PHYS 200

Ch. 2

Electric Safety

Chapter 2

Chapter Two

Electric Safety

- *Electrical Safety*
- *Effects of Electrical Current on Human Body*
- *Burns Caused by Electricity*
- *Electrical Fires*
- *Recognizing Hazards*

Electrical Safety

Electricity Is Dangerous

How Is an Electrical Shock Received?

An electrical shock is received when electrical current passes through the body. Current will pass through the body in a variety of situations. Whenever two wires are at different voltages, current will pass between them if they are connected. Your body can connect the wires if you touch both of them at the same time. Current will pass through your body.

- ***current*** — the movement of electrical charge
- ***voltage*** — a measure of electrical force
- ***circuit*** — a complete path for the flow of current
- ***You will receive a shock if you touch two wires at different voltages at the same time.***

Electrical work can be deadly if not done safely.

Electrical Safety

- ***ground***—a physical electrical connection to the earth
- ***energized (live, "hot")***—similar terms meaning that a voltage is present that can cause a current, so there is a possibility of getting shocked

- ***conductor***—material in which an electrical current moves easily
- ***neutral***—at ground potential (0 volts) because of a connection to ground

- ***You will receive a shock if you touch a live wire and are grounded at the same time.***
- ***When a circuit, electrical component, or equipment is energized, a potential shock hazard is present.***

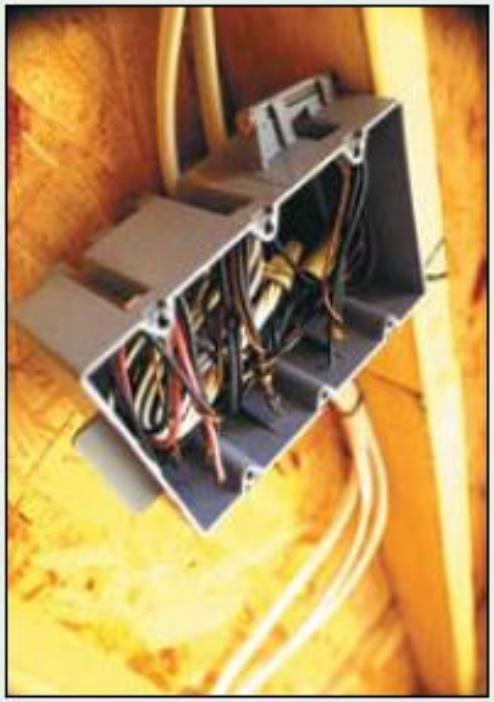
Metal electrical boxes should be grounded to prevent shocks.

Electrical Safety

Always test a circuit to make sure it is de-energized before working on it.

You will receive an electrical shock if a part of your body completes an electrical circuit by . . .

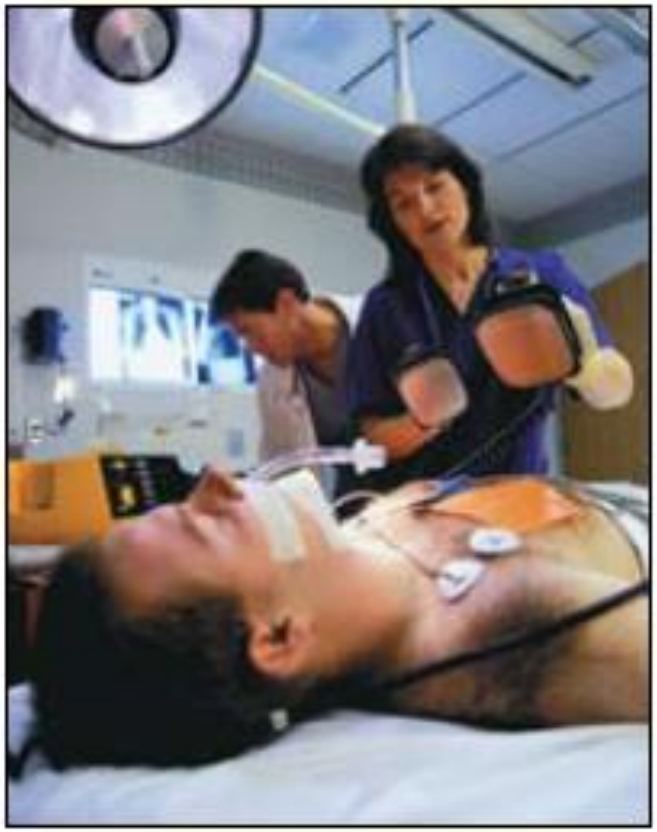
- touching a live wire and an electrical ground, or
- touching a live wire and another wire at a different voltage.



Black and red wires are usually energized, and white wires are usually neutral.

Electrical Safety

- ***ampere (amp)***—the unit used to measure current
- ***milliampere (milliamp or mA)***—1/1,000 of an ampere
- ***shocking current***—electrical current that passes through a part of the body
- ***You will be hurt more if you can't let go of a tool giving a shock.***
- ***The longer the shock, the greater the injury.***



Defibrillator in use.

Electrical Safety

Example 1:

The white wire is at:

Solution:

(C)

(A) 220 volts
(B) 110 volts
(C) Zero volts

Electrical Safety

Example 2:

Black and red wires are usually:

Solution:

(C)

(A) Neutral
(B) not-energized
(C) Energized

Electrical Safety

Example 3:

Ampere is the unit used to measure

Solution:

(B)

(A) Pressure
(B) Current
(C) Potential difference

Electrical Safety

Example 4:

The voltage is a measure of

Solution:

(A)

(A) Electric force
(B) Electric charge
(C) Electric resistance

Electrical Safety

Example 5:

Volt is unit of measurement of

Solution:

(B)

(A) Electric current
(B) Electric voltage
(C) Electric resistance

Electrical Safety

Example 6:

1 Ampere equals:

Solution:

(C)

(A) 1000000 mA
(B) 10000mA
(C) 1000 mA

Effects of Elec. Cur. on Human Body

Effects of Electrical Current on Human Body

Effects of Electrical Current in the Human Body[3,4]

Current	Reaction
Below 1 milliampere	Generally not perceptible.
1 milliampere	Faint tingle.
5 milliamperes	Slight shock felt; not painful but disturbing. Average individual can let go. Strong involuntary reactions can lead to other injuries.
6–25 milliamperes (women) **9–30 milliamperes** (men)	Painful shock, loss of muscular control. The freezing current or "let-go" range. Individual cannot let go, but can be thrown away from the circuit if extensor muscles are stimulated.*
50–150 milliamperes	Extreme pain, respiratory arrest (breathing stops), severe muscular contractions. Death is possible.
1,000–4,300 milliamperes	Rhythmic pumping action of the heart ceases. Muscular contraction and nerve damage occur; death likely.
10,000 milliamperes	Cardiac arrest and severe burns occur. Death is probable.
15,000 milliamperes	Lowest overcurrent at which a typical fuse or circuit breaker opens a circuit!

*If the extensor muscles are excited by the shock, the person may be thrown away from the power source. The lowest overcurrent at which a typical fuse or circuit breaker will open is 15,000 milliamps (15 amps).

Effects of Elec. Cur. on Human Body

- High voltages cause additional injuries!
- Higher voltages can cause larger currents and more severe shocks.
- Some injuries from electrical shock cannot be seen.

- The greater the current, the greater the shock!
- Severity of shock depends on voltage, amperage, and resis-tance.

Power drills use 30 times as much current as what will kill.

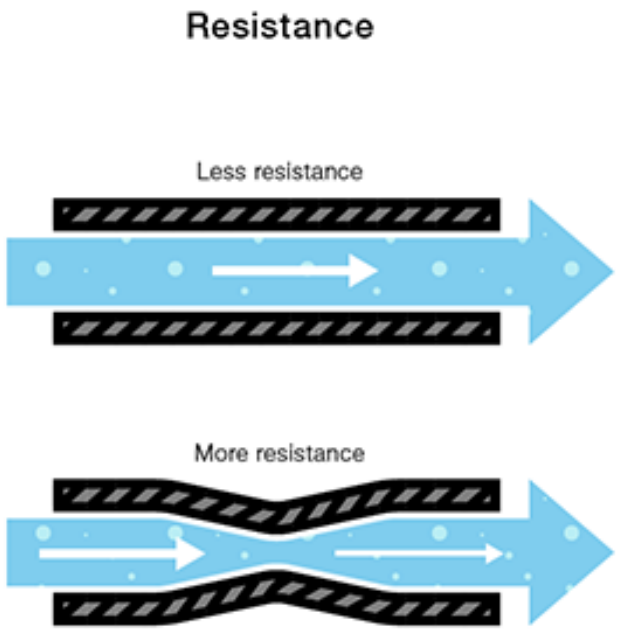
Effects of Elec. Cur. on Human Body

- ***resistance*** – a material's ability to decrease or stop electrical current

- ***ohm*** – unit of measurement for electrical resistance

- *Lower resistance causes greater currents.*

- *Currents across the chest are very dangerous.*



Effects of Elec. Cur. on Human Body

A male service technician arrived at a customer's house to perform pre-winter maintenance on an oil furnace. The customer then left the house and returned 90 minutes later. She noticed the service truck was still in the driveway. After 2 more hours, the customer entered the crawl space with a flashlight to look for the technician but could not see him. She then called the owner of the company, who came to the house. He searched the crawl space and found the technician on his stomach, leaning on his elbows in front of the furnace. The assistant county coroner was called and pronounced the technician dead at the scene. The victim had electrical burns on his scalp and right elbow.

After the incident, an electrician inspected the site. A toggle switch that supposedly controlled electrical power to the furnace was in the "off" position. The electrician described the wiring as "haphazard and confusing."

Two weeks later, the county electrical inspector performed another inspection. He discovered that incorrect wiring of the toggle switch allowed power to flow to the furnace even when the switch was in the "off" position. The owner of the company stated that the victim was a very thorough worker. Perhaps the victim performed more maintenance on the furnace than previous technicians, exposing himself to the electrical hazard.

This death could have been prevented!

- *The victim should have tested the circuit to make sure it was de-energized.*
- *Employers should provide workers with appropriate equipment and training. Using safety equipment should be a requirement of the job. In this case, a simple circuit tester may have saved the victim's life.*
- *Residential wiring should satisfy the National Electrical Code (NEC). Although the NEC is not retroactive, all homeowners should make sure their systems are safe.*

Effects of Elec. Cur. on Human Body

The danger from electrical shock depends on • • •

- the *amount* of the shocking current through the body,
- the *duration* of the shocking current through the body, and
- the *path* of the shocking current through the body.

Arm with third degree burn from high-voltage line.

Electrical burn on hand and arm.

Effects of Elec. Cur. on Human Body

Example 7:

Ohm is unit of measurement of

Solution:

(C)

(A) Laser power
(B) Current
(C) Resistance

Effects of Elec. Cur. on Human Body

Example 8:

Shocking current is the electrical current that passes through

Solution:

(A)

(A) Any part of the body
(B) Apart of a wire
(C) Hot plate.

Effects of Elec. Cur. on Human Body

Example 9:

The severity of electrical shock depends on:

Solution:

(D)

(A) The amount of the shocking current through the body.
(B) The duration of the shocking current through the body
(C) The path of the shocking current through the body.
(D) All the items.

Effects of Elec. Cur. on Human Body

Example 10:

You will receive an electrical shock if a part of your body completes an electrical circuit by

Solution:

(B)

(A) Touching a ground wire and earth wire.
(B) Touching a live wire and an electrical ground.
(C) Touching a live wire with insulating gloves

Effects of Elec. Cur. on Human Body

Example 11:

In electricity lab, keep the work area clean and dry, do not step on the wires jacks and do not work on a wet or damp floor, this is to avoid

Solution:

(B)

(A) Gas leakage
(B) Electric shock
(C) Electric short
(D) Electric current decrease

Effects of Elec. Cur. on Human Body

Example 12:

After you finish work in electricity lab and the experiment, what you should do next?

Solution:

(A)

(A) Return every device to its location.
(B) Leave the lab immediately.
(C) Make sure you didn't leave behind any working power supply or electric connections.
(D) Turn off the lights in the lab.

Effects of Elec. Cur. on Human Body

Example 13:

In case of classmate exposed to electric shock, what would you do?

Solution:

(C)

(A) Try to keep him away from any source of additional danger
(B) Use insulating material to keep him away from the source of electric shock.
(C) Switch off the main fuses.
(D) Inform the instructor.

Burns Caused by Electricity

Burns Caused by Electricity

- The most common shock-related, nonfatal injury is a burn.
- Burns caused by electricity may be of three types: electrical burns, arc burns, and thermal contact burns.
- Electrical burns can result when a person touches electrical wiring or equipment that is used or maintained improperly.

Contact electrical burns. The knee on the left was energized, and the knee on the right was grounded.

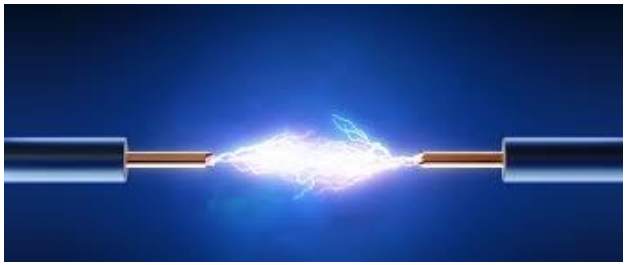
Burns Caused by Electricity

- Typically, such burns occur on the hands.
- Electrical burns are one of the most serious injuries you can receive.
- They need to be given immediate attention.
- Additionally, clothing may catch fire and a thermal burn may result from the heat of the fire.

Burns Caused by Electricity

- *arc-blast—explosive release of molten material from equipment caused by high-amperage arcs*

- *arcing—the luminous electrical discharge (bright, electrical sparking) through the air that occurs when high voltages exist across a gap between conductors*



Burns Caused by Electricity

- There are three primary hazards associated with an arc-blast.
- Arcing gives off thermal radiation (heat) and intense light, which can cause burns.
- Several factors affect the degree of injury, including skin color, area of skin exposed, and type of clothing worn. Proper clothing, work distances, and over current protection can reduce the risk of such a burn.
- A high-voltage arc can produce a considerable pressure wave blast.

Burns Caused by Electricity

- A person 2 feet away from a 25,000-amp arc feels a force of about 480 pounds on the front of the body.
- In addition, such an explosion can cause serious ear damage and memory loss due to concussion.
- Sometimes the pressure wave throws the victim away from the arc-blast.
- While this may reduce further exposure to the thermal energy, serious physical injury may result.
- The pressure wave can propel large objects over great distances.

Burns Caused by Electricity

- In some cases, the pressure wave has enough force to snap off the heads of steel bolts and knock over walls.
- A high-voltage arc can also cause many of the copper and aluminum components in electrical equipment to melt.
- These droplets of molten metal can be blasted great distances by the pressure wave.
- Although these droplets harden rapidly, they can still be hot enough to cause serious burns or cause ordinary clothing to catch fire, even if you are 10 feet or more away.

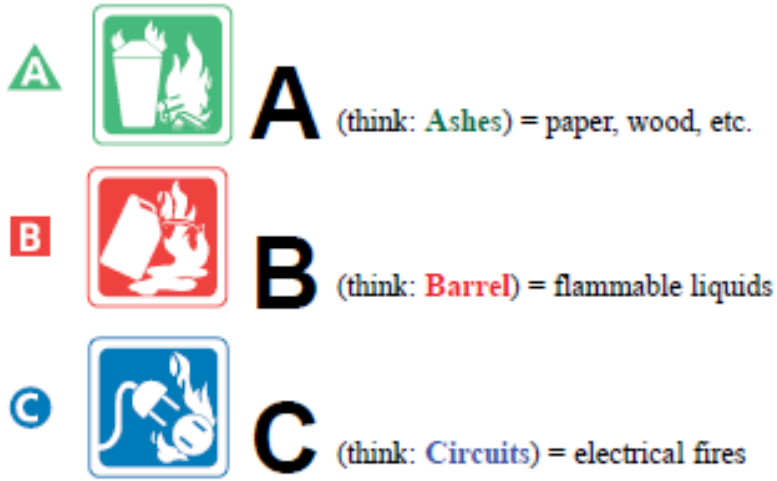
Electrical Fires

Electrical Fires

- Electricity is one of the most common causes of fires and thermal burns in homes and workplaces.
- Defective or misused electrical equipment is a major cause of electrical fires.
- If there is a small electrical fire, be sure to use only a Class C or multipurpose (ABC) fire extinguisher, or you might make the problem worse.
- All fire extinguishers are marked with letter(s) that tell you the kinds of fires they can put out.

Electrical Fires

- Some extinguishers contain symbols, too.



Electrical Fires

Burns are the most common injury caused by electricity. The three types of burns are . . .

- electrical burns,
- arc burns, and
- thermal contact burns.

- All fire extinguishers are marked with a letter(s), which identifies the kinds of fires they put out. Sometimes the label is marked with both a letter and symbol. Be sure to read the label and use the appropriate extinguisher.

Effects of Elec. Cur. on Human Body

Example 14:

Chose True or False for the following sentences:

- All fire extinguishers are suitable to all fire classes.

(False)

- You will receive electric shock if you touch two wires, at different voltages.

(True)

- The injury of electric shock increases as the time of exposure increases.

(True)

- Electrical shocks cause burns.

(True)

Recognizing Hazards

Recognizing Hazards

How Do You Recognize Hazards?

The first step toward protecting yourself is recognizing the many hazards you face on the job. To do this, you must know which situations can place you in danger. Knowing where to look helps you to recognize hazards.

- Inadequate wiring is dangerous.
- Exposed electrical parts are dangerous.
- Overhead powerlines are dangerous.
- Wires with bad insulation can give you a shock.
- Electrical systems and tools that are not grounded or double-insulated are dangerous.

Recognizing Hazards

- Overloaded circuits are dangerous.
- Damaged power tools and equipment are electrical hazards.
- Using the wrong PPE is dangerous.
- Using the wrong tool is dangerous.
- Some on-site chemicals are harmful.
- Defective or improperly set up ladders and scaffolding are dangerous.
- Ladders that conduct electricity are dangerous.
- Electrical hazards can be made worse if the worker, location, or equipment is wet.