British Informatics Olympiad

CONFIDENTIAL before 17 January 2022

The 2022 British Informatics Olympiad Marking Scheme

Instructions for setting the 2022 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. Students should not use the internet during the contest except where required to access the on-line help for their language.

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 2022 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 1 second 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 marks 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
https://olympiad.org.uk/2022/ms-submissions-bio2022.html

Marks that are received after **17 January 2022** will not be considered for the final.

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 students' programs unless requested. After this date, you are free to return scripts to the students and distribute copies of the BIO 2022 exam paper.

Finally, thank you very much for participating in BIO 2022.

Question 1(a) [24 marks available]

For each test of the program for 1(a) you need to type in a single *uppercase* string. The output should be a single string. Every letter in the output must be correct for the marks to be scored. If the output is in lowercase but the letters are otherwise correct, the marks can be awarded.

Tests *must* terminate in 1 second to receive marks.

[1]	**ESVNMCW**	ENCRYPT	
[2]	**H**	H	
[2]	**ZT**	ZT	
[2]	**IO**	IF	
[2]	**AA**	AZ	
[2]	**BIO**	BGF	
[2]	**TCCCB**	TIZZY	
[2]	**CRFZEXR**	CONTEST	
[2]	**CONTEST**	CLYFKNA	
[2]	**ABCDEFGHIJ**	AAAAAAAAAA	(10 As)
[2]	**STRAWBERRY**	SAXIVECMZG	

Additional marks are available for general program behaviour:

[1] Program inputs a string.
[1] For each test a string is output.
[1] All tests terminate without crashing / hanging.

Question 1(b) [2 marks available]

[2] Any five letter string whose first four characters are ZZZZ is a valid answer; i.e. ZZZZA, …, ZZZZZ. Only a single string needs to be given.

Question 1(c) [2 marks available]

[2] 104

Question 1(d) [4 marks available]

[4] 4394

Question 2(a) [27 marks available]

There are 15 tests used to check 2(a). For each test you will need to type in two lines, each containing two integers.

For each test you should see two lines output each with a single integer. Both integers need to be correct to score marks.

Tests *must* terminate in 1 second to receive marks.

Test 1
```
9 3
3 1
```
[1]
```
6
6
```

Test 2
```
2 11
0 0
```
[1]
```
0
0
```

Test 3
```
1 1
1 0
```
[2]
```
1
2
```

Test 4
```
1 1
4 0
```
[2]
```
1
3
```

Test 5
```
2 23
28 0
```
[2]
```
9
8
```

Test 6
```
11 5
20 0
```
[2]
```
17
7
```

Test 7
```
25 24
999 0
```
[2]
```
1
24
```

Test 8

```
2 11
0 1
```

[1]
```
2
2
```

Test 9

```
16 25
7 3
```

[2]
```
14
9
```

Test 10

```
25 15
3 13
```

[2]
```
10
13
```

Test 11

```
18 6
53 3
```

[2]
```
9
13
```

Test 12

```
25 24
11 3
```

[2]
```
7
16
```

Test 13

```
7 1
73 3
```

[2]
```
7
7
```

Test 14

```
1 2
41 15
```

[2]
```
9
2
```

Test 15

```
1 14
31 19
```

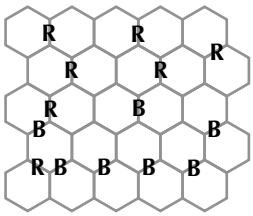
[2]
```
5
3
```

Question 2(b) [3 marks available]

To score marks, all 14 edges (indicated below) need to be clearly indicated as *red* (R below) or *blue* (B below). No other edges are to be marked as *red* or *blue*.

The method for labelling the edges does not have to match the solution below so long as it is clear which edges are red and blue.

[3]



Question 2(c) [4 marks available]

[2] Minimum: 1
[2] Maximum: 28

Question 3(a) [25 marks available]

Each test for 3(a) consists of a string of *lowercase* letters followed by an integer. The output should be a string of *uppercase* letters.

There are no marks for incorrect answers, and tests *must* terminate in 1 second to receive marks.

[1]	**cabd 5**	BCAA
[2]	**a 1**	A
[2]	**dacb 2**	BDCA
[2]	**fedcba 1**	FEDCBA
[2]	**badcef 90**	BADCEF
[2]	**dabcefgh 5000**	BBDAEFBH
[2]	**hefbdciajg 125**	HDFDBCJAGH
[2]	**bcadefghi 49999**	CAADBDBDD
[2]	**bcdefghijak 1000000**	JAABCAACFAA
[2]	**acbdefghijk 12345678**	ACBDCAEGDED
[3]	**abcdeghfklijnmop 2800700600**	ABCDDHEDKKAANFMH
[3]	**abcdefghijklmnop 12345678901234**	ABACAEFHBFJAMLCB

Question 3(b) [2 marks available]

[2] ghcdabefij

Question 3(c) [3 marks available]

[3] 120

Question 3(d) [4 marks available]

[4] 6,165,817,614,720

British Informatics Olympiad

2022 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 17 January 2022.**

Name of Student: Age: School Year:

1(a)

input	output
ESVNMCW	ENCRYPT
H	H
ZT	ZT
IO	IF
AA	AZ
BIO	BGF
TCCCB	TIZZY
CRFZEXR	CONTEST
CONTEST	CLYFKNA
ABCDEFGHIJ	AAAAAAAAAA
STRAWBERRY	SAXIVECMZG

(1) (2) (2) (2) (2) (2) (2) (2) (2) (2) (2)

TOTAL 1(a) (24)

Inputs data? (1)
Valid output? (1)
Exits okay? (1)

1(b) *see marks scheme* (2)

1(c) *Ans: 104* (2)

1(d) *Ans: 4394* (4)

2(a)

input	output
9 3 3 1	6 6
2 11 0 0	0 0
1 1 1 0	1 2
1 1 4 0	1 3
2 23 28 0	9 8
11 5 20 0	17 7
25 24 999 0	1 24
2 11 0 1	2 2
16 25 7 3	14 9
25 15 3 13	10 13

(1) (1) (2) (2) (2) (2) (2) (1) (2) (2)

input	output
18 6 53 3	9 13
25 24 11 3	7 16
7 1 73 3	7 7
1 2 41 15	9 2
1 14 31 19	5 3

(2) (2) (2) (2) (2)

TOTAL 2(a) (27)

2(b) *see marks scheme* (3)

2(c) *Ans: 1, 28* (2)+(2)

3(a)

input	output
cabd 5	BCAA
a 1	A
dacb 2	BDCA
fedcba 1	FEDCBA
badcef 90	BADCEF
dabcefgh 5000	BBDAEFBH
hefbdciajg 125	HDFDBCJAGH
bcadefghi 49999	CAADBDBDD
bcdefghijak 1000000	JAABCAACFAA
acbdefghijk 12345678	ACBDCAEGDED
abcdeghfklijnmop 2800700600	ABCDDHEDKKAANFMH
abcdefghijklmnop 12345678901234	ABACAEFHBFJAMLCB

(1) (2) (2) (2) (2) (2) (2) (2)

(2) (2) (3) (3)

TOTAL 3(a) (25)

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

3(c) *Ans: 120* (3)

3(d) *Ans: 6,165,817,614,720* (4)

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)	(34)	(34)

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2022 British Informatics Olympiad
Marks Submission Sheet

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
https://olympiad.org.uk/2022/ms-submissions-bio2022.html

Please retain all student programs and scripts until 1 February.

Marks that are received after **17 January 2022** 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 ‡	Schl Year §	Age	M/F
	1a (24)	1b (2)	1c (2)	1d (4)	2a (27)	2b (3)	2c (4)	3a (25)	3b (2)	3c (3)	3d (4)					

† 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. Intel Core i7 (2.6 Ghz)	Operating System e.g. Mac OS X 12.0.1	Programming Language e.g. Visual C++
1				
2				
3				
4				