QATs
Quality Assessment Tasks

Centre Number

Student Number

2016 HIGHER SCHOOL CERTIFICATE TRIAL EXAMINATION

Mathematics Extension 1

General Instructions

- Reading time – 5 minutes
- Working time – 2 hours
- Write using blue or black pen
- Board-approved calculators may be used
- A table of standard integrals is provided at the back of this paper
- Write your student number on this page and on the multiple-choice answer sheet
- In Questions 11-14, show relevant mathematical reasoning and/or calculations
- Answer each question in a SEPARATE writing booklet. Extra writing booklets are available

Total marks – 70

Section I Pages 2-5

10 marks
- Attempt Questions 1-10
- Allow about 15 minutes for this section

Section II Pages 6-9

60 marks
- Attempt Question 11-14
- Allow about 1 hour and 45 minutes for this section

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Section I

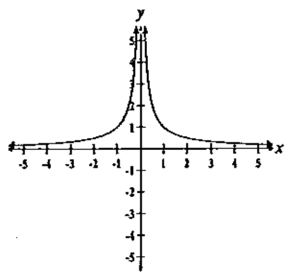
10 marks
Attempt Questions 1-10
Allow about 15 minutes for this section

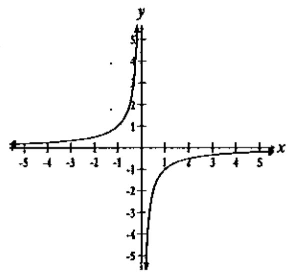
Use the multiple-choice answer sheet provided for Questions 1-10

1 When the polynomial $P(x)=x^3-5x^2+2x+k$ is divided by $(x-1)$ the reminder is 4. Which of the following is the value of k?

(A) 2
(B) -2
(C) 12
(D) 6

2 Given that $f(x)=\frac{1}{x}$. Which of the following represents the graph of $y=f^{-1}(x)$.

(A)


(B)


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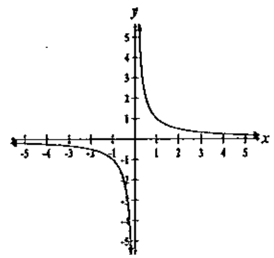

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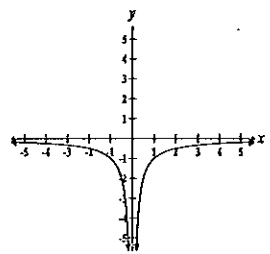


3 The acute angle between $4x+2y=7$ and $y=3x+1$ is θ. What is the value of $\tan\theta$?

(A) $\frac{5}{7}$

(B) 1

(C) $\frac{1}{7}$

(D) $\frac{1}{5}$

4 Which of the following is the exact value of $\sin\left(2\cos^{-1}\left(\frac{3}{5}\right)\right)$?

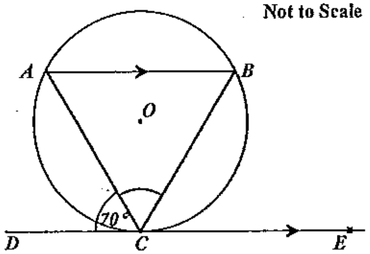
(A) $\frac{24}{25}$

(B) $\frac{\pi}{6}$

(C) $\frac{4}{5}$

(D) $\frac{3}{4}$

5 The points A, B and C lie on a circle centre O. Points C, D and E lie on a tangent to the circle and AB is parallel to DE. $\angle ACD = 70^\circ$. Which of the following is the size of $\angle ACB$?



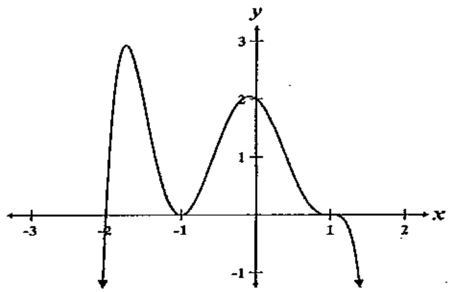
(A) 70°

(B) 50°

(C) 60°

(D) 40°

6 Which of the following best represents the graph below?



(A) $y=(x+2)(x+1)^2(x-1)^3$

(B) $y=(x+2)(x+1)^2(1-x)^3$

(C) $y=(x+2)(1-x)^2(x-1)^3$

(D) $y=(2-x)(x+1)^2(1-x)^3$

7 Given that $y=t^3-3t$ and $x=(t+1)^2$, which of the following equates to $\frac{dy}{dx}$?

(A) $\frac{3(t-1)}{2}$

(B) $2(t-1)(t+1)^2$

(C) $\frac{3}{2}$

(D) $\frac{2(t-1)}{3}$

8 Code words are created using all of the letters from the word CABRAMATTA. How many different words can be created?

(A) $\frac{10!}{4!2!}$

(B) $10! \times 4! \times 3!$

(C) $10!$

(D) $\frac{9!}{3!2!}$

9 What is the constant term in the expansion of $\left\{\left(2x+\frac{3}{x^2}\right)^{12}\left(2x-\frac{3}{x^2}\right)^{12}\right\}$?

(A) ${}^{24}C_4 2^{16}\times 3^8$

(B) ${}^{12}C_8 4^4\times 9^8$

(C) ${}^{12}C_4 4^8\times 9^4$

(D) ${}^{24}C_8 4^8\times 9^4$

10 A geometric series is given by $1-\tan^2 x+\tan^4 x-\tan^6 x$....... for $0<x<\frac{\pi}{4}$.

Which of the following are possible values of the limiting sum (S) of this series?

(A) $0\le S_\infty\le 1$

(B) $\frac{1}{2}<S_\infty<1$

(C) $-1\le S_\infty\le 1$

(D) $S_\infty =$ all real numbers

Section II

60 marks
Attempt Question 11-14
Allow about 1 hour and 45 minutes for this section

Answer each question in a SEPARATE writing booklet. Extra writing booklets are available.

In Questions 11-14, you responses should include relevant mathematical reasoning and/or calculations.

Question 11 (15 marks) Use a SEPARATE Writing Booklet.

(a) Find the co-ordinates of the point P which divides the interval AB **internally** in the ratio of $3:2$ where $A=(-3,2)$ and $B=(4,-1)$. 2

(b) Evaluate $\lim_{x\to 5}\frac{2\sin(x-5)}{(x-5)}$. 1

(c) Write down the Range of $y=\pi+2\sin^{-1}x$. 2

(d) Find $\int\frac{2}{9+4x^2}\,dx$. 2

(e) Solve $\frac{x^2-12}{x}\le 4$. 3

(f) Use the substitution $u=\cos x$ to evaluate $\int_0^{\frac{\pi}{2}}\sin^3 x\,dx$. 3

(g) Express $6\sin x+8\cos x$ in the form $R\sin(x+\alpha)$; where $0\le\alpha\le\frac{\pi}{2}$. 2

End of Question 11

Question 12 (15 marks) Use a SEPARATE Writing Booklet.

(a) Find the exact value of $\sin 75^{\circ}$. **2**

(b) The probability that any one of the 30 days in June is raining is 0.3. Write an expression for the probability that June will have exactly 10 rainy days. **2**

(c) Newton's Law of cooling states that when an object at temperature T° C is placed in an environment at temperature A° C, the rate of temperature loss is given by the equation

$$\frac{dT}{dt}=k(T-B)$$

Where t is the time in minutes and k is a constant.

(i) Verify that $T=B+Ae^{kt}$ is a solution to the above equation, where A is a constant. **1**

(ii) A train is travelling through the mountains where the outside temperature is $2^{\circ}C$. The heating inside the carriage breakdown causing the inside temperature to drop from $22^{\circ}C$ to $15^{\circ}C$ in 30 minutes. Find the exact value of k. **2**

(iii) Find the temperature after a further 30 minutes. *Leave your answer to the nearest minute.* **1**

(d) Solve the following equation, giving your answer in general form, where x is in radians. **3**

$$\cos 2x-5\cos x-2=0$$

(e) (i) Show graphically that $\sin^{-1}(x)=(x-1)^2$ has a root between $x=0$ and $x=1$. **2**

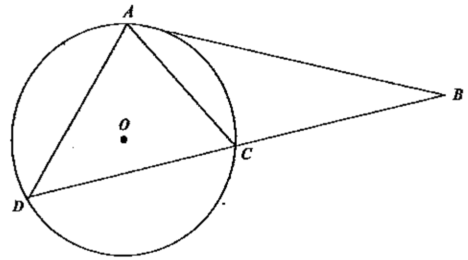
(ii) By taking $x_1=0$ as the first approximation to this root, use one step of Newton's method to find a better approximation. **2**

End of Question 12

Question 13 (15 marks) Use a SEPARATE Writing Booklet.

(a) Prove by mathematical induction that $\sum_{r=1}^{n}(r^2+1)r!=n(n+1)!$ for all integral $n\geq 1$. **3**

(b)



AB is a tangent to the circle centre O. The line BD meets the circle in C.

(i) Prove that ΔABD is similar to ΔABC. **3**

(ii) Hence prove that $AB^2=BC\times BD$. **1**

(c) The velocity of a particle moving on the $x-axis$ is given by $v=\frac{e^{-x}}{x}$.

Initially the particle is at $x=-\frac{1}{4}$.

(i) Find an expression for acceleration and hence find where the particle reaches maximum speed. **3**

(ii) Give a brief explanation why the particle will always travel in a negative direction. **1**

(d) At a dinner party, 4 couples sit at a round table. Find the probability that

(i) each couple sit next to each other. **2**

(ii) Lena does not sit between Theo and Enzo. **2**

End of Question 13

Question 14 (15 marks) Use a SEPARATE Writing Booklet.

(a) The motion of a particle is given by $x = 3 + 2\sin\left(4t + \frac{\pi}{3}\right)$.

(i) Find an expression for acceleration of the particle in terms of x, and hence explain why the motion of this particle is simple harmonic. **3**

(ii) Find the speed of the particle when it is at the centre of motion. **2**

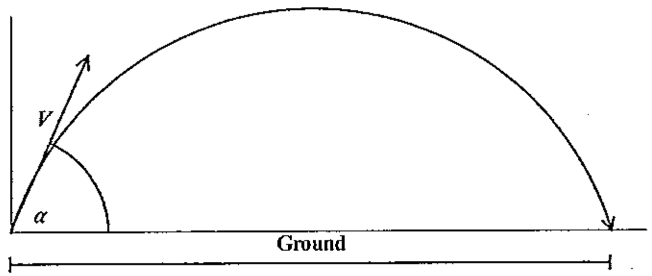
(b) (i) Given $(3+4x)^{15}$, use the Binomial Theorem to write an expression for T_k, $0 \le k \le 15$. **1**

(ii) Show that $\frac{T_{k+1}}{T_k} = \frac{64-4k}{3k}$. **3**

(iii) Hence find the greatest co-efficient in the expansion of $(3+4x)^{15}$. **2**

(c) At a golf course, a ball is hit off the ground with initial velocity $v\ m/s$, at an angle α^o to the horizontal. Let force due to gravity $= -g\,m/s^2$ and noting $\alpha > 45^o$.

NOT TO SCALE



(i) Write down the six equations of motion. *(do not derive equations).* **1**

(ii) Prove that during the motion when angle of elevation of the ball is 45^o, this will occur when $t = \frac{v(\sin\alpha - \cos\alpha)}{g}$ seconds. **1**

(iii) If the time found in part (ii) is $\frac{1}{4}$ of the total time of flight, find the value of α. **2**

End of Paper

QATs
Quality Assessed Tasks

2016 HIGHER SCHOOL CERTIFICATE TRIAL EXAMINATION

MATHEMATICS EXTENSION 1 MARKING GUIDELINES

Section I

Multiple-choice Answer Key

Question	Answer
1	D
2	C
3	B
4	A
5	D
6	B
7	A
8	A
9	C
10	B

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Section II

Question 11 (a)

Criteria	Marks
• Correct solution	2
• Achieves correct answer for either x or y	1

Sample answer

$$P=\left(\frac{12-6}{5},\frac{-3+4}{5}\right)$$
$$=\left(\frac{6}{5},\frac{1}{5}\right)$$

Question 11 (b)

Criteria	Mark
• Correct answer	1

Sample answer

$$\lim_{x\to 5}\frac{2\sin(x-5)}{(x-5)}=2\lim_{x\to 5}\frac{\sin(x-5)}{(x-5)}$$
$$=2$$

Question 11 (c)

Criteria	Marks
• Correct answer	2
• Notes that $-\pi\le 2\sin^{-1}x\le\pi$	1

Sample answer

Range $=\{y:0\le y\le 2\pi\}$

Question 11 (d)

Criteria	Marks
• Correct solution	2
• Achieves $\tan^{-1}\left(\frac{2x}{3}\right)$	1

Sample answer

$$\int\frac{2}{9+4x^2}\,dx=\frac{2}{3}\int\frac{3}{9+4x^2}\,dx$$
$$=\frac{2}{3\times 2}\tan^{-1}\left(\frac{2x}{3}\right)+c$$
$$=\frac{1}{3}\tan^{-1}\left(\frac{2x}{3}\right)+c$$

Question 11 (e)

Criteria	Marks
• Correct solutions	3
• Achieves $x(x-6)(x+2)\le 0$	2
• Multiplies both sides by x^2	1

Sample answer

$$\frac{x^2-12}{x}\le 4 \qquad x\ne 0$$
$$x(x^2-12)\le 4x^2$$
$$x^3-12x-4x^2\le 0$$
$$x^3-4x^2-12x\le 0$$
$$x(x^2-4x-12)\le 0$$
$$x(x-6)(x+2)\le 0$$
$$x\le -2 \text{ or } 0<x\le 6$$

Question 11 (f)

Criteria	Marks
• Correct solutions	3
• Achieves $I=-\int_1^0 1-u^2\,du$	2
• Achieves new limits	1

Sample answer

$$I=\int_0^{\frac{\pi}{2}}\sin^3 x\,dx$$

$u=\cos x$

$du=-\sin x\,dx$

$x=\frac{\pi}{2}\rightarrow u=0$

$x=0\rightarrow u=1$

$$I=-\int_1^0 1-u^2\,du$$

$$=\int_1^0 u^2-1\,du$$

$$=\left[\frac{u^3}{3}-u\right]_1^0$$

$$=\left[0-\left(\frac{1}{3}-1\right)\right]$$

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

Question 11 (g)

Criteria	Marks
• Correct answer	2
• Correct value of either R or α	1

Sample answer

$$6\sin x+8\cos x=10\left\{\frac{6}{10}\sin x+\frac{8}{10}\cos x\right\}$$

$$=10\sin(x+\alpha)\qquad where\ \tan\alpha=\frac{8}{6}$$

$$=10\sin(x+0.927)\qquad \alpha=\tan^{-1}\left(\frac{8}{6}\right)=0.927$$

Question 12 (a)

Criteria	Marks
• Correct solution	2
• Works positively towards answer	1

Sample answer

$$\sin 75^\circ=\sin(45^\circ+30^\circ)$$

$$=\frac{1}{\sqrt{2}}\times\frac{\sqrt{3}}{2}+\frac{1}{\sqrt{2}}\times\frac{1}{2}$$

$$=\frac{\sqrt{3}+1}{2\sqrt{2}}$$

Question 12 (b)

Criteria	Marks
• Correct solution	2
• Correct working with one mistake	1

Sample answer

$$P(R)=\frac{3}{10}\qquad P(\overline{R})=\frac{3}{10}$$

$$\therefore P(R)={}^{30}C_{10}\left(\frac{7}{10}\right)^{20}\left(\frac{3}{10}\right)^{10}$$

Question 12 (c) (i)

Criteria	Mark
• Correct solution	1

Sample answer

$$T = B + Ae^{kt}$$

$$\frac{dT}{dt} = k\left[Ae^{kt}\right]$$

$$\because T = B + Ae^{kt}$$

$$\because T - B = Ae^{kt}$$

$$\therefore \frac{dT}{dt} = k\left[T - B\right]$$

Question 12 (c) (ii)

Criteria	Marks
• Correct solution	2
• Achieves correct B and A	1

Sample answer

$$T = 2 + Ae^{kt}$$

$$22 = 2 + A$$

$$A = 20$$

$$T = 2 + 20e^{kt}$$

$$15 = 2 + 20e^{30k}$$

$$\frac{13}{20} = e^{30k}$$

$$\frac{\ln\left(\frac{13}{20}\right)}{30} = k$$

Question 12 (c) (iii)

Criteria	Mark
• Correct answer	1

Sample answer

$$T = 2 + 20e^{\left[\frac{\ln\left(\frac{13}{20}\right)}{30} \times 60\right]}$$

$T = 10.45$ minutes

T=10°

Question 12 (d)

Criteria	Marks
• Correct solution	3
• Achieves $\cos x = -\frac{1}{2}$ $\quad \cos x = 3$	2
• Achieves $2\cos^2 x - 1 - 5\cos x - 2 = 0$	1

Sample answer

$$\cos 2x - 5\cos x - 2 = 0$$

$$2\cos^2 x - 1 - 5\cos x - 2 = 0$$

$$2\cos^2 x - 5\cos x - 3 = 0$$

$$(2\cos x + 1)(\cos x - 3) = 0$$

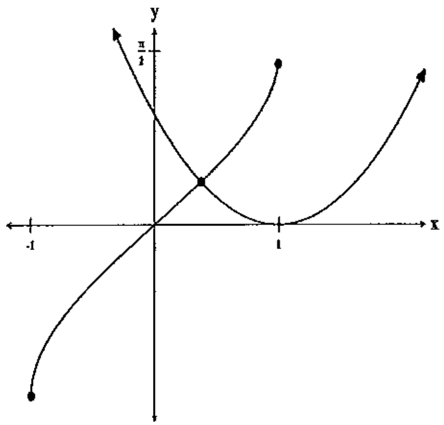
$$\cos x = -\frac{1}{2} \qquad \cos x = 3 \quad \text{(no solution)}$$

$$x = 2\pi n \pm \frac{2\pi}{3} \qquad \textit{for } n = 0, 1, 2, \ldots$$

Question 12 (e) (i)

Criteria	Marks
• Correct solution	2
• Correct graph of $y = \sin^{-1}(x)$ or $y = (x-1)^2$	1

Sample answer



Question 12 (e) (i)

Criteria	Marks
• Correct solution	2
• Uses correct formulae with one or two errors	1

Sample answer

$\sin^{-1}(x) = (x-1)^2$

$\sin^{-1}(x) - (x-1)^2 = 0$

Let $P(x) = \sin^{-1}(x) - (x-1)^2$

$P'(x) = \dfrac{1}{\sqrt{1-x^2}} - 2(x-1)$

$P(0) = -1$

$P'(0) = 3$

$x_2 = x_1 - \dfrac{P(x_1)}{P'(x_1)}$

$= 0 - \left[\dfrac{-1}{3}\right]$

$= \dfrac{1}{3}$

Question 13 (a)

Criteria	Marks
• Correct proof	1
• Makes a correct substitution in correct step 3 (from step 2)	1
• Provides clear steps similar to the first three steps below	1

Sample answer

Step 1: Prove the expression is true for n=1

$(2)1! = 1(2)!$

$2 = 2$ *(true)*

Step 2 : Assume the expression is true for n=k (where $k \geq 1$)

$(1^2+1)1! + (2^2+1)2! + ... + (k^2+1)k! = k(k+1)!$

Step 3 : Prove the expression is true for n=k+1

$(1^2+1)1! + (2^2+1)2! + ... + (k^2+1)k! + ((k+1)^2+1)(k+1)! = (k+1)(k+2)!$

$k(k+1)! + ((k+1)^2+1)(k+1)! = (k+1)(k+2)!$ from assumption

$\text{LHS} = k(k+1)! + (k^2+2k+2)(k+1)!$

$= (k+1)!\left[k + (k^2+2k+2)\right]$

$= (k+1)!(k^2+3k+2)$

$= (k+1)!(k+2)(k+1)$

$= (k+1)(k+2)!$

$= RHS$

Hence the result is proven by mathematical induction.

Question 13 (b) (i)

Criteria	Marks
• Correct proof	3
• Correct proof with one mistake or no reason.	2
• One line correct in proof	1

Sample answer

Prove ΔABD is similar to ΔABC

$\angle ABD = \angle ABC$ (common)

$\angle ADB = \angle CAB$ (Alternate angle theorem)

$\angle DAB = \angle ACB$ (angle sum of a triangle)

$\therefore \Delta ABD$ is similar to ΔABC (equiangular)

Question 13 (c) (ii)

Criteria	Mark
• Correct working	1

Sample answer

$\frac{AB}{CB} = \frac{BD}{AB}$ (corresponding sides in similar triangles are in ratio)

$\therefore AB^2 = BC \times BD$

Question 13 (c) (i)

Criteria	Marks
• Correct solution	3
• Works positively at achieves $\ddot{x} = \frac{-e^{-2x}(x+1)}{x^3}$	2
• Notes maximum speed occurs when $\ddot{x} = 0$	1

Sample answer

$$v = \frac{e^{-x}}{x}$$

$$\frac{1}{2}v^2 = \frac{e^{-2x}}{2x^2}$$

$$\ddot{x} = \frac{2x^2.-2e^{-2x} - e^{-2x}.4x}{4x^4}$$

$$= \frac{-4x^2e^{-2x} - 4xe^{-2x}}{4x^4}$$

$$= \frac{-4xe^{-2x}(x+1)}{4x^4}$$

$$= \frac{-e^{-2x}(x+1)}{x^3}$$

Maximum speed occurs when $\ddot{x} = 0$

$$\frac{-e^{-2x}(x+1)}{x^3} = 0$$

$$x = -1$$

Question 13 (c) (ii)

Criteria	Mark
• Correct reasoning	1

Sample answer

Particle starts at $x = -\frac{1}{4}$ moving to the left and particle will never stop as $v = \frac{e^{-x}}{x} \neq 0$.

Question 13 (d) (i)

Criteria	Marks
• Correct solution	2
• Achieves correct denominator	1

Sample answer

$$P(E) = \frac{(2!)^4 3!}{7!}$$

$$= \frac{96}{5040}$$

$$= \frac{2}{105}$$

Question 13 (d) (ii)

Criteria	Marks
• Correct solution	2
• Provides a method of counting which has some merit	1

Sample answer

$$P(E) = 1 - P(\textit{Lena sits between Theo and Enzo})$$

$$= 1 - \frac{2!5!}{7!}$$

$$= \frac{240}{5040}$$

$$= \frac{1}{21}$$

Question 14 (a) (i)

Criteria	Marks
• Correct solution	3
• Achieves $\ddot{x} = -16(x-3)$	2
• Correctly explains why particle's movement is SHM or achieves $\ddot{x} = -32\sin\left(4t + \frac{\pi}{3}\right)$	1

Sample answer

$$x = 3 + 2\sin\left(4t + \frac{\pi}{3}\right)$$

$$\dot{x} = 8\cos\left(4t + \frac{\pi}{3}\right)$$

$$\ddot{x} = -32\sin\left(4t + \frac{\pi}{3}\right)$$

$$= -16\left[3 + 2\sin\left(4t + \frac{\pi}{3}\right) - 3\right]$$

$$\ddot{x} = -16(x-3)$$

Hence since when $x > 3$ $\ddot{x} < 0$ and when $x < 3$ $\ddot{x} > 0$, particle will oscillate about $x = 3$.
OR quoting Since $\ddot{x} = -n^2 X$
Therefore the particle executes SHM.

Question 14 (a) (ii)

Criteria	Marks
• Correct solution	2
• Works positively towards the answer	1

Sample answer
The speed of the motion is at a maximum at the centre of motion.

Hence

$$-8 \le 8\cos\left(4t + \frac{\pi}{3}\right) \le 8$$

$\therefore$ Speed $= 8\,m/s$

Question 14 (b) (i)

Criteria	Mark
• Correct answer	1

Sample answer

$$T_k = {}^{15}C_{k-1}(3)^{16-k}(4x)^{k-1}$$

Question 14 (b) (ii)

Criteria	Marks
• Correct solution	3
• Achieves $\frac{15!(3)^{15-k}(4x)^k}{k!(15-k)!} \div \frac{15!(3)^{16-k}(4x)^{k-1}}{(k-1)!(16-k)!}$	2
• Notes correctly T_{k+1}	1

Sample answer

$$T_k = {}^{15}C_{k-1}(3)^{16-k}(4x)^{k-1}$$

$$T_{k+1} = {}^{15}C_k(3)^{15-k}(4x)^k$$

$$\frac{T_{k+1}}{T_k} = \frac{15!(3)^{15-k}(4x)^k}{k!(15-k)!} \div \frac{15!(3)^{16-k}(4x)^{k-1}}{(k-1)!(16-k)!}$$

$$= \frac{15!(3)^{15-k}(4x)^k}{k!(15-k)!} \times \frac{(k-1)!(16-k)!}{15!(3)^{16-k}(4x)^{k-1}}$$

$$= \frac{4x(16-k)}{3k}$$

$$= \left[\frac{4(16-k)}{3k}\right]x$$

$$= \left[\frac{64-4k}{3k}\right]x$$

$$\text{Co-efficient} = \left[\frac{64-4k}{3k}\right]$$

Question 14 (b) (iii)

Criteria	Marks
• Correct answer (no need to present all cases for full marks)	2
• Achieves $k < 9.143$ or $k > 9.143$	1

Sample answer

Case 1

$T_{k+1} > T_k$

$\therefore \frac{T_{k+1}}{T_k} > 1$

$\therefore \frac{64-4k}{3k} > 1$

$64-4k > 3k$

$64 > 7k$

$k < 9.143$

$k = 9, 8, 7, \ldots..1$

$\therefore T_{10} > T_9 > T_8 \ldots.$

Case 2:

$T_{k+1} \neq T_k$ as $k = 9.143$ (not an integer)

Case 3:

$T_{k+1} < T_k$

$\frac{T_{k+1}}{T_k} < 1$

$k > 9.143$

$k = 10, 11, 12 \ldots.$

$\therefore T_{10} > T_{11} > T_{12} \ldots.$

$T_{10} = {}^{15}C_9 (3)^6 (4)^9$

Question 14 (c) (i)

Criteria	Mark
• Correct answer (allow one mistake)	1

Sample answer

$\ddot{x} = 0 \qquad \ddot{y} = -g$

$\dot{x} = v\cos\alpha \qquad \dot{y} = -gt + v\sin\alpha$

$x = vt\cos\alpha \qquad y = -\frac{1}{2}gt^2 + vt\sin\alpha$

Question 14 (c) (ii)

Criteria	Mark
• Correct solution	1

Sample answer

When the angle of elevation of the ball is $45°$ $\therefore \tan\theta = \frac{\dot{y}}{\dot{x}} = 1$.

$\therefore \dot{x} = \dot{y}$

$v\cos\alpha = -gt + v\sin\alpha$

$gt = v\sin\alpha - v\cos\alpha$

$t = \frac{v(\sin\alpha - \cos\alpha)}{g}$

Question 14 (c) (iii)

Criteria	Marks
• Correct solution	2
• Achieves $0 = -\frac{1}{2}g\left[\frac{4v(\sin\alpha - \cos\alpha)}{g}\right]^2 + v\left[\frac{4v(\sin\alpha - \cos\alpha)}{g}\right]\sin\alpha$	1

Sample answer

$t = \frac{4v(\sin\alpha - \cos\alpha)}{g}$ when y=0

$0 = -\frac{1}{2}g\left[\frac{4v(\sin\alpha - \cos\alpha)}{g}\right]^2 + v\left[\frac{4v(\sin\alpha - \cos\alpha)}{g}\right]\sin\alpha$

$0 = \frac{-8v^2(\sin\alpha - \cos\alpha)^2}{g} + \frac{4v^2(\sin\alpha - \cos\alpha)\sin\alpha}{g}$

$8v^2(\sin\alpha - \cos\alpha)^2 = 4v^2(\sin\alpha - \cos\alpha)\sin\alpha$

$2(\sin\alpha - \cos\alpha) = \sin\alpha$

$\sin\alpha = 2\cos\alpha$

$\tan\alpha = 2$

$\alpha = 63°26'$