Philadelphia Museum of Art

Arts Integration Warm-Ups: How Does This Work?

Integrated learning in the sciences, technology, engineering, arts, and math relies on big ideas that transcend disciplinary boundaries. Awareness of these big ideas—like patterns, systems, and structure and function—helps students build understanding and connect knowledge across disciplines. To develop the habit of thinking in terms of crosscutting concepts, students need practice recognizing them in many different contexts.

Object-based thinking routines can provide quick and engaging opportunities for practice at the beginning of a math or science lesson. Use the Suggested Art Images below to ask your students, "How does this work?," and encourage them to describe patterns, define systems, and relate structure to function.

Grade Level

Adaptable for all grades

Common Core Academic State Standards

- CCSS.MATH.PRACTICE.MP1
- CCSS.MATH.PRACTICE.MP4
- CCSS.MATH.PRACTICE.MP7

National Visual Arts Standards

- Responding: understanding and evaluating how the arts convey meaning

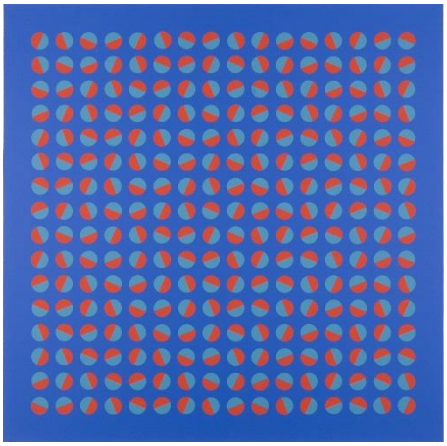
Next Generation Science Standards

- Crosscutting Concepts: Patterns; Systems and system models; Structure and function
- Scientific Practices: Analyzing and interpreting data

Suggested Art Images

Click on the titles below to view high-resolution photographs on the museum's website:

- *Arabian Sea (Checkerboard Abstraction)*, 1984, by Edna Andrade
- *Jousting Drawing*, around 1580, made in Germany
- *Night Sea*, 1977, by Edna Andrade
- *Portions of an Armor of Maximilian I of Austria, for use in the German joust of peace (Gestech)*, around 1494, armor made by Lorenz Helmschmid
- *Red Flash*, 1970, by Edna Andrade
- *Saved*, 1871, after John Dawson Watson, published by *Harper's Weekly, New York*
- *Seine*, 1951, by Ellsworth Kelly
- *Study for "Night Sea,"* around 1976, by Edna Andrade
- *The Life Line*, 1884, by Winslow Homer



Red Flash, 1970
Edna Andrade (American)
Color screenprint
Image and sheet: 29 x 29 in. (73.7 x 73.7 cm)
Gift of the estate of Edna Andrade, 2010
2010-63-2
© Estate of Edna Andrade

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Lesson Objectives

Students will be able to:

- Observe and describe patterns by looking closely
- Define and create models of a system by looking closely and making inferences
- Relate the structure and function of an object by looking and making inferences

Essential Question

How can object-based thinking routines help students develop their scientific and mathematical thinking?

Materials Needed

- Screen for projecting Suggested Art Images
- Copies of Suggested Art Images (optional)
- Grid paper (optional)

Lesson Process

A thinking routine is a short, adaptable strategy for focused looking. It can be a warm-up at the beginning of class, an introduction to or application of a specific topic, or an extension of students' learning. The "How Does It Work?" routine can be used with any of the Suggested Art Images in this lesson. Each image represents the use of a pattern, a system, a relationship between structure and function, or some combination of all three concepts. Read the Differentiation section below for guidance selecting the right image for your class.

1. Project your selected image for students to see, or pass out copies of the image.

2. Give students time to look closely at the image and answer:
    - *What do you see?* Look closely and write a description of the object, pattern, or system.
    - *How do you think it works?* Write an explanation of the rule the pattern follows, the parts and purposes of the system, or how the object functions.
    - *What questions do you have?* Write down at least one thing you want to know more about.

3. Until students have practiced and become comfortable with this routine, you may want to provide support by:
    - Modeling the routine with a very simple pattern or object
    - Doing the routine verbally, as a guided group discussion
    - Inviting students to ask questions before attempting a verbal or written explanation
    - Separating the three parts of the routine, and sharing observations, explanations, and questions in between independent work

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Differentiation

Exploring Patterns

The optical illusions in Edna Andrade's artwork seem magical, but close looking can reveal the precise rules and systems she devises to create them. Begin exploring patterns with *Red Flash*. A deceptively simple grid of red and blue circles contains multiple patterns that fill the image with tumbling, cascading movement. Challenge students to describe more than one pattern and explain its rule. Layers of overlapping geometric shapes and shifting colors create a visual puzzle in *Arabian Sea (Checkerboard Abstraction)*. Challenge students to describe all the different shapes and patterns formed by the intersecting lines as well as patterns within the colored squares. *Night Sea* appears to be an image of undulating, glowing, three-dimensional waves, but it is composed entirely of straight lines. Can students describe the regular way in which Andrade arranged the lines to create this effect? Use *Study for "Night Sea"* to support their thinking.

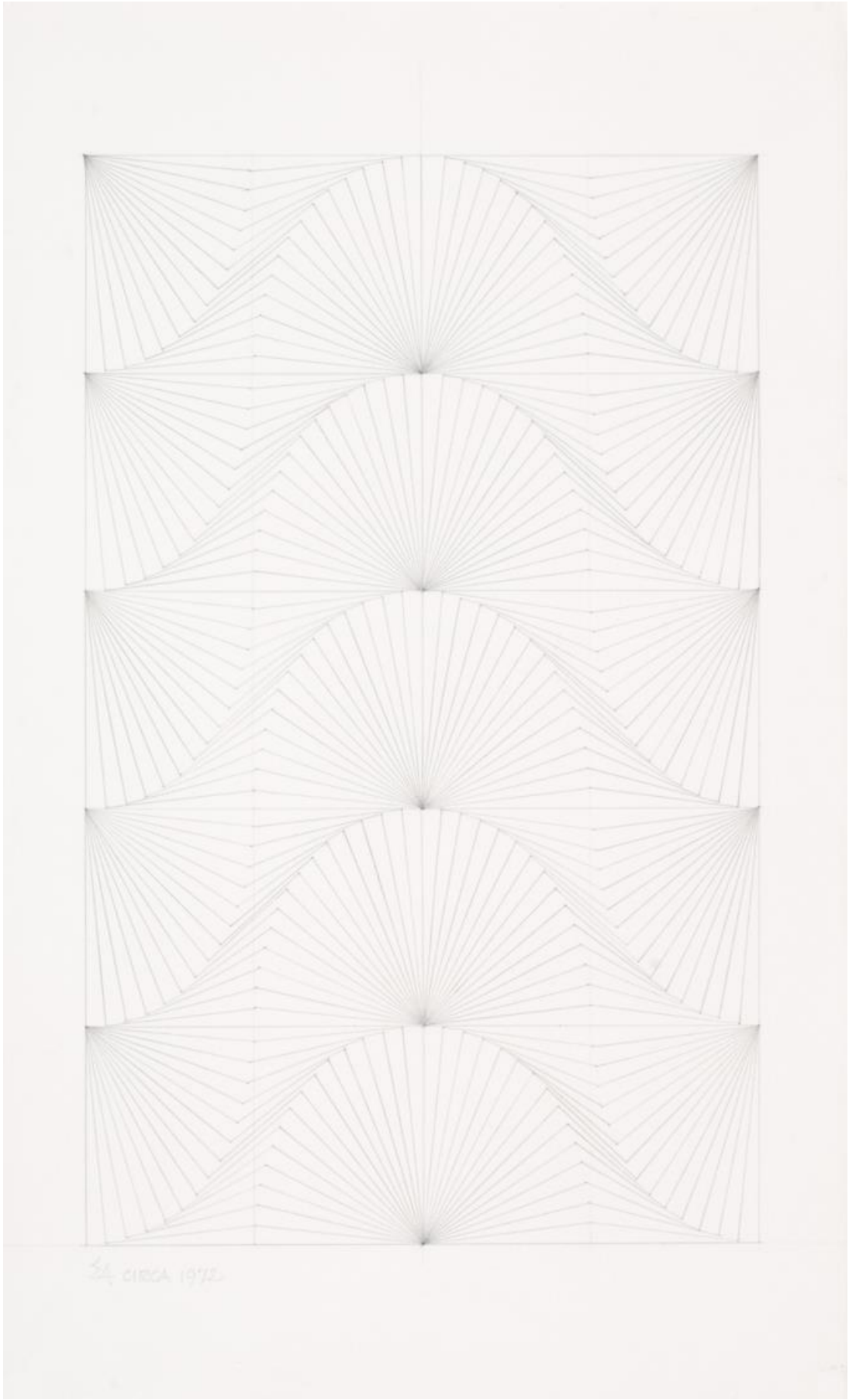
Exploring Systems

Winslow Homer's *The Life Line* depicts a real life-saving device, the breeches buoy, in vivid action. Homer's focus on the human drama at the center of the scene leaves some details of the breeches buoy system a mystery. There are enough clues, however, for a close observer to figure out how the system works. Make sure students notice that the lower rope on the left side is slack, while the lower rope on the right is pulled taught. The upper rope is dry on the left, but drops of water cling to it on the right, indicating the movement of the pulley from left to right. Students can infer that people outside the frame of the painting are pulling the characters to safety on shore. They might also infer that the buoy system is anchored to a foundering ship outside the frame of the painting on the left. Challenge students to imagine ways the people on shore might have sent the anchoring rope out to a ship in trouble. *Saved*, which depicts the same system at a different point in the process, can be used to support students' thinking.

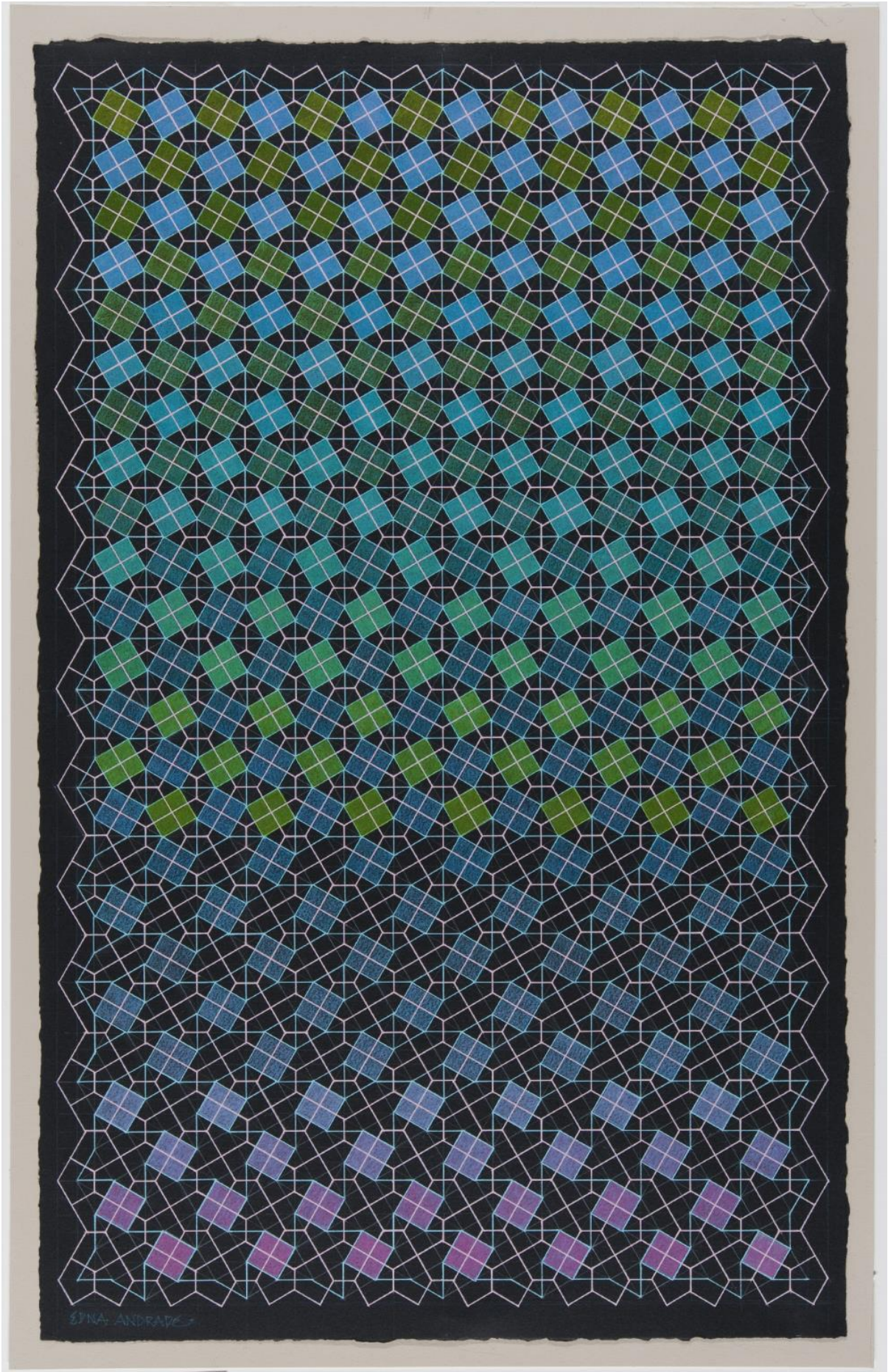
In *Seine*, Ellsworth Kelly transforms a simple modular grid into a representation of light reflecting off the surface of the Seine River. Kelly incorporated both patterns and randomization into the system he used to create this image. Working from the outside in and then back again, he painted units of the grid according to numbers pulled at random from a box. Observant students will notice that one unit is darkened in the outermost column of the grid, two in the next column in, three in the next column, and so on. Challenge students to define Kelly's system by counting to find the dimensions of the grid. Hand out grid paper. Can students create a model of Kelly's system to demonstrate how it works?

Exploring Structure and Function

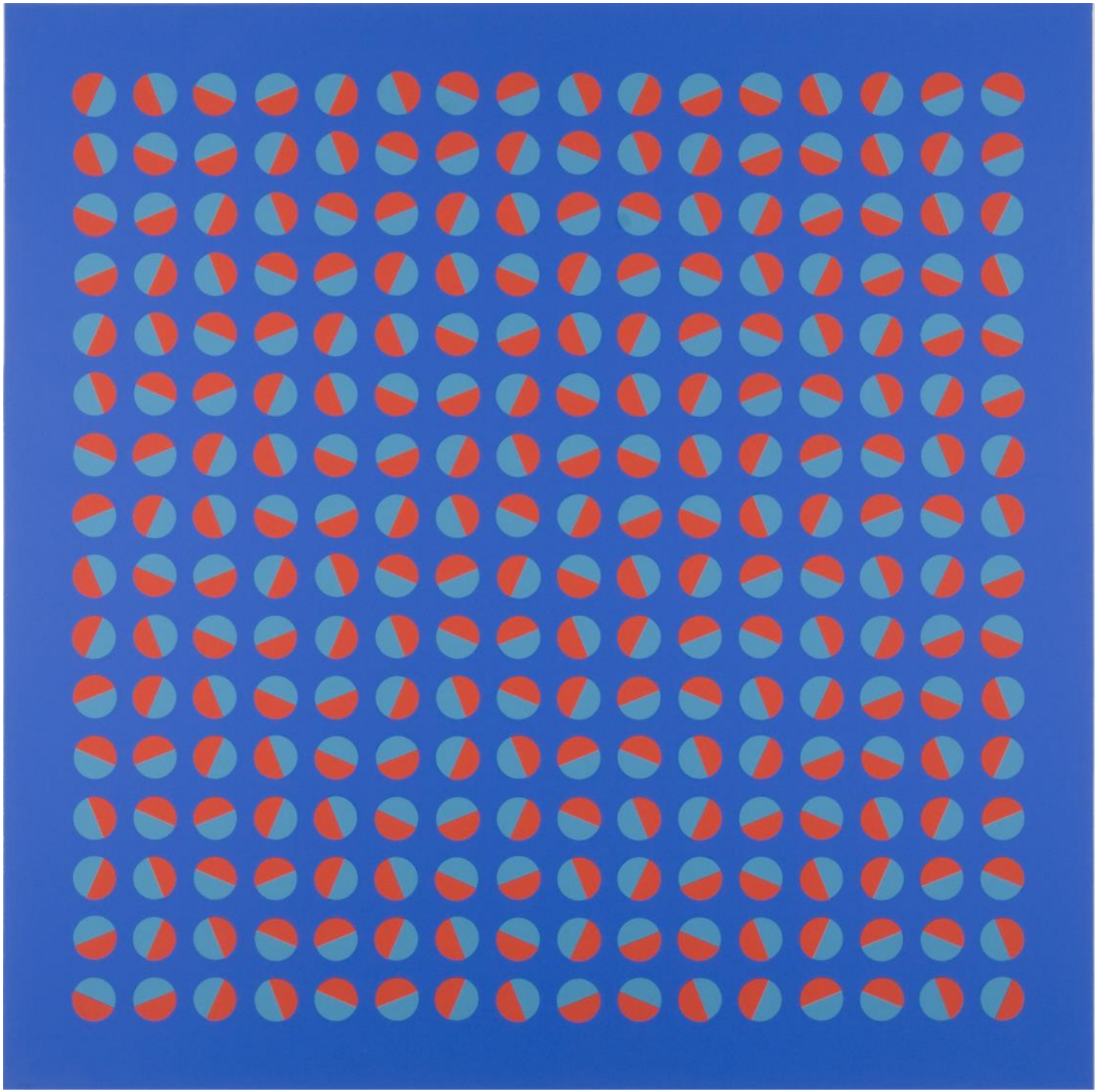
The helm and breastplate comprising *Portions of an Armor of Maximilian I of Austria* are an intriguing object designed for a very specific purpose. While students will likely immediately recognize it as part of a suit of armor, the greater challenge is to explain the function of individual features. Why might the helm be bolted to the breastplate? What is the purpose of having extra bolt holes? What might be the function of the leather straps sticking out of the helm? How do the huge hooks bolted to the right side of the armor function? Would it be possible for a knight to move his head wearing armor such as this? How would the knight see out of the thin slit in the helm? Does this structure function more for mobility or for safety? Support students' thinking about structure and function by playing the audio guide on the object page and showing them the *Jousting Drawing*. This illustration of jousting knights also presents an opportunity to talk about structure and function in the horses' armor. Make sure students notice that the horses' eyes and ears are covered and that they wear bells around their necks. What might be the function of these design features?



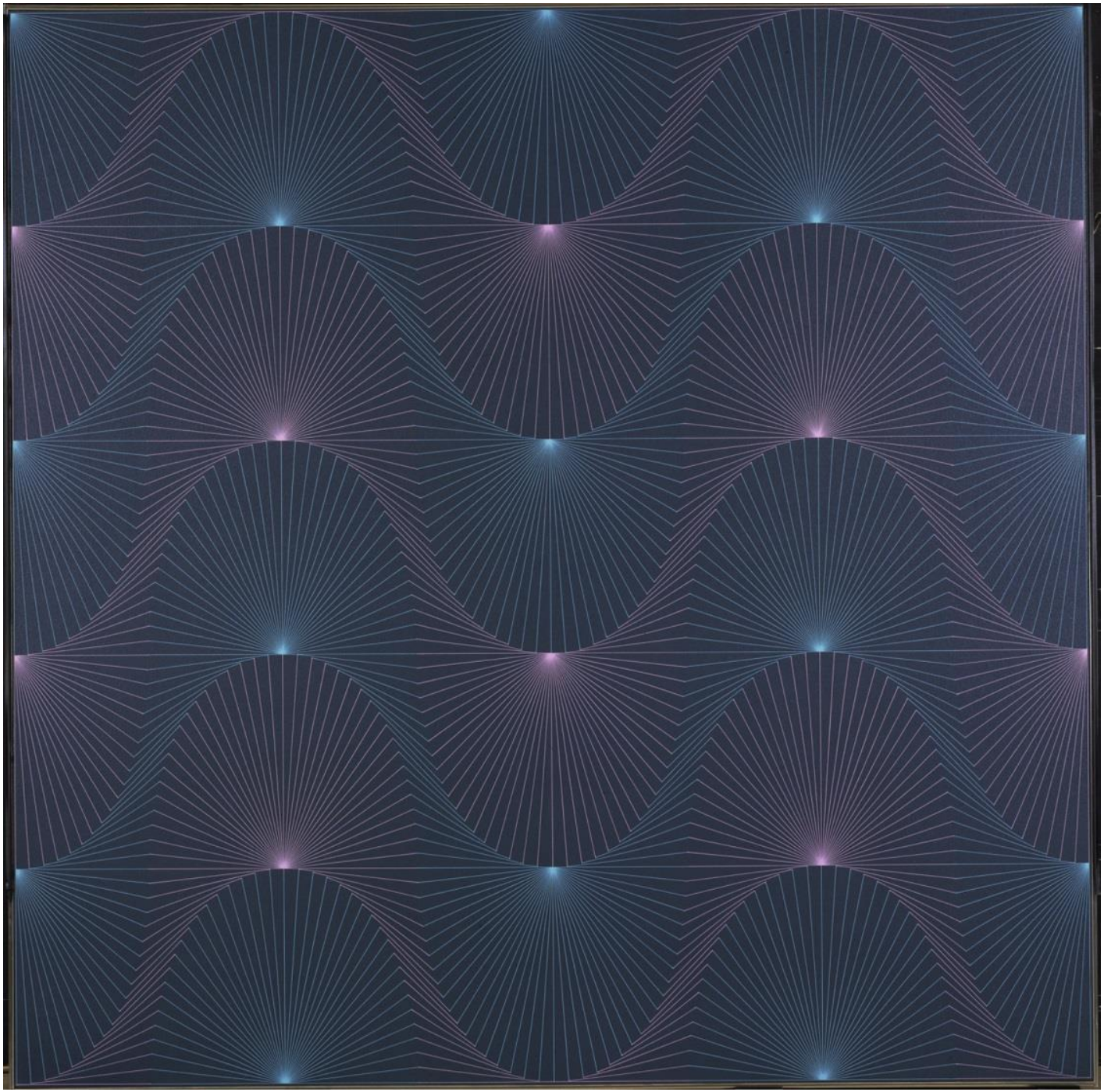
Study for "Night Sea," around 1976, by Edna Andrade (Philadelphia Museum of Art: Purchased with the Marion Stroud Fund for Contemporary Art on Paper, the Margaretta S. Hinchman Fund, and the Joseph E. Temple Fund, 2008-100-15) © Estate of Edna Andrade



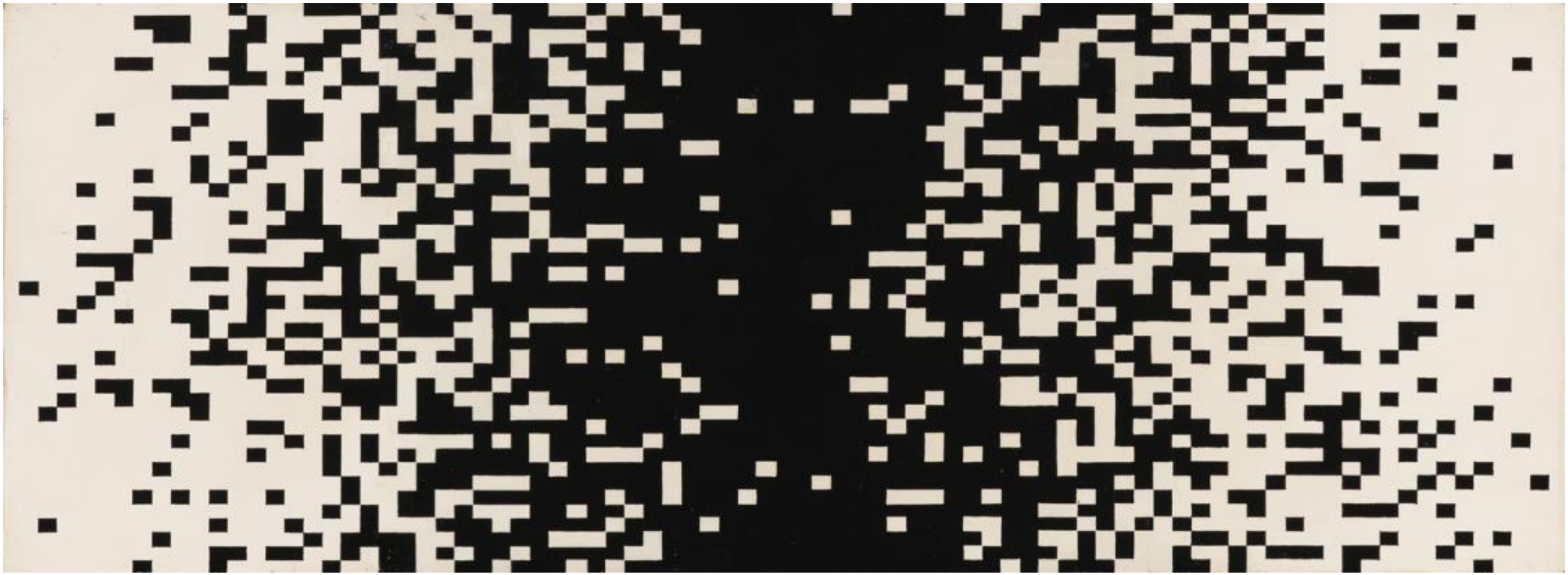
Arabian Sea (Checkerboard Abstraction), 1984, by Edna Andrade (Philadelphia Museum of Art: Gift of Ann E. and Donald W. McPhail, 2012-25-96) © Estate of Edna Andrade



Red Flash, 1970, by Edna Andrade (Philadelphia Museum of Art: Gift of the estate of Edna Andrade, 2010-63-2) © Estate of Edna Andrade



Night Sea, 1977, by Edna Andrade (Philadelphia Museum of Art: Gift of the Philadelphia Arts Exchange, 1978-13-1) © Estate of Edna Andrade



Seine, 1951, by Ellsworth Kelly (Philadelphia Museum of Art: Purchased with funds contributed in memory of Anne d'Harnoncourt and other Museum Funds, 2008-228-1) © Ellsworth Kelly, courtesy Matthew Marks Gallery