

The 2013 British Informatics Olympiad Marking Scheme

Instructions for setting the 2013 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 2013 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/2013/2013-results-submission.html>

Marks that are received after **31 December 2012** 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 31 December 2012.

All programs and student scripts should be retained by you until at least 1 February as we may require them for moderation; you do *not* need to send us student's programs unless requested. After this date, you are free to return scripts to the students and distribute copies of the BIO 2013 exam paper.

Finally, thank you very much for participating in BIO 2013.

Question 1(a) [25 marks available]

For each test of the program for 1(a) you need to type two integers, with a single space between them. The response should be a 24 hour clock time.

The question specifies that both the hour and minutes in a time should be displayed with two digits. If a student fails to output two digits but is otherwise correct (e.g. displaying the hour 01 as 1) only award [1] mark for that test.

[1]	1 31	00:48
[2]	0 0	01:00
[2]	18 18	01:18
[2]	67 1507	02:07
[2]	0 15	00:00
[2]	0 7	00:00
[2]	17 26	13:20
[2]	17 215	06:40
[2]	5779 5864	19:12
[2]	21923 26268	14:24

Additional marks are available for general program behaviour:

- [2] Program inputs two numbers.
- [2] For each a test a time is output.
- [2] Program terminates without crashing / hanging.

Question 1(b) [3 marks available]

- [1] 0;
- [2] 8, 9, 16 and 18.

(Supplementary: If a student has missed out at most one of the numbers 8, 9, 16 and 18, and / or has added at most one additional erroneous number, award [1] mark.)

Question 1(c) [4 marks available]

- [4] 1440 hours

Question 2(a) [26 marks available]

There are 5 tests used to check program 2(a). For each test you will need to type in two lines, each containing the digits 1, ..., 5 in some order; separate the digit with spaces.

For each test three grids should be output. Marks for each grid are independent. A grid must be entirely correct to receive marks.

(Supplementary: If all of a student's grids are upside-down then deduct [4] marks in total but otherwise treat the grids as though they had the correct orientation.)

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 3

1 4 3 5 2
2 3 4 1 5

[1] SSSSS
F.*..
.....
.....
.FFFF

[2] S.SSS
F...*
.....
.....S
.FFFF

[3] FFSSF
.....
.....S
S..F.
*.F.S

Test 1

1 2 3 4 5
1 2 3 4 5

[1] SSSSS
F.*..
.....
.....
.FFFF

[1] .SSSS
F...*
.....
.....S
.FFFF

[1] ..SSS
FF...
.....
.....SS
.*FFF

Test 4

1 3 5 4 2
4 1 2 5 3

[1] SSSSS
F.*..
.....
.....
.FFFF

[1] SSS.S
F...*
.....
.....S
.FFFF

[4] ..S..
F.FSF
..SF*
.S.SF
.....

Test 2

5 2 4 1 3
1 4 2 3 5

[1] SSSSS
..*.F
.....
.....
FFFF.

[1] .SSSS
...*F
.....
.....
FFFES

[3] .FF.F
...SS
....S
...F.
SS*.F

Test 5

3 4 1 5 2
3 4 1 5 2

[2] SSSSS
..*..
..F..
.....
FF.FF

[1] SS.SS
....*
..F.S
.....
FF.FF

[3] ..S.*
.S.F.
..FSS
SF..F
....F

Question 2(b) [3 marks available]

[3] 65

Question 2(c) [4 marks available]

[4] 21

Question 3(a) [24 marks available]

Each test for 3(a) consists of an input string of up to 12 distinct letters, and either an alphabetical output string or the word IMPOSSIBLE. The case of the letters for input and output is important.

Each test, other than those that are IMPOSSIBLE has multiple solutions. These have been listed in alphabetical order. A student is only required to give one solutions. *Since some of these solutions are long, it is acceptable to only verify the underlined characters.*

There are no marks for incorrect answers (this includes any letter with an incorrect case), and tests must terminate in 2 seconds to receive marks.

Test 1**mnoqRTwxy**

- [1] abCDefGhiKlNoPqrsTuw
ABcdEFgHIkLnOpQTUW
ABCdeghIjKlNoQrtwy
AbcDEGHijKlNoqSWY
ABCDfHjKlNoprSVwxy
abcDfHjKlNoPStvWXY
AbCDghIjQrtuVwx
aBcdGHijQsUvWX
ABdeFGijpqRstuvXY
abDEfgIJPQRUVxy
AbDeKlNoRSTUvXy
aBdEKlNoRSTuVxY
aCeFhJprSUwY
AcEfHjPStuWy
ACfGhiKlNoPqrsTUVwxy
acFgHIKlNopQTuvWXY
aEFGijKlNoPqRstVx
AefgIJKlNoPQRvX
BCdEfGhiPqrsTvwXy
bcDeFgHIpQTVWxy
bCDEFhJkLnOprSuvwX
BcdefHjKlNoPStUVWx
bDFGiJkLNoPqRstUy
BdfgIJKlNoPQRuY
CEghIjKlNoQrtUvwXY
ceGHiJkLnOqsuVWxy
RST

Test 2**N**

[2] IMPOSSIBLE

Test 3**abcdef**

[2] IMPOSSIBLE

*See overleaf for additional tests.***Question 3(b) [2 marks available]**

[2] abcdghijNot

Question 3(c) [4 marks available]

[4] 598

Question 3(d) [5 marks available]

[1] No

The following pieces of justification are worth at most [4] marks. Where two points are separated by an *or* only one of the points can be awarded a mark.

- [1] A button press changes the state of the lights by a procedure that does not depend on those lights.
or
 [1] A button press leaves some lights alone and changes the state of the surrounding lights to their next state — whatever their current state.
or
 [1] A sequence of button presses changes the state of the lights in a procedure that does not depend on those lights.
 [1] If two systems have different lighting there must be at least one light (*L*) that is in a different state in the two systems.
 [1] A sequence of button presses will change the state of light *L* in a consistent manner.
or
 [1] If *L* is in a different starting state, a sequence of button presses will leave it in a different final state.
 [1] If a sequence of button presses unlocks a system, it leaves light *L* off. If *L* finishes in a different state, the system is not unlocked.

Test 4 [2 marks]**ABF**

a
AbCDeFgHiKlNoPqRSuw
aBCDeFgHiPqRSvWxY
abcDeFgHIpQrsVWxY
aBcdefHjKlNoPrTUVWx
abCDEfHjKlNoPrTuvWx
ABCdeghIjKlNoQRsTwy
AbCdFhJkLnoPrTvwXY
ABcdGHiJqrStUvWX
AbDEfgIJPQstUVxy
ABdEKLnouVxY
aBdfgIjKlNoPQstuY
abDFGijKlNopqSTUy
ACeFhJpRtUwY
aCEghIjKlNoQRsTuvwXY
aceGHiJkLnoqrStuVWxy
AcFgHIKlNopQrsuvWXY
AEFGijKlNoPqSTVx
BcdEFgHIkLnoPqrsUW
bcDEGHijKlNoqrStWY
BCdFhJkLnoPrTvwxy
bCDghIjQRsTuVwx
BdeFGijpqSTuvXY
bDekLnOUvXy
cEfHjPrTuWy
CfGhikLnoPqRSUVwxY
efgIJKlNoPQstvx

Test 5 [2 marks]**gklmq**

L
ceGHiJklnOqrStuVWxy
CEghIjKNoQRsTuvwXY
bDFGijKNoPqSTUy
bcDeFgHILpQrsVWxY
bCDEfHjKlnoPrTuvWx
BdfgIjKlnoPQstuY
BcdefHjKNoPrTUVWx
BCdeFgHiLpQrsVwXy
acFgHIKNoPqrsuvWXY
aCeFhJLpRtUwY
aEFGijKlnoPqSTVx
abcDfHjKlnoPrTvwXY
abCDeFgHiKNoPqRSuw
abDEfgIjLPQstUVxy
aBcdGHiJLqrStUvWX
ABCdeghIjKlnoQRsTwY
aBdEKNouVxY
ACfGhiklnoPqRSUVwxY
AefgIJKNoPQstvx
AcEfHjLPrTuWy
AbCDghIjLQRsTuVwx
AbDekLnOUvXy
AbcDEGHijKNoqrStWY
ABcdFhJKNopRtVwxy
ABdeFGijLpqStuvXY
ABcdEFgHIklnOpQrsUW

Test 6 [3 marks]**ghkLNQSTwXy**

ABcdEFgHIkLmNoPQUWY
abCDeFgHiKMNoPqrsuwY
aBCdeghIjklMnOqrTw
AbcDEGHijKMNNoqstWy
abcDfHjklMnOPSTvWXY
ABcdFhJKNoprStVwx
AbCDghIjLMqrTuVwxY
aBcdGHiJLMqstUvWXY
ABdeFGijLmpqRsTuvXy
abDEfgIjLMPQRtUVx
AbDekLMnORSUvX
aBdEKMNoRSuVxy
aCeFhJLMprStUwy
AcEfHjLMPSTuW
ACfGhiklMnOPqrsUVwxy
acFgHIKMNoPquvWX
aEFGijklMnOpqRsTVxY
AefgIJKMNoPQRtvXY
BcdEfGhiLMPqrsVwX
bcDeFgHILmpQVWxy
bCDEfHjKlMnOpRstuvwXY
BcdefHjKMNoPSTUVWxY
BdfgIjKlMnOPQRtuy
bDFGijKMNoPqRsTU
ceGHiJklMnOqstuVWx
CEghIjKMNoQRtUvwXy
LMRsY

Test 7 [3 marks]**ghkLmNrTWXy**

ABcdEFgHIkLmNoPQRUWY
abCDeFgHiKMNoPqsuwy
aBCdeghIjklMnOQTW
AbcDEGHijKMNNoqRstWy
abcDfHjklMnOPRSTvWXY
ABcdFhJKNopStVwx
aBcdGHiJLMqRstUvWXY
AbCDghIjLMQTuVwxY
ABdeFGijLmpqrsTuvXy
abDEfgIjLMPQRtUVx
AbDekLMnOrSUvX
aBdEKMNorSuVxy
AcEfHjLMPRSTuW
aCeFhJLMPStUwy
ACfGhiklMnOPqsUVwxy
acFgHIKMNoPqRuvWX
aEFGijklMnOpqrsTVxY
AefgIJKMNoPQRtvXY
bcDeFgHILmpQRVWxy
BCdEfGhiLMPqsvwX
bCDEfHjKlMnOpStuvwXY
BcdefHjKMNoPRSTUVWxY
BdfgIjKlMnOPQRtuy
bDFGijKMNoPqrsTU
ceGHiJklMnOqRstuVWx
CEghIjKMNoQTUvwXy
LMrSY

Test 8 [4 marks]**abrs**

AbcdEFgIkLMOpRtuvwX
abCdegHIjklMOUvXY
AbCdFhJKlMnopqSTUy
abcdGiJMNQRsTuVwx
aBCeFhJMNpqSTuvXY
ABceFjMNPqRSvWxY
ABCfGHikLMOPQstuY
aBcFgIKlMnopRtVwxy
AbdeFGhiJMNpQrsVWxY
abdEhKlMnoqrStWY
ABefghIJKlMnoPrTUVWx
aBEFGhiJkLMOpQrsUW
aCDeFGHiKlMnoPQstvx
AcDEGiJkLmnoQRsTuvwXY
acDfjkLMOPqRSUVwxY
ACDgHIjMN
aDEfghIjMNPrTuWy
ADehkLMOqrStuVWxy
bCdEfGhiMNPQstUVxy
bcdefjKlMnoPqRSuw
BCEgHIjKlMnouVxY
BceGiJkLMOQRsTwy
bdfghIjKLMOPrTvwXY
BhMNqrStUvWX
cDeFgIMNpRtUwY
CDEFHJkLMOpqSTVx
DFGhiJkLMnopQrsuvWXY

Test 9 [5 marks]**deHi**

abCdefGHikNoQtUvwxy
AbcdEGiJKnopQRtUvWx
abcdfjklOqRsuVW
AbCdGHiJlNpSUwXy
ABceFgIkloPRStvWxy
aBCegHIjklOpSuvwxY
ABCfHJKnoPqsTuwXY
aBcGiJLnpQRTVWY
abdeFghIJLnrSTXY
AbdehklOpqrstVY
ABeFGhiJLNPQRUV
aBEhKnopqrstUX
aCDeFhJLNPqsTvwX
AcDEfjLNgRsUvWxY
ACDfGHikloQtwX
acDFgIKnoPRStUVWY
aDEFGhiJklOPQruXy
ADefghIJKnorStuVy
bcdeFgILNPRStuWX
bCdeFhJklOPqsTUVwy
BCEfGHILNQtuVwY
BcefjKnoqRsWXY
bdFGhiJknoPQrvxY
BfghIjklOrSTUvx
CDEgHIjKnopSVw
cDeGiJklOpQRTUWXY
DhLNPqrstuvxy

End of BIO 2013 marks scheme

British Informatics Olympiad

2013 British Informatics Olympiad 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 31 December 2012.**

Name of Student:

Age:

School Year:

		1 31		0 0		18 18		67 1507		0 15		0 7		17 26		17 215		5779 5864		21923 26268		
input																						
1(a)		(1)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	
output		00:48	01:00	01:18	02:07	00:00	00:00	13:20	06:40	19:12	14:24											
Inputs data?		(2)											1(b)		1(c)		TOTAL		1(a)			
Valid output?		(2)											Ans: 0		Ans: 1440							
Exits okay?		(2)											8, 9, 16 & 18		(1+2)		(4)		(25)			

		1 2 3 4 5					5 2 4 1 3					1 4 3 5 2						
		1 2 3 4 5					1 4 2 3 5					2 3 4 1 5						
input																		
2(a)		(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(3)	(3)	(1)	(2)	(3)	(3)	(3)	(3)	
output		SSSSS	.SSSS	..SSS	SSSSS	.SSSS	..FF.F	SSSSS	.SSSS	..FF.F	SSSSS	S.SSS	FFSSF	SSSSS	S.SSS	FFSSF	SSSSS	
		F.*..	F...*	FF...	..*.F	...*F	...SS	F.*..	F...*	...SS	..*.F	...SS	FFSSF	SSSSS	S.SSS	FFSSF	SSSSS	
		.....	.....	.....	.....	.....	.....S	.....	.....	.....S	.....	.....S	.....S	.....	.....S	.....S	.....S
		.....	.....S	..SS	.....	.....	...F.	.....	.....	...F.	.....	.....S	S..F.	.....	.....S	S..F.	S..F.
		.FFFF	.FFFF	*FFF	FFFF.	FFFFS	SS*.F	.FFFF	.FFFF	SS*.F	.FFFF	.FFFF	*.F.S	.FFFF	.FFFF	*.F.S	*.F.S	
input		1 3 5 4 2					3 4 1 5 2					3 4 1 5 2					TOTAL	
2(a)		(1)	(1)	(4)	(1)	(1)	(2)	(1)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(26)	
output		SSSSS	SSS.S	..S..	SSSSS	SS.SS	..S.*	SSSSS	SS.SS	..S.*	SSSSS	SS.SS	..S.*	SSSSS	SS.SS	..S.*	SSSSS	
		F.*..	F...*	F.FSF	..*.F	...*.F	..S.F.	..*.F	...*.F	..S.F.	..*.F	...*.F	..S.F.	..*.F	...*.F	..S.F.	..*.F	
		.....	.....	..SF*	..F..	..F.S	..FSS	..F..	..F.S	..FSS	..F..	..F.S	..FSS	..F..	..F.S	..FSS	..F..
		.....	.....S	..S.SF	.....	.....	SF..F	.....	.....	SF..F	.....	.....	SF..F	.....	.....	SF..F	.....
		.FFFF	.FFFF	.....	FF.FF	FF.FF	....F	FF.FF	FF.FF	....F	FF.FF	FF.FF	....F	FF.FF	FF.FF	....F	FF.FF
		Ans: 65		(3)	Ans: 21		(4)											

		mnoqRTwxy		N		abcdef		ABF		gklmq		ghkLNQSTwXy		ghkLmNrTWXy		abrs		deHi		
input																				
3(a)		(1)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(3)	(3)	(3)	(3)	(3)	(4)	(5)	(5)	(5)	
output		RST	IMPOSSIBLE	IMPOSSIBLE	IMPOSSIBLE	IMPOSSIBLE	IMPOSSIBLE	IMPOSSIBLE	IMPOSSIBLE	IMPOSSIBLE	LMRSY	LMrSY	LMRSY	LMrSY	ACDgHIjMN	DhLNpqrstuvxy	LMRSY	LMrSY	ACDgHIjMN	
Shortest answers shown. See Mark scheme for alternative answers.																				
3(b)		Ans: abcdghiJNot		(2)	3(c)		Ans: 598		(4)	3(d)		(see marks scheme)		(5)	TOTAL		3(a)		(24)	

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
(32)	(33)	(35)

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/2013/2013-results-submission.html>

Please retain all student programs and scripts until 1 February.

Marks that are received after **31 December 2012** 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 (3)	1c (4)	2a (26)	2b (3)	2c (4)	3a (24)	3b (2)	3c (4)	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				