British Informatics Olympiad

CONFIDENTIAL before 28 December 2008


# The 2008 British Informatics Olympiad Marking Scheme

## Instructions for setting the 2008 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 2008 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/2008/submit2008marks.html*

Marks that are received after **28 December** 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 28 December 2007.

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 2008 exam paper.

Finally, thank you very much for participating in BIO 2008.

**Question 1(a) [ 25 marks available ]**

For each test of the program for 1(a) you need to type a single integer. The response should be a single integer; the correct responses are given on the right. There are no marks for incorrect answers.

| | | |
|---|---|---|
| [1] | **22** | 3 |
| [2] | **4** | 1 |
| [2] | **8** | 1 |
| [2] | **62** | 3 |
| [2] | **114** | 10 |
| [2] | **346** | 9 |
| [2] | **1000** | 28 |
| [2] | **2326** | 35 |
| [2] | **5000** | 76 |
| [2] | **9240** | 329 |

Additional marks are available for general program behaviour:

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

**Question 1(b) [ 3 marks available ]**

There is [1] mark for the following pair of numbers:

[1] 23 23

There are [2] marks for getting all three of the following pairs (numbers can be given in any order). Award *only* [1] mark if the student is missing any of the pairs, or has written any additional pairs (other than 23 23).

[2] 3 43
5 41
17 29

**Question 1(c) [ 2 marks available ]**

[2] 9

**Question 2(a) [ 25 marks available ]**

There are nine tests used to check program 2(a). For each test you will need to type in two lines of input, the first containing an integer and the second a string of *uppercase* letters. The correct responses are given on the right.

There are no marks for incorrect answers and tests *must* complete within 2 seconds.

| | | |
|---|---|---|
| [2] | **14**<br>**AAABBB** | DBBDAD |
| [2] | **0**<br>**A** | B |
| [2] | **0**<br>**C** | D |
| [3] | **0**<br>**AAAA** | BCBC |
| [3] | **0**<br>**ABCDABCDAB** | BDDBDABCBD |
| [3] | **12**<br>**DDDDDD** | ACACCB |
| [3] | **255**<br>**CCCCCCCC** | DDADABDB |
| [3] | **1234567**<br>**ABCDABCDAB** | BAACCCDABA |
| [4] | **2001001001**<br>**ABCDABCD** | CAAABCDC |

**Question 2(b) [ 2 marks available ]**

[2] BCBCDB

**Question 2(c) [ 4 marks available ]**

[2] 4 (with one rotor)
[2] 32 (with two rotors)

**Question 2(d) [ 4 marks available ]**

[1] No

[1] Every ports is connected to a single wire.

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

[1] Each letter is wired to a single other letter.
[1] Wirings between letters can be reversed.

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

[1] If A was encrypted to B, and B was encrypted to C, then A would be connected to two letters.
*(A can be replaced by B or C in the last clause)*
[1] If A is encrypted to B, then B must be encrypted to A.

**Question 3(a) [ 24 marks available ]**

Each test for 3(a) consists of a seven digit string (a permutation of the digits `1234567`). The output is a single integer.

There are no marks for incorrect answers, and tests *must* terminate in 2 seconds to receive marks.

| | | |
|---|---|---|
| [1] | **6417352** | 5 |
| [2] | **1234567** | 0 |
| [2] | **1235674** | 1 |
| [2] | **7123456** | 2 |
| [2] | **2371456** | 2 |
| [2] | **2741356** | 4 |
| [2] | **5627413** | 6 |
| [2] | **7612543** | 8 |
| [3] | **6245173** | 11 |
| [3] | **3412765** | 13 |
| [3] | **5674321** | 14 |

**Question 3(b) [ 3 marks available ]**

[1] 11 (after 2 operations)
[2] 403 (after 6 operations)

**Question 3(c) [ 4 marks available ]**

[1] 14

[3] `7654123` *or* `5674321`

**Question 3(d) [ 4 marks available ]**

[1] No

[1] It is possible to get to `1234567` from any starting order.
[1] Finishing in a different order is equivalent to changing the embroidering on the shirts.
[1] Choosing the starting and finish orderings covers the same set of problems as just choosing the starting position.

**End of BIO 2008 marks scheme**

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# 2008 British Informatics Olympiad
## Script Cover Sheet

LIONHEAD STUDIOS

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 28 December 2007.**

Name of Student: Age: School Year:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *input* | **22** | **4** | **8** | **62** | **114** | **346** | **1000** | **2326** | **5000** | **9240** |
| **1(a)** | *(1)* | *(2)* | *(2)* | *(2)* | *(2)* | *(2)* | *(2)* | *(2)* | *(2)* | *(2)* |
| *output* | 3 | 1 | 1 | 3 | 10 | 9 | 28 | 35 | 76 | 329 |

*Inputs a number?* *(2)*
*Outputs a number?* *(2)*
*Exits okay?* *(2)*

**1(b)** *(1) +(2)*

*23 23*
*3 43 & 5 41 & 17 29*

**1(c)** *Ans: 9* *(2)*

**TOTAL 1(a)** *(25)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *input* | **14** **AAABBB** | **0** **A** | **0** **C** | **0** **AAAA** | **0** **ABCDABCDAB** | **12** **DDDDDD** | **255** **CCCCCCCC** | **1234567** **ABCDABCDAB** | **2001001001** **ABCDABCD** |
| **2(a)** | *(2)* | *(2)* | *(2)* | *(3)* | *(3)* | *(3)* | *(3)* | *(3)* | *(4)* |
| *output* | DBBDAD | B | D | BCBC | BDDBDABCBD | ACACCB | DDADABDB | BAACCCDABA | CAAABCDC |

**2(b)** *Ans: BCBCDB* *(2)*

**2(c)** *4 and 32* *(2) + (2)*

**2(d)** *(see marks scheme)* *(4)*

**TOTAL 2(a)** *(25)*

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *input* | **6417352** | **1235674** | **2371456** | **5627413** | **6245173** | **5674321** | **1234567** | **7123456** | **2741356** | **7612543** | **3412765** |
| **3(a)** | *(1)* | *(2)* | *(2)* | *(2)* | *(2)* | *(2)* | *(2)* | *(2)* | *(3)* | *(3)* | *(3)* |
| *output* | 5 | 0 | 1 | 2 | 2 | 4 | 6 | 8 | 11 | 13 | 14 |

**3(b)** *Ans: 11 and 403* *(1) + (2)*

**3(c)** *(1) + (3)*

*14*
*7654123 or 5674321*

**3(d)** *(see marks scheme)* *(4)*

**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.*

| **TOTAL Q1** | **TOTAL Q2** | **TOTAL Q3** |
|---|---|---|
| *(30)* | *(35)* | *(35)* |

Marked by:

**TOTAL BIO 2008** *(100)*

British Informatics Olympiad

# 2008 British Informatics Olympiad
## Marks Submission Sheet

LIONHEAD STUDIOS

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/2008/submit2008marks.html*

In addition, please email the source-code from your **highest-scoring student**, and all others who score **over 50 marks**.

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 (2) | 2a (25) | 2b (2) | 2c (4) | 2d (4) | 3a (24) | 3b (3) | 3c (4) | 3d (4) | | | | | |
| | | | | | | | | | | | | | | | | |
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† 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* | | | | |