British Informatics Olympiad

CONFIDENTIAL before 31 December 2011

LIONHEAD STUDIOS

The 2012 British Informatics Olympiad Marking Scheme

Instructions for setting the 2012 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 2012 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/2012/2012-submit-marking.html

Marks that are received after **31 December 2011** 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 1 February 2012.

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 2012 exam paper.

Finally, thank you very much for participating in BIO 2012.

Question 1(a) [24 marks available]

For each test of the program for 1(a) you need to enter a single integer. The response should also be a single integer.

There are no marks for incorrect answers.

[1]	**100**	10
[1]	**101**	101
[2]	**2**	2
[2]	**1001**	1001
[2]	**371293**	13
[2]	**789774**	789774
[2]	**999883**	999883
[3]	**561125**	335
[3]	**661229**	4379

Additional marks are available for general program behaviour:

[2] Program inputs an integer.
[2] For each test a single integer is output.
[2] Program terminates without crashing / hanging.

Question 1(b) [2 marks available]

To get [2] marks on this question the student needs to give (all) the following ten numbers without any additional numbers. The order is not important:

[2] 10, 20, 40, 50, 80,
100, 160, 200, 250 and 320

(**Supplementary:** If a student omits at most three of the numbers and / or has at most three incorrect numbers, they receive [1] mark.)

Question 1(c) [4 marks available]

[4] 210

Question 2(a) [23 marks available]

There are 8 tests used to check program 2(a). For each test you will type in three lines of input: the first containing six *uppercase* letters (without spaces); the second two *uppercase* letters; the third a single integer. Output will consist of a pair of letters, both of which must be correct to score marks.

Students should *not* be penalized for outputting spaces or lowercase letters.

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

[1]	**GHIJKL** **AE** **6**	FA
[2]	**ABCDEF** **HP** **1**	PV
[2]	**ABCDEF** **PH** **1**	HB
[3]	**AEFMNO** **DK** **13**	SK
[3]	**AEFMNS** **DK** **13**	SJ
[4]	**ABCDEF** **GO** **100**	QI
[4]	**FJLMQU** **GO** **100**	RJ
[4]	**FDEGNQ** **AE** **9876**	WQ

Question 2(b) [2 marks available]

The following 11 letters should appear in order:

[2] V U M L D A E M U V P

Question 2(c) [6 marks available]

For convenience we will use A–D as a shorthand for *"one of the points A, B, C or D"*; similarly for other ranges. The students do not have to use the same notation but do need to refer to the same groups of points. For example, the students may refer to the groups by their positions in the diagram (e.g. using *top* for A–D) or by some explicit labelling on a drawn diagram, or may use *up* and *down* to refer to the direction of movement.

At most [2] marks are available from the following alternative ways of expressing the train's position:

[1] The train will be between M–T and U–X.
[1] The train is facing towards the U–X point (or *down*).

or

[2] The train is at M–T → U–X

or

[1] The train will have just passed M–T.
[1] The train will next pass U–X.

The following pieces of justification are worth marks:

[2] A description of the following position cycle which the train follows:

M–T → U–X
U–X → U–X
U–X → M–T
M–T → E–L
E–L → A–D
A–D → A–D
A–D → E–L
E–L → M–T

(**Supplementary:** A student who fails to accurately describe the cycle but who indicates, directly or indirectly, that it has 8 steps, should be awarded [1] mark.)

Finally, the following pieces of justification are also worth marks:

[1] 1,000,000,000,000,000,000 is divisible by 8.
[1] The train will finish in the starting portion of the cycle.

Question 2(d) [4 marks available]

[4] 2572

Question 3(a) [23 marks available]

Each test for 3(a) consists of three lines each containing two integers separated by a space. The output should be three lines each containing a single number.

There are no marks for incorrect answers, *all three* numbers in the output must be correct, and tests *must* terminate in 5 seconds to receive marks.

	26 61	1
[1]	**1 94**	1
	1 610	2
	1 2	1
[2]	**1 3**	2
	1 4	1
	14 543	2
[2]	**5 75**	1
	71 713	1
	21 911	2
[3]	**329 927**	2
	66 71	3
	250 361	3
[3]	**34 756**	4
	18 735	3
	77 383	5
[4]	**48 677**	4
	232 471	4
	220 691	5
[4]	**198 222**	5
	410 666	6
	402 788	6
[4]	**203 959**	6
	404 777	6

Question 3(b) [2 marks available]

[2] 15

Question 3(c) [4 marks available]

[2] The largest size is 6
[2] There are 10302 such ladders

Question 3(d) [6 marks available]

[1] Yes

The following pieces of justification are worth marks. Where "number ladder" is used below the student may refer to a sequence of transformations. Whilst not strictly correct to only refer to a transformation in these cases (rather than a sequence), do not deduct marks if the student uses this terminology:

[1] The digit 0 can be transformed into a non-zero digit.
[1] A number ladder exists between any two non-zero digits, that does not involve a transformation to 0.
[1] If it is valid to transform one digit into another it is also valid to transform an arbitrary integer into another integer where a single equivalent transformation has taken place.
[2] An arbitrary integer can be transformed into another integer of the same size by a sequence of number ladders transforming the digits one at a time.

End of BIO 2012 marks scheme

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2012 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 2011.**

Name of Student: Age: School Year:

input	**100**	**101**	**2**	**1001**	**371293**	**789774**	**999883**	**561125**	**661229**
1(a)	*(1)*	*(1)*	*(2)*	*(2)*	*(2)*	*(2)*	*(2)*	*(3)*	*(3)*
output	10	101	2	1001	13	789774	999883	335	4379

Inputs data? *(2)*
Valid output? *(2)*
Exits okay? *(2)*

1(b) *Ans: 10, 20, 40, 50, 80, 100, 160, 200, 250 and 320* *(2)*

1(c) *Ans: 210* *(4)*

TOTAL 1(a) *(24)*

input	**GHIJKL** **AE** **6**	**ABCDEF** **HP** **1**	**ABCDEF** **PH** **1**	**AEFMNO** **DK** **13**	**AEFMNS** **DK** **13**	**ABCDEF** **GO** **100**	**FJLMQU** **GO** **100**	**FDEGNQ** **AE** **9876**
2(a)	*(1)*	*(2)*	*(2)*	*(3)*	*(3)*	*(4)*	*(4)*	*(4)*
output	FA	PV	HB	SK	SJ	QI	RJ	WQ

2(b) *Ans: V U M L D A E M U V P* *(2)*

2(c) *(see marks scheme)* *(6)*

2(d) *Ans: 2572* *(4)*

TOTAL 2(a) *(23)*

input	**26 61** **1 94** **1 610**	**1 2** **1 3** **1 4**	**14 543** **5 75** **71 713**	**21 911** **329 927** **66 71**	**250 361** **34 756** **18 735**	**77 383** **48 677** **232 471**	**220 691** **198 222** **410 666**	**402 788** **203 959** **404 777**
3(a)	*(1)*	*(2)*	*(2)*	*(3)*	*(3)*	*(4)*	*(4)*	*(4)*
output	1 1 2	1 2 1	2 1 1	2 2 3	3 4 3	5 4 4	5 5 6	6 6 6

3(b) *Ans: 15* *(2)*

3(c) *Ans: 6 and 10302* *(2)+(2)*

3(d) *(see marks scheme)* *(6)*

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***
(30)	*(35)*	*(35)*

British Informatics Olympiad

2012 British Informatics Olympiad
Marks Submission Sheet

Please use BLOCK CAPITALS

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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/2012/2012-submit-marking.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 **31 December 2011** 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 (23)	2b (2)	2c (6)	2d (4)	3a (23)	3b (2)	3c (4)	3d (6)					

† 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				