# Lesson plan - Lesson 2: Energy meter part I

## Using the MonkMakes solar experimenters kit

## Introduction

This lesson gives you time to introduce the MonkMakes energy meter to the students. As well as introducing the energy meter program the lesson focuses on understanding the connections between the micro:bit and other hardware. The energy meter is a quite involved circuit and it’s worth having enough time to charge the solar store to see how the program works. For this reason it is split over two lessons. In addition the PRIMM cycle is slightly adjusted here as we believe that a section of explicit teaching is needed to explain the relationship between the solar store and the micro:bit.

## Learning objectives

* To successfully set up a micro:bit/energy meter circuit and flash code to the micro:bit
* To understand the significance of the different pin connections from the solar store to the micro:bit
* To be able to read and interpret a program containing a bar chart function
* To be able to read and interpret a program containing for loops

## Keywords

Solar store, voltage, super-capacitor, terminals, bulb, harvested, circuit, GPIO, pins, iteration, loops

## Preparation

**Subject knowledge:**

This lesson is suitable for a class who already has a basic knowledge of programming using python. The coding for the micro:bit is written in a reduced version\* of python called micropython but for practical purposes the syntax will appear the same to the user. In addition the students should have already used the micro:bit, practising simple set up and smaller micro:bit specific programs so that they are used to building and flashing programs. Initially, building the circuit for the “energy meter” is a question of copying a diagram so a practical demonstration of handling the components gently and clipping with alligator clips would suffice. However, we would strongly recommend the teacher accessing the instruction booklet and trying out each of the circuits to get experience of how long charging takes in the available light levels.

**Pedagogical approach:**

The lesson is planned using the PRIMM pedagogy which stands for:

P - Predict

R - Run

I - Investigate

M - Modify

M - Make

For this reason it is important that the class have quick and easy access to the coding of the program which can be accessed via: https://tinyurl.com/skxfbrjw

The very first step is for the students to view the code and attempt to predict what the code does. We use a tool called a **code conversation** which provides the teacher with a conversation style **talkthrough** of the micropython code for you to support your students’ developing knowledge. Occasionally daggers (††) are used to clarify things in the code conversations, instead of asterisks, which could be confused with the multiply symbol.

**Practical set-up and development environment:**

We recommend either using the on-line Python editor (https://python.microbit.org) or Mu (https://codewith.mu). Or you could manage your coding in micro:bit’s own environment <https://classroom.microbit.org/> which enables you to push code to the whole class and manage their activities.

**Resources that you need:**

* Presentation
* Starter worksheet questions
* Starter worksheet answers
* Code conversation full solution
* Code conversation template (level 1 - basic)
* Code conversation template (level 2 - intermediate)
* Plenary worksheet
* Plenary worksheet answers
* Hardware Per pair - 1 micro:bit, 1 Solar panel, 1 Solar store, 1 USB/micro USB cable, 8 alligator clip leads, 1 motor, 1 fan
* Access to appropriate development environment (the on-line Python editor, Mu or micro:bit classroom - Mu is needed for the last lesson in the scheme)

## How the students’ progress is assessed

**Energy meter I**

The presentation itself begins with a slide showing the labels on the micro:bit. The students then copy the significant labels onto their worksheet and answer some hardware related questions. The lesson is interspersed with pair or whole class discussion opportunities. As this is predominantly a practical lesson, observing the students’ success in flashing the program, compiling the circuit and making small successful modifications to the program will also enable you to assess their progress. The learners also complete a worksheet at the end of the lesson which demonstrates their understanding of key principles conveyed during the lesson. Because of the complexity of the circuit and needing to leave some time for charging the lesson is split into two with the code conversation started in part I and completed in part I with time left for the modification part of the PRIMM methodology. The last lesson of the whole scheme of work focuses on modification and making but as students progress at a different pace you may have some students who are ready early to do some modification in lesson 3, which is facilitated for them.

## Plan (with approximate timings)

| Starter activity 7 mins | **Labelling the micro:bit and answering feature questions**  The slide that greets the student is of the labelled micro:bit. The students are expected to copy the labels onto their unlabelled version of the micro:bit and answer some questions to assess their current knowledge of the micro:bit. After the students have completed the worksheet quickly go through the solutions and ensure that they correct any wrong answers on their starter worksheets. |
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| Objectives & Homework 4 mins | **Objectives and homework review**  Review the objectives and last week’s homework with the students to put the lesson in context. |
| Activity 1 7 mins | In order to put the lesson and the energy meter in context the students need an introduction to the energy meter itself. This is done at quite a simple level by explaining that the energy meter provides a way of determining how much charge is available in the solar store.  **Predict: students view code and attempt overview code conversation**  The students are shown the code and are asked to predict what the whole program does i.e. an overview in a couple of sentences. You should not expect accuracy here, just an attempt and some curiosity. After the students have predicted and run the program we have inserted some explicit teaching about the relationship between the micro:bit and solar store to scaffold the students' learning.  For example:  The solar energy meter program measures the amount of energy available from the solar store. It then creates a simple LED bar chart to display the amount of energy available in the store. The program also enables the user to turn the fan on and off, using button a and b respectively. |
| **Activity 2**  8 mins | **Run: students compile the circuit, flash and run the code**  Share the slide with instructions on the board to enable the students to build the circuit, flash and run the code. Ask them if the circuit behaves as they would have expected from the **predict** phase of the lesson. Depending on how bright the day is, or the proximity to bright indoor light the solar store may take some time to charge so once the circuit is compiled it is important that the students leave the fan off and allow it to build some charge so that they can see the bar chart increasing on the micro:bit. There is plenty to do with the code conversation while they wait. |
| Activity 3 5 mins | **Explicit teaching about solar store and micro:bit**  In this section the students are given some explicit teaching about the connection between the solar store and the micro:bit. In the previous lesson they labelled the solar store so this is a good overlearning opportunity for the class to consolidate this knowledge. You might need to remind them about the function of the supercapacitor i.e. it is like a rechargeable battery, storing the charge transferred from the solar panels. |
| Activity 4 18 mins | **Investigate (part I): teacher and students use correct terminology to identify the syntax and features of the program**  Using the A4 worksheet, the learners attempt to complete the first part of the code conversation matching the correct explanation to each line of code. During this lesson they will be going through lines 1-11 of the program with you in detail but to get a sense of the program they may want to attempt to understand the whole program.  Using the slides talk through the different steps in the program. |
| **Plenary**  6 mins | **Energy meter plenary worksheet**  Students complete the plenary worksheet testing knowledge of the connection of the solar store to the micro:bit. |
| **Homework** | **Consider what other equipment in your house utilises an energy meter and how life would be without one.** |

## The Author

This lesson plan and all its parts were created by Dr. Paula Beer of Beer Academic Consultancy in collaboration with Monk Makes Ltd.



Dr Paula Beer has taught Computer Science and IT education to new and established teachers since 2007. Her own research has focused on the use of play and collaboration in computer science. She enjoys supporting practicing teachers by designing accessible lesson planning materials to get students engaged in computer science through play and collaboration. Paula has also produced educational materials for The Raspberry Pi Foundation, been a secondary school teacher, written a successful book (Hello App Inventor!) and has previously worked in IT project management for a media company and for the NHS.