7

UNIFIED SUPPLEMENTARY LEARNING MATERIALS
(USLeM)

MATHEMATICS

Week 4

*To start your journey in learning more about construction, please answer the Pretest.*

PRE-TEST

Direction: Choose the letter of the correct answer.

1.) Which term is used for making geometric figures using a straight edge and a compass only?
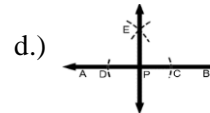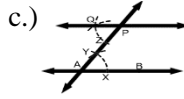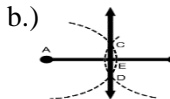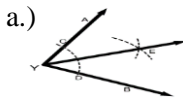   a.) Sketching b.) Drawing c.) Construction d.) Printing

2.) Which geometric tool is used to draw a circle?
   a.) Ruler b.) Compass c.) Straight Edge d.) Protractor

3.) Which figure shows how to bisect an angle?

   a.)   b.)   c.)   d.)

4.) Which figure shows how to bisect a segment?

   a.)   b.)   c.)   d.)
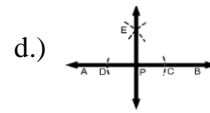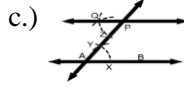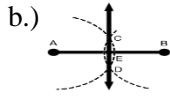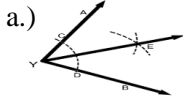
5.) Which is the correct way to construct a 45° angle?
   a.) Construct perpendicular lines and then construct the bisector of one of the angles formed.
   b.) Construct parallel lines then, draw the transversal.
   c.) Draw a right angle, then construct the bisector.
   d.) Use a protractor to draw the angle.

6.) The given figure on the right, shows how to construct an angle bisector, which conclusion is **not** correct?
   a.) ∠AOE ≅ ∠BOE
   b.) m∠AOE = ½ m∠AOB
   c.) 2m∠BOE = m∠AOB
   d.) ∠AOE ≅ ∠AOB
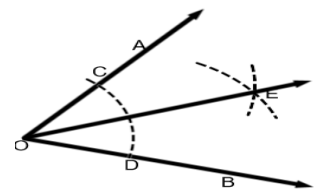
7.) What do you call the geometric tool used in construction as shown by the figure?
   a.) Straight edge b.) Triangular Ruler c.) Compass d.) T – Square

8.) What does the word **bisect** (angle/segment) mean?
   a.) To cut an angle or a segment into more than two
   b.) To cut an angle or segment into two equal parts
   c.) To double the size of an angle or segment
   d.) To cut an angle or segment into two (any sizes).

9.) In bisecting $\overline{AE}$ (as shown in the figure), place the compass point on A and mark off the radius of the compass to which point?
   a.) B – which is less than half of $\overline{AE}$.
   b.) C – which is the midpoint of $\overline{AE}$.
   c.) D – which is more than half of $\overline{AE}$
   d.) Anywhere in $\overline{AE}$, it does not matter.
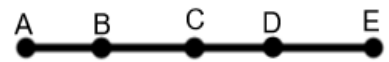
10.) In bisecting ∠AYB (as shown in the figure), the straightedge should be used to___
   a.) Mark point E.
   b.) Copy the angle with an arc.
   c.) Measure ∠AYB
   d.) Connect point E and vertex Y.
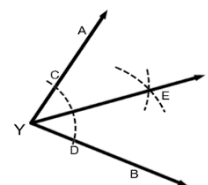
11.) Which angle can be constructed with the help of compass and straight edge?
   a.) 35° b.) 40° c.) 22.5° d.) 47.5°

12.) Which phrase will complete this statement: "When constructing a line parallel to a given line, the required process is to ___."?
    a.) Copy a segment   c.) Bisect a segment
    b.) Copy an angle   d.) Construct a perpendicular
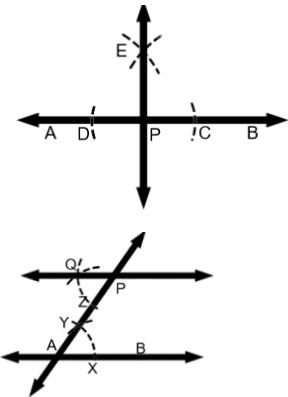
13.) Which figure shows the correct construction of an angle bisector?

    a.)   b.)   c.)   d.)

14.) When constructing a line perpendicular to a given line through a given point on the line (as shown in the figure), which is the first step ?
    a.) Use the given point as a center, cut an arc on the left side and the right side of the point.
    b.) Use the given point as the center, cut an arc above the line.
    c.) Connect point P to any point above the line.
    d.) Use the given point as the center, cut an arc below the line.

15.) Which best describes the construction shown on the figure on the right?
    a.) Line parallel to a given line through a given external point.
    b.) Line congruent to a given line through a given external point.
    c.) Line intersecting to a given line through a given external point.
    d.) Line perpendicular to a given line through a given external point.

Great, you finished answering the questions. You may request your facilitator to check your work.
Congratulations and keep on learning!

LOOKING BACK TO YOUR LESSON

WORD HUNT: This activity will give you some ideas on the terms you will encounter in this lesson.

Q	S	Q	W	E	R	T	Y	C	U
A	R	E	A	B	I	K	O	O	P
N	U	S	G	G	U	T	P	N	E
G	I	P	R	M	S	T	R	S	R
L	G	L	A	N	E	G	Q	T	P
E	J	C	O	T	Q	N	N	R	E
B	K	A	P	E	T	I	T	U	N
I	L	Q	R	S	O	T	U	C	D
S	C	O	M	P	A	S	S	T	I
E	P	V	D	W	X	Y	Z	I	C
C	S	I	E	R	S	T	U	O	U
T	M	R	O	G	E	R	A	N	L
O	K	Q	R	S	U	I	O	Q	A
R	P	A	R	A	L	L	E	L	R

Instruction: Find the words listed below and circle them in the word hunt puzzle.

ANGLE BISECTOR

MIDPOINT

PERPENDICULAR

PARALLEL

SEGMENT

COMPASS

CONSTRUCTION

Study the following terms:

Definition of Terms	
Angle bisector	is a ray that divides an angle into **two equal parts.**
Parallel lines	are two lines on the same plane that are **always the same distance apart** and **never touch.**
Perpendicular bisector	of a segment is the line that is **perpendicular to the segment** at its midpoint.

Definition of Terms
- A line is said to be **perpendicular** to another line if the two lines intersect at a right angle.
- The midpoint of a segment is said to **bisect** a segment. The **bisector** could be the midpoint of a segment, or any line, plane ray, or segment which contains the midpoint.
- A *construction* uses a straight edge and a compass to make geometric figures.
- A *compass* (figure 1) is a geometric tool used to draw circles and parts of circles are called arcs.
- A *straight edge* (figure 2) is a ruler with no markings on it.

Direction: Answer the following to form a word by getting the first letter of the answer.
1.) If AB + BC = AC then it is the same as BC + AB = AC because of _____ property.
2.) MO + OP = MP. Which point is between the other two?
3.) Does a line have a midpoint?
4.) If AB = CD then CD = AB. Why?
5.) If AB = CD and CD = EF then AB = EF. Why?
6.) What is the letter after Q?
7.) Point, line, and plane are called _____.
8.) The number that corresponds to a point.
9.) Statements that are accepted after it is proven.

What is the word formed by using the first letters of each answer?

___, ____, ____, ____, ___, ___, ____, ____, ____
 1   2   3   4   5   6   7   8   9

BRIEF INTRODUCTION

Construction in Geometry

Would you like to bisect an angle or a segment without measuring it? Or draw perpendicular and parallel lines without using a protractor or a ruler?

Before the advent of computers, people used rulers and protractors to bisect an angle or a segment. They used a ruler to draw lines and distances, and a protractor to measure an angle. Today, with so many computer apps, we can draw a straight line or an angle with given measurements.

Using apps may be the easiest way to make a line. However, there is also a manual way. This is construction in geometry using a compass and straight edge. Under this method, we do not have a ruler with number markings on it but only a straight edge so that, we can draw a straight line without measuring its distance. We also have a compass to draw circles with any given point as the center and passing through any other given points.

This method had been developed by Greek geometers of antiquity.

With so many gadgets and computers around, you should also learn how to use a compass and straight edge to bisect a segment or an angle.

What is the difference between drawing and construction?

What is the difference between drawing and construction?

To draw is to sketch; depict with lines; to produce a picture with pencil, crayon, chalk, etc. on paper, cardboard, etc. while to construct is to form a geometric figure by using just a compass and straight edge.

Notes in Construction:
1.) The dashed lines in the figure are called construction guidelines. These lines are just guides and are not part of the figure itself. Construct these lines lightly.
2.) When a compass is "set" it means that the compass point and the pencil point should be fixed. This setting should not be altered until the procedure says to reset the compass.
3.) Center means the compass point. Radius is the distance between the compass point and pencil point.
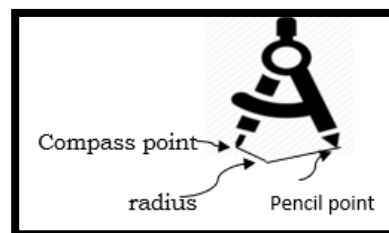
4.) Measuring segments and angles with a ruler and a protractor is not allowed. Although we can use them as a straight edge.
5.) Unless otherwise specified, do not erase guidelines. They are the basis for correcting the figures. Erasures should be minimal.
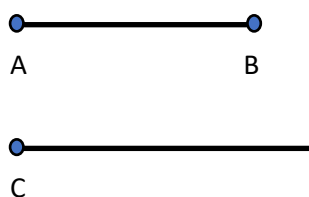6.) Maintain neatness throughout the constructions.

CONSTRUCTION

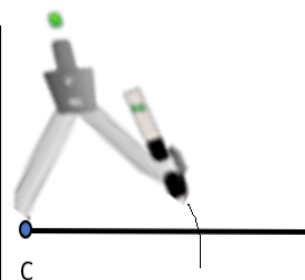## Copying Segments and Angles

Activity 1: How to copy a line segment?

Let's begin by learning how to copy a line segment. When we copy a line segment, we are constructing a line segment congruent to a given line segment. The following diagram shows the line segment $\overline{AB}$. We are going to construct $\overline{CD}$, a line segment congruent to $\overline{AB}$.
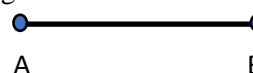
Step 1: We begin by taking a straight edge and drawing a line segment significantly longer than $\overline{AB}$ and labeling the left endpoint C.

Step 2: Place your compass point at point A and open the compass until the pencil touches point B.

Step 3: Without changing the width of the compass, place the compass point at point C and make an arc through the line you drew in step 1.
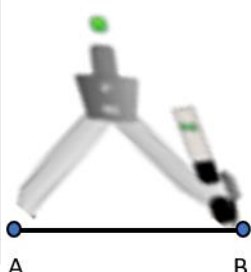
Step 4: Label the intersection point D. You have now copied $\overline{AB}$. We can now state that $\overline{CD} \cong \overline{AB}$.
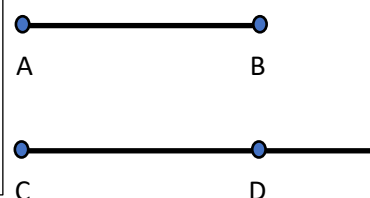
Activity 2: How to copy an angle?

In the next construction, we will learn to copy a given angle. The following diagram shows $\angle ABC$. We will be constructing $\angle DEF$, an angle congruent to $\angle ABC$.

Step 1: We begin by taking a straight edge and drawing a line segment and labeling the left endpoint E, the vertex of the new angle.
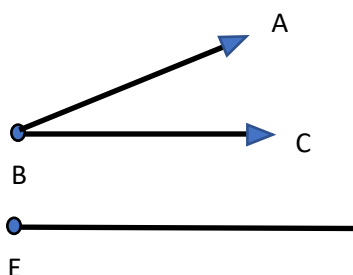
Step 2: Place the compass point at B, open the compass wide enough so that you can make an arc that intersects $\angle ABC$ on both rays.
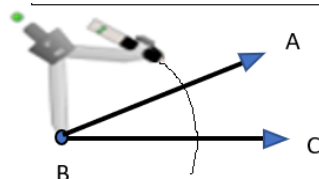
Step 3: Without changing the width of the compass, place the compass point at E. Draw a generous-sized arc through the line segment and label the intersection point F.
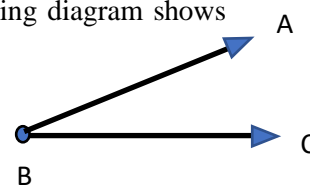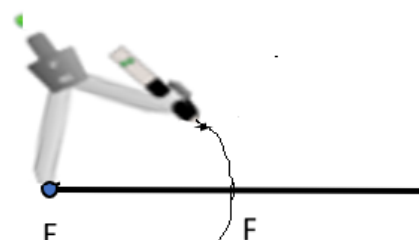
Step 4: Go back to ∠ABC and place the compass point and the pencil at the locations where the arc intersected the rays.	**Step 5**: Without changing the width of the compass, place the compass point at F and draw an arc that intersects the arc you drew in step 3. Label the intersection point D.	**Step 6**: Using a straight edge, draw a ray from point E through point D. You have now copied ∠ABC. We can now state that ∠DEF ≅ ∠ABC.
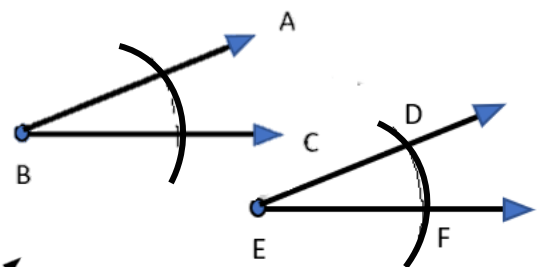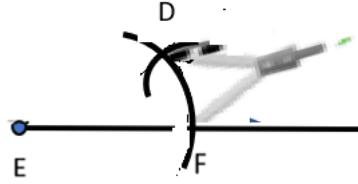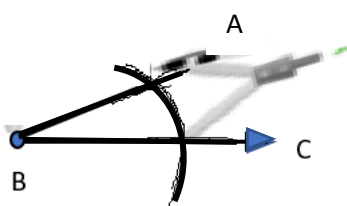
Bisectors and Perpendiculars and Parallel Lines

Activity 3: How to construct an Angle Bisector?

How to Construct Angle Bisector
Given: Any ∠ AOB
To construct: bisector of ∠AOB.
Construction Procedure:

1.) With A as center and with any radius such as $\overline{OC}$, draw an arc cutting $\overrightarrow{OA}$ at C and $\overrightarrow{OB}$ at D.

2.) With C as center and with any radius such as CE, draw an arc in the interior of ∠AOB.
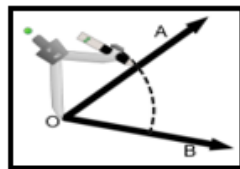
3.) With D as center and with the same radius as CE, draw an arc in the interior of ∠AOB intersecting the previous arc at E.
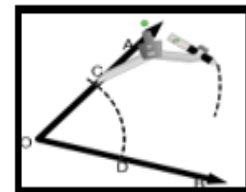
4.) Draw $\overrightarrow{OE}$.
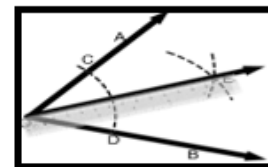
Conclusion:
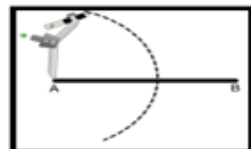$\overrightarrow{OE}$ bisects ∠AOD making ∠AOE ≅ ∠BOE.
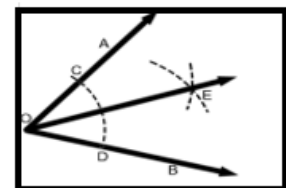
Activity 4: How to construct (Perpendicular) Bisector of a Segment?
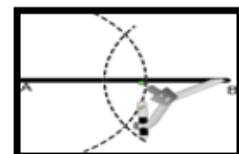**Given**: $\overline{AB}$
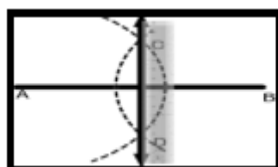**To construct**: The bisector of $\overline{AB}$.
Construction Procedure:

1.) With A as center and with a radius of more than half of the given segment, draw two arcs above and below the segment $\overline{AB}$.

2.) With B as center and with the same radius, draw two arcs above and below the given segment intersecting the previous arcs at C and D.
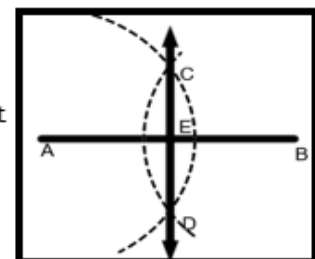
3.) Draw $\overleftrightarrow{CD}$

Conclusion:
$\overleftrightarrow{CD}$ bisect $\overline{AB}$ at E making $\overline{AE} ≅ \overline{BE}$. E is the midpoint of $\overline{AB}$
Note: Bisector of a segment is also known as perpendicular bisector because the lines formed are perpendicular.
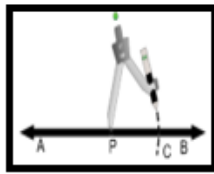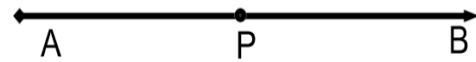
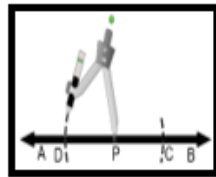*Activity 5: How to construct a line perpendicular to a given line through a given point on the line?*

Given : $\overleftrightarrow{AB}$ and point P on $\overleftrightarrow{AB}$.

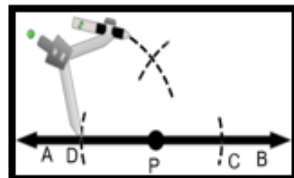**To Construct** : A line perpendicular to $\overleftrightarrow{AB}$ at P.
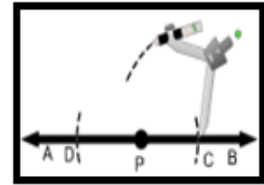
Construction Procedure:

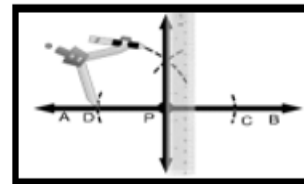**1.)** With P as center and with any radius, draw two arcs cutting $\overleftrightarrow{AB}$ at C and D.

2.) With C as center and with radius of more than half of AB, draw an arc above $\overleftrightarrow{AB}$.

3.) With D as center and with the same radius, draw an arc intersecting the previous one at E
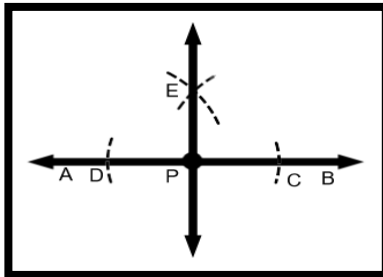

4.) Draw $\overleftrightarrow{PE}$

conclusion:

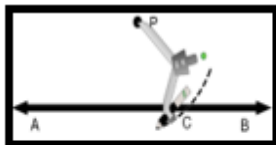$\overleftrightarrow{PE} \perp \overleftrightarrow{AB}$ at P.

Activity 6: How to Construct a Line Perpendicular to a Given Line Through A Given External Point?

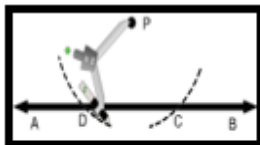**Given**: $\overleftrightarrow{AB}$ and P outside of $\overleftrightarrow{AB}$.

To Construct: A line perpendicular to $\overleftrightarrow{AB}$ from P.
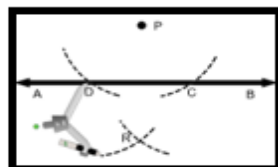
Construction Procedure:

1.) With P as center and with a radius that can reach the given line, draw an arc cutting $\overleftrightarrow{AB}$ at C and at D.
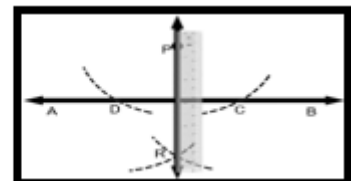
2.) With C as center and with a radius more than half of CD, draw an arc below $\overleftrightarrow{AB}$.

3.) With D as center and with the same radius CE, draw an arc below AB intersecting the previous arc at R.

4.) Draw $\overleftrightarrow{PR}$.

Conclusion: PR ⊥ AB from P.

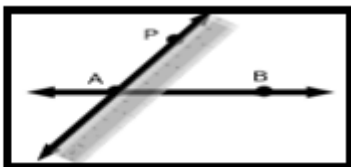*Activity 7: How to Construct a Line Parallel to a Given Line Through A Given External Point?*

Given: $\overleftrightarrow{AB}$ and P outside of $\overleftrightarrow{AB}$.
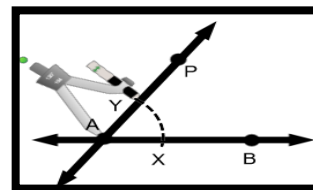
To Construct: A line perpendicular to $\overleftrightarrow{AB}$ from P.
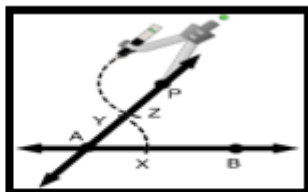**Construction Procedure:**

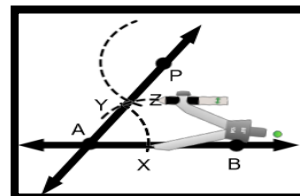1.) Draw $\overleftrightarrow{AP}$

2.) With A as center and with any convenient radius, draw an arc cutting $\overleftrightarrow{PA}$ at Y and $\overleftrightarrow{AB}$ at X.
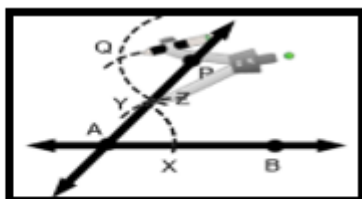
3.) With P as center and with same radius as AY draw an arc intersecting $\overleftrightarrow{PA}$ at Z.
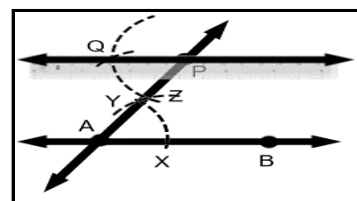
4.) Set the compass point at X and compass pencil at Y to measure XY, cut an arc.
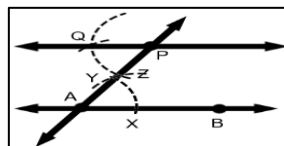
5.) Using the same radius as XY and using Z as center, draw an arc cutting the other arc at Q.

6.) Draw $\overleftrightarrow{PQ}$

Conclusion: $\overleftrightarrow{AB} \parallel \overleftrightarrow{PQ}$

ACTIVITIES

A. Given the figure on the right, construct
  1) The perpendicular to $\overrightarrow{BA}$ at A.   3) The bisector of ∠B.
  2) The parallel to $\overrightarrow{BC}$ through C.
**B**. 1.) Construct an angle whose measure is 45.
  2.) Construct a right angle
  3.) Given: Any ΔABC with obtuse ∠A
      a.) Bisect ∠A   b.) Construct the complement of ∠C.   c.) Bisect $\overline{BC}$
C. Draw any large triangle. Construct the angle bisectors of all three angles of the triangle. What can you notice about the intersection of the three angle bisectors? Draw another large triangle, construct the perpendicular bisector of each side of the triangle. Make a conclusion about the three angle bisectors, and the three perpendicular bisectors of a triangle.
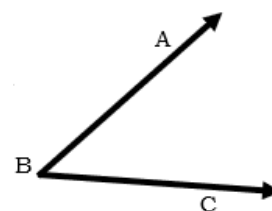
*You may explore more to check your understanding!*

REMEMBER

- A ***construction*** uses a straight edge and a compass to make geometric figures.
- A ***straightedge*** is a ruler with no markings on it.
- A ***compass*** is a geometric tool used to draw circles and parts of circles are called arcs.

One of the famous fashion designers in Manila, Philippines is **Raymund Joseph "Rajo" Teves Laurel.** He won several national and international awards over the course of his career. He has designed dresses worn by notable local and international clients.

Laurel has already showcased his talent in notable galas and exhibitions around the world. In one of his shows, he used embroidery and appliques where the focal points of his designs were patterned after the petals of flowers. He worked with the Philippine Textile Research Institute and weaving communities to yield textile with cutting-edge designs. The photo shown above is one of his designs.
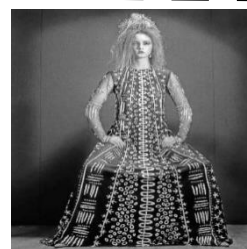
Have you ever wondered how some artists/fashion designers like Rajo Laurel make the designs or patterns for their artworks? You too can make intricate designs and patterns using only your compass.

Project: Daisy Wheel. Follow these directions to design a **Daisy Wheel**.
a.) Construct a circle. Using the same radius of your compass and using any point on your circle as a center, cut an arc. Keeping the same compass setting, put the compass point on the circle and construct an arc. The endpoint of the arc should be on the circle.
b.) Keeping the same compass setting, put the compass point on each endpoint of the first arc and draw two new arcs.
c.) Continue to make arcs around the circle from the new endpoints of the arc until you get a six-petal daisy wheel.
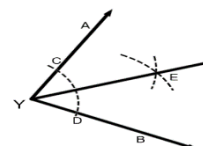d.) Personalize your daisy wheel by decorating it.
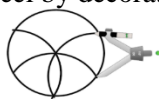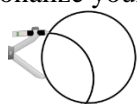
Rubrics for the Project

| Categories	Poor (1 pt.)	Fair (3 pts.)	Good (5 pts.)
Design/ Creativity	The design is basic, lacks originality, and elaboration.	The design has a pleasant visual appeal. It lacks some details.	The design incorporates artistic elements and is original, and well elaborated.
Neatness	The paper is crumpled.	The paper has some dirty streaks on it.	The work was presented neatly.

POST TEST

**Direction**: Choose the letter of the correct answer.
1.) Given the figure, what do you call this geometric tool used in construction?
   a.) Straight edge   b.) Protractor   c.) Circle Creator   d.) Compass
2.) Which is the first step in constructing the angle bisector?
   Given: ∠AYB as shown in the adjoining figure.
   a.) Draw $\overrightarrow{YE}$.
   b.) From points C and D, draw equal arcs that intersect at E.
   c.) Draw line segments connecting C and D.
   d.) With Y as center and with any radius such as $\overrightarrow{YC}$, cut $\overrightarrow{YA}$ at C and $\overrightarrow{YB}$ at D.
3.) Which figure shows how to construct parallel lines?
   a.)   b.)   c.)   d.)
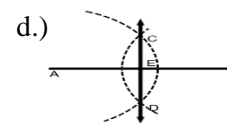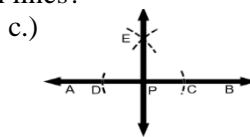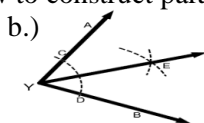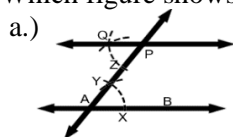
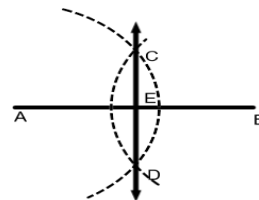4.) Which figure shows how to construct perpendicular lines?
   a.)   b.)   c.)   d.)
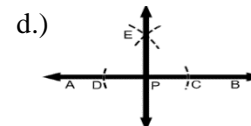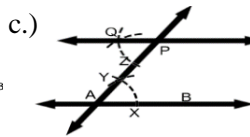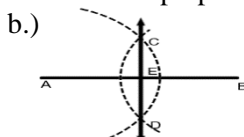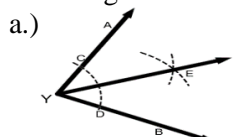
5.) The figure given shows how to bisect a segment. Which conclusion can be used for the figure?

a.) $\overline{AE} \cong \overline{BE}$ b.) $\overline{AB} \cong \frac{1}{2}\overline{AE}$ c.) $\overline{AE} \cong 2\overline{AB}$ d.) $\overline{CE} \cong \overline{DE}$

6.) Which is not possible to construct using compass and straight edge?

a.) 97°   b.) 120°   c.) 90°   d.) 22.5°

7.) The figure shows how to construct a 60° angle. Which is not part of the steps in constructing this angle? Given: $\overrightarrow{XY}$

a.) With any convenient radius, cut an arc on $\overrightarrow{XY}$.

b.) Using the same radius, cut another arc intersecting the previous arc.

c.) Connect point X and the intersection of two arcs.

d.) Draw $\overline{XC}$
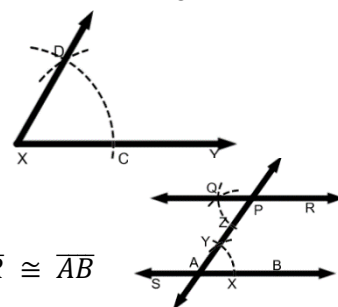
8.) The given figure illustrates the construction of parallel lines. Which statement justifies this construction?

a.) ∠QPZ ≅ ∠YAX   b.) $\overline{PA} \cong \overline{AB}$ c.) ∠QPZ ≅ ∠YAS   d.) $\overline{PR} \cong \overline{AB}$

9.) Which statement/s would always be true about construction?

     Statement 1: Measuring segments and angles with a ruler and protractor are not allowed in construction.
   Statement 2: A construction uses a straight edge and a compass to make geometric figures.
     Statement 3: There is only one way to construct perpendicular lines.
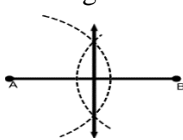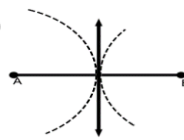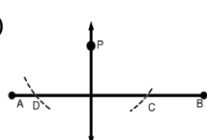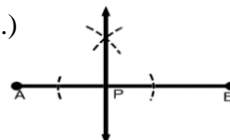
a.) Statement 1 only   c.) Statements 1, 2, and 3

b.) Statements 1 and 2   d.) Statement 1 and 3

10.) $\overline{AB}$ is given in the figure. Which two sets of construction marks, labeled I, II, III, and IV are part of the construction of perpendicular bisector of the given segment?

a.) I and II   c.) I and III
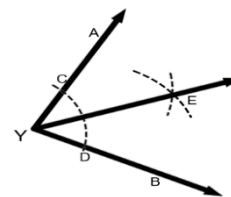
b.) II and IV   d.) I and IV
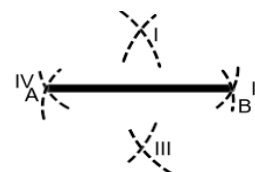
11.) Which diagram shows the construction of perpendicular bisector of $\overline{AB}$

a.)   b.)   c.)   d.)

12.) Given the figure on how to construct an angle bisector, which is a common mistake in constructing it?

a.) $\overrightarrow{YC}$ is either too short or too long.

b.) $\overrightarrow{YE}$ is either too short or too long.

c.) The arc from C and D that intersect at E are not equal.

d.) The given angle is too big.

13.) Which type of construction is shown by the figure?

a.) Parallel lines   c.) Perpendicular Lines

b.) Angle bisector   d.) Perpendicular Bisector
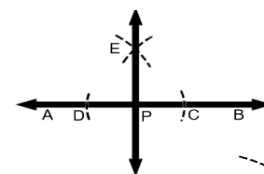
14.) The figure shows how to construct the perpendicular bisector. Which is a common mistake in constructing it?

a.) The arc from A and B that intersect at C and D are not equal.

b.) The arc from A and B did not intersect because the radius was too short.

c.) The line connecting C and D is not straight.

d.) All the above.
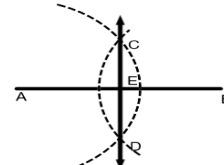
15.) Given ∠ABC on the figure, which step is not included in constructing its complement?

a.) Extend $\overrightarrow{BC}$ by drawing its opposite ray.

b.) Connect point A and point C.

c.) Using B as a given point, construct a line perpendicular to $\overleftrightarrow{BC}$ by using construction of perpendicular line to a given line through a given point on the line.

d.) The angle formed by perpendicular line and $\overrightarrow{BA}$ is the complement of ∠ABC.