British Informatics Olympiad

CONFIDENTIAL before 26 December 2008

LIONHEAD STUDIOS

The 2009 British Informatics Olympiad Marking Scheme

Instructions for setting the 2009 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 an empty USB stick (or other storage device) 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. Please also encourage the students to read the questions first before attempting any answers.

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

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 2009 finalists.

If a student gets a negative number of marks on any question, score that question as a 0.

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. Input and output may appear in different windows.

Note that, if a program does not complete a test in 2 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 to help you in grading the paper. The script cover sheet is designed to assist you with marking each student's answers and the marks submission sheet is to list the marks for all students.

Please **submit all your marks to us electronically** using the form at
http://www.olympiad.org.uk/2009/2009-mark-submission.html

Marks that are received after **26 December 2008** will not be considered for the final.

Certificates will be sent out for all participating students whose marks are returned, including those who submitted no solutions or left early, and for marks that are received before 26 December 2008.

In addition to submitting the marks for all students electronically, please email the programs for all students who score over 50 marks; if this does not apply please email the material for your highest-scoring student. All programs and student scripts should be retained by you until at least 1 February as we may require them for moderation. After this date, you are free to return scripts to the students and distribute copies of the BIO 2009 exam paper.

Finally, thank you very much for participating in BIO 2009.

Question 1(a) [24 marks available]

For each test of the program for 1(a) you need to type a single upper-case word. The response will either be a single integer or the word NO; the correct responses are given on the right. There are no marks for incorrect answers.

[1]	**BOUNCE**	1
[1]	**ENCODE**	NO
[2]	**EIGHT**	8
[2]	**BLACKJACK**	NO
[2]	**FABULOUS**	NO
[2]	**EXERCISE**	NO
[2]	**DRIFTWOOD**	2
[2]	**SERVICEMAN**	7
[2]	**INSIGNIFICANCE**	9
[2]	**THROWDOWN**	2

Additional marks are available for general program behaviour:

[2] Program inputs a single word
[2] For each test a single number, or the word NO, is output
[2] Program terminates without crashing / hanging

Question 1(b) [2 marks available]

[2] 10

Question 1(c) [4 marks available]

[1] 12 (for ONE to FIVE)
[3] 18 (for ONE to NINE)

Question 2(a) [24 marks available]

There are 6 multiple part tests used to check program 2(a). Marks are given within the tests, besides the expected output from the program; this will be a 4 by 4 grid containing the letters R, G and B followed by a single integer, or the words GAME OVER along with a single integer (the order is not important).

When a grid and an integer occur they are scored separately. Otherwise incorrect output at any stage gets no marks for that stage. For a grid every character must be correct.

For each test you will first need to type in a grid of *uppercase* letters, followed by an integer. Additional input will consist of single integers.

If the program crashes / hangs part way through a test, or takes longer than 2 seconds, the rest of that test should be discarded.

Test 1

```
RRGB
GRBG
RRGB
GBRB
2
```

```
RRRB
GRGB
RBGG
GRRG
```
[1]

```
82
```
[1]

```
0
```

Test 2

```
RBRB
GRGR
BGBG
RBRB
1
```

```
0
```
[1]

```
GAME OVER
```
[1]

Test 3

```
RGRB
BGBR
RBRB
BRBR
1
```

```
RBRB
BRBR
RBRB
BRBR
```
[2]

```
2
```
[2]

```
3
```

```
2
```
[1]

```
GAME OVER
```
[1]

Test 4

```
BBBB
BBBB
BBBB
BBBB
1

BBBB
BBBB
[1] BBBB
BBBB

[1] 16

0
```

Test 5

```
RRGG
RRGG
BBRR
BBRR
1

RRGG
RRGG
[1] BBRR
BBRR

[1] 256

99

RRGG
RRGG
[1] BBRR
BBRR

[1] 25600

0
```

Test 6

```
RRGR
RBBG
RRBR
GBBG
1

RRBR
RBBG
[1] GRBR
GBGG

[1] 25

1

RRBG
RBBR
[1] GRBG
RBGR

[1] 73

1

GRBG
RBBR
[1] GRGG
RBGR

[1] 85

12

GBGR
GRBG
[1] RBBR
GRBG

[1] 482

0
```

Question 2(b) [3 marks available]

When two or more adjacent pieces (horizontally or vertifcally) have the same colour they form a *block*. To score [3] a correct answer requires a 4 x 4 grid where each square is either an `R`, `G` or `B`, and the grid contains one block consisting of 7 pieces, one of 5 and one of 3. There will also be a single piece that is not adjacent to another piece of the same colour.

Question 2(c) [4 marks available]

[4] 324

Question 2(d) [4 marks available]

[1] No

There is [1] mark available for giving an example.

In addition, either of the following approaches can be used for up to [2] additional marks. Students may only score marks from one of the two arguments:

[1] When blocks touch each other they must be different colours.
[1] It is possible to give four blocks which touch each other.

or

Up to [2] marks can be awarded for a valid logical argument justifying an example by a sequence of implications or cases. Award [1] mark if the argument is incomplete, but otherwise valid.

Question 3(a) [23 marks available]

Each test for 3(a) consists of two integers for input and a line containing one or more integers for output. Each integer in the output must be a single digit (excluding 0) and the integers must appear in the correct order.

There are no marks for incorrect answers, and tests *must* terminate in 2 seconds to receive marks.

[1] **4 5** 2 1 1

[2] **1 1** 1

[2] **5 1** 1 1 1 1 1

[2] **6 32** 6

[2] **7 63** 6 1

[2] **8 74** 2 1 2 1 2

[2] **12 1752** 3 3 3 3

[2] **14 5000** 2 1 4 1 4 1 1

[2] **21 1000000** 5 3 3 2 1 2 2 1 2

[3] **27 50789789**
3 1 1 2 2 1 1 4 4 1 7

[3] **32 1234567890**
2 1 2 3 1 4 2 1 5 3 3 3 2

Question 3(b) [2 marks available]

[2] 88

Question 3(c) [5 marks available]

[1] They are the reverse of each other.
(It is also valid to include that, for sums from 1 to 9, they are the same; but this on its own is insufficient for this mark).

For the list in dictionary order:

[1] The last entry in the list must start with as many 9s as possible.
[1] If there is a digit which is not 9 it must appear at the end of the arrangement.

For the list in increasing numeric order, up to [2] marks are available from:

[1] The first entry in the list must be as small (in length) as possible.
[1] To minimise the length we require as many 9s as possible.
[1] If there is digit which is not 9 it must appear at the start of the arrangement.

(**Supplementary:** A student who *only* mentions that, for sums from 1 to 9 both arrangements are the same, may be awarded [1] mark in total for this question)

Question 3(d) [5 marks available]

[1] 16 (summing to 8)
[4] 31993503 (summing to 50)

End of BIO 2009 marks scheme

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Script Cover Sheet

Please use this sheet, with reference to the marks scheme, to assist you with marking each student's script. As it summarises the solutions to many questions, **do not distribute or show this sheet to any contestant before 26 December 2008.**

Name of Student: Age: School Year:

1(a)

input	BOUNCE	ENCODE	EIGHT	BLACKJACK	FABULOUS	EXERCISE	DRIFTWOOD	SERVICEMAN	INSIGNIFICANCE	THROWDOWN
	(1)	(1)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
output	1	NO	8	NO	NO	NO	2	7	9	2

Inputs a word? (2)
Valid output? (2)
Exits okay? (2)

1(b) *Ans: 10* (2)

1(c) *Ans: 12 and 18* (1)+(3)

TOTAL 1(a) (24)

2(a)

input	RRGB GRBG RRGB GBRB 2 0	RBRB GRGR BGBG RBRB 1	RGRB BGBR RBRB BRBR 1 3	BBBB BBBB BBBB BBBB 1 0	RRGG RRGG BBRR BBRR 1 99 0
	(1)+(1) /	(1)+(1)	(2)+(2) (1)+(1)	(1)+(1) /	(1)+(1) (1)+(1) /
output	RRRB GRGB RBGG GRRG 82	0 GAME OVER	RBRB 2 BRBR GAME OVER RBRB BRBR 2	BBBB BBBB BBBB BBBB 16	RRGG RRGG RRGG RRGG BBRR BBRR BBRR BBRR 256 25600

2(a)

input	RRGR RBBG RRBR GBBG 1 1 1 12 0				
	(1)+(1)	(1)+(1)	(1)+(1)	(1)+(1) /	
output	RRBR RBBG GRBR GBGG 25	RRBG RBBR GRBG RBGR 73	GRBG RBBR GRGG RBGR 85	GBGR GRBG RBBR GRBG 482	

2(b) *(see marks scheme)* (3)

2(c) *Ans: 324* (4)

TOTAL 2(a) (24)

2(d) *(see marks scheme)* (4)

3(a)

input	4 5	1 1	5 1	6 32	7 63	8 74	12 1752	14 5000	21 1000000	27 50789789	32 1234567890
	(1)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(3)	(3)
output	2 1 1	1	1 1 1 1 1	6	6 1	2 1 2 1 2	3 3 3 3	2 1 4 1 4 1 1	5 3 3 2 1 2 2 1 2	3 1 1 2 2 1 1 4 4 1 7	2 1 2 3 1 4 2 1 5 3 3 3 2

3(b) *Ans: 88* (2)

3(c) *(see marks scheme)* (5)

3(d) *Ans: 16 and 31993503* (1)+(4)

TOTAL 3(a) (23)

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.

Marked By:

TOTAL Q1	TOTAL Q2	TOTAL Q3	TOTAL BIO 2009
(30)	(35)	(35)	(100)

British Informatics Olympiad

2009 British Informatics Olympiad
Marks Submission Sheet

Please use BLOCK CAPITALS

LIONHEAD STUDIOS

This sheet is provided for your convenience and records.

Please **submit all your marks to us electronically** using the form at
http://www.olympiad.org.uk/2009/2009-mark-submission.html

In addition, please email the source-code from your **highest-scoring student**, and all others who score **over 50 marks**.

Marks that are received after **26 December** will not be considered for the final.

Please fill in details of the school/college and each pupil's name as they should appear on certificates. There is room for 10 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.

School / College: _____ Date exam taken: _____

Name of marker: _____ Date exam marked: _____

Name of Entrant (as it should appear on certificate)	Marks for each section (maximum in brackets)											Total (100) †	PC/ Lang ‡	School Year §	Age	M/F
	1a (24)	1b (2)	1c (4)	2a (24)	2b (3)	2c (4)	2d (4)	3a (23)	3b (2)	3c (5)	3d (5)					

† Write **N/S** (no submission) in this column if the student produced no answers.
‡ Give the number of the machine and language type in the computer / language type table below
§ Please indicate the type of enumeration used, e.g. year band / curriculum level: _____

Type Number	Hardware e.g. PC / Mac	Processor e.g. Pentium 4 (2 Ghz)	Operating System e.g. Mac OS X	Programming Language e.g. Visual C++
1				
2				
3				
4				