

The background is an abstract painting. At the top, there is a bright yellow sun with a greenish-yellow glow. The sky transitions from green to dark blue. In the bottom right, there is a large, dark circle with a red crack running through it, set against a yellow and white background. The overall style is expressive and textured.

TEACHER RESOURCE GUIDE
FOR GRADES 8–11

LEARN ABOUT

**SHADING TECHNIQUES
& MATHEMATICAL
ANALYSIS OF CIRCLES**

through the art of

JOCK MACDONALD

ART CANADA INSTITUTE | INSTITUT DE L'ART CANADIEN

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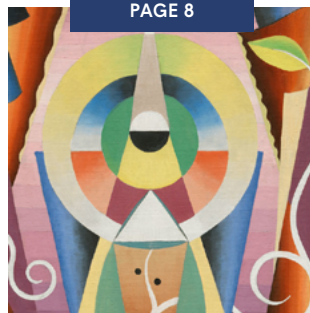
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**ADDITIONAL
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READ ONLINE



**JOCK MACDONALD:
LIFE & WORK
BY JOYCE ZEMANS**

DOWNLOAD



**JOCK MACDONALD
IMAGE FILE**

RESOURCE OVERVIEW

This teacher resource guide has been designed to complement the Art Canada Institute online art book [Jock Macdonald: Life & Work](#) by Joyce Zemans. The artworks within this guide and images required for the learning activities and culminating task can be found in the [Jock Macdonald Image File](#) provided. These activities were prepared with Laura Briscoe & Jeni Van Kesteren of Art of Math Education.

Jock Macdonald (1897–1960) was one of the most radical artists in Canada in the mid-twentieth century. In the 1930s he began experimenting with abstraction, a quest that led him to many different disciplines. As author Joyce Zemans has noted, he was “guided by the most current discussions of art and aesthetics and of mathematical and scientific theories.” In the spirit of Macdonald’s works, the activities in this guide connect visual arts and mathematics. This connection will make Macdonald’s art more engaging for students and inspire a creative, personalized approach to understanding mathematical concepts of circles. Visual arts students will develop an understanding of Macdonald as they learn about circles and experiment with new materials. The art activities in this guide are meant to encourage experimentation without a requirement of previous experience.

Curriculum Connections

- Grades 8–10 Mathematics
- Grades 8–11 Visual Arts

Themes

- Abstraction
- Equations of circles
- Experimenting with techniques
- Relationships between art and nature
- Self-expression

Teaching Exercises

In this guide’s activities, students will create artworks using colour mixing and shading techniques while analyzing circles using measurement and equations.

- Learning Activity #1: Area and circumference with colour mixing and shading techniques ([page 4](#))
- Learning Activity #2: Equations of circles and circular artworks ([page 6](#))
- Culminating Task: Collaborative circle art and math project ([page 8](#))

A Note on Using This Guide

Within the following activities, students will practise using equations to calculate the area and circumference of circles. They will also develop the equation of a circle placed on a coordinate plane by investigating the relationship between a circle’s centre, its radius, and a point on the circle. Prior knowledge of the Pythagorean theorem is required, and an understanding of the distance equation is beneficial. Please note that the artworks are designed to be created with any colour medium of choice, but some background knowledge of the elements and principles of design is helpful.



Fig 1. Jock Macdonald, *Chrysanthemum*, 1938. This work was shown at the Vancouver Art Gallery in 1938—Macdonald was the first B.C. artist to exhibit abstract painting.

WHO WAS JOCK MACDONALD?



Fig 2. Jock Macdonald, date unknown.

James (Jock) Williamson Galloway Macdonald was born in Thurso, Scotland, in 1897. His father was an architect, and after high school Macdonald apprenticed as a draftsman before enlisting to fight in the First World War. After the war, he enrolled at the Edinburgh College of Art, majoring in design. He graduated in 1922 and went to work in textile design for Morton Sundour Fabrics; that same year, he married Barbara Niece.

In 1926 Macdonald moved to British Columbia, where he became head of the design department at the Vancouver School of Decorative and Applied Arts (VSDAA; now the Emily Carr University of Art + Design). There, encouraged by his friend and fellow faculty member F.H. Varley (1881–1969), a founding member of the Group of Seven, he began to use oil paints to depict the B.C. landscape.

The Great Depression brought instability to the VSDAA, and Macdonald, along with Varley, left in 1933 and started the British Columbia College of the Arts. When it was forced to close in 1935, Macdonald, his family, and two friends sailed for Nootka Island. Over the next eighteen months, he tried to find a way to turn his ideas about art, nature, and spirituality into abstract paintings. He returned to Vancouver in 1936.

During the next decade, Macdonald taught art and made landscape paintings as well as semi-abstract paintings that he called “modalities” based on the ideas he had developed in Nootka. Around 1944 he met the British psychiatrist and surrealist artist Dr. Grace Pailthorpe (1883–1971), who introduced him to [automatic painting](#) and became an important friend and mentor for the rest of his life.

Automatic painting opened Macdonald up to a more fluid style of abstraction, and as his artwork began to change he also found his teaching prospects improving. He moved to Calgary in 1946 to become the head of the Provincial Institute of Technology and Art, and the following year he relocated again, this time to Toronto, to teach at the Ontario College of Art (now OCADU). Abstract art was becoming more accepted by the general public, and in 1954 Macdonald and a group of ten other painters who worked in a non-representational style had their first exhibition as [Painters Eleven](#). Over the next six years, Macdonald experimented with new types of industrial paint, always with the aim of integrating art and his philosophical ideas. He died in 1960, the same year that the Art Gallery of Ontario organized a retrospective exhibition of his work.



Fig 3. Jock Macdonald’s trademark for the Canadian Handicraft Guild of British Columbia. After moving to B.C., Macdonald occasionally took on design work in addition to teaching.



Fig 4. Jock Macdonald, *In the White Forest*, 1932. In the early 1930s Macdonald painted numerous modern landscapes.



Fig 5. Jock Macdonald, *Russian Fantasy*, 1946. This work is typical of the automatic watercolour paintings that Macdonald created between 1945 and 1952.



Fig 6. Jock Macdonald, *Young Summer*, 1959. Macdonald’s final paintings are remarkably delicate.

NATIONAL & WORLD EVENTS

JOCK MACDONALD'S LIFE

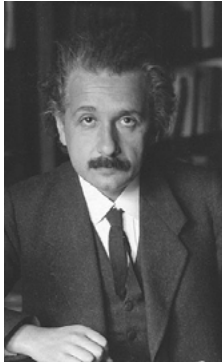


Fig 7. Albert Einstein in 1920.

The First World War begins; although initially expected to end quickly, it lasts until 1918.

Albert Einstein is awarded the Nobel Prize in Physics. His theory of general relativity, explaining relations among mass, time, and space, has far-reaching scientific and cultural influence.

Stock markets crash in London and New York, dealing devastating blows to many economies, including the Canadian economy. The Great Depression begins.

The Group of Seven disbands, and the Canadian Group of Painters is founded, with the intention of creating a national movement.

On September 1, Germany invades Poland, and the Second World War begins.

The Second World War ends.



Fig 8. A protest against police brutality in Vancouver, held after the RCMP beat several demonstrators on June 19, 1938, while breaking up a strike led by unemployed workers.



Fig 9. Members of the Painters Eleven during the Simpson's department store *Abstracts at Home* display, 1953. From left: Tom Hodgson, Oscar Cahén, Alexandra Luke, Kazuo Nakamura, Ray Mead, Jack Bush, and William Ronald.

The Soviet Union launches the first artificial satellite, Sputnik 1, into Earth orbit.

1897 James (Jock) Williamson Galloway Macdonald is born in Thurso, Scotland.

1914

1919 After having fought in the First World War, Macdonald enters the Edinburgh College of Art.

1922 Macdonald graduates with a diploma in design and a teaching certificate and marries Barbara Niece.

1926 Macdonald begins teaching at the Vancouver School of Decorative and Applied Arts.

1929

1933

1935 Macdonald and his family sail for Nootka Island, where they stay until late 1936. While there, Macdonald experiences a breakthrough and paints abstract compositions.

1939

1940 Macdonald delivers the lecture "Art in Relation to Nature" at the Vancouver Art Gallery. It explores connections between art and philosophy, geometry, and the structure of the universe.

1945

1946 Macdonald moves to Calgary to head the Provincial Institute of Technology and Art.

1947 Macdonald accepts a position at the Ontario College of Art and moves to Toronto.

1954

1957

1960 The Art Gallery of Ontario mounts a retrospective exhibition of Macdonald's work. He dies later that year.



Fig 10. Jock and Barbara Macdonald, date and photographer unknown.



Fig 11. Jock Macdonald, *Flight*, 1939. This painting was included in the Canadian Group of Painters exhibition at the Art Gallery of Toronto (now the Art Gallery of Ontario) in 1939.



Fig 12. Jock Macdonald, *Fish Playground*, 1946. Macdonald experienced great joy in painting his automatic watercolours.

LEARNING ACTIVITY #1

AREA AND CIRCUMFERENCE WITH COLOUR MIXING AND SHADING TECHNIQUES

Jock Macdonald was committed to finding his own personal form of expression in art, and in some of his most famous paintings he chose to work with circles. In this activity, students will take Macdonald's paintings *Departing Day*, 1935, and *Etheric Form*, 1936, as starting points for experimenting with shading techniques and understanding the area and circumference of a circle. Students will develop an understanding of what defines a circle by choosing their own radius and creating a circle before dividing this circle into sections and practising art techniques using a medium of their choice. This activity is intended as an opportunity for students to explore and experiment with new shading techniques as well as using equations of circles.

Big Idea

Shading techniques and measurement of circles

Learning Goals

1. I can explore shading techniques and colour mixing.
2. I can calculate the area and circumference of a circle.
3. I understand the definition of a circle.
4. I understand that the length of the radius can be calculated as the distance between the centre and any point on the circle.

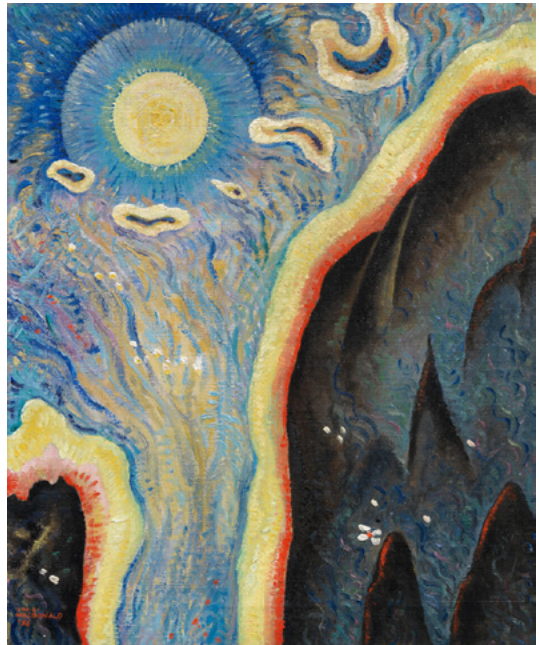


Fig 13. Jock Macdonald, *Day Break (May Morning)*, c.1937. Beginning in 1936, Macdonald created a series of abstract paintings inspired by nature that he called modalities.

Materials

- Chalkboard and chalk, or whiteboard and markers
- Colour-making medium of choice (oil pastels, chalk pastels, pencil crayons, or paints)
- [Jock Macdonald Image File](#)
- Paper
- Projector
- Rulers
- Scissors
- Thin pieces of cardboard, approximately 8½ x 11 inches in size (recycled cereal boxes are one possibility)
- “Who Was Jock Macdonald?” biographic information sheet ([page 2](#))

Learning Activity #1 Continued

Process

1. Introduce students to Jock Macdonald using the biographic information sheet ([page 2](#)), and project the paintings *Departing Day*, 1935, and *Etheric Form*, 1936. Prompt students to look for circles within Macdonald's artworks, and discuss the tone of the artworks. How do colours, circles, and curved lines affect tone? What words might you choose to describe the tones—are they calm, vibrant, energetic?
2. Review the definition of a circle with students: it is defined as a set of points on a plane at a constant distance around a fixed centre. Have students put a dot close to the middle of their cardboard and select a length for their radius. Ask students to measure this length out from the centre point and place another dot. Give students time to repeat this process to create the outline of the circle (students may use compasses to complete the circle or draw it freehand after having marked a series of dots).
3. Have students cut out their circles, and then ask them to draw straight lines from the centre point to the edge to divide the circle into different-sized pie pieces. Give students time to experiment using a different colour or mark-making technique in each slice of the pie. Techniques might include blending, cross-hatching, stippling, hatching, scumbling, or their own pattern or mark choices; consider modelling specific techniques for the class (see Additional Resources [[page 11](#)]).
4. Review the formulas for calculating the area and circumference of a circle (see Formulas for Area and Circumference handout [[page 11](#)]) and go through a few examples with the class to prepare students for independent work.
5. Ask students to calculate the area and circumference of their circles and write their calculations on the back of their circles or on a separate piece of paper. If desired, display the created circles and their equations in the classroom as a gallery exhibit.



Fig 14. Jock Macdonald, *Departing Day*, 1935. This painting represents an abstracted evening sky—Macdonald was interested in discoveries about the solar system.

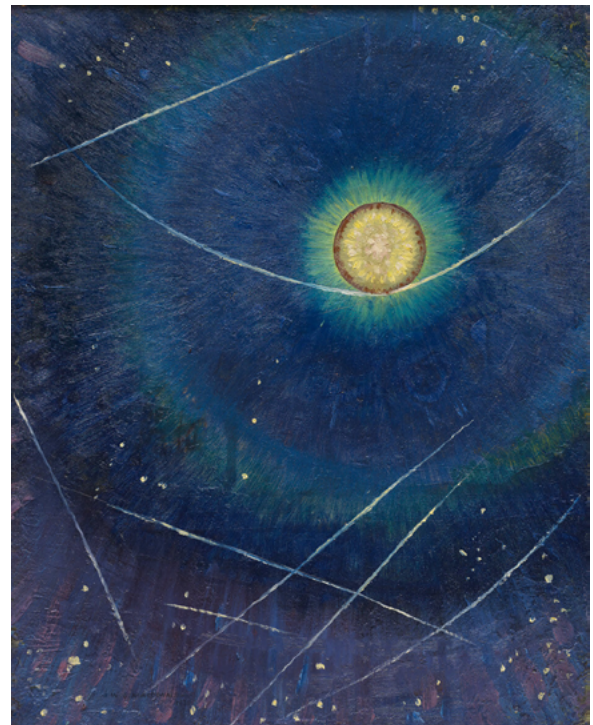


Fig 15. Jock Macdonald, *Etheric Form*, 1936 (dated 1934). In this work Macdonald uses fine lines and a glowing circle to represent a symbolic image of balance in the universe.

LEARNING ACTIVITY #2

EQUATIONS OF CIRCLES AND CIRCULAR ARTWORKS

Jock Macdonald created several geometric paintings inspired by nature and the seasons. Building from a discussion of Macdonald's painting *Fall (Modality 16)*, 1937, a work with strong design elements, this activity will introduce the abstract interpretation of a landscape scene containing circles. Students will investigate circles placed on a coordinate plane and draw on their knowledge of the Pythagorean theorem to investigate how to use an equation to describe a circle. They will use this equation to calculate the radius when given the coordinates of a point on the circle and its centre. Finally, students will analyze their own artworks and share their findings with peers.

Big Idea

Abstract compositions and equations of circles

Learning Goals

1. I can define abstract art.
2. I can create an abstract composition inspired by a landscape.
3. I understand that circles are defined in space by the location of the centre and the length of the radius.
4. I understand that the length of the radius can be calculated as the distance between the centre and any point on the circle.
5. I understand how these components are expressed in the equation of a circle.

Materials

- Colour medium of choice (such as oil pastels or coloured pencils)
- Grid paper copied onto acetate sheets, or access to Desmos (see Additional Resources [[page 11](#)]) and cameras or cellphones to upload images
- [Jock Macdonald Image File](#)
- Landscape images (from the [Jock Macdonald Image File](#), supplied by the teacher, or brought in by students)
- Paper
- Pencils
- Projector
- "Who Was Jock Macdonald?" biographic information sheet ([page 2](#))

Process

1. Introduce students to Jock Macdonald using the biographic information sheet, and project his painting *Fall (Modality 16)*, 1937. Discuss the elements and principles of design with a focus on the painting's composition, and encourage students to consider how decisions such as colour choices, mark making, and organic versus geometric styles affect the feeling of the artwork. What is the mood of *Fall (Modality 16)*?



Fig 16. Jock Macdonald, *Fall (Modality 16)*, 1937. This painting is dominated by abstract forms, but close looking reveals a tree, leaf, and butterfly.

Learning Activity #2 Continued

2. Have students select a landscape image of their choice: possibilities include Macdonald's paintings *The Black Tusk*, *Garibaldi Park*, 1934, or *Yale Valley, B.C.*, c.1932, or images provided by the teacher or brought in by students. Ask students to create an abstract interpretation of their image using lines, shapes, and a minimum of one full circle. (If desired, the circle could be created by tracing the cut-outs made during Learning Activity 1 [page 4].)

3. Show students the image of *Fall* (Modality 16) that has been placed on a coordinate grid (see [Jock Macdonald Image File](#)). Ask students to identify what is similar about the circles in the painting and what is different. Possible points to observe may include the following: area, circumference, colour, radius, and diameter.



Fig 17. Jock Macdonald, *The Black Tusk, Garibaldi Park*, 1934. Macdonald began painting in oil because he wanted a new medium to work with when capturing the dramatic landscape in B.C.



Fig 18. Jock Macdonald, *Yale Valley, B.C.*, c.1932. In the early 1930s Macdonald was interested in making his landscapes more powerful and energetic.

4. Ask students what would be an easy and efficient way to describe the location and size of a circle. Through discussion, come to the conclusion that a circle is described mathematically using the location of its centre on a coordinate plane and the length of its radius.

5. Using the Equations of Circles Handout (page 12), lead students in a guided discussion to determine the equation of a circle in Macdonald's painting. Emphasize that if the centre of a circle has the coordinates (h, k) and the circle has a radius r , the equation of the circle would be $(x-h)^2+(y-k)^2=r^2$.

6. Have each student upload an image of his or her artwork to Desmos to analyze the equations of circles in their own works (this exercise can also be done by placing acetate graph paper over top of the artwork). Students can also calculate the area and circumference of their circles (see Learning Activity 1 [page 4]).

7. Give students an opportunity to share their works, and discuss decisions made throughout the process of creating their images and completing their math analyses. Display the landscapes and equations as a gallery exhibit or in preparation for a celebration of learning event.

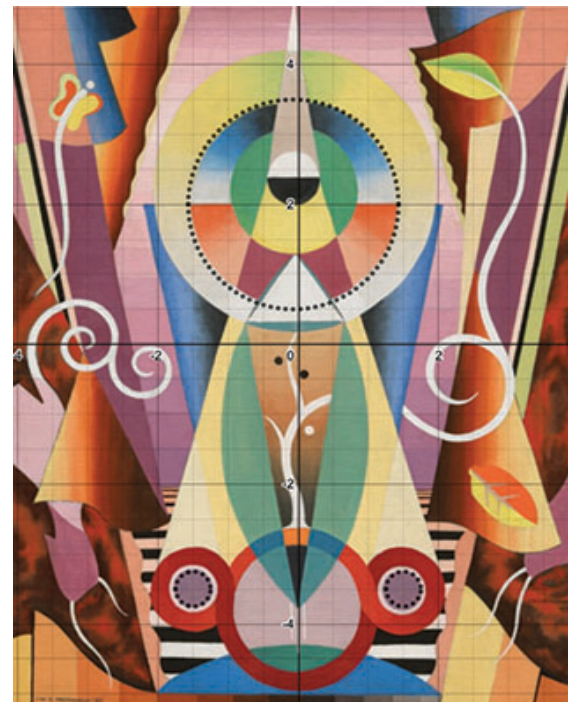


Fig 19. Jock Macdonald's *Fall (Modality 16)*, 1937, shown with a coordinate grid demonstrating how to analyze the equation of a circle using Desmos.

CULMINATING TASK

COLLABORATIVE CIRCLE ART AND MATH PROJECT

This task is designed to build community in the classroom by having students work together to demonstrate their learning, taking their learning from previous activities to create a collaborative Art of Math Circle artwork inspired by Jock Macdonald. Students will create individual circles, adding colour by using a variety of mark-making techniques and materials, and they will use their circles to make an intentional contribution to a larger collaborative artwork. Once the artwork is completed, students will select two circles and access an online graphing software (such as Desmos) to determine the equations of the circles (alternatively, students can use acetate graph paper). This personalized approach creates a deeper understanding of math concepts and exploration of art materials.

Big Idea

Creating artworks and equations of circles together

Learning Goals

1. I can describe the shading techniques I have used.
2. I can explain the rationale for my placement of my circles within the collaborative artwork with reference to the elements and principles of design.
3. I can determine the equation of my circle based on the location of its centre and its radius.
4. I can explain to my peers the components of the equation.

Success Criteria

To be added to, reduced, or changed in collaboration with students.

1. Individual circles effectively demonstrate three or more colour mixing and shading techniques.
2. Compositions successfully use the elements and principles of design while contributing a minimum of one circle to the collaborative work.
3. Circles are successfully uploaded to Desmos, scale is adjusted accurately, and equations are calculated correctly.
4. Final reports clearly communicate the process used to determine the equations of circles.



Fig 20. Jock Macdonald, *Birth of Spring*, 1939. In this painting Macdonald tried to break away from using structured, straight lines in his work.

*Culminating Task Continued***Materials**

- Colour-making medium of choice (such as oil pastels, chalk pastels, pencil crayons, or paints)
- Glue
- [Jock Macdonald Image File](#)
- Large paper for whole-class collaboration or several large papers for group artworks
- Projector
- Ruler
- Scissors
- Thin pieces of cardboard, approximately 8½ x 11 inches in size (recycled cereal boxes are one possibility)

Process

1. Project Jock Macdonald's painting *Spring Awakening*, c.1938, and lead students in a discussion about the effect of circles in visual art (see Learning Activity 1 [\[page 4\]](#) and Learning Activity 2 [\[page 6\]](#) for suggestions).
2. Ask students to create three separate circles of different sizes (following Steps 2–4 of Learning Activity 1 [\[page 4\]](#)). Encourage students to use a variety of techniques and experiment with a different medium on each circle.
3. Have students glue their circles to the large collaborative class artwork. Give students time to add background colours and designs to connect the circles so that there is a sense of unity within the piece.
4. Have students select two circles within the collaborative artwork and take a photo of each to upload to Desmos. If not using Desmos, print out the images and place acetate graph paper on top.
5. Ask students to adjust the scale of their graph in Desmos so that it is true to the dimensions of their circles, and then have students determine the equations for their circles and include the circles on their Desmos image. Ask students to print a screenshot of their Desmos work.
6. Give students time to write artist statements sharing their effective use of the elements and principles of design and their creative techniques; students should also explain the process they used to determine the equation of their circles.



Fig 21. Jock Macdonald, *Spring Awakening*, c.1938. One of a series of paintings representing the seasons, this work is strongly geometric in style.

HOW JOCK MACDONALD MADE ART: STYLE & TECHNIQUE

Here are a few of the important artistic concepts that characterize the art of Jock Macdonald. For more information see the [Style & Technique](#) chapter of *Jock Macdonald: Life & Work*.

PAINTING THE LANDSCAPE

Macdonald painted landscapes while growing up in Thurso, Scotland, making watercolour sketches outdoors. When he arrived in Vancouver, his friend F.H. Varley (1881–1969) encouraged him to switch to oil paints to better capture the powerful forms of British Columbia’s mountains and forest. As he gained confidence, Macdonald used painting to connect with nature and his environment. *The Black Tusk, Garibaldi Park, B.C.*, 1932, for example, shows the complex colours of a glacier and the dramatic way rocks can contrast with sky. Even after Macdonald became an abstract painter, the landscape continued to be a source of inspiration.



Fig 22. Jock Macdonald, *The Black Tusk, Garibaldi Park, B.C.*, 1932. Macdonald and Varley often painted in Garibaldi Park together.

ABSTRACTION AND THE NATURAL WORLD

In autumn 1936, Macdonald experienced a “breakthrough” in his art, and he developed a new approach to painting. Still inspired by the natural world, he was fascinated by scientific discoveries and the geometry of natural forms, and he believed that art should reflect current understandings of reality and of the physical and spiritual forces that shape the universe. Macdonald drew on his experiences of nature to create a personal form of abstraction. His first experiments in this new style—oil paintings that often include planets and suns or geometric forms—he called “modalities.” Some contain sharp, smoothly painted elements, while in others the paint is thicker and Macdonald’s brushstrokes are more visible.

AUTOMATIC WATERCOLOURS

Automatic painting is a form of painting in which the artist tries not to use his or her conscious mind, instead allowing the unconscious to control the paint. Macdonald was introduced to this approach in 1944, and it offered him a method of self-expression through the free association of forms and colours. For his first automatic paintings Macdonald used watercolours, a medium that is quick to work with and that allows an artist to easily add layers or washes of transparent colour to create different shapes and compositions.



Fig 23. Jock Macdonald, *The Wave*, 1939. For this modality, Macdonald mixed sand into his paint.

LATE ABSTRACT PAINTINGS

In the 1950s, as a member of the abstract artists’ group [Painters Eleven](#), Macdonald used new materials to translate the freedom of his automatic paintings to large canvases. Paints developed for industrial uses—in particular Duco and Lucite 44—were more fluid than traditional oils. Macdonald could dilute them to make them more transparent and use longer brushes to apply his paint, giving him more flexibility than the short, stiff brushes he had used before. His final paintings are light, delicate, and ethereal. Like his earlier modalities, these works were intended to speak to the spiritual in nature, and with them Macdonald felt he was really “finding his stride.”



Fig 24. Jock Macdonald, *Untitled*, c.1948. Macdonald’s automatic paintings were widely admired by other artists.

ADDITIONAL RESOURCES

Supplementary Materials Provided by the Art Canada Institute

- The online art book *book Jock Macdonald: Life & Work* by Joyce Zemans: <https://aci-iac.ca/art-books/jock-macdonald>
- [Jock Macdonald Image File](#) with artworks and images related to this lesson
- “Who Was Jock Macdonald?” biographic information sheet ([page 2](#))
- Timelines of national and world events and Jock Macdonald’s life ([page 3](#))
- “How Jock Macdonald Made Art: Style & Technique” information sheet ([page 10](#))
- Equations of a Circle Handout ([page 12](#))
- Jock Macdonald’s Lecture “Art in Relation to Nature,” 1940, a text that explores his interest in art, science, and math (including Pythagoras): <https://aci-iac.ca/wp-content/uploads/2020/10/jock-macdonald-art-in-relation-1940.pdf>

GLOSSARY

Here is a list of terms that appear in this resource guide and are relevant to the learning activities and culminating task. For a comprehensive list of art-related terms, visit the Art Canada Institute’s ever-growing [Glossary of Canadian Art History](#).

automatism

A physiological term first applied to art by the Surrealists to refer to processes such as free association and spontaneous, intuitive writing, drawing, and painting that allow access to the subconscious without the interference of planning or controlled thought.

Painters Eleven

An artists’ group active from 1953 to 1960, formed by eleven Abstract Expressionist Toronto-area painters, including Harold Town, Jack Bush, and William Ronald. They joined together in an effort to increase their exposure, given the limited interest in abstract art in Ontario at the time.

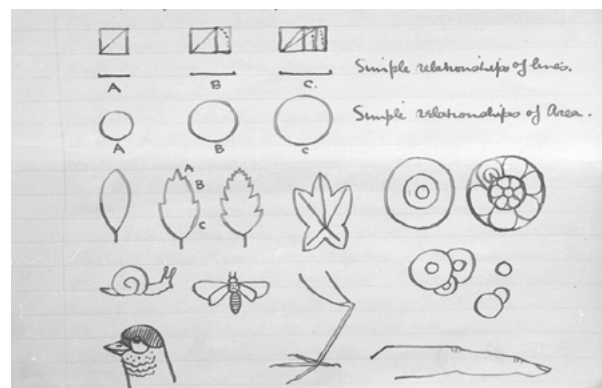


Fig 25. Jock Macdonald, notes for “Art in Relation to Nature,” 1940. Macdonald’s lecture notes include geometric diagrams.

EXTERNAL RESOURCES

The following external resources can be used to augment the learning activities and materials provided by the Art Canada Institute. They are to be used at the teacher’s own discretion.

Formulas for Area and Circumference

<https://www.eqao.com/en/assessments/grade-9-math/assessment-docs/g9-formula-sheet-academic.pdf>

Desmos (Online Graphing Calculator)

<https://www.desmos.com/calculator>

How to Upload an Image to Desmos

https://drive.google.com/open?id=0B7w_O_4KctSVbG9nb0IkRTY1WUusyVWVWQkVBVWgzX2l0aDhn

THE EQUATION OF CIRCLES

LEARNING GOALS

1. I can use mathematical vocabulary to describe a circle.
2. I can use the Pythagorean Theorem to develop the equation of a circle.
3. I can determine the equation of a circle given the location of its centre and the length of its radius.

KEY IDEA

Circles can be differentiated by their:

- a. Size (using the radius)
- b. Location (using the coordinates of the centre point)

INSTRUCTIONS

Compare and contrast the characteristics of the circles in Jock Macdonald's *Fall (Modality 16)*, 1937.



These circles are different sizes.

They would have a different circumference and area.

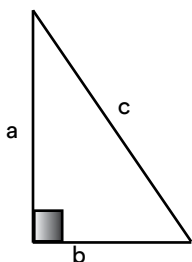
This group of circles have the same centre point.

The diameters are different.

The two smaller red circles are the same size, but have different locations in the artwork.

RECALL: Pythagorean Theorem

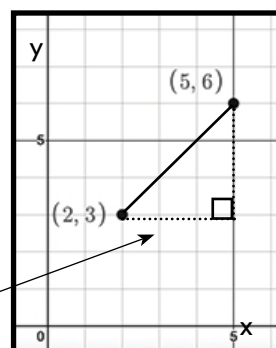
For any right-angled triangle, the relationship between the lengths of the sides is:



$$a^2 + b^2 = c^2$$

We can use the Pythagorean Theorem to find the length between two points by creating a right-angled triangle as pictured.

Distance Between Two Points



The height, or 'a' value, is the difference between the y-coordinates.

The base, or 'b' value, is the difference between the x-coordinates.

In this example:

$$a = 6 - 3 = 3$$

$$b = 5 - 2 = 3$$

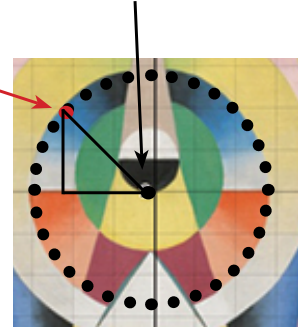
Therefore, the squared length of the line is $3^2 + 3^2 = 18$



Let's take a circle with its centre at the point (h, k) .

And a point on the circle with coordinates (x, y) .

Using these points to create a right-angled triangle means the radius of the circle is the hypotenuse of the triangle (c).



As mentioned on the previous page, the height of the triangle is the difference between the y -values.

Therefore, $a = y - k$.

Similarly, the base of the triangle is the difference between the x -values.

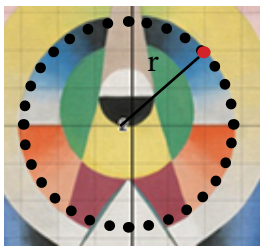
Therefore, $b = x - h$.

$$\text{And } c^2 = a^2 + b^2 \quad \text{OR} \quad c^2 = (y - k)^2 + (x - h)^2$$

Since ' c ' is the same as the radius of the circle, we can describe a circle with centre (h, k) and radius r using the following equation:

$$(x - h)^2 + (y - k)^2 = r^2$$

- ' r ' is the length of the radius
- (h, k) is the centre
- (x, y) are the coordinates of any point on the circle



Reading off the grid, the centre of this circle is $(-0.07, 2)$.

The red point on the circle is approximately $(1, 3)$.

Find the radius by substituting into the equation.

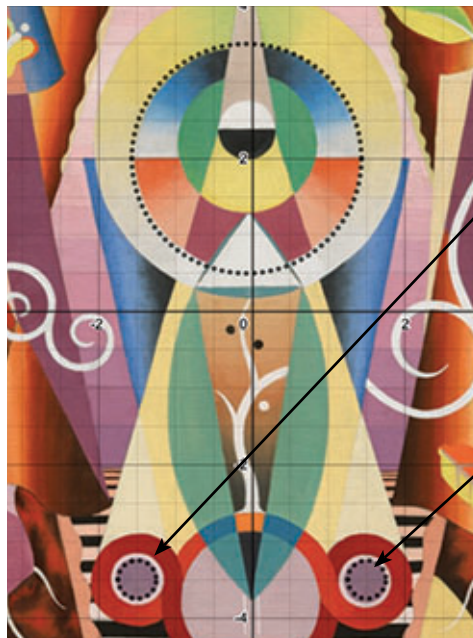
$$r^2 = (1 - (-0.07))^2 + (3 - 2)^2$$

$$r^2 = (1 + 0.07)^2 + (1)^2$$

$$r^2 = 2.1449$$

The equation of this circle is therefore:

$$(x + 0.07)^2 + (y - 2)^2 = 2.1449$$



Centre at $(-1.5, -3.5)$ and a radius of 0.25 .

$$(x + 1.5)^2 + (y + 3.5)^2 = 0.25^2$$

Centre at $(1.5, -3.5)$ and a radius of 0.25 .

$$(x - 1.5)^2 + (y + 3.5)^2 = 0.25^2$$

If r^2 is 2.1449 , then the length of the radius is the square root of 2.1449 or approximately 1.5 .

FIGURE LIST

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Fig 1. Jock Macdonald, *Chrysanthemum*, 1938, oil on canvas, 55 x 45.6 cm. McMichael Canadian Art Collection, Kleinburg, purchased 1993 (1993.26.2).

Fig 2. Photograph of Jock Macdonald. Collection unknown. Courtesy of Joyce Zemans.

Fig 3. Macdonald's trademark for the Canadian Handicraft Guild of British Columbia, date unknown. Collection unknown. Courtesy of Joyce Zemans.

Fig 4. Jock Macdonald, *In the White Forest*, 1932, oil on canvas, 66 x 76 cm. Art Gallery of Ontario, Toronto, purchase, 1975 (75/38). © Art Gallery of Ontario.

Fig 5. Jock Macdonald, *Russian Fantasy*, 1946, watercolour and ink on paper, 25.1 x 35.3 cm. Art Gallery of Ontario, Toronto, purchase, Peter Larkin Foundation, 1962 (61/45). © Art Gallery of Ontario.

Fig 6. Jock Macdonald, *Young Summer*, 1959, oil and Lucite 44 on canvas, 107.3 x 121.9 cm. Private collection. Photo credit: Kayla Rocca.

Fig 7. Albert Einstein in 1920. Courtesy: Wikicommons.

Fig 8. "Citizens Protest Police Terror," 1938. Royal BC Museum and Archives collections.

Fig 9. Members of the Painters Eleven during the Simpson's department store *Abstracts at Home* display, 1953. Collection of The Cahén Archives.

Fig 10. Jock and Barbara Macdonald, date and photographer unknown. Collection unknown. Courtesy of Joyce Zemans.

Fig 11. Jock Macdonald, *Flight*, 1939, oil on canvas, 36.5 x 46.4 cm. Private collection. Courtesy of the Vancouver Art Gallery. Photo credit: John Taylor.

Fig 12. Jock Macdonald, *Fish Playground*, 1946, watercolour on paper, 32 x 39 cm. Collection of the Alberta Foundation for the Arts (1973.013.002).

Fig 13. Jock Macdonald, *Day Break (May Morning)*, c.1937, oil on canvas, 56 x 46 cm. Private collection. Courtesy of the Vancouver Art Gallery. Photo credit: Trevor Mills, Vancouver Art Gallery.

Fig 14. Jock Macdonald, *Departing Day*, 1935, oil on wood panel, 71.5 x 56.1 cm. Art Gallery of Ontario, Toronto, purchase with assistance from Wintario, 1979 (79/60.1-.2.). © Art Gallery of Ontario.

Fig 15. Jock Macdonald, *Etheric Form*, 1936 (dated 1934), oil on panel, 38.1 x 30.5 cm. Vancouver Art Gallery, gift from an anonymous donor (2012.52.4). Photo credit: Rachel Topham, Vancouver Art Gallery.

Fig 16. Jock Macdonald, *Fall (Modality 16)*, 1937, oil on canvas, 71.1 x 61 cm. Vancouver Art Gallery, Acquisition Fund (93.71). Photo credit: Trevor Mills, Vancouver Art Gallery.

Fig 17. Jock Macdonald, *The Black Tusk, Garibaldi Park*, 1934, oil on board, 28.9 x 36.5 cm. British Columbia Archives, Royal British Columbia Museum Corporation, Victoria (PDP02138).

Fig 18. Jock Macdonald, *Yale Valley, B.C.*, c.1932, oil on canvas, 77 x 86.5 cm. Courtesy of John A. Libby Fine Art.

Fig 19. Jock Macdonald's *Fall (Modality 16)*, 1937, with a coordinate grid demonstrating how to analyze the equation of a circle using Desmos.

Fig 20. Jock Macdonald, *Birth of Spring*, 1939, oil on panel, 38.4 x 30.5 cm. Private collection. Courtesy of the Vancouver Art Gallery. Photo credit: Jeff Duns, Ingram Gallery.

Fig 21. Jock Macdonald, *Spring Awakening*, c.1938, oil on canvas, 76.2 x 70 cm. Private collection. Courtesy of the Vancouver Art Gallery. Photo credit: Ernest Mayer.

Fig 22. Jock Macdonald, *The Black Tusk, Garibaldi Park, B.C.*, 1932, oil on canvas, 71 x 90.8 cm. Vancouver Art Gallery, gift of Michael Audain and Yoshiko Karasawa (2004.24.1). Photo credit: Rachel Topham, Vancouver Art Gallery.

Fig 23. Jock Macdonald, *The Wave*, 1939, oil and sand on canvas, 102.2 x 82 cm. Montreal Museum of Fine Arts, purchased by the Horsley and Annie Townsend Bequest (2002.112). Photo credit: The Montreal Museum of Fine Arts, Christine Guest.

Fig 24. Jock Macdonald, *Untitled*, c.1948, oil on canvas, 69.8 x 83.8 cm. Art Gallery of Ontario, Toronto, purchase with assistance from Wintario, 1977 (77/61). © Art Gallery of Ontario.

Fig 25. "Art In Relation to Nature," notes for a lecture first delivered by Macdonald in February 1940. Collection of Marilyn Westlake Kuczer. Courtesy of the Art Gallery of Ontario, Toronto. Photo credit: Robert Keziere.