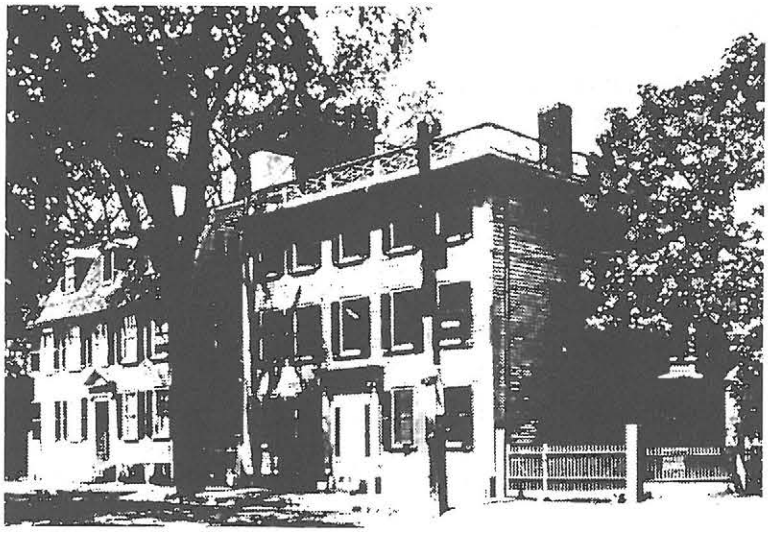
UNIT 6

PATTERNS IN ARCHITECTURE



Nathaniel Bowditch House, c. 1890, Essex St., Salem, MA
Courtesy of, copyright of the Peabody Essex Museum, Salem, MA

OVERVIEW FOR TEACHERS

Unit Outline

Introduction:

Home for Bowditch [in the early 1800s] became the beautifully proportioned Federal mansion on Chestnut Street [now 12 Chestnut Street] known as the Hodges House. The building was a two-family house, three stories high, its symmetrically spaced windows with green shutters. (**Yankee Stargazer**, 144)

Architecture is the marriage of mathematics and art. General mathematical skills such as observation are as necessary as the more specific mathematical skills of geometry, symmetry, and congruence. An understanding of architecture also demands the visual and aesthetic talents of the artist.

In this unit, students will examine four basic types of architecture popular in New England, and specifically, Salem, in the early 1800's. Students will apply the mathematical concepts of symmetry, congruence, and proportion as they analyze the common New England architectural designs. The analyses and applications will result in a greater appreciation of the beauty and durability of the regional architecture.

Objectives:

- Students will identify the following plane shapes: circle, semicircle, quarter-circle, ellipse (oval), square, rectangle, rhombus, trapezoid, triangle, pentagon, hexagon, octagon, quadrilateral
- Students will determine whether various shapes are congruent or not.
- Students will identify lines of symmetry of various plane figures.
- Students will analyze four basic styles of American architecture, identifying characteristic shapes, symmetry, and congruence
- Students will determine several solutions to dividing a 10-by-20 unit rectangle into two congruent parts.

Skills:

- Students will be able to recognize geometric shapes.
- Students will comprehend the concepts of symmetry and congruence.
- Students will apply their skills to real-life situations, such as the architecture of Salem.

Vocabulary:

- circle
- semicircle
- quarter-circle
- ellipse
- symmetry
- square
- rectangle
- rhombus
- trapezoid
- quadrilateral
- triangle
- pentagon
- hexagon
- octagon
- congruence

Frameworks Connections:

Mathematics

Strand 3: Geometry and Measurement

Standard 3.3: Geometry (p. 75)

1. Identify, describe, compare, classify geometric figures.
2. Explore and describe properties of planes.
3. Visualize and draw geometric figures.
4. Explore and describe transformations of geometric figures.
5. Apply geometric properties and relationships.

Unit 6 Lesson Plans

Lesson 1: Basic Plane Shapes

Objectives:

- Students will define congruence and give examples.
- Students will identify any and all lines of symmetry in various shapes.

Skills:

- Students will be able to identify the following plane shapes: circle, semicircle, quarter-circle, ellipse (oval), square, rectangle, rhombus, trapezoid, triangle, pentagon, hexagon, octagon, quadrilateral.
- Students will know how to draw any and all lines of symmetry in various plane shapes.

Vocabulary:

- circles
- semicircle
- quarter-circle
- ellipse
- symmetry
- square
- rectangle
- rhombus
- trapezoid
- quadrilateral
- triangle
- pentagon
- hexagon
- octagon
- congruence

Procedure:

1. Distribute worksheet "Getting Into Shapes".
2. Have students discuss the characteristics of the various shapes. What differentiates a square from a rectangle? A rhombus from a square?
3. Have students look at the examples of congruence. Why are all triangles not congruent?
4. Have the students look at the examples of symmetry. Note that some shapes have more than one line of symmetry; some have none.
5. Distribute worksheet "Which Pairs Are Congruent?" Discuss why some shapes are congruent (they are the same shape and same size even though they may be rotated differently) and some are not congruent (they may be the same shape but not the same size).

6. Distribute worksheet "Symmetry" and have students draw any and all lines of symmetry.

Handouts:

Worksheets:

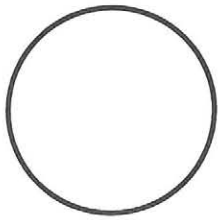
"Getting Into Shapes" (2 pp.)

"Which Pairs Are Congruent?" (2 pp.)

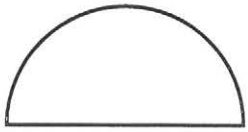
"Symmetry" (2 pp.)

UNIT 6 STUDENT HANDOUT

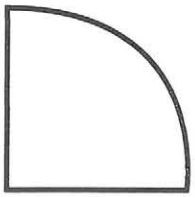
GETTING INTO SHAPES



Circle



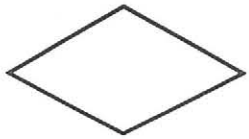
Semicircle



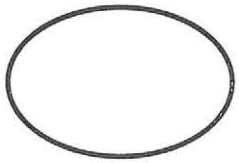
Quarter-circle

Rectangle

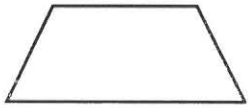
Square



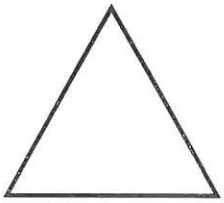
Rhombus



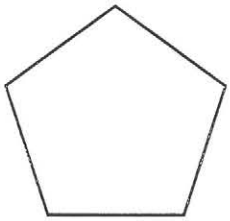
Ellipse



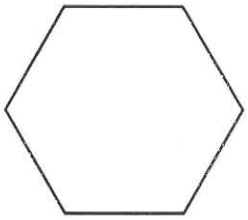
Trapezoid



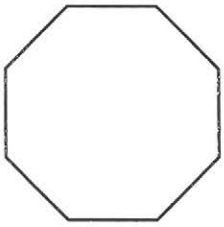
Triangle



Pentagon



Hexagon



Octagon

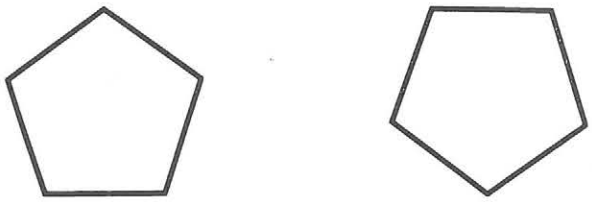
All of the figures above are *plane* figures. That means that they have *length* and *width*. They are said to be *two-dimensional*.

A *quadrilateral* is a closed plane figure made up of four line segments. Which of the figures above are quadrilaterals?

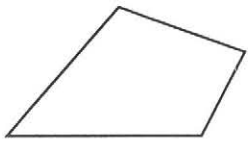
How many sides does a pentagon have? How many sides does a hexagon have? How many sides does an octagon have?

Plane figures may have other properties, including *congruence* and *symmetry*. Two plane figures are congruent if they are the same size **and** the same shape. Look at the pair of figures below:

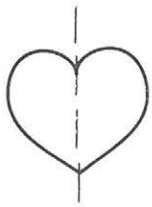
They are not congruent. They are the same shape (squares, in this case), but not the same size. The two figures below are congruent, because they are the same shape and the same size, even thought they are not 'pointing' the same way.



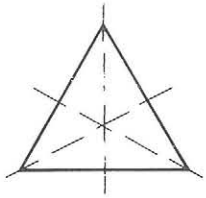
A plane figure has symmetry if a line can be drawn through the figure in such a way that if the figure were folded in half along the line of symmetry, the halves would match exactly. Some figures have more than one line of symmetry, some have none. Study the figures below for symmetry.



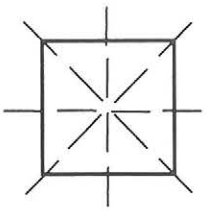
No lines of symmetry



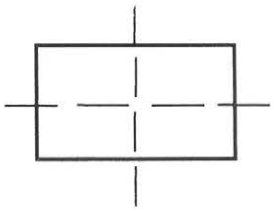
1 line of symmetry



3 lines of symmetry



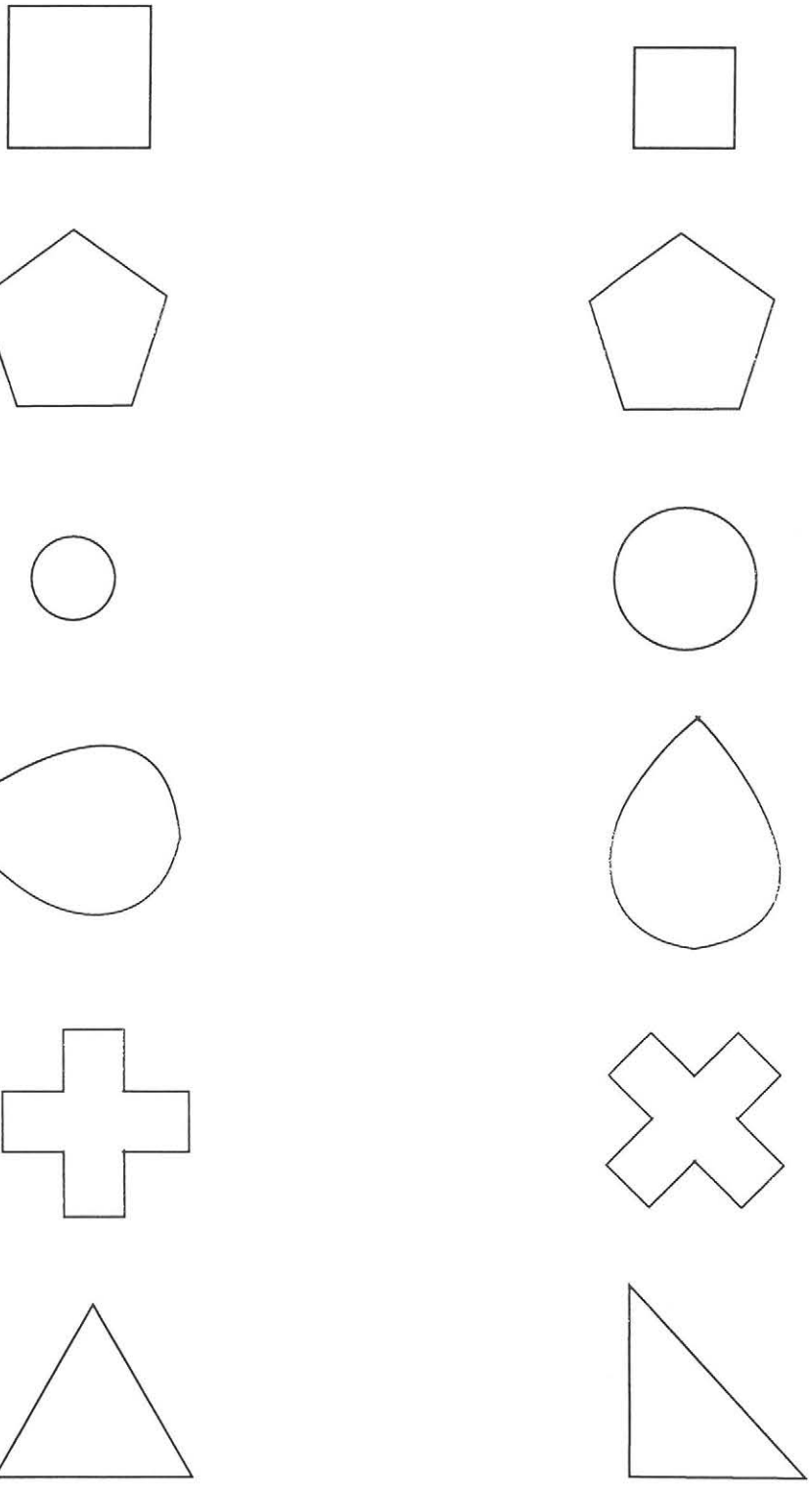
4 lines of symmetry



2 lines of symmetry

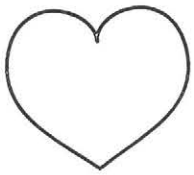
UNIT 6 STUDENT HANDOUT

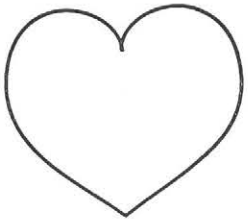
WHICH PAIRS ARE CONGRUENT?

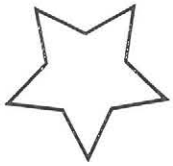


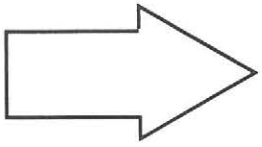
UNIT 6 STUDENT HANDOUT

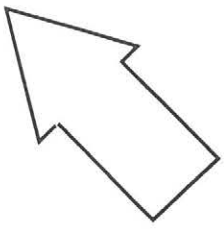
WHICH PAIRS ARE CONGRUENT?







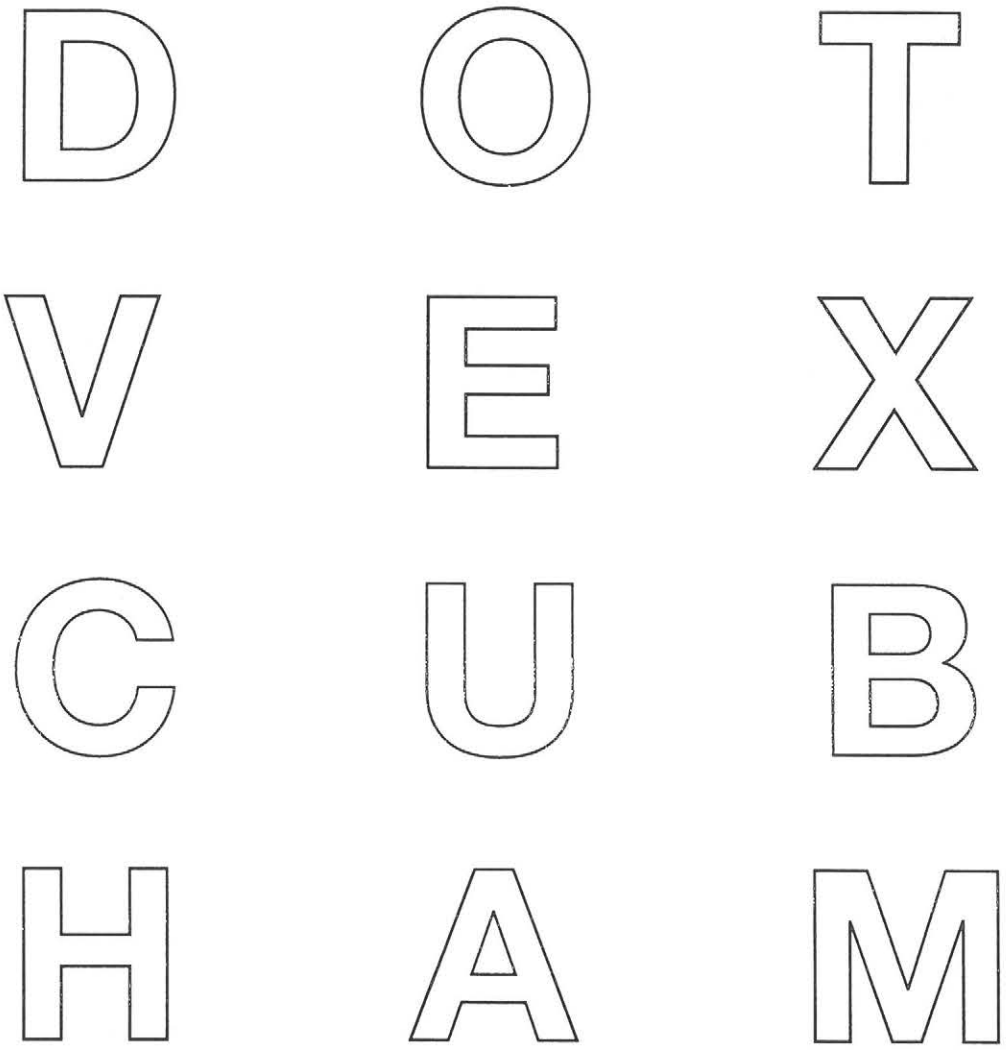




UNIT 6 STUDENT HANDOUT

SYMMETRY

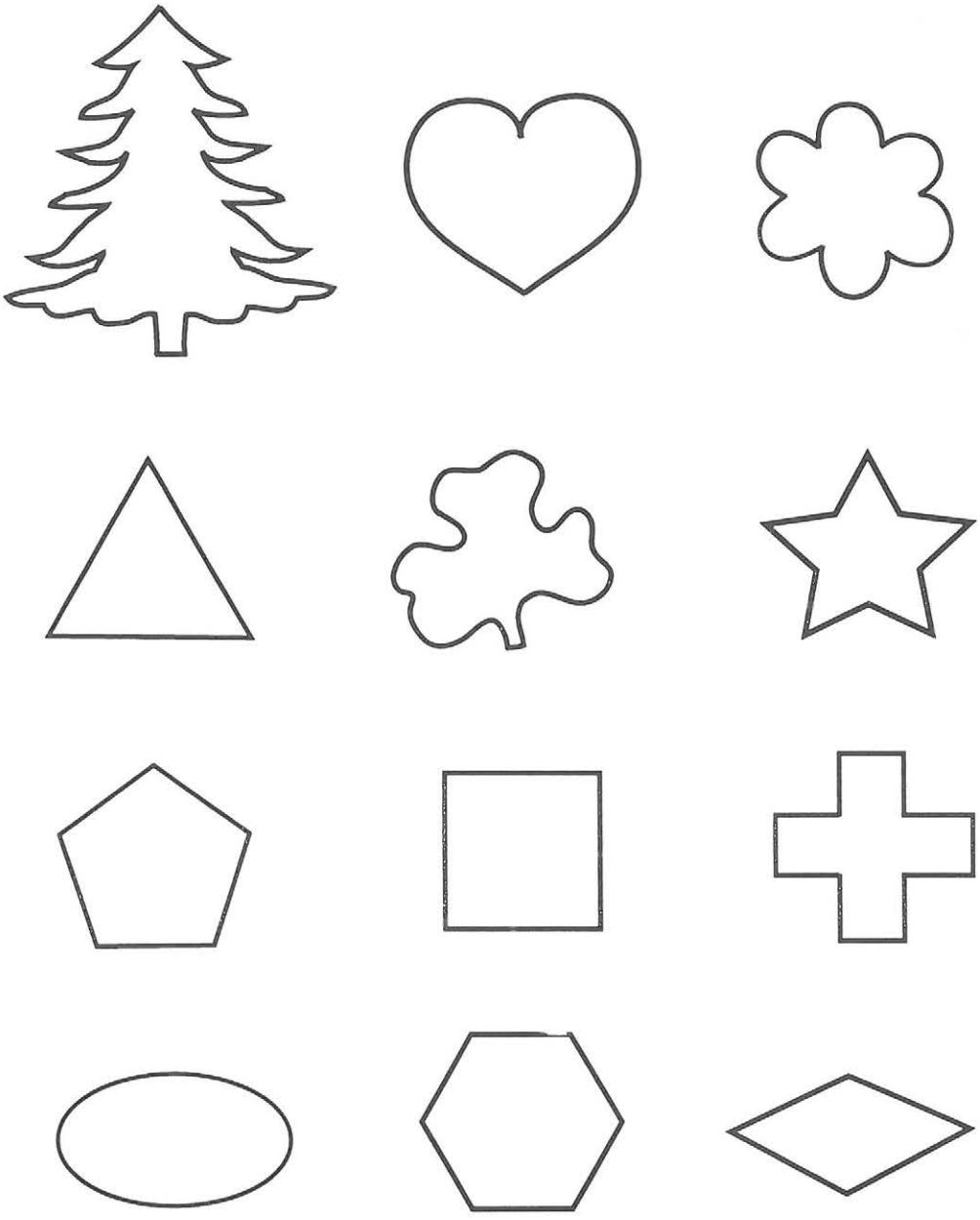
Each of the capital letters below have at least one line of symmetry. Sketch the lines of symmetry. Identify which letter has an infinite number of symmetry lines.



UNIT 6 STUDENT HANDOUT

SYMMETRY

Sketch the lines of symmetry in the figures below. Remember that some figures will have more than one line of symmetry.



Lesson 2: Math and Architecture

Objectives:

- Students will analyze four basic styles of architecture and identify the characteristic shapes featured in each style.
- Students will identify the architectural styles and determine whether they contain symmetry or not.

Skills:

- Students will understand how to create multiple solutions to a single problem.

Vocabulary:

- New England Colonial
- Georgian Style
- Federalist
- Victorian

Materials:

- worksheets

Procedure:

1. Distribute worksheet "Math and Architecture" and the line drawings of four basic architectural house styles (New England Colonial, Georgian, Federalist, Victorian).
2. Students will examine each style for symmetry and congruence.
3. Identify the shapes featured in each style.
4. Distribute worksheet "Extra Challenge" and have students think of as many ways as possible to divide a 10-by-20 rectangle into two congruent parts.

Handouts:

Worksheets:

"Math and Architecture"

"Extra Challenge"

Math and Architecture Answers

On the next four pages are drawings of four different kinds of architecture seen commonly in New England and Salem. Study the drawings and then answer the questions below:

New England Colonial

Do you see symmetry? (no)

Are the window congruent? (no)

What is the overall shape of the house (minus the chimney)? (pentagon)

What shape are the window panes? (rhombus)

What shape is the door? (rectangle)

Georgian house

Do you see symmetry? (yes)

Are the windows all congruent (yes)

What are the shapes of the following areas?

A. (trapezoid) B. (rectangle) C. (triangle)

Federalist house

Do you see symmetry? (no-quite a bit, but not completely---because of chimney, side portico)

Are all the windows congruent? (no)

What are the shapes of the following areas?

D. (semicircle) E. (trapezoid)

Victorian House

Do you see symmetry (no)

Are all the window congruent? (no)

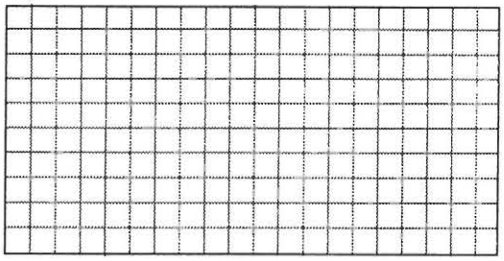
What are the shapes of the following areas?

F. (triangle) G. (rhombus) H. (ellipse)

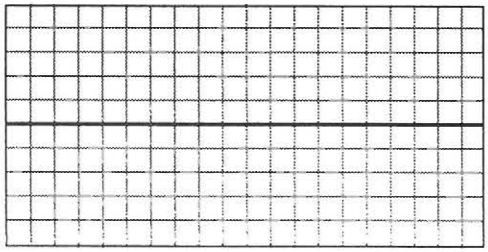
I. (rectangle) J. (quarter-circles)

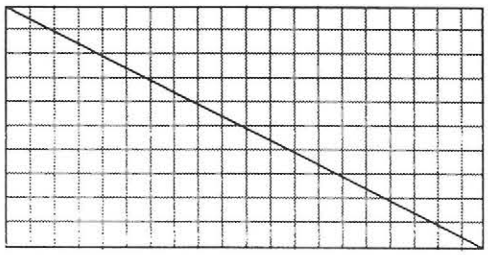
Extra Challenge Answers

Let's pretend the figure below is a piece of property which you are to share equally with your neighbor. What is the area of the property? (120 square units) How many squares units do each of your receive? (60 square units)

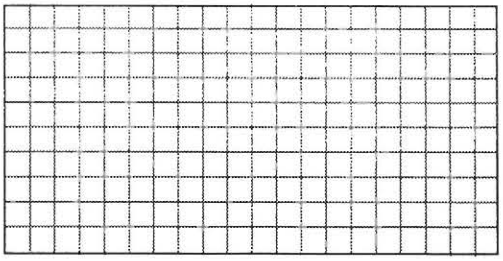


Here's the challenging part: how do you divide the property so each of you get congruent shares of the land? A couple of obvious ways are shown below.

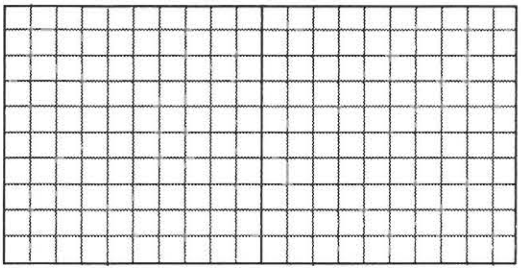


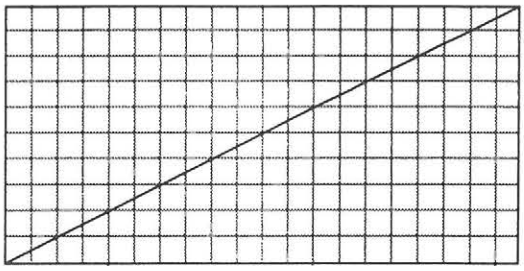


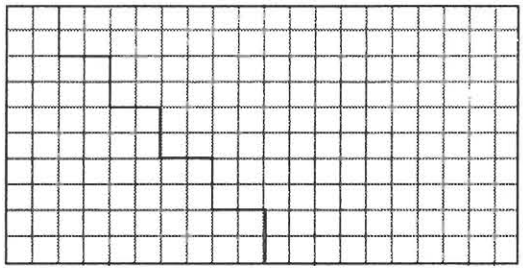
Your challenge is to find other ways to divide the parcel of land into two congruent parts. Use your imagination.

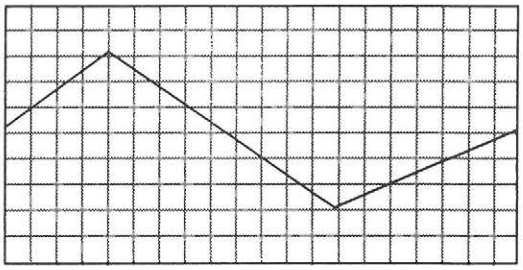


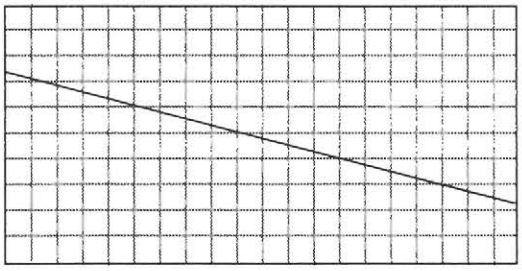
Extra Possible Chart Answers

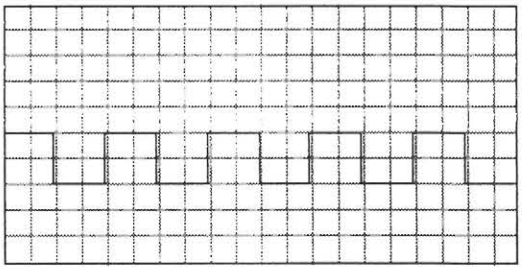






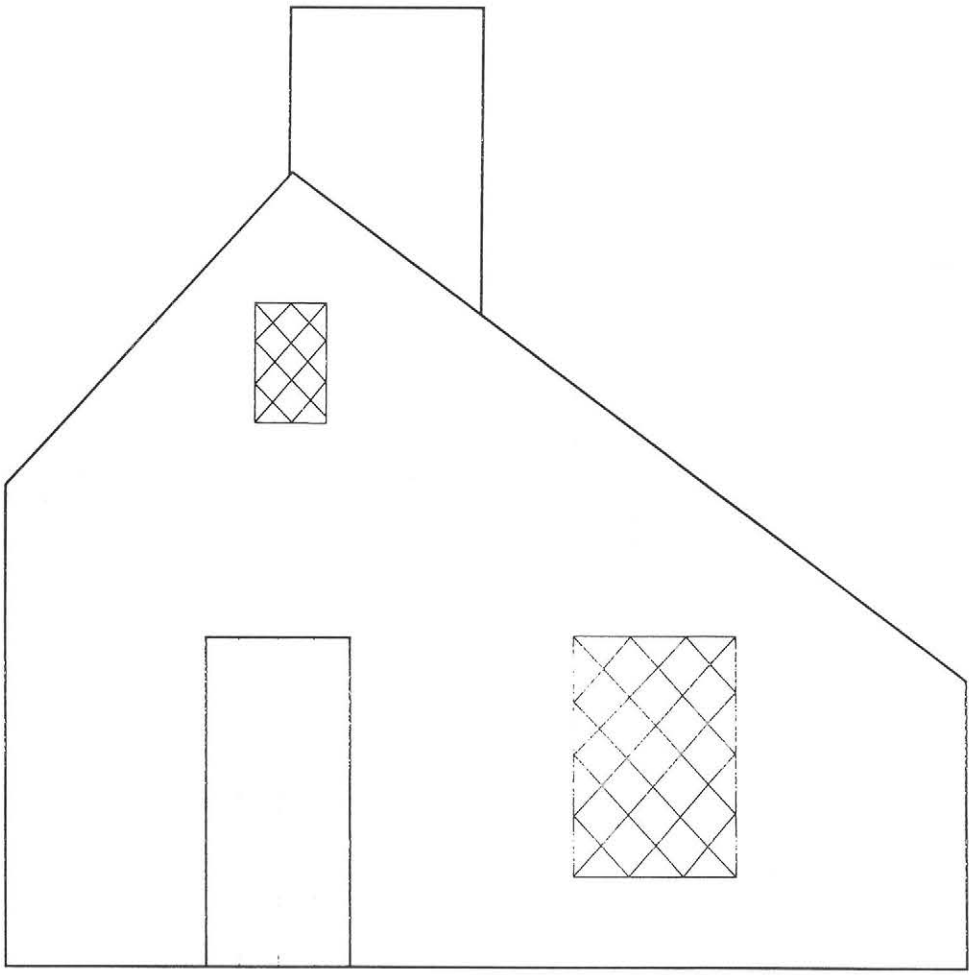






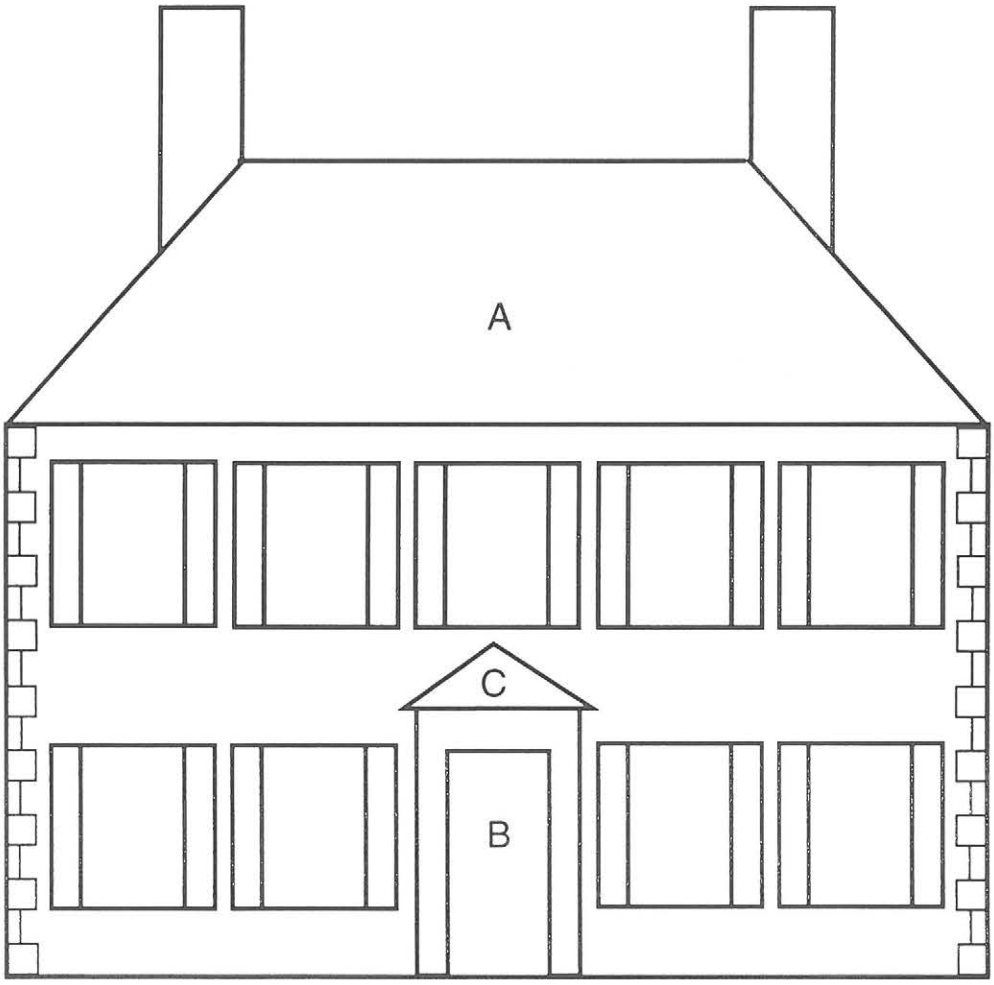
UNIT 6 STUDENT HANDOUT

The New England Colonial



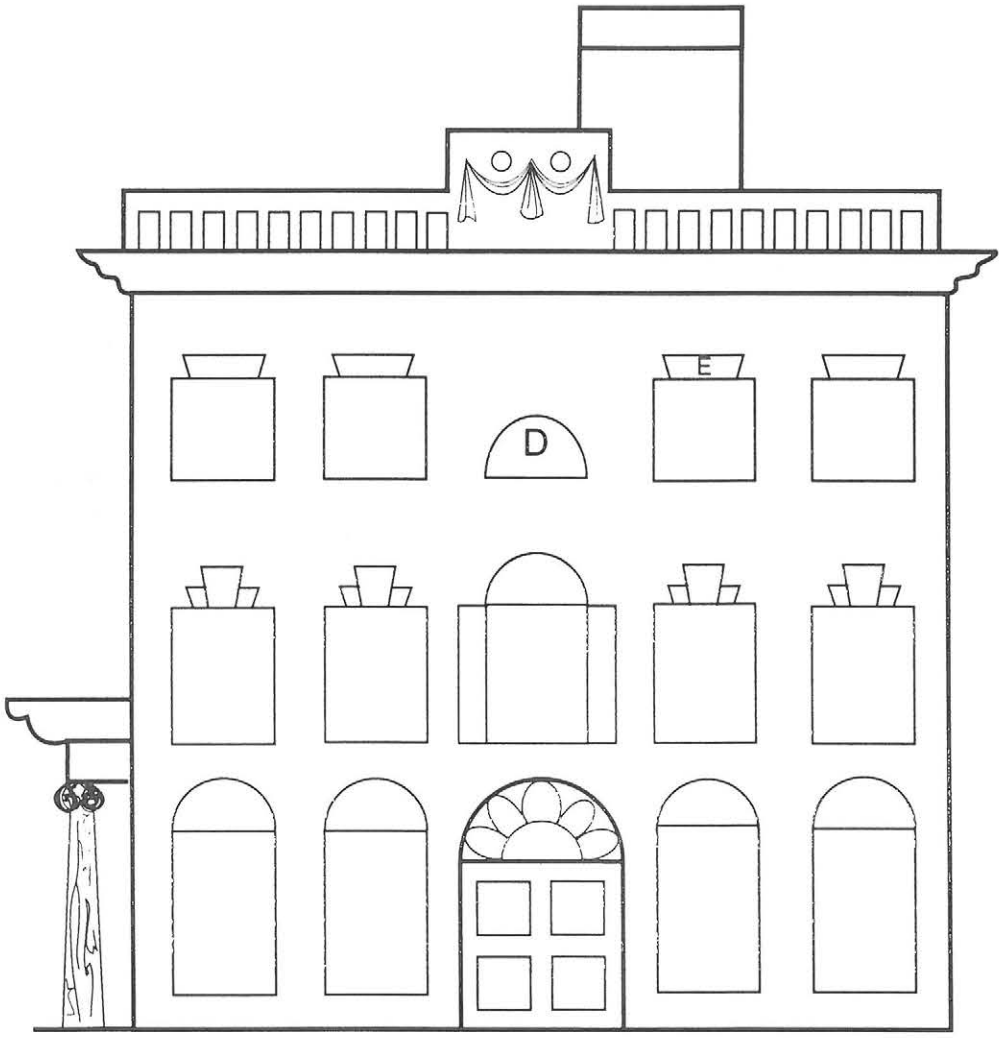
UNIT 6 STUDENT HANDOUT

Georgian 1735-1790



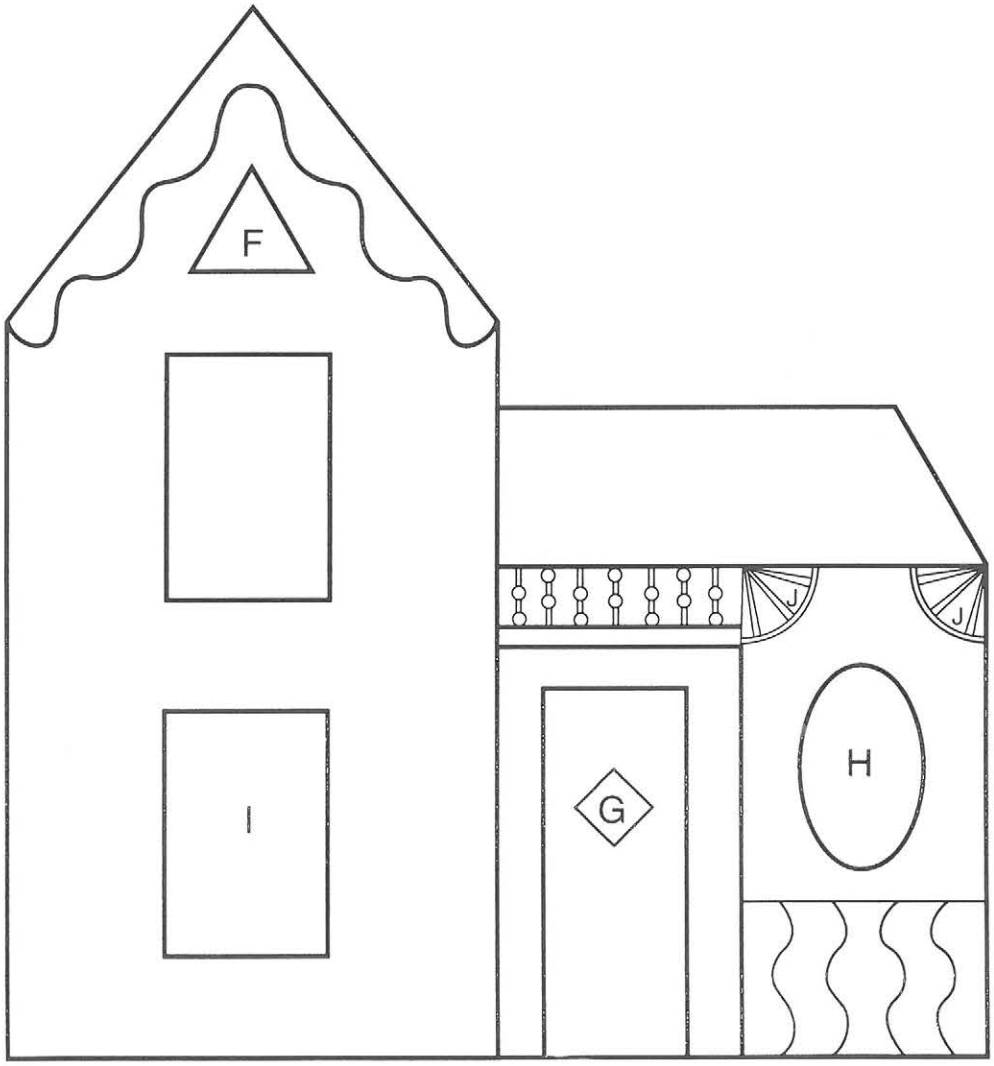
UNIT 6 STUDENT HANDOUT

Federalist 1790-1820



UNIT 6 STUDENT HANDOUT

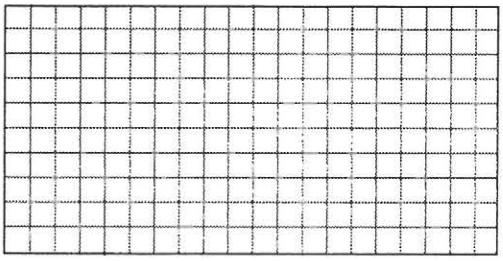
Victorian 1840-1900



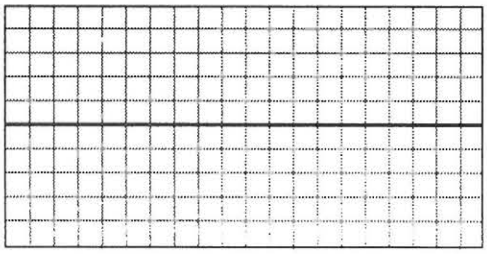
UNIT 6 STUDENT HANDOUT

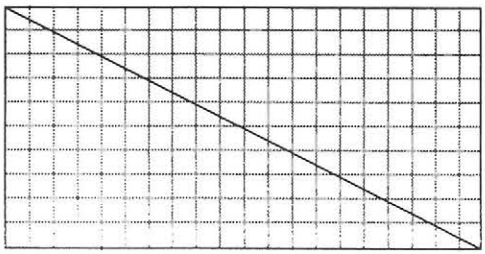
EXTRA CHALLENGE

Let's pretend the figure below is a piece of property which you are to share equally with your neighbor. What is the area of the property? How many squares units do each of your receive?

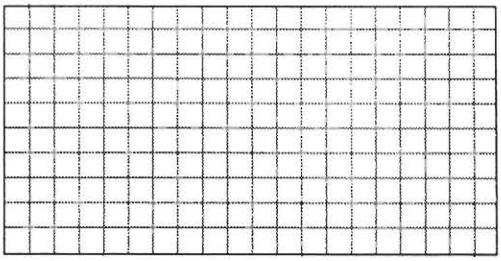


Here's the challenging part: how do you divide the property so each of you get congruent shares of the land? A couple of obvious ways are shown below.





Your challenge is to find other ways to divide the parcel of land into two congruent parts. Use your imagination.



UNIT 6 STUDENT HANDOUT

MATH AND ARCHITECTURE

On the next four pages are drawings of four different kinds of architecture seen commonly in New England and Salem. Study the drawings and then answer the questions below:

New England Colonial

Do you see symmetry?

Are the window congruent?

What is the overall shape of the house (minus the chimney)?

What shape are the window panes?

What shape is the door?

Georgian house

Do you see symmetry?

Are the windows all congruent

What are the shapes of the following areas?

A. B. C.

Federalist house

Do you see symmetry?

Are all the windows congruent?

What are the shapes of the following areas?

D. E.

Victorian House

Do you see symmetry

Are all the window congruent?

What are the shapes of the following areas?

F. G. H.

I. J.