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MATHEMATICS EXPLORATION PROBLEMS

Name : _____

Index Number : _____

Country : _____



**17th International Mathematics and Science Olympiad
Indonesia
22 January 2021**

Instructions:

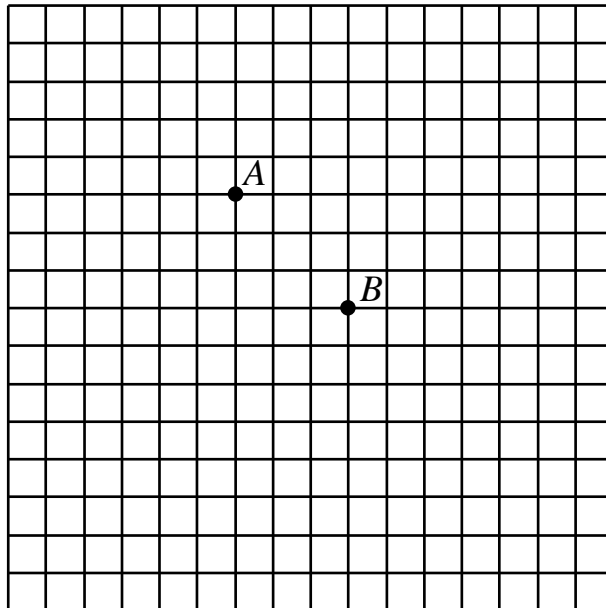
1. Write your name, country and index number on every page of the Answer Sheet.
2. Write your answers only in the Answer Sheet.
3. Answer all questions in Arabic Numerals or English.
4. There are 6 questions in this paper.
5. Each question is worth 6 marks and partial credit may be awarded.
6. You have 120 minutes to complete this paper.
7. You are provided with some manipulatives for exploration on some questions.
8. Use black pen or blue pen or pencil to write your answer.

Do not turn over this page until you are told to do so.

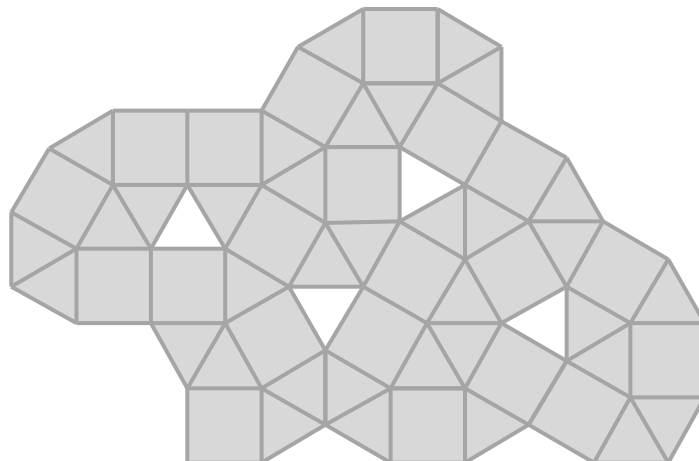
EXPLORATION PROBLEMS

1. Suppose that we are living in a city where the streets are laid out on a square grid as shown below. In this city, you are only allowed to move along vertical lines (streets that are running in the north–south direction) or along horizontal lines (streets that are running in the east–west direction). Suppose your home is located in point A and you wanted to go to your friend’s house (point B), in order to measure the distance travelled, you can’t just get a ruler and measure the distance between the two points but rather as the distance you have to walk along the streets. Therefore, we define the *TCG distance* between A and B and this can be obtained by going along one of its shortest routes. For example, from A to B – 3 right and 3 down or 3 down and 3 right, so the *TCG distance* between A and B in the diagram is 6.

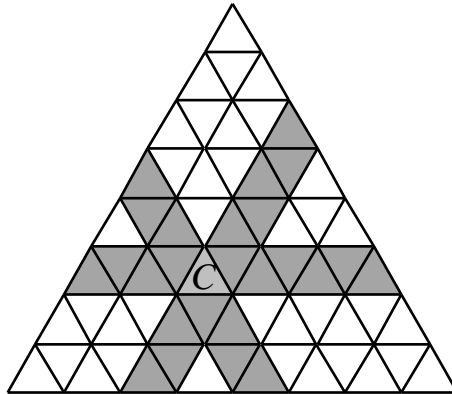
- (a) How many points in the grid have *TCG distance* to A and to B are both 6? Draw the diagram. (2 marks)
- (b) How many points in the grid have *TCG distance* to A and to B are both 12? Draw the diagram. (4 marks)



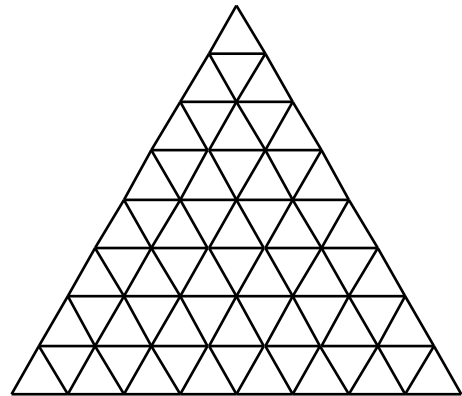
2. Divide the diagram below (only along the lines) such that the resulting diagram will be divided into 7 identical (included its reflection) pieces.



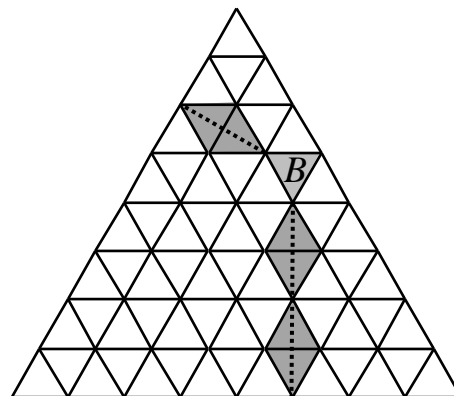
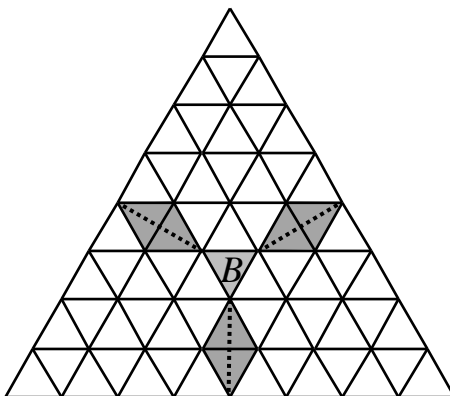
3. The diagram below shows a triangular chessboard. A chess piece *castle*, indicated as *C*, may attack along any of the three directions as highlighted below.



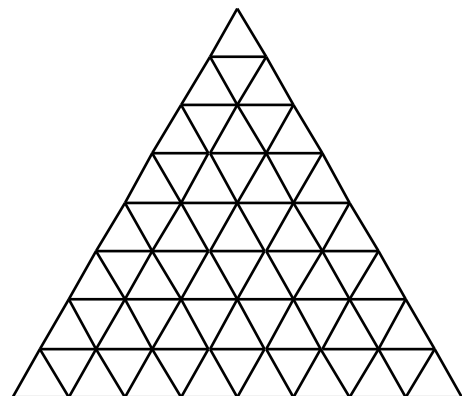
- (a) Place as many *castles* in the chessboard as possible so that no two *castles* could attack each other. (3 marks)



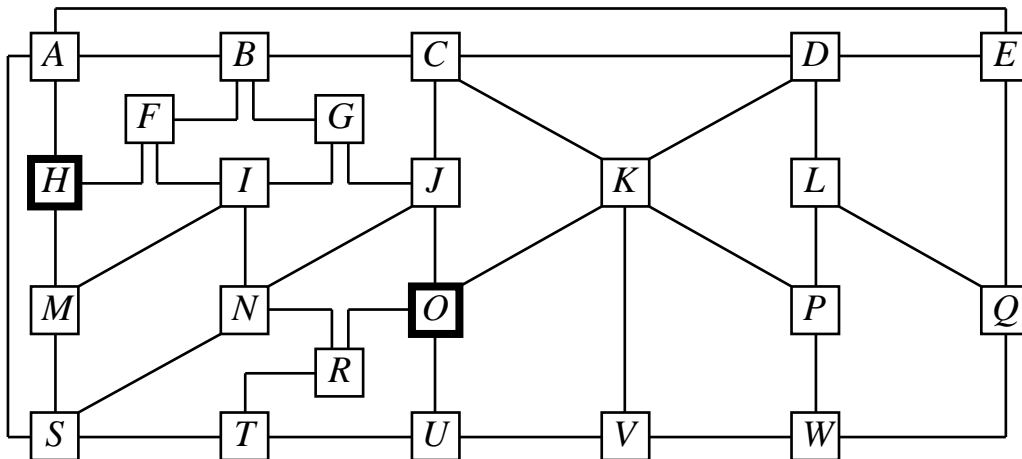
- (b) A chess piece *bishop*, indicated as *B*, may attack along the direction of any of its angles. The two diagrams below show two examples on where the attack ranges of *bishops* are highlighted. (While the broken lines indicate the direction of the angles.)



- Place as many *bishops* in the chessboard as possible so that no *bishop* is in a position that is attacking another. (3 marks)



4. The diagram below shows a map of 23 towns connected by roads, with a video arcade in each town. Andy, who loves to play video games, works in an office in town O . Every day after work, he visits all the towns exactly once to play before reaching home which is located in town H , spending much of his free time at the video arcades, which means that he is ignoring his girlfriend. One day, she decides to meet him on his way home, but he varies his routes all the time. However, she has discovered that there is one road which he must always pass in all the possible routes he can use, so she plans to wait for him along it. Which road is it?



5. Anna and Boris play a game using the integers 1, 2, 3, 4, 5, 6, 7 and 8. Anna first selects a positive integer $k \leq 8$, then Boris chooses k of these eight numbers, then Anna chooses three of among the eight numbers. If the sum of every pair of numbers chosen by Anna is among the numbers chosen by Boris, then Anna wins.
- (a) What is the minimum value of k for which Anna has a winning strategy?
(2 marks)
- (b) If Anna has a winning strategy for k , give a counterexample to show that for $k - 1$ Anna cannot guarantee a win. (4 marks)
6. There are 100 positive integers whose sum is equal to their product. Find all possible products.

MATHEMATICS EXPLORATION PROBLEMS ANSWER SHEET

Name : _____

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The following table is for jury use only.

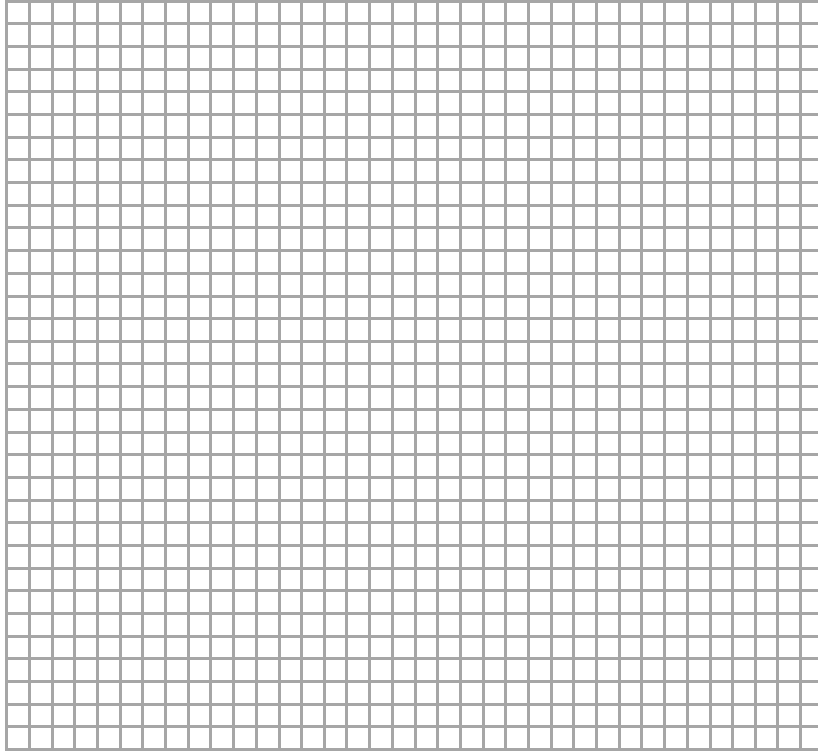
No.	1	2	3	4	5	6	Total
Score							
Signature							
Score							
Signature							

EXPLORATION PROBLEMS

ANSWER SHEET

Country: _____ Name: _____ Index Number : _____

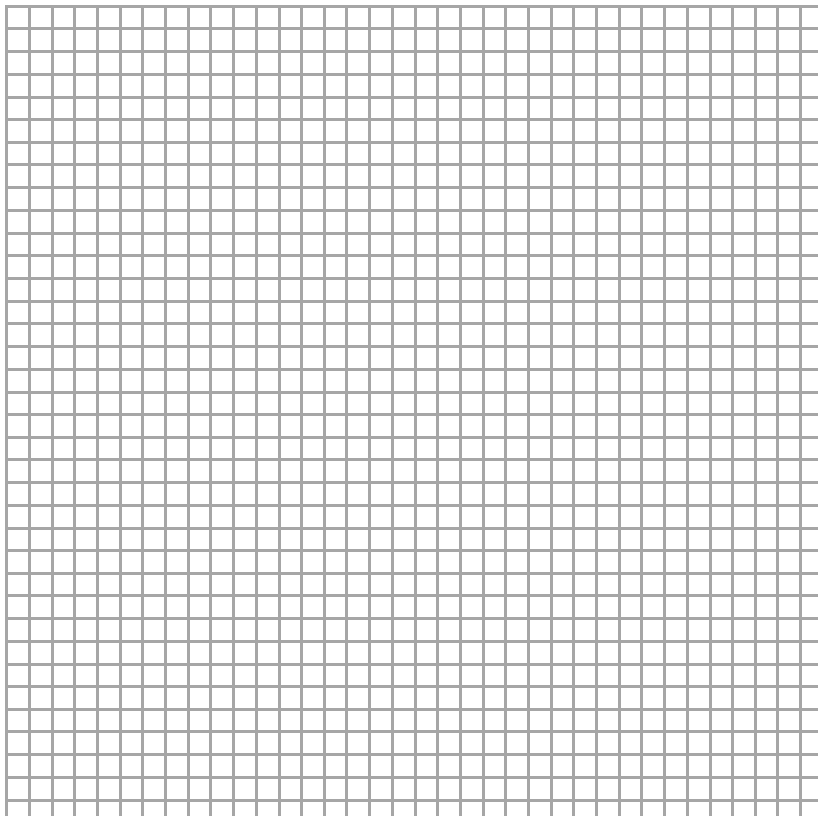
(1) (a) There are _____ points as shown in the diagram below :



<i>Score</i>
(a)
(b)

(no partial score.)

(b) There are _____ points as shown in the diagram below:



(no partial score.)

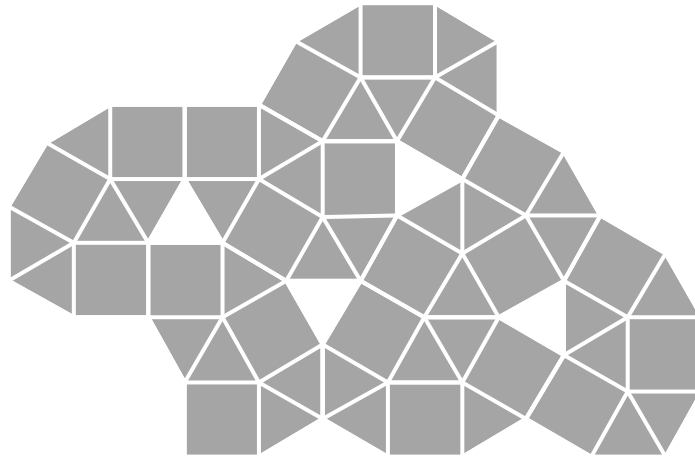
EXPLORATION PROBLEMS

ANSWER SHEET

Country: _____ Name: _____ Index Number : _____

(2)

<i>Score</i>

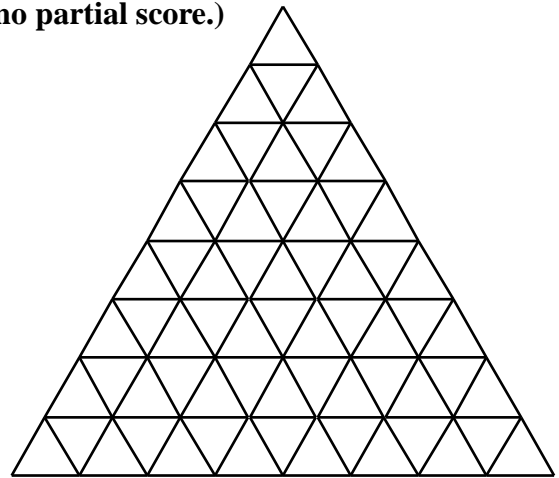
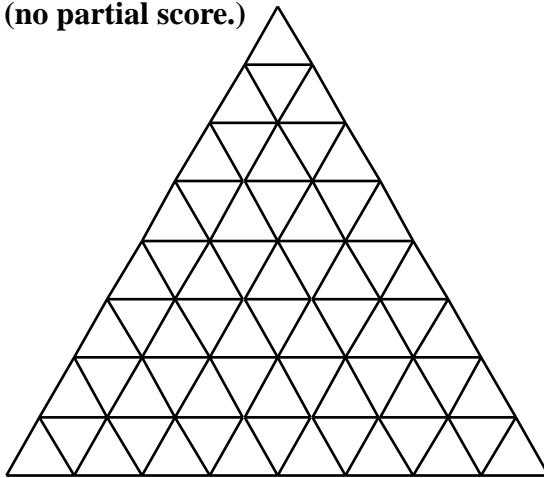


(no partial score.)

(3) (a) There are _____ castles
as shown in the diagram below:
(no partial score.)

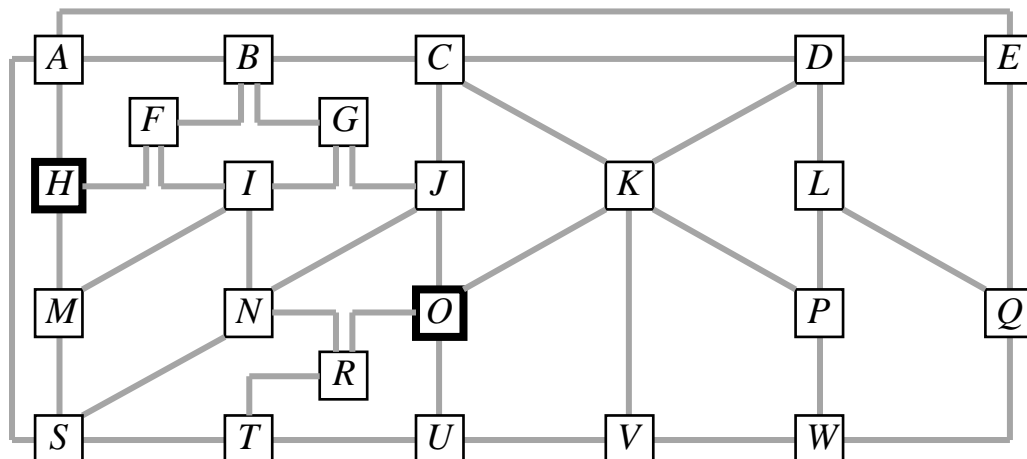
(b) There are _____ bishops
as shown in the diagram below:
(no partial score.)

<i>Score</i>
(a)
(b)



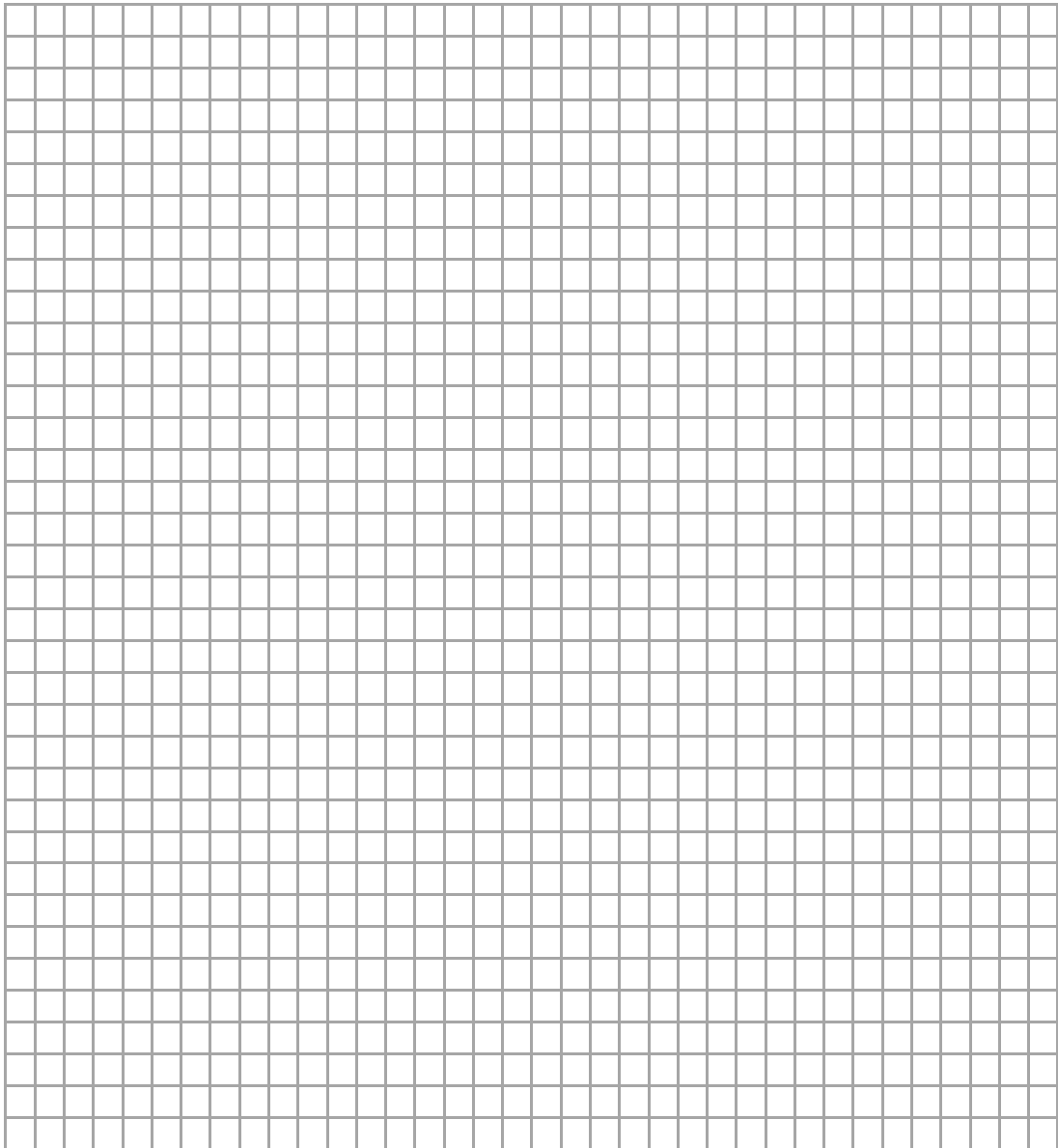
(4) Draw a possible route and she can wait for him along the road between towns
_____ and _____. (no partial score.)

<i>Score</i>

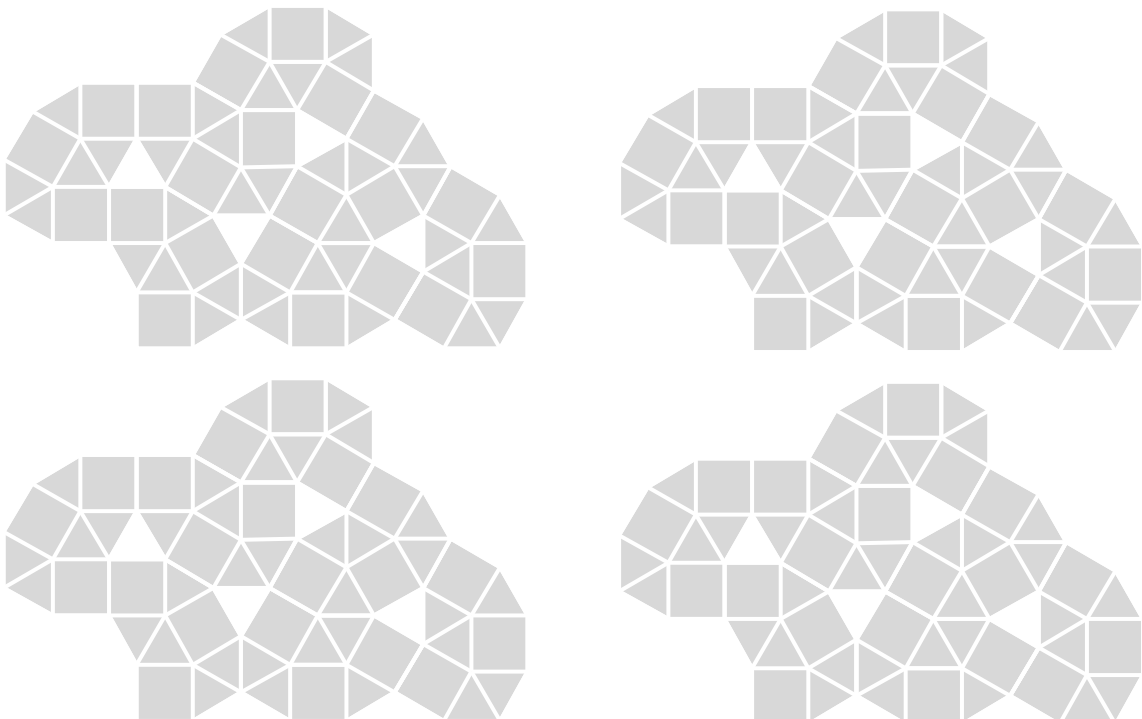


For Sketch Use

(1)

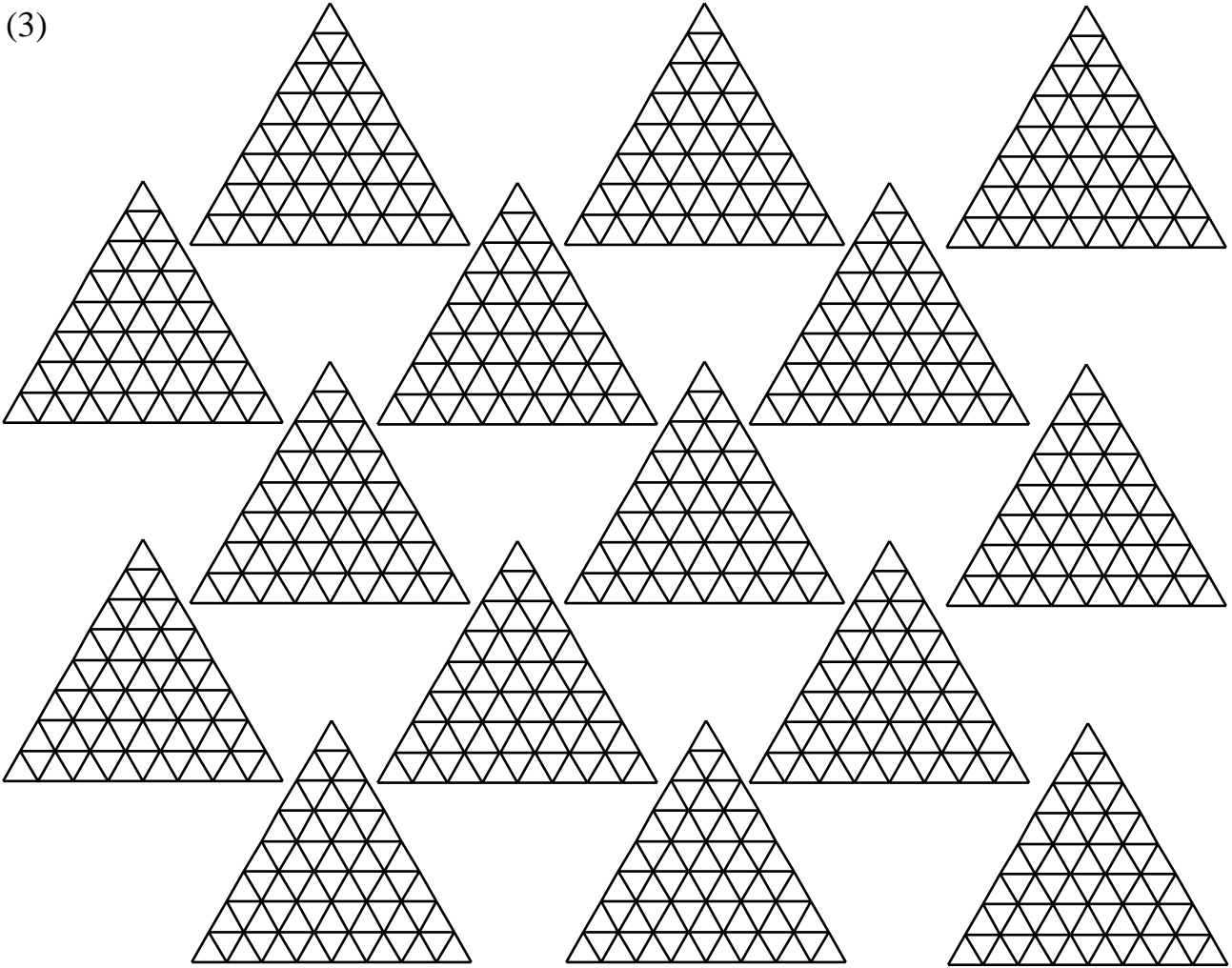


(2)



For Sketch Use

(3)



(4)

