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 2000 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. Specifically, it does not matter if the output for each test in 3(a) is given in exactly the same order as the answers. Note that if a program does not complete a test in two minutes 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. If a script is to be submitted for moderation, this cover sheet should be sent with it. 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 we will award certificates for participation.

Please send us the marks submission form and any script that scores more than 60 marks. If none of your students scored over 60, please send us the best script from your school.

Marks scheme

Question 1(a)   **[22 marks available]**

The following words (in upper case) should be used to test the program for 1(a). The correct response is given to the right of each test. There are no marks for incorrect answers.

[2]	**A**	Accepted
[2]	**LONDON**	Accepted
[2]	**BIOGRAPHY**	Accepted
[2]	**APRICOT**	Accepted
[2]	**AA**	Rejected
[2]	**QUININE**	Rejected
[2]	**RINGRING**	Rejected
[2]	**COMMITTEE**	Rejected

Additional marks are available for general program behaviour.

- [2] Program inputs words.
- [2] For each test a statement containing Accepted or Rejected is output.
- [2] Program terminates without crashing/hanging.

Question 1(b)   **[5 marks available]**

- [2] 7
- [3] Any one of the following examples:
ABACABA	ACABACA	BABCBAB
BCBABCB	CACBCAC	CBCACBC

Question 2(a)   **[30 marks available]**

There are four multiple part tests used to check program 2(a). Marks are given within the tests, besides the expected output from the program; this will either be an 11 by 11 grid of characters, or two lines of text.

Incorrect output at any stage gets no marks for that stage. For an output grid every character must be

correct. For text, both need to be correct to receive the corresponding marks. If the program crashes/hangs part way through a test, or takes longer than two minutes, the rest of that test should be discarded.

Note. If the program terminates without crashing/hanging at the end of all four tests, an additional [2] marks should be awarded.

Test 1.

```
        3 3 R
        8 8 L
        1
        ...........
        ...........
        ...........
        ......*....
  [2]   ...........
        ...........
        ...........
        ...........
        ...*.......
        ...........
  [2]   ...........
  [2]   4 3 B
        7 8 T
```

```
        6
        ...........
        ...........
        ......**...
        .......*...
  [1]   .....**....
        ...........
        ...........
        ...**......
        ..*........
        ..**.......
  [1]   ...........
  [1]   5 4 B
        6 7 T
```

```
        30
        ...........
        ...........
        ......**...
        .....*...**
  [1]   .....*..*..
        .**...*..*.
        *..*...**..
        .*..*......
        *...*......
        ..**.......
  [1]   ...........
  [1]   Removed
        11 8 B
```

```
        72
        ....**.....
        ...*..*....
        ..*.......*.
        ..*...***.*
  [1]   ....***...*
        *..*..*..*.
        ****...**..
        .*..*......
        *...*......
        ..**.......
  [1]   ...........
  [1]   Removed
        1 6 T

        -1
```

Test 2.

```
        5 5 T
        1 1 B
        96
        ...........
        ....**.....
        ...*..*....
        ....*..*...
  [1]   ....*..*...
        ..*....*...
        .*..*......
        .*...*.....
        ..*..*.....
        ...**......
  [1]   ...........
  [1]   5 7 B
        Removed
```

```
        88
        ...........
        ..****.....
        .*....*....
        ***....*...
  [1]   *******....
        .**...**...
        .*******...
        .*....***..
        ..*....*...
        ...****....
  [1]   ...........
  [1]   5 5 T
        Removed
```

```
        210
        ...........
        ..****.....
        .*....*....
        ***....*...
  [1]   *******....
        .**.*..*...
        .*...*.**..
        *..**.***..
        .*....*....
        *..****....
  [1]   ...........
  [1]   Removed
        Removed

        -1
```

Test 3.

```
        4 3 L
        6 3 T
        16
        ...........
        ...........
        ...........
  [2]   ...........
        ...........
        ...........
        ....**.....
        ..**.**....
        **.***....
        ****.......
        ..***......
  [2]   4 1 R
        4 1 T
```

```
        23
        ...........
        ...........
        ...........
        ...........
  [1]   ...........
        ...........
        ....*......
        ...*.*.....
        ..*.*.*....
        ..**.**....
  [1]   ...........
  [1]   6 2 T
        5 5 R
```

```
        16345
        ...........
        ...........
        ...........
        ...........
  [1]   ...........
        ...........
        ...........
        ...........
        ...........
        ...........
  [1]   4 3 L
        6 3 T

        -1
```
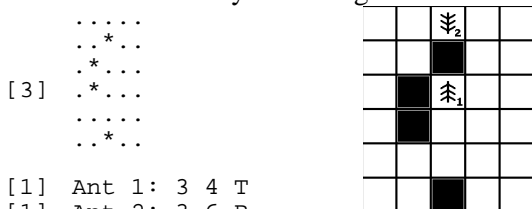
2(a)…
Test 4.

```
       9 9 R
      10 9 L

      10
      ........**.
      .......*...
      ......*..*
      .........*
      ......**.
[2]   ..........
      ..........
      ..........
      ..........
      ..........
      ..........
      10 10 R
[2]    9 8 L

      -1
```

Question 2(b)   [5 marks available]

The solution to 2(b) is a diagram and the positions/ directions of the two ants. The ants may be listed separately or be shown on the diagram, but to score marks it should be clearly indicated which ant is which, and the direction they are facing.

```
      .....
      ..*..
      .*...
[3]   .*...
      .....
      ..*..

[1]   Ant 1: 3 4 T
[1]   Ant 2: 3 6 B
```

(**Supplementary**: The following solution, which shows 6 moves in the wrong direction, is worth [2] marks, if all the details are correct.

```
      .**..
      ...*.
      ...*.
      **.*.
      *..*.
      ..*..

      Ant 1: 3 2 T
      Ant 2: 3 2 T   )
```

Question 2(c)   [5 marks available]

[1] No, it cannot be the same ant.

Additionally, up to [4] marks can be gained from the following points:
[1] An ant alternates facing horizontally (left/right) and vertically (top/bottom).
[1] After an even number of moves ant 1 can only be facing horizontally (left/right).
[1] Each square can only be entered, by a given ant, on odd or even moves.
[1] Ant 1 can only be on its start square after an even number of moves.
[1] If ant 1 is on its start square, it can only be facing horizontally (left/right).

Question 3(a)   [20 marks available]

There are ten tests for 3(a). Note that, for tests with a solution, neither the order of the two solution lines nor the order of the numbers on those lines, are important. So, for example:
```
      1 2 3
      4 5 6
```
is the same solution as
```
      4 5 6
      3 1 2
```

The first three tests have no solutions. For each test [2] marks should be given for printing the word `Impossible`. [0] marks are available for any other output.

Test 1:
```
      4
      1 1 1 1
      1 1 1 1
[2]   Impossible
```

Test 2:
```
      3
      1 3 5
      2 4 6
[2]   Impossible
```

Test 3:
```
      6
      1 2 4 1 2 4
      1 3 5 1 3 5
[2]   Impossible
```

Tests 4 – 6 have a single possible solution. For a solution to score any marks, both lines must be correct.

Test 4:
```
      6
      1 2 2 3 3 4
      8 6 5 4 3 1
[2]   1 2 3 4 5 6
      1 2 3 4 5 6
```

Test 5:
```
      4
      1 1 1 1
      1 4 5 8
[2]   1 1 4 4
      1 1 5 5
```

Test 6:
```
      5
      6 3 5 2 4
      5 4 3 2 6
[2]   1 2 3 4 5
      3 4 5 6 7
```

3(a) continued on next page…

Tests 7 – 10 have multiple solutions. All valid solutions are listed; a program need only give one solution. For a solution to score any marks, both solution lines must be correct.

Test 7:
```
         1
         1
         6
[2]      2
         5
     or
         3
         4
```

Test 8:
```
         4
         1 7 3 5
         8 4 2 6
[2]      1 3 3 5
         2 6 6 10
     or
         1 5 5 9
         2 4 4 6
```

Test 9:
```
         8
         1 2 3 4 5 6 7 8
         1 2 3 4 5 6 7 8
[2]      1 2 3 3 4 4 5 6
         1 2 5 5 6 6 9 10
     or
         1 2 2 3 5 6 6 7
         1 3 3 5 5 7 7 9
     or
         1 2 2 3 3 4 4 5
         1 3 5 5 7 7 9 11
```

Test 10:
```
         8
         7 5 3 1 1 3 5 7
         1 1 8 8 6 6 4 4
[2]      1 1 1 1 3 3 3 3
         1 4 5 6 8 8 10 12
     or
         1 1 1 1 5 5 5 5
         1 3 4 6 6 8 8 10
```

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

To score marks the dice must be correctly paired as follows. The order that the pairs are given in is not important.

[4]   {1,2,3,5,6,7} and {3,7,8,9,11,12}

        {2,3,4,6,7,8} and {2,6,7,8,10,11}

        {3,4,5,7,8,9} and {1,5,6,7,9,10}

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

[2]   The largest number of distinct sums is n^2.
[2]   The smallest number of distinct sums is 1.

Question 3(d)   **[5 marks available]**

There are 5 different sets of 3 dice which satisfy the conditions. Only one is required to score [5] marks. The order of the three dice (although not that of their respective sides) is important; only [3] marks should be given for an incorrectly ordered, but otherwise correct, solution.

[5]   A = {1,7,8} B = {4,5,6} C = {2,3,9}
   or
        A = {1,7,8} B = {3,5,6} C = {2,4,9}
   or
        A = {1,5,9} B = {3,4,8} C = {2,6,7}
   or
        A = {1,6,8} B = {4,5,7} C = {2,3,9}
   or
        A = {1,6,8} B = {3,5,7} C = {2,4,9}

End of BIO 2000 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 25 March 2000.**

Name of student: _____   Age: _____   Year in school: _____

Input:	A	LONDON	BIOGRAPHY	APRICOT	AA	QUININE	RINGRING	COMMITTEE	*Inputs words?*	*Outputs* Accepted or Rejected ?	*Exits OK?*
1(a)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Output:	Accepted	Accepted	Accepted	Accepted	Rejected	Rejected	Rejected	Rejected			

1(b) *Answer 7 gets* [2] *marks, plus* [3] *marks for any one of the following examples:* ABACABA ACABACA BABCBAB BCBABCB CACBCAC CBCACBC

Totals for Q1   **1(a)** (22)   **1(b)** (5)

Test 1
```
3 3 R
8 8 L
```
Input: 1   6   30   72   -1

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

Output:
```
..........        ..........            ..........              ....**.....
..........  4 3 B ......**...  5 4 B    ..........  Removed  ...*..*...  Removed
......*...  7 8 T ......**... 6 7 T     .......**... 11 8 B  ..*......*.  1 6 T
..........        .....**....            ......*..**           .*..***.*
..........        ..........            ...**...*.*           *..*.*..*.
..........        ..**......            *..*..**.            ****...**..
...*......        ...*......            .*..*...            *..*......
..........        .**......            ..*.*...            *..*......
..........        ..........            ..**......            ..**......
..........        ..........            ..........              ..........
```

Test 2
```
5 5 T
1 1 B
```
Input: 96   88   210   -1

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

Output:
```
..........        ..........            ..........
....**....  5 7 B .*****.....  5 5 T  .*****.....  Removed
...*..*... Removed .*....*....  Removed .*....*....  Removed
....*..*..        ***.....*.            ***.....*.
..*...*...        ********...            ********...
.*...*....        *.........            *.........
.*..*....        *......***            *..**.***
..*..*....        .*...*...            .*....*...
...**....        *......*....            *......*....
..........        ..****.....            *..****....
```

Test 4
```
9 9 R
10 9 L
```
Input: 10   -1

2(a)	(2)	(2)	(2)

Output:
```
.......**.
........*... 10 10 R  *Exits OK - see note ***
........*.. 9 8 L
..........*.
.........**
..........
..........
..........
..........
..........
```

Test 3
```
4 3 L
6 3 T
```
Input: 16   23   16345   -1

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

Output:
```
..........        ..........            ..........
..........  4 1 R ..........  6 2 T  ..........  4 3 L
..........  4 1 T ..........  5 5 R  ..........  6 3 T
..........        ..........            ..........
......**..        .....*....            ..........
..**..**..        ...*.*....            ..........
.**.***...        ..*.*.*...            ..........
.****.....        ..**.**...            ..........
..***......        ..........            ..........
```

Totals for Q 2

2(a)	**2(b)**	**2(c)**
(30)	(5)	(5)

* Note for 2(a) test 4: *award the last* [2] *marks only if program terminates correctly in* **all 4 tests**.

See marks scheme for answers to **2(b)** *and* **2(c)**

Totals for Q3

Test	1	2	3	4	5	6	7	8	9	10
3(a)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)

See marks scheme for answers to **3(a)–3(d)**.

3(a)	**3(b)**	**3(c)**	**3(d)**
(20)	(4)	(4)	(5)

Please use the back of this sheet for any further comments

Marked by _____

Total mark for BIO 2000 (100)

Send to: Fieke Dekkers, 33 Sutherland Place, London W2 5BZ   Fax: 0870 130 8498

The 2000 British Informatics Olympiad

Marks submission sheet

British Informatics Olympiad

Please fill in details of the school/college and each pupil's name as they should appear on certificates (if applicable). 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.

Make a copy of the completed forms before sending them, and enclose cover sheets, 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 2000 Name of entrant (this will appear on certificate if appropriate – please print clearly)	Marks for each section (maximum in brackets)									Total mark (100) *note 1*	PC/ Lang type *note 2*	Age in years	Year in school *note 3*
	1a (22)	1b (5)	2a (30)	2b (5)	2c (5)	3a (20)	3b (4)	3c (4)	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 e.g. PC/Mac/Arc	Processor e.g. P150	Operating system e.g. Win95	Programming language(s) e.g. Turbo Pascal
1				
2				
3				
4				

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