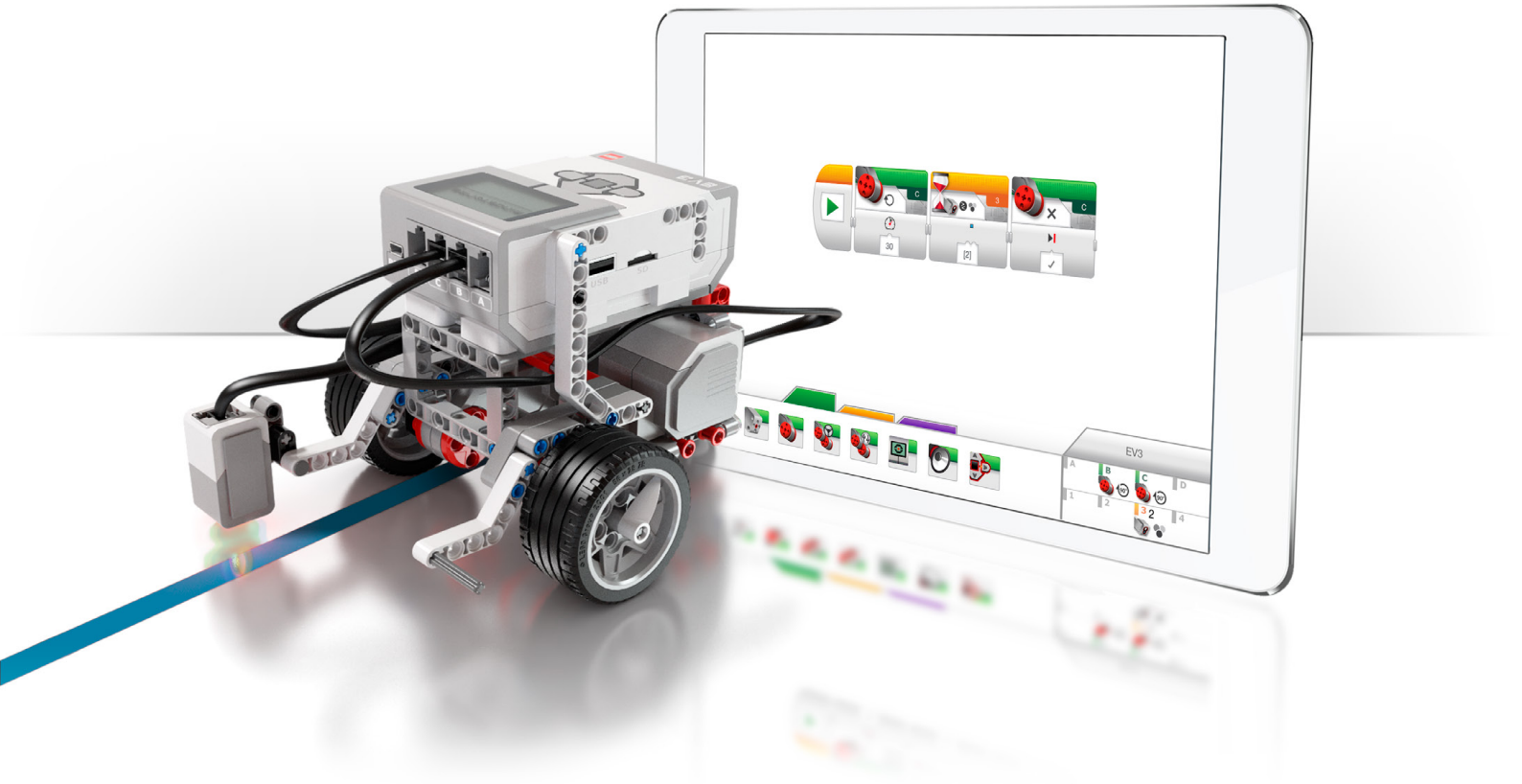
INTRODUCTION TO ROBOTICS LESSON PLAN

USING THE EV3 PROGRAMMING APP



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LEGO mindstorms education EV3

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Introduction to Robotics Lesson Plan

This Lesson Plan provides you as an educator with a step-by-step procedure for how to use the EV3 Programming App with the classroom-based lessons. Each lesson and challenge will give you the help you need to prepare, run, and assess the class. It is up to you to select which and how many of the provided extra tasks and challenges you will use in your Robotics course. In the Design Brief Challenges section you will find a range of open-ended ideas that encourage a more exploratory approach compared to the tutorials. You can either start your course by focusing on some of the Design Brief Challenges, letting students know in which tutorials and sections of the help text they can find help and inspiration OR you can have students complete them after a more structured start using the tutorials.

Before Starting the First Lesson

If you have never worked with LEGO® MINDSTORMS® Education EV3 before, you should ensure the following:

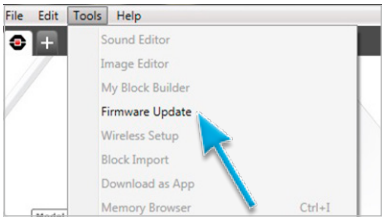
1. Each tablet has a preinstalled version of the LEGO MINDSTORMS Education EV3 Programming App.

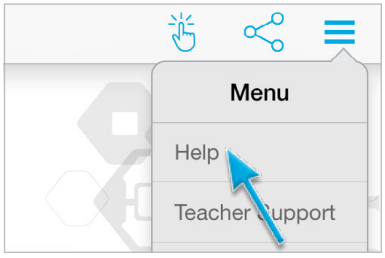
2. Each EV3 Brick has the latest firmware and is fully charged. To install firmware, you need a desktop version of the EV3 Software. For more instructions, refer to the User Guide, which you can access from the Menu.

3. Before connecting tablets and EV3 Bricks via Bluetooth in the classroom, we recommend renaming each EV3 Brick. This can be done in two ways:
   a. Update the name via the desktop EV3 Software using a USB cable.
   b. Update to firmware V1.07E or later and change the name via the EV3 Brick Settings Area (see the User Guide for more help).

4. Check out the Quick Start Video from the Menu.

Firmware Update





You may want the students to understand the names and functions of the different elements in the brick set. Discuss the naming and basic functionality of the key hardware components and establish a set of brick management rules. A copy of the 45544 LEGO MINDSTORMS Education EV3 Core Set Elements List is included in the User Guide. The User Guide is your source for everything relating to the LEGO MINDSTORMS EV3 Hardware.

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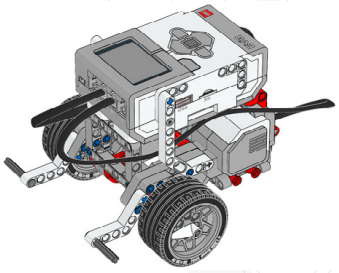
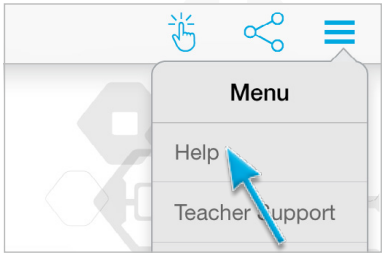
Lesson 1 – Building and Setup





Objective
After completing this lesson, students will be able to build the Driving Base, connect the tablet to the EV3 Brick, and download and run programs that control the robot's behavior.

Duration
2 to 3 x 45 mins.

Preparation
Understand the process of connecting a tablet to the EV3 Brick. Watch the Quick Start Video for guidance. Distribute one EV3 Core Set and one tablet with EV3 Programming App installed per 2-3 students. Optional: Cardboard, textiles, and other materials for personalizing the robots.

Procedure

1. Students build the Robot Educator Driving Base using the Building Instructions booklet (included with the 45544 Core Set) or the App-integrated Building Instructions available via the buttons on page 2 of each tutorial.

   Optional: An effective way of allowing students to take ownership of their robot is to have them personalize it using additional LEGO elements and other material. By doing this, they can turn their robot into a puppy, elephant, or even a fantasy creature.

2. As a class, go through the process of connecting the tablet with the EV3 Brick and running the first program OR direct the students to the Quick Start Video, which will help them to connect the devices for themselves.

3. Students use the Programming App to make simple programs that
   a. make their robot play a sound that is appropriate for their creature;

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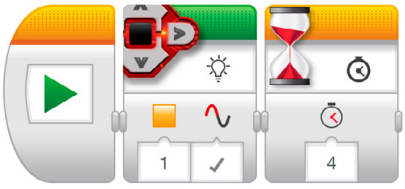
b. make their robot display an image or their own text in the EV3 Brick Display; and

c. make their robot flash the Brick Status Light.



Assessment

Observe and/or ask questions to determine if the students

- follow the building instructions to successfully construct the Driving Base;
- connect and download programs;
- manage to create and run simple programs; and
- work cooperatively to solve the tasks.

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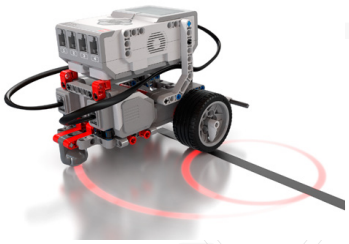
Lesson 2 – Curved Move



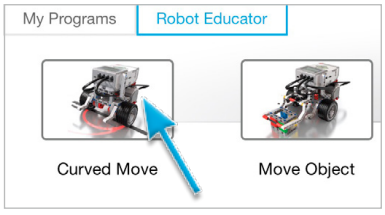
Objective
After completing this lesson, students will be able to navigate their robot through an obstacle course. By selecting the correct programming blocks and setting their parameters, students will know how and when to use point turns, single-motor turns, and curved turns.

Duration
2 to 3 x 45 mins.

Preparation
For task 5b you will need rubber bands to allow students to attach a pen to their Robot. For task 5c you will need to prepare an obstacle course on the floor. You can use a large sheet of paper and markers or place sticky tape on the floor (see illustration below).

Procedure

1. Introduce students to the Lobby of the EV3 Programming App. Students need to know where to find a given Robot Educator tutorial and how to open it. Demonstrate the flow of one tutorial to ensure that students know their way around the tutorials in combination with the Programming Canvas and Hardware Page (see also the Quick Start Video).



2. Students complete the **Curved Move** tutorial, which introduces the Move Steering Block.

3. In the "Test It" phase, the students will open a sample program (this will close the current tutorial). Ensure each group takes the time to describe the robot's behavior when running the provided sample program using their own words. This encourages the students to reflect on what they see and how that relates to the programming blocks. They can use the Comment Box provided on the canvas.

   The following sample program is provided for the students:

   Example of robot behavior description:
   The robot performs a point turn, then a single-motor turn, and last, a curved turn. Each action is separated by a pause, which allows the robot to settle before executing the next action.

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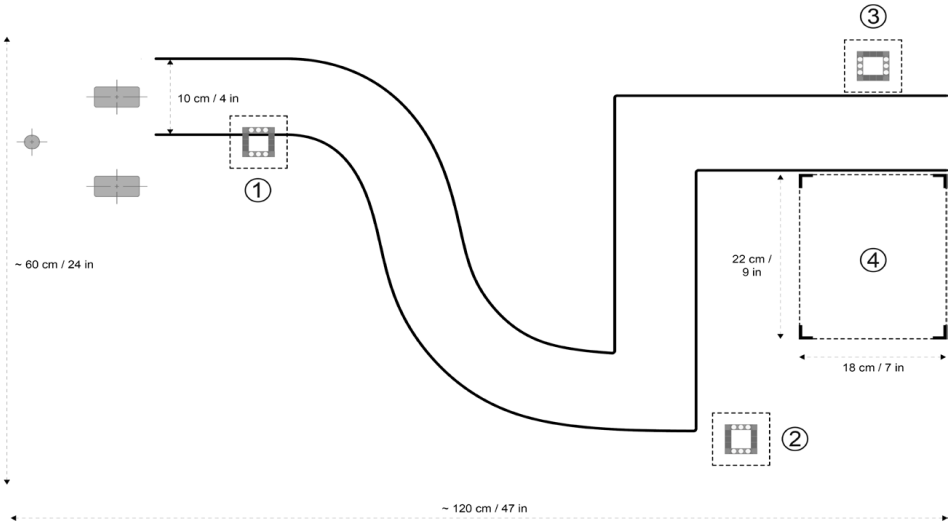
4. Students solve the “Modify It” task, which challenges them to add three Move Steering Blocks to their program in order to make the robot drive backward, following the same path back to the starting position.

5. Lesson Challenge Ideas:
    a. Program the robot to trace out a figure eight or the first letter of your name (or some other letter or number).
    b. Attach a pen to the robot and program it to draw a cloverleaf, heart, flower, or some other shape.
    c. To ensure that students know when to use different kinds of turns (point turn, single-motor turn, or curved turn), make an obstacle course that requires different turning methods (see illustration below and/or Appendix A). The students must write a program that makes the left wheel of the robot follow a path and parks the robot in the parking area.



For this path use curved turns for the first section, followed by single-motor turns for the 90-degree turns, and finally, a point turn before reversing the robot into the parking area.

Assessment

Observe and/or ask questions to determine if the students
- set the Steering Parameter Value to 50 to perform a single-motor turn;
- set the Steering Parameter Value to 100 or -100 to perform a point turn;
- manage to describe the robot behavior in relation to the program in as much detail as possible;
- for the Lesson Challenges
    a. are able to trace out the selected shape;
    b. are able to attach a pen to their robot and have it draw the correct shape;
    c. are able to have the robot follow the path by selecting the correct turn types; and
- work cooperatively to solve the tasks.

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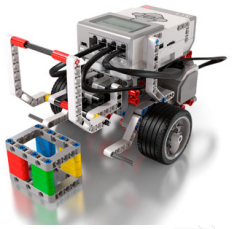
Lesson 3 – Move Object

Objective
After completing this lesson, students will be able to program their robot to move and release objects of different shapes and sizes.



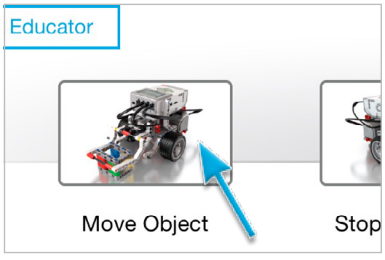
Duration
2 to 3 x 45 mins.

Preparation
Find several objects of different shapes and sizes that may or may not fit in the frame of the Medium Motor Module. For the Lesson Challenge you will need to prepare an obstacle course on the floor, if not already done. You can use a large sheet of paper, markers, or sticky tape (see illustration below).

Procedure
1. Students build and attach the Medium Motor Module to the Driving Base.

2. Students build the Cuboid.

3. Students complete the **Move Object** tutorial to understand how they use the Medium Motor Module to grab the Cuboid.



4. In the "Test It" phase, the students will open a sample program (this will close the current tutorial). Ensure each group takes the time to describe the robot's behavior when running the provided sample program using their own words. This encourages the students to reflect on what they see and how that relates to the programming blocks. They can use the Comment Box provided on the canvas.

   The following sample program is provided for the students:

   Example of robot behavior description:
   Using the Medium Motor Module, the robot lowers the frame and grabs the Cuboid. It then reverses before raising the frame to release the Cuboid.

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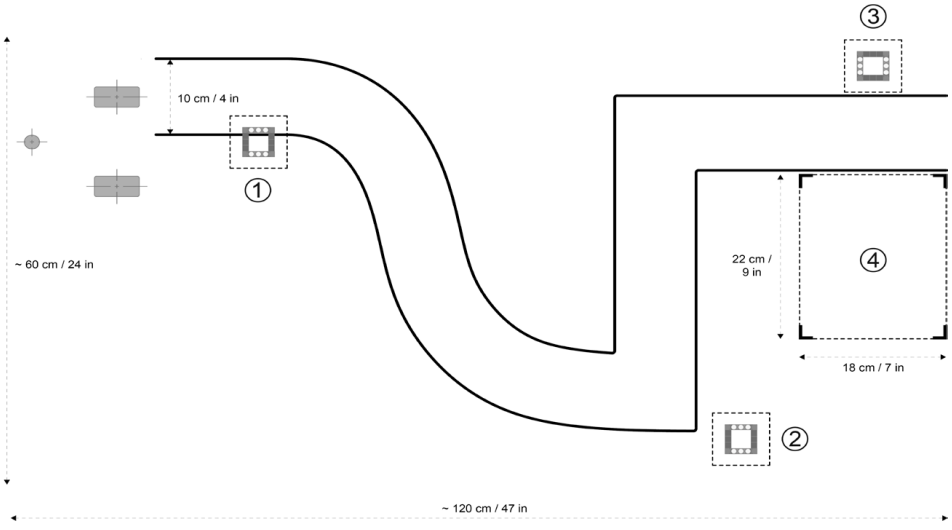
5. Students complete the “Modify It” task. The shape and size of other objects challenges students to modify their program or make changes to the Medium Motor Module that allow the robot to grab the different objects. When modifying the program, students will have to change the number of degrees the Medium Motor turns in order to accommodate the varying dimensions of the objects.

   Note: *Before modifying the Medium Motor Module, be aware that it is also required in Lesson 4 and Master Challenge 2.*

6. Lesson Challenge:
   Combine the optional challenge of Lesson 2 with moving the Cuboid (or another object) from predetermined start and end positions (see illustration below and/or Appendix A). For an additional challenge, students can also use the Ultrasonic Sensor to help detect the Cuboid (see Lesson 4 for further details).



Assessment

Observe and/or ask questions to determine if the students

- successfully grab the Cuboid with the robot;
- manage to describe the robot behavior in relation to the program in as much detail as possible;
- modify the robot to grab other objects;
- for the Lesson Challenge, grab the Cuboid and place it fairly precisely in the predetermined end position; and
- work cooperatively to solve the tasks.

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Lesson 4 – Stop at Object

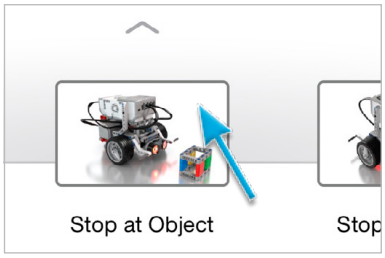
Objective
After completing this lesson, students will understand the difference between the Change and Compare Modes of the various EV3 sensors. This particular lesson features the Ultrasonic Sensor.

Duration
2 to 3 x 45 mins.

Preparation
Make sure you understand the difference between Change and Compare Modes. When using Compare Mode, the program waits for a certain distance to be read by the sensor; when using the Change Mode, the program is reading the distance and then waiting for a certain increase or decrease in distance. For the Lesson Challenge, you will need to prepare an obstacle course on the floor, if not already done. You can use a large sheet of paper, markers, or sticky tape (see illustration below).

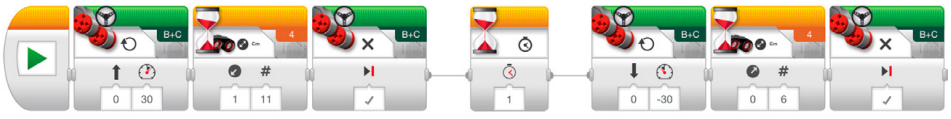
Procedure
1. Students build the Ultrasonic Sensor Module and attach it to the Driving Base.

2. Students complete the **Stop at Object** tutorial, during which they learn that the Ultrasonic Sensor measures distance to objects. Understanding this allows students to program the robot to react to a detected object.



3. In the "Test It" phase, the students will open a sample program (this will close the current tutorial). Ensure each group takes the time to describe the robot's behavior when running the sample program using their own words. This encourages the students to reflect on what they see and how that relates to the programming blocks. They can use the Comment Box provided on the canvas.

   The following sample program is provided for the students:



   Example of robot behavior description:
   Measuring distance using the Ultrasonic Sensor, the robot moves forward until it detects a decrease of 11 cm from the Cuboid and stops. The robot then reverses until it detects an increase of 6 cm from the Cuboid.

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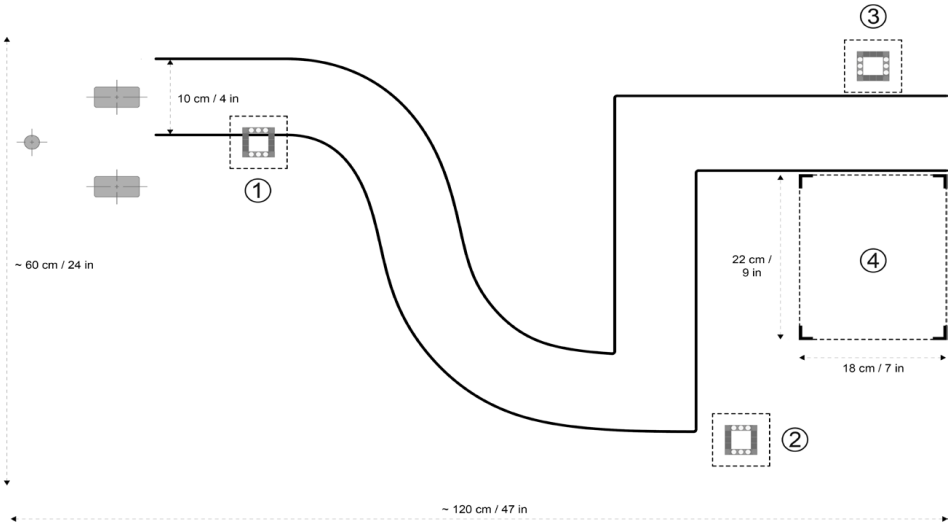
4. Students also complete the “Modify It” task. They should realize that the robot will always move forward 11 cm and then backward 6 cm, no matter the start distance to the Cuboid; this is the essence of the Ultrasonic Sensor’s Change Mode.

5. Lesson Challenge Ideas:
   Students attach the Medium Motor Module and grab the Cuboid (see illustration below and/or Appendix A). Remind students to use the Wait Block’s Ultrasonic Sensor – Compare Mode so that the robot moves close enough to the Cuboid. The following scenarios can be used:
   a. Cuboid in position 1. Robot in start position. Make the robot move the Cuboid to position 2 and return to the start position.
   b. Cuboid in position 1. Robot in start position. Make the robot move the Cuboid to position 3 and then park in position 4.
   c. Cuboid in position 3. Robot starts in position 4. Make the robot move the Cuboid to position 1 following the path.



Change Mode:

Compare Mode:

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Assessment

Observe and/or ask questions to determine if the students

- can use the Ultrasonic Sensor to detect the Cuboid;
- manage to describe the robot behavior in relation to the program in as much detail as possible;
- in the "Modify It" task, realize that the robot will always move forward 11 cm and then backward 6 cm, regardless of the start distance to the Cuboid;
- for the Lesson Challenges
    a. are able to detect and grab the Cuboid from position 1, follow the path before releasing the Cuboid in position 2, and then reverse the robot back to the start position;
    b. are able to move the Cuboid correctly from position 1 to position 3 and park the robot in position 4;
    c. are able to move the Cuboid correctly from position 3 to position 1; and
- work cooperatively to solve the tasks.

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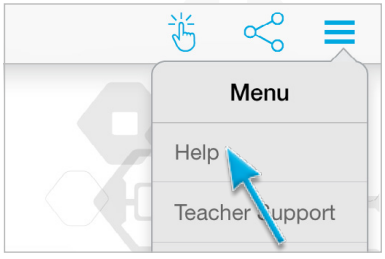
Lesson 5 – Stop at Angle

Objective
After completing this lesson, students will be able to turn their robot based on input from the Gyro Sensor.

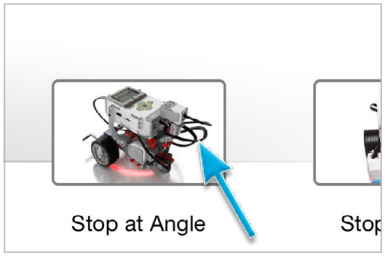
Duration
2 to 3 x 45 mins.

Preparation
Familiarize yourself with the Gyro Sensor to ensure you can detect when it is drifting and how to correct it. The Gyro Sensor chapter in the User Guide will help you familiarize yourself with the sensor. This topic is also covered in Step 4 of the procedure below. By providing sticky tape and protractors, students can create different angles on the floor to validate the turning angle of their robot. For tasks 5a and 5b, you will need to provide rubber bands to allow the students to attach a pen to their robot. For task 5c, you will need to prepare a maze on the floor. You can use a large sheet of paper, objects, markers, or sticky tape (see illustration below).



Procedure
1. The students build the Gyro Sensor Module and attach it to the Driving Base.

2. The students complete the **Stop at Angle** tutorial to make the robot turn 45 degrees based on Gyro Sensor angle readings.



3. In the "Test It" phase, the students will open a sample program (this will close the current tutorial). Ensure each group takes the time to describe the robot's behavior when running the sample program using their own words. This encourages the students to reflect on what they see and how that relates to the programming blocks. They can use the Comment Box provided on the canvas.

   The following sample program is provided for the students:

   Example of robot behavior description:
   Measuring rotational angle using the Gyro Sensor, the robot point turns until it detects an angle increase of 45 degrees. The robot then drives forward for one rotation and stops.

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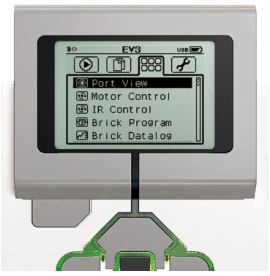
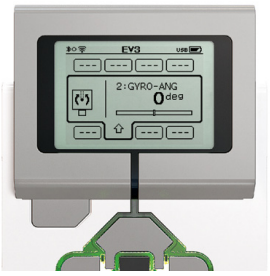
4. Troubleshooting: The troubleshooting notes included in the tutorial will help students understand how to avoid Gyro Sensor drift. Introduce the EV3 Brick Port View App as a method of checking the sensor reading. As the Gyro Sensor has a tolerance of +/- 3 degrees, you should therefore expect to compensate for that in the programs (e.g. to make a 90-degree turn, you may have to set the "Threshold Value" Parameter of the Wait Block's Gyro Sensor – Change – Angle Mode to 87 degrees).





5. In the "Modify It" task you may want to introduce students to the Loop Block as a way of decreasing the number of blocks needed to drive in a square. However, allow the students sufficient time to work it out for themselves.

   Suggested program:

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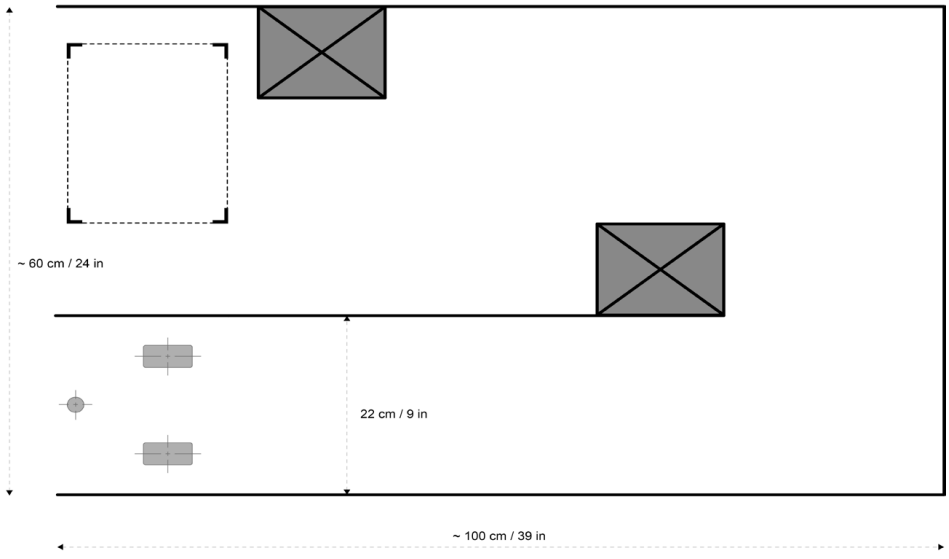
6. Lesson Challenge Ideas:
    a. Attach a pen to the robot. Use a Gyro Sensor to program your robot to draw the letter “Z.”
    b. Attach a pen to the robot. Use a Gyro Sensor to program your robot to draw a star shape (consisting of five identical angles). Next, try increasing or decreasing the angle. How does the shape change?
    c. Challenge students to make their robot navigate through a maze using the Gyro Sensor (see illustration below and/or Appendix B).



Assessment

Observe and/or ask questions to determine if the students

- can identify factors that may affect the stopping precision when using the Gyro Sensor (sensor tolerance, motor slack, and rotational momentum);
- manage to describe the robot behavior in relation to the program in as much detail as possible;
- in the “Modify It” task, can make the robot drive in a square based on Gyro Sensor input;
- for the Lesson Challenges
    a. fully or partially draw the letter “Z”;
    b. fully or partially draw a star with five identical angles;
    c. fully or partially navigate their robot through a maze; and
- work cooperatively to solve the tasks.

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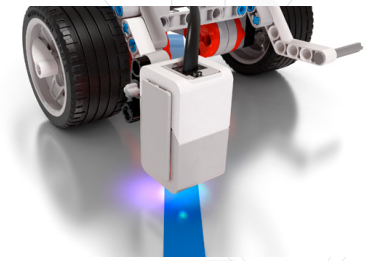
Lesson 6 – Stop at Line

Objective
After completing this lesson, students will be able to use the Color Sensor to stop the robot when a line is detected. Students will also be able to set a Threshold Value for a sensor.

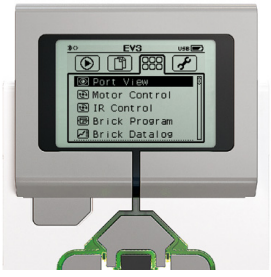


Duration
2 to 3 x 45 mins.

Preparation
Provide the students with different-colored paper or sticky tape. Carry out the following to test whether the Color Sensor can read the selected materials correctly:

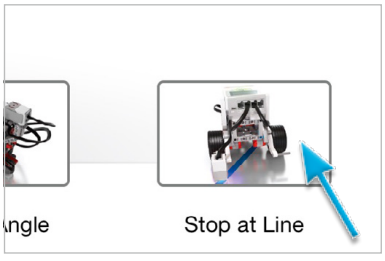
1. Turn on the EV3 Brick and connect a Color Sensor to Port 3.
2. Navigate to the Port View App and open it.
3. Use the Right Button to navigate to Port 3.
4. The value shown is the Reflected Light Intensity (COL-REFLECT). Press the Center Button to change the mode.
5. Scroll down the displayed list, select Color Mode (COL-COLOR) and then point the sensor at the colored material. The value displayed equates to the following colors: 0:No Color, 1:Black, 2:Blue, 3:Green, 4:Yellow, 5:Red, 6:White, and 7:Brown.
6. If the value does not match the color of your material, you will need to use another material.

   Note: *For best accuracy when in Color Mode or Reflected Light Intensity Mode, the sensor must be held perpendicular and close to—but not touching—the surface being detected.*



Procedure

1. Students build the Color Sensor Down Module and attach it to the Driving Base.
2. Students complete the **Stop at Line** tutorial to detect a blue line using the Color Sensor.
3. Students complete the “Modify It” task, in which the students practice detecting lines of a different color.



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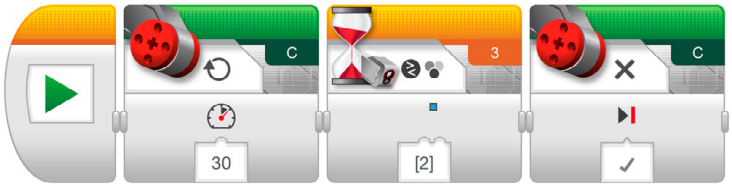
4. In the “Test It” phase, the students will open a sample program (this will close the current tutorial). Ensure each group takes the time to describe the robot’s behavior when running the sample program using their own words. This encourages the students to reflect on what they see and how that relates to the programming blocks. They can use the Comment Box provided on the canvas.

   The following sample program is provided for the students:



   Example of robot behavior description:
   Measuring color using the Color Sensor, the robot turns until it detects the color blue and then stops.

5. Lesson Challenge:
   Ask the students to find out what the “No Color” Parameter does (it causes the robot to react when the Color Sensor fails to detect a color that matches any of the predefined colors).

Assessment

Observe and/or ask questions to determine if the students

- make the robot stop at different-colored lines by changing the “Set of Colors” Parameter of the Wait Block’s Color Sensor – Compare – Color Mode;
- manage to describe the robot’s behavior in relation to the program in as much detail as possible;
- for the Lesson Challenge, can explain the “No Color” functionality; and
- work cooperatively to solve the tasks.

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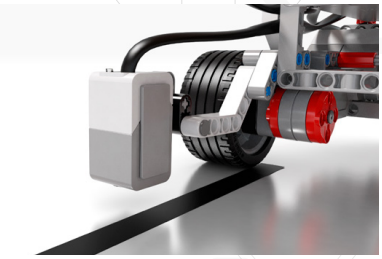
Lesson 7 – Follow a Line

Objective
After completing this lesson, students will be able to use the Switch Block to make dynamic sensor-based decisions in order to make their robot follow a line.



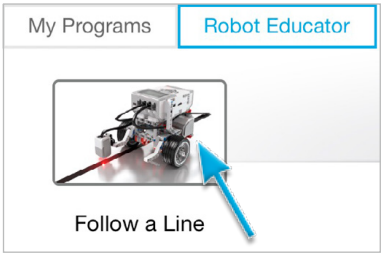
Duration
2 to 3 x 45 mins.

Preparation
Provide students with black and gray sticky tape to make a path for the robot to follow.

Procedure

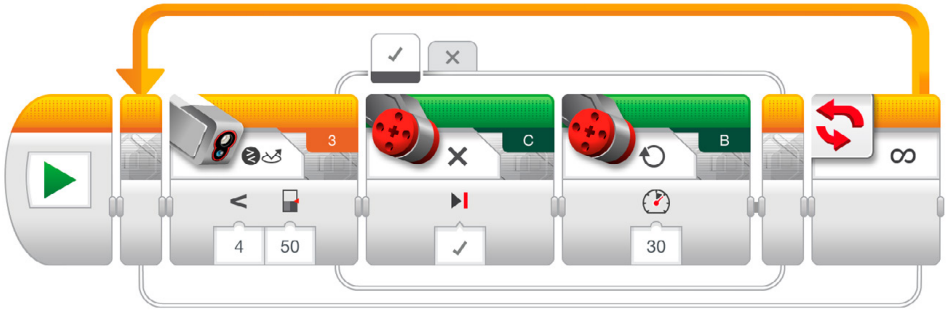
1. If not already built, students build the Color Sensor Down Module and attach it to the Driving Base pointing down.

2. Students complete the **Follow a Line** tutorial. Even though the Wait Block can be used to make a robot follow a line, this tutorial uses the Switch Block in order to introduce the abstract concept of if/then statements to the students.



3. In the “Test It” phase, the students will open a sample program (this will close the current tutorial). Ensure each group takes the time to describe the robot’s behavior when running the sample program using their own words. This encourages the students to reflect on what they see and how that relates to the programming blocks. They can use the Comment Box provided on the canvas.

   The following sample program is provided for the students:



   Example of robot behavior description:
   Moving forward along a line, the robot uses the Color Sensor to alternately switch each motor on and off when it detects changes in brightness reflected by the dark line and bright surface. This is why the robot “wiggles” forward.

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4. Students complete the “Modify It” task, which allows them to test their program with a lighter-colored line. This will challenge them to experiment with the Wait Block’s “Threshold Value” Parameter.

5. Lesson Challenge Ideas:
    a. Ask the students to test how fast they can make their robot follow a line.
    b. Make a line-follower program that uses Move Steering Blocks to perform curved turns rather than the sharp single-motor turns used in the tutorial.
    c. The tutorial sample program uses a Switch Block to create a line follower. Can they produce the same result without using a Switch Block?

Assessment

Observe and/or ask questions to determine if the students

- are able to make the robot follow the line;
- manage to describe the robot behavior in relation to the program in as much detail as possible;
- in the “Modify It” task, change the “Threshold Value” Parameter;
- for the Lesson Challenges
    a. increase the power in one or both of the Large Motor Blocks;
    b. fully or partially modify their sample program to include Move Steering Blocks;
    c. fully or partially create a line-follower program using Wait Blocks; and
- work cooperatively to solve the tasks.

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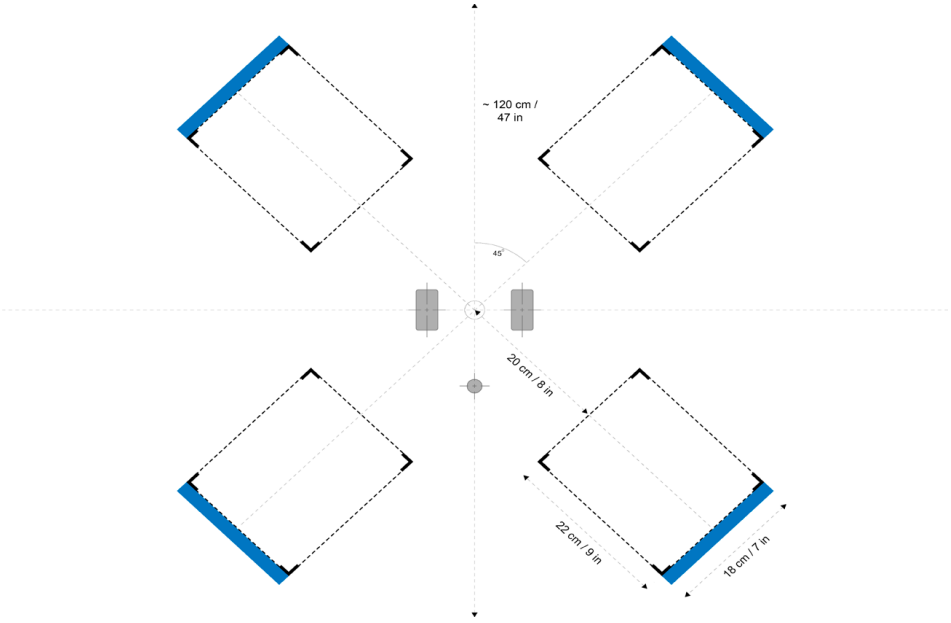
Master Challenge 1 – The Turntable Challenge

Objective
The objective of this Master Challenge is for the students to navigate their robot around a four-bay, turntable-style parking area using a combination of point turns and sensors. After completing this challenge, students will be able to use angles to predict the final position of their robot and compensate for factors that may affect the accuracy of the Gyro and Color Sensors.

Prerequisites
At a minimum, students must be familiar with the Color Sensor and Gyro Sensor, as featured in the **Stop at Line** and **Stop at Angle** Lessons.

Duration
2 to 4 x 45 mins.

Preparation
To create the challenge mat illustrated below and/or in Appendix C, the students will need blue sticky tape or blue paper, protractor, long ruler, pencil, and a marker.



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Tasks

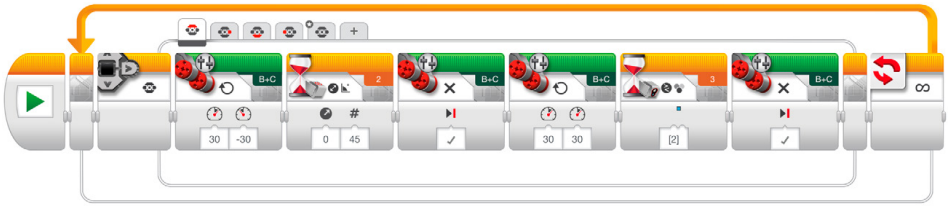
1. By using two sensors, students move the robot from the center to final positions 1, 2, 3, and 4. If using the suggested angles for the Wait Block's Gyro Sensor Mode, students should create their own copy of the chart below and try to predict which of the parking bays their robot will drive into:

Programmed Angle	Predicted parking bay	Actual parking bay
45 deg. clockwise		
135 deg. counterclockwise		
405 deg. counterclockwise		
		3

Note: *There may be several correct answers, as the robot can be rotated both clockwise and counterclockwise.*

2. Create a program that uses a Switch Block to allow students to navigate the robot to one of the four parking bays by pressing one of the EV3 Brick Buttons.

   Suggested program:



Assessment

Observe and/or ask questions to determine if the students
- use both the Color and Gyro Sensors;
- correctly predict the angle required to park the robot in each of the parking bays;
- use the blue line to stop forward movement;
- can compensate for the factors that may affect the stopping precision when using the Gyro Sensor (sensor tolerance, motor slack, and rotational momentum); and
- work cooperatively to solve the tasks.

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Master Challenge 2 – The LEGO® Factory Robot Challenge

Objective
The purpose of this Master Challenge is to create a simplified representation of one of the real-life robots used by The LEGO Group to automate various tasks at its many production facilities around the world. After completing this challenge, students will be able to combine what they have learned in the previous lessons to master the basics of Robotics.

Prerequisites
It is recommended that students complete all seven lessons before beginning this Master Challenge. However, if you prefer a more project-based, explorative method, you can start out with this challenge and allow students to find help on their own by referring to the lessons.

Duration
2 to 6 x 45 mins.

Preparation
To create the path illustrated below and/or in Appendix D, the students will need sticky tape, markers, measuring tape, the Cuboid, and a large object at the end of the black line. Students might also need a large protractor for measuring the angle in step three below.

Tasks
1. Detect and grab the Cuboid using the Medium Motor and Ultrasonic Sensor Modules.

2. Drive the robot forward exactly 84 cm.

3. Determine and turn x degrees clockwise using the Gyro Sensor to point the robot towards the target circle.

4. Drive as close as possible to the center of the target and release the Cuboid.

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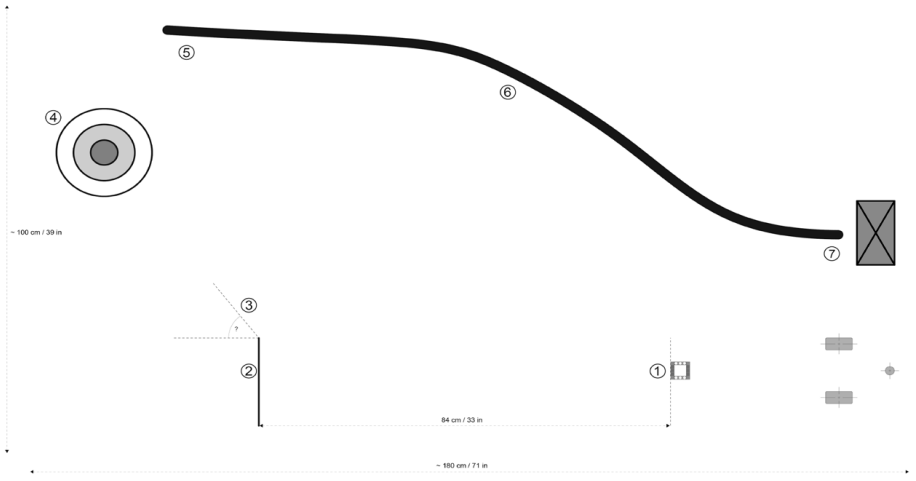
5. Locate the line using the Color Sensor. To challenge students, use sticky tape of a different color than that used in the **Stop at Line** and **Follow a Line** tutorials.

6. Have the robot follow the line towards the large object.

7. Stop right in front of the object. Here, the main challenge for the students is to define for how long the robot should follow the line before stopping. The large object at the end of the line gives the students a chance to escape the line-follower loop using the Ultrasonic Sensor. Time can also be used to solve the challenge.



Assessment

Observe and/or ask questions to determine if the students use their experience from the seven lessons to solve this seven-step challenge, by

- understanding the difference between Change and Compare Modes. For example, they use the Wait Block's Ultrasonic Sensor – Compare Mode in this challenge to achieve the best results;
- calculating the distance based on wheel circumference or using trial and error to get to the required 84 cm;
- estimating the turn angle by using a protractor and the Gyro Sensor;
- measuring the distance and then calculating the number of motor rotations to get close to the center of the target;
- programming the robot to stop at the line;
- following the line back;
- stopping in front of the large object; and
- working cooperatively to solve the tasks.

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Design Brief Challenges

Not all robots are Driving Bases! These Design Brief Challenges test the students' ability to build and program their own creations based on a brief that allows for a diversity of solutions. Students have a chance to choose an approach that, compared to the step-by-step tutorials, is more open-ended. Design Brief Challenges also allow you to assess a student's creative and collaborative skills.

Four design briefs are listed below. For each challenge, you should consider up front how many lessons the students are given in order to complete it. If the students are told that they have four 45-minute lessons and must then be ready to present their unique solution, they have a better chance of managing their time and can adjust their ambitions accordingly.

These Design Brief Challenges can be used as a starting point in your class; students can then use the tutorials and help text as a reference.

Alarm System
Build and program an alarm system using one or more sensors.

Dancing Robot
Build and program a robot with attitude that moves to your favorite music.

Greeting Robot
Build and program a robot that greets you positively when meeting it.

Robotic Sweeper
Build and program a robot that sweeps objects out of its path.

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Relevant Standards

The seven lessons, two Master Challenges, and Design Brief Challenges provide a full introduction to robotics and are great examples of how to use robotics in a STEM context. Using the LEGO® MINDSTORMS® Education EV3 concept in the classroom opens up a range of valuable learning outcomes. Skills such as teamwork, creativity, and problem solving are an inherent part of the experience, and students' natural mastery of tablet devices will help them learn the language of programming more rapidly.

Below is a selected overview of standards addressed or partially addressed when using LEGO MINDSTORMS Education EV3. This list will grow steadily when you expand the use of EV3 in the classroom.

Next Generation Science Standards Framework

Practices

- Asking questions
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics, Informational and Computer Technology, and computational thinking
- Constructing explanations and designing solutions
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information

Cross-cutting concepts

- Cause and effect: Mechanism and explanation
- Structure and function
- Systems and system models

Core Ideas: Engineering, Technology and Application of Science

- Engineering Design
- Motion and stability: Forces and interactions
- Energy
- Waves and their applications in technologies for information transfer

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Computer Science Teachers Association

Computational Thinking

- Recognize that software is created to control computer operations.
- Understand and use the basic steps in algorithmic problem solving.
- Develop a simple understanding of an algorithm.

Collaboration

- Work cooperatively and collaboratively with peers, teachers, and others using technology.
- Identify ways that teamwork and collaboration can support problem solving and innovation.

Computing Practices and Programming

- Use technology resources for problem solving and self-directed learning.
- Construct a program as a set of step-by-step instructions to be acted out.
- Implement problem solutions using a block-based visual programming language.

Computers and Computing Devices

- Use standard input and output devices to successfully operate computers and related technologies.
- Apply strategies for identifying simple hardware and software problems that may occur during use.
- Identify factors that distinguish humans from machines.
- Recognize that computers model intelligent behavior (as found in robotics, speech and language recognition, and computer animation).

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ISTE National Education Technology Standards

Creativity and Innovation

- Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology.
- Apply existing knowledge to generate new ideas, products, or processes.
- Use models and simulations to explore complex systems and issues.

Communication and Collaboration

- Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others.
- Contribute to project teams to produce original works or solve problems.

Critical Thinking, Problem Solving, and Decision Making

- Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources.
- Plan and manage activities to develop a solution or complete a project.
- Collect and analyze data to identify solutions and/or make informed decisions.
- Use multiple processes and diverse perspectives to explore alternative solutions.

Digital Citizenship

- Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.
- Demonstrate personal responsibility for lifelong learning.

Technology Operations and Concepts

- Students demonstrate a sound understanding of technology concepts, systems, and operations.
- Understand and use technology systems.
- Select and use applications effectively and productively.
- Troubleshoot systems and applications.
- Transfer current knowledge to learning of new technologies.

ITEEA Standards for Technological Literacy

The Nature of Technology

- Students will develop an understanding of the characteristics and scope of technology.
- Students will develop an understanding of the core concepts of technology.

Design

- Students will develop an understanding of the attributes of design.
- Students will develop an understanding of engineering design.
- Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

Abilities for a Technological World

- Students will develop abilities to apply the design process.
- Students will develop abilities to use and maintain technological products and systems.

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Common Core Mathematics Standards

Practices

- Make sense of problems and persevere in solving them.
- Reason abstractly and quantitatively.
- Construct viable arguments and critique the reasoning of others.
- Attend to precision.
- Look for and make use of structure.
- Look for and express regularity in repeated reasoning.
- Model with mathematics.
- Use appropriate tools strategically.

Expressions and Equations

- Solve real-life and mathematical problems using numerical and algebraic expressions and equations.

Geometry

- Solve real-life and mathematical problems involving angle measure, area, surface area, and volume.

Common Core English Language Arts

Reading Standards for Literacy in Science and Technical Subjects

- Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
- Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics.

Reading Standards for Informational Text

- Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently.

Speaking and Listening Standards

- Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on topics, texts, and issues, building on others' ideas and expressing their own clearly.

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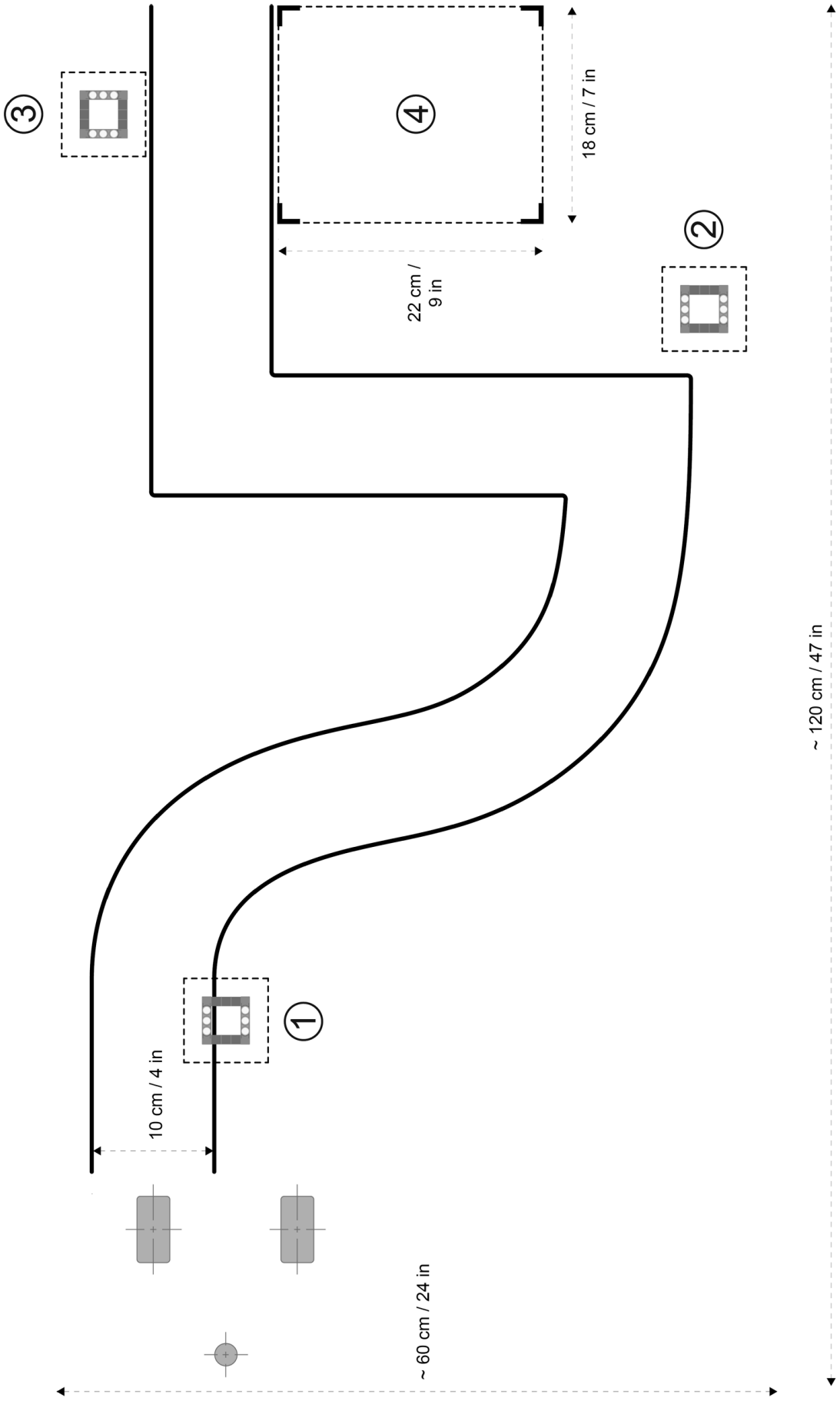

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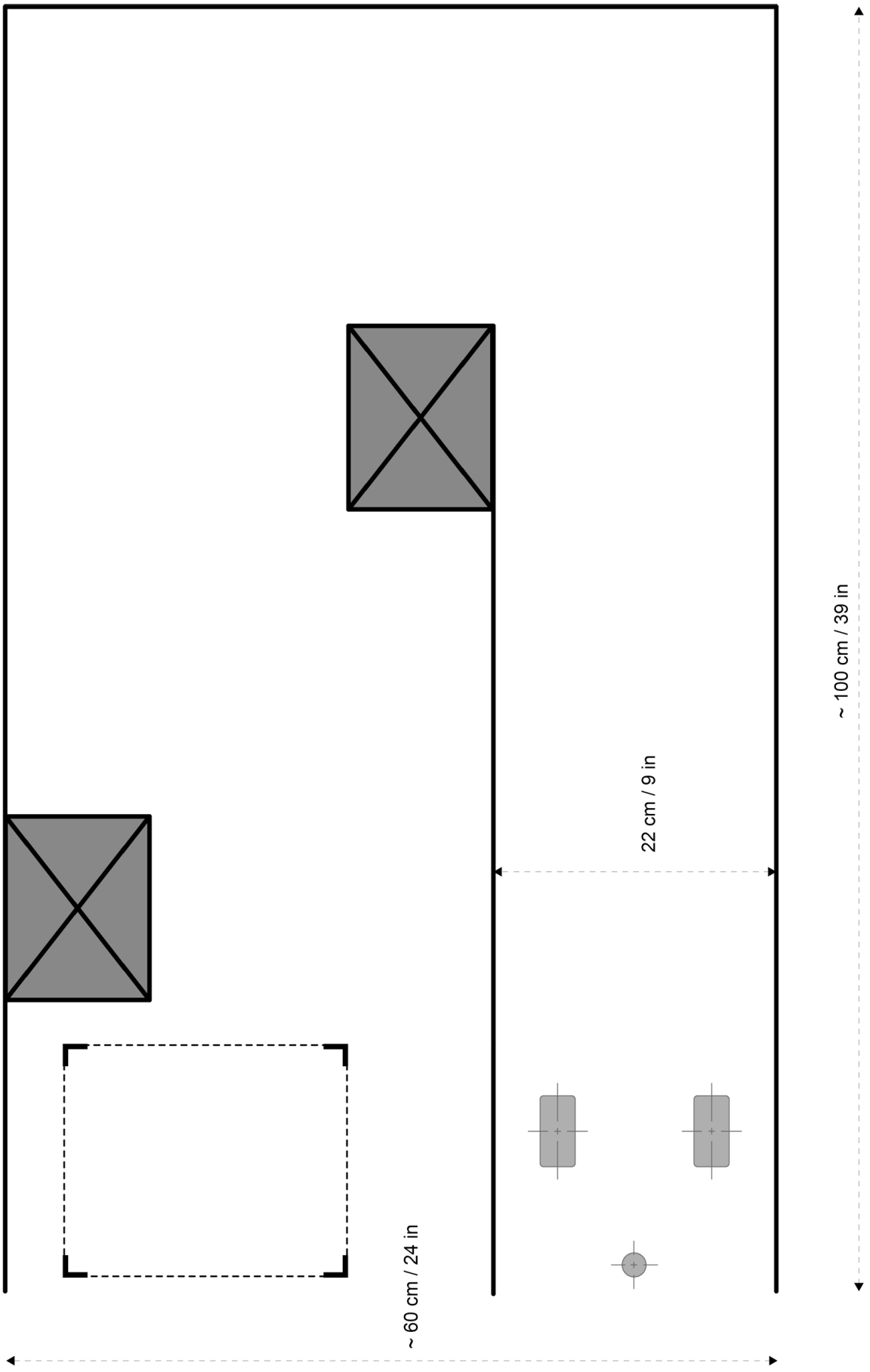

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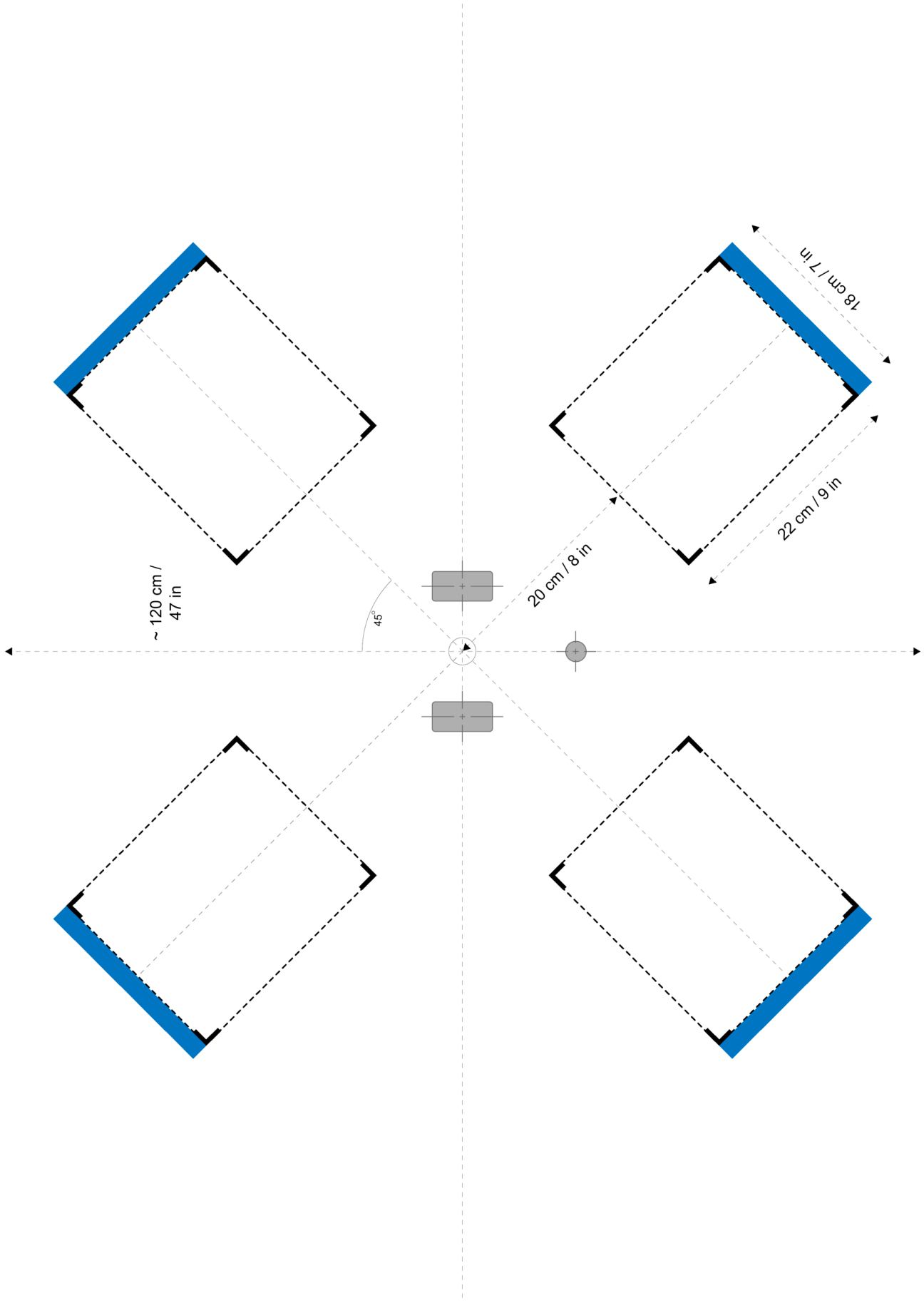

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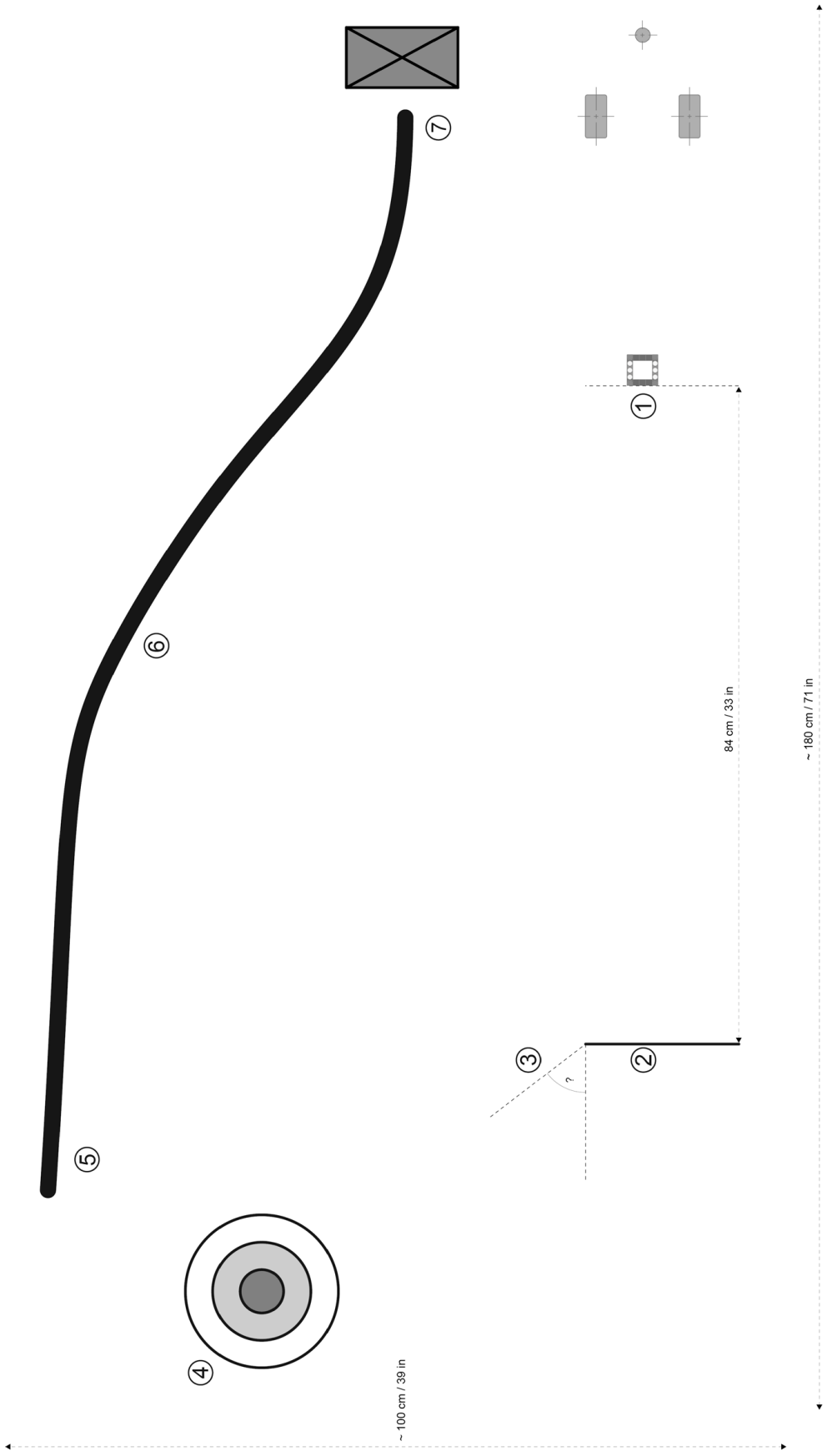

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