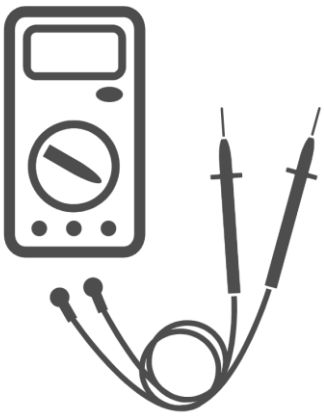
Oide

Tacú leis an bhFoghlaim Ghairmiúil i measc Ceannairí Scoile agus Múinteoirí

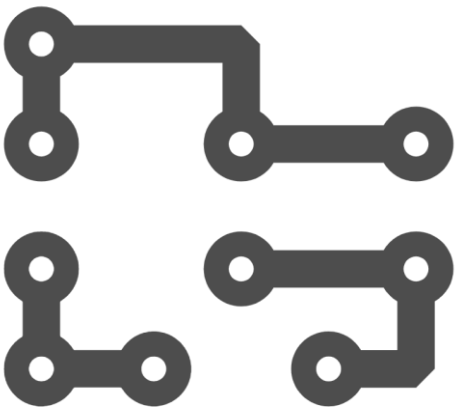
Supporting the Professional Learning of School Leaders and Teachers

Problem-solving electrical control in Applied Technology

A practical guide for teachers



Electrical inspection



Visual inspection

Introduction:

As students study Applied Technology, they will have opportunities to **investigate** and **solve real-life problems**. This learning is evident in many aspects of the subject and particularly when students engage with electrical control. Students experience great satisfaction when their electrical circuit works in their project. Sometimes, while a circuit appears to be fine, it does not work effectively and this can lead to frustration and disappointment! To resolve issues as they happen, students need to be patient and persistent. Equipped with the necessary skills to solve circuit-related problems, students will also have opportunities to develop **resilience** as they learn in a 'safe failure' environment.

This resource is designed to support students as they develop problem-solving skills through electrical control. Initially, the focus is on how students can use different investigation techniques to build knowledge and understanding in relation to common electrical faults. The resource also sets out a plan for how students can develop their fault-finding skills once a problem has been detected in their electrical work. Equipped with the necessary skills to solve these problems, students will enhance their sense of wellbeing and learn in a more enjoyable way!

Studying Applied Technology allows students to develop….

Problem-solving Electrical Control in Applied Technology:

Students will…

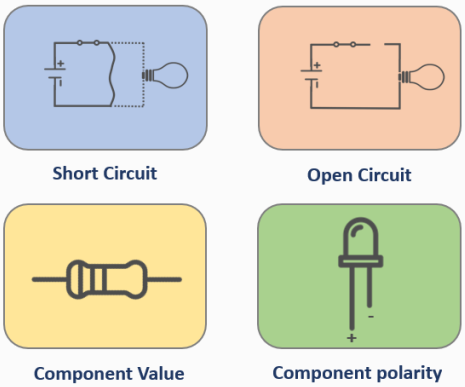
Problem-solving electrical control: Prompts to consider

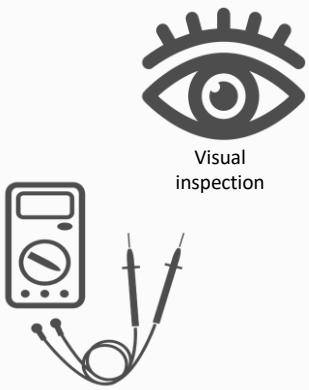
To problem-solve electrical control issues in circuits, students need to know what to look for when investigating circuits. They will also have to plan how they are going to investigate potential faults and make judgements on how best to solve problems.

Below are useful prompts to consider.

1. Learn about common faults

- Do I have an understanding of common electrical faults?
- Do I know how to recognise common faults in circuits?
- Who can help me to better understand common electrical faults?





2. Learn about investigation techniques

- How do I know that there is a problem with my circuit?
- How do I plan to investigate the problem further?
- Which technique(s) will I use to identify common faults? (Visual and/or Electrical techniques)
- What am I learning from the investigations that I carry out?

3. Planning for fault-finding skills development

- Analyse potential causes for the circuit- related issue.
- Plan how you will investigate potential causes further
- Carry out investigations using appropriate techniques
- Study the findings from your investigations
- Make judgements that help to resolve the circuit issue

Learning about investigation techniques

Visual Inspection Technique

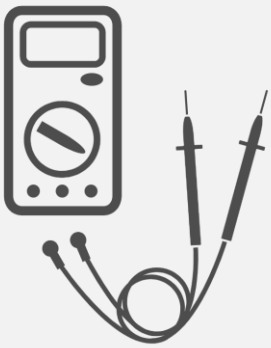
A visual inspection is where you **look** at the various elements of your work to determine any flaws. Sometimes, a fault can be identified by simply looking at it!

Visual inspection

Prompts for you to consider:

- Are there any loose connections or loose components in your circuit?
  (wiring, battery connections etc.)
- Are there any exposed wires touching accidently creating a short circuit?
- What are the quality of your soldered joints like?
  (a shiny cone-like soldered joint is good)
- Are any pads on the circuit board damaged?
- Are the correct value components used in the circuit?
- Are the components placed correctly?
  (check for indicators on components e.g., cathode identification)
- Have you placed ICs correctly in your PCB or PIC?
- Are all input and output devices connected correctly?
- Did you check your circuit with the circuit diagram?

Learning about investigation techniques



Electrical inspection

Electrical Inspection Technique

An electrical inspection is where you examine the various elements of your work using a **multimeter** to determine any faults. A typical multi-meter can measure voltage, resistance, current and continuity in a circuit.

Click on the links below to learn more about how to:

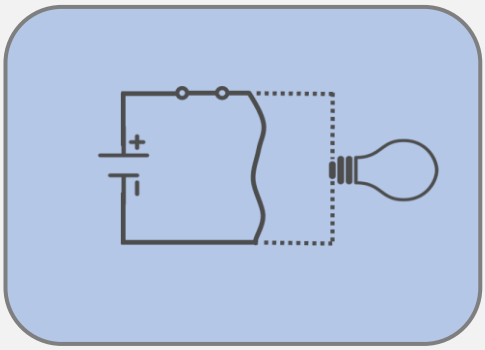
Overview of a multimeter

Connecting the probes/leads

Prompts for you to consider:

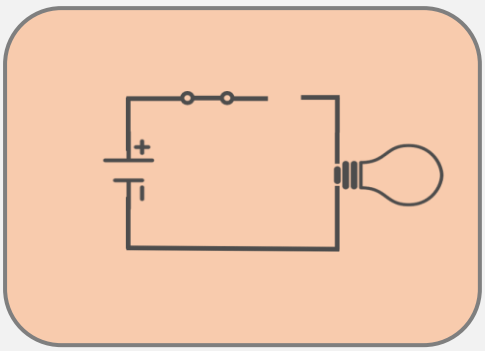
- Using a multi-meter, check the value of the voltage, current and resistance passing through components. Are these values correct?
- Using the continuity tester, identify open and short circuits (broken traces (tracks), faulty components etc.)
- Using the continuity tester, check the polarity of components.

Learning about common faults



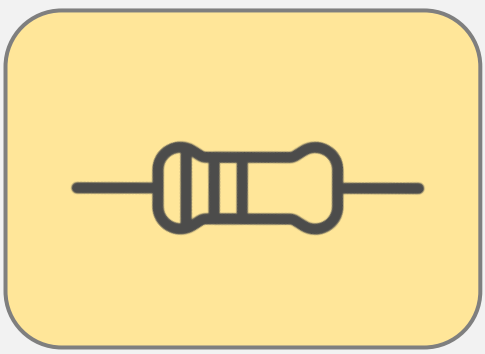
Short Circuit

A **short circuit** is a situation in which a faulty connection or damaged wire causes electricity to travel along the wrong route and damage an electrical device.



Open Circuit

An **open** circuit is a circuit where the path has been interrupted or "opened" at some point so that current will not flow. An open circuit can be intentional or un-intentional.



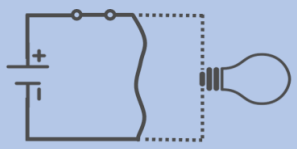
Component Value

When electrical components are used in circuits, it is important the correct value component is selected. This ensures that other components are not damaged by excessive current.

Component Polarity

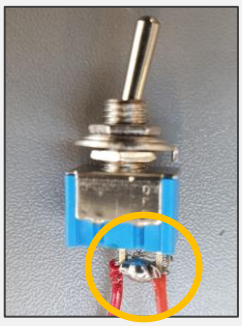
LEDs, electrolytic capacitors and diodes are examples of polarised components. This means that current flows through these components in one direction only. It is important to connect these components correctly in circuits.

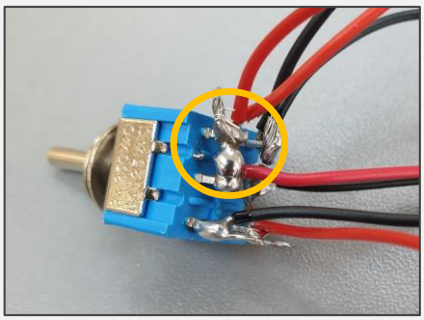
Recognising a short circuit fault

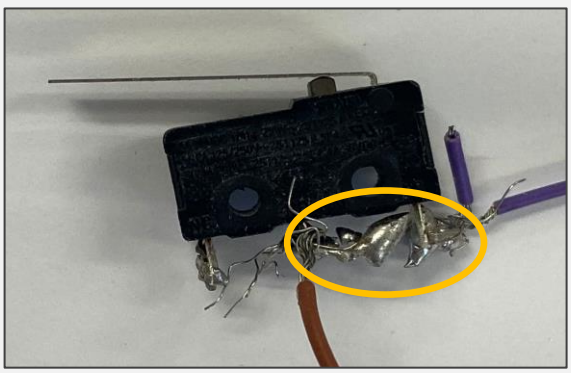


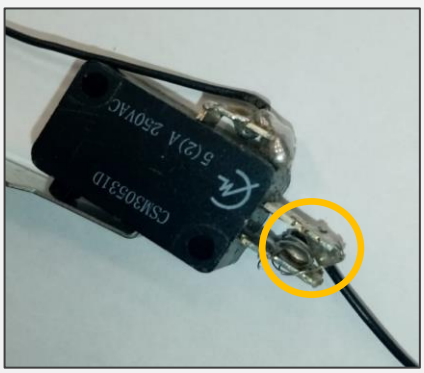
Switches: Visual inspection

The images below show a short circuit occurring when the **switch** contacts are accidently soldered together.





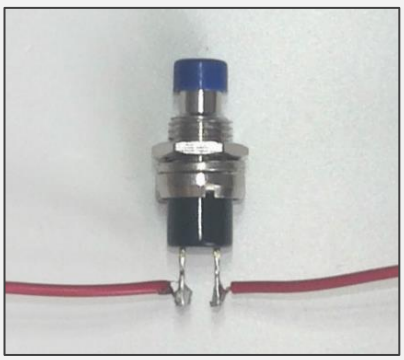




Switches: Electrical inspection

Click on the image to learn how to identify a short circuit in a switch using a multi-meter.

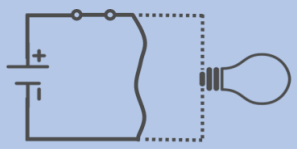
Video Link: https://youtu.be/FcJJ1VANsv0



Tips for preventing this short circuit:

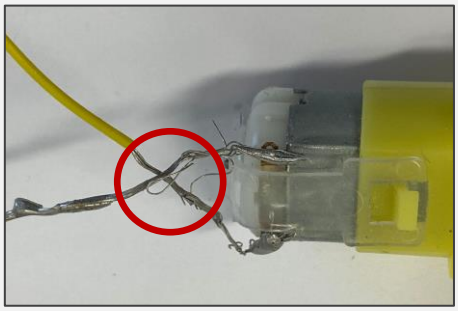
- Hold the component e.g. a switch, in a vice while you solder
- Only apply a small amount of solder to the contact area
- Only strip back enough sheathing to expose the wire to be soldered
- Snip excessive wiring once the joint is formed

Recognising a short circuit fault



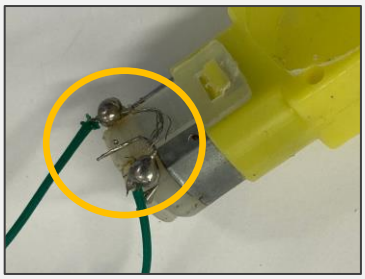
Wiring and leads: Visual inspection

The images below show a short circuit occurring when exposed wires make undesired contacts with each other.



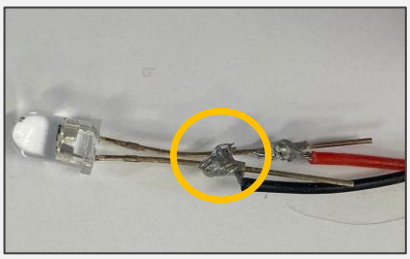
Too much plastic sheathing has been removed allowing wires to make contact with each other.

The positive (red) lead and the negative (black) lead have been accidently soldered together.



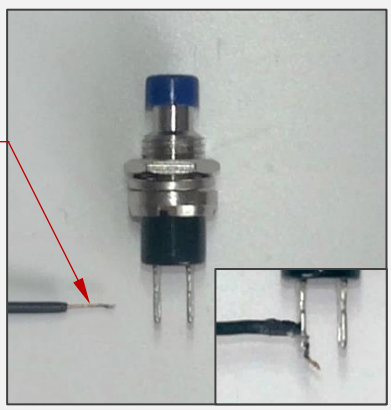
Excessive wiring which is not removed can create a short circuit.

The positive and negative leads of the LED are in contact, creating a short circuit.

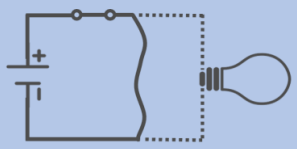


Tips for preventing these short circuits:

- Only strip back enough sheathing to expose the wire to be soldered
- Snip excessive wiring once the joint is formed
- Make sure to follow a circuit diagram if soldering wires together
- Where possible use heat shrink to prevent LED legs from making contact with each other.

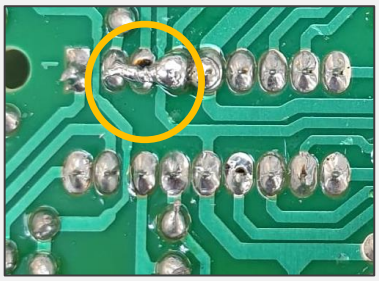


Recognising a short circuit fault



PCBs: Visual inspection

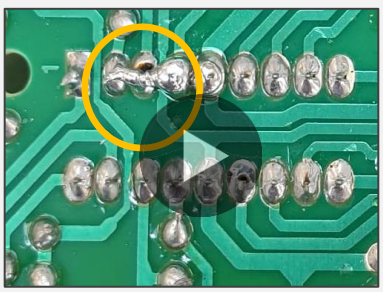
The image below shows a short circuit occurring when separate parts of the circuit are accidently soldered together creating a short circuit.



PCBs: Electrical inspection

Click on the image to learn how to identify a short circuit in a PCB using a multi-meter.

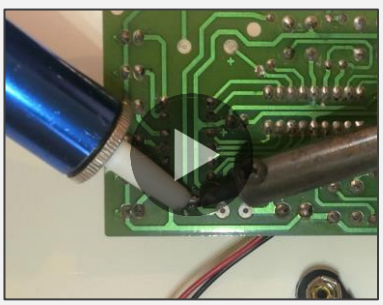
Video Link: https://youtu.be/ofkKmzscQKk



Tips for preventing these short circuits:

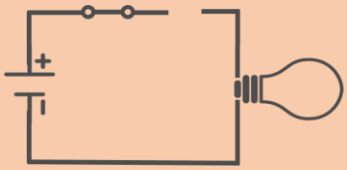
- Make sure that you know how to solder effectively
- Use a desoldering pump to remove excessive solder

How to solder effectively
Video Link: https://youtu.be/whlkq4Zdvpw



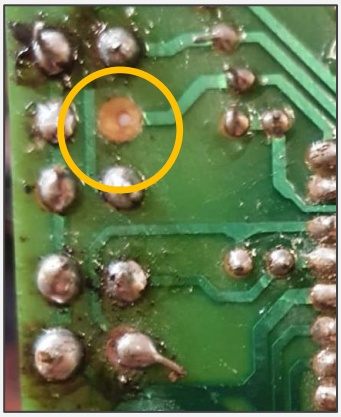
Using a desoldering pump
Video Link: https://youtu.be/o5cWuW-c-L4

Recognising an open circuit fault



Damaged PCB pad: Visual inspection

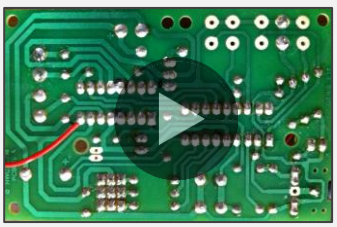
Poor soldering techniques can lead to pads being accidently pulled off PCBs. This will create open circuits and therefore the PCB will not work.



Damaged PCB pad: Electrical inspection

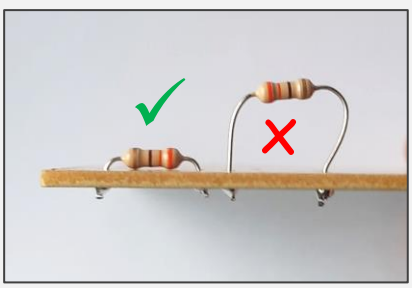
Click on the image to learn how to identify an open circuit in a PCB using a multi-meter.

Video Link: https://youtu.be/IoTy6zbey_U



Tips for preventing this fault:

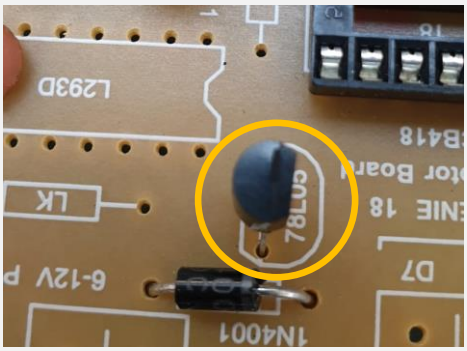
- Make sure that components are mounted flush to the PCB before soldering. A pad can be removed accidently if a soldered component that is not flush against the PCB is pressed.
- Make sure that you know how to solder effectively- Watch the video on the previous page to learn more.
- Do not put excessive pressure on the pad while you are soldering. This can damage the pad.
- Make sure that all the solder is removed before trying to remove a damaged component.



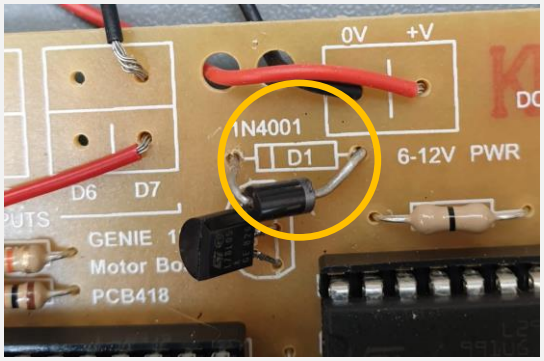
Recognising a polarity fault

Polarity: Visual inspection

The polarity of the components below have not been adhered to when mounting the components to these PCBs.



Transistor incorrectly mounted

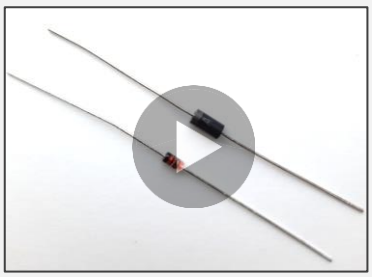


Diode incorrectly mounted

Polarity: Electrical inspection

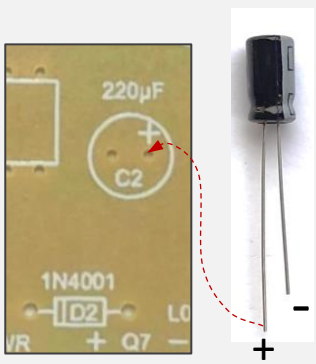
Click on the image to learn how to identify a polarity issue using a multi-meter.

Video Link: https://youtu.be/oRBdaNSi8N4

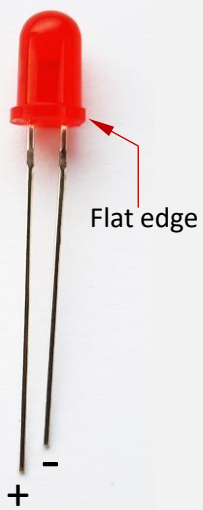


Tips for preventing a polarity fault:

- Recognise different polarised components by their markings e.g.
  - LED- flat edge identifies cathode,
  - long lead identifies anode,
  - Diode- single band identifies cathode (-)



- When mounting polarised components on PCBs, look at the component diagram on the PCB to ensure that it is mounted correctly.



Recognising a component value fault

Component value: Visual inspection

Choosing the incorrect value for a component can permanently damage other components in a circuit or prevent the circuit from working properly.

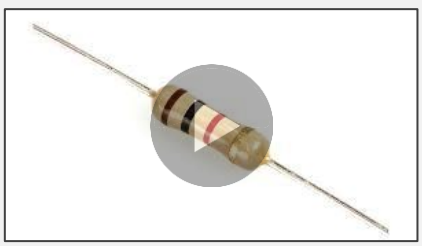
Component value: Electrical inspection

Click on the image to learn how to identify a component value issue using a multi-meter.

Video Link: https://youtu.be/ECIK0pOw5Uc

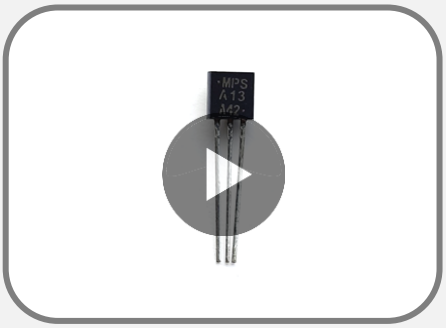
Tips for preventing component value issues:

- Make sure to read the value of resistors and capacitors correctly.
- Make sure to select the correct transistors when using specific components.



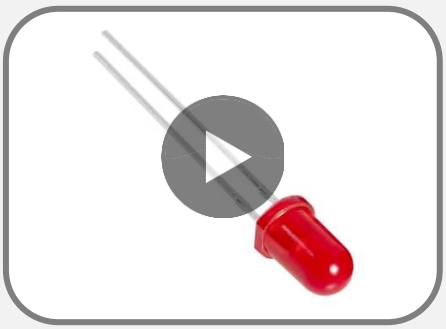
Reading the value of a resistor
Video Link: https://youtu.be/kEcJYe_QRYg

Using a multimeter- supplementary videos



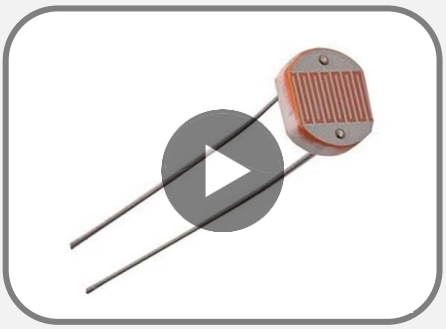
Transistor

DC motor



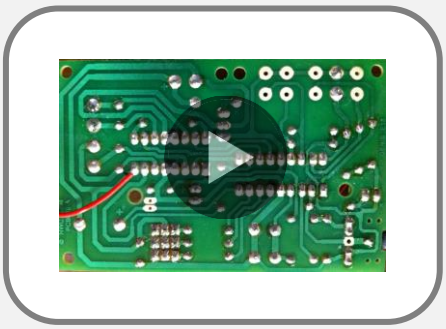
LED

Lever microswitch



LDR

Variable resistor



PCB using
an ohmmeter

Capacitor

Planning for fault-finding skills development

To help students to problem-solve circuit-related issues, it is important to provide them with opportunities to develop fault-finding skills.
The **PDSA** Cycle (Plan-Do-Study-Act) is a systematic approach that can support students in developing fault-finding skills that are demonstrated when investigating circuit-related problems.

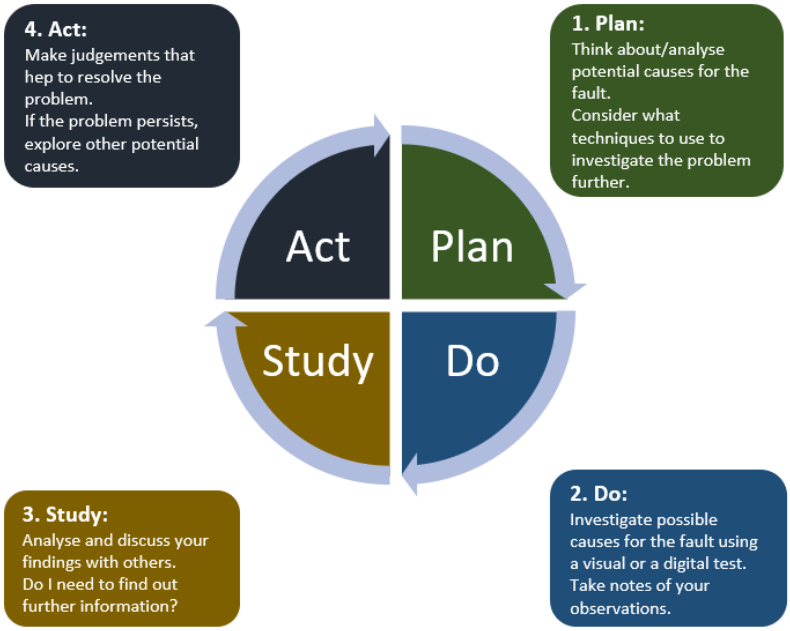
4. Act:
Make judgements that hep to resolve the problem.
If the problem persists, explore other potential causes.

1. Plan:
Think about/analyse potential causes for the fault.
Consider what techniques to use to investigate the problem further.

3. Study:
Analyse and discuss your findings with others.
Do I need to find out further information?

2. Do:
Investigate possible causes for the fault using a visual or a digital test.
Take notes of your observations.

Fault-finding Challenges



Student Activities:
For each activity given below, use the PDSA cycle to investigate and identify the faults presented.

Challenge 1:
A power supply, toggle switch, a resistor and an LED are connected together in a simple circuit. When the switch is turned on, the LED does not light.
Identify possible faults in the circuit and describe how these faults might be investigated.

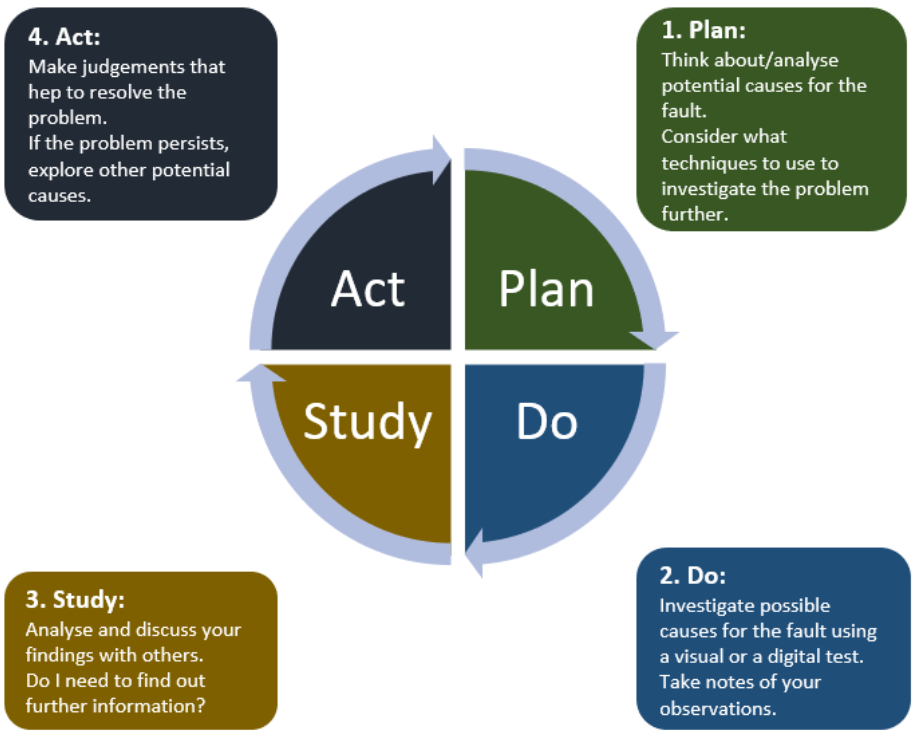
Challenge 2:
An old motor has been discarded by a student. Another student wants to re-use the motor but has detected a fault.
Describe how an open-circuit fault and a short-circuit fault could be detected.

Challenge 3:
Many Applied Technology classrooms have examples of old PCBs or circuits that don't work.
Using either visual or electrical techniques, investigate the reason(s) why one of these circuits does not work properly.

Challenge 4?
What other electrical control challenges could you offer your students using the PDSA cycle above?

Personal reflection moment

How could you adapt this process further to meet the needs of your students?



How can fault-finding strategies be integrated into learner experiences?

What are my next steps?

- When I go back to school tomorrow…
- Over the next couple of months…
- Next year…