MISSION 11: Spirit Level	Time: 45-60 minutes

Overview:

In this project you'll build a spirit level! This is more than just a fun project – it's a useful tool with practical applications. Students will create a digital level using the CodeX's built-in accelerometer and LCD display. Physically rotating the CodeX will move the digital "bubble" they create on the display, with **code**!

Cross Curricular:

- **MATH:** Use the level to measure angles.
- **SCIENCE:** Physical science -- discuss gravity and how it is measured. Use the information from z to measure and study gravity.
- Supports **language arts** through reflection writing.

Materials Included in the learning portal Teacher Resources:

Mission 11 Slidedeck

The slide deck is for teacher-led instructions that let you guide students through the material using the slides. It is an alternative to the students reading a lot of instructions in CodeSpace. The slides mirror the instructions, with simplified language that is chunked into smaller sections at a time. The information is shown on slides with "Objective". The tasks to complete are on slides with "Mission Activity".

Mission 11 Workbook

The workbook can be used instead of slides for student-led or independent work. It is an alternative to students reading a lot of instructions in CodeSpace. It mirrors the instructions (and the slide deck), with simplified language that is chunked into smaller sections at a time. Each objective is on its own page. The tasks to complete are labeled "DO THIS" and have a robot icon next to it.

Mission 11 Log (and answers)

This mission log is the worksheet for students to complete as they work through the mission. It should be printed and given to each student before the mission starts. They write on the mission log during the assignment and turn it in at the completion of the mission (assignment).

Mission 11 Lesson Plan

The lesson plan comes from the CodeX Teacher Manual and is included here for easy reference.

Mission 11 Remix Folder

Following Mission 11, students should complete a remix of their code. Get supplemental materials from the folder.

Additional Resources:

- **Mission 11 Solution (Spirit Level)** – in Answer section
- **Kahoot** (Mission 11)

Formative Assessment Ideas:

- Exit ticket
- Mission log completion
- Completed program
- Kahoot Mission 11 Review

Vocabulary:

- **Accelerometer:** A sensor chip that detects motion, impacts, and orientation; a device that measures proper acceleration.
- **Tuple:** A read-only version of a list, indicated with parenthesis, and has items you can access with an *index*.

Preparing for the lesson:

This mission will create a digital level. As mission prep, you may want to show a physical level. Discuss what it does and how it does it with the bubble in the tube.

Students will use the Codex throughout the lesson. Decide if they will work in pairs or individually.

- Look through the slide deck and workbook. Decide what materials you want to use for presenting the lesson. The slide deck can be projected on a large screen. The workbook (if used) can be printed or remain digital through your LMS.
- Be familiar with the Mission Log (assignment) and the questions they will answer.
- Print the Mission Log for each student.
- Bring a physical level to show to the students.
- The mission program does not need to be portable. If you want students to use the CodeX without a cable, then have batteries available.

Lesson Tips and Tricks:

💡 **Teaching tip:**

You can use a variety of discussion strategies to get the most engagement from your students. For example, you can have students write their answers before asking anyone for an answer. You can use one of many think-pair-share methods. You can have students write their answer and share with someone, and then have other students share answers they heard from their peers. You can randomly select students to answer.

👫 **Pre-Mission Discussion (Slide 2, page 1):**

Students can write in their log first and then share, or discuss first and then write in their log.

There is one question for the pre-mission. There isn't a "right" answer here. The purpose is to get them thinking about the need for selecting something random. Also, there are real-world applications to what they are learning.

- Your cell phone can detect if it is level or tilted. What other devices use some kind of sensor to determine their orientation?

OPTIONAL: Discuss how a real *mechanical* **spirit level** works. The "spirit" is a liquid with space for a bubble, which will be in the center of the tube when it's in a **horizontal** position.

💻 **Mission Activities:**

Most of this lesson is on the computer, writing code to make a spirit level.

- Each student will complete a Mission Log.
- Students could work in pairs through the lesson, or can work individually.
- Students will need the CodeX and USB cable.

💡 **Teaching tip: Objective #1** -- Slides 3-5, Pages 2-4

This objective gives a mild introduction to the accelerometer. Students get the definition of accelerometer from clicking on the word and going to the toolbox. They get the three values (x, y, z) from the digital instructions.

Students will answer two questions in their mission log.

Students will need to identify the accelerometer in the simulator. Then they will create their new file.

💡 **Teaching tip: Objective #2** -- Slides 6-9, Pages 5-6
Students learn more about the accelerometer, and about tuples. They learn how to get a single value from the accelerometer.

Students will answer three questions in the mission log.

🗝️ **NOTE:** The code example in the slide deck / student workbook is slightly different than the code in CodeTrek. Hopefully it will be easier to understand for students. It will pass the verifier.

💡 **Teaching tip: Objective #3** -- Slides 10-11, Pages 7-8
In this objective, the accelerometer data is transformed into degrees. The code is given to students so they don't need to do the math, which is more advanced than elementary school and middle school math.

Students will answer a question in the mission log.

🗝️ **NOTE:** The instructions here are simplified and skip over a lot of the information in the digital textbook. You can decide if they should read the reasons why and how the data is changed to degrees.

💡 **Teaching tip: Objective #4** -- Slides 12-14, Pages 9-10
This objective shows code to make the ball move. It is only two lines of code.

💡 **Teaching tip: Objective #5** -- Slides 15-16, Pages 11-12
This objective shows code to make the ball move. It is only two lines of code.

💡 **Teaching tip: Quiz** -- Slide 17, Page 12

Students take a ❓ short quiz. The 3 Quiz questions are below. You can decide if you need to go over the question with your students.

💡 **Teaching tip: Objective #6** -- Slides 18-19, Pages 13-14
Students put the final touches on the program by "erasing" the circle before drawing a new one. It is fairly straightforward.

Students will answer a question in the mission log.

💻 Mission Complete:

This mission ends with a completed, working program that will act as a spirit level. You need to decide how you will use the program for assessment. You could:

- Go to each student and check-off their code
- Have the students download their code to a text file and turn it in using your LMS
- Have students print their code (either download and then print the text file, or print a screenshot)
- Have students switch computers and run each other's code. Fill out a simple rubric and turn in to teacher
- Any other way that works for you

👫 Post-Mission Reflection:

The post-mission reflection asks students to think about real-world applications for animation, and also to reflect on their coding experience during the mission. You can change the questions if there is something else you want to emphasize with your students.

- What are some ways you can use this program?
- What is one way you can extend this program, or make it do more than measure x tilt?

End by collecting the Mission Log and any formative assessment you want to include.

RECOMMENDATION: This is a good mission to do a remix for, if you haven't had students do them after each mission.

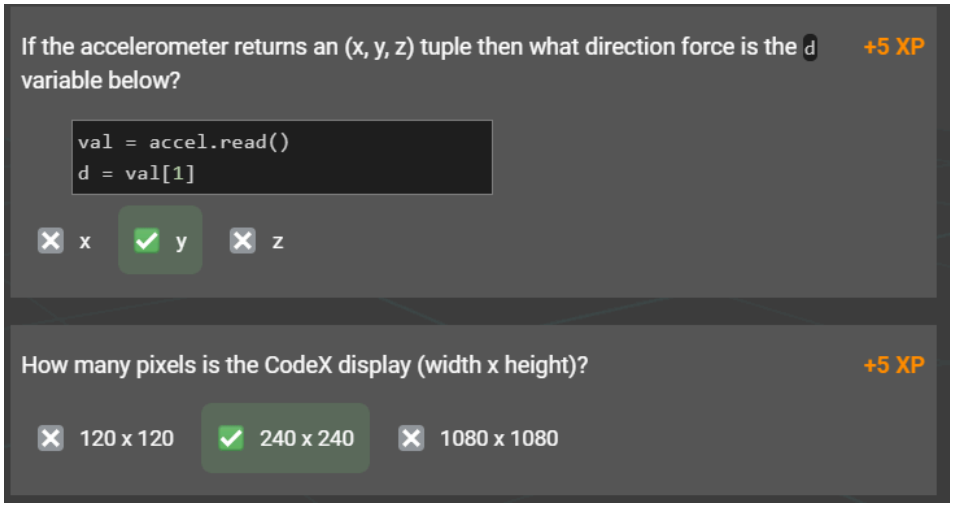
💻 IMPORTANT Clearing the CodeX:

The students have already created a "Clear" program. Students should open and run "Clear" at the end of each class period.

SUCCESS CRITERIA:

- ❏ Display a numeric "tilt" value from the accelerometer.
- ❏ Scale the raw tilt value to show 0-9, indicating 0° to 90° incline.
- ❏ Replace the number display with a graphical bubble simulation!
- ❏ Erase the graphical bubble before drawing a new bubble

❓ Quiz Questions



FIRIA LABS

Why is `tilt` divided by `16384` in the code below? +5 XP

```
val = accel.read()
tilt = val[0]
scaled = (tilt / 16384)
```

- [x] 16384 is the universal gravity wave coefficient.
- [x] There are 16384 accelerons per degree.
- [x] 16384 is the max expected value for tilt, so (tilt / 16384) will be ≤ 1