British Informatics Olympiad

The 2003 British Informatics Olympiad Marking Scheme

CONFIDENTIAL before 5 April 2003

LIONHEAD STUDIOS

Instructions for setting the 2003 British Informatics Olympiad

Students should each have a computer with their chosen programming language installed.

They should also each have a calculator, pen and paper, and a blank floppy disk on which to back up their work and save their solution programs.

If possible, please disable any network to prevent students from communicating.

Please allow the students a few minutes to carefully read the rubric; during this time they must not turn over the page and look at the questions.

The 3 hour time limit should start once you allow them to turn the page and begin the exam.

Please also encourage the students to read the questions first before attempting any answers.

Marking instructions

For each competitor you should have a set of programs and a written paper. The programs for parts 1(a), 2(a) and 3(a) are to be tested by running them with data specified in this marks scheme – you do not need to look at their program code. The written answers can also be marked as specified here, without needing any specialist knowledge.

The program names used by competitors should be clearly marked on their papers. Failure to do this, or to compile programs where necessary, should not prevent programs being marked, but deduct [2] marks for every such program. Programs produced by the competitors to help in the written questions may be used in selecting the BIO 2003 finalists.

Programs written for 1(a), 2(a) and 3(a) are to be 'black-box' tested: you should run the program, enter the given data and verify the solution. For each of these tests the data to be entered is given in `bold text`. The output format is flexible (there is no penalty for extra spaces etc.), but the solutions must be correct for marks to be scored. Note that, if a program does not complete a test in **30 seconds** of processing time, it should be interrupted and the rest of that test ignored. The other questions should be marked from the competitors' written answers.

All marks are given in square brackets by the test/answer they relate to. Answers not covered under the mark scheme should get no marks. In some cases details are given on how marks may be given for partial answers, as well as alternative answers which merit marks.

Accompanying this marks scheme are two forms. The script cover sheet is designed to assist you with marking each student's answers. Use the marks submission sheet to list the marks for all your students, including those who submitted no solutions or left early. This information helps us to assess the level of the exam and allows us to send out certificates for every student who takes part.

Please send us the mark submission sheet and **all** cover sheets. For any student who scores 50 or more marks, please send us their written answers by mail, and email their programs. If none of your students score 50 or higher, please send us the material from your highest scoring student.

To help us send you certificates promptly, please submit all your marks to us electronically, in addition to mailing the marks submission sheet, using the on-line form at http://www.rixcam.com/forms/biomkssub.html.

Finally, thank you very much for participating in BIO 2003!

Marks scheme

Ouestion 1 (a) [24 marks available]

For each test of the program for 1(a) you need to type in a 10 digit number, containing a single question mark. The response should be a statement containing a single integer. There are no marks for incorrect answers.

[2]	**15688?111X**	1
[2]	**812071988?**	3
[2]	**0201615586?**	X
[2]	**?131103628**	0
[2]	**?86046324X**	1
[2]	**1?68811306**	5
[2]	**951?451570**	4
[2]	**0393020?31**	2
[2]	**0136744O?5**	9

Additional marks are available for general program behaviour:

[2]	Program inputs numbers
[2]	For each test, a single number is output
[2]	Program terminates without crashing/hanging

Ouestion 1 (b) [2 marks available]

There are two correct ISBNs. Give [1] mark for each correct ISBN, but deduct [1] mark for each incorrect ISBN.

[1]	3540678654
[1]	9514451570

Question 1(c) [4 marks available]

There are four answers, with one mark for each.

[1]	2301014525
[1]	0201314525
[1]	3401012525
[1]	3200114525

Ouestion 2(a) [27 marks available]

There are nine tests used to check program 2(a). Answer grids have to be totally correct to score the marks.

Test 1

[3]

```
2
-3 0 1
0 0 2
4 100
4
--------X
-*------X
*-*-*---X
-o-*-*--X
o-----*-X
-o-*-*--X
*-*-*---X
-*------X
--------X
```

Test 2

[3]

```
1
1 1 1
100 200
4
-----*---
----*-*--
---*-o-*-
--*-o-o-*
---*-o-*-
----*-*--
-----*---
---------
---------
```

Test 3

[3]

```
2
-1 1 2
1 -1 3
100 200
5
---*-----
--*-*----
-*-o-*---
*-o-o**--
-*-o***--
--***o-*-
---**-*--
-----*---
---------
```

Test 4

```
3
10 10 1
-10 10 1
0 1 21
100 200
21
```

[3]

```
*-o---o-*
-*-o-o-*-
--*-o-*--
----*----
--o-*-o--
-o-*-*-o-
o-*---*-o
-*-----*-
*-------*
```

Test 5

```
2
112525 112525 225048
0 450000 100
-500000 500000
450100
```

[3]

```
--o---o-*
---o-o-*-
*---o-*--
-*---*---
--*------
---*-o---
----*-o--
-----*-o-
------*-o
```

Test 6

```
1
-5 0 1
3 100
12
```

[3]

```
----o-*X-
-----o*X-
-----*oX-
----*-oX-
---*-o-X-
----*-oX-
-----*oX-
-----o*X-
----o-*X-
```

Test 7

```
1
0 0 1
-4 4
13
```

[3]

```
X-------X
X-*-o-*-X
X*-o-o-*X
X*o---o*X
Xo*---*oX
X*o---o*X
X*-o-o-*X
X-*-o-*-X
X-------X
```

Test 8

```
2
-1 1 1
1 -1 1
-5 5
500000
```

[3]

```
o-*-*-o--
-o-*-o-*-
--*-o-o-*
-*-o-*-o*
*---o---*
*o-*-o-*-
*-o-o-*--
-*-o-*-o-
--o-*-*-o
```

Test 9

```
3
0 0 1
-2 0 1
2 0 1
-1 1
4
```

[3]

```
---X-X---
--*X*X*--
-**X*X**-
**oX*Xo**
*ooX-Xoo*
**oX*Xo**
-**X*X**-
--*X*X*--
---X-X---
```

Question 2(b) **[3 marks available]**

[3] 3

Question 2(c) **[4 marks available]**

[1] The maximum number is 792
[3] The minimum number is 400

Question 3(a) [21 marks available]

There are eight tests used to check program 3(a). The student's program should output a space between every 6th digit in the output and this is indicated below. This is to aid marking; do not deduct marks if the spaces are absent or incorrectly placed.

[1]	**3 4**	11011
[2]	**1 0**	0
[2]	**20 1**	100000 000000 000000 00
[2]	**1 24**	111111 111111 111111 111111
[2]	**8 3**	11001
[3]	**1000 5**	100111 001000 0
[3]	**1000000 10**	110010 101011 010010 00010
[3]	**5000000 8**	100100 000101 100010 100000 100000
[3]	**77558760 15**	111111 111111 111000 000000 00000

Question 3(b) [7 marks available]

[1]	(i)	n=3 and m=4:	10
[1]	(ii)	n=1 and m=24:	0
[1]	(iii)	n=32 and m=5:	11111
[2]	(iv)	n=6410 and m=14:	111010 001100 00
[2]	(v)	n=1000000 and m=21:	110100 011000 011111 000

Question 3(c) [3 marks available]

[3] 62

Question 3(d) [5 marks available]

There is [1] mark for the answer:

[1] *m* digits can change

Additionally, up to [4] marks can be gained from the following points:

[2] When *m* is odd, moving from the last number with (*m*-1)/2 *1*s to next number, changes *m* digits.

[2] When *m* is even, moving from the highest number with *m*/2 *1*s and a 0 in the rightmost position, to the next number, changes *m* digits,

(Supplementary: If examples are given for the even and odd cases which are not generic, ie. they only cover a specific value of *m*, only [1] mark should be awarded.)

End of BIO 2003 marks scheme

British Informatics Olympiad

2003 British Informatics Olympiad
Script Cover Sheet

LIONHEAD STUDIOS

Please use this sheet, with reference to the marks scheme, to assist you with marking each student's script. This cover sheet should accompany all scripts submitted to the BIO organisers. As it summarises the solutions to many questions, **do not distribute or show this sheet to any contestant before 5 April 2003.**

Name of student: _____ Age: _____ Year in school: _____

Input: `15688?111X 8120719887 0201615867 ?131103628 ?86046324X 1?68811306 951?451570 0393020?31 0136744?5`

	1(a)								
	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]
Output:	1	3	X	0	1	5	4	2	9

1(a)	*Inputs numbers?*	*Outputs a digit?*	*Exits OK?*
	[2]	[2]	[2]

1(b) *Two correct ISBNs:*
[1] 3540678654
[1] 9514451570
Deduct [1] *for each incorrect ISBN*

1(c) *One mark each for:*
[1] 2301014525
[1] 0201314525
[1] 3401012525
[1] 3200114525

Totals for Q1

1(a)	[24]
1(b)	[2]
1(c)	[4]

Input:

```
2
-3 0 1
0 0 2
4 100
4
```

```
1
1 1 1
100 200
4
```

```
2
-1 1 2
1 -1 3
100 200
5
```

```
3
10 10 1
-10 10 1
0 1 21
100 200
21
```

```
2
112525 112525 225048
0 450000 100
-500000 500000
450100
```

```
1
-5 0 1
3 100
12
```

```
1
0 0 1
-4 4
13
```

```
2
-1 1 1
1 -1 1
-5 5
500000
```

```
3
0 0 1
-2 0 1
2 0 1
-1 1
4
```

2(a)

[3]	[3]	[3]	[3]	[3]	[3]	[3]	[3]	[3]

Output:

```
--------X  -----*---  ---*-----  *-o---o-*      --o---o-*      ----o-*X-  X-------X  o-*-*-o--  ---X-X---
-*------X  ----*-*--  --*-*----  -*-o-o-*-      ---o-o-*-      -----o*X-  X-*-o-*-X  -o-*-o-*-  --*X*X*--
*-*-*---X  ---*-o-*-  -*-o-*---  --*-o-*--      *---o-*--      -----*oX-  X*-o-o-*X  --*-o-o-*  -**X*X**-
-o-*-*--X  --*-o-o-*  *-o-o**--  ----*----      -*---*---      ----*-oX-  X*o---o*X  -*-o-*-o*  **oX*Xo**
o-----*-X  ---*-o-*-  -*-o***--  --o-*-o--      --*------      ---*-o-X-  Xo*---*oX  *---o---*  *ooX-Xoo*
-o-*-*--X  ----*-*--  --***o-*-  -o-*-*-o-      ---*-o---      ----*-oX-  X*o---o*X  *o-*-o-*-  **oX*Xo**
*-*-*---X  -----*---  ---**-*--  o-*---*-o      ----*-o--      -----*oX-  X*-o-o-*X  *-o-o-*--  -**X*X**-
-*------X  ---------  -----*---  -*-----*-      -----*-o-      -----o*X-  X-*-o-*-X  -*-o-*-o-  --*X*X*--
--------X  ---------  ---------  *-------*      ------*-o      ----o-*X-  X-------X  --o-*-*-o  ---X-X---
```

2(b) *One valid answer:*
[3] 3

2(c) *Marks as follows:*
[1] The maximum number is 792
[3] The minimum number is 400

Totals for Q2

2(a)	[27]
2(b)	[3]
2(c)	[4]

Input:	**3(a)**	*Output:*
`3 4`	[1]	`11011`
`1 0`	[2]	`0`
`20 1`	[2]	`100000 000000 000000 00`
`1 24`	[2]	`111111 111111 111111 111111`
`8 3`	[2]	`11001`

Input:	**3(a)**	*Output:*
`1000 5`	[3]	`100111 001000 0`
`1000000 10`	[3]	`110010 101011 010010 00010`
`5000000 8`	[3]	`100100 000101 100010 100000 100000`
`77558760 15`	[3]	`111111 111111 111000 000000 00000`

Totals for Q3

3(a)	[21]
3(b)	[7]
3(c)	[3]
3(d)	[5]

See marks scheme for answers to **3(b)–3(d)**.

Deduct **[2]** *marks for every part (a) program name that is not clearly marked on the script, or where the student has failed to compile the program for languages that require compiling.*

Total question 1	**Total question 2**	**Total question 3**
(30)	(34)	(36)

Please use the back of this sheet for any further comments

Marked by

Total mark for BIO 2003 (100)

Send to: Dr Richard Forster, British Informatics Olympiad, Flat B, 20 East Heath Road, Hampstead, London NW3 1AJ
Phone: +44 7803 044 741
Email: forster@olympiad.org.uk

British Informatics Olympiad

2003 British Informatics Olympiad
Marks Submission Sheet

Please fill in details of the school/college and each pupil's name as they should appear on certificates. There is room for 8 entrants in the marks submission table, so duplicate this page if more space is required. It would also be very helpful for us to know what hardware, operating system and programming language(s) each entrant used; please list the different combinations you used in the computer summary table.
Please send us copies of the completed marks submission forms and all cover sheets by post, along with the scripts from your **highest-scoring student**, and all others who score **over 50 marks**. Please email the source-code for any students whose scripts you return.

School/College: _____ Date exam taken: _____

Name of marker: _____ Date exam marked: _____
(in BLOCK CAPITALS)

Marks submission table.

BIO 2003 Name of entrant (this will appear on certificate – please print clearly)	Marks for each section (maximum in brackets)										Total mark (100) *note 1*	PC/ Lang type *note 2*	Age in years	Year in school *note 3*	Gender
	1a (24)	1b (2)	1c (4)	2a (27)	2b (3)	2c (4)	3a (21)	3b (7)	3c (3)	3d (5)					

Note 1 Write N/S (no submission) in this column if the student produced no answers.
Note 2 Give the number of the machine and language type in the computer/language type table below.
Note 3 Please indicate the type of enumeration used, eg. year band / curriculum level: _____

Computer summary table.

Type number	Hardware *e.g. PC/Mac/Arc*	Processor *e.g. Celeron 500*	Operating system *e.g. Win98*	Programming language(s) *e.g. Visual C*
1				
2				
3				
4				

Send to: Dr Richard Forster, British Informatics Olympiad, Flat B, 20 East Heath Road, Hampstead, London NW3 1AJ
Phone: +44 7803 044 741
Email: forster@olympiad.org.uk