



The 2005 British Informatics Olympiad Marking Scheme

Instructions for setting the 2005 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 (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 2005 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 **10 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 form at <http://www.olympiad.org.uk/2005/bio-marks-2005.html>. The closing deadline for the return of marks, for students to be considered for the final, is **11 March**.

Finally, thank you very much for participating in BIO 2005!

Question 1(a) [24 marks available]

For each test of the program for 1(a) you need to type in a decimal fraction (including the initial 0 and decimal point). The response should be a proper fraction in its lowest form. There are no marks for incorrect answers.

[2]	0.125	1 / 8
[2]	0.9	9 / 10
[2]	0.0008	1 / 1250
[2]	0.49	49 / 100
[2]	0.2005	401 / 2000
[2]	0.1418	709 / 5000
[2]	0.7525	301 / 400
[2]	0.9952	622 / 625
[2]	0.016	2 / 125

Additional marks are available for general program behaviour:

[2]	Program inputs a decimal fraction
[2]	For each test, a proper fraction is output
[2]	Program terminates with crashing / hanging

Question 1(b) [2 marks available]

[2] 24

(Supplementary: 25 scores [1]).

Question 1(c) [4 marks available]

[4] 0.9584

(Supplementary: Writing the fraction as 599/625 is worth [3] marks.)

Question 2(a) [25 marks available]

For each test of the program for 2(a) you need to type in several lines of input. The first and last lines will always contain a single integer. The other lines will each contain two pairs of triplets; each of these triplets is a single digit (0 or 1), followed by a single letter (L or R) and another digit (0, 1, 2 or 3).

Output should consist of two lines. These lines are marked separately, i.e. it is not necessary for both to be correct for marks to be scored on a question. Marks are given within the tests, besides the corresponding line of output.

Test 1

	2
	1R2 OR2
	1L1 1L0
	10
[1]	0000100
[1]	4

Test 2

	1
	1R0 OL1
	1
[2]	0010000
[1]	1

Test 3

	2
	1R2 OL2
	1R1 OL1
	12345
[2]	1110000
[1]	12345

Test 4

	3
	OR3 1L1
	OL1 1R2
	OR2 1L3
	99
[2]	0000000
[1]	99

Test 5

	2
	1L2 1R1
	1R2 OR1
	1000000
[2]	1110100
[1]	1000000

Test 6

	3
	1R2 OL3
	1L3 OR1
	1L1 1L2
	21
[2]	0101101
[1]	21

Test 7

	2
	1R2 1L2
	1L1 1R0
	50
[2]	0111100
[2]	6

Test 8

	3
	1R2 1R0
	1L2 OR3
	1L3 1L1
	100
[2]	0111110
[2]	21

Question 2(b) [2 marks available]

- [1] There will be $n+m$ 1s on the tape.
- [1] The 1s will be adjacent / in a single block.

Question 2(c) [3 marks available]

There are four different correct solutions for this question. Only one is necessary to score the [3] marks.

<i>Solution 1</i>	<i>Solution 2</i>
1R2 1L2	1R2 1L2
1L1 1L0	1L1 1R0

<i>Solution 3</i>	<i>Solution 4</i>
1L2 1R2	1L2 1R2
1R1 1L0	1R1 1R0

Question 2(d) [5 marks available]

- [1] No
- [1] A rule is only necessary if neither machine has terminated, and both machines are on the same tape cell.

In addition, either of the following two arguments can be used for up to [3] additional marks. Students may only score marks from one of the two arguments.

- [1] The machines start the simulation an odd number of cells apart.
- [1] On each iteration a machine moves (if it has not terminated) to an adjacent cell.
- [1] After each iteration the machines (if neither has terminated) must still be an odd number of cells apart.

or

- [1] The tape can be considered as consisting of cells of alternating state (e.g. alternating odd / even, or alternating black / white).
- [1] The two machines start off on cells with different states.
- [1] On each iterating a machine (if it has not terminated), moves to a cell with the alternative state.
- [1] After each iteration the machines (if neither has terminated) will be on cells with different states.

Question 3(a) [25 marks available]

Each test for 3(a) consists of two lines input and a single line containing a integer for output. There are no marks for incorrect answers.

	2		
[1]	3 2		5
	1		
[2]	8		1
	8		
[2]	1 1 1 1 1 1 1 1		1
	3		
[3]	3 3 3		42
	5		
[3]	3 3 2 2 1		990
	4		
[3]	4 4 2 2		2640
	8		
[3]	8 1 1 1 1 1 1 1		3432
	5		
[4]	5 4 3 2 1		292864
	6		
[4]	5 4 2 2 2 1		630630

Question 3(b) [3 marks available]

- [1] 6 (for 2 actors with 2 scenes each)
- [2] 1680 (for 3 actors with 3 scenes each)

Question 3(c) [4 marks available]

- [1] All the actors must have the same number of scenes.

- [1] If all the actors have the same number of scenes, the most junior actor must film their last scene last, or the hierarchy condition will be broken.

Additionally, up to [2] marks can be gained from the following points:

- [1] Hierarchy means the most junior actor cannot have more scenes than any other actor.
- [1] If the actors have different numbers of scenes, there must be an actor with more scenes than the most junior actor.
- [1] An actor with more scenes than the junior actor may film their last scene after the junior actor has filmed all their scenes.

Question 3(d) [3 marks available]

- [3] 12869

(Supplementary: 12870 scores [2])



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 4 April 2005.**

Name of Student:

Age:

School Year:

input	0.125	0.9	0.0008	0.49	0.2005	0.1418	0.7525	0.9952	0.016	
1(a)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	
output	1/8	9/10	1/1250	49/100	401/2000	709/5000	301/400	622/625	2/125	
Inputs decimals?	<input type="text"/>	<input type="text"/>	TOTAL			<input type="text"/>	1(b)	<input type="text"/>	1(c)	<input type="text"/>
Outputs fractions?	<input type="text"/>	<input type="text"/>	1(a)			<input type="text"/>	Ans: 24	<input type="text"/>	Ans: 0.9584	<input type="text"/>
Exists okay?	<input type="text"/>	<input type="text"/>				<input type="text"/>				<input type="text"/>

(Supl. 25 scores [1]) (Supl. 599/625 scores [3])

input	2	2	3	2	3	2	3
	1R2 OR2	1R2 OL2	OR3 1L1	1L2 1R1	1R2 OL3	1R2 1L2	1R2 1R0
	1L1 1L0	1R0 OL1	1R1 OL1	OR2 1L3	1R2 OR1	1L1 1L2	1L1 1R0
	10	1	12345	99	1000000	21	50
2(a)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
output	0000100	0010000	1110000	0000000	1110100	0101101	0111100
	4	1	12345	99	1000000	21	6
							21
TOTAL	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
2(a)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

2(b) (see marks scheme) (2)

2(c) (3)

2(d) (see marks scheme) (5)

Answers (only one required):
 1R2 1L2 1R2 1L2 1L2 1R2 1L2 1R2
 1L1 1L0 1L1 1R0 1R1 1L0 1R1 1R0

input	2	1	8	3	5
	3 2	8	1 1 1 1 1 1 1 1	3 3 3	3 3 2 2 1
3(a)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
output	5	1	1	42	990
input	4	8	5	6	TOTAL
	4 4 2 2	8 1 1 1 1 1 1 1	5 4 3 2 1	5 4 2 2 2 1	3(a)
	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
output	2640	3432	292864	630630	<input type="text"/>
3(b)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Ans: 6 and 1680	(1)+(2)	(see marks scheme)	(4)	Ans: 12869	(3) (Supl. 12870 scores [2])

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.

Please use the back of this sheet for any further comments.

TOTAL	TOTAL	TOTAL
Q1	Q2	Q3
<input type="text"/>	<input type="text"/>	<input type="text"/>
(30)	(35)	(35)

Marked by:

TOTAL
BIO 2005 (100)



Please use BLOCK CAPITALS

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.

Please **submit all your marks to us electronically**, using the form at <http://www.olympiad.org.uk/2005/bio-marks-2005.html>. In addition, 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: _____

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 (25)	2b (2)	2c (3)	2d (5)	3a (25)	3b (3)	3c (4)	3d (3)						

† 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 <i>e.g. PC / Mac</i>	Processor <i>e.g. Pentium 4 (2 Ghz)</i>	Operating System <i>e.g. Mac OS X</i>	Programming Language <i>e.g. Visual C++</i>
1				
2				
3				
4				