

2009 TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION CATHOLIC SECONDARY SCHOOLS ASSOCIATION MATHEMATICS EXTENSION 1

300 M	marks)	
	47	
	100	
G	Zest	

(a) (2 marks)

Outcomes assessed: PE3

Targeted Performance Bands: E2-E3

The second secon	Criteria	Marks
applies the Remainder Theorem of	equivalent progress towards solution	-
finds correct remainder	1	-

Sample Answer:

$$P(x) = x^3 - 3x^2 + 3x - 5$$

By the Remainder Theorem P(2) = remainder : remainder = 8 - 12 + 6 - 5

=-3

OR

Correct division of polynomial.

(b) (2 marks)

Outcomes assessed: HE6, HE7

Targeted Performance Bands: E2-E3

1	CTIETIA	Marks	
•	correct trigonometric substitution in integral	-	
•	finds a correct primitive (+C not necessary)	-	

Sample Answer:

$$\int \sin^2 6x \, dx = \frac{1}{2} \int (1 - \cos 12x) \, dx$$
$$= \frac{1}{2} \left(x - \frac{1}{12} \sin 12x \right) + C$$
$$= \frac{x}{2} - \frac{\sin 12x}{24} + C$$

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(c) (3 marks)

Targeted Performance Bands: E2-E3 Outcomes assessed: HE4

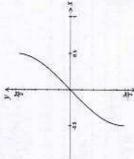
Criteria	Marks
draws correctly shaped graph	-
identifies correct domain	-
identifies correct range	-

Sample Answer:

$$y = 3\sin^{-1}(2x)$$

domain:
$$\frac{-1}{2} \le x \le \frac{1}{2}$$

range:
$$\frac{-3\pi}{2} \le y \le \frac{3\pi}{2}$$



(d) (i) (2 marks)

Outcomes assessed: PE3

Targeted Performance Bands: E2-E3

Civina	Mark
uses correct trigonometric identity	_
substitutes correctly and determines correct equation	

Sample Answer:

$$x = \cos t$$

$$y = 3 + \sin t$$
 \Rightarrow $\sin t = y - 3$
substitute into $\cos^2 t + \sin^3 t = 1$
 $x^2 + (y - 3)^2 = 1$

(d) (fi) (1 mark)

Outcomes assessed: PE3

Targeted Performance Bands: E2-E3

Mark	-
Ĕ	
	locus
	ly describes loca
	orrectl

Sample Answer:

Geometrically the locus is a circle with centre (0, 3) and radius 1.

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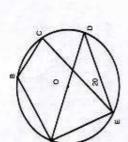
(e) (2 marks)

Outcomes assessed: PE2, PE3

Targeted Performance Bands: E2-E3

The state of the s	Mark
ds ZAED, giving correct reason	
ds ZABC, giving correct reason	-

Sample Answer:



 $\angle AED = 90^{\circ}$ (angle in a semicircle, AD is a diameter)

 $\angle ABC = 110^{\circ}$ (opposite angles of cyclic quadrilateral ABCE are supplementary)

Question 2 (12 marks)

(a) (I mark)

Outcomes assessed: PE2

Targeted Performance Bands: E2-E3

Marks Criteria gives correct result

Sample Answer:

$$\lim_{x \to 0} \frac{\sin 3x}{x} = 3 \lim_{x \to 0} \frac{\sin 3x}{3x}$$

using $\lim_{x\to 0} \frac{\sin x}{x} = 1$ = 3×1 =3

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(b) (3 marks)

Targeted Performance Bands: E2-E3 Outcomes assessed: HE6

Criteria

	Criteria	Mark
	rewrites the integral using the substitution	-
	finds the new limits	-
-044	evaluates the integral correctly (correct numerical equivalence)	-

Sample Answer:

$$\int_{1}^{2} \frac{x}{3x-1} dx = \frac{1}{9} \int_{1}^{3} \frac{3x}{3x-1} \times 3dx \qquad u = 3x-1 \qquad 3x = u+1$$

$$= \frac{1}{9} \int_{1}^{3} \frac{u+1}{u} du \qquad \frac{du}{dx} = 3$$

$$= \frac{1}{9} \int_{1}^{5} \left(1 + \frac{1}{u}\right) du \qquad x = 2 \Rightarrow u = 5$$

$$= \frac{1}{9} \left[(u + \ln u) \right]_{2}^{5}$$

$$= \frac{1}{9} \left[(3 + \ln 5) \right]_{2}^{5}$$

(c) (4 marks)

Outcomes assessed: HE7

Targeted Performance Bands: E2-E3

Criteria	Mark
uses logarithmic laws	
establishes the quadratic equation	
solves the quadratic equation	
gives correct solution	

Sample Answer

$$\ln(2x+3) + \ln(x-2) = 2\ln(x+4)$$
$$\ln(2x+3)(x-2) = \ln(x+4)^2$$

for valid solutions x > 2

$$x^2 - 9x - 22 = 0$$

 $(x+2)(x-11) = 0$

 $2x^2 - x - 6 = x^2 + 8x + 16$

$$x + 2)(x - 11) = 0$$

$$x = -2 \text{ or } x = 11$$

but x = -2 is not valid $\therefore x = 11$ is the only solution

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(d) (i) (2 marks)

Outcomes assessed: PE3

Targeted Performance Bands: E2-E3

Criteria	Mark
uses combinations correctly or significant progress towards answer	1
gives correct answer	-

Sample Answer:

Girls can be selected in ${}^{1}C_{1} = 35$ ways

Boys can be selected in "C, = 15 ways

There are ${}^{7}C_{1} \times {}^{6}C_{2} = 525$ groups of 5.

(d) (ii) (2 marks)

Outcomes assessed: PE3

Targeted Performance Bands: E2-E3

Criteria	Mark
calculates the number of ways that the boys can stand together	-
finds the correct probability	-

Sample Answer:

In the line there are 3 girls and the group of boys to be arranged ⇒ 4! = 24 arrangements. If the boys stand together then there are 2! = 2 ways to arrange themselves. $\therefore 2! \times 4! = 48$ ways of the boys standing together in the line.

If no restrictions the 5 can be arranged in 5! = 120 ways in a line.

P(boys stand together) =
$$\frac{48}{120} = \frac{2}{5}$$
.

Question 3 (12 marks)

(a) (3 marks)

Outcomes assessed: PE3

Targeted Performance Bands: E3-E4

•	establishes correct quadratic or other correct significant step towards solution	
٠	further significant step towards solution	_
٠	finds solution	-

Criteria

Marks

Sample Answer:

$$\frac{x^{2}-4}{x+3} < x-4 \qquad \times (x+3)^{2} \qquad x \neq -3$$

$$(x+3)(x^{2}-4) < (x-4)(x+3)^{2}$$

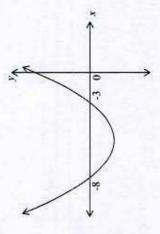
$$(x+3)(x^{2}-4) - (x-4)(x+3)^{2} < 0$$

$$(x+3)(x^{2}-4-(x-4)(x+3)) < 0$$

$$(x+3)(x^{2}-4-(x^{2}-x-12)) < 0$$

$$(x+3)(x+8) < 0$$

$$-8 < x < -3$$



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(b) (4 marks)

Outcomes assessed: HE2

Targeted Performance Bands: E2-E3

	Criteria	Marks
Succes	 establishes the truth of S(1) 	_
1 000	 establishes the result for S(k) 	_
	substitutes result in $S(k+1)$	-
	deduces the required result	_

Sample Answer:

Let S(n) be the statement $3^{3n} + 2^{n+2}$ is divisible by 5

Consider
$$S(1)$$
: $3^3 + 2^3 = 35$ which is divisible by 5.
Hence $S(1)$ is true

If
$$S(k)$$
 is true: $3^{2k} + 2^{k+2} = 5M$ where M is an integer

RTP
$$S(k+1)$$
 is true i.e. prove $3^{3(k+1)} + 2^{(k+1)+2} = 5Q$ where Q is an integer $LHS = 3^{3k+2} + 2^{k+3}$

$$= 3^3 \times 3^{3k} + 2 \times 2^{k+2}$$

=
$$27(5M - 2^{k+2}) + 2 \times 2^{k+2}$$
 if $S(k)$ is true using
= $27 \times 5M - 27 \times 2^{k+2} + 2 \times 2^{k+2}$
= $5 \times 27M - 25 \times 2^{k+2}$
= $5 \times 27M - 5 \times 2^{k+2}$

Hence if S(k) then S(k+1) is true. Thus since S(1) is true it follows by induction that S(n) is true for positive integral n.

= 5Q where Q is an integer since M and k are integers

OR

LHS =
$$3^{4k+1} + 2^{k+3}$$

= $3^3 \times 3^{4k} + 2 \times 2^{4k+2}$
= $25 \times 3^{4k} + 2 \times 3^{3k} + 2^{k+2}$
= $25 \times 3^{4k} + 2 \times 3^{4k}$
= $25 \times 3^{4k} + 2 \times 5M$ if $S(k)$ is true using **
= $5(5 \times 3^{4k} + 2 \times 5M)$

= $5(5 \times 5^{\circ} + 2M)$ = 5Q where Q is an integer since M and k are integers

Conclusion as above

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(c) (i) (3 marks)

Outcomes assessed: HE5 Targeted Performance Bands: E3-E4

Criteria

Marks

|--|

Sample Answer:

$$v = \frac{L}{1+3x}$$

$$\frac{1}{2}v^2 = \frac{1}{2(1+3x)^2}$$
Now
$$a = \frac{d}{dx}(\frac{1}{2}v^2)$$

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

$$= \frac{-12}{(1+3x)^3}$$

$$= -12 \times \frac{8}{(1+3x)^3} \times \frac{1}{8}$$

$$= -12 \times \frac{8}{(1+3x)^3} \times \frac{1}{8}$$

$$= -12 \times \frac{8}{(1+3x)^3} \times \frac{1}{8}$$

.. a varies directly as v

(c) (ii) (2 marks)

Outcomes assessed: HE7

	Criteria	
--	----------	--

Sample Answer:

describes motion as t→∞

Initially $v = 2 \text{ cms}^4$: the particle moves in a positive direction from the origin.

As t increases, x increases and v decreases.

As $t \to \infty$, the particle continues in a positive direction with $v \to 0$.

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Question 4 (12 marks)

(a) (2 marks)

Outcomes assessed: PE3, HE7

Targeted Performance Bands: E2-E3

1	Criteria	Marks	_
	progress towards solution	15	_
	finds correct approximation (correct numerical assistance)		_
1	and the second second deliver control of the second		_

Sample Answer:

$$f(x) = e^{x} - x - 2$$

$$\therefore f'(x) = e^{x} - 1$$
Let $x_{1} = 1.2$

$$f(x_{1}) = e^{1.2} - 1.2 - 2 = 0.1201169...$$

$$f'(x_{1}) = e^{1.2} - 1 = 2.3201169...$$

$$x_{2} = x_{1} - \frac{f(x_{1})}{f'(x_{1})}$$

$$= 1.2 - \frac{0.1201169...}{2.3201169...}$$

$$= 1.14822...$$

$$= 1.15$$

(b) (i) (2 marks)

Outcomes assessed: PE6

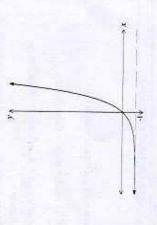
Targeted Performance Bands: E2-E3

	Clucina	Mark
ws correct graph		1
tes correct range		-

Crittania

Sample Answer:

$$y = e^{3x} - 1$$
Range: $y > -1$



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(b) (ii) (3 marks)

Targeted Performance Bands: E2-E3 Outcomes assessed: HE4

Criteria

es variables or progress towards solution biect of constion or further progress toward	interchanges variables or progress towards solution	CHICAGO	Marks
biect of equation or further progress toward		interchanges variables or progress towards solution	-
amust craffeed commit to mount in the	changes subject of equation or further progress towards solution	bject of equation or further progress toward	-

Sample Answer:

$$y = e^{3x} - 1$$
Swap x and y
$$x = e^{3y} - 1$$

$$e^{3y} = x + 1$$

$$3y = \ln(x + 1)$$

$$y = \frac{1}{3}\ln(x + 1)$$

$$f^{-1}(x) = \frac{1}{3}\ln(x + 1), x > -1$$

(c) (f) (2 marks)

Outcomes assessed: HE3

Targeted Performance Bands: E2-E3

erentiates correctly	
ws motion is simple harmonic	

=-9√3 cos 3t +9 sin 3t =-3 \sin 31 -3 cos 31 $=-9(\sqrt{3}\cos 34 - \sin 34)$ $x = \sqrt{3}\cos 3t - \sin 3t$ x6-= å

which is of the form $a = -n^2x$ where n = 3.. motion is simple harmonic

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(c) (ii) (3 marks)

Outcomes assessed: HE3

Targeted Performance Bands: E3-E4

Criteria	Marks
 establishes result using auxiliary angle or other progress toward solution 	
solves correctly for time	-
finds correct velocity (correct numerical equivalence)	-

Sample Answer:

when
$$x = 1$$
, $\sqrt{3}\cos 3t - \sin 3t = 1$

Let
$$\sqrt{3}\cos 3t - \sin 3t = R\cos(3t + \alpha)$$

$$R\cos(3t+\alpha) = R\cos 3t\cos \alpha - R\sin 3t\sin \alpha$$

$$\therefore R\cos\alpha = \sqrt{3}$$

Rsin
$$\alpha = 1$$

i.e. $\tan \alpha = \frac{1}{\sqrt{3}} \implies \alpha = \frac{\pi}{6}$

$$A_3 = 6$$

$$R^2 = 1 + 3 \implies R = 2$$

$$\sqrt{3}\cos 3t - \sin 3t = 2\cos\left(3t + \frac{\pi}{6}\right)$$

i.e. solve
$$2\cos\left(3t + \frac{\pi}{6}\right) = 1$$

$$\cos\left(3t + \frac{\pi}{6}\right) = \frac{1}{2}$$

$$34 + \frac{\pi}{6} = \frac{\pi}{3}$$
 (first oscillation)

$$t = \frac{\pi}{18}$$
 seconds

When
$$t = \frac{\pi}{18}$$
 $v = -3\sqrt{3}\sin\frac{\pi}{6} - 3\cos\frac{\pi}{6}$
= $-3\sqrt{3} \times \frac{1}{2} - 3 \times \frac{\sqrt{3}}{2}$
= $-3\sqrt{3} \text{ cms}^{-1}$

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Question 5 (12 marks)

Outcomes assessed: PE3 (a) (i) (2 marks)

Targeted Performance Bands: E3-E4

٠	defines roots in arithmetic series		1
•	o show result	0	

Sample Answer:

Also sum of roots = $a - d + \alpha + \alpha + d = 3\alpha$ Let the roots be a-d, a and a+di.e. one of the roots is 2 sum of roots = $\frac{-b}{a}$ = 6 $x^3 - 6x^2 + 3x + k = 0$ $\therefore 3\alpha = 6$ $\alpha = 2$

(a) (ii) (3 marks)

Outcomes assessed: PE3

Targeted Performance Bands: E2-E3

•	finds correct value for k	-
	progress toward solution	-
7	Gode correct roots	-

Since one root is 2 substitute into equation to find k.

$$\therefore k = 10$$
i.e. equation is $x^3 - 6x^2 + 3x + 10 = 0$

product of roots =
$$\frac{-d}{a} = -10$$

product of roots = $\alpha(\alpha - d)(\alpha + d)$

from (i)

$$= \alpha(\alpha - \alpha)$$
= \alpha(\alpha - \alpha)
$$-10 = 2 \times (2^2 - d^2)$$

$$-5 = 4 - d^2$$

$$d^2 = 9$$

$$d = \pm 3$$

.: roots are -1, 2, 5

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(b) (3 marks)

Outcomes assessed: PE2

Targeted Performance Bands: E3-E4

310	Criteria	Marks
	establishes correct r-formula or other progress towards result	-
1	significant progress toward the result	-
	completes the proof	1

Sample Answer:

Let
$$t = \tan \theta$$
, $\therefore \tan 2\theta = \frac{2t}{1 - t^2}$
LHS = $\frac{\tan 2\theta - \tan \theta}{\tan 2\theta + \cot \theta}$
= $\left(\frac{2t}{1 - t^2} - t\right) + \left(\frac{2t}{1 - t^2} + \frac{1}{t}\right)$
= $\frac{2t - t + t^2}{1 - t^2} + \left(\frac{2t^2 + 1 - t^2}{t(1 - t^2)}\right)$
= $\frac{2(1 + t^2)}{1 - t^2} \times \frac{t(1 - t^2)}{t^2 + 1}$
= $\frac{t(1 + t^2)}{1 - t^2} \times \frac{t(1 - t^2)}{t^2 + 1}$
= t^2
= $tan^2 \theta$
= RHS

OR

LHS =
$$\frac{\tan 2\theta - \tan \theta}{\tan 2\theta + \cot \theta}$$
=
$$\left(\frac{2 \tan \theta}{1 - \tan^{2} \theta} - \tan \theta\right) + \left(\frac{2 \tan \theta}{1 - \tan^{2} \theta} + \frac{1}{\tan \theta}\right)$$
=
$$\left(\frac{2 \tan \theta - \tan \theta + \tan^{3} \theta}{1 - \tan^{2} \theta}\right) \times \left(\frac{\tan \theta (1 - \tan^{2} \theta)}{2 \tan^{2} \theta + 1 - \tan^{2} \theta}\right)$$
=
$$\tan \theta (1 + \tan^{3} \theta) \times \frac{\tan \theta}{\tan^{3} \theta + 1}$$
=
$$\tan^{3} \theta$$
= RHS

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(c) (i) (2 marks)

Outcomes assessed: PE4

Targeted Performance Bands: E3-E4

1	Criteria	Mark
	uses correct formula for division of interval or progress using other correct method	-
	finds correct coordinates from working	-

Sample Answer:

$$P(2ap, ap^2), S(0, a) \text{ and } PQ : QS = -4:3$$

Let Q have coordinates (x_q, y_q)

$$x_{q} = \frac{3 \times 2ap - 4 \times 0}{-4 + 3} \qquad y_{q} = \frac{3 \times ap^{2} - 4 \times a}{-4 + 3}$$
$$= \frac{6ap}{-1} = -6ap \qquad = a(4 - 3p^{2})$$

 $\therefore Q$ has coordinates $\left(-6ap, a(4-3p^2)\right)$

(c) (ii) (2 marks)

Outcomes assessed: PE4

Targeted Performance Bands: E3-E4

The state of the s	Marks
makes progress to finding the locus	-

Sample Answer:

From (i)
$$x = -6ap$$

$$\therefore p = \frac{-x}{6a} \text{ and } p^2 = \frac{x^2}{36a^2}$$

$$\therefore y = a\left(4 - 3p^2\right)$$

$$= a\left(4 - \frac{3x^2}{36a^2}\right)$$

$$=4a-\frac{x^2}{12a}$$

$$-=4a-y$$

$$\frac{x^2}{12a} = 4a - y$$

$$x^2 = 48a^2 - 12ay$$

= -12a(y-4a)

which is the form of a parabola [with vertex (0, 4a)]

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Question 6 (12 marks)

(a) (3 marks)

Outcomes assessed: PE2

Targeted Performance Bands: E2-E3

•	argeieu i erjormente pannes: ca-co	
	Criteria	Marks
	simplifies some indices	-
	further progress with simplifying indices	1
	gives correct expression	-

Sample Answer:

$$\frac{2^{4a} \times 3^{2a}}{8^n \times 6^n} + 3^n = \frac{2^{4a} \times 3^{2a}}{2^{3a} \times 2^n \times 3^n} + 3^n$$

$$= \frac{2^{4a} \times 3^n}{2^{4a}} + 3^n$$

$$= 3^n + 3^n$$

$$= 2 \times 3^n$$

(b) (i) (2 marks)

Targeted Performance Bands: E3-E4 Outcomes assessed: PE5, HE7

Marks Criteria establishes correct derivative shows the result

Sample Answer:

$$V = \pi r^{2}h$$

$$= \pi r^{3}k \quad \text{since } h = kr$$

$$\frac{dV}{dt} = \frac{dV}{dr} \times \frac{dr}{dt}$$

$$\frac{dV}{dt} = 3\pi r^{2}k \times \frac{dr}{dt}$$

$$\frac{dV}{dt} = 0.2 \text{ when } r = 4$$

$$\therefore 0.2 = 3\pi \times 4^{2}k \times \frac{dr}{dt}$$

$$\therefore 0.2 = 3\pi \times 4^{2}k \times \frac{dr}{dt}$$

$$\frac{dr}{dt} = \frac{0.2}{240\pi k}$$

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(b) (ii) (3 marks)

Targeted Performance Bands: E3-E4 Outcomes assessed: PES, HE7

 equates expressions using (i) or significant progress toward result 	finds expression for $\frac{1}{dt}$ using surface area or progress toward result
A STATE OF THE PARTY OF THE PAR	nt progress toward

Criteria

Marks

Sample Answer:

$$S = 2\pi rh + 2\pi r^{2}$$

$$= 2\pi r^{2}k + 2\pi r^{2}$$
 since $h = kr$

$$= 2\pi r^{2}(k+1)$$

$$\frac{dS}{dt} = \frac{dS}{dr} \times \frac{dr}{dt}$$

$$\frac{dS}{dt} = 4\pi r(k+1) \times \frac{dr}{dt}$$

$$\frac{dS}{dt} = 0.1 \text{ when } r = 4$$

$$\frac{dS}{dt} = 0.1 \text{ when } r = 4$$

$$\frac{dS}{dt} = \frac{0.1}{16\pi(k+1)}$$

$$\frac{dr}{dt} = \frac{0.1}{160\pi(k+1)}$$

from (i) $160\pi(k+1) = 240\pi k$ 240k = 160k + 16080k = 160k=2

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(c) (i) (2 marks)

Outcomes assessed: HE7

Targeted Performance Bands: E3-E4

differentiate LHS correctly differentiate RHS correctly	The state of the s	11.
- A THE STATE OF	differentiate LHS correctly	
	The state of the s	THE REAL PROPERTY OF THE PARTY

Sample Answer:

$$(1+x)^{2n} = \sum_{k=0}^{2n} {}^{2n}C_k \ x^k = {}^{2n}C_0 + {}^{2n}C_1 \ x + {}^{2n}C_2 \ x^2 + \ldots + {}^{2n}C_k \ x^k + \ldots + {}^{2n}C_{2n} \ x^{2n}$$

Differentiate both sides with respect to x.

 $LHS = 2n(1+x)^{2n-1}$

RHS = ${}^{2n}C_1 + {}^{2n}C_2 2x + ... + {}^{2n}C_k kx^{k-1} + ... + {}^{2n}C_{2n} 2nx^{2n-1}$

 $= \sum_{k=1}^{2n} 2^n C_k k x^{k+1}$

 $\left[\therefore 2n (1+x)^{2n-1} = \sum_{k=1}^{2n} k^{2n} C_k \ x^{k+1} \right]$

(c) (ii) (2 marks)

Outcomes assessed: HE7

Targeted Performance Bands: E3-E4

Criteria	Marks
correct substitution into equation	-
gives correct conclusion	-

Sample Answer:

Let
$$x = 1$$
 in the expansion of $2n(1+x)^{2n-1} = \sum_{i=1}^{2n} k^{-2n}C_k x^{i-1}$.

LHS =
$$2n \times 2^{2n-1}$$

= $n \times 2^{2n}$

$$= m \times 4^{\circ}$$

$$= m \times 4^{\circ}$$

$$RHS = \sum_{k=1}^{2n} k^{2n} C_k$$

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

$$\sum_{k=0}^{2n} k^{2n} C_k = n \times$$

 $\sum_{i=1}^{2n} k^{2n} C_k = n \times 4^n$

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Question 7 (12 marks)

(a) (i) (2 marks)

Outcomes assessed: HE3

fargeted Performance Bands: E2-E3

	Mark	
establishes correct binomial probability		
gives correct answer (correct numerical equivalence)	-	

Sample Answer:

Let probability of correct guess, p=0.3 and incorrect guess, q=0.7Binomial probability; (0.7 + 0.3)50

 $P(25 \text{ correct}) = {}^{50}C_{25}(0.7)^{25}(0.3)^{25}$

= 0.0014

(a) (ii) (3 marks)

Outcomes assessed: H5

Targeted Performance Bands: E3-E4

Sample Answer:

Most likely number correct \Rightarrow find the greatest term in $(0.7 + 0.3)^{30}$

Find k such that $\frac{T_{k+1}}{T_c} \ge 1$ $\frac{T_{\text{tot}}}{T_{\text{c}}} = \frac{50 - k + 1}{k} \times \frac{0.3}{0.7}$

i.e. $\frac{153-3k}{7k} \ge 1$

153-3k ≥ 7k

10k < 153

k < 15.3

.. k = 15

Most likely number correct is 15.

 $T_{l_6} = {}^{99}C_{1s}(0.3)^{1s}(0.7)^{1s} = 0.122$

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(b)(i) (2 marks)

Outcomes assessed: HE3

Targeted Performance Bands: E2-E3

Marks
-

Sample Answer:

Particle reaches maximum height when y' = 0

$$y = Vt \sin \theta - \frac{1}{2}gt$$
 \Rightarrow $y' = V \sin \theta - gt$
when $y' = 0$, $gt = V \sin \theta$ i.e. $t = \frac{V \sin \theta}{L}$

(b) (ii) (3 marks)

Outcomes assessed: HE3

Targeted Performance Bands: E3-E4

some progress toward solution 1 I		Criteria	Marks
further progress toward solution	11 170	come progress toward solution	_
many programs of the second se		Gurher progress toward solution	
		numer progress toward solution	

Sample Answer:

At maximum height
$$t = \frac{V \sin \theta}{g}$$
, $x = c$ and $y = h$

$$h = \frac{V^{+} \sin^{2} \theta}{g} - \frac{1}{2} \frac{V^{+} \sin^{2} \theta}{g}$$
 and $c = \frac{V^{+} \cos \theta \sin \theta}{g}$

$$h = \frac{V^{+} \sin^{2} \theta}{2g}$$

$$\therefore \sin^{2} \theta = \frac{2gh}{V^{+}}$$
 (1)
$$\frac{V^{+} \frac{2gh}{g} \left(1 - \frac{2gh}{V^{+}}\right)}{g}$$
 substituting for $\sin^{2} \theta$ from (1)

$$\therefore V' = 2gh + \frac{c^2 g}{2h}$$

$$= \frac{4gh^2 + c^2 g}{2h}$$

$$= \frac{g}{2h} \left(4h^2 + c^2\right)$$

2h(V' -2gh)

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(b) (iii) (2 marks)

Outcomes assessed: HE3

Targeted Performance Bands: E3-E4

	Criteria	Marks
signi	ifficant progress towards solutions	1
finds	is a correct expression for θ	1

Sample Answer:

$$c = \frac{V^{2} \cos \theta \sin \theta}{g} \qquad h = \frac{V^{2} \sin^{2} \theta}{2g}$$

$$\frac{h}{c} = \frac{V^{2} \sin^{2} \theta}{2g} \times \frac{g}{V^{2} \cos \theta \sin \theta}$$

$$\frac{h}{c} = \frac{\sin \theta}{2 \cos \theta}$$

$$\frac{2h}{c} = \tan \theta$$

$$\therefore \theta = \tan^{-1} \left(\frac{2h}{c}\right)$$

$$V^{2} = \frac{8}{2h} \left(4h^{2} + c^{2} \right) \quad h = \frac{V^{2} \sin^{2} \theta}{2g} \quad \text{i.e. } \sin^{2} \theta = \frac{2gh}{V^{2}}$$

$$\sin^{2} \theta = \frac{2gh}{2h}$$

$$\sin^{2} \theta = \frac{4h^{2}}{\left(4h^{2} + c^{2}\right)}$$

$$\sin \theta = \frac{2h}{\sqrt{4h^{2} + c^{2}}} \quad (\theta \text{ acute})$$

$$\theta = \sin^{-1} \left(\frac{2h}{\sqrt{4h^{2} + c^{2}}} \right)$$

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