



The 2010 British Informatics Olympiad Marking Scheme

Instructions for setting the 2010 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 2010 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 5 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/2010/submit-marks-2010.html>

Marks that are received after **26 December 2009** 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 2009.

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 2010 exam paper.

Finally, thank you very much for participating in BIO 2010.

Question 1(a) [25 marks available]

For each test of the program for 1(a) you need to type a single number. The response will either be one or more single digits or the word NO; the correct responses are given on the right.

There are no marks for incorrect answers, however if the solution requires several digits they may appear in any order.

- [1] **123456789** 2 4 5 7 8
- [1] **100** NO
- [2] **1** NO
- [2] **148258** NO
- [2] **555** NO
- [2] **1035** 3
- [2] **123876** 3 7
- [2] **142857** 2 3 4 5 6
- [2] **49271085** 2
- [3] **123450186** 7

Additional marks are available for general program behaviour:

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

Question 1(b) [2 marks available]

There are [2] marks for getting all three of the following numbers (in any order). Award *only* [1] mark if the students is missing any of the numbers or has written any additional numbers.

- 14207985
- [2] 17049582
- 28415970

Question 1(c) [3 marks available]

- [3] 138

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 3x3 grid containing the digits 1 to 6 and xs.

To score marks for a grid every entry must be correct.

For each test you will first need to type in a grid of digits, followed by an integer. Digits on the same line *must* be separated by spaces. Additional input will consist of single integers.

If the program crashes / hangs part way through a test, or takes longer than 5 seconds, the rest of that test should be discarded.

Test 1

1 3 5
1 6 5
1 1 5
1

- 111
- [1] 135
- 115

- 1**
- 111
- [1] 251
- 151

- 3**
- 221
- [1] 161
- 131

0

Test 2

1 1 1
4 4 4
1 1 1
65

- 111
- [2] 141
- 111

0

Test 3

2 1 2
1 2 1
2 1 2
1

- 131
- [1] 212
- 111

- 1**
- 212
- [1] 131
- 232

- 1**
- 141
- [1] 232
- 111

2

- 121
- [2] 411
- 551

0

Test 4

6 6 6
6 6 6
6 6 6
1

[1] 111
666
616

2

[1] 111
456
616

32

[2] 111
111
111

27

[3] 161
111
xxx

0

Test 5

4 5 4
4 5 4
4 5 4
19

[2] 111
564
111

81

[2] 111
355
125

64

[3] xxx
51x
32x

0

Question 2(d) [5 marks available]

[1] Yes

[1] The current numbers on the grid and the die's orientation and heading fully determine the state of simulation.

[1] There are only a finite number of different states.

[1] Since there are only a finite number of states we must, eventually, encounter one for the second time.

Up to [1] mark is available for either of the following:

[1] If we return to a state that we have previously visited the die will repeat the same sequence of moves which lead back to the same state.

[1] If we return to a state that we have previously visited the die will be stuck in a loop.

Question 2(b) [2 marks available]

[2] 32

Question 2(c) [4 marks available]

[1] 8 (with 4 tips)

[3] 160 (with 6 tips)

Question 3(a) [23 marks available]

Each test for 3(a) consists of two lines, the first containing 2 integers and the second between 1 and 3 integers. The output will always be a single integer.

There are no marks for incorrect answers, and tests *must* terminate in 5 seconds to receive marks.

[1]	2 4 3 5	6
[2]	1 20 20	1
[2]	2 10 10 20	1
[2]	2 10 1 30	20
[2]	2 15 1 20	10
[2]	2 9 249 18	86
[2]	3 48 158 62 14	2
[2]	3 24 158 62 14	27
[2]	2 3 31 79	12
[3]	2 19 31 79	56
[3]	3 13 241 181 31	40

Question 3(b) [2 marks available]

It is necessary for all four steps listed below to be given, in order, to receive [2] marks.

- [2] Fill jug B
 Pour from jug B into jug A
 Empty jug A
 Pour from jug B into jug A

The student is permitted to refer to jug A as the 3 oz jug, and to jug B as the 8 oz jug.

Question 3(c) [5 marks available]

- [2] 4 (with 2 jugs)
 [3] 30 (with 3 jugs)

(Supplementary: There are [2] marks for saying 57 for 3 jugs; this would have been the answer if duplicate jugs were allowed in a cookery set.)

Question 3(d) [5 marks available]

- [1] No

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

- [1] Pouring liquid between two jugs either empties the pourer, fills the recipient, or both.
- [1] Every step (*or* each of the three operations) either empties or fills at least one jug.
- [1] After each step there must be at least one empty or one full jug.
- [1] There are no 1oz capacity jugs, so a jug containing 1oz is neither full or empty.
- [1] If no jug is empty or full then no sequence of steps will work.



Please use BLOCK CAPITALS

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/2010/submit-marks-2010.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 (25)	1b (2)	1c (3)	2a (24)	2b (2)	2c (4)	2d (5)	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				