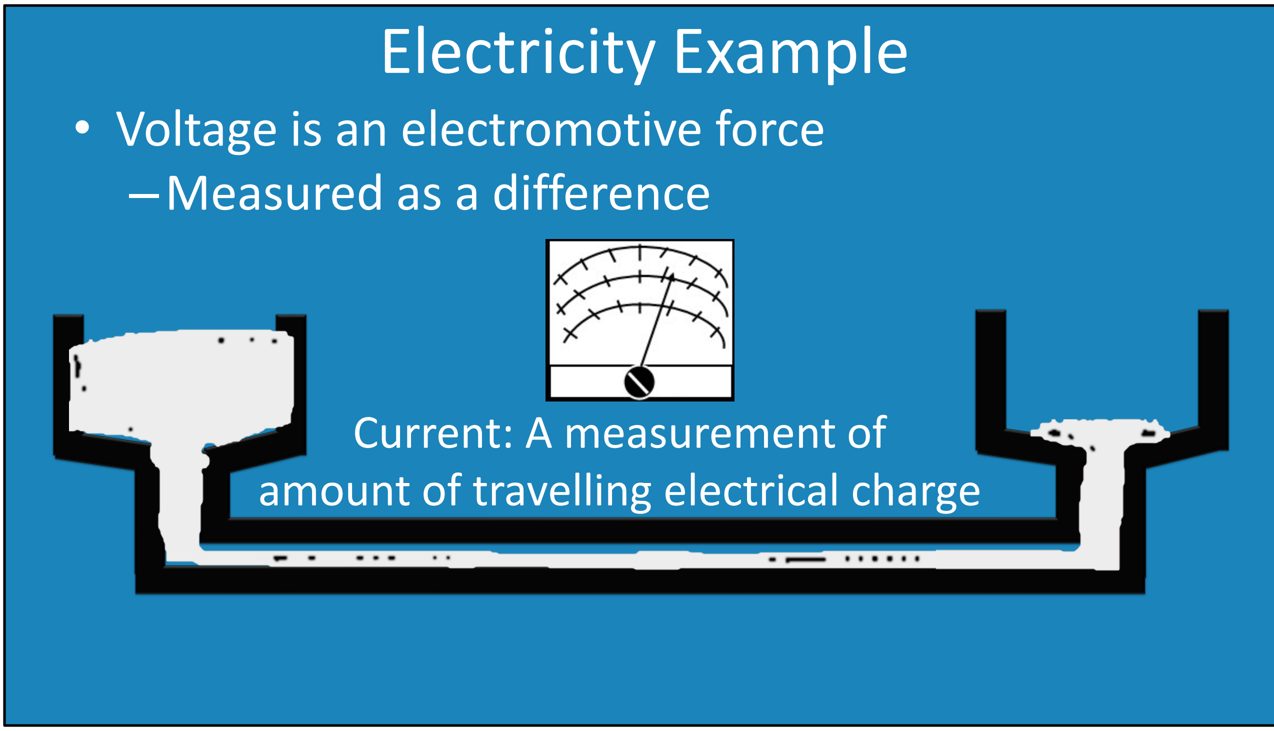
In this video from ITFreeTraining, I will look at electrical hazards. Computer and IT equipment run on electricity and electricity can hurt or even kill humans. This video does not cover a particular CompTIA exam objective, but it is important to understand how to work safely so that you can finish work safely and go home to the people who care about you.

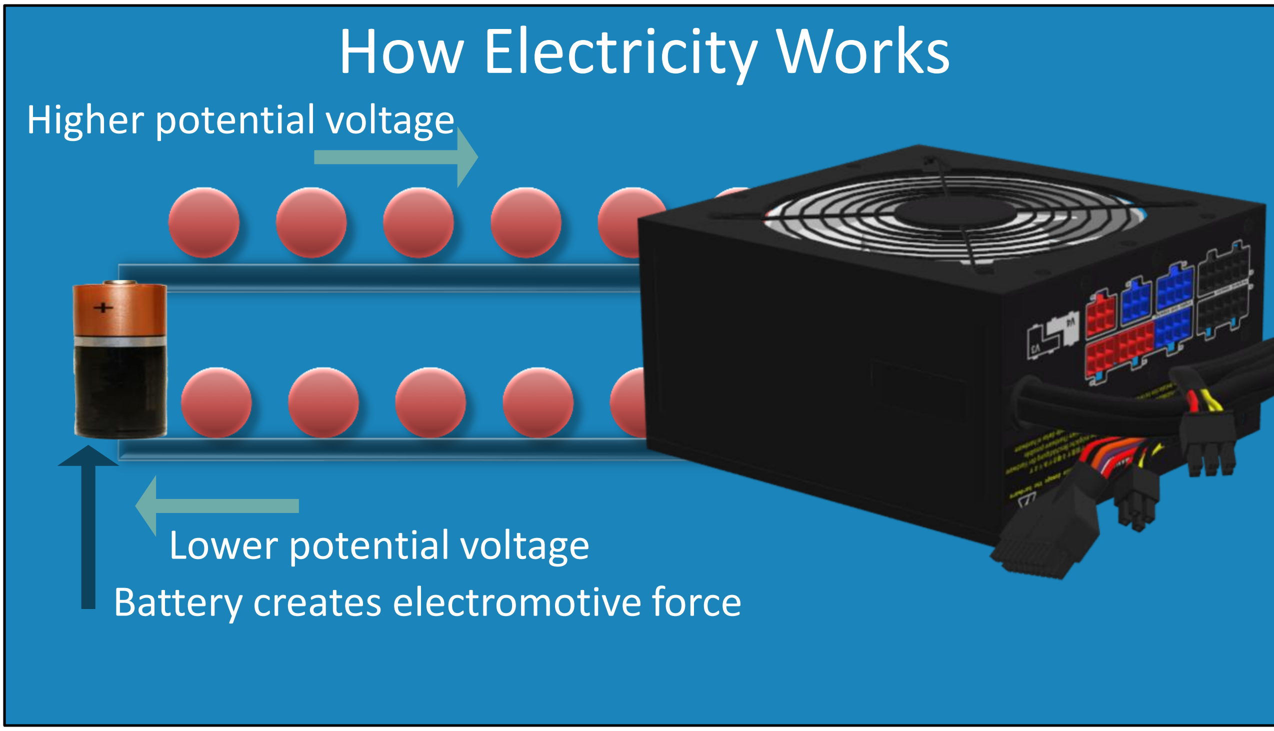


0:21 To start with, let's first get an understanding of what electricity is. Electricity is simply the movement of electric charge. The first question is, what makes it move and the first concept is voltage. Voltage is defined as electromotive force that moves electric charge around. It is measured by the difference of voltage.

To understand electricity, consider it like water. If I have two connected tanks of water, where one is full and the other is not, the water will run from one tank to the other, attempting to balance out the tanks. This is essentially what voltage is – a difference at one point compared to another. The electricity will flow from one point to the other attempting to balance out this difference.

The amount of electrical charge traveling is measured as current. If you think of it as water, the current is a measure of how much water is traveling past a certain point.

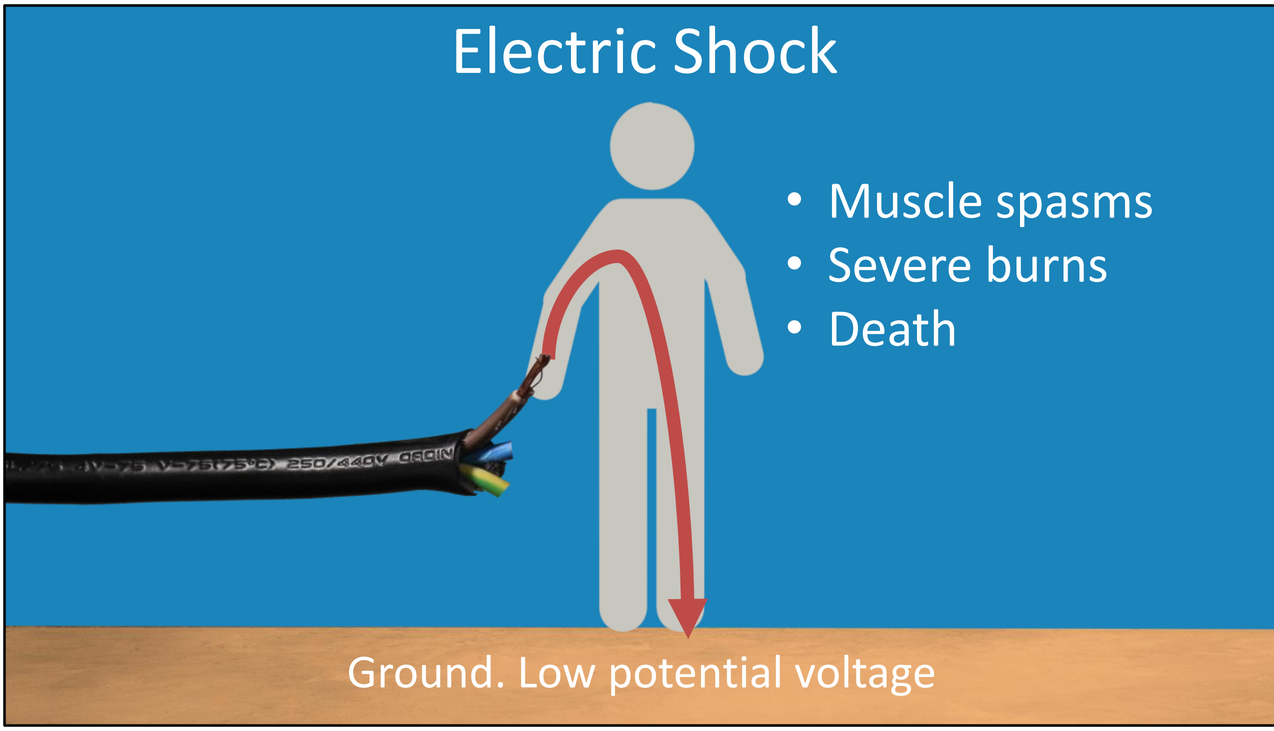
If the tanks were to become balanced, the water would stop, and the same applies to voltage. If the voltage drops to zero, the electricity stops. Therefore, if the difference in voltage between two points becomes zero, the current stops. Essentially when a computer is switched on a difference in voltage allows electricity to flow through the computer. If the computer is switched off, the voltage difference is stopped and the current stops with it. Let's have a look at a different example so it will make more sense.



1:51 So, let’s consider that we have a computer power supply. In this case, it is powered by a powerful battery. In this example I am just using a battery because hopefully it is easier to understand. The battery has a positive and a negative end. The positive end has higher potential voltage. The negative end has lower potential voltage.

Therefore, what essentially happens is the electricity travels from the higher potential voltage to the lower potential voltage. If you think of it like water, one is a tank full of water and the other end is empty. The water travels to the empty tank from the full tank.

When the difference between the voltages becomes zero, the electricity will stop flowing. Or to put it in simpler terms, the battery is dead! So now that we understand how electricity works, let’s consider what it does to a human if we come in contact with it.



2:47 When we come in contact with electricity, either by touching an exposed wire or something that has become electrically charged, the electricity needs to go somewhere. Electricity like water will take the path of least resistance. The best path for electricity generally to go is the ground or the floor.

This can be either the physical ground itself, or a cable that is connected to the ground. Any electricity will want to go to the ground since it will have what is referred to as a low potential. If you were to think of it like water, ground is essentially the drain. A drain will draw water into it and ground will draw electricity towards it.

So, when we touch an exposed wire or something that is electrically charged, the electricity will essentially go to ground. This can cause us some problems as the electricity passes through us to get to ground. This can result in, muscle spasms, severe burns and even death.

Humans are not the best conductors of electricity and thus will resist the flow of electricity to a certain degree. This may sound good, however this resistance causes a byproduct which is heat. If enough electricity passes through it can cause severe burns or even cause your clothes to catch on fire. In the most extreme case, it can interfere with the electrical impulses in of the heart causing a heart attack resulting in death. Therefore, you don't want to touch any exposed wires.

Electricity can also pass through liquids and metals. So, if you have an exposed wire in a pool of water, stepping in the water can cause the electricity to pass through you.

Current is what causes the damage; as the voltage gets higher its ability to push current through you increases. However, static electricity can be in the thousands of volts range and does not cause us these problems. I will look at that next.

Static Electricity

- Imbalance of electrical charge

4:45 Static electricity simply put is, the imbalance of electrical charge. Certain material either gives off or attracts an electrical charge. If you ever scuffed your shoes on a carpeted floor and then touched a metal door knob, you most likely would have got an electric shock. This is static electricity in action. Scuffing your shoes on the carpet gave you a static charge. The door knob has a different level of potential voltage and touching it transfers charge from you to the door knob. Once the potential voltage is the same, the transfer of charge stops. This is a very quick process and thus you only feel a mild shock in the process.

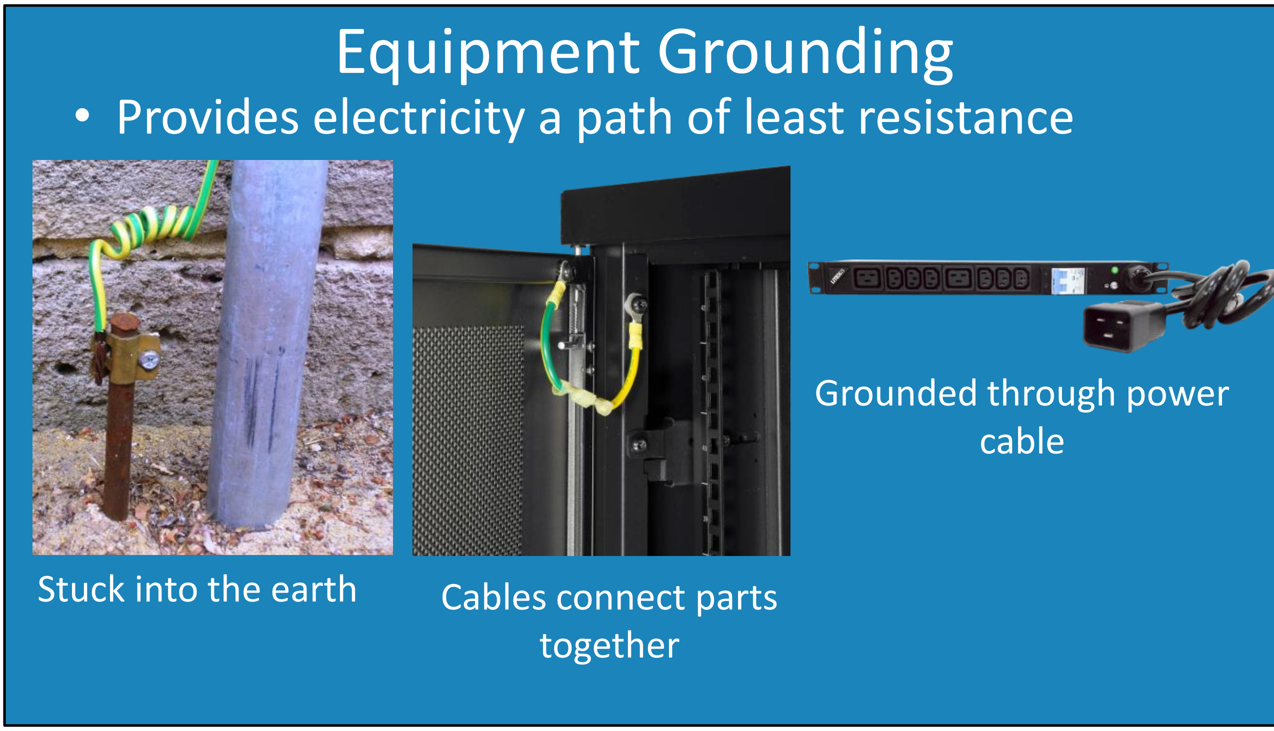
If you touch electrical equipment while you have a static charge you risk damaging it. So, let’s have a look at how static electricity works.

In this demonstration, I have an empty aluminum can. To demonstrates static electricity, I will conduct an experiment like one that you may have done at school. I will take this PVC pipe and charge it with static electricity using this cloth. Notice that the can is now attracted to the PVC pipe.

Before you touch any electrical components, you need to ensure that you do not have any built-up static electricity. To demonstrate how to remove static electricity, I will once again charge up the PVC pipe. Once the PVC pipe is charged up, I will attach an anti-static wrist band to the PVC pipe. Once the anti-static wrist band is attached, notice that when I place the PVC pipe near the can it is no longer attracted to the pipe.

Essentially what has happened is, static charge in the PVC pipe has traveled over the wrist band to the computer case, effectively causing the pipe to have a neutral charge. Once at the computer case it has traveled to the power supply which is connected to the ground via the power cord. The computer supply will always be connected to ground, even with the power switched off. Normally you would unplug the power before working on a computer, however I left it plugged in this case to demonstrate how computers ground themselves.

Electricity needs to have somewhere to go, this is why it is important that electrical equipment and work areas are grounded. Let’s have a closer look.

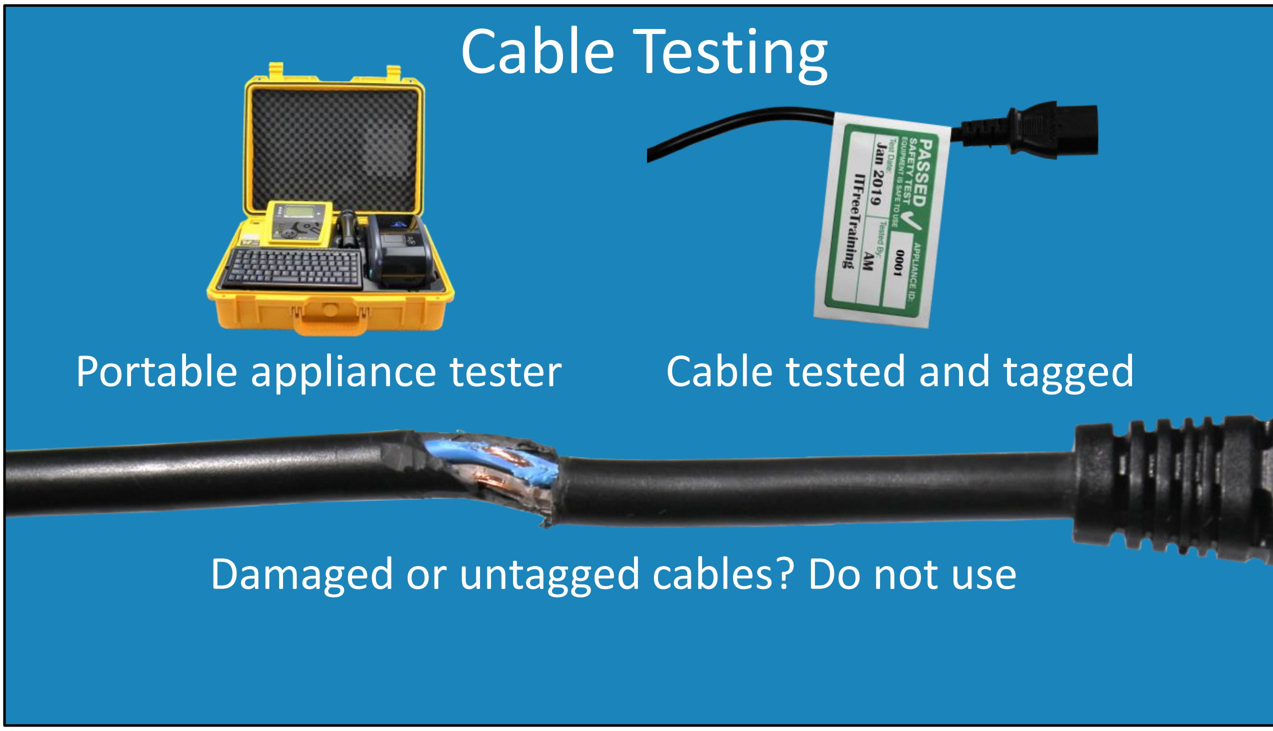


7:10 You will find that electrical equipment, machines and other devices will have some sort of equipment grounding. This provides a path of least resistance for electricity. Hopefully, if there is a short circuit in the equipment, the electricity will go through the grounding wire rather than through you.

Grounding can be achieved in a number of different ways. For example, the grounding wire can be stuck directly into the ground. IT equipment is not generally grounded this way, but given that nowadays computers run just about everything, you may find a small integrated computer in the cabinet controlling everything. When it breaks, the first person they are going to call is you to fix it. If you see ground wires like this that are damaged, call an electrician to fix it. For safety reasons it is important that the ground wire is correctly attached.

You will find in any decent sized organization that the IT equipment will be installed in a server cabinet. The parts of the cabinet will be connected together, either physically or using a wire. You can see in this example the cabinet is connected to a door by a wire. It is important not to remove this wire. If you remove the door from the cabinet and put it back on, make sure that you re-connect this wire.

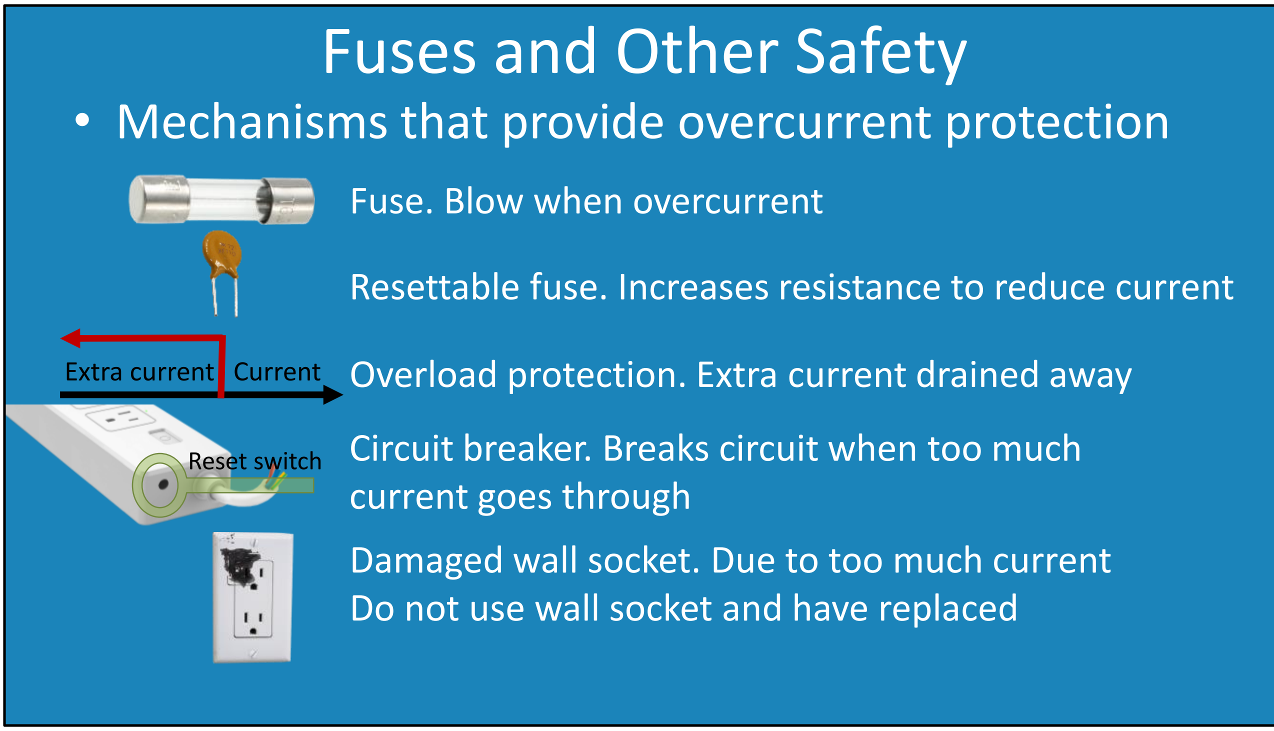
When looking at a server cabinet, it may or may not have a grounding wire. Many server rooms have a raised floor making it hard to attach a ground wire, but not impossible. To get around this, many server cabinets are grounded through a power cable. Many server cabinets will have a power distribution unit either built-in or screwed into the cabinet which will be attached to the power. A power distribution unit is essentially a power strip like the one shown. Using this, if the cabinet is short-circuited and becomes live with electricity, the electricity has somewhere to go. So, what else can we do to prevent electrical shock?



9:10 Different parts of the world have different standards. Many countries will require electrical devices to be tested to ensure that they do not pose a risk. This is often done with a portable appliance tester. This will be done by a qualified electrician or technician to ensure that the device is safe to use.

Once complete, the power cable will often be tagged so you know the device has been tested. The tags vary, but will essentially have the date and who performed the testing. The regulations of your country and the environment the device is used in will determine how often this will need to be done.

In a work environment, if you have a damaged or untagged cable do not use it, particularly if the cable is damaged. It is not worth getting an electric shock from the cable or for the cable to damage other equipment, injuring people or causing a fire. So, what happens when our equipment has problems or may be even faulty? Let’s look at what may protect us and our equipment.



10:11 To protect us and our equipment, there are fuses and other devices. They work differently but achieve the same goal of providing protection against ‘over current’. Over current is simply when too much current is passing through the wire or device. Too much current will damage the device, causing extra heat to build up, which may in turn lead to a fire or cause an electrical shock if touched.

In your device you may have a fuse. You don’t see these on motherboards, but you may see them in the power supply or in other electrical devices. The fuse contains a thin wire. If the current going through the wire gets to much the wire becomes hot and melts, thus breaking the circuit.

Hopefully if something goes wrong the fuse will blow rather than the equipment. A fuse is very cheap to replace. If you do have a fuse blow, you can replace it, however make sure that you replace it with a fuse that is of the same rating. If you replace it with a fuse that allows more current through, it may not blow when extra current goes through it causing the device to be damaged. Always be careful when replacing a fuse; if a faulty part in the device has caused the fuse to blow, replacing the fuse may cause the faulty part to blow rather than the fuse.

There are many other ways that over current can be corrected rather than a fuse blowing, which will essentially disable the device until it is fixed. You will find that some motherboards have other safety features on the motherboard for current and voltage. For example, there may be parts like resettable fuses.

Resettable fuses work differently than a traditional fuse. When extra current passes through it, the fuse heats up. Heating up causes the material in the fuse to expand. A property of the material used is that, when it expands less current is allowed to pass through. Think of it like a tap. If the water starts coming out too quickly, the tap is closed slightly, or if not enough water is coming out, the tap is opened. The end result is that the amount of current passing through is limited to a certain extent.

The next form of protection which is typically used in power supplies is overload protection. Essentially this is a circuit in the device that, when extra current is put through the device, it is diverted. If I compare this to a river, then if too much water starts going down the river a bypass channel is opened to divert the extra water somewhere else. So essentially, if too much current is put through the power supply a circuit is opened to drain the extra current.

The next form of safety you will find is a circuit breaker. Modern houses and buildings will contain circuit breakers. Old style houses and offices will contain fuses. Circuit breakers work the same way fuses do. If the current gets to high the circuit breaker will trip. The advantage of a circuit breaker is that you don't need to replace it if it trips. All you need to do is reset it by flipping a switch or pressing a button.

Many power strips contain circuit breakers. On the end of the power strip there is usually a button to reset the power strip. When purchasing a power strip, it is worth spending the extra money on a power strip that has a circuit breaker.

Power strips can cause problems when too many are used together. Consider that a power strip effectively splits electricity up between multiple devices. If you have devices that require a lot of current, they don't use less, they draw more current through the power strip. All the current is combined together into a single plug connecting the power strip. Therefore, all the current across all the devices is being added together and going through a single point which is the wall socket. This is why it is not a good idea to plug multiple power strips together. Doing this increases the amount of current that will be going through a single wall socket. This is also the same reason you should not put multiple high current devices on the same power strip, such as for example, multiple air conditioners.

The power strip circuit breaker should trip if too much power is being drawn through it. However, if it does not or you don't have one, this can cause damage to the wall socket. You can see in the case of this wall socket the black soot around the plug. This is caused by too much current being drawn through the wall socket. Extra current also causes heat which can melt the plastic in the wall socket or the wires in the wall socket leaving them exposed. If you find a wall socket that is like this, have it replaced.

We have already looked at static electricity, but it is also possible for electronic devices to hold a charge; let's have a look.

Electricity Used in Computers

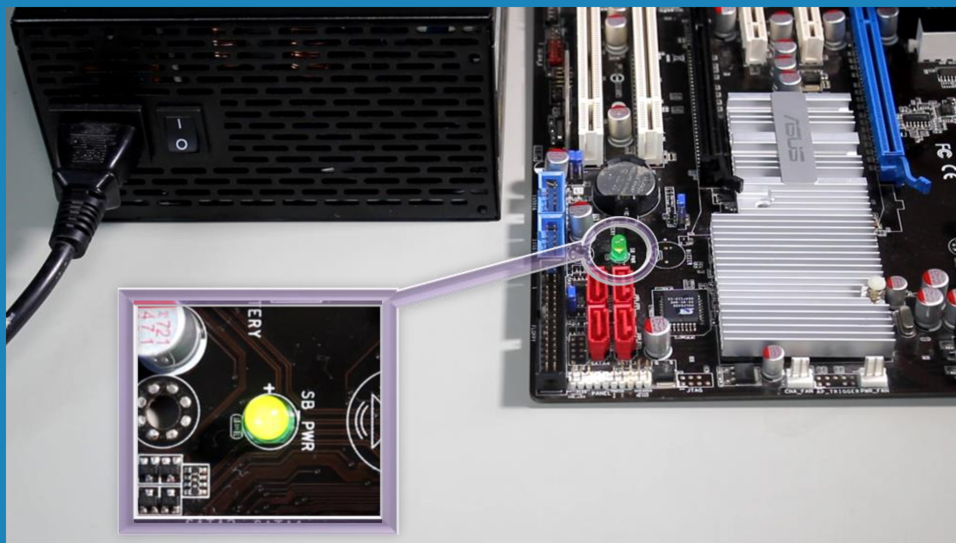
- Computer circuitry < 12 Volts (Low current/Low risk)
- Some devices high voltages and capacitors
  - Capacitors may hold charge for hours
- Devices include
  - Power supplies
  - LCD inverter cards
  - Laser printers
- Do not open these devices unless trained to do so

15:02 In most cases, the IT technician will be working on computer equipment. The circuits inside a computer use less than 12 volts and low current and thus have a low risk of injury. However, some equipment you will be working with may have high voltages inside. These devices may also have capacitors. Capacitors are devices that hold a charge. This is a similar concept to a battery; however, capacitors don't hold the charge for as long. Having said that, a capacitor can hold charges for seconds or even hours. For this reason, even if the device has been off for a while, it can still pose an electrical threat.

If you work in an area like a factory, it is likely that there will be high voltage equipment around. You may find the computer that you are working on fixing is controlling a high voltage device, so you need some understanding of electrical safety.

When working with electronic devices, pay attention to electrical warning labels. Devices that hold charges like this include power supplies, LCD inverter cards and laser printers. Do not open devices like these unless you are trained to do so. If you ignore a label like this and open the device, you risk getting an electric shock from the device.

Example of Held Charge



16:20 To give you an understanding of what a held charge may look like consider this motherboard. This motherboard has an LED light on it that indicates power is coming from the power supply. Not all motherboards will have this.

When I switch the power supply on, you will notice the light will switch on. No surprises there. However, notice what happens when I switch the power off. The light stays on. The light will stay on for about eight seconds before it switches off. Essentially the LED light is draining the power from the capacitors and from the power supply. Keep in mind that computer power supplies generate a number of different voltages and even if the light is off, there is no guarantee that the power supply will not still have charge in it. Power supplies generally have multiple capacitors in them and this single LED may not be draining them all. You can still get a shock from opening a computer's power supply. One trick that works with some devices is to switch them off, unplug the power and switch them back on again. This will hopefully drain any remaining power, but you can never be sure this is the case.

Summary

- Ensure equipment is grounded
  - Ensure you are grounded
- Replace damaged cables/Ensure cables tagged
- Don't bypass electric shock warning labels
  - Unless trained to do so
- Electricity has to go somewhere

17:33 To end this video, I will do a quick summary of the major points. First ensure that your workbench and equipment is grounded. Do not remove any ground wires or cables and if you see they are damaged or broken, have an electrician repair them.

Next, ensure that you are grounded. When possible, use an anti-static strap. If this is not available, touching the case of the computer will ground you.

Replace any damaged cables and ensure that they are tagged. Different countries will have different regulations on how often the cables need to be tagged. This can also vary depending on where the cable is being used.

Don't bypass electrical shock warning labels unless you are trained to do so. Some devices hold a lot of charge. Opening the device and touching the wrong part may give you an electric shock. Remember, electric shock can cause muscle spasms, burns and in some cases death. Keep yourself safe.

Lastly, remember that electricity has to go somewhere. I like to think of it like water because it acts in a similar way. Electricity will take the path of least resistance. Hopefully it does not find you being that path of least resistance. Make sure your devices and workbench are grounded. It may not stop you getting an electric shock, but hopefully it will reduce the effect it has on you.

I hope you have enjoyed this video from ITFreeTraining. I look forward to seeing you in the next video from us, and until the next video I would like to thank you for watching.

References
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Credits
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