

Compass

Textbook

Compass



The code for this lesson is from Microsoft MakeCode

What is a Magnetic Field?

Imagine a bubble around Earth. Earth has invisible shields to protect it from dangerous things. These shields are called magnetic fields. The Earth's core is made of two elements - nickel and iron, which create a [magnetic field](#) around our planet. When particles from the sun and space hit this "shield" the particles glow green. Fun fact: Have you ever heard of the northern lights? This is where that light comes from!

Magnetic fields always have two poles - north and south. A compass always points north. [Compasses](#) have helped guide people for hundreds of years!

Digital Compass

Smartphones have digital compass. For instance, when you open a maps app to guide you to your destination, you can use your phone to see which way you are driving. The micro:bit also has a digital compass, otherwise known as a magnetometer, that can sense where North is. Learn how the compass works in this introductory video:



Degrees

If you were facing forward and turned to your right, that would be turning 90 degrees. If you were facing forward and turned around to face the back, that would be turning 180 degrees. If you were facing forward and turned around in a full circle that would be turning 360 degrees. Degrees are used to measure many things, and compasses use degrees to help measure distance.

Variables

To program the micro:bit to act as a compass, you will need to use a variable.

A reminder that a [variable](#) holds information. A compass heading is an example of a piece of information that a variable can hold. A compass heading tells you the direction you are pointing. This information is possible to track on the micro:bit because of the micro:bit's magnetometer. The magnetometer senses and registers the micro:bit's position on the earth. This position is called a compass bearing. Compass bearing is how many degrees you are away from the north. So if your compass heading reads 60 degrees, you are turned 60 degrees from the north direction.

Program the Compass Heading

How to program your compass heading: To do this, use a forever function so your code works with every change as opposed to only one time.

Find Your Heading

First you need to store your current heading in a variable named heading.

```
1 def on_forever():
2     degrees = input.compass_heading()
3
4 basic.forever(on_forever)
5
```

Now let's display the variable named heading with a `basic.show_number()` command.

```
1 def on_forever():
```

```

2   degrees = input.compass_heading()
3   basic.show_number(degrees)
4
5   basic.forever(on_forever)
6

```

Now we need to see what direction the degrees are pointing to and label them with North, South, East, and West. We will shorten these down to **N**, **S**, **E**, and **W**.

Finding North

IF the variable named degrees is less than **45**, then the compass is pointing **North**, so we will show **N** on the micro:bit.

```

1 def on_forever():
2     degrees = input.compass_heading()
3     if degrees < 45:
4         basic.show_string("N")
5
6 basic.forever(on_forever)
7

```

Finding East

IF the variable named degrees is less than **135**, then the compass is pointing **East**, so we will show **E** on the micro:bit.

```

1 def on_forever():
2     degrees = input.compass_heading()
3     if degrees < 45:
4         basic.show_string("N")
5     elif degrees < 135:
6         basic.show_string("E")
7 basic.forever(on_forever)
8

```

Go to the simulator and rotate the micro:bit logo to simulate changes in the compass heading.

Finding South

IF the variable named degrees is less than **225**, then the compass is pointing **South**, so we will show **S** on the micro:bit.

```

1 def on_forever():
2     degrees = input.compass_heading()
3     if degrees < 45:
4         basic.show_string("N")
5     elif degrees < 135:
6         basic.show_string("E")
7     elif degrees < 225:
8         basic.show_string("S")
9 basic.forever(on_forever)

```

Go to the simulator and rotate the micro:bit logo to simulate changes in the compass heading.

Finding West

If the variable named `degrees` is less than **315**, then the compass is pointing **West**, so we will show **W** on the micro:bit.

```

1 def on_forever():
2     degrees = input.compass_heading()
3     if degrees < 45:
4         basic.show_string("N")
5     elif degrees < 135:
6         basic.show_string("E")
7     elif degrees < 225:
8         basic.show_string("S")
9     elif degrees < 315:
10        basic.show_string("W")
11 basic.forever(on_forever)
12

```

Go to the simulator and rotate the micro:bit logo to simulate changes in the compass heading.

Else

If none of these conditions returned true, then the micro:bit must be pointing **North** again. Display **X** on the micro:bit.

```

1 def on_forever():
2     degrees = input.compass_heading()
3     if degrees < 45:
4         basic.show_string("N")
5     elif degrees < 135:
6         basic.show_string("E")
7     elif degrees < 225:
8         basic.show_string("S")
9     elif degrees < 315:
10        basic.show_string("W")
11    else:
12        basic.show_string("X")
13 basic.forever(on_forever)

```

Adopted from microbit.org platform

Critical Thinking Questions

- Imagine you're developing a smart hiking app. Besides just showing North, how could a digital compass use degrees (0-360) to help a hiker navigate a complex trail, especially if they need to follow a specific bearing that isn't exactly North, South, East, or West?

- Magnetic fields are described as invisible shields. How does understanding the concept of Earth's magnetic field and how a digital compass interacts with it help us appreciate the technology in everyday devices like smartphones that guide our travel?
- Think about a situation where a traditional, physical compass might be difficult to read or use (e.g., in very low light, or if it's placed incorrectly). How does a digital compass, which can provide a numerical heading, offer advantages for navigation in certain challenging environments?

Questions (10)

1. A student wants to create a compass that shows direction letters only when pointing exactly North or South, while ignoring East or West. How should they modify the degree ranges in the code?

MULTIPLE CHOICE

Choose the correct answer:

- A. Make all the ranges smaller
- B. Remove the East and West conditions
- C. Change the forever block to run once
- D. Use different variable names

2. Looking at the compass code structure, why does the program use elif instead of separate if statements for each direction?

MULTIPLE CHOICE

```
def on_forever(): degrees = input.compass_heading() if degrees < 45: basic.show_string("N") elif degrees < 135: basic.show_string("E") elif degrees < 225: basic.show_string("S") elif degrees < 315: basic.show_string("W") else: basic.show_string("X") basic.forever(on_forever)
```

Choose the correct answer:

- A. To make the code run faster
- B. To save memory space
- C. To check conditions in order and stop when one is true
- D. To display multiple directions at once

3. If you change the first condition from degrees < 45 to degrees < 90, what will happen to the north detection?

MULTIPLE CHOICE

```
def on_forever(): degrees = input.compass_heading() if degrees < 45: basic.show_string("N") elif degrees < 135:
basic.show_string("E") elif degrees < 225: basic.show_string("S") elif degrees < 315: basic.show_string("W") else:
basic.show_string("X") basic.forever(on_forever)
```

Choose the correct answer:

- A. North will be detected in a smaller range
- B. North will be detected in a larger range
- C. North will point to a different direction
- D. The compass will stop working

4. A programmer wants to add northeast (NE) detection between north and east. Where should they place this new condition in the code?

MULTIPLE CHOICE

```
def on_forever(): degrees = input.compass_heading() if degrees < 45: basic.show_string("N") elif degrees < 135:
basic.show_string("E") elif degrees < 225: basic.show_string("S") elif degrees < 315: basic.show_string("W") else:
basic.show_string("X") basic.forever(on_forever)
```

Choose the correct answer:

- A. Before the north condition
- B. Between the north and east conditions
- C. After all the other conditions
- D. In a separate forever block

5. What would happen if you removed the else statement at the end of the compass code?

MULTIPLE CHOICE

Choose the correct answer:

- A. The compass would be more accurate
- B. Some directions might show no letter at all
- C. The program would crash
- D. All directions would show "N"

6. A student notices their compass shows "E" when they expect it to show "S". Based on the code logic, what degree range is most likely being detected?

MULTIPLE CHOICE

```
def on_forever():
    degrees = input.compass_heading()
    if degrees < 45:
        basic.show_string("N")
    elif degrees < 135:
        basic.show_string("E")
    elif degrees < 225:
        basic.show_string("S")
    elif degrees < 315:
        basic.show_string("W")
    else:
        basic.show_string("X")
    basic.forever(on_forever)
```

Choose the correct answer:

- A. 0 to 44 degrees
- B. 45 to 134 degrees
- C. 135 to 224 degrees
- D. 315 to 359 degrees

7. Why does the compass program use a forever block instead of running the code just once?

MULTIPLE CHOICE

Choose the correct answer:

- A. To save battery power
- B. To make the display brighter
- C. To continuously update as the micro:bit rotates
- D. To store more compass readings

8. If a student wants to create a more precise compass with 8 directions instead of 4, what is the main change they need to make?

MULTIPLE CHOICE

Choose the correct answer:

- A. Use smaller degree ranges for each direction
- B. Change the variable name from "degrees"
- C. Remove the forever block
- D. Add more basic.show_number() commands

9. What is the purpose of the `input.compass_heading()` function in the code?

```
def on_forever(): degrees = input.compass_heading() if degrees < 45: basic.show_string("N") elif degrees < 135:
basic.show_string("E") elif degrees < 225: basic.show_string("S") elif degrees < 315: basic.show_string("W") else:
basic.show_string("X") basic.forever(on_forever)
```

Choose the correct answer:

- A. To display the current direction letter
- B. To get the current compass reading in degrees
- C. To turn on the magnetometer
- D. To rotate the micro:bit automatically

10. A teacher wants students to create a program that shows the actual degree number along with the direction letter. What should students add to their code?

MULTIPLE CHOICE

```
def on_forever(): degrees = input.compass_heading() if degrees < 45: basic.show_string("N") elif degrees < 135:
basic.show_string("E") elif degrees < 225: basic.show_string("S") elif degrees < 315: basic.show_string("W") else:
basic.show_string("X") basic.forever(on_forever)
```

Choose the correct answer:

- A. Replace `basic.show_string()` with `basic.show_number()`
- B. Add `basic.show_number(degrees)` before or after the direction display
- C. Change the variable name to "numbers"
- D. Remove all the if-elif statements

Robotics Challenges (1)

1. Create a Compass

Challenge

Textbook

Create a Compass

Create the compass from the lesson!

1. Create a variable named `degrees` and set it equal to the current compass heading.

```
degrees =  
input.compass_heading()
```

2. If the variable named `degrees` is less than 45, show the string `N`

3. Elif the variable named `degrees` is less than 135, show the string `E`

4. Elif the variable named `degrees` is less than 225, show the string `S`

5. Elif the variable named `degrees` is less than 315, show the string `W`

6. Else, show `N`.

Adopted from [micro.bit.org](https://micro.bit.org/projects) projects

Requirements

Create the forever

Step 1

Create the forever function

Create a Compass Step 1 of 7



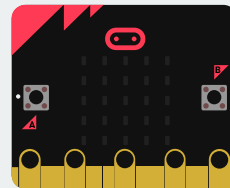
1

Next

Toolbox

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```
1 def on_forever():  
2     pass  
3     basic.forever(on_forever)  
4
```



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Answer Keys & Solutions

Questions

1. A student wants to create a compass that shows direction letters only when pointing exactly North or South, while ignoring East or West. How should they modify the degree ranges in the code?

MULTIPLE CHOICE

Correct Answer:

- A. Make all the ranges smaller ✗ Incorrect
- B. Remove the East and West conditions ✓ Correct
- C. Change the forever block to run once ✗ Incorrect
- D. Use different variable names ✗ Incorrect

Explanation:

To show only north and south, eliminate the code parts that check for east and west.

2. Looking at the compass code structure, why does the program use elif instead of separate if statements for each direction?

MULTIPLE CHOICE

Correct Answer:

- A. To make the code run faster ✗ Incorrect
- B. To save memory space ✗ Incorrect
- C. To check conditions in order and stop when one is true ✓ Correct
- D. To display multiple directions at once ✗ Incorrect

Explanation:

Think about what happens when the first condition matches – should the others still be checked?

3. If you change the first condition from degrees < 45 to degrees < 90, what will happen to the north detection?

MULTIPLE CHOICE

Correct Answer:

- A. North will be detected in a smaller range ✗ Incorrect
- B. North will be detected in a larger range ✓ Correct
- C. North will point to a different direction ✗ Incorrect
- D. The compass will stop working ✗ Incorrect

Explanation:

A larger number means more degree values will meet that condition.

4. A programmer wants to add northeast (NE) detection between north and east. Where should they place this new condition in the code?

MULTIPLE CHOICE

Correct Answer:

- A. Before the north condition ✗ Incorrect
- B. Between the north and east conditions ✓ Correct
- C. After all the other conditions ✗ Incorrect
- D. In a separate forever block ✗ Incorrect

Explanation:

Conditions are checked in order, so place it where the degree range fits logically.

5. What would happen if you removed the else statement at the end of the compass code?

MULTIPLE CHOICE

Correct Answer:

- A. The compass would be more accurate ✗ Incorrect
- B. Some directions might show no letter at all ✓ Correct
- C. The program would crash ✗ Incorrect

D. All directions would show "N"

✗ Incorrect

Explanation:

The else statement handles degree values that do not match any other condition.

6. A student notices their compass shows "E" when they expect it to show "S". Based on the code logic, what degree range is most likely being detected?

MULTIPLE CHOICE

Correct Answer:

A. 0 to 44 degrees

✗ Incorrect

B. 45 to 134 degrees

✓ Correct

C. 135 to 224 degrees

✗ Incorrect

D. 315 to 359 degrees

✗ Incorrect

Explanation:

Look at which condition in the code would display "E".

7. Why does the compass program use a forever block instead of running the code just once?

MULTIPLE CHOICE

Correct Answer:

A. To save battery power

✗ Incorrect

B. To make the display brighter

✗ Incorrect

C. To continuously update as the micro:bit rotates

✓ Correct

D. To store more compass readings

✗ Incorrect

Explanation:

A compass needs to show changes in direction as you move the device.

8. If a student wants to create a more precise compass with 8 directions instead of 4, what is the main change they need to make?

MULTIPLE CHOICE

Correct Answer:

- A. Use smaller degree ranges for each direction ✓ Correct
- B. Change the variable name from "degrees" ✗ Incorrect
- C. Remove the forever block ✗ Incorrect
- D. Add more `basic.show_number()` commands ✗ Incorrect

Explanation:

More directions mean dividing the 360-degree circle into smaller sections.

9. What is the purpose of the `input.compass_heading()` function in the code?

MULTIPLE CHOICE

Correct Answer:

- A. To display the current direction letter ✗ Incorrect
- B. To get the current compass reading in degrees ✓ Correct
- C. To turn on the magnetometer ✗ Incorrect
- D. To rotate the micro:bit automatically ✗ Incorrect

Explanation:

Input functions gather information from sensors - in this case, the compass sensor.

10. A teacher wants students to create a program that shows the actual degree number along with the direction letter. What should students add to their code?

MULTIPLE CHOICE

Correct Answer:

- A. Replace `basic.show_string()` with `basic.show_number()` ✗ Incorrect
- B. Add `basic.show_number(degrees)` before or after the direction display ✓ Correct
- C. Change the variable name to "numbers" ✗ Incorrect

D. Remove all the if-elif statements

✖ Incorrect

Explanation:

To show both pieces of information, you need commands for both the letter and the number.