CHAPTER 5

Sine Functions

Vocabulary

amplitude
coterminal angles
cycle
initial arm
period
periodic function
phase shift
sine curve
sine function
standard position
terminal arm
terminal point
unit circle

Curriculum Expectations

Trigonometric Functions

By the end of this course, students will:

2.1 describe key properties of periodic functions arising from real-world applications, given a numeric or graphical representation

2.2 predict, by extrapolating, the future behaviour of a relationship modelled using a numeric or graphical representation of a periodic function

2.3 make connections between the sine ratio and the sine function by graphing the relationship between angles from 0° to 360° and the corresponding sine ratios, with or without technology, defining this relationship as the function $f(x) = \sin x$, and explaining why the relationship is a function

2.4 sketch the graph of $f(x) = \sin x$ for angle measures expressed in degrees, and determine and describe its key properties (i.e., cycle, domain, range, intercepts, amplitude, period, maximum and minimum values, increasing/decreasing intervals)

2.5 make connections, through investigation with technology, between changes in a real-world situation that can be modelled using a periodic function and transformations of the corresponding graph

2.6 determine, through investigation using technology, and describe the roles of the parameters a, c, and d in functions in the form $f(x) = a \sin x$, $f(x) = \sin x + c$, and $f(x) = \sin (x - d)$ in terms of transformations on the graph of $f(x) = \sin x$ with angles expressed in degrees (i.e., translations, reflections in the x-axis, vertical stretches and compressions)

2.7 sketch graphs of $f(x) = a \sin x$, $f(x) = \sin x + c$, and $f(x) = \sin (x - d)$ by applying transformations to the graph of $f(x) = \sin x$, and state the domain and range of the transformed functions

3.1 collect data that can be modelled as a sine function, through investigation with and without technology, from primary sources, using a variety of tools, or from secondary sources, and graph the data

3.2 identify periodic and sinusoidal functions, including those that arise from real-world applications involving periodic phenomena, given various representations (i.e., tables of values, graphs, equations), and explain any restrictions that the context places on the domain and range

3.3 pose and solve problems based on applications involving a sine function, and solve these and other problems by using a given graph or a graph generated with technology from a table of values or from its equation

Chapter 5 Planning Chart

Section	Suggested Timing	Student Text Page(s)	Materials and Technology Tools
Chapter 5 Opener	10–15 min	228–229	
Prerequisite Skills	80 min	230–231	• grid paper • protractors • scientific calculators
5.1 Periodic Functions	80 min	232–238	• grid paper • graphing calculators (optional)
5.2 Circles and the Sine Ratio	80 min	239–247	• grid paper • protractors • scientific calculators • computers with *The Geometer's Sketchpad*® (optional) • Cabri Jr™ (optional)
5.3 Investigate the Sine Function	80 min	248–253	• clear tape • compasses • elastic bands • graphing calculators • grid paper • large sheets of grid paper • markers • paper plates • pieces of paper 14.0 cm by 21.5 cm • protractors • rulers • tennis balls
5.4 Investigate Transformations of Sine Curves	160–240 min	254–263	• CBR™ (calculator-based ranger) • chalk • graphing calculators • grid paper • link cable
5.5 Make Connections With Sine Functions	80 min	264–267	• graphing calculators
Chapter 5 Review	80 min	268–269	• graphing calculators • grid paper
Chapter 5 Problem Wrap-Up	40 min	269	• graphing calculators
Chapter 5 Practice Test	80 min	270–271	• graphing calculators • grid paper
Task: Model the Rotation of the Earth on its Polar Axis	80–160 min	272–273	• grid paper
Chapters 4 and 5 Review	80 min	274–275	• graphing calculators • grid paper

Chapter 5 Blackline Masters Checklist

	BLM	Title	Purpose
Prerequisite Skills			
	BLM G–1	Grid Paper	Student Support
	BLM 5–1	Prerequisite Skills	Practice
	BLM 5–2	Prerequisite Skills Self-Assessment Checklist	Student Self-Assessment
5.1 Periodic Functions			
	BLM G–1	Grid Paper	Student Support
	BLM A–4	Presentation Checklist	Assessment
	BLM 5–3	Section 5.1 Periodic Functions	Practice
	BLM 5–4	Section 5.1 Achievement Check Rubric	Assessment
5.2 Circles and the Sine Ratio			
	BLM G–1	Grid Paper	Student Support
	BLM A–9	Communication General Scoring Rubric	Assessment
	BLM 5–5	Section 5.2 Communicate Your Understanding	Student Support
	BLM 5–6	Section 5.2 Circles and the Sine Ratio	Practice
5.3 Investigate the Sine Function			
	BLM G–1	Grid Paper	Student Support
	BLM A–17	Learning Skills Checklist	Assessment
	BLM 5–7	Section 5.3 Investigate B	Student Support
	BLM 5–8	Section 5.3 Investigate the Sine Function	Practice
5.4 Investigate Transformations of Sine Curves			
	BLM G–1	Grid Paper	Student Support
	BLM T–6	Using the CBR™ (Calculator-Based Ranger)	Technology
	BLM 5–9	Section 5.4 Investigate Transformations of Sine Curves	Practice
	BLM 5–10	Section 5.4 Achievement Check Rubric	Assessment
5.5 Make Connections With Sine Functions			
	BLM A–8	Application General Scoring Rubric	Assessment
	BLM 5–11	Section 5.5 Make Connections With Sine Functions	Practice
Chapter 5 Review			
	BLM G–1	Grid Paper	Student Support
	BLM 5–12	Chapter 5 Review	Practice
Chapter 5 Problem Wrap-Up			
	BLM 5–13	Chapter 5 Problem Wrap-Up Rubric	Summative Assessment
Chapter 5 Practice Test			
	BLM G–1	Grid Paper	Student Support
	BLM 5–14	Chapter 5 Practice Test	Diagnostic Assessment
	BLM 5–15	Chapter 5 Test	Summative Assessment
	BLM 5–16	Chapter 5 Practice Test Achievement Check Rubric	Assessment
Task: Model the Rotation of the Earth on its Polar Axis			
	BLM 5–17	Chapter 5 Task Rubric	Assessment
Chapters 4 and 5 Review			
	BLM G–1	Grid Paper	Student Support
	BLM A–13	Self-Assessment Recording Sheet	Student Self-Assessment
	BLM A–14	Self-Assessment Checklist	Student Self-Assessment
	BLM 5–18	Chapter 5 BLM Answers	Answers

Prerequisite Skills

Student Text Pages
230–231

Suggested Timing
80 min

Materials and Technology Tools
• grid paper
• protractors
• scientific calculators

Related Resources
• BLM G–1 Grid Paper
• BLM 5–1 Prerequisite Skills
• BLM 5–2 Prerequisite Skills Self-Assessment Checklist

Common Errors

• Some students may use the incorrect sides when applying the trigonometric ratios.

R_x Have students sketch a diagram and use the memory device SOH CAH TOA. Encourage students to explain how they determine the opposite and adjacent sides.

• Some students may not use the inverse trigonometric functions on their calculators to solve for an angle.

R_x Have students solve a few problems for the sides and the angles, walking them through the keystrokes for their particular calculator.

Accommodations

Visual–provide students with enlarged copies of the triangles for **questions 1 to 3**. Encourage students to label the hypotenuse and the sides opposite and adjacent to the angle of interest.

Perceptual–for **question 9**, encourage students to sketch a graph of $y = x^2$ and the image of $y = x^2$ after the transformation(s) before they write the equation of the transformed function

Motor–encourage students to work with a partner when using technology

Teaching Suggestions

• Use the Prerequisite Skills exercise as a diagnostic tool to check where students need help preparing for chapter 5.
• Remind students of the three primary trigonometric ratios.
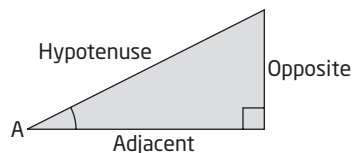
$$\sin A = \frac{\text{opposite}}{\text{hypotenuse}}$$
$$\cos A = \frac{\text{adjacent}}{\text{hypotenuse}}$$
$$\tan A = \frac{\text{opposite}}{\text{adjacent}}$$

• Students may not recall the meaning of the word *adjacent*. Remind students that *adjacent* means *beside*, but that it is not the hypotenuse.
• Have copies of **BLM G–1 Grid Paper** available for students to use.
• You may wish to wait until students have completed Section 5.1 to 5.3 before assigning Prerequisite Skills **questions 9, 10, and 12**.
• Use **BLM 5–1 Prerequisite Skills** for remediation or extra practice. To further reinforce the concepts, you may wish to refer students to specific skills in the **Prerequisite Skills Appendix** on student text pages 420–435.

Assessment

• Assess student readiness to proceed by informal observation as students are working on the questions. A formal test would be inappropriate since this material is not part of the curriculum to be covered by this chapter.
• Student self-assessment is also an effective technique; students can place a checkmark beside topics in the Prerequisite Skills in which they feel confident with the necessary skills. Use **BLM 5–2 Prerequisite Skills Self-Assessment Checklist** as a self-assessment for students.
• Remedial action can be taken in small groups or with a whole-class skills review.

Chapter Problem

• The Chapter Problem is introduced in the Chapter 5 Opener. Have students discuss their understanding of the topic. You may wish to have students complete the Chapter Problem revisits that occur throughout the chapter. These questions are designed to help students move toward the Chapter 5 Problem Wrap-Up at the end of the Chapter 5 Review.
• Alternatively, you may wish to assign the Chapter Problem when students have completed the chapter. The Chapter Problem is a summative assessment.