9

INDUSTRIAL ARTS:

REFRIGERATION AND AIRCONDITIONING

(INSTALL DOMESTIC REFRIGERATION AND AIR-CONDITIONING UNIT)

This instructional material was collaboratively developed and reviewed by educators from public and private schools, colleges, and/or universities. We encourage teachers and other education stakeholders to email their feedback, comments, and recommendations to the Department of Education at action@deped.gov.ph.

We value your feedback and recommendations.

Department of Education
Republic of the Philippines

Industrial Arts: Refrigeration and Air-conditioning –
(Install Domestic Refrigeration and Air-Conditioning Unit)
Learner's Material
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INSTALL DOMESTIC REFRIGERATION
AND AIR-CONDITIONING UNIT

INSTALL DOMESTIC REFRIGERATION AND AIR-CONDITIONING UNIT

Content Standard	Performance Standard
The learner demonstrates understanding of concepts, and underlying theories and principles in installing domestic refrigeration and air-conditioning unit.	The learner independently provides quality, competitive and profitable service in installing domestic refrigerator and air-conditioning unit.

INTRODUCTION

This quarter contains information that is necessary to prepare the learners for today's world of work. Included in this quarter is the process of selecting the most appropriate area and general rules for installation of window air-conditioning unit. The Philippine Electrical Code (PEC) is likewise discussed to ensure that the learners consider the provisions of the PEC in installing electrical devices and equipment.

Electrical conductors and insulators, wiring materials, power circuit terminators, and protective devices are also provided to serve as valuable guide for the learners while making a wiring outlet for an air-conditioning unit. The characteristics of connections, load center, safety switches and its configuration is similarly included to guarantee that the learners will be able to conduct survey and install electrical cabling and wiring based on a solid knowledge of refrigeration and air-conditioning.

Conduct Survey for Unit Installation

- Assess site conditions and installation according to the job requirements
- Determine tools, equipment and materials needed for installation according to site conditions and site requirements
- Record result of the survey on site condition and site installation

PRE/DIAGNOSTIC TEST 1

Directions: Read the questions carefully. Choose the letter of the correct answer and write the answer on a separate sheet of paper.

1. What is the most important thing to consider in selecting an area for the installation of a window-type air conditioning unit?

a. Select an area that allows good drainage for condensed water.
b. Select an area that is high in place.
c. Select an area where the power supply is nearest
d. Select an area based on the needs of the clients.

2. Why should you avoid placing the unit's backside away from your neighbor?
   a. To allow better air circulation
   b. To prevent the unit from blowing hot air on your neighbors
   c. To allow better servicing space
   d. To have better drainage

3. What location should be avoided in installing an air conditioning unit?
   a. Low sunlight exposure
   b. High rise building
   c. Direct air flow
   d. Areas near flammable gas.

4. What should be done before installing the air conditioning unit?
   a. Check it by parts
   b. Check it by the paint
   c. Check it by the weight
   d. Check it by the sound

5. Where should be the proper location of air conditioning unit?
   a. Window
   b. Adjacent convenient outlets
   c. Near light fixture
   d. Beside heating element

INFORMATION SHEET 1.1
Survey Area for Installation

On the past activities you have found out that a window-type air-conditioning units can be installed in the wall concrete or wood and in window sills. In every type of surface different preparations must be made that's why in practice before the unit is installed, a survey at the area is conducted. The purpose of this survey is to select the most appropriate location of the unit to be installed, to identify the needed preparation to be done before installation and to identify the needed materials, tools and equipment.

In this activity you will be doing a simulated survey and you will be selecting the most appropriate location for installation and identifying the needed materials, tools and equipment.

SELECTING AN AREA FOR INSTALLATION

In selecting an area for installation, the following should be avoided to prevent damage or harmful effect to the unit.

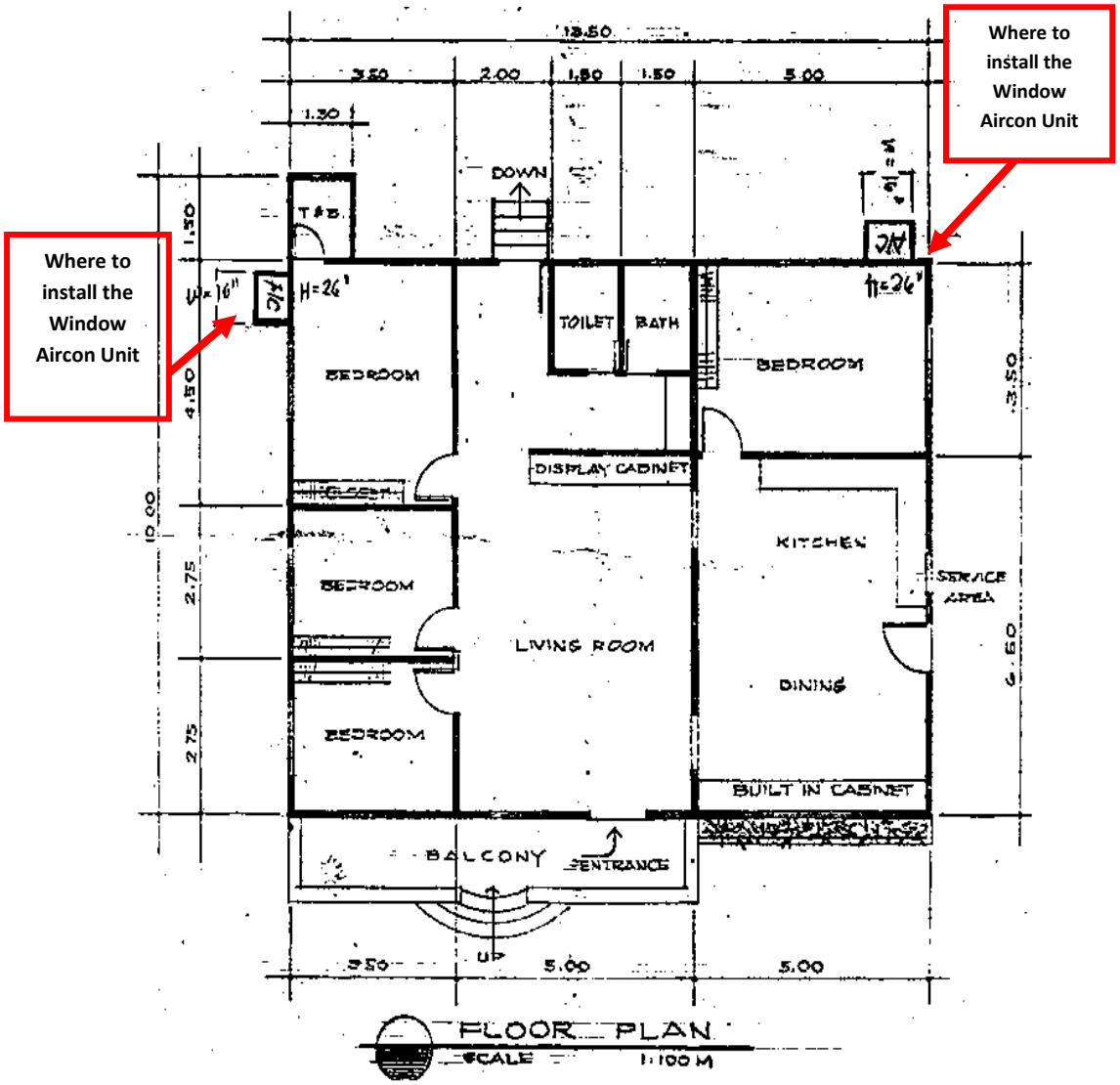
- Greasy areas (e.g. areas near a machine)
- Salty areas (e.g. places/areas near the coast)
- Areas where sulfuric gas is present (such as hot spring areas)
- Areas near flammable gas (e.g. LPG)

The following are general rules which need to be considered in installing window-type air conditioning unit.

a. It is important that the selected location where the unit is to be placed suits the customer's need.
b. Install the unit in an area with good ventilation. Any obstacles affecting the airflow near the air inlet and the air outlet will cause blockage to the airflow.

c. Install the unit away from heat or vapor.
d. Install the unit in an area away from television and audio units, cordless phones, fluorescent lighting fixtures and other electrical appliances (at least 1 meter clearance). This is to eliminate or reduce interference to other units generated by the motors running from the air conditioning units.
e. Install the unit in an area that provides easy drainage for condensed water.
f. Install the unit in an area not exposed to rain or direct sunlight.(Install a separate sunblind if expose to direct sunlight)
g. Fix the unit firmly if it is mounted in a high place. See to it that the area would be able to endure the vibration from the unit.
h. Install the unit where it will not cause neighbors to experience hot wind and noise generated by the unit.
i. Install the unit where power source conforms to the unit's power requirements.

Sample Floor/Work Plan for Air-conditioning Survey Installation



Notes on Site Consideration

Direction: Complete the survey form by putting a tick mark (✓) in the appropriate box.

Considerations	YES	NO
1. Is there good ventilation?		
2. Are the appliances (e.g. TV, Lighting Fixtures, and other electrical appliances) at least 1 Meter away from the location of the air conditioning unit?		
3. Is there an easy drainage system?		
4. Is the area exposed to rain or direct sunlight?		
5. Can the area endure the vibration of the unit?		
6. Is the area of installation at least 1 meter away from the nearest neighbor?		
7. Does the power requirement conform to the unit requirement?		

Note: All answers must be YES before installing the unit. In case there is a NO answer discuss the matter with the client and find better space that will meet the considerations to avoid future problems.

Inspected by: _____
(Name of Learner)

Checked by: _____
(Teacher/Instructor)

INSTALL ELECTRICAL CIRCUIT

- Perform roughing-in activities according to appropriate provision in the Philippine Electrical Code (PEC)
- Select electrical cabling and wiring devices of correct load carrying capacity
- Install electrical cabling and wiring devices in line with manufacturer's instruction.

PRE/DIAGNOSTIC TEST 2

Directions: Read the questions carefully. Choose the letter of the correct answer and write the answer on a separate sheet of paper.

1. What is the distance of the convenient outlet from the unit to the ground?
   a. 4 meters
   b. 5 meters
   c. 1 meter
   d. 2 meters

2. What is the wire size we used in installing an ac power circuit?
   a. 8 mm
   b. 10 mm
   c. 18 mm
   d. 12mm

3. What is the material that allow current to flow?
   a. Insulator
   b. Steel
   c. Conductor
   d. Plastic

4. What is the path of electric current from the source back to source?
   a. Current
   b. Voltage
   c. Circuit
   d. Conductor

5. In the lay-out of an ac electrical circuit, we must make the _____ to have a blue print on what are we going to be?
   a. Circuit
   b. Working drawing
   c. Space
   d. Unit

6. The Philippine Electrical Code covers the following except_____.
   a. Electrical Conductors
   b. Optical Fiber Cables
   c. Raceways
   d. Automotive Vehicles

7. American Wire Gauge (AWG) is the English System of measuring wire sizes. If the size of the wire is 12 AWG, its Metric System Equivalent is ____.
   a. 2.0 mm^2
   b. 3.5 mm^2
   c. 5.5 mm^2
   d. 8.0 mm^2

8. The code letter of Moisture and Heat-resistant Thermoplastic is _____.
   a. THWN
   b. THW
   c. MTW
   d. THHW

9. What is the code letter of Moisture Heat and oil resistant thermoplastic?
   a. THWN
   b. THW
   c. MTW
   d. THHW

10. Which of the following is a low voltage device?
   a. Thermostat
   b. NM Cable
   c. Metal Conduit and Coupling
   d. Surface Raceway

INFORMATION SHEET 2.1
Philippine Electrical Code

Purpose

(a) Practical Safeguarding. The purpose of this *Code* is the practical safeguarding of persons and property from hazards arising from the use of electricity.

(b) Adequacy. This *Code* contains provisions that are considered minimum requirements necessary for safety. Compliance therewith and proper maintenance will result in an installation that is essentially free from hazard but not necessarily

efficient, convenient, or adequate for good service or future expansion of electrical use.

(c) Intention. This Code is intended for the exclusive use of licensed electrical practitioners (PEE, REE, and RME). This *Code* is not intended as a design specification nor an instruction manual for a non-licensed electrical practitioner, unless under the supervision of a licensed electrical practitioner.

(d) Relation to Other International Standards. The requirements in this *Code* address the fundamental principles of protection for safety contained in Section 131 of International Electrotechnical Commission

Authority

Standard 60364-1, *Electrical Installations of Buildings*.

(a) This *Code* has been approved and adopted by the Board of Electrical Engineering, Professional Regulation Commission.

(b) By virtue of authority vested in the Board under RA 7920, it hereby direct strict adherence to the provisions of this *Code*.

Scope

(c) Where deviations from these provisions are necessary, such deviations shall not be made, except with written permission from this government bodies exercising legal jurisdiction applicable only to the particular job for which such permission was granted.

(a) Covered. This *Code* covers the installation of electrical conductors, equipment, and raceways; signaling and communications conductors, equipment, and raceways; and optical fiber cables and raceways installed within or on, to or from:

Enforcement

(1) Public and private buildings, including but not limited to residential, commercial, industrial, institutional, cultural, agricultural, agro-industrial, planned unit development and all other buildings/premises that may require practical safeguarding of persons and property from the hazards arising from the use of electricity.

(a) This *Code* is intended for mandatory application by government bodies exercising legal jurisdiction over electrical installations.

(b) These government bodies, only through a licensed electrical practitioner, shall have the responsibility of implementing the provisions of this *Code* in deciding on the approval of equipment and materials and for granting the special permission contemplated in this
Code, where it is assured that equivalent objectives can be achieved by establishing and maintaining effective safety.
(2) Electric generating plants
(3) Industrial plants

(4) Transformer stations
(5) Permanent and temporary substations, etc.
(6) Airfields
(7) Railways switchyards
(8) Yards, carnival, parks, parking and other lots

(c) The authority having jurisdiction may waive specific requirements in this *Code* or permit alternate methods where it is assured that equivalent objectives can be achieved by establishing and maintaining effective safety.
(9) Quarries and mines
(10) Watercraft
(11) Dockyards
(12) Trailers
(13) Mobile homes and recreational vehicles

(d) This *Code* may require new products, constructions, or materials that may not yet be available at the time this *Code* is adopted. In such event, the authority having jurisdiction may permit the use of the products, constructions, or materials that comply with the most recent previous edition of this *Code* adopted by the jurisdiction.
(14) Offshore facilities

(b) Not Covered. This *Code* does not cover the following:
(1) Installations in railway rolling stock, aircraft, or automotive vehicles FPN: Application of electrical products and equipment for additional installation or replacement is suggested to be

Mandatory Rules, Permissive Rules, and Explanatory

Material

FPN No. 1: See requirements in Section 1.10.1.3.
FPN No. 2: Listed is defined in Article 1.0

(a) Mandatory Rules. Mandatory rules of this *Code* are those that identify actions that are specifically required or prohibited and are characterized by the use of the terms shall or shall not.
FPN No. 3: Appendix A contains an informative list of product safety standards for electrical equipment.
FPN No. 4: Application of electrical equipment and devices shall always be

(b) Permissive Rules. Permissive rules of this *Code* are those that consulted with a licensed electrical practitioner. Identify actions that are allowed but not required, are normally used to describe options or alternative methods, and are characterized by the use of the terms shall be permitted or shall not be required.

Wiring Planning

(a) Future Expansion and Convenience. Plans and specifications that provide ample space in raceways, spare raceways, and additional spaces allow for future increases in electric power and communication circuits. Distribution centers located in readily accessible locations provide convenience and safety of operation.

(b) Explanatory Material. Explanatory material, such as references to other standards, references to related sections of this *Code*, or information related to a Code rule, is included in this *Code* in the form of fine print notes (FPN). Fine print notes are informational only and are not enforceable as requirements of this *Code*.

(c) Number of Circuits in Enclosures. It is elsewhere provided in this *Code* that the number of wires and circuits confined in a single enclosure be varyingly restricted. Limiting the number of circuits in a single enclosure will minimizes the effects from a short circuit or ground fault in one circuit.

Interpretation
In case of controversy, the recommendation of the Code Committee and concurrence of the Board of Electrical Engineering shall be the final interpretation of any portion of the Philippine Electrical Code

Metric Units of Measurement. For the purpose of this *Code*, metric units of measurement are in accordance with the modernized metric system known as the International System of Units (SI).
Examination of Equipment for Safety. For specific items of equipment and materials referred to in this *Code*, examinations for safety made under standard conditions will provide a basis for approval where the record is made generally available through promulgation by organizations properly equipped and qualified for experimental testing, inspections of the run of goods at factories, and service-value determination through field inspections. This avoids the necessity for repetition of examinations by different examiners, frequently with inadequate facilities for such work, and the confusion that would result from conflicting reports as to the suitability of devices and materials examined for a given purpose.

Common electrical wire sizes used in ac circuit line installation

American Wire Gauge (AWG) is the English System of measuring wire sizes. The following are the Metric System equivalents of AWG wire sizes:

WIRE SIZES

(English System)		(Metric System)
14 AWG	=	2.0 mm^2
12 AWG	=	3.5 mm^2
10 AWG	=	5.5 mm^2
8 AWG	=	8.0 mm^2

PREPARE ELECTRICAL WIRING MATERIALS
Electrical Conductors and Insulators

1. Electricity is a flow of electron

2. Some materials will not give up their electrons, and these materials are called insulators.

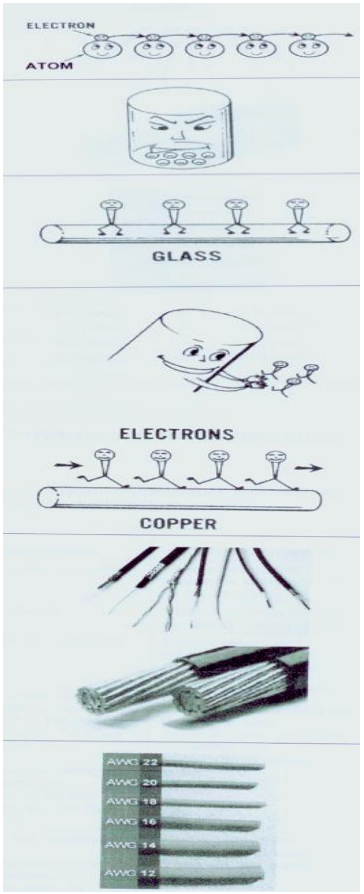
3. Electricity does not travel easily through certain materials like rubber, thermoplastic, glass, varnish and asbestos. These materials are known as insulators.

4. Some materials like metals give up their electrons. These materials are called conductors**.** It allows electricity to flow through easily. Metals (such as silver, copper, aluminum, bronze and iron) are good conductors.

5. That's why electrical wires are made of metal.

6. Electrical conductors may be solid or stranded. Solid wire is an insulated single conductor while stranded wire is usually several strands twisted conductor.

7. Wires commonly used in electrical wiring vary in different sizes. The common standard used to determine the size of wire is the American Wire Gauge (also known as Brown and Sharp gauge).



Types of Electrical Insulation

Insulation Type	**Code Letters**	**Application**	**Characteristics**
Moisture-resistant thermoplastic	TW	Dry and wet locations	Flame retardant, moisture resistant; no outer covering
Heat-resistant thermoplastic	THHN	Dry and damp locations	Flame retardant ; heat resistant; nylon jacket
Moisture and heat-resistant thermoplastic	THHW	Wet and dry locations	Flame retardant, moisture and heat resistant; no outer covering

Moisture-, heat-, and oil resistant thermoplastic	MTW	Machine tool wiring in wet locations as permitted in NFPA Standard No. 79 (See Article 670) Machine tool wiring in dry locations as permitted in NFPA Standard No. 79 (See Article 670)	Flame retardant; moisture, heat, and oil resistant; wet applications, no outer covering; dry applications, nylon jacket
Moisture-, and heat-resistant thermoplastic	THW	Dry and wet locations Special applications within electric discharge lighting to equipment; limited to 1,000 open-circuit volts or less (size 14-8 only as permitted in Section 410-31	Flame retardant ; moisture and heat resistant; no outer covering
Moisture- and heat-resistant thermoplastic	THWN	Dry and wet locations	Flame retardant; moisture and heat resistant; nylon jacket

Conductors commonly found in electrical wiring

a. Copper
b. Aluminum
c. Copper-clad aluminum

Wiring Materials in Electrical Trades.

a. Nonmetallic sheathed cable (Romex)

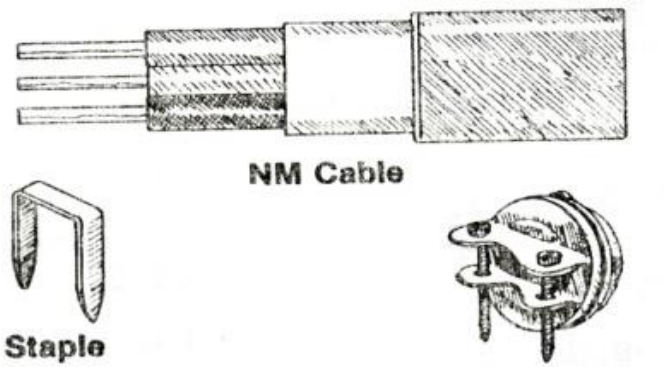


Figure 1

b. Concealed knob and tube wiring.

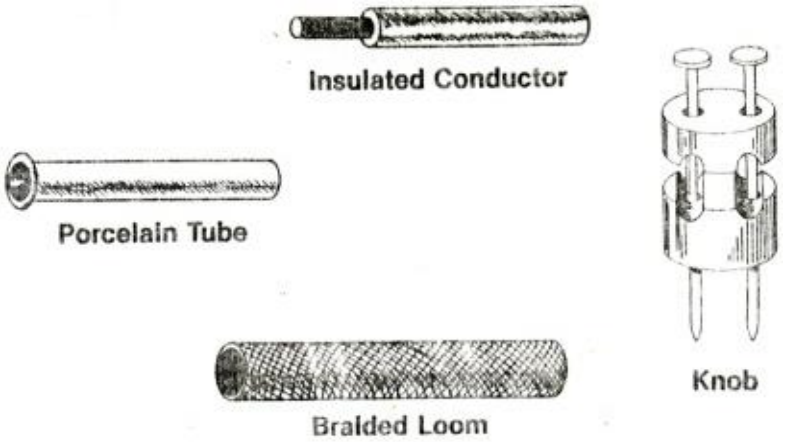


Figure 2

c. Rigid metal conduit.

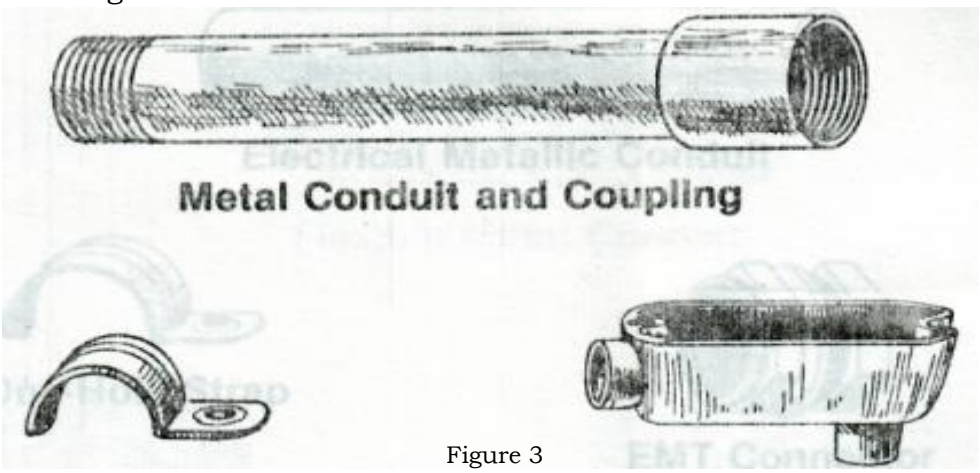


Figure 3

d. Electrical metallic tubing (EMT)

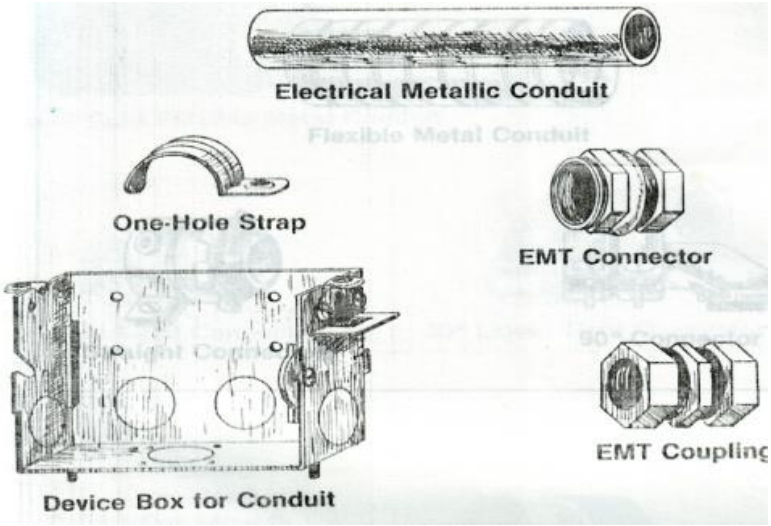


Figure 4

e. Flexible metal conduit.

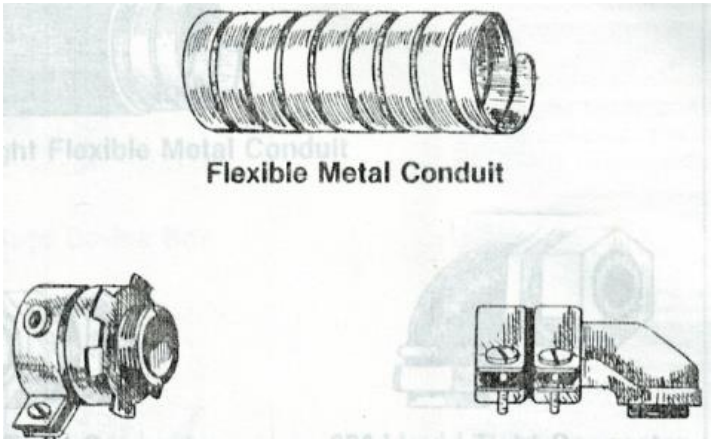


Figure 5

f. Liquid tight flexible metal conduit.

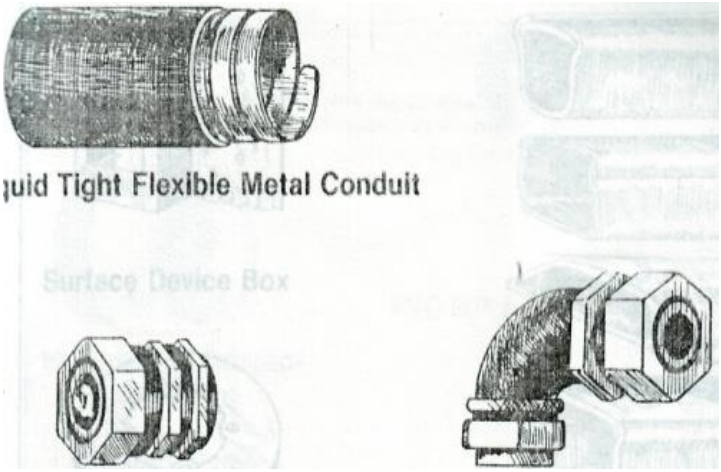


Figure 6

g. Low voltage devices

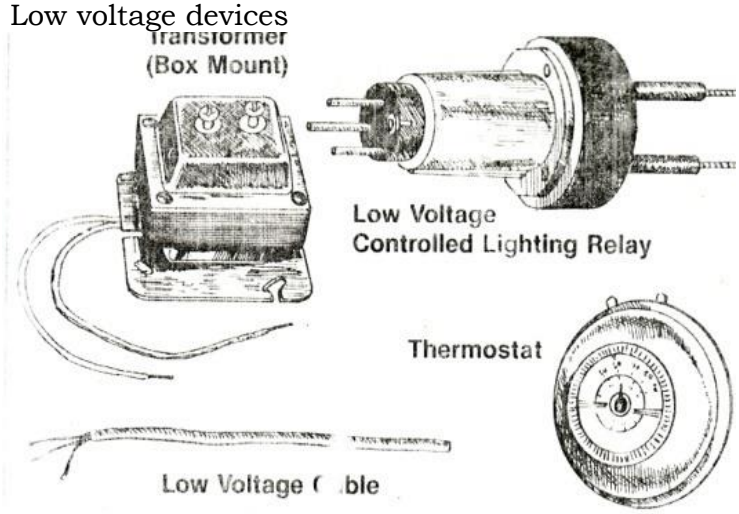


Figure 7

h. Surface raceways and boxes.

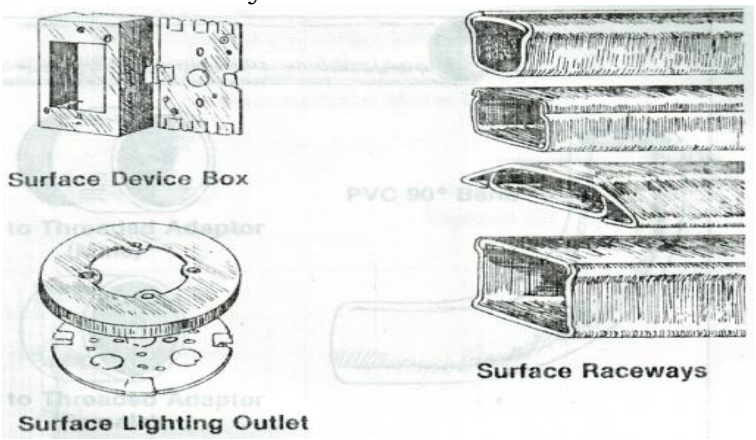


Figure 8

i. PVC fittings and connections

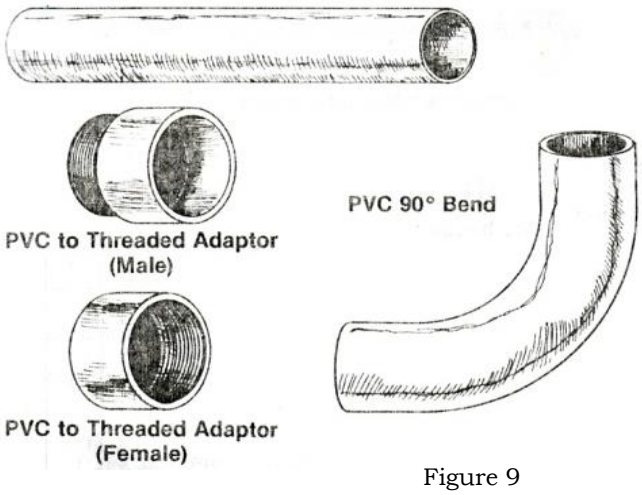


Figure 9

j. Intermediate metal conduit

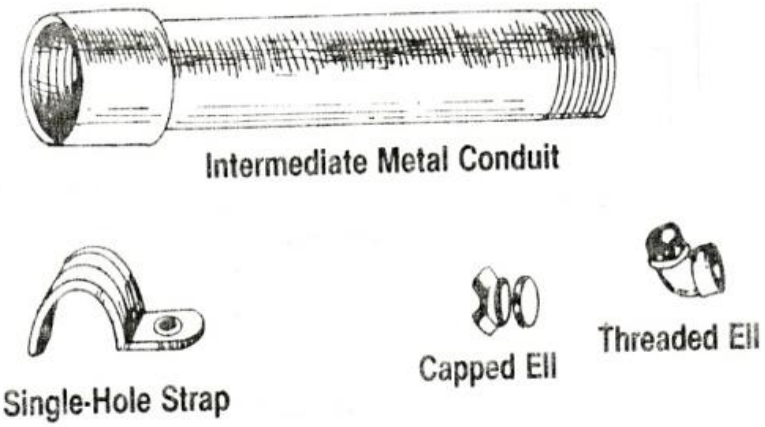
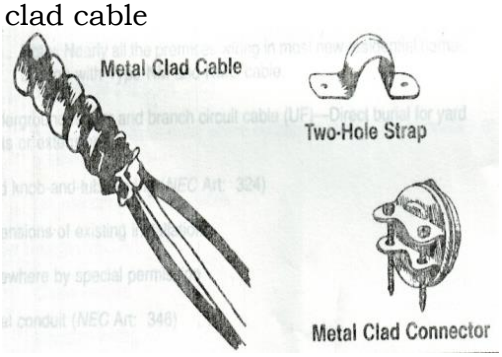
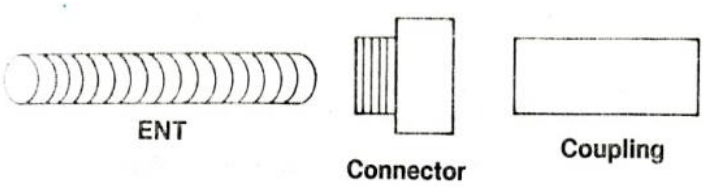


Figure 10

k. Metal clad cable





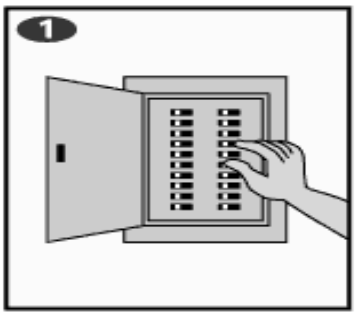
Installation of AC Electrical Circuit Line

Instruments/ Equipment:	**Hand Tools:**	**Materials:**
Multi-tester Ammeter L-Square Level Bar Pull- Push Rule Steel Square Electric Drill Multi-tester Sander	Wire Splicer Side cutter pliers Mechanical pliers Screw driver: Flat Philips Knife Claw hammer	#12 Stranded/Solid wire Plastic molding Screws (metal or wood) 2 circuit breaker set with panel board (20 A) Drill bits Parallel/ tandem AC Outlet set

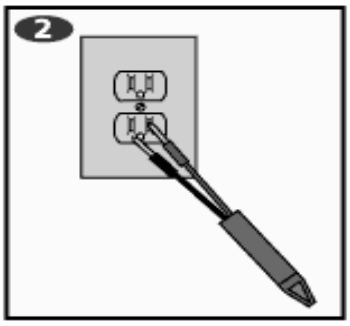
ACTIVITY SHEET 2.1

Steps in making a wiring outlet for air conditioning unit:

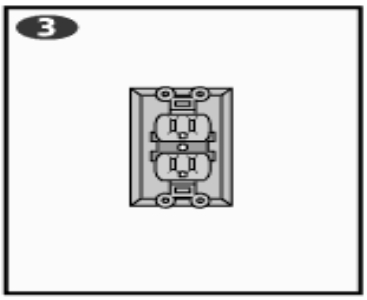
1. The first and most important step is to turn off the circuit that you will be working on. Find the correct breaker in the breaker box and flip it to the "Off" position. If you have a fuse box, find the right fuse and remove it completely from the panel.



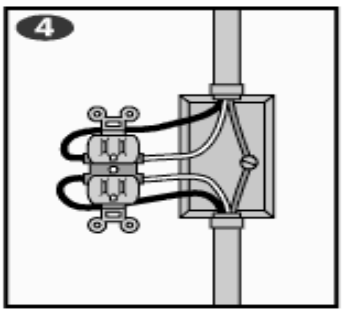
2. Using a circuit tester, verify that the power has been turned off. If the tester glows, try turning off a different breaker or removing a different fuse.



3. Remove the old receptacle plate.



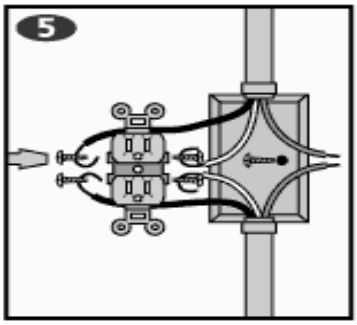
4. Remove the old receptacle from the workbox.



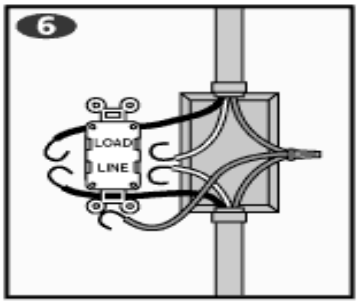
5. Disconnect the wiring from the old receptacle.

If you have 2 wires in the box (plus a ground wire), then the receptacle is probably at the end of a series of receptacles. If you have 4 wires (plus 2 ground wires) then the old receptacle is in the middle of a series of receptacles.

If you have 4 wires and 2 grounds coming into the workbox, you need to determine which wires are coming from the breaker panel. If you are not sure, spread the wires apart and turn the breaker back on. Carefully use your circuit tester to determine which wires are hot. Turn the breaker back off.

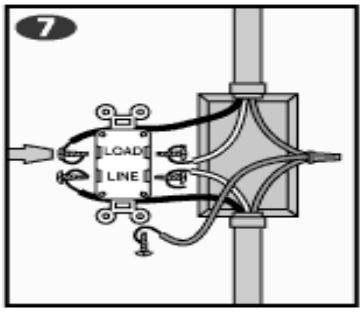


6. The black and white wires that you determined come from the breaker panel need to be attached to the two terminals on the new GFCI (Ground Fault Circuit Interupter) outlet that say “LINE”. Loop each wire so that it wraps around the screw in a clockwise direction.

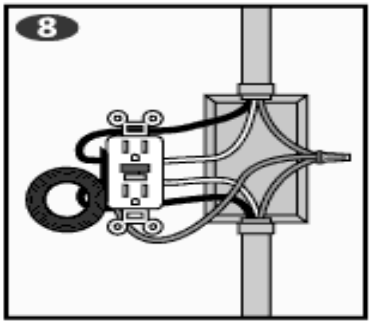


7. This will keep the wire from slipping off as you tighten the screw.

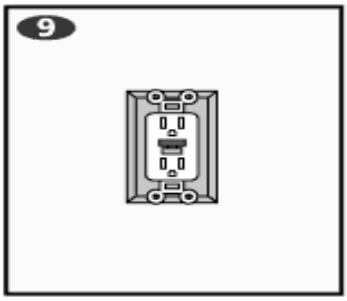
If you have a second set of wires that continue on to other receptacles, attach them to the other two terminals on the GFCI outlet. Again, loop the wires so that they wrap around the screw in a clockwise direction.
Take the one or two ground wires coming into the box and attach them to the grounding terminal on the GFCI outlet.



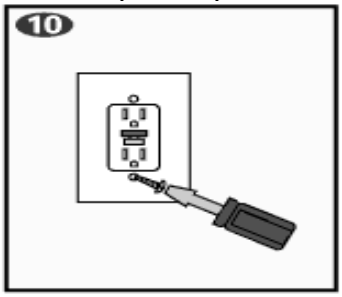
8. Wrap electrical tape around the GFCI outlet so that it covers all of the screw heads on both sides.



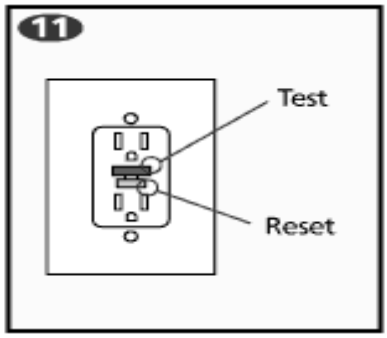
9. Bend the wires in a zigzag pattern so that they easily fold into the workbox. Push the new outlet into place. Adjust the outlet so that it is perpendicular to the floor. Tighten the two screws that hold it in position.



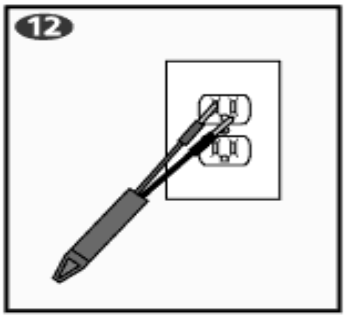
10. Install the new receptacle plate over the receptacle.



11. Switch the breaker back on (or reinstall the fuse). Test the new GFCI outlet to make sure the installation was successful by pressing the TEST button on the front of the outlet. You should hear a “click” as the breaker inside the outlet trips. Press the RESET button to reactivate the outlet.



If you installed the GFCI outlet in the middle of a series, you should also test receptacles further down the line using a circuit tester to confirm that you maintained the integrity of the series.



SELF-CHECK 2.1

Activity:

Observation on unit installation

Directions:

1. Go to other buildings in your area (school premises).
2. Try to check the air conditioning unit installed in each building.
3. Determine what type of load center or safety switch enclosures they use.
4. Record your observation on the table provided below. Try to record as many as you can.

Rating	Type of Enclosure	Location
1.		
2.		
3.		
4.		
5.		

SELF-CHECK 2.2

Installation of AC Electrical Circuit

Perform installation of AC electrical circuit using the listed tools, equipment and materials in AC Circuit Installation.

ASSESSMENT CRITERIA:

Unit of Competency	Point System (100 Points)	Raw Deductions	Total Deductions	Total Score
1. Safety use of tools, equipment, and materials				
b. 2.working drawing and location plan (diagram)				
3. Installation procedures of boxes/panel board and outlet				

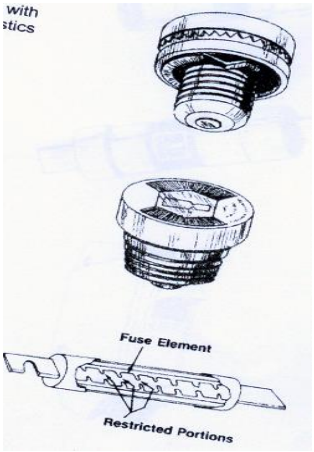
4. Unit operation				
5. Checking and testing the wiring connections				
6. SPEED				

Note: Two points deduction on every mistake or error made during the Performance Assessment.

INFORMATION SHEET 2.2

POWER CIRCUIT TERMINATOR

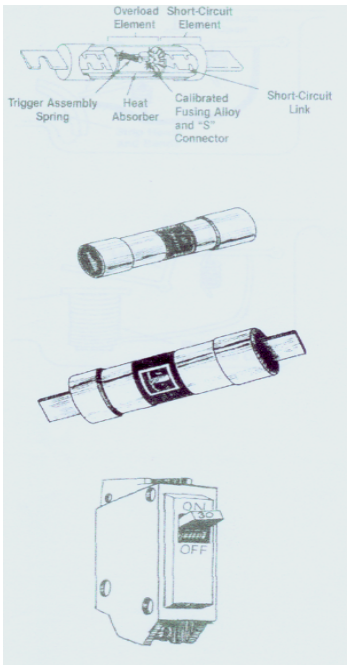
Over current Protection



1. Over current protection – Weak Link in the circuit that limits the amperage to a specified amount.

2. Fuse and circuit breakers are commonly used circuit protection.

3. Fuse damages itself when over current or overload occurs in the circuit while circuit breaker trips when fault is detected and can be reset after the fault is corrected.



4. The "S" plug fuse – fuse with special size limiting characteristics for each amperage range.

5. Edison-base plug fuse – Fuse with a base that fits the same socket as a regular based incandescent bulb.

6. Single-element fuse – Fuse that contains only one element and is not designed to carry an overload.

7. Dual-element fuse – fuse that has within it a thermal cutout element with a time delay that permits momentary harmless inrush currents to flow without harming the fuse.

Note: Dual element fuses should not be confused

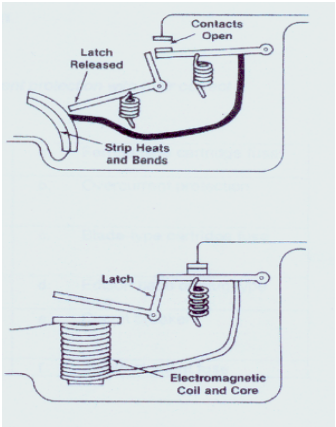
with fuses with two renewable links in a fuse cartridge.

8. Ferrule- type cartridge fuse – fuse with metal caps on a cylindrical case. Standard ampere ratings are 15, 20, 30, and 60A

9. Blade-type cartridge fuse – Fuse with flat contact blades on a cylindrical case. Standard ampacities starts at 65 A.

10. Circuit breaker – Automatic over current device that trips on overloads or shorts and is resettable. Standard ampacities starts at 15 A.

11. A thermal trip type of circuit breaker. If current flow exceeds the rated limit of the breaker, the bimetallic strip heats and bends. As the strip bends, the latching mechanism is tripped and the contacts open.



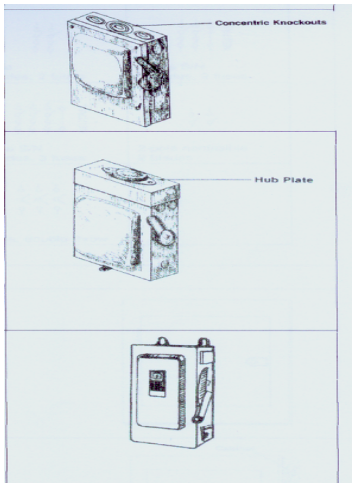
12. Electromagnetic Trip Type – as the current flows through the breaker, it creates a magnetic field within the coil; the magnetic field interferes and draws the core into the coil. The metal trip bar is attracted to the core forcing the latch to move, thus opening the contact.

Types of Safety Switch Enclosures

1. NEMA 1 (Indoor)
   Note: NEMA 1 safety switch enclosure maybe easily identified because of the presence of concentric knockouts on the top of the enclosure

2. NEMA 3R (Rainproof)
   Note: NEMA 3R safety switch enclosure maybe easily identified by the presence of hub plate on the top of the safety switch.

3. NEMA 4X (watertight, corrosion resistance)
   Note: NEMA 4X enclosures is generally constructed of stainless steel.



Types of Over Current Protective Devices.

a. Edison base plug fuse
b. Type "S" plug fuse (fustat)
c. Ferrule type cartridge fuse.

Note: *Standard ampacities are 15, 20, 30, 40, and 60 amps.*

d. Blade type cartridge fuse
Note: *Standard ampacities start at 65 amps.*

e. Circuit breaker
Note: *Standard ampacities start at 15 amps.*

Operation of a single element fuse – This normally happens under sustained overload conditions, the restricted portions of the fuse element heat to their predetermined melting point, thus opening and interrupting the flow of current.

Operation of a dual-element, time-delay fuse – Under sustained overload conditions, the trigger spring fractures the fusing alloy and releases the "S" connector.

Types of circuit breakers and their operation

a. Thermal trip
   - If current flow exceeds the rated limit of the breaker, the bimetallic strip heats and bends.
   - As the strip bends, the latching mechanism is tripped and the contacts open.

b. Electromagnetic trip
   - As current flows through the breaker, it creates a magnetic field within the coil. During sustained overload conditions, the magnetic field interferes and draws the core into the coil.
   - The metal trip bar is attracted to the core forcing the latch to move, thus opening the contacts.

Requirements for fusses of less than 600 volts

a. Plug fuses shall not be used in circuits exceeding 125 volts between conductors.
b. Fuses shall be marked with their amperage rating.
c. Plug fuses shall be classified 0 to 30 amperes.
d. Edison-base plug fuses shall only be used for replacement in existing installations where there is no evidence of over fusing or tampering.
e. Type "S" fuses (Fuse tats) shall be classified at not over 125 volts

Characteristics of good connections

a. Are clean
b. Are tight
c. Are strong
d. Provide full contact
e. Use approved devices and oxidation inhibitors when connected copper to aluminum.

Types of connectors, terminals, and lugs

a. Crimp sleeve connector
b. Set-screw lug
c. Split bolt lug
d. Service-entrance lug
e. Wire nut lugs
f. Crimp-type butt connectors
g. Ring lugs
h. Spade Connectors
i. Quick disconnect connectors'
j. Single terminal
k. Twin or double terminal
Note: Twin terminals are available in many configurations.

Load Center and Safety Switches

a. **Cabinet** – An Enclosure designed either for surface or flush mounting and provided with a frame, mat , or trim in which a swinging door are or may be hung.

b. **Concentric knockout**- Several removable metal rings that allow for the entrance of various standard sizes of connectors into a cabinet

Note: Standard concentric knockout sizes are ½ inch, ¾ inch, 1 inch, 1 ¼ inches, 1 ½ inches, 2 inches, and 2 ½ inches.

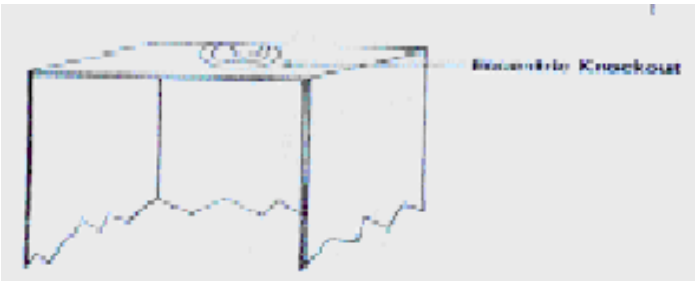
c. **Dead Front** - Removable cover used to prevent exposure of live parts to persons on the operating side of the equipment.

d. **Disconnecting means** – A device of group of devices, or other means, by which the conductors of a circuit can be disconnected from their source of supply.

e. **Dustproof –** so constructed or protected that dust will not interfere with its successful operation.

f. **Dust-light-** So constructed that dust will not enter the enclosing case.

g. **Eccentric knockout** – Knockout that is removed in sections to arm larger holes



h. **NEMA (National Electrical Manufacturer's Association)** – Organization responsible for setting specifications for various classes of enclosures.

i. **NEMA Type 1** – General purpose enclosure for use indoors under usual service conditions.

j. **NEMA Type 2** – Drip tight enclosure used indoors to exclude falling moisture and dirt.

k. **NEMA Type 3 –** Weather resistant (weatherproof) enclosure suitable for indoor or outdoor use; will exclude falling dirt, light liquid splashing, rain, show, sleet, and windblown dust.

Note: *Descriptions placed after the code numbers specify the suitable applications. ANEMA Type 3R is a common residential outdoor enclosure. The R stands for rain tight and signifies that the enclosure will not exclude windblown dust.*

l. **NEMA Type 4** – Watertight and dustproof enclosure suitable for areas where a great amount of splashing occurs such as hose down areas.

m. **NEMA type 5** – Dust – tight enclosures not suitable for use around water

Note: *All NEMA Type 12 enclosures and JIC (Joint Industry Conference) enclosures are suitable for NEMA Type 5 applications.*

n. **NEMA Type 12** – Industrial use enclosure designed to exclude oil coolant, flying dust and lint, and falling dirt.

o. **Rainproof** – So constructed, protected, or treated as to prevent rain from interfering with successful operation of the apparatus.

p. **Rain tight** – So constructed or protected that exposure to a beating rain will not result in the entrance of water.

Types of safety switch enclosure

a. NEMA 1 (indoor)

Note: NEMA 1 safety switch enclosures may be easily identified because of the presence of concentric knockouts on the top of the enclosure.

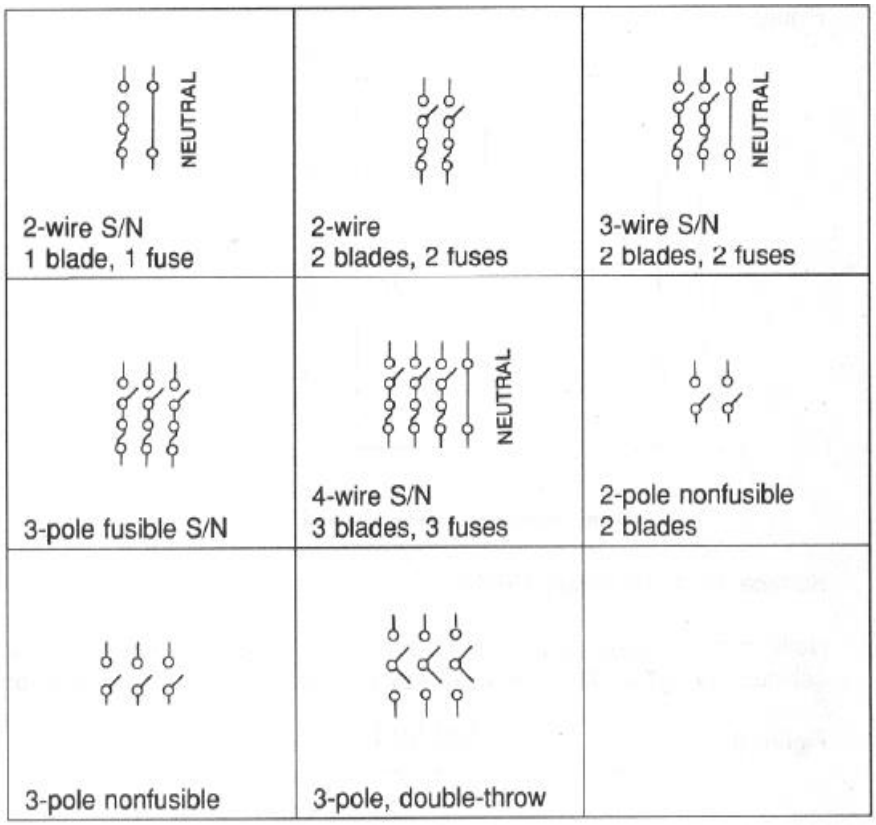
b. NEMA 3R (rainproof)
Note: NEMA 3R safety switch enclosures may be easily identified by the presence of a hub plate on the top of the safety switch.

c. NEMA 4X (water tight, corrosion resistant)

Note: MEMA 4X enclosures are generally constructed of stainless steel

3. **Safety switch configurations**

* S/N designates "solid neutral"



SELF-CHECK 2.2

Conductors and Insulators

Enumeration: List down at least 5 types of conductors and insulators that are commonly used.

Conductor	**Insulator**
1. _____	1._____
2. _____	2._____
3. _____	3._____
4. _____	4._____
5. _____	5._____

SUMMATIVE TEST

Test I. Multiple Choices

Directions: Read the questions carefully. Choose the letter of the correct answer and write the answer on a separate sheet of paper.

1. What is the most important thing to consider in selecting an area for the installation of a window-type air-conditioning unit?
   a. Select an area that allows good drainage for condensed water.
   b. Select an area that is high in place.
   c. Select an area where the power supply is nearest
   d. Select an area based on the needs of the clients.

2. Why should you avoid placing the unit's backside away from your neighbor?
   a. To allow better air circulation
   b. To prevent the unit from blowing hot air on your neighbors
   c. To allow better servicing space
   d. To have better drainage

3. What is the distance of the convenient outlet from the unit to the ground?
   a. 4 meters
   b. 5 meters
   c. 1 meter
   d. 2 meters

4. What is the wire size we used in installing ac power circuit?
   a. 8 mm
   b. 10 mm
   c. 18 mm
   d. 12mm

5. What is the material that allow current to flow?
   a. Insulator
   b. Steel
   c. Conductor
   d. Plastic

6. What is the path of electric current from the source back to source?
   a. Current
   b. Voltage
   c. Circuit
   d. Conductor

7. In lay-out of the ac electrical circuit, we must make the_____ to have a blue print on what are we going to be?
   a. Circuit
   b. Working drawing
   c. Space
   d. Unit

8. The Philippine Electrical Code covers the following except_____.
   a. Electrical Conductors
   b. Optical Fiber Cables
   c. Raceways
   d. Automotive Vehicles

9. American Wire Gauge (AWG) is the English System of measuring wire sizes. If the size of the wire is 12 AWG, its Metric System Equivalent is ____.
   a. 2.0 mm^2
   b. 3.5 mm^2
   c. 5.5 mm^2
   d. 8.0 mm^2

10. The code letter of Moisture and Heat-resistant Thermoplastic is _____.

a. THWN
b. THW
c. MTW
d. THHW

11. What is the code letter of Moisture Heat and oil resistant thermoplastic?

a. THWN
b. THW
c. MTW
d. THHW

4. Which of the following is a low voltage device?

a. Thermostat
b. NM Cable
c. Metal Conduit and Coupling
d. Surface Raceway

13. What location should be avoided in installing an air conditioning unit?

a. Low sunlight exposure
b. High rise building
c. Direct air flow
d. Areas near flammable gas.

14. What should be done before installing the air conditioning unit?

a. Check it by parts
b. Check it by the paint
c. Check it by the weight
d. Check it by the sound

15. Where should be the proper location of air conditioning unit?

a. Window
b. Adjacent convenient outlets
c. Near light fixture
d. Beside heating element

16. Which of the following is NOT true about the general rules in installing window air conditioning unit?

a. Select location where the unit to be placed suits the customer's needs.
b. Install the unit in an area with good ventilation.
c. Install the unit where vapor is present.
d. Install the unit in an area that provides easy drainage.

17. To prevent harmful effect to the air conditioning unit, the following should be avoided except_____.

a. Greasy Areas
b. Salty Areas (Near the shore)
c. Near Hot Springs
d. Areas that is not exposed to rain

18. Corroded base of an air conditioning unit may cause misalignment of the mechanical parts usually the_____.

a. Fan Blade
b. Drain Pan
c. Brackets
d. Housing

19. Which of the following is not true about the Enforcement of Philippine Electric Code?

a. This code is intended for mandatory application by government bodies exercising legal jurisdiction over electrical installation.
b. The code does not cover installation in railway rolling stock.
c. The code may not require new products, constructions, or materials that

may not yet be available at the time this code is adopted.

d. The authority having jurisdiction may waive specific requirements in this code.

20. What is the correct procedure in making a wiring outlet for air conditioning unit?

1. Turn off the circuit
2. Remove the old receptacle
3. Remove the old receptacle from the work box
4. Verify if the power has been turned-off using the tester

a. 1432 b. 1423 c. 1324 d. 1342

Test II. Essay

Directions: Discuss the procedure / steps in making a wiring outlet for air conditioning unit. Use specific steps that have to be emphasized to avoid accident while doing the procedure. Write your answer on a separate sheet of paper.

Writing Rubrics

Directions: The paper will be given one of the three scores: P (10), A (8), or B (5). The presenter will present the paper with these descriptors in mind:

Criteria	Descriptions
Proficient (10)	Can easily complete process • has no more than three minor errors (mechanics, word choice, sentence structure) • captures message fully
Approaching (8)	Take some efforts to complete process • has four to seven minor errors (mechanics, word choice, sentence structure) • captures message partially
Beginning (5)	Cannot complete process • has more than seven errors (mechanics, word choice, sentence structure) • does not capture message