

CASE 2

Swimming Robot

Nezha Inventor's Kit V2 — STEAM Lesson Plan

Grade 6–8

45–90 Minutes

STEM + Robotics

Motor Physics

5E Model

LESSON OVERVIEW

Category	Details
Subject	STEM, Robotics, Computer Science
Grade Level	6–8
Time Required	1–2 periods (45–90 minutes)
Kit	ElecFreaks Nezha Inventor's Kit V2
Key Concepts	Motors, Friction, Speed-Time-Distance, Propulsion
Approach	5E Learning Model: Engage → Explore → Explain → Elaborate → Evaluate

LEARNING OBJECTIVES

By the end of this lesson, students will be able to:

01 Design & Build	Design and build a functional swimming robot using the Nezha Inventor's Kit V2 that moves forward without wheels.
02 Understand Motors	Understand the basic principles of motor operation and how motors create movement through rotational force and propulsion.
03 Explore Friction	Explore the concept of friction and investigate its effect on the speed of a moving object in water versus on land.

04 Speed-Time-Distance

Investigate the relationship between speed, time, and distance — recording and analyzing robot performance data.

05 Problem-Solving

Develop problem-solving, collaboration, and critical thinking skills through iterative design and group testing.

MATERIALS & EQUIPMENT

REQUIRED	OPTIONAL / HELPFUL
<ul style="list-style-type: none"> • ElecFreaks Nezha Inventor's Kit V2 (one per group) 	<ul style="list-style-type: none"> • Computers/tablets for coding component
<ul style="list-style-type: none"> • Building blocks (structural pieces) 	<ul style="list-style-type: none"> • Student engineering journal
<ul style="list-style-type: none"> • Timers or stopwatches 	<ul style="list-style-type: none"> • Graph paper for data recording
<ul style="list-style-type: none"> • Markers or tape to create swimming track 	<ul style="list-style-type: none"> • Camera to record robot performances
<ul style="list-style-type: none"> • Water container / simulated swimming pool 	

PHASE 1 — ENGAGE

10 Minutes

- 1 Introduce the concept of swimming and its benefits — highlight swimming as a full-body exercise with low joint impact.
- 2 Pose discussion questions: 'What are the different ways animals and machines move in water?' or 'What challenges might a robot face moving through water?'
- 3 Show a video of competitive swimmers or robotic aquatic devices — spark curiosity and provide real-world visual context.

Teacher Tip: Encourage students to relate swimming mechanics to everyday experience — ask who swims, what makes swimming harder or easier, and how they think a robot might replicate those movements.

PHASE 2 — EXPLORE

20 Minutes

- 1 Divide students into small groups and provide Nezha Inventor's Kit V2 and building blocks — allow free exploration first.

- 2 Challenge students to brainstorm designs for a robot that moves forward without wheels — how can the motor create propulsion in water?
- 3 Guide students with discussion prompts: 'How can we use the motor to create movement in water?' and 'How do we test which design is most efficient?'

Key Focus: Encourage creative problem-solving and innovation. Resist over-guiding — let students experiment with propulsion concepts before the Explain phase.

PHASE 3 — EXPLAIN

15 Minutes

MOTORS & PROPULSION	FRICTION & SPEED-TIME-DISTANCE
<ul style="list-style-type: none"> • Motor converts electrical energy to rotation 	<ul style="list-style-type: none"> • Friction resists motion between surfaces/fluids
<ul style="list-style-type: none"> • Rotational force creates thrust in water 	<ul style="list-style-type: none"> • Water creates more resistance (drag) than air
<ul style="list-style-type: none"> • Propeller/paddle design affects efficiency 	<ul style="list-style-type: none"> • Speed = Distance ÷ Time
<ul style="list-style-type: none"> • Motor speed controlled by program settings 	<ul style="list-style-type: none"> • Streamlined shapes reduce drag, increase speed
<ul style="list-style-type: none"> • Direction determines forward/backward motion 	<ul style="list-style-type: none"> • Compare designs using timed trials

Teacher-Led Steps:

- 1 Each group shares their design ideas and explains their reasoning — encourage critical thinking and communication skills.
- 2 Review key concepts: Motors, Friction, and Speed-Time-Distance relationships with real-world examples from nature (fish, dolphins).
- 3 Introduce key vocabulary: motor, friction, speed, velocity, efficiency, propulsion, drag, buoyancy — use a word wall.

Motor | Friction | Propulsion | Drag | Buoyancy | Speed = Distance ÷ Time | Velocity = speed with direction

PHASE 4 — ELABORATE

30–40 Minutes

BUILD

Students build their swimming robots based on brainstormed designs. Focus on motor placement, paddle/propeller shape, and hull design for buoyancy and propulsion efficiency.

TEST

Students test robots in the swimming pool, timing each run. Record speed, time, and distance data. Use the class data table: Group name, Distance, Time, Speed (Distance \div Time).

REFINE

Encourage redesign and improvements based on testing results. What changes reduce drag? What improves propulsion? Iterate until performance improves — celebrate each improvement.

Speed Calculation: Speed = Distance \div Time (e.g. 50 cm \div 5 s = 10 cm/s) — have students calculate and compare group results.

Tip: Encourage students to sketch design iterations in their engineering journals — document what changed and why, not just the final result.

PHASE 5 — EVALUATE**15 Minutes****Robot Race Format:**

- 1 Hold robot races to compare designs — identify the fastest or most efficient robot in the class.
- 2 Students record speed, time, and distance data and create graphs or calculations to visually analyze results.
- 3 Students present their robots and reflect on their design process, challenges, and solutions to the class.
- 4 Class debrief: what design choices had the biggest impact? What did we learn about friction and propulsion?

Reflection Questions:

- "What design choice had the biggest impact on your robot's speed?"
- "How did friction affect your robot's performance in the water?"
- "What would you change if you redesigned the robot from scratch?"
- "How does your robot's motion compare to how fish or dolphins swim?"

Assessment Focus: Observe teamwork, problem-solving approach, and how students use data to make design decisions. Assess the quality of reflection, not just robot speed.

DIFFERENTIATION STRATEGIES

SUPPORT — Struggling Students	CHALLENGE — Advanced Students
<ul style="list-style-type: none"> • Simplify designs — focus on basic movement and friction 	<ul style="list-style-type: none"> • Introduce complex coding challenges for motor control
<ul style="list-style-type: none"> • Provide a pre-built base structure to start 	<ul style="list-style-type: none"> • Explore different propulsion systems (paddle vs propeller)
<ul style="list-style-type: none"> • Pair with a stronger engineering partner 	<ul style="list-style-type: none"> • Incorporate sensors for autonomous navigation
<ul style="list-style-type: none"> • Focus on observing and recording data only 	<ul style="list-style-type: none"> • Calculate theoretical vs actual speed — analyze differences
<ul style="list-style-type: none"> • Use land-based testing if water is unavailable 	<ul style="list-style-type: none"> • Optimize for minimum friction and maximum efficiency

EXTENSION ACTIVITIES

1. Research	Research different types of aquatic robots and how they are used in real-world applications — ocean exploration, marine rescue, underwater inspection. Present findings to the class.
2. Design Challenge	Design and build a robot that can perform a specific task in water — retrieving objects, navigating an obstacle course, or carrying a payload. Document mechanical changes needed.
3. Physics Deep-Dive	Investigate the physics of swimming: buoyancy (Archimedes' Principle), drag force, thrust, and how different shapes affect fluid resistance. Calculate drag and compare to results.

TEACHER NOTES

ADAPTABILITY	This lesson can be adapted to fit specific needs. For classrooms without water, use a smooth flat surface and simulate swimming friction. Adjust complexity based on grade level.
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SAFETY	Ensure water containers are stable and cannot tip. Keep electronics away from water at all times. Dry hands before handling the kit. Supervise water testing closely.
COLLABORATION	Highlight the importance of teamwork. Rotate roles each phase: Builder, Tester, Recorder, Presenter. Ensure all students have hands-on time with the kit and data recording.
ENCOURAGEMENT	Emphasize creativity and problem-solving throughout. Celebrate design iterations as learning — not failure. Connect results to how real engineers work in iterative cycles.

STANDARDS ALIGNMENT

Standard	Codes	Application in This Lesson
NGSS	MS-PS2-2, MS-ETS1-1, MS-ETS1-2, MS-ETS1-3	Forces & Engineering Design — apply Newton's laws to robot motion; evaluate solutions with test data
CSTA	1B-AP-10, 2-AP-11, 2-AP-12	Algorithms & Programming — loops and events to control motor-driven robot movement
CCSS Math	7.RP.A, 6.EE.C	Ratios & Rates — apply $\text{speed} = \text{distance} \div \text{time}$; graph and analyze timed performance data
Phys. Sci.	MS-PS2-1, MS-PS2-2	Motion & Stability — investigate friction as a force; analyze how net force affects motion in water

TECHTELLIGENCE — Empowering Students Through STEAM + Robotics

This lesson plan was created for use with the ElecFreaks Nezha Inventor's Kit V2. For more curriculum resources, visit

techtelligence.ae