LO & Behold - possible learning outcomes

1. Electricity needs a source of energy
2. Electrical energy flows in a circuit
3. Materials that allow electricity to pass through are called conductors
4. Materials that do not allow electricity to pass through are called non-conductors
5. Human body fluid is a conductor (ionic liquid)
6. Liquids that conduct electrical energy are called ionic
7. Solids that conduct electricity include metals, carbon, and silicon, but not wood or plastic
8. When electricity passes through a metal or graphite conductor some of the energy is released as heat
9. Silicon is an example of a semiconductor used to make electronic components, such as diodes, which only allow current to flow in one direction
10. Some diodes are designed to emit light - hence Light Emitting Diode (LED)
11. LEDs have two electrodes - the positive is longer, the negative is shorter
12. The positive electrode is connected to the 'flat', +ve side of a 3V button battery.
13. Not all LEDs use the same amount of energy
14. Learning to understand electricity and electronics is hard but it can be fun, 'hard fun' being Seymour Papert's term for learning through playing with stuff
15. Hard fun is one of the best ways to learn
16. When something is learned this way, the learner can't wait to go off and try it again, or show someone else
Shopping list for demo

A. a ‘conductance’ toy - the chick, micro:bit or energy stick*
B. metal scissors with plastic handles
C. wooden pencil sharpened at both ends
D. small glass of water
E. living plant, piece of silicon, coal (optional)
F. Diode (and an LED)

Also for Workshop

G. 3V coin batteries and LEDs, badges, sellotape

*The energy stick, like the chick, makes a noise or shows lights when its metal ends are connected by a medium that conducts electricity.

Step-by-step demo activity (~ 30 mins)

1. Put ‘LO & Behold’ list in a volunteer's pocket
2. Arrange participants in a circle
3. Show chicken, explain it has a battery, show it makes a noise when you touch each terminal with your two hands
4. Invite two, three, four to join hands and make the circuit
5. Explain ionic solutions - our flesh - as conductors
6. Expand to whole circle - set the scientific method ONE RULE - always check it works before making a change
7. Discuss human contact - why pinkies; what cytoplasm is
8. Invite two participants to break circuit (after check) and complete the circuit inserting scissors - plastic first, then metal; explain action of conductors and non-conductors
9. Invite others to complete the circuit using water; refer to dangers of electricity in bathrooms
10. Now complete the circuit inserting the pencil - wood first, then graphite (note it is carbon not lead, discuss graphene)
11. Add in a living plant, a removed leaf, a twig; optional others: graphite refill, thermo paper, lump of silicon, lump of coal
12. Introduce the diode, and change its direction - explain why it works only when it is ‘this way’, but not the opposite way
13. While keeping the diode in the circuit, change the direction of the chicken terminals in the circuit

Workshop (~ 45 mins)

14. If you have more conductance toys or Micro:bits, groups work independently to find out what materials conduct
15. Challenge to set up a classic circuit with a battery, bulb, paper clip - notice the heat being produced by the bulb
16. Introduce the LED and explain that it is a diode
17. Introduce the LEDs and coin battery, looking at the rules
18. Give each person an LED and a coin battery, to make a ‘glowie’ and invite questions
19. Some may take two or several LEDs, then questions will flow
20. All wear their glowie, perhaps share a selfie with their glowie, and come back to the human circuit again for a group photo
21. Bring out the LO & Behold list - how did we do?
22. Offer participants a copy of this guide and tidy up
Using a micro:bit instead of a conductance toy

The plan is, that the happy face icon will indicate a circuit is conducting between pin P0 and GND on the micro:bit.

Start by writing this program in Makecode to detect when pin P0 is connected to GND.

```plaintext
forever
  if pin P0 is pressed then
    show icon
  else
    show icon
  pause (ms) 100
```

The program above will make the micro:bit repeat forever a test using the ‘if then else’, which will show the icon of a happy face if ‘pin P0 is pressed’ is true.

Otherwise, else, ‘pin P0 is pressed’ is false, and the sad face icon is shown.

The pause for 100 milliseconds gives us slow humans time to see the changes!

Connecting Pin 0 and GND completes the circuit using your body as a conductor, which means ‘pin P0 is pressed’ becoming true.

If you hold hands with someone else to make a bigger circuit, that should also work.