Ohio Standards Connection:

Geometry and Spatial Sense

Benchmark A
Formally define geometric figures.

Indicator 1
Formally define and explain key aspects of geometric figures, including:

a. interior and exterior angles of polygons;

b. segments related to triangles (median, altitude, midsegment);

c. points of concurrency related to triangles (centroid, incenter, orthocenter, circumcenter);

d. circles (radius, diameter, chord, circumference, major arc, minor arc, sector, segment, inscribed angle).

Benchmark H
Establish the validity of conjectures about geometric objects, their properties and relationships by counter-example, inductive and deductive reasoning, and critiquing arguments made by others.

Lesson Summary:
Students discover the points of concurrency and their properties using paper folding, interactive geometric software or constructions. This lesson has two goals: (1) to have students understand how each point of concurrency can be determined and to apply them to problem solving and (2) to provide a new context in which to practice vocabulary associated with triangles. As an assessment, students use the points of concurrency in a problem solving application in which mathematicians aid archaeologists in determining the size of a circular object with missing pieces. For the assessment students use paper folding or pencil constructions.

Estimated Duration: Two hours

Commentary:
This lesson is an introductory lesson to the points of concurrency. Students should understand properties of triangles to solve problems and use proportions to express relationships among corresponding parts of similar figures. “Point of Concurrency” is accessible to students at many different levels. Here, a real world problem provides motivation and promotes learning. The lesson could be used to reinforce the concepts of median, altitude and perpendicular bisector with less emphasis on the points of concurrency. Expand the lesson to have students learn or practice constructions with paper and pencil, to have students work with dynamic geometric software and/or to have students use the context to do informal or formal proofs.

Pre-Assessment:
- The teacher reviews definitions of altitude, perpendicular bisector, angle bisector, and median. Include with the definitions a visual representation with correct geometric markings. (For this step students will display only one altitude in a triangle, only one perpendicular bisector in a triangle, etc.)
Points of Concurrency Related to Archaeology – Grade Ten

Ohio Standards Connection:

Geometry and Spatial Sense

Indicator 3
Make, test and establish the validity of conjectures about geometric properties and relationships using counterexample, inductive and deductive reasoning, and paragraph or two-column proof, including:

a. prove the Pythagorean Theorem;

b. prove theorems involving triangle similarity and congruence;

c. prove theorems involving properties of lines, angles, triangles and quadrilaterals;

d. test a conjecture using basic constructions made with a compass and straightedge or technology.

Patterns, Functions and Algebra

Benchmark D
Use algebraic representations, such as tables, graphs, expressions, functions and inequalities, to model and solve problem situations.

Indicator 4
Use algebraic representations and functions to describe and generalize geometric properties and relationships.

• Students work in groups of four. Give each group a large triangle, Group Triangles, Attachment A. Each member of the group describes, draws and labels one of the four segments on the large triangle using side \(a\) and/or angle \(A\).

• When the group finishes, each large triangle has four new segments. Display these triangles around the room and have the students do a Gallery Walk, identifying differences and similarities among the segments created and the types of triangles used.

Instructional Tips:
The Jigsaw Method could be used with this pre-assessment. Groups of four each receive one triangle (four copies) to draw the four segments. Each member of the group regroups with a member from other groups. The new group has a representative from each of the four different triangles. Each group identifies differences and similarities among the segments created and the types of triangles used.

• Lead a discussion of observations made regarding the segments of the triangles.

Suggested discussion questions:

• On one of the triangles, the median, angle bisector, perpendicular bisector, and the altitude are all represented by the same line segment. What type of triangle does this appear to be? Does it always happen on this type of triangle? Why? Would it happen on any other type of triangle? Is it the same for all three of the angles of this triangle?

(This would always occur on an isosceles triangle when side \(a\) is between the congruent base angles. It would also always occur on an equilateral triangle with any side as \(a\). This occurs because the altitude is also a line of symmetry. The line of symmetry bisects angle \(A\) and is perpendicular to side \(a\) at the midpoint.)

• Are medians always in the interior of a triangle? Why or why not?

(Medians must always be in the interior of the triangle because the endpoints are the vertex and the midpoint of the opposite side.)
Points of Concurrency Related to Archaeology – Grade Ten

Mathematical Processes

**Benchmarks**

A. Formulate a problem or mathematical model in response to a specific need or situation, determine information required to solve the problem, choose method for obtaining this information, and set limits for acceptable solution.

B. Apply mathematical knowledge and skills routinely in other content areas and practical situations.

F. Use precise mathematical language and notations to represent problem situations and mathematical ideas.

G. Write clearly and coherently about mathematical thinking and ideas.

H. Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.

- Are angle bisectors always in the interior of a triangle? Why or why not? (Angle bisectors of the angles of a triangle are rays which divide each angle into two equal angles. These rays contain both interior and exterior points of the triangle.)

- Do perpendicular bisectors always lie within the interior of a triangle? Why or why not? (Perpendicular bisectors of the sides of a triangle are segments, rays or lines which are perpendicular to and pass through the midpoint of each side. These lines, rays or segments contain both interior and exterior points of the triangle.)

- Are altitudes always in the interior of a triangle? Why or why not? (Altitudes are drawn from any vertex of the triangle perpendicular to the opposite side. In a right triangle two of the altitudes are the legs of the triangle with the third altitude inside the triangle. In an acute triangle all three altitudes lie inside the triangle. In an obtuse triangle one altitude is inside and two are outside the triangle.

**Scoring Guidelines:**

Informal teacher observation. If students struggle to draw these four segments in triangles, they are not ready for this lesson and need additional instruction before proceeding.

**Instructional Tips:**

- If students have not recently worked with altitude, perpendicular bisector, angle bisector and median, they may need more review before starting the group work. *Alternate Pre-Assessment, Attachment B,* is a supplementary group activity to provide additional review.

- As students work individually, watch for correct geometric notation which indicates an understanding of each component. The altitude forms a right angle with side \(a\); the perpendicular bisector also forms a right angle with side \(a\) and forms two congruent segments on side \(a\); the angle bisector forms two congruent angles at vertex A; the median forms two congruent segments on side \(a\).
Points of Concurrency Related to Archaeology – Grade Ten

- In small groups the teacher gives each student a different color marker. Students with blue markers draw and label the altitude; students with green markers draw and label the perpendicular bisector; etc. Use a different triangle for each group. See triangle patterns provided on *Alternate Pre-Assessment*, Attachment B. Enlarge these triangles using the overhead projector or sketch each triangle on classroom boards and use colored chalk.

**Post-Assessment:**
Put students into pairs and give each the *Post-Assessment Introduction*, Attachment C, and *Post-Assessment Student Problem*, Attachment D, a handout with a picture of the broken parts of a CD that have been pieced together. Some of the pieces are missing. Students determine the exact size of the original CD by using one of the points of concurrency.

- Study the picture of the broken CD to determine which point of concurrency should be used. The pair comes to agreement.
- Copy the picture on tracing paper and use paper folding techniques to find the point of concurrency or use paper-pencil constructions to find the point of concurrency, working directly on the handout, which locates the center of the CD.
- Remind students to determine the length of the radius of the CD and not to fill in the missing edges of the CD.
- Measure the exact length of the radius of the CD to the nearest millimeter.
- Write individual letters to the archaeologists, explaining mathematically how they determined the size of the found object. Students convince the archaeologists of their accuracy through their mathematical explanations. (This writing can be a homework assignment.)

**Scoring Guidelines:**
Give students points for the completed sheet showing the CD’s point of concurrency, for the graphic organizer and/or for the group triangles. *Post-Assessment Rubric*, Attachment E, scores student writing on the post-assessment. Use an overhead of the rubric to guide the writing.

- Students may attempt to measure an actual CD to answer this problem or to trace a CD over the broken CD in the picture. However, the assessment requires the students to show their work using a point of concurrency to determine the exact radius. The radius may not exactly match that of an actual CD due to reduction during copying. This could lead to a class discussion about the inaccuracy of photocopying.
- The CD has a radius of 6 cm. Students can inscribe a triangle, using the given CD edges to locate three vertices. The perpendicular bisectors should be used to locate the circumcenter, the center of the triangle inscribed in a circle, which would also be the center of the CD. Students can measure from this center to one of the edges of the broken CD to determine the radius. It is also possible to determine the center of the CD by creating a triangle that would circumscribe the CD and then find the center of the triangle.
- The mathematical explanation to the archaeologist can be as simple as explaining the point of concurrency used, or expanded to an informal proof or a formal proof, depending on student background.
Points of Concurrency Related to Archaeology – Grade Ten

Instructional Procedures:
1. Use paper folding, constructions or geometric software to discover the four points of concurrency. These instructions can be adapted for paper-pencil constructions or for geometric software. Acquire paper folding activities from commercial vendors or obtain paper-pencil construction and geometric software instructions.
2. Use rulers and four or more sheets of patty paper, copy paper, vellum paper or other transparent paper can be used. Get patty paper, the transparent paper used to separate hamburger patties, at restaurant supply stores and some educational supply companies. The paper can be square, rectangular or circular for this project. It is easiest to do the paper folding if each triangle is on its own sheet of paper. If needed, cut paper into appropriately sized pieces.
3. Draw triangles similar to the triangles used in the Pre-Assessment. Have one group use the first type of triangle, another the second type, etc. Be sure that the class has examples of different types of triangles. If desired, the teacher can copy and reduce the size of the triangles for group work so that students can each have one of the triangles to copy instead of drawing their own triangle.
4. Find the Circumcenter, Discovery 1, as a class. Draw the triangle on the patty paper.
   a. If tracing a triangle, put the patty paper over the triangle and mark each vertex with a small dot. Join the vertices with segments drawn with a straight edge, which should result in a very accurate replication of the triangle. The teacher can demonstrate by having a copy of the triangle on an overhead and use a second overhead to show the steps. Have the students label vertex A and also label the other two vertices B and C (order does not matter).
   b. Fold the perpendicular bisectors by marking the midpoint of side $BC$. Fold the paper so that points B and C coincide with each other. Make a sharp crease at the midpoint through the triangle. The resulting line is the perpendicular bisector of side $BC$. Note that vertex A may or may not be on the fold. Repeat with sides $AB$ and $AC$. 

![Diagram of Circumcenter](image.png)
Points of Concurrency Related to Archaeology – Grade Ten

c. Make observations when the paper folding is complete. Observe that the three perpendicular bisectors in each triangle intersect at one point. Check to make certain this is true for each student. Are there any types of triangles that might have a different outcome? Consider other triangles and allow students to draw those triangles and fold the perpendicular bisectors.

Instructional Tip:
This would be a good point to review the conjecture made regarding whether the perpendicular bisectors reside only in the interior of the triangle. Explore an example where the perpendicular bisectors extend outside of the triangle in order to intersect. Instruct students to revise conjectures as more information is discovered.

d. Describe the circumcenter as the point which represents the center of the circle that circumscribes the triangle. Demonstrate this by using a compass to draw a circle with a center of the circle being the circumcenter and the radius being the distance between the circumcenter and any of the vertices of the triangle.

e. Show students the overhead model for the graphic organizer or give them each a copy, Graphic Organizer, Attachment F. The teacher models completion of one quadrant, by recording a brief description of a circumcenter as well as a diagram. (See Graphic Organizer Key, Attachment G, for example.) Markings should show right angles for each of the perpendicular bisectors and congruent segments on the triangle.
5. Find the Centroid, Discovery 2. Draw/trace a triangle on the patty paper as in Step 4A.
   a. To fold a median, locate the midpoint of the side by moving the top portion until points B and C coincide. Make a small crease on the segment $\overline{BC}$. This will create a mark at the midpoint when the paper is opened.

   ![Diagram](image1)

   b. To create the median students should fold the paper in two so it can be creased on a line that connects point A with the midpoint of segment $\overline{BC}$ (just marked in the previous step with a slight crease). Make a sharp crease in the paper to create a median. (Points B and C may or may not coincide with each other when the median is created.)

   ![Diagram](image2)

   c. Repeat this process for each side of the triangle. Markings should show two congruent segments on each side of the triangle.

   d. Describe to the students that the Centroid represents the center of gravity for the triangle. Therefore, the Centroid must be somewhere in the interior of the triangle. (Within the closure this is discussed at greater length, with ideas of how to further explore the Centroid.)

   e. Record information for the Centroid on the graphic organizer.
Points of Concurrency Related to Archaeology – Grade Ten

6. Find the Orthocenter, Discovery 3. Draw/trace a triangle on the patty paper as in Step 4A.
   a. To create the altitudes, begin to fold a line through point A perpendicular to $\overline{BC}$. To determine if the line segment is perpendicular to $\overline{BC}$ the segment must be in alignment with itself. Points B and C may or may not coincide with each other. Mark this line by making a sharp crease in the paper. This line segment is the altitude for side $\overline{BC}$.

   ![Diagram of a triangle with altitudes]

   b. Repeat this process with sides $\overline{AB}$ and $\overline{AC}$. Markings should show right angles at the base of each altitude.
   c. The point of intersection created by the intersection of the altitudes is the Orthocenter.

   ![Diagram of a triangle with Orthocenter]

   d. Students record this information for the Orthocenter.

7. Find the Incenter, Discovery 4. Draw/trace a triangle on the patty paper as in Step 4A.
   a. To create angle bisectors, begin to fold a line through point A to side $a$ where line segments $\overline{AB}$ and $\overline{AC}$ are in alignment with each other. Mark this line by making a sharp crease in the paper. This line segment is the angle bisector for angle A. (Points B and C may or may not coincide with each other.)

   ![Diagram of a triangle with angle bisectors]

   b. Repeat with angle B and angle C. Markings should show that each angle of the triangle has been divided into two congruent angles. Show students the Incenter is the center of an inscribed circle.

   ![Diagram of a triangle with Incenter and inscribed circle]
Points of Concurrency Related to Archaeology – Grade Ten

c. Describe the Incenter as the center of a circle inscribed in a triangle.

d. Record information for the Centroid on the graphic organizer.

Closure:
8. Share findings through discussion of each point of concurrency: Orthocenter, Incenter, Circumcenter and Centroid. Students complete the graphic organizer. Teacher could display NCTM applets to prompt discussion. (See Technology Connections at the end of the lesson.)

Suggested discussion for each point of concurrency with applications:

• For each point of concurrency, ask students if the point is always in the interior of the triangle. Why or why not? (The incenter and the centroid must be in the interior. Angle bisectors and medians are both located in the interior of a triangle so the points of concurrency must also be in the interior of the triangle.)

• Circumcenter (Perpendicular bisectors): What is minimum size arc needed to determine the center of a circle? (The arc of the circle must only be large enough to have three points that will be vertices of a triangle (in theory). However, for a person to construct the perpendicular bisectors, the triangle must be of workable size. The point of this discussion is that the triangle vertices need only be three points anywhere on the edge of the circle and the resulting triangle can be very small. The intersection will still be the circumcenter.)
  o If there are three communities needing a centrally located facility (hospital, school, etc.), how can the location be determined? (The circumcenter will be equidistant from all three.)

• Incenter (Angle bisectors): The incenter is the center of an inscribed circle. That is, the incenter is equidistant from all three sides of the triangle. Have students use a compass to draw the inscribed circle.
  o If there are three paths that form a triangle, where could you stand to be equal distance from each of the three paths? (The incenter will be the same distance from the paths but not from the vertices.)

• Centroid (Medians): Demonstrate the centroid is the center of gravity by having a cut-out cardboard triangle with the medians drawn. Balance the triangle on a pencil point at the centroid. Is the centroid the center of gravity for any type triangle? Do other polygons have centers of gravity that can be found with medians? All types of triangles have a center of gravity at the centroid.
Points of Concurrency Related to Archaeology – Grade Ten

- What is the relationship of the length of the two median segments created by the centroid? Each median is split into two segments; one is twice the length of the other.

9. Pose the CD problem on Mathematical Archaeology Problem, Attachment C. Have students provide evidence through partner discussion and written response to demonstrate understanding. Students share ideas during class discussion and group work. Post group work, including the triangles and letters to archaeologists. Students could share their letters with the class. Ask students to define / explain concurrent lines.

Differentiated Instructional Support:
Instruction is differentiated according to learner needs, to help all learners either meet the intent of the specified indicator(s) or, if the indicator is already met, to advance beyond the specified indicator(s).

- The initial level of content understanding is for students to identify the median, altitude, perpendicular bisector and angle bisector, when used with a triangle. Students also connect the segments with the corresponding points of concurrency. The students define these points and explain the process used to create them.

- The next level of content understanding is for students to understand, create, and apply the concepts of centroid, orthocenter, circumcenter and incenter in problem solving. Students formally define these points and explain them with informal mathematical language.

- The highest level of understanding is for students to understand, create and apply the concepts of centroid, orthocenter, circumcenter and incenter in novel situations. The students formally define these points and explain them with an informal or formal mathematical language.

- Students who have difficulty with the paper folding method to find the points of concurrency may be able to use paper and pencil construction or geometry software.

- Providing the student with a smaller portion of a circular object may make it more of a challenge for the student.

- Ask students to hypothesize the outcomes of the discovery activities before they actually do the activity to find the points of concurrency. This would provide more direction in the activity.

- Identify aspects of assessment strategies that align to student interest, learning style and level of understanding (formative and summative).

- Display examples of a median, altitude, perpendicular bisector and angle bisector. Designate student groups or individuals as “experts” to help anyone who asks for help during the discovery activities.

Extension:

- Research: Do these points (centroid, orthocenter, and incenter) occur in Euclid’s Elements? If so, are the definitions the same?

- There are over 400 triangle centers. Students find information on a Web search.

- Find the geographic center (centroid) of other shapes and objects such as Ohio using a map.
  a. Cut out a model from cardboard and hang it from a thread attached to a point on the edge.
  b. Draw a vertical line from that point directly downward. Do that for several points on the edge.
  c. Ask students;
Points of Concurrency Related to Archaeology – Grade Ten

1. What do you notice?
2. What is the point of intersection called?
3. Why does this process work?

Place the object on the point of a pin at the centroid.

- Find the population center of a state. Glue weights to the card board cut where major cities are located, each weight proportional to the population of that city. Find the center of mass with the thread method.

Home Connections:
- Using points of concurrency, find the geographic center of your county, of Ohio, the United States…
- Archaeologists may have used points of concurrency to study Stonehenge. What is Stonehenge? How would archaeologists have used points of concurrency to replicate the original site?
- Approximate the centroid of an irregular object. Does inscribing the object within a triangle give you a better approximation of the centroid? Or does inscribing the triangle within the object give you a better approximation of the centroid? Would there be another way to determine the centroid of the object?

Interdisciplinary Connections:
Science Standard: Scientific Inquiry
Benchmark:
A. Participate in and apply the processes of scientific investigation to create models and to design, conduct, evaluate, and communicate the results of these investigations.
Indicator(s):
3. Use mathematical models to predict and analyze natural phenomena.
4. Draw conclusions from inquiries based on scientific knowledge and principles, the use of logic and evidence (data) from investigations.

Materials and Resources:
The inclusion of a specific resource in any lesson formulated by the Ohio Department of Education should not be interpreted as an endorsement of that particular resource, or any of its contents, by the Ohio Department of Education. The Ohio Department of Education does not endorse any particular resource. The Web addresses listed are for a given site’s main page, therefore, it may be necessary to search within that site to find the specific information required for a given lesson. Please note that information published on the Internet changes over time, therefore the links provided may no longer contain the specific information related to a given lesson. Teachers are advised to preview all sites before using them with students.

For the teacher: Four markers of different colors for each group, overhead transparencies (optional), patty paper (the paper used between hamburgers, sold at restaurant supply stores or some educational supply companies), semi-transparent paper, vellum paper, or other copying paper and a straight edge for each student.

For the student: Copies of Pre-Assessment Group Triangles, Attachment B, and Post-Assessment Student Problem (Attachment D) for each student, compasses
Points of Concurrency Related to Archaeology – Grade Ten

**Vocabulary:**
- altitude
- angle bisector
- centroid
- circumcenter
- incenter
- median
- orthocenter
- perpendicular bisector
- point of concurrency

**Technology Connections:**
- Dynamic geometry software
- NCTM’s Illuminations site also has an applet with in-depth discussion of the properties of lines including median, angle bisector and perpendicular bisector
  http://illuminations.nctm.org/mathlets/IGD_lines/index.html

**Research Connections:**


Points of Concurrency Related to Archaeology – Grade Ten

**Attachments:**
Attachment A, *Pre-Assessment Group Triangles*
Attachment B, *Alternate Pre-Assessment for In depth Review of Altitude, Median, Perpendicular Bisector, Angle Bisector*
Attachment C, *Mathematical Archaeology Problem*
Attachment D, *Post-Assessment Student Problem*
Attachment E, *Post-Assessment Rubric*
Attachment F, *Graphic Organizer and Key*
Points of Concurrency Related to Archaeology – Grade Ten
Attachment A

Pre-Assessment Group Triangles

Directions: Each group needs one triangle. Each group member draws one of the segments (altitude, perpendicular bisector, angle bisector, or median) on the triangle. Triangles will be displayed to share observations. If there are more than four groups of four, some groups will have the same triangle.
Attachment A (continued)
Pre-Assessment Group Triangles
Attachment A (continued)
Pre-Assessment Group Triangles

\[ \triangle ABC \]
Attachment A (continued)
Pre-Assessment Group Triangles
Attachment B
Group Triangles Alternative Pre-Assessment

Directions:
Give each student a sheet with four triangles. Ask them to draw the following segments: altitude, perpendicular bisector, angle bisector and median.

In a group of four, each member draws all four of the segments (altitude, perpendicular bisector, angle bisector, and median) on one of the triangles. Have students work individually to sketch each of the given segments. Students use geometric markings on each triangle.

Then, the group compares and discusses sketches of the four triangles. The students confirm that each student has correctly completed the sketches.

Move among groups checking the work and assisting as needed.
Enlarge these triangles. Each group needs one enlarged triangle. Each group member draws one of the segments (altitude, perpendicular bisector, angle bisector, or median) on the triangle. The triangle will be displayed to share observations. If there are more than four groups of four, some groups will have the same triangle.
In 3000 c.e., archaeologists have found the remains of an object pictured below.

The archaeologists are intrigued as to its use.
If the archaeologists can determine the original size of the object, they may be able to specify its use by comparing it to the remains of other objects they have discovered.

The archaeologists have agreed to piece the objects together. They will consult a group of mathematicians for help to find the original size of the object. How will the mathematicians determine the original size?
Points of Concurrency Related to Archaeology – Grade Ten

Attachment D
Mathematical Archaeology – Post-Assessment

Names: ___________________________ and ___________________________

1. Study the picture of the broken CD to determine which point of concurrency you and your partner will use. Come to an agreement.

Point of concurrency to be used ___________________________

2. Use tracing paper to make a copy of the details. You do not need to trace the entire CD. Copy only what you need. Then use paper folding to find the point of concurrency. This will locate the center of the CD.
3. Measure the length of the radius of the CD to the nearest millimeter.
   __________ mm.

4. Write to the archaeologists to share your findings. Explain mathematically how the radius was determined. Convince the archaeologists you are correct with your mathematical explanation.

   Use the rubric as a guide for the writing.
## Points of Concurrency Related to Archaeology – Grade Ten
### Attachment E
#### Post-Assessment Rubric

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Receives 4 points</th>
<th>Receives 3 points</th>
<th>Receives 2 points</th>
<th>Receives 1 point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predicted measure within 1 mm.</td>
<td>Predicted measure within 2 mm.</td>
<td>Predicted measure within 3 mm.</td>
<td>Predicted measure is more than 3 mm from answer.</td>
<td></td>
</tr>
<tr>
<td>Used an appropriate point of concurrency and applied it correctly to this problem.</td>
<td>Used an appropriate point of concurrency but did not locate one of the vertices on the given CD edge.</td>
<td>Used an appropriate point of concurrency but did not locate two or more vertices on the given CD edge.</td>
<td>Used a point of concurrency that does not lead to the solution.</td>
<td></td>
</tr>
<tr>
<td>Logically presented steps used to locate the given point of concurrency. The reader could replicate results.</td>
<td>Presented steps used to locate the given point of concurrency but one or two steps are vague or unclear.</td>
<td>Presented steps used to locate the given point of concurrency but steps are not in order.</td>
<td>Reader will not be able to locate point of concurrency from the presented steps.</td>
<td></td>
</tr>
<tr>
<td>Used appropriate mathematical vocabulary from the lesson throughout the explanation.</td>
<td>Used mathematical vocabulary correctly but did not use it every place they should have.</td>
<td>Misused or misspelled more than two mathematical terms.</td>
<td>Did not use mathematical vocabulary.</td>
<td></td>
</tr>
</tbody>
</table>
Use the post assessment rubric to evaluate the report each pair of students submitted to the archaeologists.

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>16–14 Points</td>
<td>Your report was accepted by the archaeologists and they are using your finding within their research.</td>
</tr>
<tr>
<td>13–10 Points</td>
<td>Your report was well received by the archaeologists; however, they plan to ask for a second review of the data to confirm your results.</td>
</tr>
<tr>
<td>9–6 Points</td>
<td>The archaeologists are requesting additional facts and review of your report before they accept your findings.</td>
</tr>
<tr>
<td>4–5 Points</td>
<td>The archaeologists have asked that you redo your analysis of the artifact and submit a new report.</td>
</tr>
</tbody>
</table>
Points of Concurrency Related to Archaeology – Grade Ten

Attachment F
Graphic Organizer
Points of Concurrency Related to Archaeology – Grade Ten

Attachment F (Continued)
Graphic Organizer Key

**Median** of a triangle – a segment whose endpoints are the vertex and the midpoint of the opposite side

**Altitude** of a triangle – a segment with an endpoint at the vertex of a triangle that is perpendicular to a line that contains the opposite side of the triangle

**Centroid** – point of concurrency of the medians of any triangle

**Orthocenter** – point of concurrency of the altitudes of any triangle

**Circumcenter** – point of concurrency of the perpendicular bisectors of any triangle

**Incenter** – point of concurrency of the angle bisectors of any triangle

**Perpendicular bisector** of a triangle – a line that forms a 90 degree angle with the side of the triangle at the midpoint of the side

**Angle bisector** of a triangle – a line that bisects the angle of a triangle