British Informatics Olympiad

CONFIDENTIAL before 18 January 2021

The 2021 British Informatics Olympiad Marking Scheme

Instructions for setting the 2021 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 2021 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 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
https://olympiad.org.uk/2021/mark-bio2021-record.html

Marks that are received after **18 January 2021** 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 2021.

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 2021 exam paper.

Finally, thank you very much for participating in BIO 2021.

Question 1(a) [24 marks available]

For each test of the program for 1(a) you need to type in two *uppercase* strings. The output should be three `YES`/`NO` answers; *all* are required to match (in the order given). `YES`/`NO` answers may appear one per line or separated by spaces.

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

[1]	**DE C**	NO YES YES
[2]	**A A**	YES YES NO
[2]	**A B**	YES YES NO
[2]	**B A**	YES YES YES
[2]	**AB CD**	NO NO NO
[2]	**BEFCD A**	NO YES YES
[2]	**GEA DBCF**	NO NO YES
[2]	**EFCD GAB**	YES YES YES
[2]	**ECBDFA LKJIHG**	YES NO NO
[2]	**BDIGEF HCA**	NO NO YES
[2]	**JKHGIL ADFEBC**	NO NO YES

Additional marks are available for general program behaviour:

[1] Program inputs two strings.
[1] For each a test three `YES`/`NO` are output.
[1] All tests terminate without without crashing / hanging.

Question 1(b) [3 marks available]

[3] BDCA, CBDA, CDAB, DBAC, DACB

(**Supplementary:** Score [2] marks if only 4 correct strings are shown. Do not award marks if there are any incorrect strings.)

Question 1(c) [5 marks available]

[5] 343,059,613,650

Question 2(a) [24 marks available]

There are 10 tests used to check 2(a). For each test you will need to type in two integers on one line, followed by another line of between 1 and 5 integers.

For each test you should see several lines of numbers. All but the last line should be treated as a single block, and every line in the block needs to match exactly (and in order) to score.

The last line is graded separately and the number must match to score. A blank line has been added before the last line for clarity below – this will *not* be present in student output.

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

Test 1

```
2 5
16 2
```

[1]
```
1
0
```

[1]
```
8
```

Test 2

```
1 1
1
```

[2]
```
0
```

[2]
```
4
```

Test 3

```
1 3
1
```

[2]
```
1
```

[2]
```
6
```

Test 4

```
1 36
3
```

[1]
```
17
```

[1]
```
21
```

Test 5

```
1 1250
15
```

[1]
```
989
```

[1]
```
216
```

Test 6

```
2 2
5 7
```

[1]
```
0
0
```

[1]
```
5
```

Test 7

```
2 16
11 13
```

[1]
```
0
0
```

[1]
```
15
```

Test 8

```
2 2000
5 13
```

[1]
```
474
478
```

[1]
```
275
```

Test 9

```
3 2222
13 19 23
```

[1]
```
207
220
222
```

[1]
```
292
```

Test 10

```
5 4999
2 3 5 7 11
```

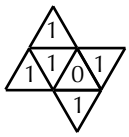
[1]
```
84
73
71
91
135
```

[1]
```
382
```

Question 2(b) [4 marks available]

For the following answers additional *empty* triangles can be drawn but no additional *filled* triangles can appear. All values need to match.

[2]



[2]

Question 2(c) [3 marks available]

[3] 51

Question 2(d) [5 marks available]

[5] 377

Question 3(a) [24 marks available]

Each test for 3(a) consists of a string of *uppercase* letters. The output should be a single number.

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

[1]	**ACBD**	6
[1]	**A**	1
[1]	**AB**	2
[1]	**BA**	3
[1]	**ACB**	5
[1]	**DCBA**	8
[2]	**ABCDEFGH**	8
[2]	**BACDE**	6
[2]	**AEDBC**	12
[2]	**BACDEFGH**	9
[2]	**CFBGAHDE**	15
[2]	**GADEFBC**	16
[2]	**GCFBEDA**	21
[2]	**CHDGABFE**	23
[2]	**AHGEFDCB**	27

Question 3(b) [3 marks available]

[3] BACDE, BCADE, BCDAE, BCDEA

(**Supplementary:** Score [1] mark if only 3 correct strings are shown. Do not award marks if there are any incorrect strings.)

Question 3(c) [5 marks available]

[5] 84

(**Supplementary:** Score [3] marks for the answer 72)

British Informatics Olympiad

2021 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 18 January 2021.**

Name of Student: Age: School Year:

1(a)

input	DE C	A A	A B	B A	AB CD	BEFCD A	GEA DBCF	ECBDFA LKJIHG	EFCD GAB	JKHGIL ADFEBC	BDIGEF HCA
	(1)	*(2)*	*(2)*	*(2)*	*(2)*	*(2)*	*(2)*	*(2)*	*(2)*	*(2)*	*(2)*
output	NO	YES	YES	YES	NO	NO	NO	YES	YES	NO	NO
	YES	YES	YES	YES	NO	YES	NO	YES	NO	NO	NO
	YES	NO	NO	YES	NO	YES	YES	YES	NO	YES	YES

TOTAL 1(a) *(24)*

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

1(b) *Ans (✢): BDCA, CBDA, CDAB, DBAC, DACB* *(3)*

1(c) *Ans: 343,059,613,650* *(5)*

2(a)

input	2 5 16 2	1 1 1	1 3 1	1 36 3	1 1250 15	2 2 5 7	2 16 11 13	2 2000 5 13	3 2222 13 19 23	5 4999 2 3 5 7 11
	(1)+(1)	*(2)+(2)*	*(2)+(2)*	*(1)+(1)*	*(1)+(1)*	*(1)+(1)*	*(1)+(1)*	*(1)+(1)*	*(1)+(1)*	*(1)+(1)*
output	1	0	1	17	989	0	0	474	207	84
	0 8	4	6	21	216	0 5	0 15	478 275	220 222 292	73 71 91 135 382

TOTAL 2(a) *(24)*

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

2(c) *Ans: 51* *(3)*

2(d) *Ans: 377* *(5)*

3(a)

input	ACBD	A	AB	BA	ACB	DCBA	ABCDEFGH	BACDE
	(1)	*(1)*	*(1)*	*(1)*	*(1)*	*(1)*	*(2)*	*(2)*
output	6	1	2	3	5	8	8	6

3(a)

input	AEDBC	BACDEFGH	CFBGAHDE	GADEFBC	GCFBEDA	CHDGABFE	AHGEFDCB
	(2)	*(2)*	*(2)*	*(2)*	*(2)*	*(2)*	*(2)*
output	12	9	15	16	21	23	27

TOTAL 3(a) *(24)*

3(b) *Ans (✢): BACDE, BCADE, BCDAE, BCDEA* *(3)*

3(c) *Ans (✢): 84* *(5)*

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)	*(36)*	*(32)*

✢ See mark scheme for supplementary marks

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2021 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/2021/mark-bio2021-record.html

Please retain all student programs and scripts until 1 February.

Marks that are received after **18 January 2021** 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										Total (100) †	PC/ Lang ‡	School Year §	Age	M/F
	1a (24)	1b (3)	1c (5)	2a (24)	2b (4)	2c (3)	2d (5)	3a (24)	3b (3)	3c (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. Intel Core i7 (2.6 Ghz)	Operating System e.g. Mac OS X 10.14	Programming Language e.g. Visual C++
1				
2				
3				
4				