TOKYMAKER | Science Course

Heat

Course Overview

In this course, students will learn the basics of heat. Using the Tokymaker, students will complete small projects to give them some freedom for creativity and a hands-on experience in understanding what heat energy is.

Core Objectives: (1) How to measure the heat in hot and cold objects
(2) Heat transfer

Course Requirements

Age Restrictions	Subject	Objective	Duration
7 years or older	STEM/STEAM, Engineering, Computer Science	Understanding heat	70 minutes

Prerequisite Skills	Hardware Requirement	Evaluation	Additional Resources
“Hello World” program: Understand Tokymaker coding basics (how to drag and drop code blocks/ download templates from the internet). Tutorial: Tokymaker basic tutorial, course one.	Starter kit (1 kit per group of 2-3 students) MacBook OSX, or Chromebook, or Android Tablet or Android Smartphone with version 6.0 up. Internet	Use this guide to assess students' understanding of the content of the course.	Tokymaker Workbook

Keywords

- Temperature
- Thermometer
- Heat
- Friction
- Heat generation
- Heat transfer
- Conductor

Instructions

Step 1: Preparation Before Class

Duration: 5 minutes

The completion of this course can be done by an individual or group.

Required

Before starting the next part of the course, students must complete the basic language course. This will give them the foundation necessary to understand future lessons.

Optional

The code and walkthrough for the “Cold or Hot?” and “Thermometer” sections can be printed (see Appendix for details).

Materials

- Tokymaker
- Computer/ Laptop
- Tokymaker Workbook
- Temperature sensor
- A strip of LED lights
- Speakers
- Adapter pin
- Bowl
- Water
- Ice
- Boiling Water
- Cup
- Plastic bag

Precautions

The video on Heat has audio. If the school is unable to provide audio support, the students can watch the video on laptops or personal electronic devices.

Step 2: Physics – What is temperature? How do you acquire heat? What is heat transfer?

Duration: 70 minutes

Main Objectives

- What is temperature? How to measure temperature?
- What are the ways to get calories?
- What is the definition of “heat transfer” and “conditions of occurrence”
- What are good conductors? What are bad conductors?

Next is the teaching guide. We recommend teaching the content in this order.

Temperature

(1) Experiment

- The teacher prepares three cups of water in a glass and a thermometer on the table of each group. They are cold water, warm water, and hot water. Have the students puts their fingers in, touch the outside of the cup, or place a thermometer in the cups for at least 2 minutes.

(2) Discussion

- Can you tell me the difference between the water in these three cups? What methods can you use to determine the temperature difference between these three glasses of water? Ask the students to share their ideas.

(3) Summary

- The warmth in an object is called temperature. The colder an object, the lower the temperature, the hotter the object, the higher the temperature. The unit of temperature is called a “degree” and the symbol is °. It is unreliable to judge the temperature by feeling only. To accurately measure the temperature of an object, a tool is used, called a thermometer.

How is heat generated?

(1) Experiment

Let the students put their hands together and have them rub them back and forth.

(2) Discussion

- When we are cold, we can get warm by rubbing our hands back and forth because friction can generate heat. When we are cold, is there any other ways to get your body warm? Ask the students to share their ideas.

- How do these methods keep our bodies warm? Can clothes and quilts give us heat?

(3) Summary

- We can transfer heat to our bodies through external means like sunbathing, hot springs, roasting fires, and using electric heaters.
- By eating, it is energy that enters our body through food.
- By running we can generate heat through blood circulation.
- Clothes and quilts do not generate heat. They only provide insulation to prevent heat from escaping and cold air from entering.

Heat Transfer

(1) Video

- Show the following video to the students with a projector.

  link：https://v.youku.com/v_show/id_XMjAzNzI3MDA4.html

- The matchsticks that are closer to the lamp will melt faster than the matchsticks that are farther away. The closer to the source of heat, the more heat energy the matchsticks will feel and receive.

(2) Discussion

- What is the direction of heat transfer mentioned in the video? Can you give a similar example in our daily lives of heat transferring? Ask the students to share their thoughts.

(3) Summary

- In the video, we can see that heat is being emitted from the lamp and supplies heat to the matchsticks.
- Heat transfers from a higher temperature to a lower temperature.
- As long as there is a temperature difference between objects or between different parts of the same object, heat transfer will occur and will continue until the temperature is the same.
- An object that is easy to transfer heat is considered a good conductor of heat. Copper and iron in the video are good conductors.
- Objects that are not easy to transfer heat are considered poor conductions of heat. Cotton, ceramics, air, and plastics are all considered poor conductors.

Step 3: Practice – Using new knowledge to complete a Tokymaker experiment

Duration: 30 minutes

Experiment 1 – Cold or Hot?

(1) Introduction

- There are two cups of water. Which cup is cold and which cup is hot? We have many ways to tell whether a cup of water is hot or cold. How can the Tokymaker know which cup is hotter?

(2) Preparation

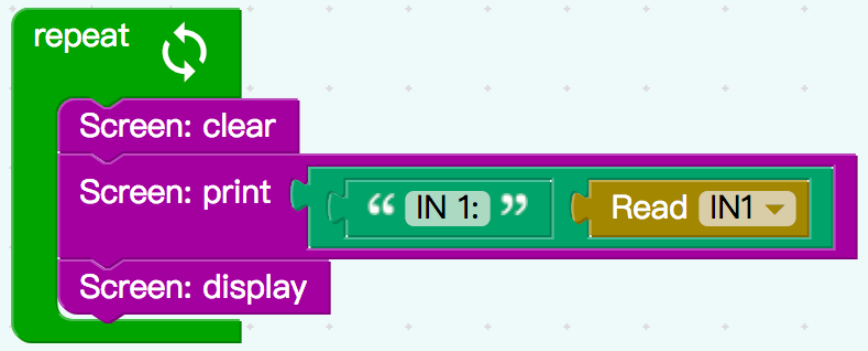
- Connect the Tokymaker to a power supply and computer to the online coding environment

(3) Required Components

- Input: Temperature sensor
- Output: Speakers
- Additional: Adapter pin, Plastic bag, Bowl, Ice, Water, Boiling water

(4) Experiment

Step 1: Download the program to the Tokymaker



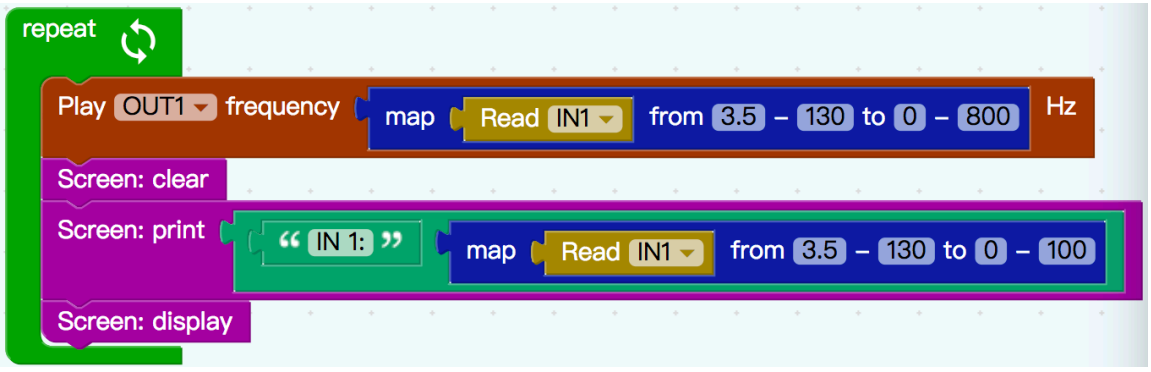
Step 2: Connect the sensors

1. Connect the temperature sensor to Input 1
   Note: The VCC is connected to the positive pole and the GND is connected to the negative pole.
2. Connect the adapter pin to the Speakers
3. Connect the Speakers to Output 1.
   Note: The black wire is connected to the negative pole and the red is connected to the positive pole.

Step 3: Teacher preparation (before class starts)

Place the temperature sensor in the bag and place it in ice water. Take note of what the temperature sensor reads. Now place the temperature sensor in boiling water and note what the temperature sensor reads. Modify the code so that in the map statement it reads the cold – hot values. In our case, it is (3.5 – 130).

Step 4: Download the program to the Tokymaker



Step 5: Investigate

Put the temperature sensor in cold and hot water respectively. What did you find?

Step 6: Summary

The temperature sensor is the way that the Tokymaker senses heat. When it encounters cold water, the Tokymaker will make a low sound. When it encounters hot water, the Tokymaker will make a very high pitched sound.

Experiment 2 – Thermometer

(1) Introduction

- When a child has a fever, the mother will use a thermometer to measure the child's body temperature. The thermometer is a very useful tool to help determine the current state the child is in. Can we make a thermometer with the Tokymaker?

(2) Preparation

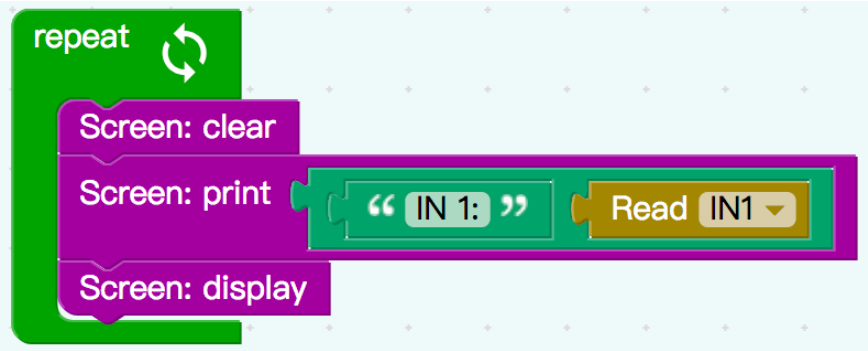
- Connect the Tokymaker to a power supply and computer to the online coding environment.

(3) Required Components

- Input: Temperature sensor
- Output: Strip of LED lights
- Additional: Plastic bag, Bowl, Ice, Water, Boiling water

(4) Experiment

Step 1: Download the program to the Tokymaker



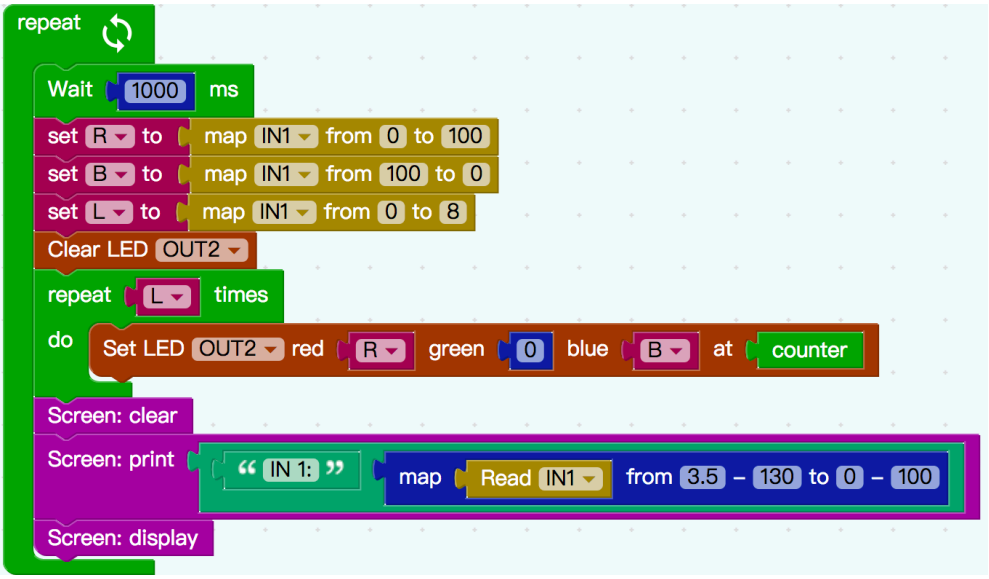
Step 2: Connect the sensors

1) Connect the temperature sensor to Input 1
   Note: The VCC is connected to the positive pole and the GND is connected to the negative pole.
2) Connect the LED strip to Output 2

Step 3: Teacher Preparation (before class starts)

Place the temperature sensor in a bag and place it in a bowl of ice water. Take note of the value read from the temperature sensor. Place the temperature sensor in a bowl of boiling water and note the value from the temperature sensor. Modify the values in the [map] statement to the cold and hot values read from the temperature sensor. In our case it is 3.5 – 130.

Step 4: Download the program to the Tokymaker



Step 5: Discussion

What happens to the LED when the temperature rises? What happens to the LED when the temperature drops?

Step 6: Summary

Maintaining body temperature is very important to human life. If humans get too hot or cold, they can become sick. There are many bodily reactions if we don't maintain our body temperature. When it's too hot out, out body starts sweating to try to cool down. When it's too cold out, our body starts shivering to try to get warm.

Step 4: Discussion – What did you learn through this course? What questions do you still have?

Duration: 15 minutes

(1) Classroom questions

- What are the conditions for heat to transfer?
- What is temperature?
- What are sources of heat?

Ask 1-2 students to share their answers.

(2) Programming Reflection

- What did you gain from this programming experiment? Have 3-5 students share their thoughts.

Step 5: The End

Duration: 5 minutes

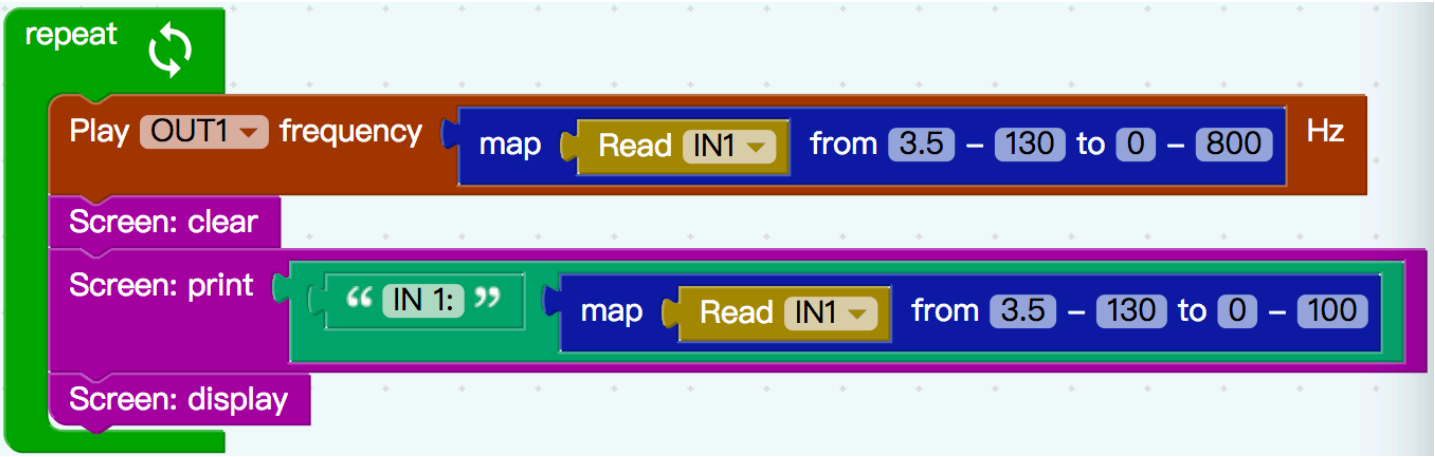
Have the students shut down their computers and Tokymakers. Put all the sensors and equipment back in their box and clear their workspace.

Appendix

Code Tutorial

4.1 Cold or hot?

Code



Understanding the Code

In green [repeat]: The statement represents that the program inside will be executed again and again.

In brown [Play]: The statement plays a frequency at Output 1.

In purple [Screen： clear]: Will clear the screen from previous images displayed.

In purple [Screen： print]: Indicates that the following content will be printed.

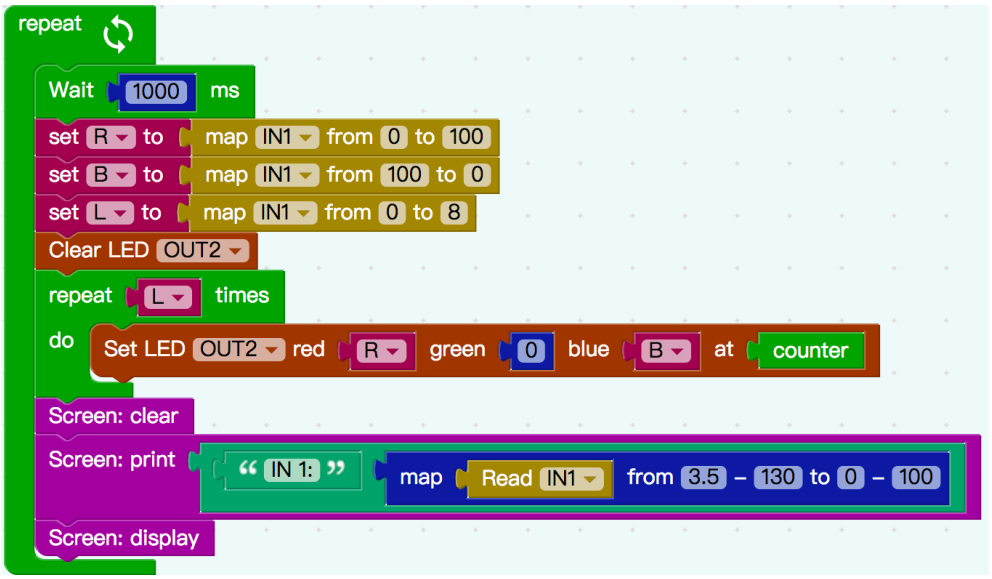
In purple [Screen： display]: Indicates that the contents from the print command be displayed on the screen.

The first blue [map]: The statement indicates that the 3.5 (temperature sensor value in ice water) to 130 (temperature sensor value in boiling water) is converted to the range 0 – 800 Hz.

The second blue [map]: The statement indicates that the 3.5 (temperature sensor value in ice water) to 130 (temperature sensor value in boiling water) is converted to the range 0 – 100 degrees Celsius to indicate the current temperature.

4.2 Thermometer

Code



Understanding the Code

In green [repeat]: The statement represents that the program inside will be executed again and again.

In green [Wait]: The statement indicates a waiting period of 1000 milliseconds.

In red [set]: The statement creates three variables, R, B, L, which represents the red color value, blue color value, and the number of lights.

In yellow [map]: The statement sets the range of input 1 values from 0 to 100, so when the temperature is the highest, the lights will become redder and the blue color will disappear. The strip of LED lights will also be illuminated as the temperature increases. The lower the temperature, the more blue the LED lights and only one LED light will be on.

In green [repeat]: The statement sets the number of times to repeat the [do] statement. Here it will be repeated L times. Each time lighting a LED light at Output 2, the red value is represented by the variable R, the green value is 0, and the blue value is represented by the variable B. The counter will add one to its value each time the statement is repeated. This is to help determine the location of the LED that needs to be lit.

In purple [Screen： clear]: Indicates that the screen is cleared from previous images on the screen.

In purple [Screen： print]: Indicates that the following content is printed.

In purple [Screen：display]: Indicates that the contents of the [print] statement is displayed on the screen.

The first blue [map]: The statement indicates that the 3.5 (temperature sensor value in ice water) to 130 (temperature sensor value in boiling water) is converted to the range 0 – 800 Hz.

The second blue [map]: The statement indicates that the 3.5 (temperature sensor value in ice water) to 130 (temperature sensor value in boiling water) is converted to the range 0 – 100 degrees Celsius to indicate the current temperature.