



Teacher Notes for Ultimate Brackets

Compatibility: TI-83+/83+SE/84+/84+SE

Run The Program Called: **UB**

► Summary

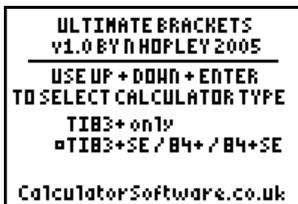
Ultimate Brackets provides the user with unlimited practice at both Factorising and Expanding brackets. It contains 188 levels of questions for expanding and simplifying and 69 levels of factorising questions, each organised into exercises of increasing difficulty.

The **test conditions** option allows a pre-test to be done, which in turn starts the user off on the correct exercise for their capabilities.

► Suggestions

If the program is being used for the first time with a class then see **Appendix 1** for recommended lesson plans to help both staff and students experience a productive lesson.

► Features



The title screen requires the user to declare which calculator model they are using. One feature of the program is that the user is timed for how long it takes to complete each question, presenting a mean time at the end of each set of 5 questions. As different models of calculator have different processing speeds, this selecting the calculator model is required so that the program's clock runs at the correct pace.

Listed below are explanations of the various options from which the user may select:

x VARIABLE ONLY VARIOUS VARIABLES

Questions can either be presented in terms of a variable **x**, or a different letter from the alphabet. This is purely a cosmetic feature and does not affect the difficulty of the questions that need to be answered.

AUTO CORRECT +/- SIGNS STRICT CHECKING OF +/-

Students are often unsure when to type a negative sign or a subtraction sign. Also, they often type expressions that contain consecutive operators, such as “+-”
Choosing the **AUTO CORRECT** option enables the program to “fix” these, and many other situations, which would otherwise be logically wrong in terms of normal calculator syntax.
Choosing **STRICT CHECKING** requires the user to enter all answers in exactly correct calculator syntax.

**PRACTICE QUESTIONS
TEST CONDITIONS**

PRACTICE QUESTIONS generates a sequence of 5 questions from the subsequently chosen level or exercise. The user has up to two attempts at each question. If factorising questions are attempted, they may obtain **Hints** about the format of the answer.

TEST CONDITIONS generates a sequence of 5 questions from the subsequently chosen difficulty of test - either Novice, Intermediate or Advanced. Each of these three settings selects questions from a range of exercises. See **Appendix 3** for more details. The user has, in general, only one attempt at each question. The **Hint** facility for factorising is disabled in **TEST** mode.

**EXPANDING + SIMPLIFYING
FACTORISING**

In line with which of these is chosen, the answers must be entered in either their most simplified or most factorised form. Partially simplified or factorised answers are not accepted and error messages are displayed to this effect.

**START ON EXERCISE (1-n)
TRY SINGLE LEVEL (1-m)**

If **PRACTICE QUESTIONS** was previously chosen, the user selects from **START ON EXERCISE** or **TRY SINGLE LEVEL**. They must then subsequently type in the number of the exercise or the level that they are starting at.

**NOVICE (a-b)
INTERMEDIATE (b-c)
ADVANCED (c-d)**

If **TEST CONDITIONS** was previously chosen, the user selects the difficulty of the test. The **NOVICE**, **INTERMEDIATE** and **ADVANCED** test levels all overlap by one exercise (eg. the hardest level on Novice is the easiest level on Intermediate, etc.) See **Appendix 3** for more details.

For each menu item, the numbers listed in brackets indicate the levels, or exercises, that may be attempted from that option.

**PROGRESSIVE ORDER
RANDOM ORDER**

If the user selected **TEST CONDITIONS** then they must choose either to have their 5 questions presented to them in increasing order of difficulty (**PROGRESSIVE**) or in a mixed up order (**RANDOM**)

**QUESTION FORM: ax^2+bx+c
QUESTION MAY MIX UP ORDER**

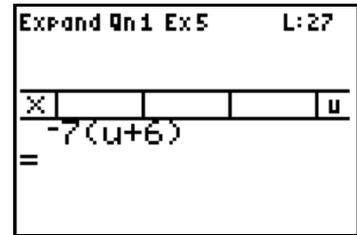
If the user selected **FACTORISING** then they must choose either to have every question presented to them with the terms strictly in the order **ax^2+bx+c** , or in different orders. (eg. instead of x^2-5x+6 , it could be presented as $6+x^2-5x$, or as $6-5x+x^2$, but not $-5x+x^2+6$)

Selecting **MIX UP ORDER** gives, where possible, expressions whose first term is not negative.

Once the desired options have been entered, the program prepares the question database and then presents the user with their first question. Full exercise and level details are in **Appendix 3**.

Along the very top line of the display, from left to right is the following information:

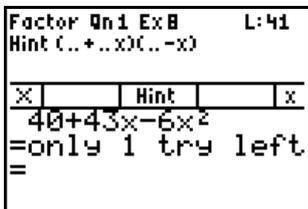
- Expand *or* Factorise
- the Question number
- the Exercise number, *or* Test Difficulty (when selected)
- the level number.



Halfway down the screen are 5 boxes that align with the 5 buttons below the calculator's display - **Y= WINDOW ZOOM TRACE GRAPH**

Press **Y=** at any time to **QUIT**. The menu gives the options of either returning to the question, restarting the program, or quitting from the program. After at least one question has been attempted, there is also the option from this menu screen to view the score before quitting.

- To answer the question, the user must type in the correct expression next to the = sign, and then press **ENTER**. Note that when expanding expressions, the bracket keys are disabled.
- A variable may be typed by either pressing X,T,θ,n or pressing **GRAPH** (this is the button that is aligned below the boxed letter that is in the middle, right-hand side of the screen's display)
- Squared terms may be obtained by pressing the x^2 button, as normal.



When tackling **Practice Questions** on **Factorising**, pressing **ZOOM** displays a **Hint** for the format of the answer. However, this counts as an attempt at the question, thereby reducing the number of attempts at the question that they have left.

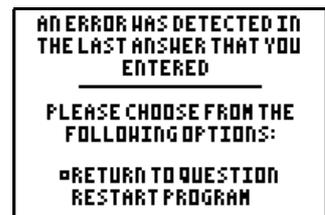
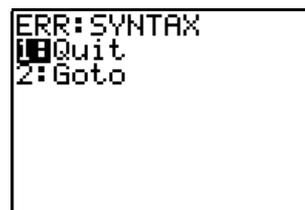


All answers are checked in a variety of ways and appropriate messages are displayed - see **Appendix 2** for the full list of messages which can be displayed, and their causes.

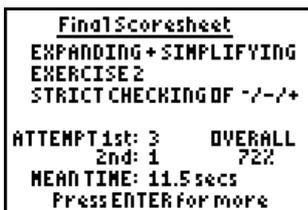
Where a problem is identified within an answer, pressing **ZOOM** displays more information, and the problematic part of the expression is underlined. Where more than one problem has been detected, repeated pressing of **ZOOM** displays the extra information messages.

If the submitted answer is correct, the user moves onto the next question in their set of 5.

If an illogical answer is submitted that contains errors that are not able to be corrected by the program (such as typing in the answer "5+++6x") an **ERR:SYNTAX** screen like the one on the right will be displayed.



If this happens, the program can be restarted by pressing **ENTER** twice. The above screenshot will then be displayed which allows the user to return to the question and re-attempt it.



After the 5th question, they are presented with a Final Scoresheet of

- the options that were selected at the start of the program
- the number of questions answered correctly on the 1st and 2nd attempts
- their overall percentage score
- the mean time taken per question.

```

You Had Problems With....
Level: 9 of exercise: 2

Press ENTER for options

```

If any questions were answered incorrectly, the program lists the exercise(s) and level(s) of these questions.

```

      ☹
Based upon your score, you
are recommended to press

X|      | Retry |      |

```

In light of the score obtained, the user is then presented with options of what to do next, chosen by pressing the appropriate aligned key from:
Y= WINDOW ZOOM TRACE GRAPH

Also, the drawn face is either sad, neutral or smiling depending upon the score:

all 5 questions correct and no more than one 2nd attempt required ☺ progress up to the next level/exercise/test

all 5 questions correct and either two or three 2nd attempts required ☹ either retry the same level/exercise/test, or progress up to the next

3 or 4 questions correct ☹ retry the same level/exercise/test

1 or 2 questions correct ☹ ask for help from their teacher, or move down a level/exercise/test

► Acknowledgements

A section of code used in this program is gratefully acknowledged to Raymond Bonneau.

Appendix 1 - Recommended First Lessons

See the next few pages for recommended First Lessons covering the following four scenarios:

1. Expanding (with a class who are meeting expanding for the first time)
 2. Expanding (with a class who know how to expand already)
 3. Factorising (with a class who are meeting factorising for the first time)
 4. Factorising (with a class who know how to expand already)
-

1. Expanding (with a class who are meeting expanding for the first time)

1. Clear RAM memory
 2. Ungroup the group **BRACKETS**
 3. Run the **PrgmUB**
 4. Title Screen - select appropriate model of calculator
 5. Select **Various Variables**
 6. Select **Auto Correct -/+/ Signs**
 7. Select **Practice Questions**
 8. Select **Expanding + Simplifying**
 9. Select **Start on Exercise (1-17)**
 10. Type in **1** and press **Enter**
- At each menu choice, you might wish to describe to the class the difference between the various options, before the one that they want is selected.
11. At the screen with the first question, direct their attention to the information displayed along the very top of the screen.
 12. Instruct the class how to obtain the variable letter - either press X, T, θ, n or **GRAPH**
- As students progress through their 5 questions, they may get error messages that require teacher support. Remember, pressing **ZOOM** presents more information about what the problem might be.
 - At the end of the 5 questions, their final score and performance will be displayed, along with details of questions that were answered incorrectly
 - The class will then start to diverge in the tasks being tackled. Students will either move up to the next level/exercise, or retry the same level/exercise again.

2. Expanding (with a class who know how to expand already)

1. Clear RAM memory
 2. Ungroup the group **BRACKETS**
 3. Run the **PrgmUB**
 4. Title Screen - select appropriate model of calculator
 5. Select **Various Variables**
 6. Select **Auto Correct -/+/ Signs**
 7. Select **Test Conditions**
 8. Select **Expanding + Simplifying**
 9. Select **Novice (Ex 1-8)**
 10. Select **Progressive Order**
- At each menu choice, you might wish to describe to the class the difference between the various options, before the one that they want is selected.
11. At the screen with the first question, direct their attention to the information displayed along the very top of the screen.
 12. Instruct the class how to obtain the variable letter - either press X, T, θ, n or **GRAPH**
- As students progress through their 5 questions, they may get error messages that require teacher support. Remember, pressing **ZOOM** presents more information about what the problem might be.
 - At the end of the 5 questions, their final score and performance will be displayed, along with details of questions that were answered incorrectly
 - The class will then start to diverge in the tasks being tackled. Students will either start the next level of test (Intermediate level) or start on the exercise number that corresponded to the easiest question that they answered incorrectly.
- ◆ At any point in time, the students can restart the program and run another test, or start at a higher difficulty exercise.

3. Factorising (with a class who are meeting factorising for the first time)

1. Clear RAM memory
2. Ungroup the group **BRACKETS**
3. Run the **PrgmUB**
4. Title Screen - select appropriate model of calculator
5. Select **Various Variables**
6. Select **Auto Correct -/+/ Signs**
7. Select **Practice Questions**
8. Select **Factorising**
9. Select **Start on Exercise (1-17)**
10. Type in **1** and press **Enter**
11. Select **Question May Mix Up Order**

*[this last choice may seem strange for a first lesson, but it means that students will be presented with expressions in the simpler form of **8-12x**, rather than **-12x+8**]*

- At each menu choice, you might wish to describe to the class the difference between the various options, before the one that they want is selected.
12. At the screen with the first question, direct their attention to the information displayed along the very top of the screen.
 13. Instruct the class how to obtain the variable letter - either press X, T, θ, n or **GRAPH**
- As students progress through their 5 questions, they may get error messages that require teacher support. Remember, pressing **ZOOM** presents more information about what the problem might be.
 - At the end of the 5 questions, their final score and performance will be displayed, along with details of questions that were answered incorrectly
 - The class will then start to diverge in the tasks being tackled. Students will either move up to the next level/exercise, or retry the same level/exercise again.

4. Factorising (with a class who know how to expand already)

1. Clear RAM memory
 2. Ungroup the group **BRACKETS**
 3. Run the **PrgmUB**
 4. Title Screen - select appropriate model of calculator
 5. Select **Various Variables**
 6. Select **Auto Correct -/+ Signs**
 7. Select **Test Conditions**
 8. Select **Expanding + Simplifying**
 9. Select **Novice (Ex 1-8)**
 10. Select **Progressive Order**
 11. Select either **Question Form: ax^2+bx+c** or **Question May Mix Up Order**
- At each menu choice, you might wish to describe to the class the difference between the various options, before the one that they want is selected.
12. At the screen with the first question, direct their attention to the information displayed along the very top of the screen.
 13. Instruct the class how to obtain the variable letter - either press X,T,θ,n or **GRAPH**
- As students progress through their 5 questions, they may get error messages that require teacher support. Remember, pressing **ZOOM** presents more information about what the problem might be.
 - At the end of the 5 questions, their final score and performance will be displayed, along with details of questions that were answered incorrectly
 - The class will then start to diverge in the tasks being tackled. Students will either start the next level of test (Intermediate level) or start on the exercise number that corresponded to the easiest question that they answered incorrectly.
- ◆ At any point in time, the students can restart the program and run another test, or start at a higher difficulty exercise.

Appendix 2 - Messages

Items which have an @ next to them do not register if **AUTO CORRECT** 'I-I+ SIGNS' is selected.

MESSAGE	CAUSE /REASON
Well Done! / etc	Answer correct on 1 st attempt
Correct Answer	Answer correct on 2 nd attempt
Answer Accepted	Answer correct on 3 rd attempt <i>This option only arises from an incorrect 1st attempt, the 2nd attempt being "used up" by requesting a Hint and then the correct answer.</i>
<hr/>	
"Problems are underlined..."	<i>Press ZOOM to view the message(s)</i>
Not correct	Answer not algebraically equivalent to the question.
Not allowed	Only x^2 and y^2 terms allowed. No other items may be squared. After a variable, you may only have one of the following: 2 () + - @ - sign at the very start of the answer [it should be negative sign]
Confusing	@ Before a negative sign, you may only have one of the following: (+ - @ After an open bracket you may not have a subtraction sign, -
Not required	@ + sign at the very start of the answer
Can be simplified	@ -+, +-, + or + combination is the same as - @ --, - or ++ combination is the same as + x^2 , x or constant terms can be simplified.
Missing bracket	No brackets contained in an answer to a factorisation question. An odd number of brackets are present.
Bracket error	Brackets are not in the order: open, close, open, close, etc. More than two pairs of brackets are in the answer. Brackets do not contain an allowed expression
Surplus brackets	Brackets do not contain an operand, and are therefore not needed.
Factorise more	Bracket can still have a common factor removed from it. Bracket is a difference of two squares and can be split up further.
<hr/>	
"Correct, but tidy up..."	<i>These are not recorded as errors, but aim to encourage "good form"</i>
Make more elegant	All terms in a bracket are negative, so factorise out a negative sign. Both brackets are the same and therefore can be written as $(...)^2$ Re-order terms inside a bracket so that first term is not negative (for example, re-type $-x+a$ as $a-x$)

Appendix 3 - Expanding & Factorising Exercises and Levels

Exercises & Levels for Expanding & Simplifying (Nov=Novice, Int=Intermediate, Adv=Advanced)

1	1	...(x+...)	8	50	...x(...+...x)	10	103	(...+...x)(x-...)
Nov	2	...(x+...)	Nov	51	...x(...x-...)	Int	104	(...-...x)(...+x)
	3	...(x-...)	Int	52	...-...x(...x+...)		105	(...-...x)(...-x)
	4	...(x-...)		53	...-...x(...-...x)		106	(...-...x)(x-...)
	5	...(x-...x)		54	...x-x(...x+...)		107	(...+...x)(...+...x)
	6	...(x-...x)		55	...x-x(...x-...)		108	(...+...x)(...x-...)
				56	...x-...x(...+...x)		109	(...-...x)(...+...x)
				57	...x-...x(...x-...)		110	(...-...x)(...-...x)
							111	(...-...x)(...x-...)
2	7	...+...(x+...)	9	58	...(x+...)+...(x+...)	11	112	...(x+...)(x+...)
Nov	8	...+...(x-...x)	Int	59	...(x-...)+...(x-...)	Int	113	...(x+...)(x-...)
	9	...x+...(x+...)		60	...x(x-...)+...(x-...)		114	...(x-...)(x-...)
	10	...x+...(x-...)		61	...(x+...)+...x(...x+...)		115	...(x+a)(x+a)
				62	...(x-...)+...x(...x-...)		116	...(x+a)(x-a)
3	11	x(x+...)		63	x(...x+...)+...x(...x+...)		117	...(x+...) ²
Nov	12	x(...x+...)		64	...(x-...)-...(x-...x)		118	...(x-a)(x+a)
	13	x(x-...)		65	...x(...+...x)-...(x+...x)		119	...(x-a)(x-a)
	14	x(x-...)		66	...x(x-...)-...(x-...)		120	...(x-...) ²
	15	x(...-...x)		67	...(x-...)(x-...x)		121	...(x+...)(x+...)
	16	x(...x-...)		68	...x(...+...x)-...(x+...x)		122	...(x-...)(x+...)
	17	...x(x+...)		69	...x(...-...x)-...(x-...x)		123	...(x-...)(x-...)
	18	...x(...x+...)		70	...(x+...)-x(...x+...)		124	...(x+...)(x-...)
	19	...x(...-...x)		71	...x(...x+...)-x(...x+...)		125	...(x-...)(x-...)
	20	...x(x-...)		72	...x(x-...)-x(...x-...)		126	...(x+...x)(x+...x)
	21	...x(...-...x)		73	...(x-...)-x(...-...x)		127	...(x+...x)(x-...x)
	22	...x(...x-...)		74	...x(...-...x)-...x(...-...x)		128	...(x-...x)(x+...x)
				75	x(...x+...)-...x(...x+...)		129	...(x-...x)(x-...x)
4	23	...+...x(...x+...)	10	76	(x+...)(x+...)		130	...(x-...x)(x-...)
Nov	24	...+...x(...x-...)	Int	77	(x-...)(x+...)		131	...(x+...)(x+...)
	25	...x+...x(...+...x)		78	(x-...)(x-...)		132	...(x-...)(x+...)
	26	...x+...x(...x-...)		79	(x+a)(x+a)		133	...(x-...)(x-...)
				80	(x+...) ²		134	...(x+...)(x+...)
5	27	-...(x+...)		81	(x-a)(x-a)		135	...(x+...)(x-...)
Nov	28	-...(x+...)		82	(x-...) ²		136	...(x-...)(x+...)
	29	-...(x-...)		83	(x+a)(x-a)		137	...(x-...)(x-...)
	30	-...(x-...x)		84	(x-a)(x+a)		138	...(ax+b)(ax+b)
	31	-(x+...)		85	(...+x)(x+...)		139	...(ax+b)(ax-b)
	32	-(x-...)		86	(...+x)(x-...)		140	...(x+...) ²
	33	-(...+...x)		87	(...-x)(x+...)		141	...(ax-b)(ax+b)
	34	-(...x-...)		88	(...-x)(x-...)		142	...(ax-b)(ax-b)
	35	-(...x-...)		89	(...-x)(x-...)		143	...(x-...) ²
	36	-(...+...x)		90	(...x+...)(x+...)		144	...(x-...x)(x+...x)
				91	(...x+...)(...x+...)		145	...(x-...x)(x-...x)
6	37	...-...(x+...x)		92	(...x+...)(x-...)		146	...(x-...x)(x+...x)
Nov	38	...-...(x-...x)		93	(...x+...)(x-...)		147	...(x-...x)(x-...x)
	39	...-(x+...x)		94	(...x-...)(x+...)			
	40	...-(x-...x)		95	(...x-...)(x-...)		12	148 ...+...(x+...x) ²
	41	...x-...(x+...x)		96	(...x-...)(x-...)	Int	149	...+...(x-...x) ²
	42	...x-...(x-...x)		97	(...x+...)(x+...)	Adv	150	...x+...(x+...x) ²
	43	...x-(x-...x)		98	(...x+...)(x-a)		151	...x+...(x-...x) ²
	44	...x-(x-...x)		99	(...x+...) ²			
7	45	-x(...+...x)		100	(...x-a)(x-a)			
Nov	46	-x(...x+...)		101	(...x-...) ²			
	47	-x(...x-...)		102	(...+...x)(x-...x)			
	48	-x(...x+...)						
	49	-x(...-...x)						

Expanding cont./

13	152	$-(...x+...)^2$
Adv	153	$-(...-...x)^2$
	154	$-(...x+...)^2$
	155	$-(...x-...)^2$
14	156	$...-...(...x+...)^2$
Adv	157	$...-...(...-...x)^2$
	158	$...-(...x+...)^2$
	159	$...-(...x-...)^2$
	160	$...x-...(...x+...)^2$
	161	$...x-...(...x-...)^2$
	162	$...x-(...x+...)^2$
	163	$...x-(...-...x)^2$
15	164	$...(...x+...)+...(...x+...)^2$
Adv	165	$(...x+...)^2+...x(...x+...)$
	166	$...(x-...)^2+...(x-...)$
	167	$...x(x-...)+...(x-...)^2$
	168	$...(x-...)^2+...x(...-...x)$
	169	$...x(...-...x)+...(x-...x)^2$
16	170	$...(x+...x)-...(x+...x)^2$
Adv	171	$x(...x+...)-...(x+...)^2$
	172	$...(x+...)^2-x(x+...)$
	173	$(...x+...)^2-...x(...x+...)$
	174	$...x(...x+...)-...(x+...)^2$
	175	$...(x+...)-...(x+...)^2$
	176	$...(x+...x)-(x+...x)^2$
	177	$...(x-...)-...(x-...)^2$
	178	$...x(...-...x)-...(x-...x)^2$
	179	$...(x-...)^2-x(x-...)$
	180	$...(x-...)-...(x-...)^2$
	181	$...(x-...x)-...(x-...x)^2$
	182	$...x(x-...)-...(x-...)^2$
17	183	$...(x-...)^2+...(x-...)^2$
Adv	184	$(...x+...)^2+...(x+...)^2$
	185	$...(x-...)^2-...(x-...x)^2$
	186	$...(x-...)^2-(x-...)^2$
	187	$...(x+...x)^2-(x+...x)^2$
	188	$(...x+...)^2-...(x+...)^2$

Exercises & Levels for Factorising (*Format of Answer*)

(Nov=Novice, Int=Intermediate, Adv=Advanced)

1	1	$...(x+...)$	8	41	$(...+...x)(...-x)$
Nov	2	$...(x-...x)$	Adv	42	$(...-...x)(...+x)$
	3	$...(x-...)$		43	$(...-...x)(...+...x)$
	4	$...(x+...)$		44	$(...x+...)(x-...)$
	5	$...(x-...x)$		45	$(...-...x)(x-...)$
	6	$...(x-...)$		46	$(...-...x)(...x-...)$
2	7	$x(x+...)$		47	$...(x+...)(x+...)$
Nov	8	$x(...-x)$		48	$...(x-...)(x-...)$
	9	$x(x-...)$		49	$...(x+...)^2$
	10	$x(...x+...)$		50	$...(x-...)^2$
	11	$x(...-...x)$		51	$...(x+a)(x-a)$
	12	$x(...x-...)$		52	$...(x+...)(x-...)$
3	13	$...x(x+...)$		53	$...(x-...)(...+x)$
Nov	14	$...x(...x+...)$		54	$...(x-...)(x-...)$
	15	$...x(...-...x)$		55	$...(x-...)(x-...)$
	16	$...x(x-...)$	9	57	$...(x+...)(...x+...)$
	17	$...x(...-...x)$	Adv	58	$...(x-...)(...x-...)$
	18	$...x(...x-...)$		59	$...(x-...)(...x+...)$
4	19	$...(x+...)$		60	$...(x-...x)(x-...)$
Nov	20	$...(x+...)$		61	$...(x+...x)(...-x)$
Int	21	$-(x+...)$		62	$...(x-...x)(...+x)$
	22	$-x(...x+...)$		63	$...(x+...)(x-...)$
	23	$-x(...x-...)$		64	$...(x-...)(x+...)$
5	24	$(x+...)(x+...)$		65	$...(x+...)^2$
Int	25	$(x-...)^2$		66	$...(x-...)^2$
	26	$(x+...)^2$		67	$...(ax+b)(ax-b)$
	27	$(x-...)(x+...)$		68	$...(x-...x)(...x-...)$
	28	$(x+a)(x-a)$		69	$...(x-...x)(...x+...)$
	29	$(x-...)(x-...)$			
	30	$(...-x)(...+x)$			
	31	$(...-x)(x-...)$			
6	32	$(...x+...)(x+...)$			
Int	33	$(...x-...)(x-...)$			
Adv	34	$(...x-...)(x+...)$			
7	35	$(...x+...)(...x+...)$			
Adv	36	$(...x-...)(...x-...)$			
	37	$(...x+...)(...x-...)$			
	38	$(...x+a)(...x+a)$			
	39	$(...x-a)(...x-a)$			
	40	$(...x+a)(...x-a)$			