IET BBC micro:bit class session
A sun exposure alarm

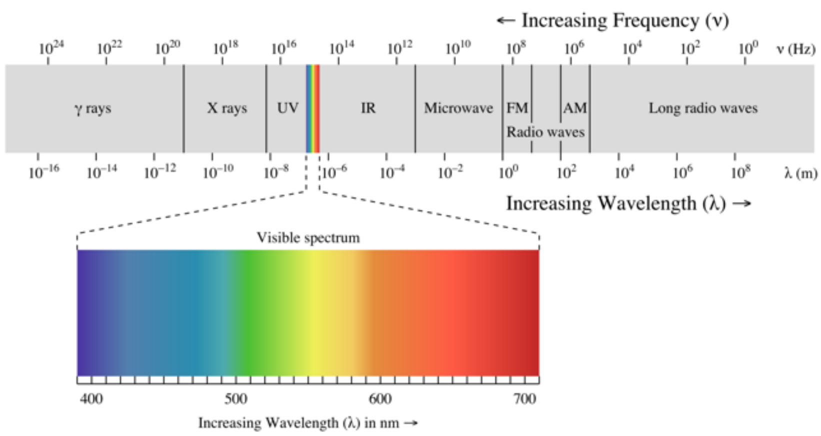
This activity is incremental and builds on each step. Worked examples are shown but it is feasible for students to come up with other working solutions. At worst, get a projector up to show them what to do. Preferably describe what to do (you can look at a students screen) - it means you are out on the shop floor and the students have to translate your words in to their actions on screen. If they see you do it, they will just copy it parrot fashion (bonus points for Norwegian Blue references). The science notes are optional and not required for the engineering activity.

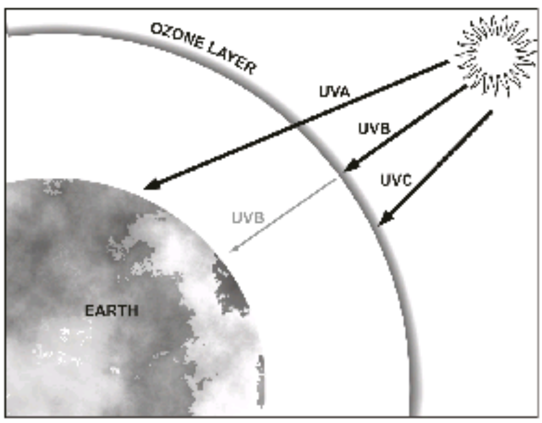
You will need to tell them how to connect the external accessories & find the right blocks to use them.

The brief: Sun exposure is a major cause of skin cancer, the rate doubled between 1975 & 2000. Because we can’t see the light that causes the problem, you have been asked to create a device that monitors light levels and displays/sounds an alarm if a certain level is reached.

Question: What causes sun burn?
Elicit: Ultra-violet, UV-A, UV-B, which end of spectrum that UV is, what’s at the other end (IR). From the sun: UV-A reaches us, UV-B largely absorbed, UV-C completely absorbed by Ozone layer / atmosphere.

Note/elicit: Importance of Ozone layer.





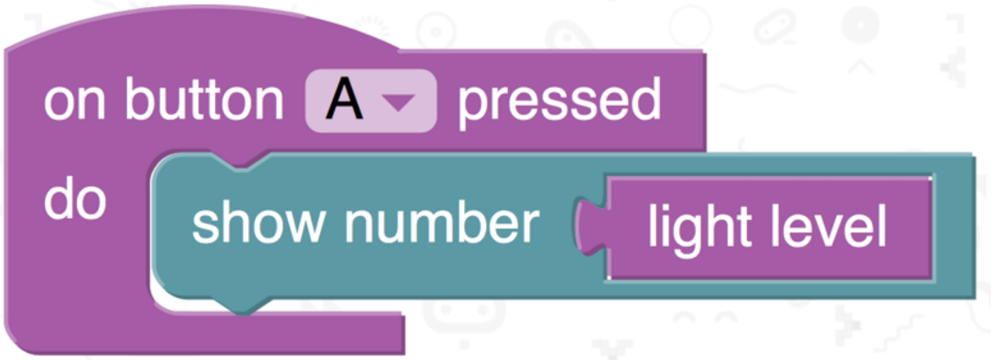
Don’t spend more than a couple of minutes on this, it’s all about the coding ….

There will be LDR sensors, buzzers & small torches for each student but don’t hand them out until they get to that point.

There will be a device with a calibrated UV Index sensor for demo purposes.

Emphasise that product development is incremental, small steps based on the success from the previous step - big bang projects tend to go wrong.

1. Start coding: Initially student to use the built in light sensors on the micro:bit:



Wait for all students to complete above to gauge ability levels.

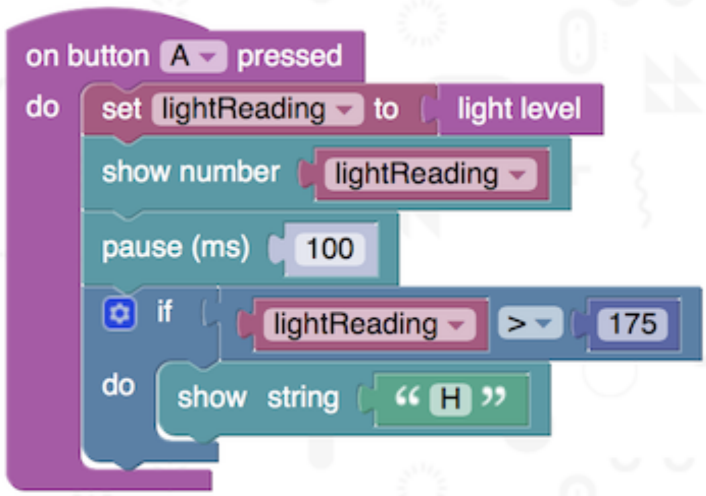
2. Calibration: Students to document values for various light levels - dark, ambient, directed at light source, with torch. The range will be 0 to 255. **Give them the torches.**

Elicit: Where is the light sensor?
Answer: The LEDs in the grid. They can be used by reversing the voltage on them to charge them (fill with electricity/electrons) and then time the discharge rate - the photons hitting the LED cause it to discharge quicker - more light = more photons = faster discharge.

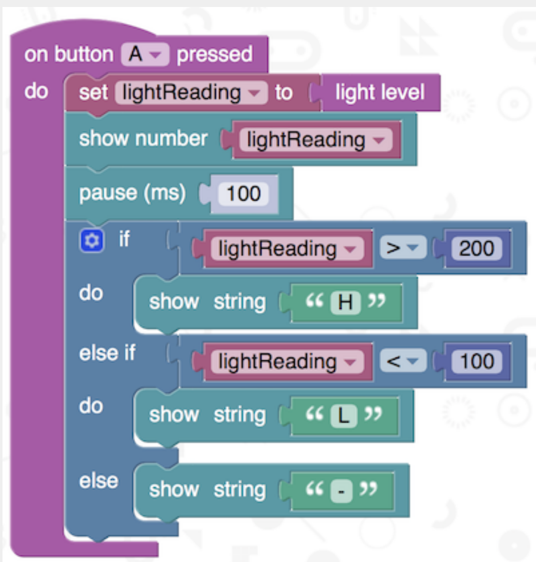
3. Alarm: An IF block to display an appropriate message:

We use the variable block to store the value from the P0 pin. If we then do further comparisons in the same block we can then be sure that it hasn't suddenly changed. See example below.

Storing the reading in a variable is good programming and control systems practise. Reading the value for each comparison is exactly the sort of error that ends up with rockets going sideways or aeroplanes running out of fuel.

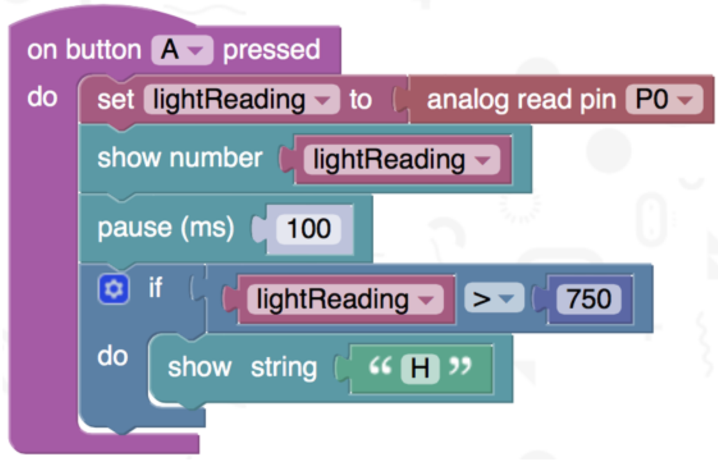


Optional Extend: ELSE IF (click the little cog wheel) to set appropriate messages - Low, Med, Hi or L, M, H or graphics like a tick, dash and cross. Encourage students to make it easy to understand for their user, get them to make a timely decision (perfect graphics = delay in product shipping).



4. External sensor: Use a Light Dependant Resistor (LDR) as a more accurate light sensor. Connect Red, Black and the other lead to P0.

To read the value, use this



Background: The LDR is a photo-resistor made of an almost conductive material, in this case, cadmium sulphide. The photons give electrons trying to cross the conductivity gap enough extra energy to make it across. (Ask, what is the average speed of an unladen swallow for extra points).

A fuller version with the multiple comparisons as bottom of page 2.

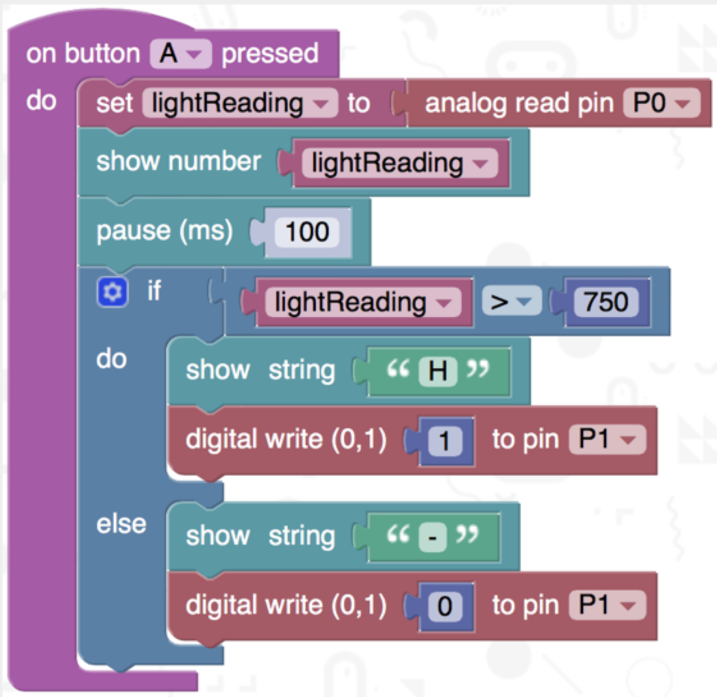
5. Re-calibrate: Document new values and change code appropriately. The range will be 0 to 1023.

6. Alter code: Use the new readings they have obtained. The high value should not be when using the torches. To save the batteries, get them back off the students. As desirable objects, counting them back in is appropriate.

7. Buzzer: Add a buzzer to the alarm by using one of the pin outputs. Connect Red, Black and the other lead to P1.

To turn on:

To turn off:



8. Reset the buzzer. If the student hasn't already put the ELSE block in, they will have to now otherwise once they trigger the buzzer it will sound continuously without the ELSE and the turn off blocks.

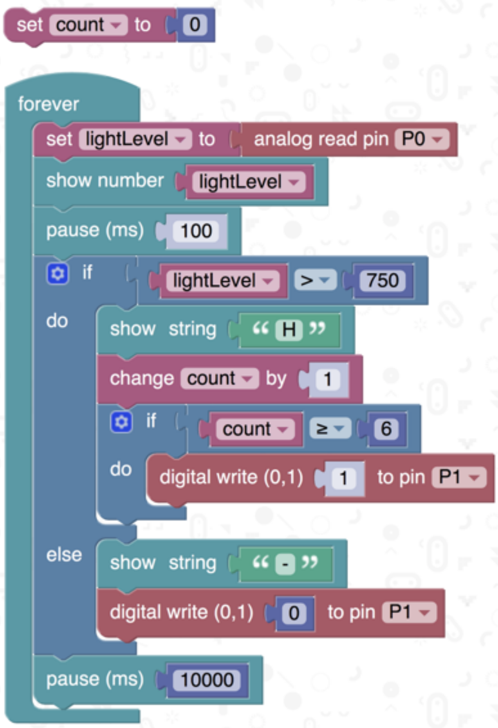
See above

9. Continuous checking: Change the button press in to the FOREVER block and add a PAUSE at the bottom of the loop.

9a. Timer: For those that make good progress, they can have the buzzer sound once some time has passed.

Note, the World Health Organisation does not recommend the notion of safe time in the sun - it’s about using appropriate levels of protection. The thinking here is to give time for the user to get out of the sun without driving them insane from the constant alarm.

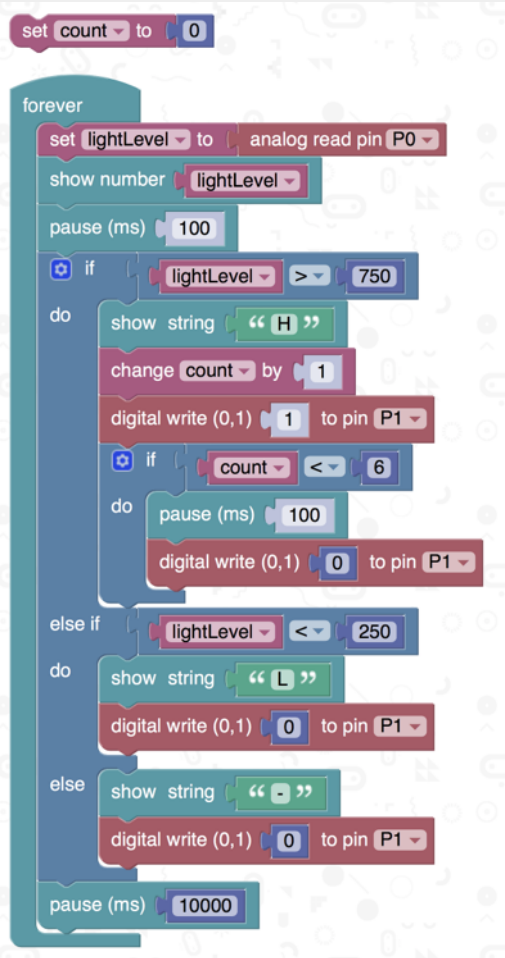
Create a variable to count with and initialise it as per good programming practise (hence the unconnected block at the top). Insert a check every few seconds, student to choose appropriate duration, 10 - 30 seconds would be about right, too long may result in over exposure, too short & they are checking silly number. Delay is in milliseconds so it will be 1000 times the number of seconds. If it’s high, add one to the counter. When an appropriate number of counts has been reached, display / sound the alarm.



9b. Timer: Students can have two levels of alarm. High level reached can briefly buzz and once 10 minutes has passed, the buzzer can sound continuously.

Every time the loop detects high, it increments the count and turns on the buzzer. If we haven't exceeded the count, we have a small pause and then turn the buzzer off. Once the count has been exceeded, it will never reach the turn off line unless taken in to lower level light.

This can be subsequently extended to decrease the time between buzzes as it gets closer to the chosen full alarm time. Or intervals can vary depending on the light levels.



If possible just before class changeover, take them outside to show the calibrated UV sensor - it will display in official UV Index units.