



# Teaching Suggestions

## Patterns In Nature

### **Materials**

- Recording Sheet master, p. 3

### **Overview**

In this project, students will identify mathematical patterns, such as the Fibonacci sequence, found in nature. They will study leaves and pinecones and draw their own spirals. Make a copy of the Recording Sheet master on page 3 for each student.

### **Mathematical Overview**

This project utilizes the following mathematical skills and concepts.

- Compare and order rational numbers.

### **Outside Resources**

Gardner, Robert. *Math in Science and Nature*. New York: Franklin Watts, 1994.

Hansen, Vagn Lundsgaard. *Geometry in Nature*. Boston: Jones and Bartlett Publishers, 1992.

Tesar, Jenny E. *Patterns in Nature*. Woodbridge, CT: Blackbirch Press, 1994.

# Scoring Guide

## Patterns In Nature

Level	Specific Criteria
<b>3 Superior</b>	<ul style="list-style-type: none"> <li>• Shows a thorough understanding of the concepts of <i>comparing and ordering rational numbers</i>.</li> <li>• Uses appropriate strategies to solve problems.</li> <li>• Computations are correct.</li> <li>• Written explanations are exemplary.</li> <li>• Charts, model, and any statements included are appropriate and sensible.</li> <li>• Goes beyond the requirements of some or all problems.</li> </ul>
<b>2 Satisfactory, with minor flaws</b>	<ul style="list-style-type: none"> <li>• Shows understanding of the concepts of <i>comparing and ordering rational numbers</i>.</li> <li>• Uses appropriate strategies to solve problems.</li> <li>• Computations are mostly correct.</li> <li>• Written explanations are effective.</li> <li>• Charts, model, and any statements included are appropriate and sensible.</li> <li>• Satisfies the requirements of problems.</li> </ul>
<b>1 Nearly Satisfactory, with obvious flaws</b>	<ul style="list-style-type: none"> <li>• Shows understanding of most of the concepts of <i>comparing and ordering rational numbers</i>.</li> <li>• May not use appropriate strategies to solve problems.</li> <li>• Computations are mostly correct.</li> <li>• Written explanations are satisfactory.</li> <li>• Charts, model, and any statements included are appropriate and sensible.</li> <li>• Satisfies the requirements of problems.</li> </ul>
<b>0 Unsatisfactory</b>	<ul style="list-style-type: none"> <li>• Shows little or no understanding of the concepts of <i>comparing and ordering rational numbers</i>.</li> <li>• Does not use appropriate strategies to solve problems.</li> <li>• Computations are incorrect.</li> <li>• Written explanations are not satisfactory.</li> <li>• Charts, model, and any statements included are not appropriate or are not sensible.</li> <li>• Does not satisfy the requirements of the problems.</li> </ul>

# Recording Sheet

## Patterns In Nature

### *Getting Started*

No. of Clockwise Spirals:

No. of Counterclockwise Spirals:

### *Working on the Project, Exercise 1*

a. 1, 1, 2, 3, 5, 8, 13, 21, \_\_\_\_, \_\_\_\_, \_\_\_\_

The sequence is:

b.

c.

d.

### *Working on the Project, Exercise 2*

a. Use this space to draw centimeter boxes.

b. Use this space to draw spirals found in nature.

## PATTERNS IN NATURE

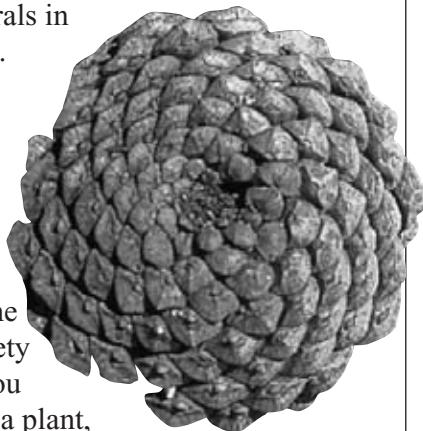
In this project, you will explore one of the mathematical patterns found in nature. You will use what you find to create a poster or collage, or to present a slide show with narration.

### Getting Started

- Collect a variety of pinecones. If these are not available, check with your science teacher. Identify the clockwise and counterclockwise spirals of scales from the bottoms of the cones. Count the number of individual spirals in each direction.

Record the numbers of spirals you find.

- Study the arrangements of leaves on the stem of a variety of plants. If you look down on a plant, leaves are often arranged so that each one gets water and light. Make a drawing of each plant. Number the leaves from the bottom of the stem to the top. What is the difference between the numbers of the leaves that are aligned? How many times do you go around the stem to reach aligning leaves? Record these numbers for several different types of plants.



### Technology Tips

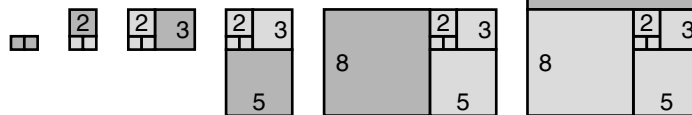
- Use an **electronic encyclopedia** to do your research.
- Write portions of your poster or write your slide show script using **word processing** or **presentation** software.
- Record the information you gather about pinecone spirals or plant leaves in a **database**.



## PATTERNS IN NATURE

### Working on the Project

1. The sequence of numbers 1, 1, 2, 3, 5, 8, 13, 21, . . . is called the **Fibonacci sequence**. Each number in the sequence is found by adding the previous two terms. For example,  $8 + 13 = 21$ .
  - a. Find the next three terms in the sequence.
  - b. Compare the numbers in the Fibonacci sequence to the numbers you found in the pinecone spirals and plant leaves. Describe your findings.
  - c. The ratios of the first three pairs of Fibonacci numbers are  $\frac{1}{1}$ ,  $\frac{2}{1}$ , and  $\frac{3}{2}$ . Find the ratios of the next 5 pairs of numbers in the Fibonacci sequence. Are the ratios in order from greatest to least or in order from least to greatest?
  - d. The ratios of the pairs of Fibonacci numbers approach a number called the **Golden Mean**. Research the golden mean and its connection to nature and art.
2. Nautilus shells, hurricanes, and galaxies all form spirals. You can model a spiral using the squares of the Fibonacci numbers.
  - a. Use a ruler to draw two squares with sides 1 centimeter long as shown. Then add a square with sides of 2 centimeters, 3 centimeters,



5 centimeters, and so on. Use a compass to draw quarter circles in each square. The result is a *Fibonacci spiral*.

- b. Look for spirals in nature. Add their descriptions and pictures to your project.

### Completing the Project

Use the following checklist to make sure your display or slide show is complete.

- You have included a clear, well-organized description of the Fibonacci sequence, the Golden Mean, and the Fibonacci spiral.
- Include pictures of examples of Fibonacci numbers in nature.

# Sample Solutions

## Patterns In Nature

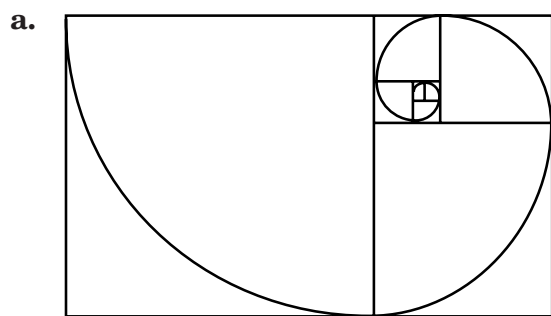
### Getting Started

- Sample answer: 12 clockwise spirals and 12 counterclockwise spirals
- Sample answer: Redbud, Every other leaf is aligned; Crepe Myrtle, Every third leaf is aligned; Devil's Ivy, Every fifth leaf is aligned.

### Working on the Project, Exercise 1

- a. 34, 55, 89; neither; There is no common difference or common ratio.
- b. Sample answer: The numbers are all Fibonacci numbers.
- c.  $\frac{3}{5}$ ,  $\frac{8}{5}$ ,  $\frac{13}{8}$ ,  $\frac{21}{13}$ ,  $\frac{34}{21}$ ; in order from greatest to least
- d. Answers will vary.

### Working on the Project, Exercise 2



- b. Students should include a variety of objects that model spirals and patterns.