

# 尺規作圖 1

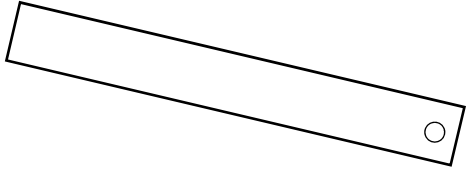
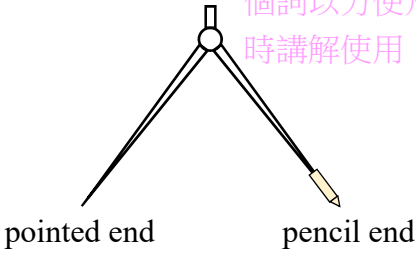
## Ruler and compass constructions 1

Class: \_\_\_\_\_ Name: \_\_\_\_\_

In this section, we will learn 6 basic ruler and compass constructions. To learn well in this section, here are two important things to keep in mind:

- (1) There are 2 important tools: a ruler and a compass. Please remember to bring them to math class.
- (2) Listen carefully to the instructions from the teacher and do the exercise by yourself.

### 1. Introduce the tools:


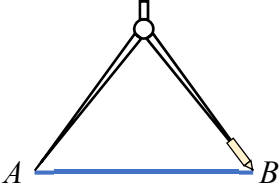
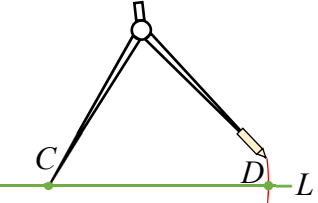
<p>(1) ruler: draw lines without using the markings on it</p> 	<p>(2) compass: draw circles and arcs</p> <p style="color: magenta; font-size: small;">教師可介紹 pointed end 及 pencil end 兩個詞以方便尺規作圖時講解使用</p>  <p style="text-align: center;">pointed end                  pencil end</p>
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### 2. Copy a line segment (等線段作圖)

Given a line segment  $\overline{AB}$ . Construct a line segment  $\overline{CD}$  such that  $\overline{CD} = \overline{AB}$ .

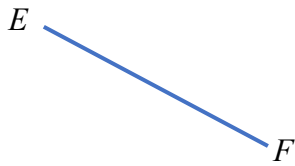


尺規作圖前半段(Constructing step by step)逐步針對每個步驟教學，後半部(Try it by yourself)則讓學生練習類題

Constructing step by step		
<p>(1)</p> 	<p>(2)</p> 	<p>(3)</p> 
<p>(1) Draw a line <math>L</math>, and a point <math>C</math> on <math>L</math>.</p> <p>(2) We use the compass to measure the length of <math>\overline{AB}</math>. Place the pointed end of the compass on point <math>A</math> and the pencil end on point <math>B</math>.</p> <p>(3) Without changing the width, place the pointed end of the compass on <math>C</math> and draw an arc which intersects <math>L</math> at point <math>D</math>. Then, <math>\overline{CD}</math> is the required line segment.</p> <p style="color: magenta; font-size: small; text-align: right;">文字敘述的(1)(2)(3)與上方的圖相對應</p>		

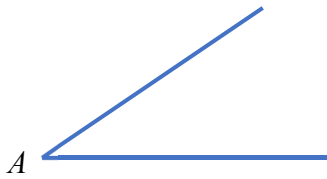
Try it by yourself


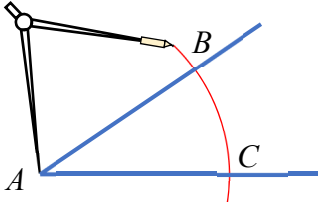
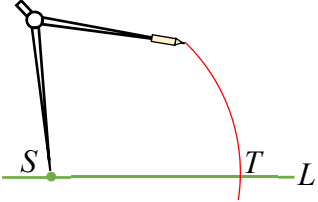
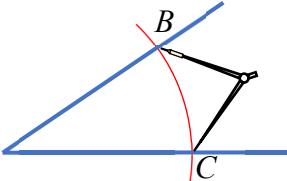
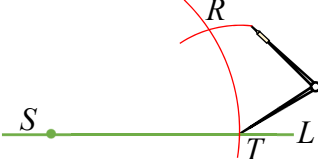
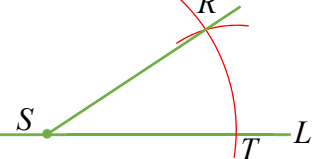
Given a line segment  $\overline{EF}$ . Construct a line segment  $\overline{GH}$  such that  $\overline{GH} = \overline{EF}$ .



3. Copy an angle (等角作圖)

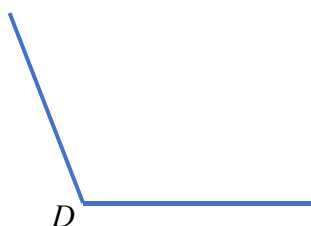
Given  $\angle A$ . Draw an angle that equals  $\angle A$ .



(1) 	(2) 	(3) 
(4) 	(5) 	(6) 
<p>(1) Draw a line <math>L</math>, and draw a point <math>S</math> on <math>L</math>.</p> <p>(2) Draw an arc centered at <math>A</math> and intersects two sides of the <math>\angle A</math> at points <math>B</math> and <math>C</math>.</p> <p>(3) Draw an arc with radius <math>\overline{AB}</math> centered at <math>S</math> and intersects <math>L</math> at point <math>T</math>.</p> <p>(4) Use the compass to measure <math>\overline{BC}</math>.</p> <p>(5) Draw an arc with radius <math>\overline{AB}</math> centered at <math>T</math> and intersects the arc drawn in step 3 at point <math>R</math>.</p> <p>(6) Connect a ray <math>\overline{SR}</math>. <math>\angle RST</math> is the required angle.</p>		

Try it by yourself

Given  $\angle D$ . Draw an angle that equals  $\angle D$ .



4. Construct the perpendicular bisector (中垂線作圖)

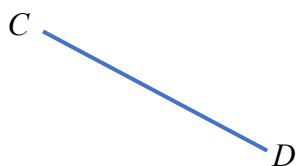
Given a line segment  $\overline{AB}$ . Construct the perpendicular bisector of  $\overline{AB}$ .



<p>(1)</p>	<p>(2)</p>
<p>(3)</p>	<p>(4)</p>
<p>(1) Draw the arc centered at <math>A</math>, and adjust the compass such that its width is greater than half the length of <math>\overline{AB}</math>.</p> <p>(2) Keep the same width and draw an arc centered at <math>B</math>.</p> <p>(3) Let two arcs intersect at points <math>P</math> and <math>Q</math>.</p> <p>(4) Connect a line through <math>P</math> and <math>Q</math>. <math>\overline{PQ}</math> is the perpendicular bisector of <math>\overline{AB}</math>.</p>	

Try it by yourself

Given a line segment  $\overline{CD}$ . Construct the perpendicular bisector of  $\overline{CD}$ .



### 一、設計理念：

1. 尺規作圖又可譯為 straightedge and compass construction 或 geometric construction。
2. 尺規作圖教師需解說與操作互相搭配，故同學可藉由教師的操作理解每個過程的操作方式。


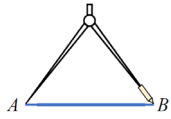
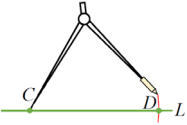
### 二、英文詞彙：

中文	英文
直尺	ruler
圓規	compass
線段	line segment
圓弧	arc
角	angle
半徑	radius
中垂線	perpendicular bisector
相交	intersect

### 三、數學英文用法：

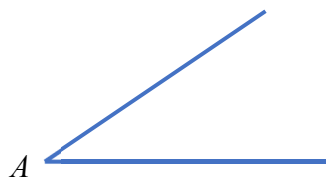
數學表示法	英文
$\overline{AB}$	line segment AB
$\overrightarrow{AB}$	ray AB
$\overleftrightarrow{AB}$	line AB
$\angle A$	angle A

四、教學參考範例：

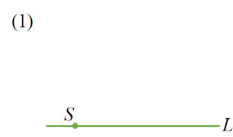
<p>1 【等線段作圖】</p>	<p>Copy a line segment (等線段作圖)</p> <p>Given a line segment <math>\overline{AB}</math>. Construct a line segment <math>\overline{CD}</math> such that <math>\overline{CD} = \overline{AB}</math>.</p> <p style="text-align: center;"><math>A \text{ ————— } B</math></p>	
		<p>First, we want to copy a line segment. There is a segment AB on the paper, and we are going to draw another segment with the exact same length as AB. You might think this is so easy. Take out the ruler and measure the length. However, when we do the ruler and compass construction, we cannot use the markings on the ruler. Therefore, rather than measure the length, the ruler can only help us to make straight lines. We cannot use the ruler to measure the length, but we still need to copy a line segment. As a result, we will learn how to measure the length by compass.</p>
	<p>(1)</p> 	<p>Let's start our construction. We should draw a line segment congruent to AB. First, take out the ruler and draw a line L and a point C on the line L. The line L should be longer than AB, or the segment which we copy will be not long enough.</p>
	<p>(2)</p> 	<p>Next, we will use the compass to measure AB, so take out your compass. Put the pointed end on A and adjust the compass until the pencil end is on B. You will find the distance from the pointed end to the pencil end is exactly the same as the length of AB. As a result, we use the compass to measure the distance from A to B.</p>
	<p>(3)</p> 	<p>Last, don't change the length of the radius. Fix the compass opening and put the pointed end on C. Make an arc and intersect the line L at D. It is not necessary to make a whole circle. Then, the radius of the arc is the same as the length of AB, so now we have the line segment CD congruent to the given segment AB.</p>
	<p>Remember to maintain the arc so that the teacher knows the process of the construction.</p>	

2  
【等角作圖】

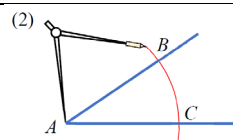
Copy an angle (等角作圖)  
Given  $\angle A$ . Draw an angle that equals  $\angle A$ .



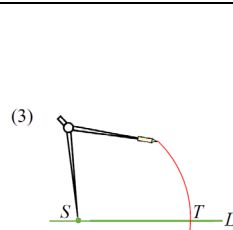
Next, we are going to copy an angle. Here is an angle A and we have to recreate a new angle congruent to angle A. Remember that we can only use the compass and the ruler, so we cannot use the protractor to measure the angle.



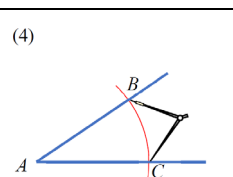
First, we draw one side of my new angle. Draw a line L and draw a point S on L. Notice that the length of the side of the new angle doesn't have to be the same as the original one because the measurement of the angle is not related to the length of two sides of the angle.



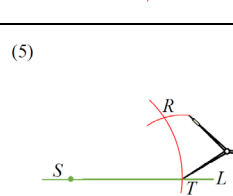
Put the pointed end on A and draw an arc that covers both sides of angle A. The arc intersects the sides of the angle A at points B and C respectively.



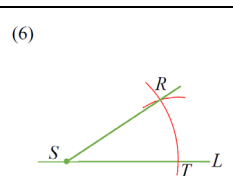
Keep the same radius and what we want to do is recreate the arc on line L. Point A is the vertex of the angle, and point S will be the vertex of the new angle soon. Therefore, we want to do the same thing at S as we do at point A. Put the pointed end on S and use the same radius to draw an arc with center S. The arc intersects line L at T.



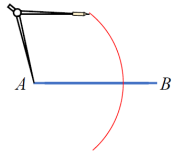
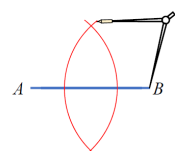
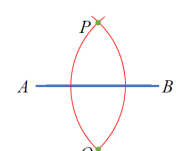
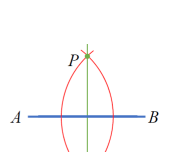
We are going to measure the length from B to C, so we will adjust the compass opening to length BC.



Point C is just like point T so we are doing the similar thing on T. We put the pencil end on T and draw an arc across the existing arc. Two curves intersect at point R. The length of AB is the same as TR.



Last, connect the ray SR to complete the angle. You can see the new angle RST is congruent to angle A.

<p>3 【中垂線作圖】</p>	<p>Construct the perpendicular bisector (中垂線作圖)</p> <p>Given a line segment <math>\overline{AB}</math>. Construct the perpendicular bisector of <math>\overline{AB}</math>.</p> <p style="text-align: center;"><math>A \text{ ————— } B</math></p>	
		<p>Next, we are going to draw a perpendicular bisector of the given line segment AB. When we draw the perpendicular bisector of AB, do we need to draw in another place, or do we directly draw on the given line segment AB? We can directly draw on AB.</p>
	(1)	 <p>Take out the compass and put the pointed end on A. Adjust the width of the compass to a little bit longer than half of the AB. Then, draw a larger arc across AB.</p>
	(2)	 <p>Now, we do the same thing with the same length from the other side. Keep the compass in the same setting. Put the pointed end on B. Draw a long arc that intersects the previous one at two points. If the arcs do not intersect, increase the length of the arcs.</p>
	(3)	 <p>We can see one of the intersections is above the line segment AB, and the other intersection is below the line. We label these two intersections P and Q respectively.</p>
(4)	 <p>Last, take out the ruler. Draw a line connecting points P and Q. You can see this new segment PQ meet AB at the midpoint of AB, so PQ bisects AB. Then, PQ also forms a right angle there, so it is perpendicular to AB as well. Thus, we have line PQ as the perpendicular bisector of the given line segment AB.</p>	