



The 2002 British Informatics Olympiad Marking Scheme

CONFIDENTIAL before 5 April 2002

Instructions for setting the 2002 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 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.

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

Please also encourage the students to read the questions first before attempting any answers.

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 2002 finalists.

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.

Note that, if a program does not complete a test in **30 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 60 or more marks, please send us their written answers and floppy disk containing their programs. If none of your students score 60 or higher, please send us the material from your highest scoring student.

Finally, thank you very much for participating in BIO 2002!

Marks scheme

Question 1 (a) [22 marks available]

For each test of the program for 1(a) you need to type in a string in lower case. The response should be a statement containing a single integer. There are no marks for incorrect answers.

[2]	no	0
[2]	sobi	98
[2]	muxa	56
[2]	zexamu	765
[2]	vocirepa	4321
[2]	civozeno	3470
[2]	renonore	2002
[2]	panonononono	1000000

Additional marks are available for general program behaviour:

[2]	Program inputs strings
[2]	For each test, a single number is output
[2]	Program terminates without crashing/hanging

Question 1 (b) [2 marks available]

There is only one possible answer. Ignore any spaces the student may have introduced between the letters.

[2] **pareno**

(**Supplementary for 1(b)**. If the answer is not given in Lojban, rather as 120, [1] mark is available.)

Question 1(c) [4 marks available]

There are four possible answers, only one is required.

[4] **48** or **51** or **vobi** or **mupa**

Question 2(a) [25 marks available]

There are fourteen tests used to check program 2(a). There are no marks for incorrect answers.

[1]	b	2 3 4 5 6 7 8 1
[1]	i	5 1 6 2 7 3 8 4
[1]	o	1 5 2 6 3 7 4 8
[2]	bioib	6 1 8 3 2 5 4 7
[2]	3i	8 7 6 5 4 3 2 1
[2]	2io	7 8 5 6 3 4 1 2
[2]	8b	1 2 3 4 5 6 7 8
[2]	b3oi	6 2 7 3 8 4 1 5
[2]	2(io)	6 2 5 1 8 4 7 3
[2]	b2(ib)o	2 3 1 6 7 8 5 4
[2]	3(i2(io)o)	3 4 1 2 7 8 5 6
[2]	4(4(io)2b)	5 4 3 6 8 1 2 7
[2]	5(6(bi)7(io))	1 2 8 4 5 3 7 6
[2]	2(3(4(io)b)b)b	1 6 4 3 5 2 8 7

Question 2(b) [2 marks available]

[2] 12 17 2 7 13 18 3 8 14 19 4 9 15 20 5 10 16 1 6 11

Question 2(c) [3 marks available]

[1]	6 in riffles are required
[1]	3 out riffles are required
[1]	8 breaks are required

Question 2 continues overleaf...

Question 2(d) [7 marks available]

[2] Yes, it is always possible to restore the pack of cards.

Additionally, up to two marks can be gained from the following points:

[1] Each in riffle changes the order of the cards. (*Students are not required to comment on the case of a pack containing less than 2 cards, which is the exception to this rule.*)

[1] A pack of cards can only be ordered in a finite number of ways.

[1] We must eventually return to an ordering that has already occurred.

Additionally, up to three marks can be gained from the following points:

[1] If x and y are different orderings for the pack, then the result of the in riffle applied to x is different to the result of the in riffle applied to y .

[1] Each ordering is the result of the in riffle applied to only one other ordering.

[1] We cannot return to the ordering after $n+1$ shuffles, before returning to the ordering after n shuffles.

[1] The first ordering we return to must be the original one (i.e. the order before we started shuffling).

Question 3(a) [24 marks available]

There are twelve tests used to check program 3(a). There are no marks for incorrect answers.

[2]	1	1
[2]	6	5
[2]	22	10
[2]	41	12
[2]	121	15
[2]	259	17
[2]	729	18
[2]	1024	20
[2]	1991	24
[2]	6299	30
[2]	6724	26
[2]	10000	28

Question 3(b) [3 marks available]

The answer will be a mathematical expression that only uses ones, multiplications, pluses and brackets. An expression with any other mathematical symbols scores [0] marks.

A correct expression, worth [3] marks, must be equal to 100 and have exactly 16 number 1s.

Question 3(c) [3 marks available]

[1] Yes, it is always possible to find a longer mop.

Additionally, up to two marks can be gained from the following points:

[1] Multiplying a mop by 1 leaves its value unchanged.

[1] Multiplying a mop by 1 increases its length.

[1] A mop multiplied by 1 is still a mop.

Question 3(d) [5 marks available]

[5] 9,565,938

End of BIO 2002 marks scheme

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 5 April 2002.**

Name of student: _____

Age: _____ Year in school: _____

Question 1(a)

Name of solution program:

Input	Output	Mark
no	0	(2)
sobi	98	(2)
muxa	56	(2)
zexamu	765	(2)
vocirepa	4321	(2)
civozeno	3470	(2)
renonore	2002	(2)
panonononono	1000000	(2)

Additional marks for general program behaviour:	
Program inputs strings	(2)
For each test, a single number is output	(2)
Program terminates without crashing/hanging	(2)

Total for Q1(a)

Question 1(b) (written question)

Question 1(c) (written question)

(Supplementary for 1(b). If the answer is not given in Lojban, rather as 120, [1] mark is available.)

Question 2(a)

Name of solution program:

Input	Output	Mark
b	2 3 4 5 6 7 8 1	(1)
i	5 1 6 2 7 3 8 4	(1)
o	1 5 2 6 3 7 4 8	(1)
bioib	6 1 8 3 2 5 4 7	(2)
3i	8 7 6 5 4 3 2 1	(2)
2io	7 8 5 6 3 4 1 2	(2)
8b	1 2 3 4 5 6 7 8	(2)
b3oi	6 2 7 3 8 4 1 5	(2)

Input	Output	Mark
2(io)	6 2 5 1 8 4 7 3	(2)
b2(ib)o	2 3 1 6 7 8 5 4	(2)
3(i2(io)o)	3 4 1 2 7 8 5 6	(2)
4(4(io)2b)	5 4 3 6 8 1 2 7	(2)
5(6(bi)7(io))	1 2 8 4 5 3 7 6	(2)
2(3(4(io)b)b)b	1 6 4 3 5 2 8 7	(2)

Total for Q2(a)

Question 2(b) (written question)

Question 2(c) (written)	Mark
6 in riffles are required	(1)
3 out riffles are required	(1)
8 breaks are required	(1)

See marks scheme for Question 2(d). Mark for 2(d):

Question 3(a)

Name of solution program:

Input	Output	Mark
1	1	(2)
6	5	(2)
22	10	(2)
41	12	(2)

Input	Output	Mark
121	15	(2)
259	17	(2)
729	18	(2)
1024	20	(2)

Input	Output	Mark
1991	24	(2)
6299	30	(2)
6724	26	(2)
10000	28	(2)

Total for Q3(a)

See marks scheme for answers to Questions 3(b)-3(d) Mark for 3(b) Mark for 3(c) Mark for 3(d)

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.

Total question 1	Total question 2	Total question 3
<input type="text" value="(28)"/>	<input type="text" value="(37)"/>	<input type="text" value="(35)"/>

Please use the back of this sheet for any further comments

Marked by

Total mark for BIO 2002



Please fill in details of the school/college and each pupil's name as they should appear on certificates. There is room for 8 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 send us copies of the completed marks submission forms and all cover sheets. Please also send us the scripts, printouts and disks (labelled with type e.g. PC 1.4MB) from your **highest-scoring student**, and all others who score **over 60 marks**.

School/College: _____ Date exam taken: _____

Name of marker: _____ Date exam marked: _____
(in BLOCK CAPITALS)

Marks submission table.

BIO 2002 Name of entrant (this will appear on certificate – please print clearly)	Marks for each section (maximum in brackets)												Total mark (100) <i>note 1</i>	PC/ Lang type <i>note 2</i>	Age in years	Year in school <i>note 3</i>
	1a (22)	1b (2)	1c (4)	2a (25)	2b (2)	2c (3)	2d (7)	3a (24)	3b (3)	3c (3)	3d (5)					

- Note 1* Write N/S (no submission) in this column if the student produced no answers.
- Note 2* Give the number of the machine and language type in the computer/language type table below.
- Note 3* Please use National Curriculum year bands: year 11 (age 15-16, 5th form, GCSE year), 12 for lower VIth, 13 for upper VIth, etc.

Computer summary table.

Type number	Hardware <i>e.g. PC/Mac/Arc</i>	Processor <i>e.g. Celeron 500</i>	Operating system <i>e.g. Win98</i>	Programming language(s) <i>e.g. Visual C</i>
1				
2				
3				
4				

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