = 9$ **A1**

[10 marks]

Total [15 marks]

2. (a) $u_1 = 12$

A1

[1 mark]

(b) $15 - 3n = -33$

(A1)

$n = 16$

A1

[2 marks]

(c) valid approach to find d

(M1)

$u_2 - u_1 = 9 - 12$ OR recognize gradient is -3 OR attempts to solve
 $-33 = 12 + 15d$

$d = -3$

A1

[2 marks]

Total [5 marks]

3. (a) $(n-1) + n + (n+1)$ **(A1)**
 $= 3n$ **A1**
 which is always divisible by 3 **AG**
[2 marks]

- (b) $(n-1)^2 + n^2 + (n+1)^2$ ($= n^2 - 2n + 1 + n^2 + n^2 + 2n + 1$) **A1**
 attempts to expand either $(n-1)^2$ or $(n+1)^2$ (do not accept $n^2 - 1$ or $n^2 + 1$) **(M1)**
 $= 3n^2 + 2$ **A1**
 demonstrating recognition that 2 is not divisible by 3 or $\frac{2}{3}$ seen after correct
 expression divided by 3 **R1**

$3n^2$ is divisible by 3 and so $3n^2 + 2$ is never divisible by 3

OR the first term is divisible by 3, the second is not

OR $3\left(n^2 + \frac{2}{3}\right)$ OR $\frac{3n^2 + 2}{3} = n^2 + \frac{2}{3}$

hence the sum of the squares is never divisible by 3

AG

[4 marks]

Total [6 marks]

6. (a) EITHER

recognises the required term (or coefficient) in the expansion

(M1)

$$bx^5 = {}^7C_2 x^5 1^2 \quad \text{OR} \quad b = {}^7C_2 \quad \text{OR} \quad {}^7C_5$$

$$b = \frac{7!}{2!5!} \left(= \frac{7!}{2!(7-2)!} \right)$$

correct working

A1

$$\frac{7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1}{2 \times 1 \times 5 \times 4 \times 3 \times 2 \times 1} \quad \text{OR} \quad \frac{7 \times 6}{2!} \quad \text{OR} \quad \frac{42}{2}$$

OR

lists terms from row 7 of Pascal's triangle

(M1)

1, 7, 21, ...

A1**THEN**

$$b = 21$$

AG**[2 marks]****(b) $a = 7$** **(A1)**

correct equation

A1

$$21x^5 = \frac{ax^6 + 35x^4}{2} \quad \text{OR} \quad 21x^5 = \frac{7x^6 + 35x^4}{2}$$

correct quadratic equation

A1

$$7x^2 - 42x + 35 = 0 \quad \text{OR} \quad x^2 - 6x + 5 = 0 \quad (\text{or equivalent})$$

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

$$(x-1)(x-5) = 0 \quad \text{OR} \quad x = \frac{6 \pm \sqrt{(-6)^2 - 4(1)(5)}}{2(1)}$$

$$x = 1, x = 5$$

A1

Note: Award final **A0** for obtaining $x = 0, x = 1, x = 5$.

[5 marks]**Total [7 marks]**

Section B

1.

Note: The first time an answer is not given to two decimal places, the final **A1** in that part is not awarded.

(a) **EITHER**

$$N = 10$$

OR

$$N = 20$$

$$I\% = 2.74$$

$$I\% = 2.74$$

$$PV = (\mp)1700$$

$$PV = (\mp)1700$$

$$P/Y = 1$$

$$P/Y = 2$$

$$C/Y = 2$$

$$C/Y = 2$$

(M1)(A1)

Note: Award **(M1)** for an attempt to use a financial app in their technology with at least two entries seen, and award **(A1)** for all entries correct. Accept a positive or negative value for PV .

OR

$$1700 \left(1 + \frac{0.0274}{2} \right)^{2 \times 10}$$

(M1)(A1)

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

THEN

$$\$2231.71$$

A1**[3 marks]***continued...*

Question 1 continued(b) **EITHER**

$$N = 10$$

$$PV = \mp 1700$$

$$FV = \pm 2231.71\dots$$

$$P/Y = 1$$

$$C/Y = 1$$

(M1)**Note:** Award **(M1)** for an attempt to use a financial app in their technology with at least two entries seen.**OR**

$$1700 \left(1 + \frac{r}{100} \right)^{10} = 2231.71\dots$$

(M1)**THEN**

$$r = 2.75876\dots$$

$$r = 2.76$$

A1**Note:** Ignore omission of opposite signs for PV and FV if $r = 2.76$ is obtained.**[2 marks]**

(c) \$531.71

A1**[1 mark]****Total [6 marks]**

4. (a)

Note: Award a maximum of **M1A0A0** if the candidate manipulates both sides of the equation (such as moving terms from one side to the other).

METHOD 1 (working with LHS)

attempting to expand $(a^2 - 1)^2$ (do not accept $a^4 + 1$ or $a^4 - 1$) **(M1)**

$$\text{LHS} = a^2 + \frac{a^4 - 2a^2 + 1}{4} \text{ or } \frac{4a^2 + a^4 - 2a^2 + 1}{4} \quad \textbf{A1}$$

$$= \frac{a^4 + 2a^2 + 1}{4} \quad \textbf{A1}$$

$$= \left(\frac{a^2 + 1}{2} \right)^2 (= \text{RHS}) \quad \textbf{AG}$$

Note: Do not award the final **A1** if further working contradicts the AG.

METHOD 2 (working with RHS)

attempting to expand $(a^2 + 1)^2$ **(M1)**

$$\text{RHS} = \frac{a^4 + 2a^2 + 1}{4}$$

$$= \frac{4a^2 + a^4 - 2a^2 + 1}{4} \quad \textbf{A1}$$

$$= a^2 + \frac{a^4 - 2a^2 + 1}{4} \quad \textbf{A1}$$

$$= a^2 + \left(\frac{a^2 - 1}{2} \right)^2 (= \text{LHS}) \quad \textbf{AG}$$

Note: Do not award the final **A1** if further working contradicts the AG.

[3 marks]

continued...

Question 4 continued

- (b) recognise base and height as a and $\left(\frac{a^2-1}{2}\right)$ (may be seen in diagram) **(M1)**

correct substitution into triangle area formula **A1**

$$\text{Area} = \frac{a}{2} \left(\frac{a^2-1}{2} \right) \text{ (or equivalent) } \left(= \frac{a(a^2-1)}{4} = \frac{a^3-a}{4} \right)$$

[2 marks]

Total [5 marks]

4. $86.4 = 50r^3$ (A1)

$r = 1.2 \left(= \sqrt[3]{\frac{86.4}{50}} \right)$ seen anywhere (A1)

$\frac{50(1.2^n - 1)}{0.2} > 33500$ OR $250(1.2^n - 1) = 33500$ (A1)

attempt to solve their geometric S_n inequality or equation (M1)

sketch OR $n > 26.9045$, $n = 26.9$ OR $S_{26} = 28368.8$ OR $S_{27} = 34092.6$ OR algebraic

manipulation involving logarithms

$n = 27$ accept $n \geq 27$ A1

Total [5 marks]

6.

Note: Do not award any marks if there is clear evidence of adding instead of multiplying, for example ${}^9C_r + (ax)^{9-r} + (1)^r$.

valid approach for expansion (must be the product of a binomial coefficient with $n = 9$ and a power of ax) (M1)

$${}^9C_r(ax)^{9-r}(1)^r \text{ OR } {}^9C_{9-r}(ax)^r(1)^{9-r} \text{ OR } {}^9C_0(ax)^0(1)^9 + {}^9C_1(ax)^1(1)^8 + \dots$$

recognizing that the term in x^6 is needed (M1)

$$\frac{\text{Term in } x^6}{21x^2} = kx^4 \text{ OR } r = 6 \text{ OR } r = 3 \text{ OR } 9 - r = 6$$

correct term or coefficient in binomial expansion (seen anywhere) (A1)

$${}^9C_6(ax)^6(1)^3 \text{ OR } {}^9C_3a^6x^6 \text{ OR } 84(a^6x^6)(1) \text{ OR } 84a^6$$

EITHER

correct term in x^4 or coefficient (may be seen in equation) (A1)

$$\frac{{}^9C_6}{21}a^6x^4 \text{ OR } 4a^6x^4 \text{ OR } 4a^6$$

Set their term in x^4 or coefficient of x^4 equal to $\frac{8}{7}a^5x^4$ or $\frac{8}{7}a^5$ (do not accept other powers of x) (M1)

$$\frac{{}^9C_3}{21}a^6x^4 = \frac{8}{7}a^5x^4 \text{ OR } 4a^6 = \frac{8}{7}a^5$$

continued...

*Question 6 continued***OR**correct term in x^6 or coefficient of x^6 (may be seen in equation) **(A1)**

$$84a^6x^6 \text{ OR } 84a^6$$

set their term in x^6 or coefficient of x^6 equal to $24a^5x^6$ or $24a^5$ (do not accept other powers of x) **(M1)**

$$84a^6x^6 = 24a^5x^6 \text{ OR } 84a = 24$$

THEN

$$a = \frac{2}{7} \approx 0.286(0.285714\dots) \quad \mathbf{A1}$$

Note: Award **A0** for the final mark for $a = \frac{2}{7}$ and $a = 0$.**Total [6 marks]**

Section B

8. (a) (i) recognition that $n = 5$ (M1)
 $S_5 = 45$ A1

- (ii) **METHOD 1**
 recognition that $S_5 + u_6 = S_6$ (M1)
 $u_6 = 15$ A1

METHOD 2

- recognition that $60 = \frac{6}{2}(S_1 + u_6)$ (M1)
 $60 = 3(5 + u_6)$
 $u_6 = 15$ A1

METHOD 3

- substituting their u_1 and d values into $u_1 + (n-1)d$ (M1)
 $u_6 = 15$ A1

[4 marks]

- (b) recognition that $u_1 = S_1$ (may be seen in (a)) OR substituting their u_6 into S_6 (M1)
 OR equations for S_5 and S_6 in terms of u_1 and d

$$1 + 4 \quad \text{OR} \quad 60 = \frac{6}{2}(u_1 + 15)$$

$$u_1 = 5 \quad \text{A1}$$

[2 marks]

continued...

Question 8 continued**(c) EITHER**valid attempt to find d (may be seen in (a) or (b)) **(M1)**

$$d = 2$$
 (A1)

ORvalid attempt to find $S_n - S_{n-1}$ **(M1)**

$$n^2 + 4n - (n^2 - 2n + 1 + 4n - 4)$$
 (A1)

OR

equating $n^2 + 4n = \frac{n}{2}(5 + u_n)$ **(M1)**

$$2n + 8 = 5 + u_n \text{ (or equivalent)}$$
 (A1)

THEN

$$u_n = 5 + 2(n - 1) \text{ OR } u_n = 2n + 3$$
 A1

[3 marks]**(d)** recognition that $v_2 r^2 = v_4$ OR $(v_3)^2 = v_2 \times v_4$ **(M1)**

$$r^2 = 3 \text{ OR } v_3 = (\pm)5\sqrt{3}$$
 (A1)

$$r = \pm\sqrt{3}$$
 A1

Note: If no working shown, award **M1A1A0** for $\sqrt{3}$.**[3 marks]****(e)** recognition that r is negative **(M1)**

$$v_5 = -15\sqrt{3} \quad \left(= -\frac{45}{\sqrt{3}} \right)$$
 A1

[2 marks]**Total [14 marks]**

2. (a) 9% (accept 0.09)

A1
[1 mark]

(b) $t = 5$ (seen anywhere)

(A1)

24961.28...

25000 (dollars)

A1
[2 marks]

continued...

Question 2 continued(c) **EITHER**

$$n = 5$$

$$I\% = 3$$

$$PV = (\mp)15000$$

$$P/Y = 1$$

$$C/Y = 1$$

(A1)

Note: Award **(A1)** for use of a financial app in their technology with all entries correct.

$$(\Rightarrow FV = (\pm)17389.11\dots)$$

OR

$$15000\left(1 + \frac{3}{100}\right)^5 (=17389.11\dots)$$

(A1)**THEN**

subtracting their value from their answer to part (b)

(M1)

$$7572.17\dots$$

$$7570 \text{ (dollars)}$$

A1**[3 marks]****Total [6 marks]**

6. product of a binomial coefficient, a power of ax^3 and a power of b seen **(M1)**
evidence of correct term chosen

for $n = 8$: $r = 2$ (or $r = 6$) OR for $n = 10$: $r = 2$ (or $r = 8$) **(A1)**

correct equations (may include powers of x) **A1A1**

$${}^8C_2 a^2 b^6 = 448 \left(28a^2 b^6 = 448 \Rightarrow a^2 b^6 = 16 \right), {}^{10}C_2 a^2 b^8 = 2880 \left(45a^2 b^8 = 2880 \Rightarrow a^2 b^8 = 64 \right)$$

attempt to solve their system in a and b algebraically or graphically **(M1)**

$$b = 2; a = \frac{1}{2} \quad \mathbf{A1A1}$$

Note: Award a maximum of **(M1)(A1)A1A1(M1)A1A0** for $b = \pm 2$ and/or $a = \pm \frac{1}{2}$.

[7 marks]

Section B

5. (a) attempt to use the binomial expansion of $(x+h)^8$ (M1)

$${}^8C_0 x^8 h^0 + {}^8C_1 x^7 h^1 + {}^8C_2 x^6 h^2 + \dots$$

(i) $a = 8h$ (accept ${}^8C_1 h$) A1

(ii) $b = 28h^2$ (accept ${}^8C_2 h^2$) A1

(iii) $d = 70h^4$ (accept ${}^8C_4 h^4$) A1

[4 marks]

- (b) recognition that there is a common ratio between their terms (M1)

$$8h \times r = 28h^2 \text{ OR } 28h^2 \times r = 70h^4 \text{ OR } 8h \times r^2 = 70h^4$$

correct equation in terms of h (A1)

$$\frac{28h^2}{8h} = \frac{70h^4}{28h^2} \text{ (or equivalent)}$$

$h = 1.4$ A1

[3 marks]

Total [7 marks]

8.

Note: The first time an answer is not given to two decimal places in parts (a)(ii), (c)(i) or (d), the final **A1** in that part is not awarded.

(a) (i) 4200×36 **(A1)**

$$= 151200$$

$$= (\$)151000$$
 A1

(ii) recognizing sum of a geometric sequence is required **(M1)**

$$\frac{1500(1 - 1.04^{36})}{1 - 1.04}$$
 (A1)

$$= 116397.4707\dots$$

$$= (\$)116397.47$$
 A1

[5 marks]

(b) Sorin's future value after n years = $160000 \left(1 + \frac{5}{100 \times 12} \right)^{12n}$ **A1**

[1 mark]*continued...*

Question 8 continued

(c) (i) Sorin's total = $160000 \left(1 + \frac{5}{100 \times 12} \right)^6$ (= 164041.89...) **(A1)**

Daniela's total = $\frac{1500(1 - 1.04^6)}{1 - 1.04}$ (= 9949.46...) **(A1)**

total value = (\$)173991.36 **A1**

(ii)

EITHER (finding number of months, m)

$160000 \left(1 + \frac{5}{100 \times 12} \right)^m + \frac{1500(1 - 1.04^m)}{1 - 1.04} (\geq 257000)$ **(A1)**

$m \geq 28.4412...$ OR $(m = 28 \Rightarrow) 254707$ AND $(m = 29 \Rightarrow) 259954$ **(A1)**

Note: Condone use of an equation or strict inequality.

OR (finding number of years, n)

$160000 \left(1 + \frac{5}{100 \times 12} \right)^{12 \times n} + \frac{1500(1 - 1.04^{12 \times n})}{1 - 1.04} (\geq 257000)$ **(A1)**

$n \geq 2.37010...$ (years) **(A1)**

Note: Condone use of an equation or strict inequality.

THEN

$m = 29$ (months) **A1**

[6 marks]

continued...

Question 8 continued(d) **EITHER**

$$N = 24$$

OR

$$N = 6$$

$$PV = \mp 30000$$

$$PV = \mp 30000$$

$$PMT = 0$$

$$PMT = 0$$

$$FV = \pm 41000$$

$$FV = \pm 41000$$

$$P/Y = 4$$

$$P/Y = 1$$

$$C/Y = 4$$

$$C/Y = 4$$

(M1)(A1)

Note: Award **(M1)** for an attempt to use a financial app in their technology with at least two entries seen, award **(A1)** for all entries correct. PV and FV must have opposite signs.

OR

$$30000 \left(1 + \frac{r}{100 \times 4} \right)^{6 \times 4} = 41000$$

(M1)(A1)

Note: Award **(M1)** for attempting to substitute into compound interest formula, award **(A1)** for correct equation.

THEN

$$5.24027\dots$$

$$(r =) 5.24 (\%)$$

A1**[3 marks]****Total [15 marks]**

8.

Note: The first time an answer is not given to two decimal places in parts (a)(ii), (c)(i) or (d), the final **A1** in that part is not awarded.

(a)	(i)	5500×36	(A1)
		$= (\$) 198000$	A1

	(ii)	recognizing sum of a geometric sequence is required	(M1)
--	------	---	-------------

		$\frac{2000(1 - 1.06^{36})}{1 - 1.06}$	(A1)
--	--	--	-------------

$$= 238241.7333\dots$$

		$= (\$) 238241.73$	A1
--	--	--------------------	-----------

[5 marks]

(b)		Sorin's future value after n years $= 120000 \left(1 + \frac{4}{100 \times 12} \right)^{12n}$	A1
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[1 mark]*continued...*

Question 8 continued

$$(c) \quad (i) \quad \text{Sorin's total} = 120000 \left(1 + \frac{4}{100 \times 12} \right)^6 (= 122420.09) \quad (A1)$$

$$\text{Daniela's total} = \frac{2000(1 - 1.06^6)}{1 - 1.06} (= 13950.64) \quad (A1)$$

$$\text{total value} = (\$)136370.73 \quad A1$$

(ii) **EITHER** (finding number of months, m)

$$120000 \left(1 + \frac{4}{100 \times 12} \right)^m + \frac{2000(1 - 1.06^m)}{1 - 1.06} (\geq 250000) \quad (A1)$$

$$m \geq 26.0905... \text{ OR } (m = 26 \Rightarrow) 249157... \text{ AND } (m = 27 \Rightarrow) 258692... \quad (A1)$$

Note: Condone use of an equation or strict inequality.

OR (finding number of years, n)

$$120000 \left(1 + \frac{4}{100 \times 12} \right)^{12 \times n} + \frac{2000(1 - 1.06^{12 \times n})}{1 - 1.06} (\geq 250000) \quad (A1)$$

$$n \geq 2.17421... \text{ (years)} \quad (A1)$$

Note: Condone use of an equation or strict inequality.

THEN

$$m = 27 \text{ (months)} \quad A1$$

[6 marks]

continued...

Question 8 continued(d) **EITHER**

$$N = 24$$

OR

$$N = 6$$

$$PV = \mp 40000$$

$$PV = \mp 40000$$

$$PMT = 0$$

$$PMT = 0$$

$$FV = \pm 53000$$

$$FV = \pm 53000$$

$$P/Y = 4$$

$$P/Y = 1$$

$$C/Y = 4$$

$$C/Y = 4$$

(M1)(A1)

Note: Award **(M1)** for an attempt to use a financial app in their technology with at least two entries seen, and award **(A1)** for all entries correct. PV and FV must have opposite signs.

OR

$$40000 \left(1 + \frac{r}{100 \times 4} \right)^{6 \times 4} = 53000$$

(M1)(A1)

Note: Award **(M1)** for attempting to substitute into compound interest formula, award **(A1)** for correct equation.

THEN

$$4.71781\dots$$

$$(r =) 4.72 (\%)$$

A1**[3 marks]****Total [15 marks]**

1. (a) valid method to find the common difference (M1)

$$d = \frac{22-10}{2} \text{ OR } 10+2d=22 \text{ OR } u_1+d=10, u_1+3d=22 \text{ OR } u_3=16$$

$$d=6$$

A1

[2 marks]

- (b) $u_1=10-6(=4)$ (A1)

$$u_n=4+6(n-1) \text{ OR } u_n=6n-2$$

A1

[2 marks]

Total [4 marks]

3. (a) $\log_{10} 1 - \log_{10} a$ OR $\log_{10} a^{-1} = -\log_{10} a$ OR $\log_{10} 10^{-\frac{1}{3}}$ OR $10^x = \frac{1}{10^{\frac{1}{3}}}$ (A1)

$$= -\frac{1}{3}$$

A1

[2 marks]

(b) $\frac{\log_{10} a}{\log_{10} 1000}$ OR $\frac{1}{3} \log_{1000} 10$ OR $\log_{1000} \sqrt[3]{1000^{\frac{1}{3}}}$ OR $10^{\frac{1}{3}} = 1000^x \left(= (10^3)^x \right)$ (A1)

$$\frac{\log_{10} a}{3} \text{ OR } \frac{1}{3} \log_{1000} 1000^{\frac{1}{3}} \text{ OR } \log_{1000} 1000^{\frac{1}{9}} \text{ OR } 3x = \frac{1}{3} \quad (A1)$$

$$= \frac{1}{9}$$

A1

[3 marks]

Total [5 marks]

6. (a) $S_n = \frac{10^n - 1}{9}$ **A1**

$$(a=10, b=9)$$

[1 mark]

(b) **METHOD 1**

$$S_1 + S_2 + S_3 + \dots + S_n$$

$$= \frac{10-1}{9} + \frac{10^2-1}{9} + \dots + \frac{10^n-1}{9} \quad \text{(A1)}$$

$$= \frac{10-1+10^2-1+10^3-1+\dots+10^n-1}{9} \quad \text{OR} \quad \frac{9(10-1+10^2-1+10^3-1+\dots+10^n-1)}{81}$$

attempt to use geometric series formula on powers of 10, and collect -1's together **M1**

$$10+10^2+10^3+\dots+10^n = \frac{10(10^n-1)}{10-1} \quad \text{and} \quad -1-1-1\dots = -n \quad \text{A1}$$

$$= \frac{\frac{10(10^n-1)}{10-1} - n}{9} \quad \text{OR} \quad \frac{9\left(\frac{10(10^n-1)}{10-1}\right) - 9n}{81} \quad \text{A1}$$

Note: Award **A1** for any correct intermediate expression.

$$= \frac{10(10^n-1) - 9n}{81} \quad \text{AG}$$

continued...

*Question 6 continued***METHOD 2**attempt to create sum using sigma notation with S_n **M1**

$$\sum_{i=1}^n \frac{10^i - 1}{9} \quad \left(= \frac{1}{9} \left(\sum_{i=1}^n 10^i - \sum_{i=1}^n 1 \right) \right)$$

$$\sum_{i=1}^n 10^i = \frac{10(10^n - 1)}{9}$$

A1

$$\sum_{i=1}^n 1 = n$$

A1

$$= \frac{1}{9} \left(\frac{10(10^n - 1)}{9} - n \right) \text{ OR } \frac{1}{9} \left(\frac{10(10^n - 1) - 9n}{9} \right)$$

A1

$$= \frac{10(10^n - 1) - 9n}{81}$$

AG**[4 marks]****Total [5 marks]**

Section B

9. (a) attempt to find a difference (M1)

$$d = p - a, 2d = q - a, d = q - p \text{ OR } p = a + d, q = a + 2d, q = p + d$$

correct equation A1

$$p - a = q - p \text{ OR } q - a = 2(p - a) \text{ OR } p = \frac{a + q}{2} \text{ (or equivalent)}$$

$$2p - q = a \quad \text{AG}$$

[2 marks]

- (b) attempt to find a ratio (M1)

$$r = \frac{s}{a}, r^2 = \frac{t}{a}, r = \frac{t}{s} \text{ OR } s = ar, t = ar^2, t = sr$$

correct equation A1

$$\left(\frac{s}{a}\right)^2 = \frac{t}{a} \text{ OR } \frac{s}{a} = \frac{t}{s} \text{ (or equivalent)}$$

$$s^2 = at \quad \text{AG}$$

[2 marks]

continued...

Question 9 continued(c) **EITHER**

$$2p - 1 = s^2 \text{ (or equivalent)} \quad \mathbf{A1}$$

$$(s^2 > 0) \Rightarrow 2p - 1 > 0 \text{ OR } s = \sqrt{2p - 1} \Rightarrow 2p - 1 > 0 \text{ OR } p = \frac{s^2 + 1}{2} \text{ (and } s^2 > 0) \quad \mathbf{R1}$$

OR

$$2p - 1 = a \text{ and } s^2 = a \quad \mathbf{A1}$$

$$(s^2 > 0, \text{ so }) a > 0 \Rightarrow 2p - 1 > 0 \text{ OR } p = \frac{a + 1}{2} \text{ and } a > 0 \quad \mathbf{R1}$$

$$\Rightarrow p > \frac{1}{2} \quad \mathbf{AG}$$

Note: Do not award **A0R1**.

[2 marks]*continued...*

Question 9 continued

(d) (i) 9, 5, 1, –3

A1A1**Note:** Award **A1** for each of 2nd term and 4th term(ii) 9, 3, 1, $\frac{1}{3}$ **A1A1****Note:** Award **A1** for each of 2nd term and 4th term**[4 marks]**

(e) (i) attempt to find the difference between two consecutive terms

(M1)

$$d = u_2 - u_1 = 5 + \ln 3 - 9 - \ln 9 \quad \text{OR} \quad d = u_3 - u_2 = 1 + \ln 1 - 5 - \ln 3$$

$$\ln 9 = 2 \ln 3 \quad \text{OR} \quad \ln 1 = 0 \quad \text{OR} \quad \ln 3 - \ln 9 = \ln \frac{1}{3} \left(= \ln 3^{-1} = -\ln 3 \right) \quad (\text{seen anywhere}) \quad \textbf{(A1)}$$

$$d = -4 - \ln 3$$

A1*continued...*

Question 9 continued.

(ii) **METHOD 1**

attempt to substitute first term and their common difference into S_{10} **(M1)**

$$\frac{10}{2}(2(9 + \ln 9) + 9(-4 - \ln 3)) \text{ OR } \frac{10}{2}(2(9 + 2 \ln 3) + 9(-4 - \ln 3)) \text{ (or equivalent) } \quad \mathbf{A1}$$

$$= 5(-18 - 5 \ln 3) \text{ (or equivalent in terms of } \ln 3) \quad \mathbf{A1}$$

$$\sum_{i=1}^{10} u_i = -90 - 25 \ln 3 \quad \mathbf{AG}$$

METHOD 2

$$u_{10} = 9 + \ln 9 + 9(-4 - \ln 3) (= -27 + \ln 9 - 9 \ln 3)$$

attempt to substitute first term and their u_{10} into S_{10} **(M1)**

$$\frac{10}{2}(2(9 + \ln 9) + 9(-4 - \ln 3)) \text{ OR } \frac{10}{2}(9 + \ln 9 - 27 + \ln 9 - 9 \ln 3) \text{ OR}$$

$$\frac{10}{2}(2(9 + 2 \ln 3) + 9(-4 - \ln 3)) \text{ OR } \frac{10}{2}(9 + \ln 9 - 27 - 7 \ln 3) \text{ (or equivalent) } \quad \mathbf{A1}$$

$$= 5(-18 - 5 \ln 3) \text{ (or equivalent in terms of } \ln 3) \quad \mathbf{A1}$$

$$\sum_{i=1}^{10} u_i = -90 - 25 \ln 3 \quad \mathbf{AG}$$

[6 marks]

Total [16 marks]

2. (a) recognition that a 15% loss leaves 85% OR finding 15% and subtracting from original **(M1)**
 0.85×35000 OR $35000 - 0.15 \times 35000$
 $= (\$)29750$ **A1**

Note: Accept $(\$)29800$.

[2 marks]

- (b) **EITHER**

$$29750 \times 0.89^9$$

(A1)

OR

$$N = 9$$

$$I\% = -11$$

$$PV = \mp 29750$$

(A1)

THEN

$$\text{value}(FV) = (\$)10423$$

A1

Note: For this **A1** the answer must be rounded to the nearest dollar.
 Accept $(\$)10441$ from using 3 sf answer from part (a).

[2 marks]

continued...

Question 2 continued(c) **METHOD 1**

attempt to solve the inequality (or equation) $29750 \times 0.89^{n-1} < 3500$ OR table of values **(M1)**

19.3643... OR $(n = 19 \Rightarrow) 3651.80...$ OR $(n = 20 \Rightarrow) 3250.10...$ **(A1)**

Note: For candidates using (\$)29800, $n > 19.3787...$, $(n = 19 \Rightarrow) 3657.93...$,
 $(n = 20 \Rightarrow) 3255.56...$

$n = 20$

A1

[3 marks]

METHOD 2

use of the finance app with $I\% = -11$, $PV = \mp 29750$, $FV = \pm 3500$

OR $29750 \times 0.89^N < 3500$ (condone the use of n or x) **(M1)**

$(N =) 18.3643...$ **(A1)**

Note: For candidates using (\$)29800, $N = 18.3787...$

$n = 20$

A1

[3 marks]

Total [7 marks]

4. METHOD 1

attempt to expand $(2n+5)^2 - (2n-5)^2$ **M1**

Note: Award **M0** for invalid attempts such as $(2n+5)^2 = 4n^2 + 25$.

$= 4n^2 + 20n + 25 - (4n^2 - 20n + 25)$ or equivalent **A1**

$= 40n$ OR $20n + 20n$ **A1**

$= 10(4n)$ OR $\frac{40}{10} = 4$ OR $\frac{40n}{4} = 10n$ OR $20n + 20n = 10(2n + 2n)$ (or equivalent) **R1**

so is a multiple of 10 **AG**

Note: Do not award the **R1** unless both **A** marks have been awarded.

METHOD 2

use of $a^2 - b^2 = (a+b)(a-b)$ where $a = 2n+5$, $b = 2n-5$ **M1**

$= (2n+5+2n-5)(2n+5-2n+5)$ **A1A1**

Note: Award **A1** for each correct bracket.

$= 4n \times 10 (= 40n)$ **R1**

so is a multiple of 10 **AG**

Note: Do not award the **R1** unless both **A** marks have been awarded.

[4 marks]

6. attempt to use $u_n = u_1 + (n-1)d$ or $S_n = \frac{n}{2}[2u_1 + (n-1)d]$ or $S_n = \frac{n}{2}[u_1 + u_n]$ to set up at least one equation in u_1 and d **(M1)**

$$14 = u_1 + 9d \text{ and } 200 = \frac{25}{2}[2u_1 + 24d] \quad \textbf{A1}$$

attempt to solve their two linear equations in u_1 and d simultaneously (must eliminate one variable) **(M1)**

$$d = -2 (\Rightarrow u_1 = 32) \quad \textbf{(A1)}$$

attempt to solve $u_k = 0$ with their d (or with their d and u_1) **(M1)**

$$\Rightarrow k = 17 \quad \textbf{A1}$$

[6 marks]

Section B

4. METHOD 1

attempt to expand $(3n+2)^2 - (3n-2)^2$ **M1**

Note: Award **M0** for invalid attempts such as $(3n+2)^2 = 9n^2 + 4$.

$= 9n^2 + 12n + 4 - (9n^2 - 12n + 4)$ or equivalent **A1**

$= 24n$ OR $12n + 12n$ **A1**

$= 12(2n)$ OR $\frac{24}{12} = 2$ OR $\frac{24n}{2} = 12n$ OR $12n + 12n = 12(n+n)$ (or equivalent)

R1

so is a multiple of 12 **AG**

Note: Do not award the **R1** unless both **A** marks have been awarded.

METHOD 2

use of $a^2 - b^2 = (a+b)(a-b)$ where $a = 3n+2$, $b = 3n-2$ **M1**

$= (3n+2+3n-2)(3n+2-3n+2)$

$= 6n \times 4$ **A1**

$= 24n$ **A1**

$= 12(2n)$ OR $\frac{24n}{12} = 2n$ OR $\frac{24n}{2} = 12n$ OR $12n + 12n = 12(n+n)$ (or equivalent)

R1

so is a multiple of 12 **AG**

Note: Do not award the **R1** unless both **A** marks have been awarded.

[4 marks]

6. attempt to use $u_n = u_1 + (n-1)d$ or $S_n = \frac{n}{2}[2u_1 + (n-1)d]$ or $S_n = \frac{n}{2}[u_1 + u_n]$ to set up at least one equation in u_1 and d **(M1)**

$$16 = u_1 + 9d \text{ and } 100 = \frac{25}{2}[2u_1 + 24d] \quad \text{ **(A1)** }$$

attempt to solve their two linear equations in u_1 and d simultaneously (must eliminate one variable) **(M1)**

$$d = -4 (\Rightarrow u_1 = 52) \quad \text{ **A1** }$$

attempt to solve $u_k = 0$ with their d (or with their d and u_1) **(M1)**

$$\Rightarrow k = 14 \quad \text{ **A1** }$$

[6 marks]

SECTION B

2. EITHER

attempt to form a product of binomial coefficient, a power of $2x$ and a power of -5 seen **(M1)**

${}^{11}C_8(2x)^8(-5)^3$ OR ${}^{11}C_3(2x)^8(-5)^3$ OR $165 \times (2x)^8(-5)^3$ **(A1)(A1)**

Note: Award **A1** for ${}^{11}C_8$ or ${}^{11}C_3$ or 165, **A1** for $(2x)^8(-5)^3$.

OR

attempt to use the general term **(M1)**

${}^{11}C_r(2x)^{11-r}(-5)^r$ and $r = 3$ **(A1)(A1)**

THEN

-5280000 (exact) **A1**

Note: Award **A0** for a final answer of $-5280000x^8$.

[4 marks]

2. EITHER

attempt to form a product of binomial coefficient, a power of $2x$ and a power of -5 seen **(M1)**

${}^9C_3(2x)^6(-5)^3$ OR ${}^9C_6(2x)^6(-5)^3$ OR $84 \times (2x)^6(-5)^3$ **(A1)(A1)**

Note: Award **A1** for ${}^9C_6$ or ${}^9C_3$ or **84**, **A1** for $(2x)^6(-5)^3$.

OR

attempt to use the general term **(M1)**

${}^9C_r(2x)^{9-r}(-5)^r$ and $r = 3$ **(A1)(A1)**

THEN

-672000 (exact) **A1**

Note: Award **A0** for a final answer of $-672000x^6$.

[4 marks]

3. (a) $k = \frac{4}{400} \left(= \frac{1}{100} = 0.01 \right)$ **A1**

[1 mark]

(b) attempt to find binomial coefficients or multiply out brackets **(M1)**

e.g. Pascal's triangle down to correct row OR $(1 + 2x + x^2)^2$ OR substitute into binomial expansion

$$(1 + x)^4$$

$$= 1 + 4x + 6x^2 + 4x^3 + x^4$$

A1

[2 marks]

(c) **METHOD 1**

recognition that the expansion can be used with x replaced with k **(M1)**

$$\left(1 + \frac{1}{100} \right)^4$$

$$= 1 + \frac{4}{100} + \frac{6}{100^2} + \dots (= 1 + 0.04 + 0.0006 + \dots)$$

(A1)

multiplies by 1000 (seen anywhere) **(M1)**

$$1000 \left(1 + \frac{1}{100} \right)^4$$

$$= 1000 + 40 + 0.6 + \dots (= 1040.6\dots)$$

$$= 1041 \text{ (dinar)}$$

A1

METHOD 2

attempt to find the value of $(1 + k)^4$ by hand **(M1)**

$$(1.01)^4 = (1.0201)(1.01)^2 = (1.030301)(1.01)$$

$$= 1.0406\dots$$

(A1)

multiplies by 1000 (seen anywhere) **(M1)**

$$1000(1.01)^4$$

$$= 1040.6\dots$$

$$= 1041 \text{ (dinar)}$$

A1

[4 marks]

Total [7 marks]

6. (a) (i) for a sequence of areas, uses two consecutive terms to find a common ratio OR for sequences of both widths and heights uses two consecutive terms for both sequences to find both common ratios OR recognises that

both widths and heights are geometric sequences with common ratio $\frac{3}{2}$ **M1**

areas form a geometric sequence with first term 20 and common ratio $\frac{45}{20}$ **A1**

OR area of picture frame F_n is $4\left(\frac{3}{2}\right)^{n-1} \times 5\left(\frac{3}{2}\right)^{n-1}$

area of F_n is $20\left(\frac{9}{4}\right)^{n-1}$ **AG**

- (ii) attempt to find the sum of the areas using $S_n = \frac{u_1(r^n - 1)}{r - 1}$ **(M1)**

sum of areas $\frac{20\left(\left(\frac{9}{4}\right)^{10} - 1\right)}{\frac{9}{4} - 1} \left(= 16\left(\left(\frac{9}{4}\right)^{10} - 1\right) \right)$ **(A1)**

mean area $= \frac{1}{10} \left(\frac{20\left(\left(\frac{9}{4}\right)^{10} - 1\right)}{\frac{9}{4} - 1} \right) \left(= \frac{1}{10} \left(16\left(\left(\frac{9}{4}\right)^{10} - 1\right) \right) \right)$

$= \frac{16}{10} \left(\left(\frac{9}{4}\right)^{10} - 1 \right) \left(= \frac{8}{5} \left(\left(\frac{9}{4}\right)^{10} - 1 \right) \right)$ **A1**

$p = \frac{8}{5}, a = 10$

[5 marks]

continued...

Question 6 continued

- (b) recognition that median is between 5
- th
- and 6
- th
- picture frame

(M1)

$$\text{median area} = \frac{20\left(\frac{9}{4}\right)^4 + 20\left(\frac{9}{4}\right)^5}{2}$$

(A1)

$$= \frac{20\left(\frac{9}{4}\right)^4 \left(1 + \frac{9}{4}\right)}{2}$$

$$= \frac{65}{2} \left(\frac{9}{4}\right)^4$$

A1

$$q = \frac{65}{2}$$

[3 marks]**Total [8 marks]**

Section B

8. (a) (i) METHOD 1attempt to equate differences of consecutive terms **(M1)**

$$(3-2k)-(k-5)=(5k+3)-(3-2k) \text{ OR } (k-5)-(3-2k)=(3-2k)-(5k+3) \quad \mathbf{A1}$$

$$8-3k=7k$$

$$(k=) \frac{4}{5} \quad \mathbf{A1}$$

METHOD 2 (system of equations)**TWO** correct equations involving k and d **A1**

$$k-5+d=3-2k \text{ OR } 3-2k+d=5k+3 \text{ OR } k-5+2d=5k+3$$

$$\text{OR } \frac{3}{2}(2(k-5)+2d)=k-5+3-2k+5k+3 \text{ (or equivalent)}$$

valid attempt to solve their system of equations using substitution or elimination **(M1)**

$$(d=5.6)$$

$$(k=) \frac{4}{5} \quad \mathbf{A1}$$

METHOD 3 (in terms of k)

$$\frac{3}{2}(k-5+5k+3)=k-5+3-2k+5k+3 \text{ (or equivalent)} \quad \mathbf{A1}$$

combining like terms **(M1)**

$$9k-3=4k+1 \text{ OR } 5k=4 \text{ (or equivalent)}$$

$$(k=) \frac{4}{5} \quad \mathbf{A1}$$

METHOD 4 (arithmetic mean)attempt to find mean of u_1 and u_3 **(M1)**

$$\frac{(k-5)+(5k+3)}{2}=3-2k \quad \mathbf{A1}$$

$$3k-1=3-2k$$

$$(k=) \frac{4}{5} \quad \mathbf{A1}$$

(ii) substituting their value of k into expression for u_3 **(A1)**

$$(u_3=) 5 \times \frac{4}{5} + 3$$

$$= 7 \quad \mathbf{A1}$$

[5 marks]

continued...

Question 8 continued

(b) (i) substituting $k = 12$ into u_1 , u_2 or u_3 (M1)

$(u_1 =) 7$ AND $(u_2 =) -21$ AND $(u_3 =) 63$ (A1)

$(r =) \frac{-21}{7} = \frac{63}{-21} (= -3)$ OR $(-21)^2 = 7 \times 63$ OR $r = -3$ R1

u_1 , u_2 and u_3 are in geometric sequence AG

(ii) since $|r| \geq 1$ R1

hence not convergent AG

[4 marks]

(c) (i) attempts to find ratios, in terms of k , of consecutive terms and equating (M1)

$\frac{(3-2k)}{(k-5)} = \frac{(5k+3)}{(3-2k)}$ OR $(3-2k)^2 = (k-5)(5k+3)$ (or equivalent)

$9-12k+4k^2 = 5k^2-22k-15$ A1

Note: Award **A1** for correct expansion of all brackets leading to given result.

$k^2-10k-24=0$ AG

(ii) recognizing need to factorize, complete the square or substitute into quadratic formula (M1)

$(k+2)(k-12) (=0)$ OR $(k-5)^2-49 (=0)$ OR $k = \frac{10 \pm \sqrt{196}}{2}$

$k = -2$ (accept $k = -2$ and $k = 12$) A1

substituting their value of k (other than $k = 12$) to find u_1 , u_2 or u_3 (M1)

$(u_1 =) -7$ AND $(u_2 =) 7$ AND $(u_3 =) -7$ A1

(iii) $(S_{2m} =) 0$ A1

[7 marks]

Total [16 marks]

8. (a) 15

A1**[1 mark]**

- (b) attempt to add 11 cards onto a stack with 3 rows OR attempt to consider all 4 rows

(M1)valid diagram with 4 rows OR $t_4 = 15 + 11$ OR $t_4 = 2 + 5 + 8 + 11$ $= 26$ **A1****[2 marks]**

- (c)
- METHOD 1**

recognition that t_n is a sum of an arithmetic sequence**(M1)**

$$t_n = 2 + 5 + 8 + 11 + \dots$$

attempt to use formula for the sum of n terms of an arithmetic sequence**M1**

$$t_n = \frac{n}{2}(2(2) + 3(n-1))$$

A1

$$t_n = \frac{n}{2}(3n+1)$$

AG**METHOD 2**attempt to split t_n into the total number of stacked and horizontal cards**(M1)**

$$\text{stacked } 2 + 4 + 6 + \dots = \frac{n}{2}(4 + 2(n-1)) \left(= \frac{n}{2}(2n+2) \right)$$

A1

$$\text{horizontal } 0 + 1 + 2 + \dots = \frac{n}{2}(0 + 1(n-1)) \left(= \frac{n}{2}(n-1) \right)$$

A1

$$t_n = \frac{n}{2}(4 + 2(n-1)) + \frac{n}{2}(0 + 1(n-1)) \left(= \frac{n}{2}(2n+2) + \frac{n}{2}(n-1) \right)$$

$$t_n = \frac{n}{2}(3n+1)$$

AG*continued...*

Question 8 continued.

METHOD 3

recognition that a stack with n rows is made up of complete triangles with the bottom row of horizontal cards removed and that the numbers of complete triangle cards form an arithmetic sequence

(M1)

$$t_n = (3 + 6 + 9 + 12 + \dots + 3n) - n \text{ OR } t_n = 3(1 + 2 + 3 + 4 + \dots + n) - n$$

attempt to use formula for the sum of n terms of an arithmetic sequence

M1

$$t_n = \frac{n}{2}(2(3) + 3(n-1)) - n \text{ OR } t_n = 3 \times \frac{n}{2}(1+n) - n$$

A1

$$t_n = \frac{n}{2}(3n+1)$$

AG

[3 marks]

(d) attempt to solve $\frac{n(3n+1)}{2} \leq 14(52) (= 728)$

(M1)

Note: Accept an attempt to solve an equation for (M1).

$$21.8642\dots \text{ OR } n = 21, t_n = 672 \text{ and } n = 22, t_n = 737$$

(A1)

max number of rows is 21

A1

[3 marks]

continued...

Question 8 continued.

(e) **EITHER**

attempt to solve by listing at least six values of t_n **(M1)**

2, 7, 15, 26, 40, 57...

OR

recognition that $\frac{1}{2}n(3n+1)$ must be an integer **(M1)**

$$\frac{1}{2}n(3n+1) = 52k \quad (\text{where } k \text{ is an integer})$$

THEN

min number of rows is 13 **A1**

Note: Award **(M1)A0** for an answer of 5 packs.

Award **M0A0** for any answer resulting from solving $\frac{1}{2}n(3n+1) = 52$.

[2 marks]

continued...

Question 8 continued.

(f) **EITHER**

attempt to use Pythagoras's Theorem or trigonometry to find the height of an equilateral triangle with sides 88mm

(M1)

$$\text{height} = \sqrt{88^2 - 44^2} \text{ OR } 88 \sin 60^\circ \text{ OR } 88 \cos 30^\circ \text{ OR } 44 \tan 60^\circ \text{ OR}$$

$$\frac{44}{\tan 30^\circ} \text{ OR } 44\sqrt{3} (= 76.2102\dots)$$

(A1)

attempt to solve $44n\sqrt{3} > 2000$ OR their perpendicular height $\times n > 2000$

(M1)

Note: Accept an attempt to solve an equation for **(M1)**.

OR

attempt to use trigonometry to find the side of an equilateral triangle with height 2000mm

(M1)

$$\text{side} = \frac{2000}{\sin 60^\circ} \text{ OR } \frac{2000}{\cos 30^\circ} \text{ OR } \frac{4000}{\sqrt{3}} (= 2309.40\dots)$$

(A1)

attempt to solve $88n > 2309.40\dots$ OR $88n > \text{their side}$

(M1)

Note: Accept an attempt to solve an equation for **(M1)**.

THEN

$$n > 26.2431\dots$$

so min number of rows is 27

(A1)

$$t_{27} = 1107$$

A1

[5 marks]

Total [16 marks]

4. EITHER

attempt to use the binomial expansion of $(2x + k)^{10}$ **(M1)**

$${}^{10}C_0 (2x)^{10} + {}^{10}C_1 (2x)^9 k^1 + {}^{10}C_2 (2x)^8 k^2 + \dots \text{ OR } {}^{10}C_0 k^{10} + {}^{10}C_1 k^9 (2x)^1 + {}^{10}C_2 k^8 (2x)^2 + \dots$$

Note: Do not award any marks if there is clear evidence of adding instead of multiplying, for example ${}^{10}C_r + (2x)^{10-r} + k^r$.

identifying the correct term **(M1)**

$${}^{10}C_4 (2x)^6 k^4 \text{ OR } {}^{10}C_6 k^4 (2x)^6$$

OR

attempt to use general term ${}^{10}C_r (2x)^{10-r} k^r$ OR ${}^{10}C_r k^{10-r} (2x)^r$ **(M1)**

$$r = 4 \text{ OR } r = 6 \quad \text{ **(A1)** }$$

THEN

correct equation in terms of k only **(A1)**

$${}^{10}C_4 2^6 k^4 = 8.4 \times 10^6 \text{ OR } {}^{10}C_6 k^4 2^6 = 8.4 \times 10^6 (= 8400000)$$

$$k = \pm 5 \quad \text{ **A2** }$$

Note: Award **A1** for $k = 5$ only.

Total [5 marks]

9. (a) recognising geometric sequence with $r = \frac{2}{3}$ (seen anywhere) (M1)

$$10\left(\frac{2}{3}\right)^{6-1} \text{ OR } \frac{20}{3}\left(\frac{2}{3}\right)^{5-1} \quad \text{(A1)}$$

1.31687...

height after 5th bounce = 1.32 (m) (accept $\frac{320}{243}$) A1

[3 marks]

- (b) recognition of the need to use S_n (seen anywhere) (M1)

$$10 + 10 \times \left(\frac{2}{3}\right) + 10 \times \left(\frac{2}{3}\right)^2 + 10 \times \left(\frac{2}{3}\right)^3 + 10 \times \left(\frac{2}{3}\right)^4 \text{ OR } S_5$$

recognition to double the height (M1)

$$10 + 2 \times S_4 \text{ OR } 2 \times S_5 - 10 \text{ OR}$$

$$10 + 2 \times 10 \times \left(\frac{2}{3}\right) + 2 \times 10 \times \left(\frac{2}{3}\right)^2 + 2 \times 10 \times \left(\frac{2}{3}\right)^3 + 2 \times 10 \times \left(\frac{2}{3}\right)^4 \text{ (or equivalent)}$$

42.0987...

total distance travelled = 42.1 A1

[3 marks]

- (c) recognising the need to use S_∞ formula (seen anywhere) (M1)

$$2S_\infty + u_1 \text{ OR } 2S_\infty - x$$

$$2\left(\frac{\frac{2}{3}x}{1-\frac{2}{3}}\right) + x \text{ OR } 2\left(\frac{x}{1-\frac{2}{3}}\right) - x \text{ OR } \frac{x}{1-\frac{2}{3}} + \frac{\frac{2}{3}x}{1-\frac{2}{3}} \quad \text{A1}$$

$$2(2x) + x \text{ OR } 6x - x \text{ OR } 3x + 2x \quad \text{A1}$$

total distance travelled = 5x AG

[3 marks]

continued...

Question 9 continued.

(d) $\delta_1 = 50 \text{ (m)}$

A1**[1 mark]**

(e) $\delta_2 (= 5 \times 9.56) = 47.8$

$d = 47.8 - 50 (= -2.2) \text{ OR } d = 5 \times -0.44 (= -2.2)$

(A1)attempt to find n using n th term of an AP with their d **(M1)**

$50 + (n-1)(-2.2) < 25 \text{ (accept equation)}$

12.3636...

(A1)

Ball 13

A1**[4 marks]****Total [14 marks]**

- 3.** (a) 12 (terms) **A1**
- [1 mark]**
- (b) product of a binomial coefficient and a power of k **(M1)**
- $${}^{11}C_4 \times k^4 (\times x^7)$$
- evidence of correct term chosen **(A1)**
- $$r = 4 \text{ (or } r = 7)$$
- equating their coefficient to 1320 or their term to $1320x^7$ **(M1)**
- $${}^{11}C_4 \times k^4 = 1320 (\Rightarrow k^4 = 4)$$
- 1.41421...
- $(k =) 1.41 (\sqrt{2} \text{ exact})$ **A1**
- [4 marks]**
- Total [5 marks]**

2. (a) attempt to find the common difference (M1)

$$12 = 36 + 4d \quad \text{OR} \quad \frac{12 - 36}{5 - 1}$$

$$d = -6 \quad \text{(A1)}$$

attempt to use the term formula for an arithmetic sequence (M1)

$$u_{13} = u_1 + 12(-6) \quad \text{OR} \quad u_5 + 8(-6)$$

$$u_{13} = -36 \quad \text{A1}$$

[4 marks]

- (b) **METHOD 1**

attempt to set $S_n = 0$ (M1)

$$\frac{n}{2}(2(36) + (n-1)(-6)) = 0 \quad \text{OR} \quad \frac{n(36 + u_n)}{2} = 0 \Rightarrow u_n = -36$$

$$n = 13 \quad \text{A1}$$

METHOD 2

attempt to recognize symmetry (M1)

$$36 + 30 + \dots + 0 + \dots - 30 - 36$$

$$n = 13 \quad \text{A1}$$

[2 marks]

Total [6 marks]

3.

METHOD 1attempt to use $u_n = u_1 + (n-1)d$ (M1)

$$u_1 + 6d = 6$$
 (A1)

$$u_1 + 5d + u_1 + 11d = 24$$
 (A1)

$$2u_1 + 16d = 24 \quad (u_1 + 8d = 12)$$

attempt to solve their equations simultaneously (M1)

$$u_1 = -12 \text{ and } d = 3$$
 A1

METHOD 2attempt to express u_6 and u_{12} in terms of the 7th term and d (M1)

$$u_6 = 6 - d$$
 (A1)

$$u_{12} = 6 + 5d$$
 (A1)

setting their sum of u_6 and u_{12} equal to 24 (M1)

$$12 + 4d = 24$$

$$d = 3 \text{ and } u_1 = -12$$
 A1

[5 marks]

4. rewriting $\sqrt{x}$ as $x^{\frac{1}{2}}$ seen anywhere (A1)
- product of a binomial coefficient, a power of $\sqrt{x}$ and a power of k seen (M1)
- evidence of correct term chosen (A1)
- $r = 3$ (or $r = 9$)
- equating their coefficient to $-112\,640$ or their term to $-112\,640x^{\frac{3}{2}}$ (M1)
- ${}^{12}C_9 k^9 = -112\,640$
- $k = -2$ A1

Total [5 marks]

7. (a) (i) 15.75 **A1**
- (ii) 189 **A1**
- (iii) $5000 + 189n$ **A1**
- (iv) $5000 + 189 \times 5$ **A1**
 $= 5945$ **AG**
- [4 marks]**
- (b) (i) **EITHER**
- attempt to use formula $FV = PV \times \left(1 + \frac{r}{100k}\right)^{kn}$ with $n = 5$ **(M1)**
- $FV = 5000 \left(1 + \frac{3}{100}\right)^5$ OR $5000(1 + 0.03)^5$
- OR**
- attempt to use GDC app (at least two correct entries seen) **(M1)**
- $PV = 5000, I = 3\%, n = 5, P/Y = C/Y = 1$
- OR**
- 5150, 5304.5, 5463.635, 5627.54..., 5796.37... **(M1)**
- THEN**
- 5796.37... **A1**
- 5796 **A1**
- (ii) $796 (= 796.370...)$ **A1**
- [3 marks]**

continued...

Question 7 continued

(c) (i) $FV = PV \times \left(1 + \frac{r}{100k}\right)^{kn}$ or equivalent with $k = 1$ **(M1)**

$$5000(1 + 0.03)^n$$

$$5000(1.03)^n$$
 A1

(ii) setting $5000(1.03)^n \geq 5000 + 189n$ **(M1)**

Note: Condone equality but do not accept $5000(1.03)^n \leq 5000 + 189n$.

attempt to solve their inequality or equation to find n **(M1)**

16.0097...seen OR either $8023.53... < 8024$ or $8264.23... > 8213$

17 (years) **A1**

[5 marks]

Total [12 marks]

