

2024

## COMPUTATIONAL AND ALGORITHMIC THINKING



Junior  
Years 7–8

### Information 考试说明

- There are 9 questions in the competition: 6 multiple choice and 3 three-part integer.  
本次考试共 9 道题，分为 6 道单选题和 3 道填空题，答案为整数。
- You are allowed 60 minutes to do the questions. There is no extra reading time.  
本次考试时长为 60 分钟，没有额外的读题时间。
- There are no penalties for incorrect answers. You should attempt all questions.  
答错不扣分，尝试回答所有问题。
- The questions have been checked thoroughly. Each question is clearly written and no further explanation can be given.  
本场考试的所有问题已仔细核查，内容详尽，不提供更多解释。
- Diagrams are not drawn to scale. They are intended only as aids.  
图形未按比例绘制，仅供参考。

### Competition rules 考试规则

- You must maintain silence at all times.  
考试过程中请保持安静。
- Do not open the paper until told to do so.  
收到监考老师指示前，请勿打开试卷。
- Mobile phones and smart watches are not allowed. If you have one, you must give it to a supervisor who will store it in a safe place.  
禁止携带手机和智能手表。如有携带这些设备，请暂时交与监考老师保管。
- You may use calculators and printed language dictionaries.  
允许使用计算器和纸质语言词典。
- You may not borrow equipment without a supervisor's permission.  
未经监考老师许可，禁止向他人借用工具。
- You must not leave your seat during the competition. You must remain seated until the competition finishes.  
考试期间禁止离开座位，直到考试结束。
- If you wish to leave the room, a supervisor must accompany you. Raise your hand and wait for a supervisor to come to you.  
如需离开考场，必须举手示意并等待监考老师陪同。
- If you have any other questions or problems, raise your hand and wait for a supervisor.  
如果有其他问题，请举手示意监考老师。

No student may sit the competition more than once or sit more than one division of the competition. AMT conducts integrity checks on competition results and reserves the right to withhold results or disqualify students if plagiarism or duplicate sittings are suspected.

DATE

**22 May**

TIME ALLOWED

**60 minutes**

#### IMPORTANT

**All papers must be immediately returned to a supervisor at the end of the competition.**

考试结束后，监考老师立即收回所有试卷。

**This paper is not for circulation or distribution until Monday 3 June 2024.**

**2024 年 6 月 3 日前禁止传播或公开发布该试卷内容。**



## Part A: Questions 1-6

Each question should be answered by a single choice from A to E.

每题有五个选项，考生应从中选出一个正确答案。

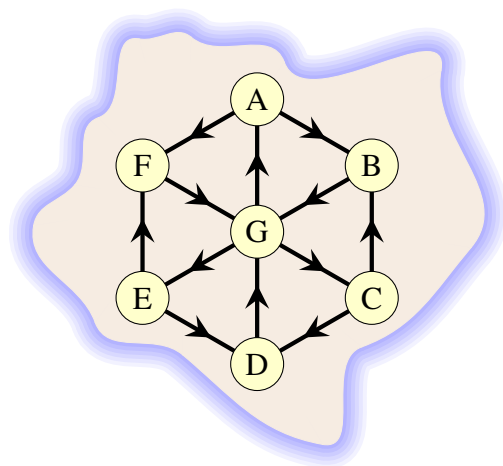
Questions are worth 3 marks each.

每题 3 分。

### 1. Octave Island-奥克塔夫岛

Octave Island has seven small towns labelled A to G. The towns are connected by one-way roads as shown.

岛上有七个小镇，分别用字母 A 到 G 进行标记。各小镇之间通过单行道相连，如图所示。



Mabel lives in A and needs to visit G, E and D in order, then return to A. But she can't drive directly from A to G because of the one-way roads. Each road takes 1 hour to travel on, so her return journey takes 6 hours.

住在 A 小镇的 Mabel 想按照 G、E、D 的顺序去这三个小镇旅游，然后再回到 A 小镇。但由于各小镇之间都是单行道，她无法直接从 A 小镇去到 G 小镇。每条单行道的行驶时间为 1 小时，Mabel 往返路程一共耗时 6 小时。

Mabel's friend Klara lives in D and wants to visit the towns F, C and A in order and return to D.

Mabel 的朋友 Klara 住在 D 小镇，想按照 F、C、A 的顺序去这三个小镇旅游，然后再回到 D 小镇。

What is the shortest time, in hours, that Klara could take for her return journey?

请问 Klara 往返路程最少需要几个小时？

(A) 10

(B) 11

(C) 12

(D) 13

(E) 14

## 2. Heads up-翻面

You have a line of coins, some with the head side up and some with the tail side up. You want all of the coins to have the head side up. The only move you are allowed is to flip two adjacent coins. You will apply this move repeatedly until all the coins have their head sides up.

一排硬币中，有些正面（H）朝上，有些背面（T）朝上。此时，你想让一排硬币全部正面（H）朝上。操作过程中，每轮只能同时翻转两个相邻硬币，一直翻转直到所有硬币都正面（H）朝上为止。

*Example* 举例



You are given the following line:

给定如下一排硬币：



What is the smallest number of moves to have all of the coins with their head sides up?

请问至少需要翻转几轮才能使所有硬币正面（H）朝上？

(A) 5

(B) 6

(C) 7

(D) 8

(E) 9

### 3. Growth-野蛮生长

The game of *Growth* takes place on a grid of white squares.

野蛮生长 游戏采用一个由白色方格组成的网格。

- To start, a single square somewhere in the grid is chosen. It is shaded.

游戏开始时，网格中随机出现一个阴影方格。

- To make a move, a player chooses a shaded square and shades two white squares that are adjacent to it. (Adjacent means the squares have an edge in common.)

玩家每一轮需要选择一个阴影方格，然后为其两个相邻白色方格涂上阴影。(相邻方格指的是共用一条边的方格。)

- A shaded square **cannot** be chosen if it does not have two white squares adjacent to it.

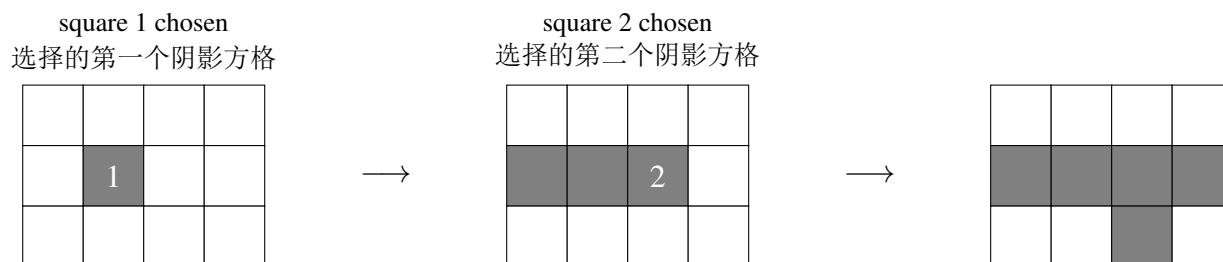
如果一个阴影方格没有两个相邻的白色方格，那么它就不能被选择。

- A shaded square **can** be chosen more than once.

一个阴影方格可以被多次选择。

The example below shows the first shaded square and how the board *could* develop over two moves on a  $4 \times 3$  grid.

下图显示了在这个  $4 \times 3$  网格中选择的第一个阴影方格以及经过两轮操作后网格可能的变化情况。

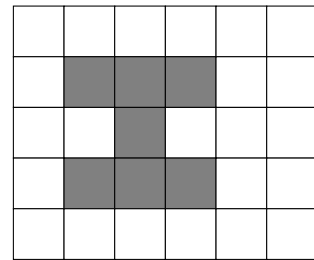
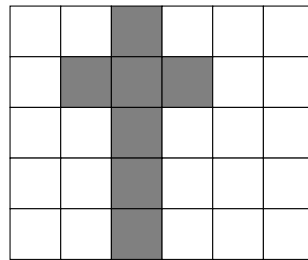
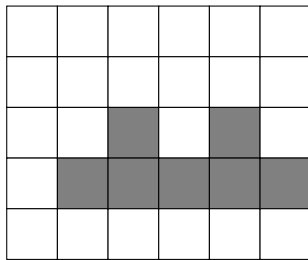
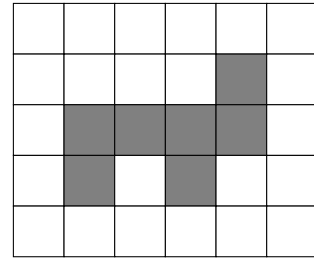
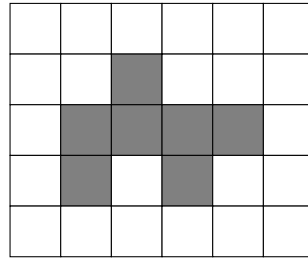
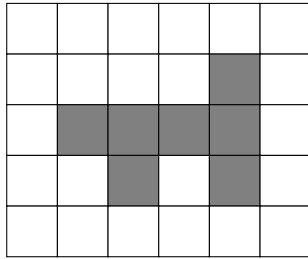


A game is played on a  $6 \times 5$  grid.

如果该游戏采用的是一个  $6 \times 5$  的网格。

How many of the following diagrams are possible after three moves?

请问在下列图片中，有多少张图片显示的是三轮操作之后的结果？



(A) 1

(B) 2

(C) 3

(D) 4

(E) 5

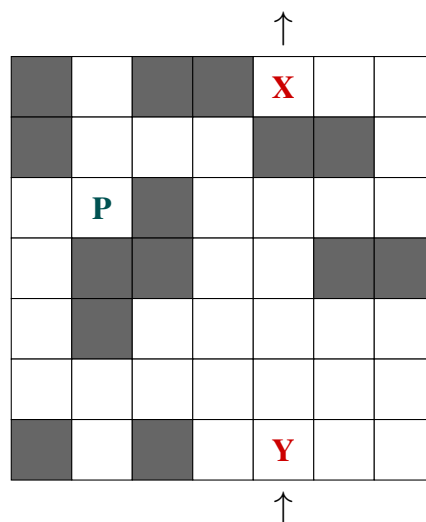
#### 4. Donut Prince-甜甜圈王子

The game *Donut Prince* is played on the  $7 \times 7$  grid shown. The prince can move one square up, down, left or right on each turn. He cannot move onto a solid grey square and diagonal moves are not allowed.

甜甜圈王子 游戏采用如下的  $7 \times 7$  网格。王子每轮都可以在上、下、左、右四个方向上移动一个方格。但是，他不能进入灰色方格，也不能在对角线方向上移动。

When the prince is at any of the four edges of the grid, one more move towards that edge transports him to the same position on the opposite side. For example, he can get from square **X** to square **Y** with one move up.

当王子位于该网格四条边中任意一边时，朝着所在边方向再前进一步可以被传送到对边的同一位置。例如，王子可以从 **X** 方格向上移动一步到达 **Y** 方格。



The prince starts at square **P**.

现在王子从 **P** 方格出发。

How many of the white squares could *not* be reached by the prince in 6 moves or fewer?

请问经过 6 次或者更少次数的移动后，王子 并未 涉足的白色方格有多少个？

(A) 2

(B) 3

(C) 4

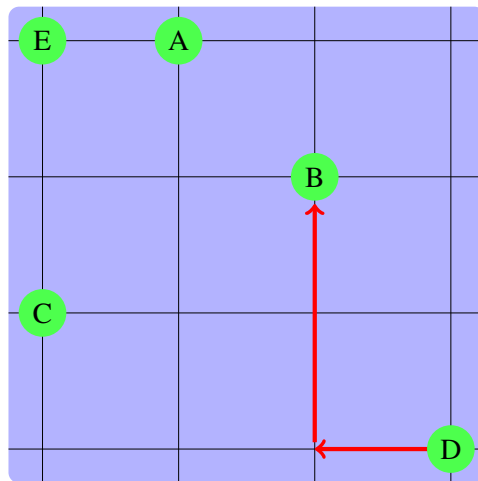
(D) 5

(E) 6

## 5. Magnetic drone-磁力飞侠

Magnetic drones can only fly along magnetic field lines or perpendicular to them. Their instructions are of the form  $m \rightarrow n \downarrow$ .

磁吸无人机只能沿着磁场边线或垂直于这些边线飞行。该无人机指令形式为  $m \rightarrow n \downarrow$ 。



For instance, the instruction  $1 \leftarrow 2 \uparrow$  could be used to fly from island D to island B.

例如，无人机执行指令  $1 \leftarrow 2 \uparrow$ ，可从 D 岛飞往 B 岛。

David's drone started on one of the islands, but we don't know which one. It then flew to three other islands and landed on the fourth. Thus it spent time on all of the islands exactly once, and did not return to its starting point.

David 的无人机从其中某个岛屿起飞，经过其他三个岛屿后，在第四个岛屿降落。此次飞行中，这架无人机对所有岛屿都恰好进行了一次飞越，并且它并未返回起飞岛屿。

To carry out this tour, it used exactly four of the instructions below in some order.

此次飞行，无人机恰好按某种顺序执行了以下指令中的四种指令。

$2 \rightarrow 2 \uparrow$

$2 \leftarrow 3 \uparrow$

$2 \rightarrow 1 \downarrow$

$2 \leftarrow 1 \uparrow$

$1 \rightarrow 2 \downarrow$

$1 \leftarrow 2 \downarrow$

On which island did the drone start?

请问无人机是从哪个岛屿起飞的？

(A) A

(B) B

(C) C

(D) D

(E) E



## 6. Square-sum-平方-和

A *square-sum sequence* is a list of numbers where pairs of adjacent numbers add to a perfect square.

平方-和数列由一系列数字构成，其中两个相邻数字相加等于一个完全平方数。

- 7, 2, 14 is a square-sum sequence because  $7 + 2 = 9 = 3^2$  and  $2 + 14 = 16 = 4^2$ .  
7, 2, 14 是一个平方-和数列，因为  $7 + 2 = 9 = 3^2$ ； $2 + 14 = 16 = 4^2$  都等于一个完全平方数。
- 7, 14, 2 is *not* a square-sum sequence because  $7 + 14 = 21$ , which is not a square.  
7, 14, 2 不是一个平方-和数列，因为  $7 + 14 = 21$  不是一个完全平方数。
- Note that the reverse of any square-sum sequence is also a square-sum sequence.  
注意，任何一个平方-和数列从后往前排列也是一个平方-和数列。

For example, 14, 2, 7 is a square-sum sequence.

例如，14、2、7 就是一个平方-和数列。

You have been given the nine numbers 2, 3, 6, 8, 17, 19, 30, 34, 47.

给定九个数字 2、3、6、8、17、19、30、34、47。

Your task is to arrange them into a square-sum sequence.

现在需要对这九个数字进行排列组合，形成一个平方-和数列。

After you have arranged them, how many numbers are between the 19 and the 47?

请问通过排列组合得到的这个平方-和数列中，数字 19 和 47 之间有多少个数字？

(A) 0

(B) 1

(C) 2

(D) 3

(E) 4

## Part B: Questions 7–9

**Each question has three parts, each of which is worth 2 marks.**

每题有三个部分，每部分 2 分。

**Each part should be answered by a number in the range 0–999.**

每部分答案应为一个介于 0–999 之间的数字。

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### 7. Plantings-苗床种植

Elle wants to plant her rural block with banksias (B), grevilleas (G) and waratahs (W). She has marked out several rectangular garden beds. She wants to plant out her garden beds so that:

Elle 想要在农村种植山茂櫟 (B)、银桦木 (G)、瓦松 (W)。她已经将土地规划成多块矩形苗床，并且计划按照以下模式在苗床中栽种：

- each garden bed will be planted with only one type of plant – banksias or grevilleas or waratahs

每块苗床只栽种一种植物——山茂櫟 (B)、银桦木 (G) 或瓦松 (W)

- neighbouring garden beds will not be planted with the same type of plant (neighbouring garden beds are those that have an edge or part of an edge in common, but not just a corner).

相邻苗床中栽种的植物类型不同（相邻苗床指的是共用一条边或者共用一部分边的苗床。注意，仅共用一个角落的苗床不是相邻苗床。）

Just as she is pondering the possibilities, her mother announces that she has just put some plants in! Luckily the rules Elle set have been obeyed, and now there is no decision to make: there is only one possible way to plant the rest of the beds.

正当 Elle 考虑计划可行性时，她的妈妈说她已经在一些苗床里面种了一些植物了！不过，幸好妈妈遵循了 Elle 设定的栽种规则，现在 Elle 只能在剩下未种植的苗床中栽种植物了。

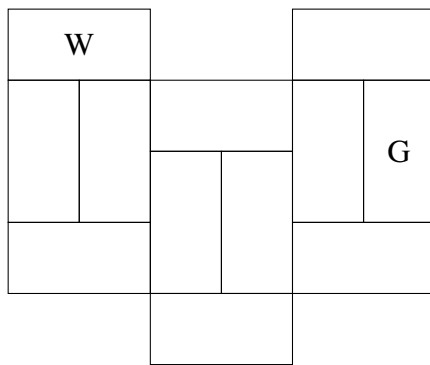
For each of the rural blocks below, find the number of beds that are planted with each type of plant. *This includes the beds Elle's mother has planted.*

对于下列各块农村土地，求每种植物的苗床数量。其中包含 Elle 妈妈栽种的苗床。

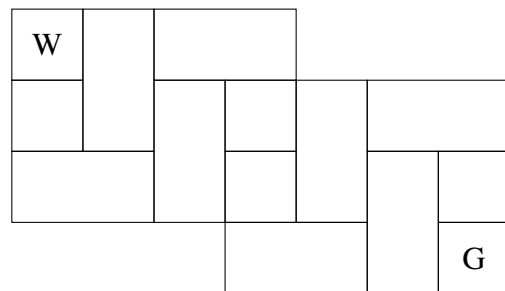
Your answer will be a 3-digit number, giving the number of beds planted with banksias, grevilleas and waratahs. For instance 123 would mean 1 bed planted with banksias, 2 with grevilleas and 3 with waratahs.

你的答案应该为一个 3 位数，分别表示山茂桉苗床、银桦木苗床、瓦松苗床的数量。例如数字 123 表示 1 个山茂桉苗床、2 个银桦木苗床和 3 个瓦松苗床。

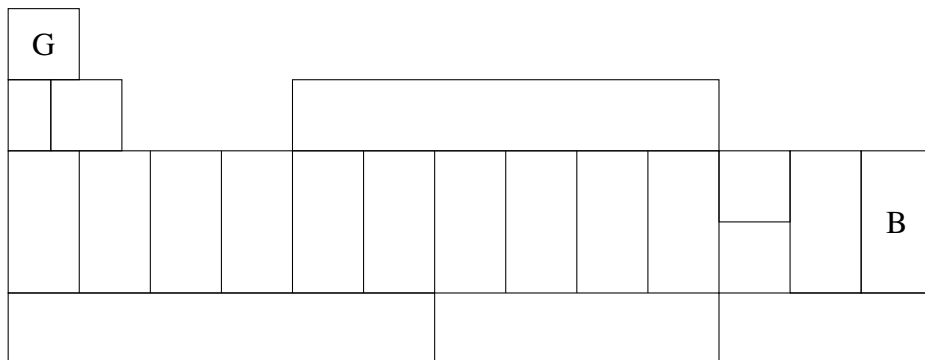
**A.**



**B.**



**C.**

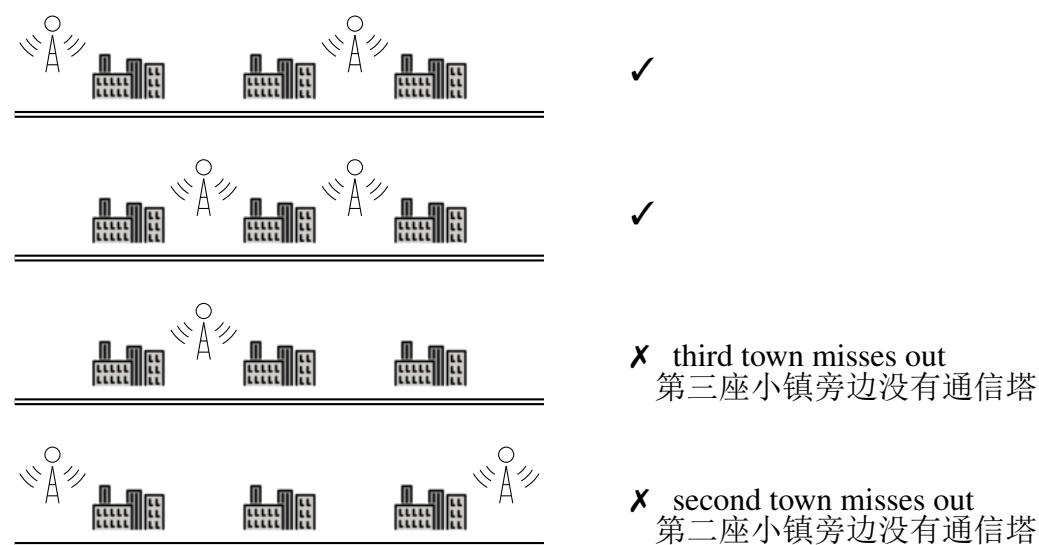


## 8. Communication towers-通信塔

There are several towns along a road. Sites have been identified for communication towers to service the towns. To have service, each town must be next to one or two communication towers.

沿路有几座通信塔。搭建通信塔是为了给城市带来更好的通信保障，因此必须确保每个小镇旁边有一座或两座通信塔。

*Examples* 举例:



You know the cost of building a communication tower on each site. You want the total cost of building the communication towers to be as low as possible.

基于你所掌握的在各个位置搭建通信塔的成本，现在你想将所有通信塔的总搭建成本尽可能降到最低。

For each of the following, what is the lowest cost to build communication towers so that every town is next to at least one tower?

对于下列每一种通信塔搭建方案，计算可以使得每个小镇旁边都至少有一座通信塔的最低成本。

(Each number represents the cost of building a tower on that site. The Ts represent towns.) (其中各个数字代表在该位置搭建一座通信塔的成本。T 代表小镇。)

A. 1 2 5 3 2 8 6 5 6 1  
T T T T T T T T T

B. 3 2 1 2 5 3 2 3 4 5  
T T T T T T T T T

C. 4 3 2 1 4 7 2 6 5 3 4 1  
T T T T T T T T T T T

## 9. Bus passengers-公交乘客

A bus is travelling from A to B, with several stops along the way.

一辆公交车从 A 点开往 B 点，沿途有一些经停站点。

At each stop several passengers get on and get off, as shown in the following tables.

每到达一个经停点时，都有一些乘客上下车，如下列表所示。

*Every passenger travels at least one leg.* No-one gets on and off at the same stop.

每位乘客至少搭乘一站，且没有人在同一站点上下车。

For each of the following trips, what is the greatest number of passengers who could have travelled from A to B for the entire journey?

对于下列每种公交线路，计算可以从 A 点一直搭乘到 B 点下车的最大乘客数量。

A.

Stop 经停站点	A	1	2	3	4	5	6	B
Passengers on 上车人数	20	10	0	5	0	5	0	–
Passengers off 下车人数	–	0	8	0	10	0	3	19

B.

Stop 经停站点	A	1	2	3	4	B
Passengers on 上车人数	20	10	4	7	0	–
Passengers off 下车人数	–	0	8	10	5	18

C.

Stop 经停站点	A	1	2	3	4	5	6	B
Passengers on 上车人数	20	5	6	4	8	5	5	–
Passengers off 下车人数	–	8	3	6	10	7	7	12