Escher Terminology

Crystallography: A branch of science that examines the structures and properties of crystals; greatly influenced the development of Escher’s tessellations

de Mesquita, S. J.: A master printmaker at the School for Architecture and Decorative Arts, where Escher was studying, who encouraged Escher to pursue art rather than architecture

H. S. M. Coxeter: A mathematician whose geometric “Coxeter Groups” became known as tessellations. Like Escher, Coxeter also loved music and its mathematical properties. The initial ideas for Circle Limit came from Coxeter.

Infinity/Droste Effect: An image appearing within itself in smaller and smaller versions on to infinity; for example, when one mirror placed in front and one behind, creating an in infinite tunnel of the image

Lithograph: A printing process in which the image to be printed is drawn on a flat stone surface and treated to hold ink while the negative space is treated to repel ink.

Mezzotint: A method of engraving a copper or steel plate by scraping and burnishing areas to produce effects of light and shadow.

Möbius strips: A surface that has only one side and one edge, making it impossible to orient; often used to symbolize eternity; used to how red ants is Escher’s Möbius Strip II

Necker cube: An optical illusion proposed by Swiss crystallographer Louis Albert Necker, where the drawing of a cube has no visual cues as to its orientation; in Escher’s Belvedere, the Necker cube becomes an “impossible” cube.
**Penrose, Sir Roger:** Mathematical physicist and philosopher of science known for his brilliant work in cosmology and general relativity; significantly influenced Escher, and Escher likewise influenced Penrose and his own impossible constructions

**Penrose stairs:** An impossible construction shown in *Ascending and Descending* (1960), where stairs descend at the same time they are ascending; inspired by an article written by Lionel (father) and Roger (son) Penrose, the latter being a renowned British mathematician and inventor

**Penrose triangle:**

**Penrose tribar:** Inspired by Escher’s earlier depictions of impossible objects, it came to be known as the “tribar” and often appears beneath Escher’s signature

**Pólya, George:** Hungarian mathematician who influenced Escher’s work in plane symmetry by identifying 17 plane-symmetry groups, such as reflection, rotation, and translation groups

**Polygon:** A plane figure that has at least three, but typically five or more straight edges and angles (triangles, rectangles, pentagons)

**Polyhedron:** A group of polygons attached by their edges (cubes, pyramids, crystals)

**Regular division of the plane:** A series of Escher drawings, beginning in 1936, based on the principle of tessellation—irregular shapes that interlock and entirely cover a surface or plane; the idea was first inspired in 1922 while visiting the Alhambra, a 14th-century Moorish palace in Spain (see sketch below)
**Reutersvärld, Oscar**: Swedish graphic artist known as the “father of the impossible figure;” greatly influenced Escher, who expanded Reutersvärld’s impossible shapes into entire worlds

**Woodcut**: Escher’s method of choice, it involves carving and engraving into a block of wood, covering the wood with ink and then printing it

**Symmetry**: In art and design, when one side balances the other; including reflection symmetry (mirror images), radial symmetry (revolving around a central point, aka rotational symmetry), and translational symmetry (repeated without changing its shape), and fractals (larger portions are repeated in ever smaller portions, aka self-similarity)

**Tessellation**: A pattern formed by repeated shapes over a surface without any gaps or overlaps, as a bee’s honeycomb or the pattern of a soccer ball

**Topology**: A study of the way in which constituent parts are interrelated or arranged; especially where the properties of space are preserved while being stretched, crumpled, or bent, such as in Escher’s Print Gallery (on the left)

**Escher Films**

- *Escher Documentary* – One of the best on YouTube
  https://www.youtube.com/watch?v=g4VAviI1TRGs
- *Art of the Impossible* – Renowned cosmologist Prof. Sir Roger Penrose sheds light on Escher’s complex mathematical ideas
  https://www.youtube.com/watch?v=f7kW8xd8p4s
- *Escher Documentary* – Footage of his creative process and a glimpse into his own thought process
  https://www.youtube.com/watch?v=qYnrL5ud_9A
- *The Fantastic World of M. C. Escher* – Extended film with interesting anecdotes
  https://www.youtube.com/watch?v=zCbsS6D-yD0
- Radio interview of Currier Museum educator
  http://cpa.ds.npr.org/nhpr/audio/2014/09/WOM09182014C.mp3
- Online at the official M. C. Escher website are two videos—one of Escher at work and another of an interview with his son.
  http://www.mcescher.com/about/escher-at-work/
  http://www.mcescher.com/about/interview-with-eschers-son/
Escher Animations

- **Sky and Water I**
  https://www.youtube.com/watch?v=2KfSdOhgMvk
- **Relativity**
  https://www.youtube.com/watch?v=JdgPvripL9A
- **Variety of Works**
  https://www.youtube.com/watch?v=b7aHMp9aOOs
- **Snakes**, by animator Christobal Vila
  https://www.youtube.com/watch?v=VUQ8t0IWqkc&index=18&list=PLeN9z9NMMON_Z2WHqUGvGSISOGiqVG80d
- **Inspirations**, by Christobal Vila – fascinating representation of an Escher-esque workspace inspired by Reptiles
  https://www.youtube.com/watch?v=nUEh8PV1V0g
- **Metamorphosis II**
  https://www.youtube.com/watch?v=hDFUqHRNgzl
- **Penrose Stairs** – Short demonstration
  https://www.youtube.com/watch?v=E7e_9QbA7lQ&index=12&list=PLeN9z9NMMON_Z2WHqUGvGSISOGiqVG80d
- **Anatomy of an Escher Flying Horse** – Short demonstration
  https://www.youtube.com/watch?v=NYGIhZ_HWfg
- **How to Draw and Optical Illusion – Escher Cube**
  https://www.youtube.com/watch?v=T6L6bE_bTMo
- **Anatomy of an Escher Flying Horse** – Short demonstration

Escher and Mathematics Online Interactive Educational Tools

- [https://www.youtube.com/watch?v=CZAQ_b2rzAA](https://www.youtube.com/watch?v=CZAQ_b2rzAA)
- [http://www.michaelbach.de/ot/cog-impossWFallMcwolles/index.html](http://www.michaelbach.de/ot/cog-impossWFallMcwolles/index.html)
Escher Math Concepts Scavenger Hunt

Below is an activity created by BYU Professor Tara Carpenter to help her Art Education students explore math concepts evident in the exhibition *M.C. Escher: Other Worlds.*

Directions:
1. For each math standard below, identify an artwork in the Escher exhibit that could be shown to help students gain a deeper understanding of the concept. Write the name of the work (or works) next to the standard.
2. When finished identifying artworks, select one combination of artwork and standard that you would like to develop further. With your partner, brainstorm ideas for visual art projects that students could create that would help solidify their understanding of the mathematics concept.
3. Prepare to share your ideas with the group.

Overarching standard (same for every grade level)
Look for and make use of structure. Recognize and apply the structures of mathematics, such as patterns, place value, the properties of operations, or the flexibility of numbers. See complicated things as single objects or as being composed of several objects.

Standard K.G.1
Describe objects in the environment using names of shapes, and describe the relative positions of these objects using terms such as above, below, beside, in front of, behind, and next to.

Standard K.G.2
Correctly name shapes regardless of their orientations or overall sizes.

Standard 1.G.1
Distinguish between defining attributes (for example, triangles are closed and three-sided) versus non-defining attributes (for example, color, orientation, overall size); build and draw shapes that possess defining attributes.

Standard 1.G.2
A. Compose two-dimensional shapes (rectangles, squares, trapezoids, triangles, half-circles, and quarter-circles) to create a composite shape, and compose new shapes from the composite shape.

Standard 2.G.1
Recognize and draw shapes having specified attributes, such as a given number of angles or a given number of equal faces. Sizes are compared directly or visually, not compared by measuring. Identify triangles, quadrilaterals, pentagons, hexagons, and cubes.

Standard 3.G.1
Understand that shapes in different categories (for example, rhombuses, rectangles, and others) may share attributes (for example, having four sides), and that the shared attributes can define a larger category (for example, quadrilaterals). Recognize rhombuses, rectangles, and
squares as examples of quadrilaterals, and draw examples of quadrilaterals that do not belong to any of these subcategories.

**Standard 3.G.2**
Partition shapes into parts with equal areas. Express the area of each part as a unit fraction of the whole. *For example, partition a shape into four parts with equal area, and describe the area of each part as \(1/4\) of the area of the shape.*

**Standard 4.MD.5**
Recognize angles as geometric figures that are formed wherever two rays share a common endpoint, and understand concepts of angle measurement.

**Standard 4.G.1**
Draw points, lines, line segments, rays, angles (right, acute, and obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures.

**Standard 4.G.3**
Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded along the line into matching parts. Identify line-symmetric figures and draw lines of symmetry.

Brainstorm ideas for visual art projects that could connect with and help students to better understand one of the math standards above. Prepare to share with the group: