

**香港培正中學第三屆數學邀請賽**  
**Pui Ching Middle School 3rd Invitational Mathematics Competition**

**個人賽（中四組）**  
**Individual Event (Secondary 4)**

**時限：1 小時 30 分**

**Time allowed: 1 hour 30 minutes**

**參賽者須知：**

**Instructions to Contestants:**

1. 本卷共設甲、乙兩部分，總分為 100 分。

This paper is divided into Section A and Section B. The total score is 100.

2. 除特別指明外，本卷內的所有數均為十進制。

Unless otherwise stated, all numbers in this paper are in decimal system.

3. 除特別指明外，所有答案須以數字的真確值表達，並化至最簡。不接受近似值。

Unless otherwise stated, all answers should be given in exact numerals in their simplest form.

No approximation is accepted.

4. 把所有答案填在答題紙指定的空位上。毋須呈交計算步驟。

Put your answers on the spaces provided on the answer sheet. You are not required to hand in your steps of working.

5. 不得使用計算機。

The use of calculators is not allowed.

6. 本卷的附圖不一定依比例繪成。

The diagrams in this paper are not necessarily drawn to scale.

甲部 (60 分)

Section A (60 marks)

第 1 至第 4 題，每題 3 分。

Questions 1 to 4 each carries 3 marks.

第 5 至第 8 題，每題 5 分。

Questions 5 to 8 each carries 5 marks.

第 9 至第 12 題，每題 7 分。

Questions 9 to 12 each carries 7 marks.

1. 若  $n$  除以 2004 時的餘數為 13，則  $n^3$  除以 2004 時的餘數是多少？

If  $n$  leaves a remainder of 13 when divided by 2004, what is the remainder when  $n^3$  is divided by 2004?

2. 3600 個正方形盒子排成了一個邊長為 60 個盒子的正方形。小明在其中一個盒子裏放了一個金幣。小芳想找出金幣。她每次可以選一個盒子，並打開它和（最多八個）圍繞著它的盒子。她最少要選多少個盒子才可保證找到金幣？

3600 square boxes were aligned as a square with a length of 60 boxes. Alan put a coin in one of the boxes. Betty wanted to find the coin. Every time she could choose one of the boxes, open it and the (at most eight) boxes surrounding it. At least how many boxes must Betty choose to guarantee that she must find the coin?

3. 若  $p$  和  $q$  為質數，且  $5p + 3q = 91$ ，求  $p$ 。

If  $p$  and  $q$  are prime numbers such that  $5p + 3q = 91$ , find  $p$ .

4. 數字之和為偶數的五位正整數（例如：49991、80446）共有多少個？

How many 5-digit positive integers have the sum of their digits even (e.g. 49991, 80446)?

5. 兩圓的半徑分別為 5 和 7，它們的圓心的距離為 8。求兩圓的兩個交點之間的距離。

Two circles have radii 5 and 7 respectively, and the distance between their centres is 8. Find the distance between the two points of intersection of the two circles.

6. 在去年的「第二屆香港培正中學數學邀請賽」中，個人賽中四組的試卷共有 20 題，其中 3 分題、4 分題、5 分題、6 分題和 7 分題各佔四題。參賽者答對一題可得該題分數，否則該題得 0 分。那麼，參賽者的得分中位數有多少個不同的可能值？

In the 'Pui Ching Middle School 2nd Invitational Mathematics Competition' held last year, the paper for Individual (Secondary 4) consisted of 20 questions, with four of each of 3-mark, 4-mark, 5-mark, 6-mark and 7-mark questions. If a contestant got a question correct, he/she got the score allocated to that question; otherwise he/she got 0 mark for that question. How many different possible values of the median score of the contestants are there?

7. 求右列方程組中  $x$  的值。

Find the value of  $x$  in the following system of equations.

$$\begin{cases} x^2 + 9x + 10y - 70 = 0 \\ y^2 - 5x - 6y - 166 = 0 \\ xy = -120 \end{cases}$$

8. 兩點  $X$  和  $Y$  相距 1 單位。兩個半徑為 1 的圓分別以  $X$  和  $Y$  為圓心，且  $Z$  是兩圓的其中一個交點。過  $Z$  作一條直線相切於以  $Y$  為圓心的圓形。設  $P$  為切線上的一點，使得  $PY = 2$ 。求  $PX$  的長度的最大值。

Two points  $X$  and  $Y$  are 1 unit apart. Two circles of radius 1 are drawn using  $X$  and  $Y$  as centres respectively.  $Z$  is one of the points of intersection of the two circles. Through  $Z$  a line is drawn tangent to the circle centred at  $Y$ . Let  $P$  be a point on the tangent such that  $PY = 2$ . Find the greatest possible length of  $PX$ .

9. 一種常用的日期表示法是以「年 / 月 / 日」六位數字形式寫出日期，例如：2004 年 3 月 7 日寫成 04/03/07。由於  $04 + 03 = 07$ ，我們說這天是「好日子」。一般來說，若某天在以上的日期表示法中，代表「年」、「月」、「日」的三個兩位數中其中一個等於另外兩個之和，則那天稱為「好日子」。那麼，在二十一世紀中（2001 年 1 月 1 日至 2100 年 12 月 31 日），「好日子」共有多少天？

A usual way of writing dates is the 'YY/MM/DD' method of expressing a date as a six-digit number. For instance, 7th March 2004 is denoted as 04/03/07. Since  $04 + 03 = 07$ , we say that this is a 'good day'. In general, a day is said to be a 'good day' if, among the three two-digit numbers representing 'year', 'month' and 'day' in the above representation, one of them is equal to the sum of the other two. How many 'good days' are there in the 21st century (from 1st January 2001 to 31st December 2100)?

10. 一個半徑為 1 的圓形以  $O$  為圓心。 $A$ 、 $B$ 、 $C$  是圓周上的三點。 $D$  是使得  $ABCD$  為平行四邊形的一點。若  $A$ 、 $O$ 、 $D$  成一直線，且  $AB:AD = 1:2$ ，求  $ABCD$  的周界。

A circle centred at  $O$  has radius 1.  $A$ ,  $B$ ,  $C$  are three points on the circumference, and  $D$  is a point such that  $ABCD$  is a parallelogram. If  $A$ ,  $O$ ,  $D$  are collinear and  $AB:AD = 1:2$ , find the perimeter of  $ABCD$ .

11. 某國家流通的貨幣只有 \$1、\$2、\$4、\$8 和 \$16 紙幣。要付款剛好 \$23，不設找續，共有多少種方法？

The currency in a country consists of only \$1, \$2, \$4, \$8 and \$16 notes. How many ways are there to pay exactly \$23 if no change is allowed?

12. 一個遊戲的玩法如下：開始時黑板上寫著 0，另有一個盒子，內有九個分別寫上 1 至 9 的球。玩者然後從盒子中隨意抽出一個球，並把球上的數字加上黑板上的數。之後黑板上的數被擦掉，換上所得之和。遊戲一直繼續（每次抽出的球均會被放回盒內），直至黑板上的數大於 10 為止。若遊戲中黑板上曾出現 9 的概率為  $\frac{k}{9^9}$ ，求  $k$ 。

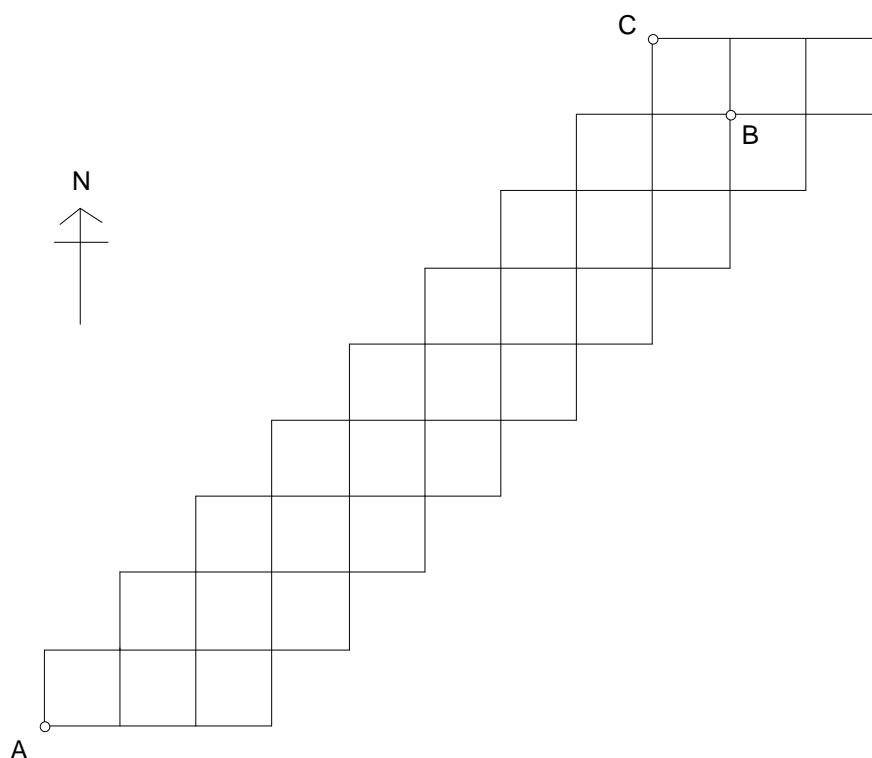
A game is played as follows. On the blackboard the number 0 is written. On the other hand there is a box in which nine balls numbered 1 to 9 are placed. One then randomly takes a ball from the box and then adds the number on the ball to the number on the blackboard. The number on the blackboard is then replaced by the sum obtained. This is repeated (with the ball drawn put back into the box each time) until the number on the blackboard exceeds 10. If the probability that the number 9 ever appears on the blackboard during the game is  $\frac{k}{9^9}$ , find  $k$ .

乙部 (40 分)

Section B (40 marks)

13. 下圖所示為「正方形城」的街道圖。每個小正方形的邊長均代表實際距離 1 公里。陳先生在  $A$  點開設了一間薄餅店，提供薄餅速遞服務。

The figure below is the street map of 'Square City'. The side length of each small square represents an actual distance of 1 km. Mr Chan operates a pizza restaurant at point  $A$  and provides pizza delivery service.



- (a) 某天，陳先生分別接到在  $B$  點和  $C$  點的兩個訂單。他從  $A$  點出發，需要沿街道把薄餅送到  $B$  點和  $C$  點（次序不拘），並返回  $A$  點。那麼，他所走的距離最短是多少公里？

(2 分)

One day Mr Chan received two orders at points  $B$  and  $C$  respectively. Starting from point  $A$ , he had to deliver the pizzas to points  $B$  and  $C$  (the order of which does not matter) via the streets and then return to point  $A$ . What is the minimum distance (in km) that he must travel?

(2 marks)

- (b) 若陳先生只可沿街道向北方或東方走，則由 A 點走到 C 點有多少種不同的走法？ (5 分)

If Mr Chan can only go northward or eastward via the streets, in how many different ways can he travel from point A to point C? (5 marks)

- (c) 陳先生發現，薄餅店位於城市的西南端，地點並不理想。一旦接到偏遠的東北部的訂單，送貨的成本高昂，並不划算。因此，他決定把現有的薄餅店關閉，另覓兩個地點開設兩間新店。每間新店必須位於兩條街道的交匯處（即街道圖中小正方形的頂點），並且要求從城市內街道上的任何一點接到訂單時，均可從其中一間新店沿街道送貨，其距離不超過 6 公里。那麼，兩間新店的選址有多少個不同的組合？ (6 分)

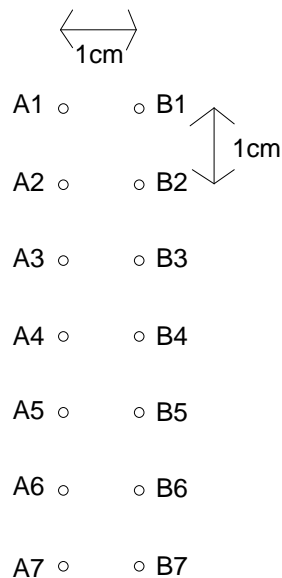
Mr Chan finds that the pizza restaurant, situated in the southwestern tip of the city, is not at an ideal location. Whenever orders from the remote northeastern area are received, high costs of transportation will be involved and thereby greatly reducing cost-effectiveness. As a result, he decides to close down the current restaurant and chooses two other locations for two new restaurants. Each new restaurant must be at the intersection of two streets (i.e. the vertices of the small squares in the street map), and it is required that whenever orders at any point on the streets of the city are received, delivery service can be provided from one of the new restaurants, and the distance of delivery is at most 6 km along the streets. How many different combinations are there for the locations of the two new restaurants? (6 marks)

- (d) 為了方便起見，陳先生把街道圖上的每個小正方形塗上紅色、黃色或綠色，使得同一橫行或直行中，沒有兩個小正方形的顏色相同。那麼，街道圖共有多少種不同的填色方法？ (7 分)

For convenience, Mr Chan colours each small square on the street map in red, yellow or green, in a way such that no two small squares in the same row or column are assigned the same colour. How many different colouring schemes are there? (7 marks)

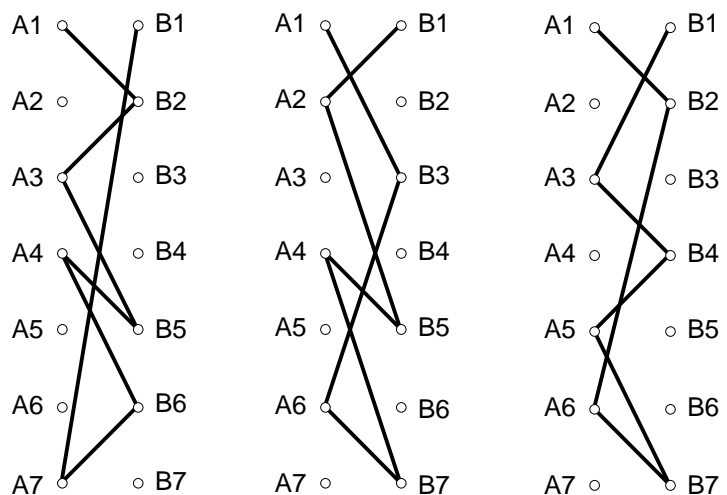
14. 小月要為一隻鞋穿鞋帶。鞋上有兩列、每列七個鞋帶孔，這些鞋帶孔整齊地在平面上排成一個長方形，相鄰的鞋帶孔相隔 1 厘米（見圖一）。小月穿鞋帶時，每次均會由 A1 孔開始穿，穿到 B 列的某一個孔，再穿回 A 列的另一個孔，如此類推，一直穿回 B1 孔為止。此外，為了節省時間起見，除第一行（A1 和 B1 孔）外，鞋帶只會同時穿過同一行的兩個孔中的剛好一個（即不會同時穿過 A2 和 B2，不會同時穿過 A3 和 B3，如此類推）。鞋帶只可以穿過每個孔最多一次。圖二所示的是一些符合上述規則的穿鞋帶方法。

Mary is tying her shoelace. There are 2 columns of holes, each with 7 holes on it. The holes are evenly distributed on a plane in a rectangular shape, with each of the holes at a distance of 1 cm from its neighbours (see Figure 1). When Mary ties the shoelace, she always ties the shoelace through hole A1 first, then to a hole on column B, and then back to a hole on column A and so on, until she returns to hole B1. In order to save time, Mary will only tie the shoelace through exactly one of the two holes on the same row except for the first row (holes A1 and B1), i.e. the shoelace will not go through both A2 and B2, nor both A3 and B3, etc. The shoelace can pass through each hole at most once. Figure 2 shows some possible configurations of the shoelace under the above rules.



圖一

Figure 1



圖二

Figure 2

- (a) 小月有多少種不同的方法穿鞋帶？（只要穿孔的次序相同，兩種穿鞋帶的方法便視為相同。） (4 分)

In how many different ways can Mary tie the shoelace? (Two ways are regarded to be the same if the orders by which the shoelace passes through the holes are the same in both ways.) (4 marks)

- (b) 圖中所示為各鞋帶孔的面積。若鞋帶所穿過的孔的面積之和是  $S \text{ cm}^2$ ，那麼  $S$  除以 15 時的餘數有多少個不同的可能值？ (6 分)

The figure shows the areas of the holes. Suppose that the sum of the areas of the holes which the shoelace passes through is  $S \text{ cm}^2$ . How many different remainders are possible when  $S$  is divided by 15? (6 marks)

1cm <sup>2</sup> , A1	<input type="radio"/>	B1, 14cm <sup>2</sup>
2cm <sup>2</sup> , A2	<input type="radio"/>	B2, 13cm <sup>2</sup>
3cm <sup>2</sup> , A3	<input type="radio"/>	B3, 12cm <sup>2</sup>
4cm <sup>2</sup> , A4	<input type="radio"/>	B4, 11cm <sup>2</sup>
5cm <sup>2</sup> , A5	<input type="radio"/>	B5, 10cm <sup>2</sup>
6cm <sup>2</sup> , A6	<input type="radio"/>	B6, 9cm <sup>2</sup>
7cm <sup>2</sup> , A7	<input type="radio"/>	B7, 8cm <sup>2</sup>

- (c) 圖中所示為穿過各鞋帶孔所需的時間。那麼，小月穿鞋帶最少需要多少秒？ (4 分)

The figure shows the time needed to tie the shoelace through each of the holes. What is the minimum amount of time (in seconds) that Mary needs to tie the shoelace? (4 marks)

14s, A1	<input type="radio"/>	B1, 1s
13s, A2	<input type="radio"/>	B2, 2s
12s, A3	<input type="radio"/>	B3, 3s
11s, A4	<input type="radio"/>	B4, 4s
10s, A5	<input type="radio"/>	B5, 5s
9s, A6	<input type="radio"/>	B6, 6s
8s, A7	<input type="radio"/>	B7, 7s

- (d) 求由 A1 孔到 B1 孔的鞋帶的長度的最小值。 (6 分)

Find the minimum length of the shoelace from hole A1 to hole B1. (6 marks)

全卷完

END OF PAPER

個人賽（中四組）答案

Individual Event (Secondary 4) Answers

- |     |                 |        |                         |
|-----|-----------------|--------|-------------------------|
| 1.  | 193             | 13 (a) | 36                      |
| 2.  | 400             | 13 (b) | 3281                    |
| 3.  | 17              | 13 (c) | 87                      |
| 4.  | 45000           | 13 (d) | 1542                    |
| 5.  | $5\sqrt{3}$     | 14 (a) | 720                     |
| 6.  | 197             | 14 (b) | 10                      |
| 7.  | 10              | 14 (c) | 51                      |
| 8.  | $\sqrt{7}$      | 14 (d) | $5\sqrt{5} + 2\sqrt{2}$ |
| 9.  | 730             |        |                         |
| 10. | $6\sqrt{3} - 6$ |        |                         |
| 11. | 74              |        |                         |
| 12. | 100 000 000     |        |                         |