INTERNATIONAL BACCALAUREATE

Mathematics: analysis and approaches

MAA

EXERCISES [MAA 1.6] BINOMIAL THEOREM

Compiled by Christos Nikolaidis

Ο.	Pract	cice questions	
1.		kimum mark: 9] [without GDC]	
		e down the expansions of	
	(a)	$(1\pm x)^3$	[3]
	(b)	$(1\pm x)^4$	[3]
	(c)	$(1\pm x)^5$	[3]

	ximum mark: 9]
Writ	e down the first four terms in ascending powers of x
(a)	in the expansion of $(1+x)^{10}$
(b)	in the expansion of $(1+2x)^{10}$
(c)	in the expansion of $(2-x)^{10}$

kimum mark: 5] [with GDC] the term in x^{16} in the expansion of $(1-x^2)^{10}$
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5.	[Max	kimum mark: 10] <i>[with GDC]</i>	
	(a)	Expand (i) $\left(x - \frac{1}{x}\right)^3$ (ii) $\left(x - \frac{1}{x}\right)^4$	[5]
	(b)	In the expansion of $\left(x - \frac{1}{x}\right)^{10}$	
		(i) find the constant term	
		(ii) find the term in x^2	
		(iii) find the term in x^{-2} .	[5]

6* .	[Max	mum mark: 10] <i>[with GDC]</i>	
	(a)	Expand $(2x+1)^4$	[2]
	Henc	ee, find	
	(d)	the term in x^2 in the expansion of $x(2x+1)^4$ the term in x^2 in the expansion of $(x+1)(2x+1)^4$ the term in x^2 in the expansion of $(3-x^2)(2x+1)^4$.	[2] [3] [3]

7.

[Max (a)	dimum mark: 6] Show that	[without GD	OC]	
` ,	(i) $\binom{8}{7} = 8$,	(ii) $\binom{8}{6} = 28$,	(iii) $\binom{8}{5} = 56$	[3]
(b)	Find			
	(i) $\binom{10}{9}$,	(ii) $\binom{10}{8}$,	(iii) $\begin{pmatrix} 10 \\ 7 \end{pmatrix}$	[3]

8*.	[Maxi	imum mark: 8]	
	(a)	Show that	
		(i) $\binom{n}{0} = 1$, (ii) $\binom{n}{1} = n$, (iii) $\binom{n}{2} = \frac{n(n-1)}{2}$	[5]
	(b)	Simplify $\binom{n}{3}$	[3]

9*.		imum mark: 9]	
	In the	e expansion of $\left(3x - \frac{2}{x}\right)^{12}$ find	
	(a)	the constant term;	[3]
	(b)	the coefficient of x^4 ;	[3]
	(c)	the first three terms in descending powers of x .	[3]

10*.		imum mark: 9]	
	In the	e expansion of $\left(3x^2 - \frac{2}{x}\right)^{12}$ find	
		the constant term;	[3]
	(b)	the coefficient of x^6 ;	[3]
	(c)	the first three terms in descending powers of x .	[3]

11*.	[Max	ximum mark: 9] <i>[with GDC]</i>	
	In th	the expansion of $\left(3x^3 - \frac{2}{x}\right)^{12}$ find	
	(a)	the constant term;	[3]
			[3]
	(c)	the first three terms in descending powers of x .	[3]
	(-)	9 F	[-]

A. Exam style questions (SHORT)

[Max		\ -						
Ехрі	ess $(\sqrt{3} -$	$(2)^3$ in the	ne form a_{N}	$\sqrt{3} + b$, wh	ere $a, b \in \mathcal{A}$	Z .		
	`	,						
			[with / w $a + a \sqrt{7}$ v			eaers fina	ł	
Give	en that $(3 +$	$+\sqrt{7}$) ³ =	$p + q\sqrt{7}$ v		DC] p are integrated p	egers, find	i	
Give		$+\sqrt{7}$) ³ =	$p + q\sqrt{7}$ v			egers, find	I	
Give	en that $(3 +$	$+\sqrt{7}$) ³ =	$p + q\sqrt{7}$ v			egers, finc	i	
Give	en that $(3 +$	$+\sqrt{7}$) ³ =	$p + q\sqrt{7}$ v			egers, finc	I	
Give	en that $(3 +$	$+\sqrt{7}$) ³ =	$p + q\sqrt{7}$ v			egers, finc	i	
Give	en that $(3 +$	$+\sqrt{7}$) ³ =	$p + q\sqrt{7}$ v			egers, find		
Give	en that $(3 +$	$+\sqrt{7}$) ³ =	$p + q\sqrt{7}$ v			egers, finc		
Give	<i>p</i> ;	(b)	$p + q\sqrt{7}$ v q .	vhere <i>p</i> ar	nd <i>q</i> are into			
Give	<i>p</i> ;	(b)	$p + q\sqrt{7}$ v q .	vhere <i>p</i> ar				
Give	<i>p</i> ;	$+\sqrt{7})^3 =$ (b)	$p + q\sqrt{7}$ v q .	vhere <i>p</i> ar	nd <i>q</i> are into			
Give	<i>p</i> ;	$+\sqrt{7})^3 =$ (b)	$p + q\sqrt{7}$ v q .	vhere <i>p</i> ar	nd <i>q</i> are into			
Give	<i>p</i> ;	$+\sqrt{7})^3 =$ (b)	$p + q\sqrt{7}$ v q .	vhere <i>p</i> ar	nd <i>q</i> are into			
Give	<i>p</i> ;	$+\sqrt{7})^3 =$ (b)	$p + q\sqrt{7}$ v q .	vhere <i>p</i> ar	nd <i>q</i> are into			
Give	<i>p</i> ;	$+\sqrt{7})^3 =$ (b)	$p + q\sqrt{7}$ v q .	vhere <i>p</i> ar	nd <i>q</i> are into			
Sive	en that (3 + p;	(b)	$p + q\sqrt{7}$ v q .	vhere <i>p</i> ar	nd <i>q</i> are into			
Sive	en that (3 + p;	(b)	$p + q\sqrt{7}$ v q .	vhere <i>p</i> ar	nd <i>q</i> are into			
Sive	en that (3 + p;	(b)	$p + q\sqrt{7}$ v q .	vhere <i>p</i> ar	nd q are into			
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16.		imum mark: 6] [without GDC]	
	(a)	Expand $\left(e + \frac{1}{e}\right)^4$ in terms of e.	[4]
	(b)	Express $\left(e + \frac{1}{e}\right)^4 + \left(e - \frac{1}{e}\right)^4$ as the sum of three terms.	[2]

17.	[Maximum mark: 6]	[with / without GDC]
	Complete the following	expansion.
		$(2+ax)^4 = 16 + 32ax + \dots$
18.	[Maximum mark: 4]	[with GDC]
	Use the binomial theor	em to complete this expansion.
		$(3x+2y)^4 = 81x^4 + 216x^3y + \dots$

19.	[Max		[without GDC]	
	Find	(i) $\binom{7}{3}$	(ii) $\binom{200}{2}$	
20.	[Max	imum mark: 8]	[without GDC]	
	(a)	Verify that	$ \binom{5}{2} + \binom{5}{3} = \binom{6}{3} $	[3]
	(b)	Prove that	$ \binom{19}{9} + \binom{19}{10} = \binom{20}{10} $	[5]

ind	
	kimum mark: 4] [with / without GDC]
	ximum mark: 4] [with / without GDC] the coefficient of a^3b^4 in the expansion of $(5a+b)^7$.
	the coefficient of a^3b^4 in the expansion of $(5a+b)^7$.
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23.	[Max	kimum mark: 6]	[without GDC]	
	The	fifth term in the ex	expansion of the binomial $(a+b)^n$ is given by $\binom{10}{4}p^6(2q)^4$.	
	(a)	Write down the		[1]
	(b)	Write down a an	d b , in terms of p and/or q .	[2]
	(c)	Write down an e	expression for the sixth term in the expansion.	[3]
•	FN 4			
24.	livia	kimum mark: 5]	[with GDC]	
24.	_	_	[with GDC] x^7 in the expansion of $(2+3x)^{10}$, giving your answer as a whole	
24.	_	the coefficient of		
24.	Find	the coefficient of		
24.	Find	the coefficient of		
24.	Find	the coefficient of		
24.	Find	the coefficient of ber.		
24.	Find	the coefficient of ber.	x^7 in the expansion of $(2+3x)^{10}$, giving your answer as a whole	
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	ximum mark: 5] [with / without GDC]	
Cons	sider the expansion of $(x+2)^{11}$.	
(a)	Write down the number of terms in this expansion.	
(b)	Find the term containing x^2 .	
[Мах	kimum mark: 6] <i>[with / without GDC]</i>	
	cimum mark: 6] [with / without GDC] the coefficient of x^3 in the expansion of $(2-x)^5$.	
	the coefficient of x^3 in the expansion of $(2-x)^5$.	
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27 .	[Maximum mark: 4]	[with GDC]
	Find the coefficient of	x^5 in the expansion of $(3x-2)^8$
28.	[Maximum mark: 6]	
	Find the term containing	ng x^3 in the expansion of $(2-3x)^8$.

	ium mark: 6j	[with GDC]	
Find th	e coefficient of a	x^3 in the binomial expansion of $\left(1 - \frac{1}{2}x\right)^8$.	
			•••••
••			
••			
••			
••			
30. [Maxim	num mark: 6]	[with GDC]	
		[with GDC] ne x^3 term in the expansion of $\left(2 - \frac{3x}{2}\right)^6$.	
Find the	e coefficient of th		
Find the	e coefficient of th	the x^3 term in the expansion of $\left(2 - \frac{3x}{2}\right)^6$.	
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Find the	e coefficient of th	the x^3 term in the expansion of $\left(2 - \frac{3x}{2}\right)^6$.	
Find the	e coefficient of th	the x^3 term in the expansion of $\left(2-\frac{3x}{2}\right)^6$.	

31.	[Maximum mark: 5] [N	rith GDC]
	Find the term in x^3 in the	expansion of $\left(\frac{2}{3}x-3\right)^8$.
32.		_
32.		with / without GDC] repansion of $(x + 2y)^{10}$ is $ax^8 y^2$. Find the value of a .
32.		_
32.	One of the terms of the ex	_
32.	One of the terms of the ex	epansion of $(x + 2y)^{10}$ is $ax^8 y^2$. Find the value of a .
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3. [Max	rimum mark: 6]
Find	the term containing x^{10} in the expansion of $(5 + 2x^2)^7$.
1. [Max Con	sider the expansion of $(x^2-2)^5$.
Con (a)	Write down the number of terms in this expansion.
Con	
Con (a)	Write down the number of terms in this expansion. The first four terms of the expansion in descending powers of <i>x</i> are
Con (a)	Write down the number of terms in this expansion. The first four terms of the expansion in descending powers of x are $x^{10} - 10x^8 + 40x^6 + Ax^4 +$
Con (a)	Write down the number of terms in this expansion. The first four terms of the expansion in descending powers of x are $x^{10} - 10x^8 + 40x^6 + Ax^4 +$
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Con (a)	Write down the number of terms in this expansion. The first four terms of the expansion in descending powers of x are $x^{10}-10x^8+40x^6+Ax^4+$ Find the value of A .
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	sider the expansion of the expression $(x^3 - 2x)^0$
Jons (a)	sider the expansion of the expression $(x^3 - 3x)^6$. Write down the number of terms in this expansion.
	Find the term in x^{12} .
(b)	Find the term in x .
Ma> Find	simum mark: 6] [with / without GDC] the term in x^4 in the expansion of $\left(3x^2 - \frac{2}{x}\right)^5$.
Ma> Find	cimum mark: 6] [with / without GDC] the term in x^4 in the expansion of $\left(3x^2 - \frac{2}{x}\right)^5$.
Max Find	the term in x^4 in the expansion of $\left(3x^2 - \frac{2}{x}\right)^5$.
<u>(</u> Max Find	the term in x^4 in the expansion of $\left(3x^2 - \frac{2}{x}\right)^5$.
Max Find	the term in x^4 in the expansion of $\left(3x^2 - \frac{2}{x}\right)^5$.
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Max	the term in x^4 in the expansion of $\left(3x^2 - \frac{2}{x}\right)^5$.
Max-ind	the term in x^4 in the expansion of $\left(3x^2 - \frac{2}{x}\right)^5$.
Мах ⁻ ind	the term in x^4 in the expansion of $\left(3x^2 - \frac{2}{x}\right)^5$.
Max Find	the term in x^4 in the expansion of $\left(3x^2 - \frac{2}{x}\right)^5$.
Max Find	the term in x^4 in the expansion of $\left(3x^2 - \frac{2}{x}\right)^5$.

37.		kimum mark: 6]		
	Cons	sider the expansio	n of $\left(3x^2 - \frac{1}{x}\right)^9$.	
	(a)	How many terms	are there in this expansion?	[1]
	(b)	Find the constan	t term in this expansion.	[5]
38.		kimum mark: 4]	_	
38.			[with GDC] In the expansion of $\left(x - \frac{2}{x^2}\right)^9$.	
38.			_	
38.		ermine the constan	_	
38.		ermine the constan	It term in the expansion of $\left(x - \frac{2}{x^2}\right)^9$.	
38.		ermine the constan	It term in the expansion of $\left(x - \frac{2}{x^2}\right)^9$.	
38.		ermine the constan	It term in the expansion of $\left(x - \frac{2}{x^2}\right)^9$.	
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38.		ermine the constan	It term in the expansion of $\left(x - \frac{2}{x^2}\right)^9$.	
38.		ermine the constan	It term in the expansion of $\left(x - \frac{2}{x^2}\right)^9$.	

39.	•
	Find the constant term in the expansion of $\left(x^2 - \frac{2}{x^2}\right)^6$.
40.	[Maximum mark: 6] [with / without GDC]
	Find the coefficient of x in the expansion of $\left(3x - \frac{2}{x}\right)^5$.

шк	the value of a.
Ma	ximum mark: 61
	ximum mark: 6] <i>[with GDC]</i>
	ximum mark: 6] [with GDC] coefficient of x in the expansion of $\left(x + \frac{1}{ax^2}\right)^7$ is $\frac{7}{3}$. Find the possible values
	coefficient of x in the expansion of $\left(x + \frac{1}{ax^2}\right)^7$ is $\frac{7}{3}$. Find the possible values
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	coefficient of x in the expansion of $\left(x + \frac{1}{ax^2}\right)^7$ is $\frac{7}{3}$. Find the possible values

43.	[Max	imum mark: 6]	
	(a)	Expand $(x-2)^4$ and simplify your result.	[3]
	(b)	Find the term in x^3 in $(3x+4)(x-2)^4$.	[3]

44*.	[Max	imum mark: 6]	
		Expand $(2+x)^4$ and simplify your result.	[3]
	(b)	Hence, find the term in x^2 in $(2+x)^4 \left(1+\frac{1}{x^2}\right)$.	[3]

45 *.	[Max	faximum mark: 8]		
	(a)	Find the expansion of $(2+x)^5$, giving your answer in ascending powers of x .	[3]	
	(b)	By letting $x = 0.01$ or otherwise, find the exact value of 2.01^5 .	[2]	
	(c)	Find the exact value of 1.99^5 .	[3]	

46**.	[Maximum mark: 6]	[with GDC]
	Determine the first thre of x .	be terms in the expansion of $(1-2x)^5 (1+x)^7$ in ascending powers

47**.	[Maximum mark: 6]	[without GDC]
	Given that	
	(1-	$(1+ax)^{5} (1+ax)^{6} \equiv 1+bx+10x^{2}+\cdots+a^{6}x^{11},$
	find the values of a,b	∈ ℤ *.

18*.	18*. [Maximum mark: 6] [without GDC]	
	Find the term in x^2 in $(1+x)^4 \left(3+\frac{2}{x^2}\right)$	

9**.	[Maximum mark: 6]	[with / without G	DCJ		
	Find the coefficient of	x^3 in the expansion	of $(2+x)^4 (1+x)^4$	$(x^2)^5$	
			•••••		

50.** [Maximum mark: 6] [with GDC] Find the constant term in the expansion of $(2+x)^4 \left(2x+\frac{1}{x}\right)^5$

(a)	Write down the quadratic expression $2x^2 + x - 3$ as the product of two linear factors.
(b)	Hence, or otherwise, find the coefficient of x in the expansion of $(2x^2 + x - 3)^8$.

52**.	[Maxi	imum mark: 9] <i>[with GDC]</i>	
		e binomial expansion of $(a+x)^n$, where $n \ge 4$, the coefficient of x^3 is twice the cient of x^4 .	
	(a) Show that $n = 2a + 3$		
	(b)	Given that $a = 3$, find the coefficients of x^3 and x^4 . [4]	

53**.	[Maximum mark: 6] [with GDC]	
	In the expansion of $(1 + ax)^n$ the first term is 1, the second term is $24x$ and the third	t
	term is $252x^2$. Find the values of a and n .	

54*.		imum mark: 8]
	Wher	$n\left(1+\frac{x}{2}\right)^n, n \in \mathbb{N}$, is expanded in ascending powers of x , the coefficient of x^3 is 70.
	(a)	Find the value of n . [4]
	(b)	Hence, find the coefficient of x^2 . [4]

B. Exam style questions (LONG)

55. [Maximum mark: 12] [without GDC]

Consider the binomial expansion $(1+x)^4 = 1 + \binom{4}{1}x + \binom{4}{2}x^2 + \binom{4}{3}x^3 + x^4$

- (a) By substituting x = 1 into both sides, or otherwise, evaluate $\binom{4}{1} + \binom{4}{2} + \binom{4}{3}$. [2]
- (b) Evaluate $\binom{4}{1} \binom{4}{2} + \binom{4}{3}$ in a similar way. [3]
- (c) Evaluate $\binom{9}{1} + \binom{9}{2} + \binom{9}{3} + \binom{9}{3} + \binom{9}{4} + \binom{9}{5} + \binom{9}{6} + \binom{9}{7} + \binom{9}{8}$. [4]
- (d) Show that $\binom{9}{1} + \binom{9}{3} + \binom{9}{5} + \binom{9}{7} = \binom{9}{2} + \binom{9}{4} + \binom{9}{6} + \binom{9}{8}$. [3]

56**.	[Maxi	mum mark: 9] <i>[without GDC]</i>		
	Let $S=a+b$ and $P=ab$. By using the appropriate expansions of $(a+b)^n$, express the following in terms of S and P .			
	(a)	$a^2 + b^2$	[2]	
	(b)	$a^3 + b^3$	[3]	
	(c)	$a^4 + b^4$	[4]	