



Participant Handbook

Sector
Electronics

Sub-Sector
**Consumer Electronics
and IT Hardware**

Occupation
After Sales Service

Reference ID: **ELE/Q3118, Version 1.0**
NSQF Level 4



**Multi Skill Technician
- Consumer Durables
(Elective 1)**

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Electronics Sector Skills Council of India (ESSCI)

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Shri Narendra Modi
Prime Minister of India

“ Skilling is building a better India.
If we have to move India towards
development then Skill Development
should be our mission. ”



Certificate
COMPLIANCE TO
QUALIFICATION PACK - NATIONAL OCCUPATIONAL
STANDARDS

is hereby issued by the
Electronics Sector Skills Council of India
for
SKILLING CONTENT : PARTICIPANT HANDBOOK

Complying to National Occupational Standards of
Job Role/ Qualification Pack: "Multi Skill Technician - 'QP No. ELE/Q3118, NSQF Level 4
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Electronics Sector Skills Council of India

Acknowledgements

The need for having a standard curriculum for the Job Role based Qualification Packs under the National Skills Qualification Framework was felt necessary for achieving a uniform skill based training manual in the form of a Participant Handbook.

I would like to take the opportunity to thank everyone who contributed in developing this Handbook for the QP Multi Skill Technician - Consumer Durables.

The Handbook is the result of tireless pursuit to develop an effective tool for imparting the Skill Based training in the most effective manner.

The preparation of this Handbook would not have been possible without the Industry's support. Industry feedback has been extremely encouraging from inception to conclusion and it is with their input that we have tried to bridge the skill gaps existing today in the Industry. This handbook is dedicated to the aspiring youth who desire to achieve special skills which will be a lifelong asset for their future endeavours.

About this book

This Participant Handbook is designed to enable training for the specific Qualification Pack (QP). Each National Occupational (NOS) is covered across Unit/s.

This book is designed to enable a candidate to acquire skills that are required for employment. The content of this book is completely aligned to the National Occupation Standards QP/NOS and conform to the National Skills Qualification Framework (NSQF).

The Qualification pack of Multi Skill Technician - Consumer Durables, Level 4 includes the following NOS's which have all been covered across the units -

Compulsory NOS:

1. **DGT/VSQ/N0102:** Employability Skills (60 Hours)

Elective 1:

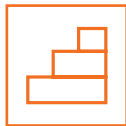
2. **ELE/N3169:** Installation and Repair of Refrigerator (DIOS)
3. **ELE/N3170:** Installation and Repair of Washing Machine
4. **ELE/N3163:** Installation and Repair of DishWasher
5. **ELE/N3162:** Installation and Repair of Air Conditioner
6. **ELE/N3161:** Gas Charging in the Refrigerator and AC

Key Learning Objectives for the specific NOS mark the beginning of the Unit/s for that NOS. The symbols used in this book are described below.

Symbols Used



Key Learning
Outcomes



Steps



Exercise



Notes



Unit
Objectives

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1. Introduction to the role of Multiskill Technician - Consumer Durables

Unit 1.1 – About Electronics Industry

Unit 1.2 – Basics of Electricity and Electronics

Unit 1.3 – Role of Multi skill Technician - Consumer Durables in Industry



Key Learning Outcomes



At the end of this module, participants will be able to:

1. Describe about electronics industry
2. List applications of electronics industry
3. Describe trends and challenges in electronics industry
4. Describe electric circuits
5. Describe voltage, current and resistance
6. Define Ohm's law
7. Explain the difference between alternating current (AC) and direct current (DC)
8. Describe active and passive components
9. Identify colour coding in different electrical components
10. List role and responsibilities of a Multi Skill Technician

UNIT 1.1: About Electronics Industry

Unit Objectives



At the end of this unit, participants will be able to:

1. Describe about electronics industry
2. List applications of electronics industry
3. Describe trends and challenges in electronics industry

1.1.1 Introduction

The electronics industry is the economic sector that produces electronic devices. It emerged in the 20th century and is today one of the largest global industries. Contemporary society uses a vast array of electronic devices built-in automated or semi-automated factories operated by the industry.

Electronics industry, the business of creating, designing, producing, and selling devices such as radios, televisions, stereos, computers, semiconductors, transistors, and integrated circuits etc. The electronics industry transformed factories, offices, and homes, emerging as a key economic sector that rivalled the chemical, steel, and auto industries in size.

The electronics sector produces electronic equipment and consumer electronics and manufactures electrical components for a variety of products. Common items in the electronics sector include mobile devices, televisions, and circuit boards. Industries within the electronics sector include telecommunications, networking, electronic components, industrial electronics, and consumer electronics.

Growth in the Electronics Sector

The electronics sector is growing rapidly as a result of increasing demand from emerging market economies. As a result, many countries are increasingly producing more electronics, and investment in the foreign production of electronics has increased dramatically.

Electronics sector growth is accelerated by increased consumer spending around the world. As developing economies grow, consumer demand for electronics also grows. Countries that produce electronics now have strong consumer bases that can afford new electronic products. At the same time, increased competition is driving the costs of electronics production down, making products even cheaper for individuals.

The supportive role of the electronics sector in providing equipment and components for other industries is also a factor of growth as consumers demand more automobiles, energy-efficient homes, and medical technologies.

1.1.2 Application of Electronics in Different Fields

The various electronics applications are:

- **Consumer Electronics:** The devices and equipment meant for daily use are known as customer electronics; this industry is widely applicable to the common people. Some of its applications included office gadgets like computers, scanners, calculators, FAX machines, projectors etc.

It also includes home appliances like washing machines, refrigerators, microwaves, TVs, vacuum cleaners, video games, loudspeakers etc. and some advanced storage devices such as HDD jukebox, DVDs etc.

- **Industrial applications of electronics:** Electronics engineering has a huge impact on the smooth functioning of the industries as it is used in various systems, grids and processing units. For example, smart electric systems collect information from the communication technology department, and several machines use automation and motor control systems using electronics; also, it is used in extracting 3D images from 2D using image processing systems.
- **Robotics and artificial intelligence:** Apart from image processing that involves computer graphics, electronic systems are also used in artificial intelligence and robotics technologies for inspection, navigation and assembly. Virtual reality and face gesture recognition are computer-based, and these developments have been possible because of electronics engineering.
- **Medical applications:** For data recording and physiological analysis, advanced, sophisticated instruments are being developed using the latest technologies and electronics engineering, and these instruments are very useful in diagnosing diseases and for healing purposes.
Electronics play a vital role in the functioning of medical instruments; for instance, the stethoscope is used to listen to the inner sounds of the human or animal body, a glucose metre for checking sugar levels, a pacemaker for dropping and increasing heartbeat count and so on.
- **Defence and Aerospace:** Electronics technology has been used extensively in the defence and aeronautical systems, which include missile launching systems, cockpit controllers, military radars, aircraft systems, rocket launchers for space and many more.
- **Automobiles:** Electronics are widely used in the latest automobile technologies, like anti-collision units, anti-lock braking systems, traction controls, window regulators and several electronic control units.

1.1.3 Electronic Industry Trends and Challenges

The electronics sector appears to be overgrowing, owing to increased demand from developing countries. Before the virus outbreak, due to increased demand, electronics production skyrocketed, accompanied by a surge in investment.

The global electronic products market is expected to be worth nearly \$1,191.2 billion in 2020, with a Compound Annual Growth Rate (CAGR) of 5.4 percent since 2015. The increase is primarily due to the increasing demand for various electronic products as employees and students have transitioned to online.

Consumer Electronics Market size was valued at over USD 1 trillion in 2020 and is estimated to grow at a CAGR of more than 8% from 2021 to 2027. Rapidly increasing internet penetration across the globe will drive the market growth.

Consumer electronics are electronic equipment for non-commercial use. Consumer electronics include devices that provide one or more functionalities such as computers, laptops, mobile devices, smart wearables, television sets, refrigerators, smartphones, and home appliances.

Continuous investments by market players in R&D for the development of new consumer electronic products with enhanced features will fuel the industry growth of consumer electronics.

Challenges in the electronic industry

Regardless of its merits, the electronic industry faces disruptive forces that will test its business model and ability to survive and thrive.

The global electronic industries are the fastest-growing sector, worth trillions of dollars, and play a critical role in driving consumers to purchase innovative and smart electronic products. The global market for electronic components is expected to grow at a compound annual growth rate (CAGR) of about 4.8 percent from 2020 to 2025.

Electronic industries have always been at the forefront of the most recent technological innovations to reduce costs and improve efficiency with such a large future market potential. Many SMEs have found it challenging to keep up with the trends/changes as technology has advanced faster.

For example, top players such as Apple, Samsung, Microsoft, and Intel, to name a few, are investing heavily in new cutting-edge technology to expand their technological capabilities and remain competitive. They are the leading example of an IR4.0 (industrial Revolution 4.0) Eco-friendly system.

The integration of digital tools and technologies has increased revenue and productivity, improved product quality, reduced waste, and operational costs, and met the most recent customer/global demands.

Electronic Industry Trends

Here are some predictions for the specific trends that are likely to have the most significant impact in 2022. The most important trends in 2022 will likely focus on the convergence of technology trends as tools emerge that let us combine them in new and amazing ways.

1. **The 5G Optimization:** 5G is laying the groundwork for a fully digitalized and connected world. We have seen many new field trials and an increasing number of commercial rollouts over the last two years. Furthermore, we are seeing 5G being adopted in various industries, ranging from manufacturing to healthcare.

With its high output and ultralow latency, 5G can access many high-value areas such as 3D robotic control, virtual reality monitoring, and remote medical control that previous technologies could not. 5G is redefining and accelerating industries like automotive, entertainment, computing, and manufacturing. It will eventually change the way we work and live.

2. **Digitization, data, and virtualization:** Many of us witnessed the virtualization of our offices and workplaces in 2020 and 2021, as remote working arrangements were quickly implemented.

This was simply a crisis-driven acceleration of a much longer-term trend. In 2022, we'll be more familiar with the concept of a **"metaverse"** - persistent digital worlds that exist alongside the physical world we live in.

3. **Concentrate on Software Quality Standards:** The focus on quality will be the trend for 2022 and beyond. Software solutions will be integrated into our daily lives and the majority of the goods and appliances we use. As a result, software must meet the quality standards of the manufacturing industry.
4. **Teleworking:** Teleworking will continue to grow in 2022, bringing advances in software development. Companies worldwide will need to support hybrid forms of team management and collaboration to increase the productivity of their workforces. As the trend of conducting online meetings and video sales calls continues, this new standard will grow even more in 2022.
5. **Green, Clean, and Lean Energy:** Renewable energy was the only type of energy that saw an increase in use during the pandemic. As industries shut down and people stayed at home, global non-renewable energy consumption decreased, resulting in an 8% reduction in emissions. As a result, increased investment in renewable energy generation is expected in the coming years.

According to the International Energy Agency (IEA), 40% more renewable energy was generated and used in 2020 than the previous year. This trend is expected to continue through 2022. Overall, the cost of generating renewable energy from various sources, such as onshore and offshore wind, solar, and tidal, has decreased by 7 to 16%. This will be highly beneficial to countries and businesses attempting to meet emissions targets such as becoming carbon neutral or even carbon negative.

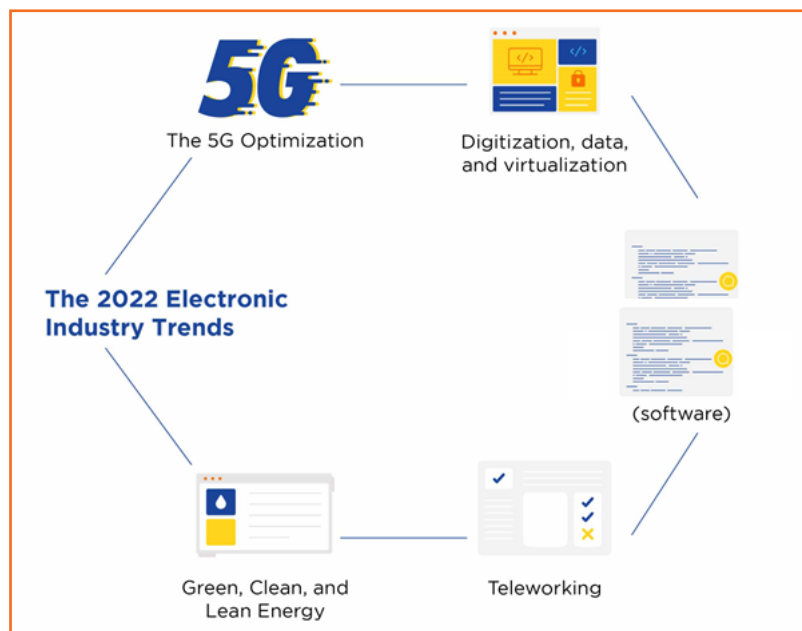


Fig 1.1.1: Trends in electronics industry

Electronics manufacturing trends for 2022

1. **Advanced Materials:** The semiconductor industry has been reliant on silicon for decades, but there is a limit to how far you can etch, lithograph, and pattern a silicon material. As a result,

innovation to increase the performance of integrated circuits is coming from new materials and architectures. Startups and scaleups are developing silicon alternatives and other semiconductor materials or composites for high performance and efficiency.

2. **Organic Electronics:** Organic Electronics offer massive advantages over traditional inorganic electronics. They are cost-effective, flexible, indissoluble, optically transparent, lightweight, and consume low power. In addition, the rise in awareness for sustainable development and eco-friendly manufacturing attracts manufacturers to opt for organic electronics. Designing circuits with microbial components or producing devices with biodegradable and recyclable materials is seen to be the next electronics manufacturing trend.
3. **Artificial Intelligence:** AI-powered solutions are gaining popularity in every sector. AI impacts the growth of semiconductor manufacturing in two ways, one is by building demand for innovative AI-capable electronics components, and two, enhancing the product manufacturing and design processes. The conventional methods have limitations to reshaping product development cycles, improving product design processes, and reducing defects. But the application of AI is solving all these limitations.
4. **Internet of Things:** The rapid growth of the Internet of Things represents an unprecedented opportunity for the electronics manufacturing industry. It re-evaluates the fabrication process and manages practices that are found to be difficult to achieve with conventional approaches. In other ways, the IoT enables electronic manufacturing machines to self-process and store data while being digitally connected. Continuous improvements in the fabrication of sensors are also required since sensors are the key components that enable IoT applications. Further, the transition to 5G-enabled devices requires flawless, innovative chips with more efficient architectures at lower costs.
5. **Embedded Systems:** Embedded systems are an unavoidable part of any electronic device nowadays and it has a crucial role in deciding the speed, security, size, and power of the devices. Since we are in the transition phase of a connected world, there is high demand for embedded systems. So the designing and manufacturing sector of such systems is undergoing numerous innovations to improve performance, security, and connectivity capabilities.
6. **Printed Electronics:** Printing electronics components on a semiconductor substrate is the most effective way to reduce the overall cost of the manufacturing process. So, manufacturers are always trying to tackle this challenge by searching for new technologies and advancements in conventional printing technologies. Unlike traditional semiconductors that use tiny wires as circuits, printed electronics rely on conductive inks and often flexible films. Further, the advancements in printing technologies allow the flexible hybrid electronics field to obtain enough momentum. Therefore, startups and scaleups are developing solutions for advanced printing technologies.
7. **Advanced IC Packaging:** In recent years, chip packaging has become a hot topic along with chip design. The traditional way to scale a device based on Moore's law has limitations nowadays. The other way to get the benefits of scaling is to put multiple complex devices in an advanced package. So, semiconductor manufacturers develop new advanced IC packaging technologies to provide greater silicon integration in increasingly miniaturized packages. This also enables manufacturers to offer customization and improve yields by vertically stacking modular components.

8. **Additive Manufacturing:** 3D Printing in electronics manufacturing eliminates the need for flat circuit boards. It enables new innovative designs and shapes that cannot be produced through conventional means. 3D printers also fabricate electronic components as a single, continuous part, effectively creating fully functional electronics that require little or no assembly. Consequently, the implementation of this electronics manufacturing trend speeds up prototyping, offers mass customization, and decentralizes parts production. In general, 3D printing technology made possible electronic components production in terms of 3D design and not only 2D, with new ways of stacking the circuits.

Notes



UNIT 1.2: Basics of Electricity and Electronics

Unit Objectives

At the end of this unit, participants will be able to:

1. Describe electric circuits
2. Describe voltage, current and resistance
3. Define Ohm's law
4. Explain the difference between alternating current (AC) and direct current (DC)
5. Describe active and passive components
6. Identify colour coding in different electrical components

1.2.1 Electric Circuits

An electric circuit is a path made by the interconnection of electrical components. Electrons from a voltage or current source flow along this path. The following figure lists the elements present in a basic electric circuit -



A source that provides electrical pressure known as voltage or Electromagnetic force (EMF) to electrical equipment to enable them to work.

Example: Battery



A device in a circuit which consumes electric power is called load.

Example: Bulb



A conductor that connects the supply source and the load.

Example: Wires

Fig 1.2.1 Electric circuit constituents

An electric circuit consists of two paths/loops, as shown in the following image -

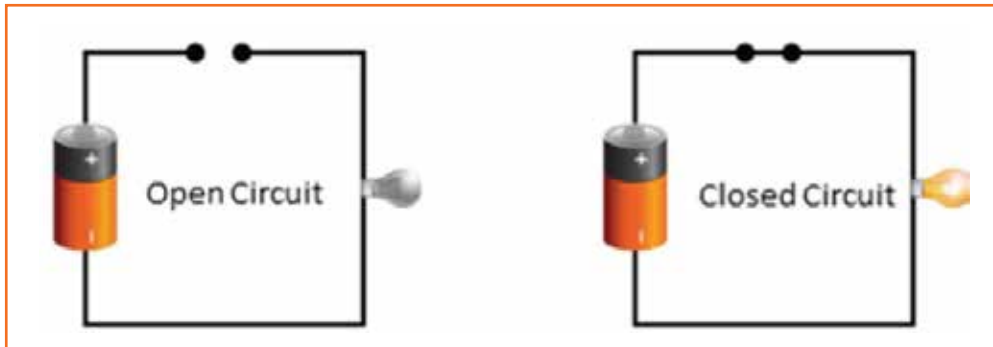


Fig 1.2.2 Closed and open path

In a typical circuit, a battery provides voltage for the load through wires. For example, the required voltage for a bulb to glow is provided by a battery. The following image shows such an electric circuit -

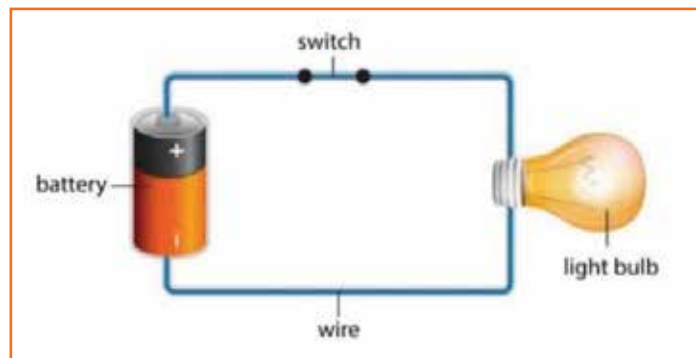


Fig 1.2.3 An electric circuit

1.2.2 Types of Electric Circuits

An electric circuit is classified into two types:

- Series circuit
- Parallel circuit

Series Circuit

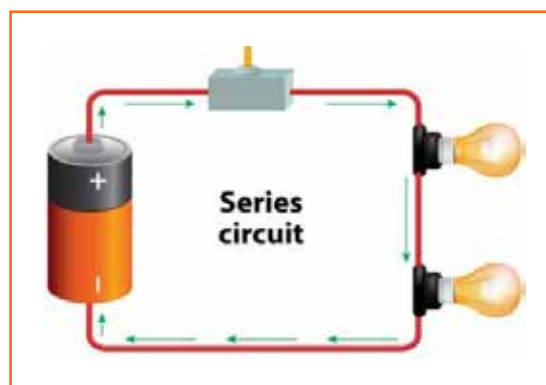


Fig 1.2.4 A series circuit

In this type of a circuit, all components are connected as a chain and the current flowing through each one of them is the same all over the circuit. There is a single route through which the current flows. So, the current passes through each and every component. Opening or breaking any point in a series circuit causes the whole circuit to stop functioning, which then needs to be replaced.

Parallel Circuit

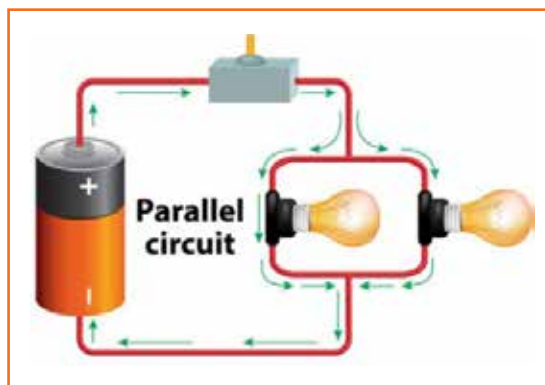


Fig 1.2.5 A parallel circuit

In this type of a circuit, two or more than two components are connected in parallel. In a parallel circuit, the components are of the same voltage. The current flow varies across the components. If any point of the circuit gets damaged, only that part needs to be replaced.

1.2.3 Parameters of Electric Circuit

Electricity comes into existence whenever there is a flow of electric charge between any two components. The main parameters associated with electricity are as follows -

Voltage

A force that causes electricity to move across a wire/cable is known as voltage. Volt is the unit of voltage and is denoted with letter V.

Current

Electric current, or simply current, is the flow of electric charge carried through electrons moving across wires. Ampere is the unit of current and is denoted with letter I.

AC and DC Current

The following figure lists the two types of current sources that are dependent on the direction in which the electrons flow -

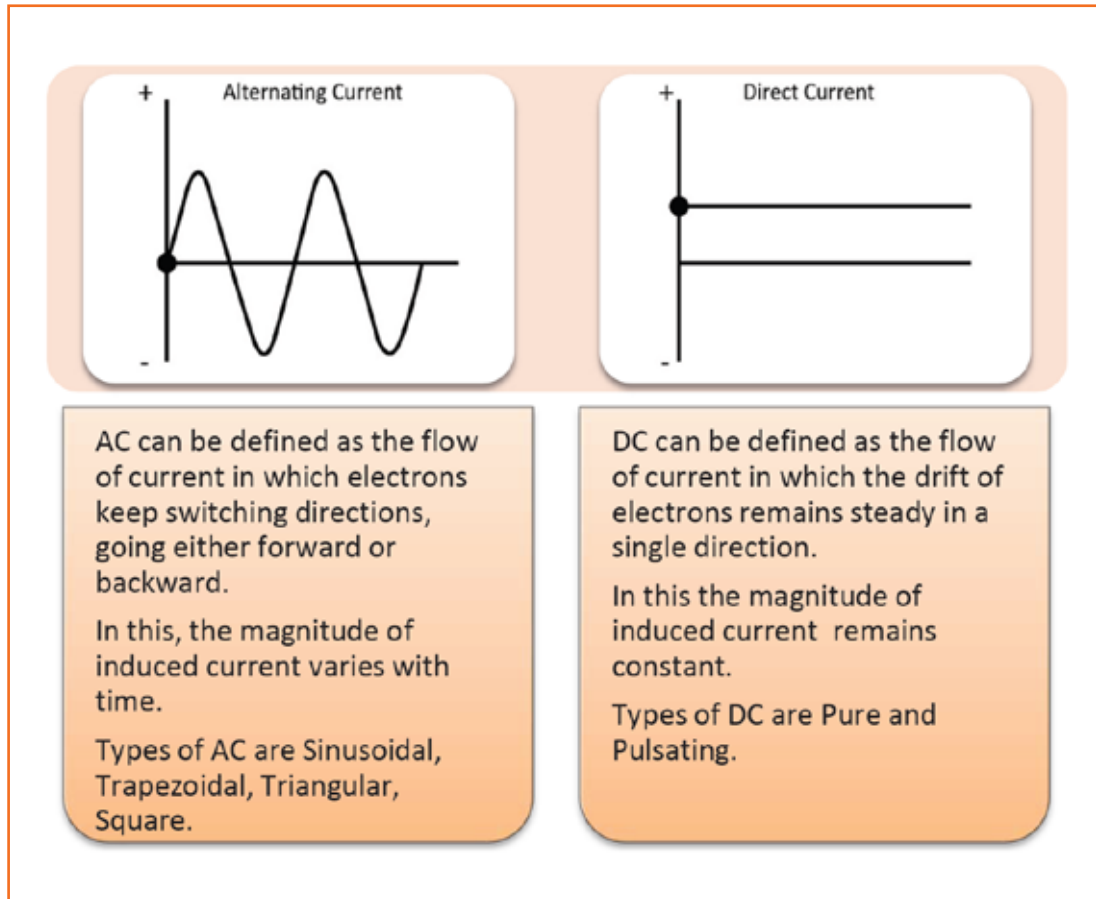


Fig 1.2.6 Difference between AC and DC current

Resistance

Resistance is an obstruction caused by a substance to the current flow. The unit of resistance is ohm and it is denoted with the symbol, Ω . According to Ohm's law, 1Ω resistance allows $1A$ of current to flow from one point to the other with a $1V$ voltage difference.

1.2.4 Ohm's Law

According to Ohm's law, the flow of current through a conducting material is directly proportional to the conductor's voltage. The mathematical equation of Ohm's law is as follows -

$$I = V/R$$

Where,

I is the current

V is the potential difference

R is the resistance

Ohm's law states that R in the preceding relation is constant and independent of the current flowing through it as shown in the following image -

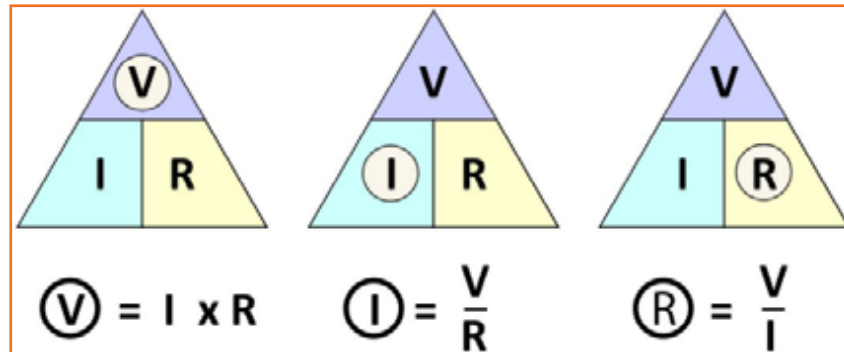


Fig 1.2.7 Ohm's law

1.2.5 Circuit Elements

A circuit consists of a number of components that may be electrical, electronic, mechanical and so on. The following figure shows various types of circuit elements or components that are used in a control panel -

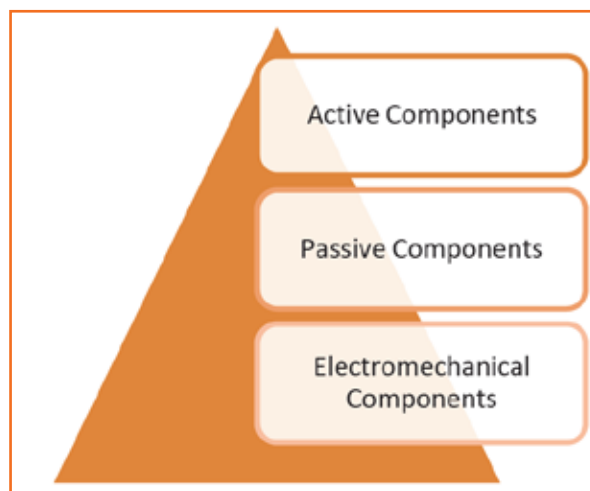


Fig 1.2.8 Circuit elements

Active Components

Active components depend on a source of energy to perform their functions. These components can amplify current and can produce a power gain.

The following figure lists the different types of active components in a circuit -

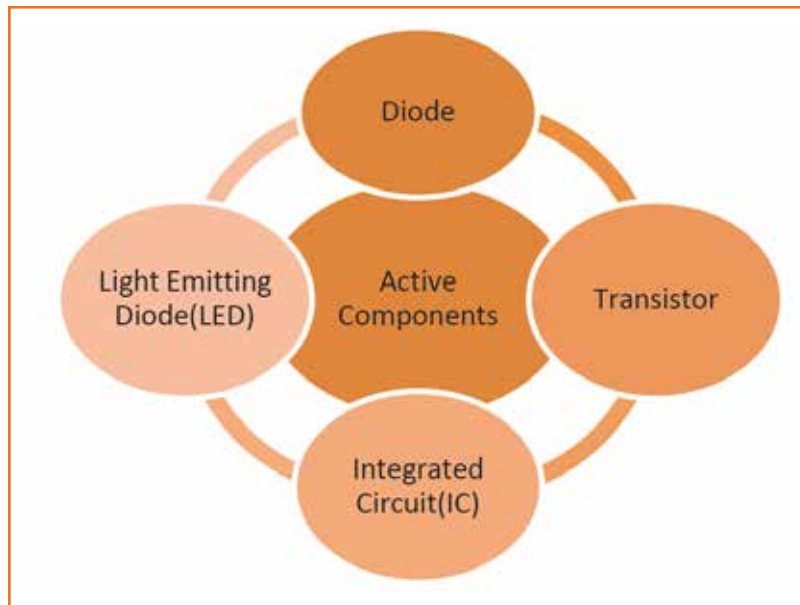


Fig 1.2.9 Active components

Passive Components

Passive components are those components which can perform their specific functions without any power source. These components are incapable of controlling current. The following figure lists the different types of passive components in a circuit -

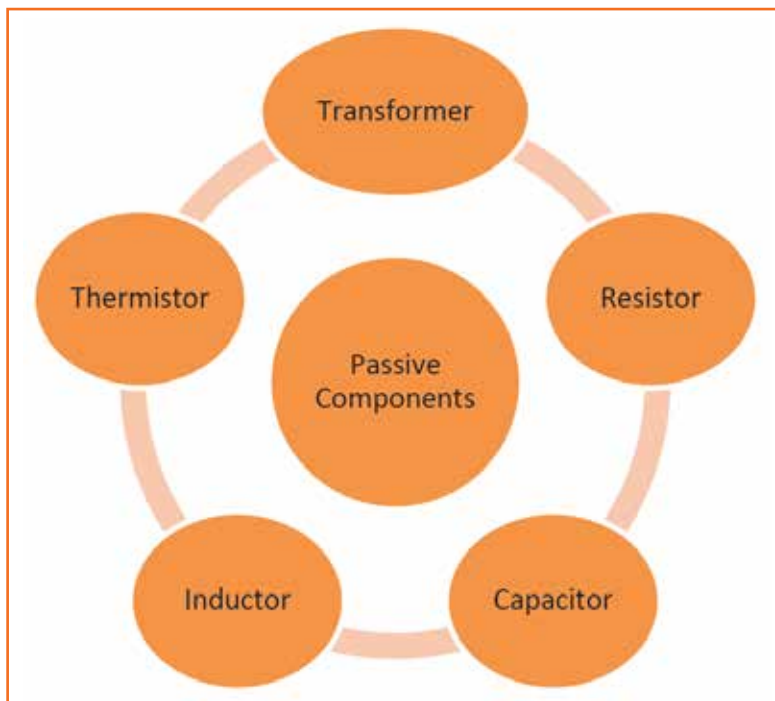


Fig 1.2.10 Passive components

Electromechanical Components

Electromechanical components convert electric energy into mechanical energy (mechanical movement) or vice versa for carrying out electric operations. The following figure lists various electromechanical components -

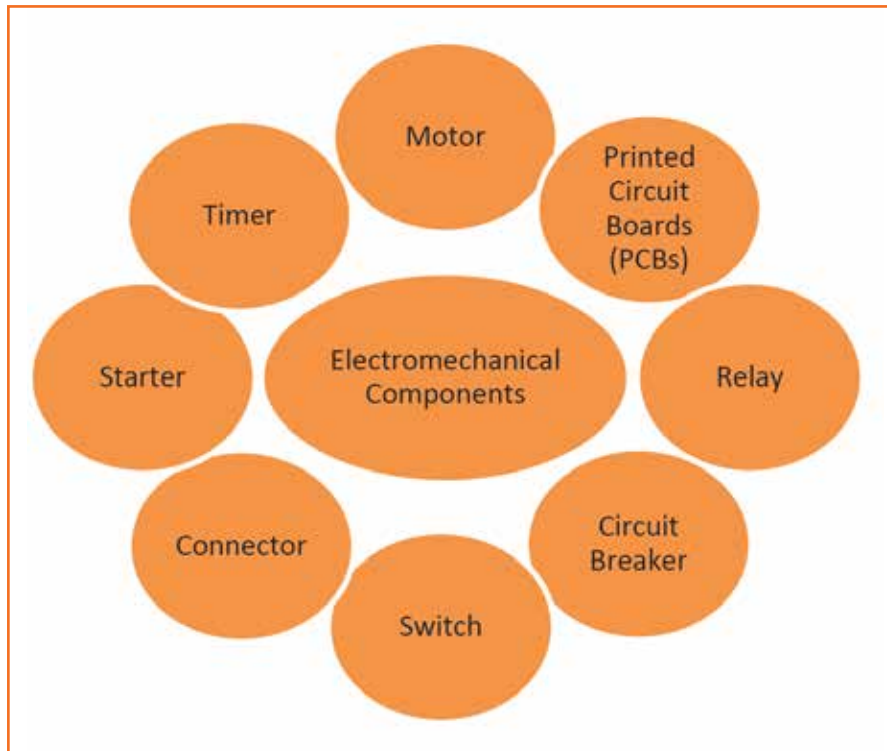


Fig 1.2.11 Electromechanical components

UNIT 1.3: Role of Multiskill Technician - Consumer Durables in Industry

Unit Objectives



At the end of this unit, participants will be able to:

1. Describe role of Multiskill Technician in industry

1.3.1 Role of Multiskill Technician in Industry

A multiskill technician is responsible for installation, diagnose, troubleshoot and repair all consumer durables like refrigerator, TV, washing machine, water purifier, microwave etc. and communicate the Service Manager/Lead Mechanic regarding repair priorities and status.

Responsibilities of a multiskill technician are:

- Prepare the work area for installation and servicing activities
- Carryout installation of consumer durables like refrigerator, AC, washing machine, microwave, dish washer, TV etc.
- Demonstrate use and function of appliance after installation work
- Identify faults in the defective appliance
- Replace or repair the faulty component of the appliance
- Perform servicing and maintenance activities of appliance as per the requirement
- Maintain documents and records related to work

Exercise

1. Name this equipment



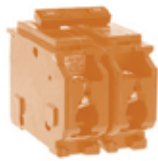
2. Electric tools should not be used in damp or wet locations.

(a) True

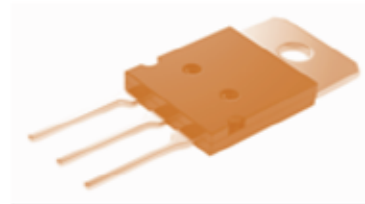
(b) False

3. Identify the different electronic components and write down their names in the boxes give below them:

1.



2.



3.



4.



5.



4. Perform categorisation of the following components as active or passive:

1. Resistor
2. Transistor
3. Capacitor
4. Diode
5. LED
6. Inductor
7. IC
8. Thermistor
9. Transformer

Notes



2. Install and Repair Refrigerator (DIOS)



Unit 2.1 – Basics of Refrigeration and Refrigerators

Unit 2.2 – Installation and Operation of Refrigerator (DIOS)

Unit 2.3 – Troubleshooting and Repairing of Refrigerator (DIOS)



Key Learning Outcomes



At the end of this module, participants will be able to:

1. Define refrigeration
2. Explain refrigeration cycle
3. List parts of a refrigerator
4. Describe different types of refrigerators
5. Demonstrate procedure of installing refrigerator (DIOS)
6. Demonstrate how to setup and use the features of refrigerator (DIOS)
7. Demonstrate procedure of troubleshooting and repairing of faults in refrigerator (DIOS)

UNIT 2.1: Basics of Refrigeration and Refrigerators

Unit Objectives

At the end of this unit, participants will be able to:

1. Define refrigeration
2. Explain refrigeration cycle
3. List parts of a refrigerator
4. Describe different types of refrigerators

2.1.1 Refrigeration

Refrigeration is the process of removing unwanted heat from an object or an area and transferring it to another object or area. This enables an item to be stored below room temperature by keeping it in a system that is designed to cool or freeze.



Fig 2.1.1 Refrigerator

A system/ machine that provides refrigeration under controlled conditions is called refrigerator. A refrigerator uses a chemical substance called refrigerant to transfer heat from one area to another.

Uses of Refrigeration

Refrigeration has had a huge impact on lifestyle, agriculture, manufacturing and processing industry. It has made it possible to preserve food for long periods of time, to store and distribute agriculture produce over long distances, to facilitate many chemical processes, to manufacture different medicines and to provide comfort air conditioning.



Fig 2.1.2 Uses of refrigeration

Apart from comfort, refrigeration has provided suitable conditions in the industries to carry out processes required in the manufacture of various products. Some applications of industrial air conditioning are in -

- IT industry
- Printing industry
- Textile industry
- Semi-conductor industry
- Mines and power plants

2.1.2 Refrigeration Cycle

The basic principle behind the refrigeration process is that when a liquid expands into gas, it extracts heat from its surrounding area. A refrigerant is a chemical liquid which evaporates at a very low temperature enabling it to extract heat at a faster rate. This refrigerant is propelled through a closed system to ensure that it is not dispersed in the surroundings and can be used again and again.

The following figure shows the refrigeration cycle:

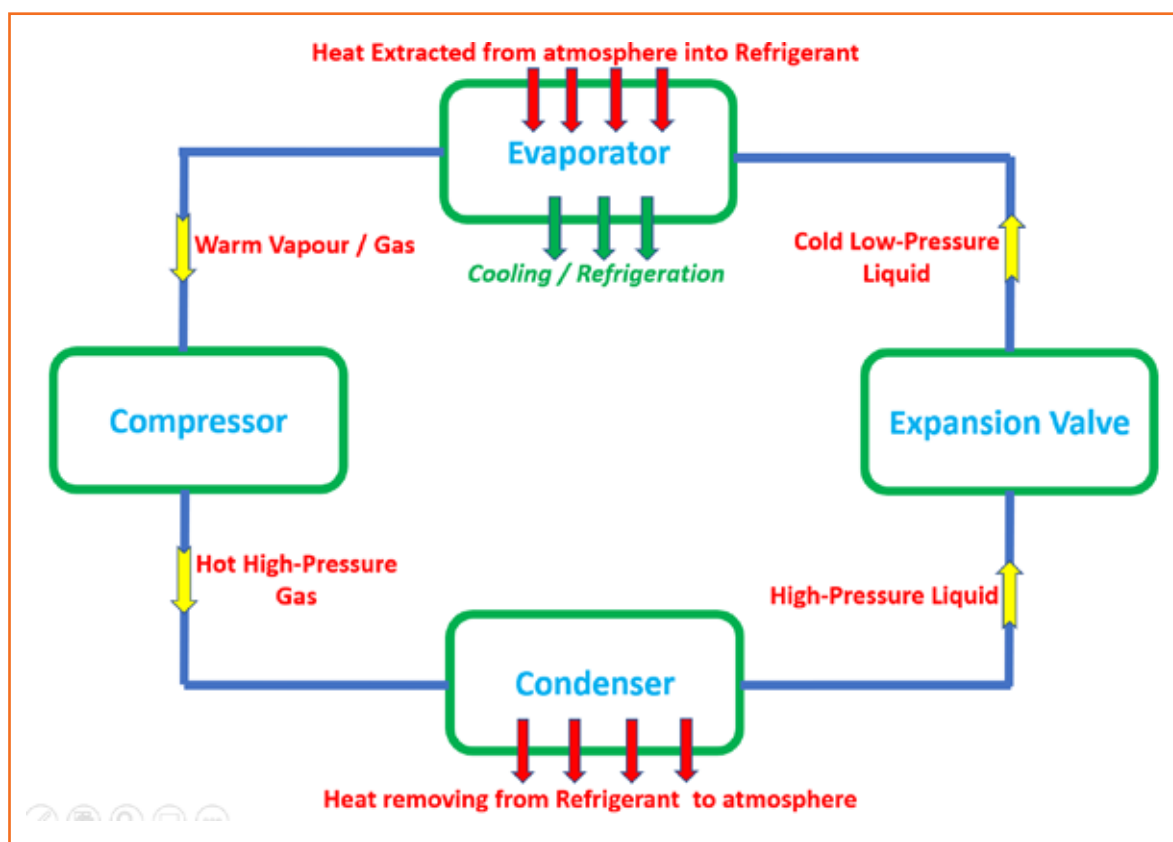


Fig 2.1.3 Refrigeration cycle

A refrigeration cycle consists of two sides or pressure areas, the evaporating or low pressure side and the condensing or high pressure side. A metering device such as an expansion valve or a capillary tube separates the two areas on one side. On the other side, a compressor is placed between the two areas. The metering device controls the flow of refrigerant and the compressor compresses the refrigerant into high pressure gas. The low-pressure refrigerant passes through the evaporator causing it to evaporate. This low-pressure vapour then enters the compressor where it is compressed into a high temperature, high pressure vapour. It then goes into the condenser where it gives up its heat to the cooler air passing through the condenser. The refrigerant condenses back into high pressure liquid which travels to the metering device. It is made to pass through a small opening resulting in a drop of temperature and pressure. This low-pressure refrigerant then enters the evaporator again, thereby completing the refrigeration cycle.

2.1.3 Components of a Refrigerator

A refrigerator consists of four main components as shown in the following figure -

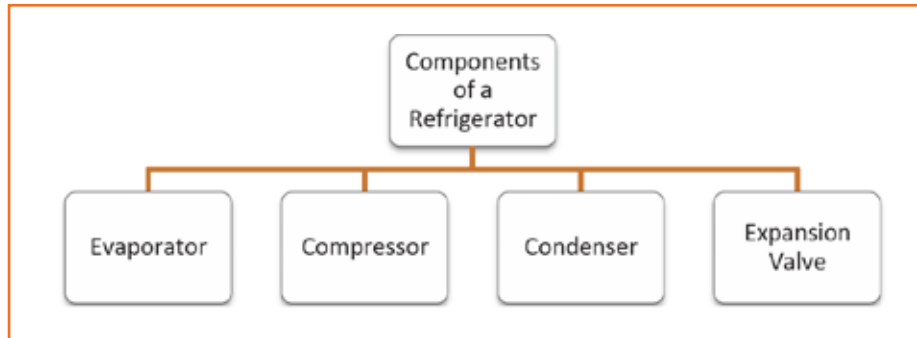


Fig 2.1.4 Components of a refrigerator

Evaporator

The evaporator turns the cold, low pressure refrigerant into vapour. It is in the freezer section of the refrigerator and has a fan blowing across coils of copper or aluminium tubing. The cooler refrigerant absorbs the warmer heat from the surroundings and its temperature rises. This cools down the surrounding and a warm, low pressure refrigerant is sucked into the compressor.



Fig 2.1.5 An evaporator

Compressor

The compressor is the most important part of the refrigeration system. It pulls in the low pressure refrigerant from the evaporator through a suction line and compresses it into a high pressure vapour.

The compressor is a mechanical device that consists of a power source, that is the motor and a compressing mechanism sealed inside a metal housing. There are five main types of compressors that are used in any refrigeration system. -



Fig 2.1.6 A compressor

Reciprocating compressor	A positive displacement compressor that delivers gas at high pressure by using pistons
Scroll compressor	A positive displacement rotary compressor with a fixed and rotating scroll. Gas is compressed by confining in between the two scrolls
Screw compressors	A positive displacement rotary compressor made up of two intermeshing screws/ rotors. Gas is compressed by confining in between the two rotors
Rotary compressors	A positive displacement compressor that uses a rotary impeller to drive the air through a curved chamber to compress it.
Centrifugal compressors	A compressor that uses centrifugal force generated by rotating impeller blades to compress gas

Fig 2.1.7 Types of compressors

Condenser

The condenser is a device that removes heat from the refrigerant and changes it to a liquid form. It consists of coils of aluminium exposed to the atmosphere and a fan that blows across the coils. It is located at the back of a refrigerator. When the hot, high pressure refrigerant flows through the copper tubes, fan cools the vapour refrigerant and changes it into liquid. This liquid refrigerant enters the expansion valve.



Fig 2.1.8 A condenser

Thermal Expansion Valve

The thermal expansion valve is a type of metering device. It consists of a spring-loaded valve connected to a diaphragm. A thin, capillary tube connects the valve with a thermal bulb. The expansion valve restricts the flow of the regular temperature; high pressure refrigerant. The refrigerant expands as it passes through leading to a drop in its temperature and pressure as it leaves the valve and enters the evaporator thereby completing the refrigeration cycle.

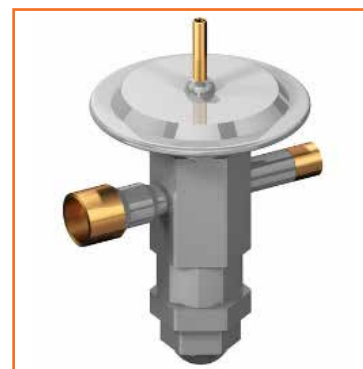


Fig 2.1.9 Thermal expansion valve

2.1.4 Types of Refrigerators

A refrigerator is one of the most essential appliances in the kitchen. There are many types of refrigerators that are available in the market today and it is very important to select the right type of refrigerator.

Refrigerators can be divided into two broad categories:

- Direct Cool
- Frost Free

The following figure shows the different types of refrigerators:

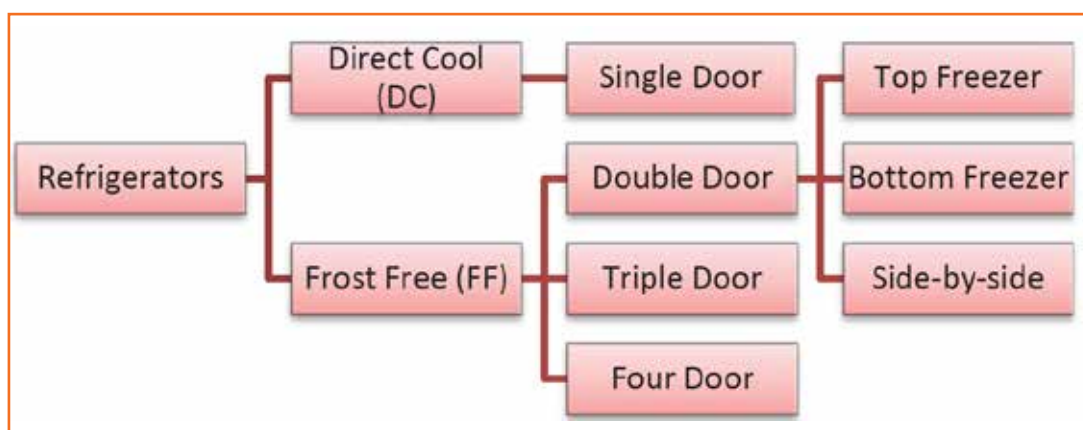


Fig 2.1.10 Types of refrigerators

Direct Cool (DC)

The Direct Cool refrigerator works on the principle of vapour condensation and natural convection. They are single door refrigerators which need to be defrosted manually or semiautomatically.

**Frost Free**

The Frost-Free refrigerators do not require manual defrosting. They contain a small element that melts the built-up ice without interfering in the cooling cycle of the refrigerator.

**Top Freezer**

The Top freezer has the freezer compartment on the top and the refrigerator at the bottom. It has a spacious design with wide shelves which allow easy access to items at the back. It is the most economical and energy efficient model.



Bottom Freezer

The bottom freezer has the refrigerator on the top and the freezer compartment at the bottom. It makes it easy to reach the food items in the refrigerator without needing to bend. The freezer section is either a door or a pull-out drawer. It is slightly expensive than the top freezer model.

**Side-by-Side**

The unit is divided vertically with the refrigerator and the freezer compartments parallel to each other. The doors of both compartments open from the middle. It provides easy access to both fresh and frozen foods. It is more expensive than the basic models.

**Triple Door / French Door**

The French door features side-by-side refrigerator compartments and a bottom freezer. It is one of the most expensive models and is available in many designs. They are wider than the double-door models.



Four Door

The four door model is a variant of the French door one where the freezer compartment is also split in two.



Direct Cool Vs Frost Free refrigerators

The following figure lists the various differences between Direct Cool and Frost-Free refrigerators -

Direct Cool	Frost Free
Single door model only	Multiple door models
Cooling achieved by natural convection	Cooling achieved by forced convection
Single thermostat controls cooling	Multiple thermostats control cooling
Non-uniform cooling	Uniform cooling
Slow cooling	Fast cooling
Manual defrost	Automatic defrost
Capacity upto 300 litres only	Capacity upto 800 litres

Fig 2.1.11 Direct cool Vs frost free refrigerators

2.1.5 Direct Cool (DC) Refrigerator

DC refrigerators are single door refrigerators having separate compartments within one unit. The top compartment is the freezer which stores frozen food. The middle compartment is the storage where food items are kept. The bottom compartment consists of vegetable drawers to store fresh vegetables and fruits.



Fig 2.1.12 Compartments in a DC refrigerator

All the compartments are maintained at different temperatures according to their function and the food they store. The following table shows the functions and temperatures of the different compartments in DC refrigerator -

Compartment	Food stored		Temperature
Freezer		Frozen meat, fish, ice cream	-16 ⁰ C to -18 ⁰ C
Chiller		Milk, butter, cheese	1 ⁰ C to 3 ⁰ C
Refrigerator		Cooked food, cut fruits	3 ⁰ C to 6 ⁰ C
Vegetable drawer		Fruits and vegetables	6 ⁰ C to 8 ⁰ C
Door shelf		Water bottles, juices, eggs	8 ⁰ C to 10 ⁰ C

Fig 2.1.13 Functions and temperatures of compartments in a DC refrigerator

Working of DC Refrigerator

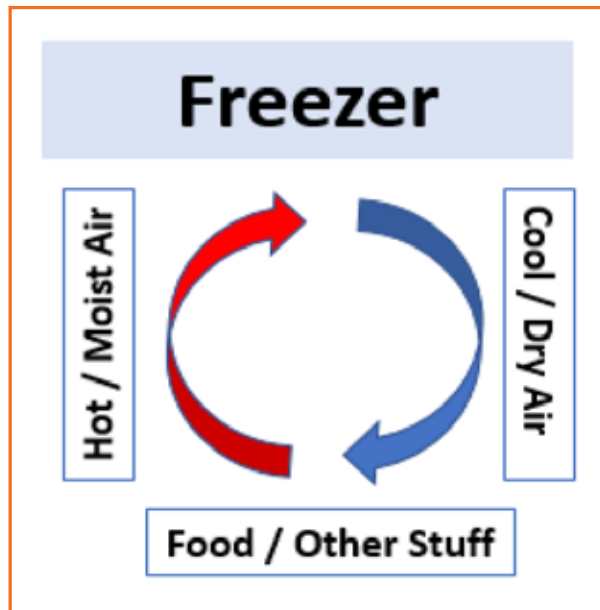


Fig 2.1.14 Working of a DC refrigerator

DC refrigerators are based on the principle of cooling through vapour condensation and natural convection. The air within the inner compartments of the DC refrigerator is hot and moist. This air rises up and comes in contact with the evaporator. The evaporator absorbs the heat and moisture from the hot air. As a result, the air in the freezer compartment becomes cold and dry. Being heavier, this cold air moves down and cools the remaining compartments. The cold air again pushes the hot air up. In this way, the cycle keeps on repeating till the set temperature is attained. The compressor then switches off. When the temperature rises again, the thermostat restarts.

Components of DC Refrigerator

Component	Description
Drier	Absorbs moisture content in the sealed system and prevents the moisture from entering the capillary.
Accumulator	- Located in the suction line between the evaporator and compressor - Stores excess liquid refrigerant or oil that has not evaporated - Designed to avoid damage to the compressor
Overload protector (OLP)	- Mounted in series with the common terminal of compressor - Designed to protect the compressor from overload
Thermostat	- Regulates the temperature inside the refrigerator - Controls the running and stopping time of the compressor

PTC Relay	Disconnects the power supply to the compressor when it reaches 80% of its speed
Door Switch	Controls the operation of cabinet bulb
Cabinet bulb	Glowes when the refrigerator door opens
Drain pipe	Connects the chill tray with the drain pan
Drain pan	Collects the drain water
Door gasket	- Located at the edges of the door - Prevents flow of air from inside the refrigerator to outside and vice versa

Defrosting DC Refrigerator

The evaporator absorbs the moisture from the air in the freezer compartment. When this moisture condenses, it results in the formation of frost on the evaporator. If the refrigerator door is opened frequently or if the humidity in air is more, it will lead to more frost. As ice is a bad conductor of heat, excess frost adversely impacts the heat transfer in the refrigerator.

Therefore, to ensure efficient cooling, a DC refrigerator needs to be defrosted regularly.



Fig 2.1.15 Frost formation in the freezer of DC refrigerator

Defrost Method

Press the defrost switch manually. The power supply to the compressor gets switched off automatically. The air inside the compartments starts to heat up making the frost on the evaporator melt. The defrosted water gets accumulated in a chill tray and is carried by a drain pipe to a drain pan. As soon as the temperature of evaporator reaches a pre-set value (zero-degree C), the thermostat restores the power to the compressor and the cooling cycle starts.

Before defrosting the refrigerator, remember to:

- Turn off the freezer
- Remove frozen items from the freezer

Wiring Diagram of DC Refrigerator

A wiring diagram represents the electrical circuit of an appliance. It depicts the power and signal connections between the devices and the components in an electrical circuit. This information is useful while installing or servicing a device.

The following figure shows the wiring diagram of a DC refrigerator with electronic controls (PCB):

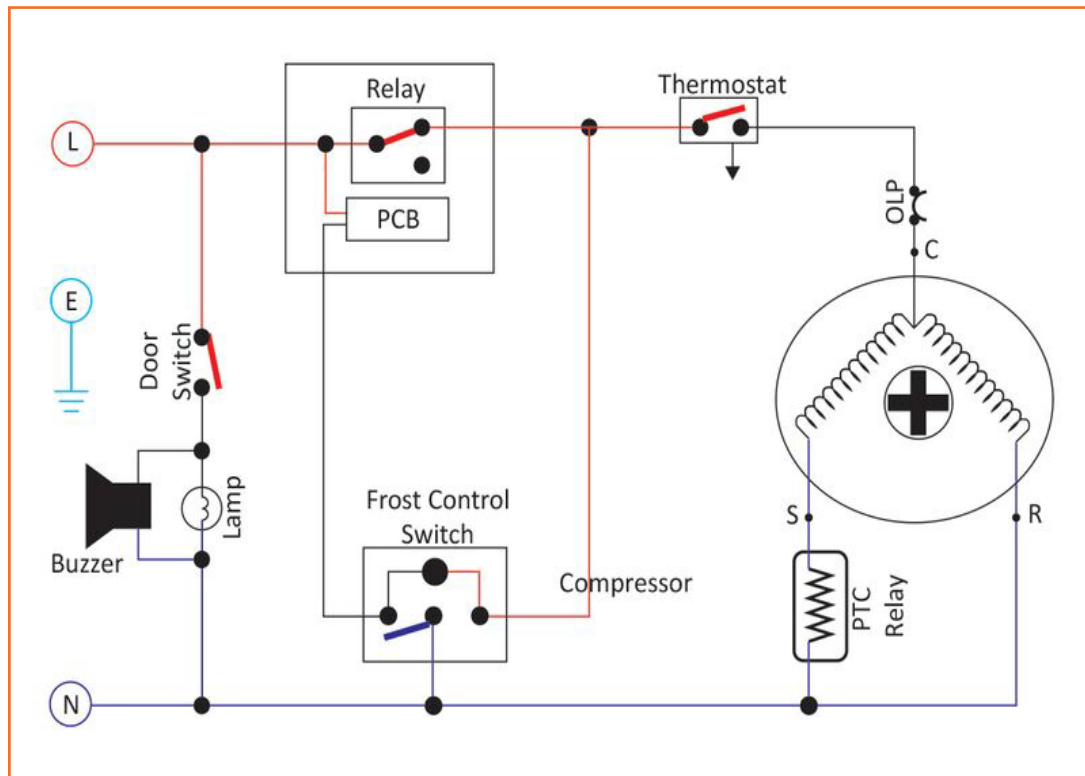


Fig 2.1.16 Wiring diagram of DC refrigerator with electronic controls

The following figure shows the wiring diagram of a DC refrigerator with timer for auto defrost:

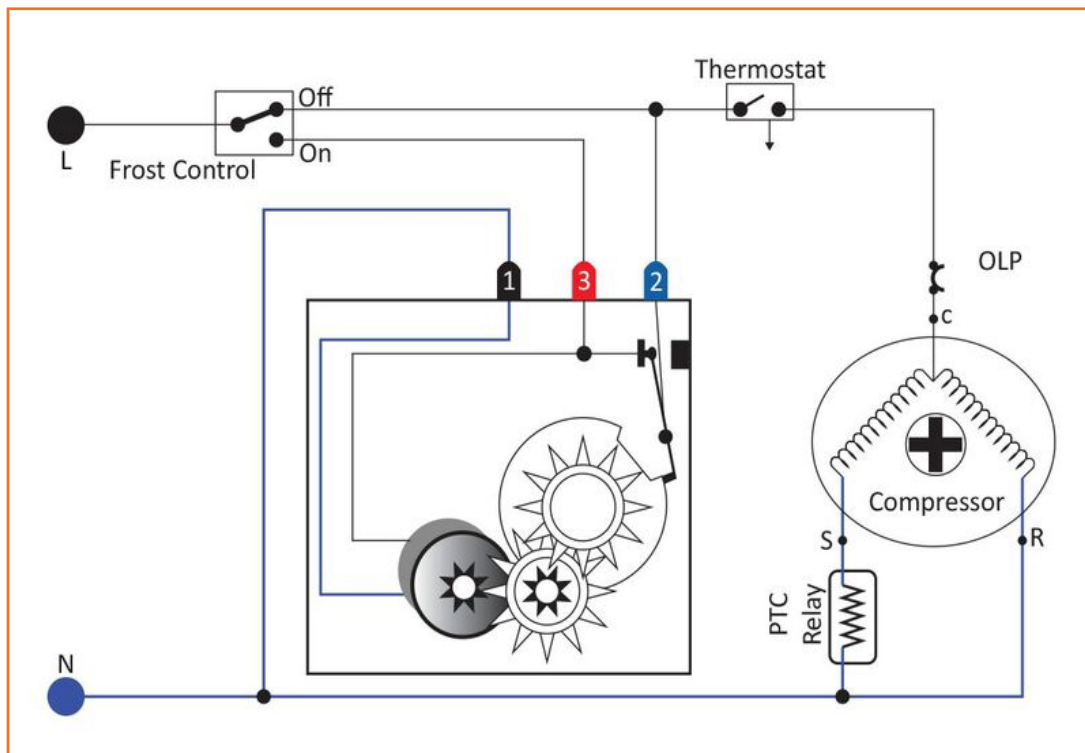


Fig 2.1.17 Wiring diagram of DC refrigerator with timer for auto defrost

2.1.6 Frost Free (FF) Refrigerator

FF refrigerators are multi-door units that are based on the principle of auto-defrost technique. In FF refrigerators, the freezer and the refrigerator compartments open separately. This ensures that when one compartment is opened, there is no cooling loss in another. They are spacious and wider than the DC refrigerators.



Fig 2.1.18 FF refrigerator

The following table shows the different compartments in FF refrigerator

Compartment	Food stored		Temperature
Freezer		Frozen meat, fish, ice cream	-16 ⁰ C to -18 ⁰ C
Chiller		Milk, butter, cheese	1 ⁰ C to 3 ⁰ C

Refrigerator top compartment		Dairy products, cooked meat/fish	2° C to 3° C
Refrigerator middle compartment		Cooked or raw vegetable or food	3° C to 6° C
Vegetable drawer		Fruits and vegetables	6° C to 8° C
Door shelf		Water bottles, juices, eggs	8° C to 10° C

Working of FF Refrigerator

FF refrigerators work on the principle of forced convection wherein a fan is used to force the heat transfer. The freezer and the refrigerator compartment are connected to each other to allow air to pass from the freezer to the refrigerator compartment. A damper regulates this flow of air. A blower fan generates forced air circulation to cool the compartments. The fan sucks in the hot air and pushes it through the evaporator fins. The evaporator fins are at subzero temperature and absorb heat and moisture from the hot air. The resulting cold, dry air is pushed to the freezer and the refrigerator compartments. This cycle continues till the preset temperature for both the compartments is achieved. An electrical thermostat regulates the temperature in the freezer/refrigerator compartments by switching the compressor on and off.

Components of FF Refrigerator

Some of the components of the FF refrigerator are similar to the DC refrigerator -

Component	Description
Evaporator fan motor	Drives the evaporator fan to facilitate the movement of air
Condenser fan	Sucks hot air from the condenser and throws it outside

Component	Description
Bi-metal thermostat	Contains a bi-metal coil that contracts when cold and expands when heated Fixed in the evaporator Cuts off the defrost heater after defrosting is over
Thermal fuse	Protects the freezer compartment from damage Fixed in the evaporator
Defrost timer	Automatically starts the defrost timer
Damper thermostat	Non-electrical device Regulates the temperature inside the refrigerator
Defrost heater	Melts the frost formed in the freezer
Door switch	Controls the operation of refrigerator lamp

Defrosting FF Refrigerator

The defrost system of FF refrigerator consists of the defrost timer, heater and thermostat. The defrost timer is the most important component of the defrost system. It is a motorized device with the defrost heater circuit on one end and the cooling system on the other. It opens and closes these contacts at pre-set intervals such that when one of the contacts is switched on, the other is switched off.

The following image shows a typical defrost cycle:

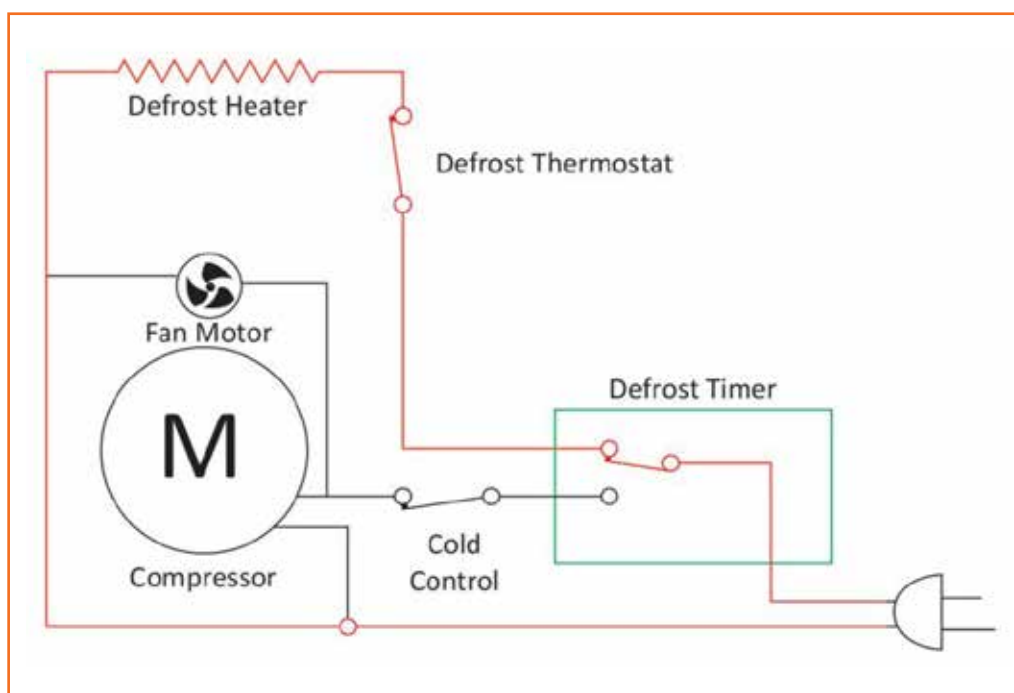


Fig 2.1.19 Defrost cycle of a FF refrigerator

The defrost timer automatically starts the defrost cycle after an interval of eight hours of compressor ON time. The defrost heater, located beneath the evaporator, starts melting the frost around the evaporator coils. The melted water flows out of a duct into a drain pan located on top of the compressor. The heat from the compressor evaporates the accumulated water. As soon as the frost is melted, the temperature of the evaporator coil increases due to the heat. The bi-metal sensor mounted on the evaporator coil senses the increase in temperature and turns off the heater.

Wiring Diagram of FF Refrigerator

A wiring diagram uses symbols to give information about the arrangement and the relative position of the components of an electrical circuit. It helps in understanding and troubleshooting problems by ensuring that all the components are present, and all the connections have been made.

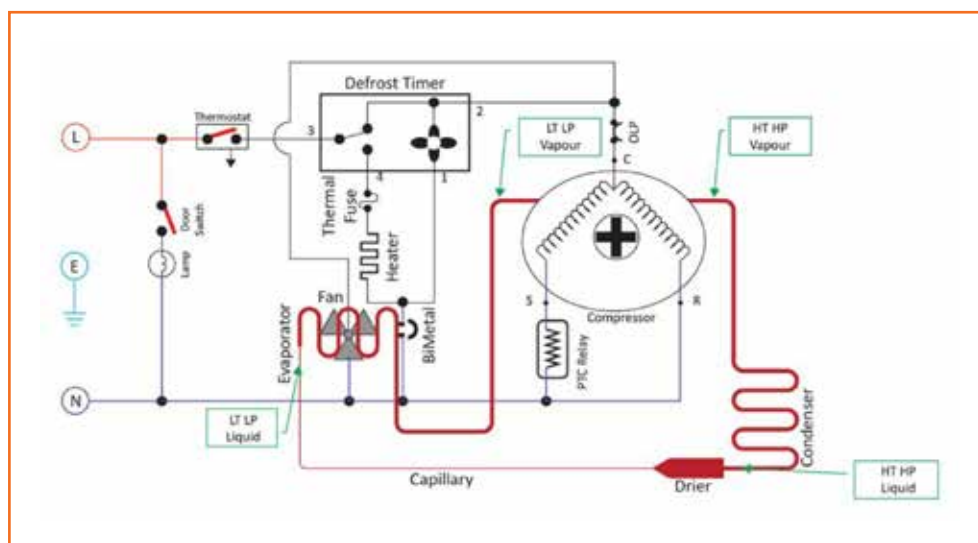


Fig 2.1.20 Wiring diagram of a FF refrigerator with manual controls

The following figure shows the wiring diagram of a FF refrigerator with electronic controls (PCB):

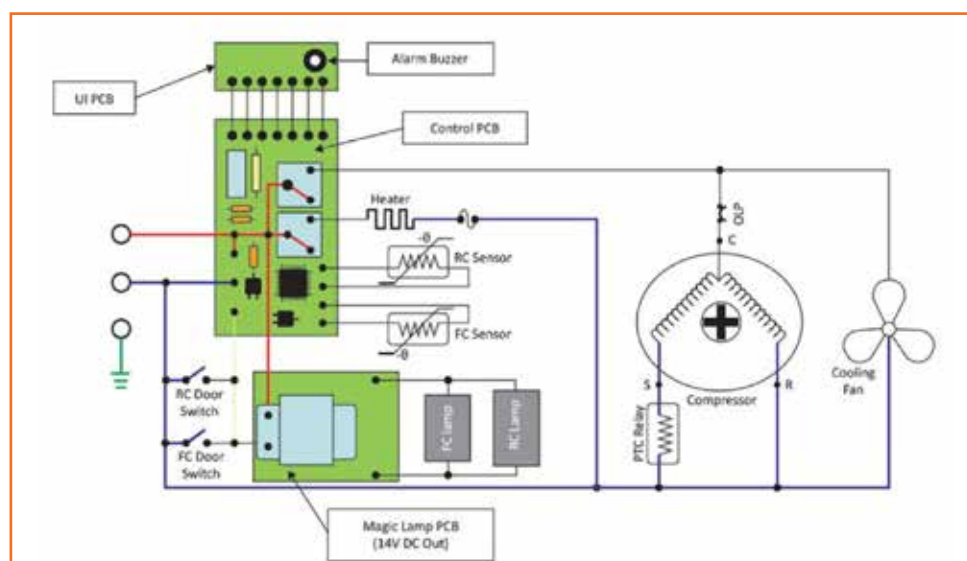


Fig 2.1.21 Wiring diagram of a FF Refrigerator with electronic controls

UNIT 2.2: Installation and Operation of Refrigerator (DIOS)

Unit Objectives

At the end of this unit, participants will be able to:

1. Demonstrate procedure of installing refrigerator (DIOS)
2. Demonstrate how to setup and use the features of refrigerator (DIOS)

2.2.1 Refrigerator (DIOS)

The kitchens of today are more connected than ever before with feature-rich, futuristic appliances that are both beautiful and functional. A DIOS refrigerator is a smart refrigerator or internet refrigerator which is a great addition to any kitchen with a number of benefits above and beyond cold storage. A smart refrigerator is able to communicate with the internet. This kind of refrigerator is often equipped to determine itself whenever a food item needs to be replenished.



Fig 2.2.1 Smart refrigerator

In step with the move toward tighter integration of white and information consumer electronics products to create a Home Network, the “Internet Digital DIOS Refrigerator” was developed as a digital white appliance product where moving image communication technology, which up to now was available with multimedia products, has been used for the first time to home appliance product.

DIOS Refrigerator has a high quality 15.1 TFT-LCD and its own LAN port to allow not only Internet shopping,

but also two-way video communication for a videophone call with your family or friends.

Depending on the refrigerator that you choose and the brand, a smart fridge can offer several different convenient features. Most smart fridge brands offer an app that can be installed on a mobile phone or other devices to allow the owner to see updates on their fridge remotely.

Through a link with an Internet company, the refrigerator also offers real-time price information on grocery products and stocks available on the Internet. In particular, for beginning Internet users, it has a separate GUI (Graphic User Interface) that is more user-friendly than web browsers to make surfing on the Internet easier.

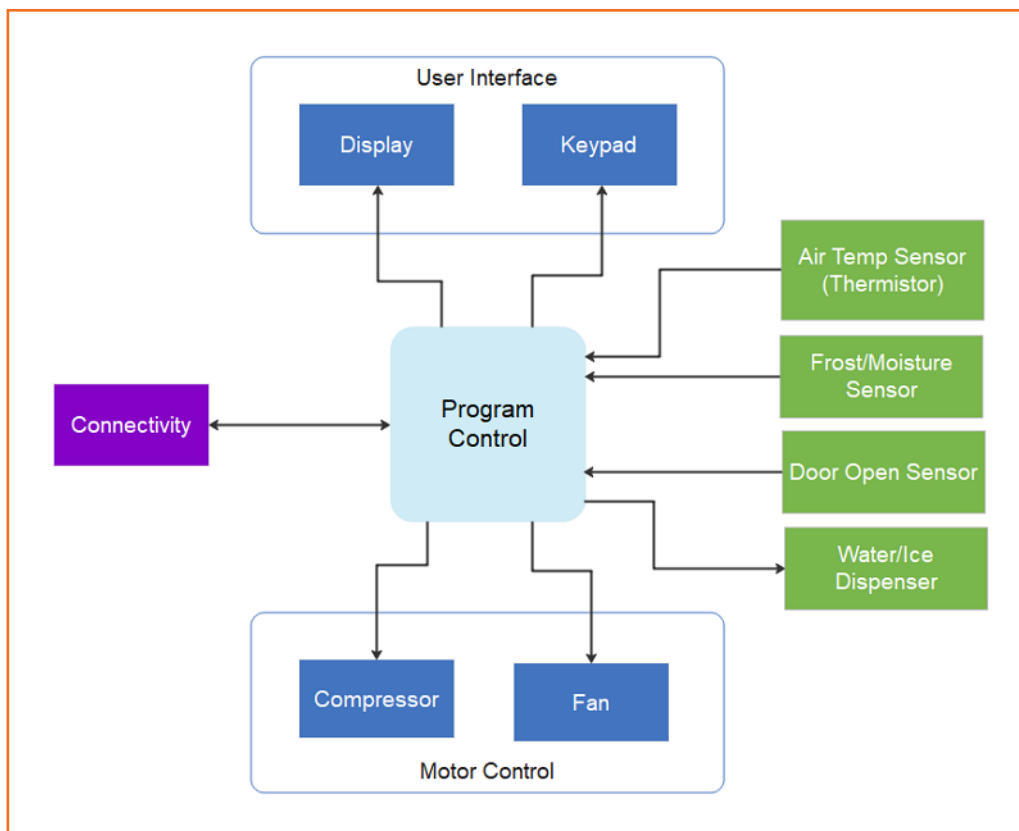


Fig 2.2.1 Architecture of smart refrigerator

Internet refrigerator also offers a wide range of information through its LCD information window - everything from the refrigerator's temperature to tips on food, nutrition and recipes including expiration dates, nutrition information and cooking methods of the products stored inside.

Filter status is also monitored to automatically inform the timing for filter change so that the inside of the refrigerator can be always kept fresh and clean. The location of the filter is also moved to the inside the refrigerator so that changing the filter no longer entails the inconvenience of having to move the whole refrigerator.

Most smart fridges allow you to see what is in your refrigerator in real-time from anywhere. Some also provide the feature to see expiration dates on all of your groceries so you can remember to eat them before they go bad, saving you the added cost of buying it again.

Smart Refrigerator Features

The features on a smart refrigerator can vary depending on the make and model, but here is a list of some common features and their benefits.

- **Touchscreen Interface:** The touchscreen on your smart refrigerator may be used to access a multitude of features with the touch of a button. Newer models may have a large screen with computing power similar to that of your laptop. Built-in speakers can enhance the experience but don't expect theater-quality sound just yet.
- **Wi-Fi Connectivity:** Connect your smart refrigerator to your existing network for seamless integration with your voice-controlled smart devices and wireless access from your smartphone or tablet.
- **Interior Camera:** Look inside your refrigerator from across the room or across town to take the guesswork out of meal preparation and shopping.
- **Shopping List:** Use the touchscreen or voice commands to add items to your weekly list and sync them to your smartphone in real-time.
- **Built-In Browser:** Surf the internet from the door of your refrigerator, eliminating the need to expose your phone or tablet to sticky fingers and spills while in the kitchen.
- **Recipe Database:** Look up your favourite recipes, have the refrigerator read you the steps as you go, or watch a video on how to make the dish you want.
- **Entertainment:** Stream your favourite shows, upload photos, or listen to music while you cook, eat, or clean up after your meal.
- **Whiteboard:** Leave messages for family members, create lists, or keep track of your family's schedule with an interactive whiteboard that can be edited as needed.
- **Connect to Other Smart Home Devices:** You can easily connect a smart refrigerator to your network of other smart home devices.

2.2.2 Site Requirements for Installation

The first step of an installation process is to conduct a site survey and ensure that it meets all the requirements. The successful operation of a refrigerator is dependent on proper installation. The selected site should comply with all the safety codes and should not interfere with normal movement of people.

Site requirements for installing a refrigerator (DIOS):

- Select a well-ventilated place
- Choose a location without direct exposure to sunlight. A refrigerator functions efficiently at the room temperature.
- Ensure path of delivery has enough clearance
- Avoid extreme heat and cold

- Avoid installing near any heating appliance
- Place the refrigerator near a location with level flooring. The location should be with enough space for the refrigerator doors to open easily.
- Measure the dimensions of refrigerator and ensure that it will fit properly into the desired space.

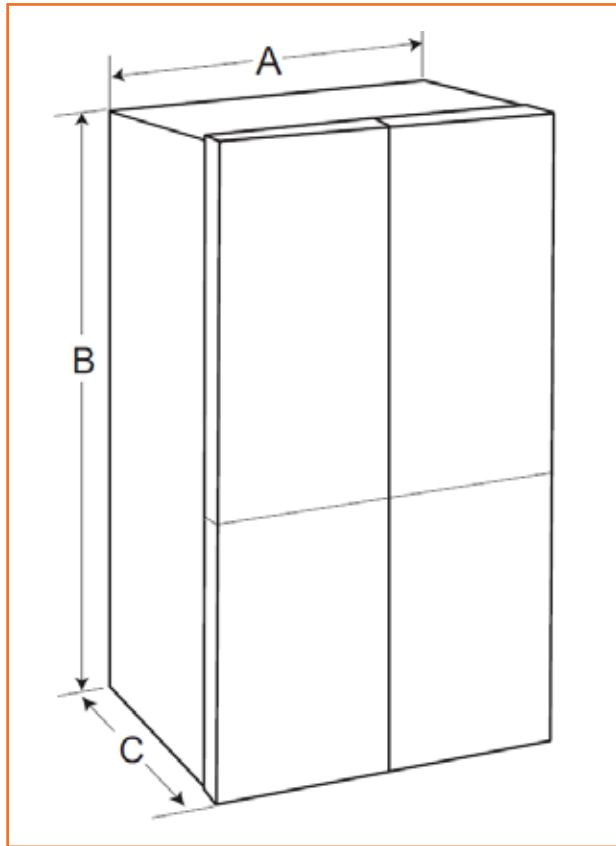


Fig 2.2.3 Refrigerator dimensions

- ☐ Allow for a ½ inch of space around each side of the refrigerator and one inch between the back of the refrigerator and the wall to help ensure there is proper ventilation.
- ☐ The refrigerator should be able to rest flat and centered on the floor with the doors able to be opened freely.

After checking the site requirements, the next step is to check the power supply at the location site. Power requirements for installation are -

- Ensure that voltage and electrical wiring is appropriate
- Use a separate socket for refrigerator
- Ensure wall socket is properly earthed
- Place the refrigerator close to the electrical outlet
- Do not use an extension cord

2.2.3 Installation Process

The installation process consists of transporting the unit from the delivery truck to the location, unpacking the unit, disposing the packing material and installing the refrigerator at the designated place.

Transporting Refrigerator

Remove all shelves and drawers of the new appliance and tape the doors securely shut or remove them if applicable. With the help of another person, use caution when transporting freestanding fridges and other heavy appliances.

- Using two people, carefully load the refrigerator upright onto the hand cart or dolly and fasten it securely into place. Do not lay the refrigerator on its side.
- Ensure there is a clear path into the kitchen and guide the refrigerator to its desired space.



Fig 2.2.4 Handling refrigerator

Unpacking Refrigerator

- Cut the binding strip of carton
- Remove the adhesive tapes and open the top flaps
- Remove the top buffers
- Remove the carton
- Remove the base plate assembly
- Remove and unpack the accessories
- Remove any tape or glue residue with mild soap solution
- Avoid using sharp instruments or abrasive cleaners

Installing the Refrigerator

If entrance door is too narrow for the appliance to pass through, remove the appliance doors and pass the appliance laterally.

Removing the Fridge and Freezer Door

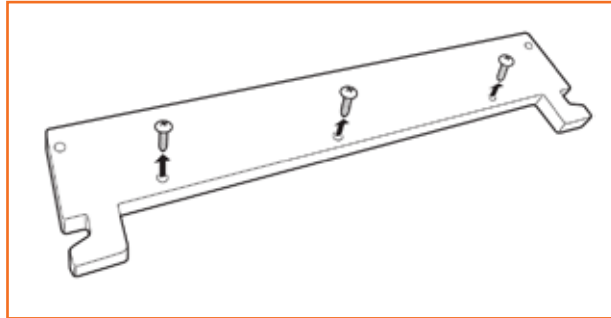


Fig 2.2.5 Removing fridge doors

1. Remove the screws from the hinge cover at the top of the appliance. Lift the hook (not visible), located at the bottom of the front side of the cover with a flat-head screwdriver.
2. **Removing the fridge doors:**
 - ☐ Disconnect all wire harnesses. Unscrew the ground wire.
 - ☐ Remove the hinges
 - ☐ Lift the doors from the middle hinge pin and remove the doors.

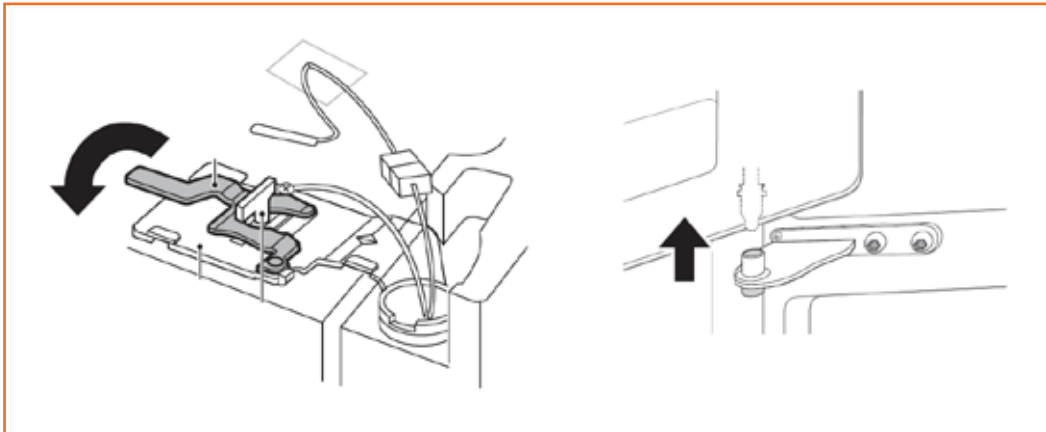


Fig 2.2.6 Removing fridge doors

3. Removing the freezer door
 - ☐ Remove the two hinge bolts.
 - ☐ Lift the door off the lower hinge pin and remove it.
 - ☐ Remove the door by lifting it off the lower hinge pin.

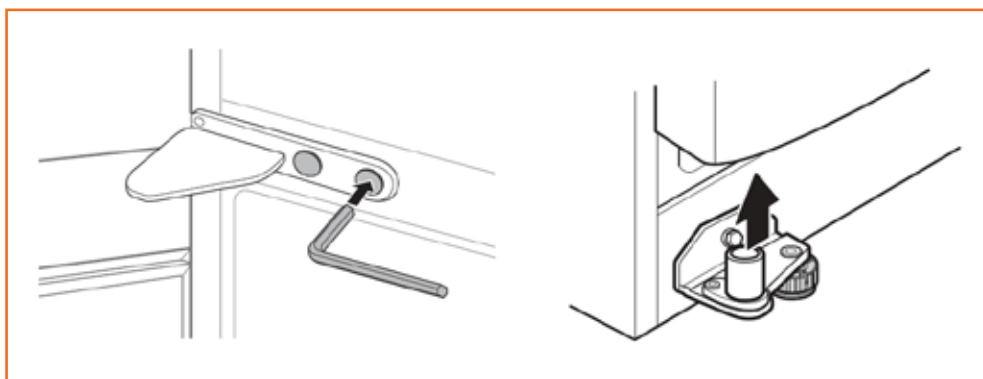


Fig 2.2.7 Removing fridge doors

4. Refit the doors in the reverse sequence of their removal once the appliance has been passed through all access doors.
5. Once reach the desired space, position the refrigerator into the cut-out, leaving enough space behind the appliance to manoeuvre around it freely. Once it is in place, check the air gap on each side to make sure it is as wide as the manufacturers recommend. If not, pull it out, move it in the required direction and slide it in again.
6. If at any point the refrigerator was tipped on its side, allow it to sit upright for a few hours to allow it to settle before connecting its power supply.
7. **Level the refrigerator**

Ensuring refrigerator level is imperative for proper function and aesthetics. Using a level, determine whether or not the unit is stable and adjust the legs as needed.

- ☐ Place a level on top of the refrigerator and measure all sides accordingly.
- ☐ Remove the base grille, if applicable.
- ☐ Locate the leveling legs at the bottom of the unit.
- ☐ Adjust the height of the legs by using a wrench. Turn clockwise to shorten the legs and lower your refrigerator. Turn counter-clockwise to lengthen the legs and raise your fridge.

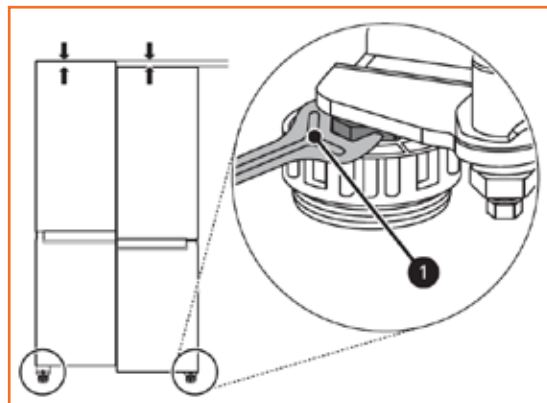


Fig 2.2.8 Level the refrigerator

8. Level the refrigerator doors

An aligned refrigerator door or doors allow for a proper seal. This is especially important for French door or side-by-side models. Adjusting refrigerator's door hinges will ensure they are aligned correctly.

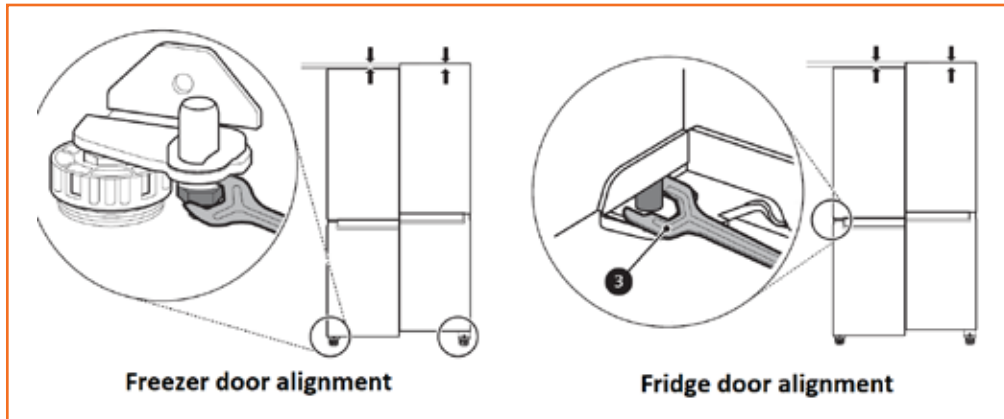


Fig 2.2.9 Level the refrigerator doors

- ☐ Loosen the hinges on the misaligned door using a socket wrench.
- ☐ Align the door into place and tighten the hinges accordingly.

9. Now install the shelves and trays, close the doors and let the refrigerator start working.

Connecting Electric Supply

Before plugging-in the refrigerator, check the power supply with the help of a voltmeter. If the voltage is below 170V or above 250V, advise the customer to install voltage stabilizer. This will safeguard the sealed system from any possible damage due to voltage fluctuation.

The following figure shows the steps to connect the electric supply:

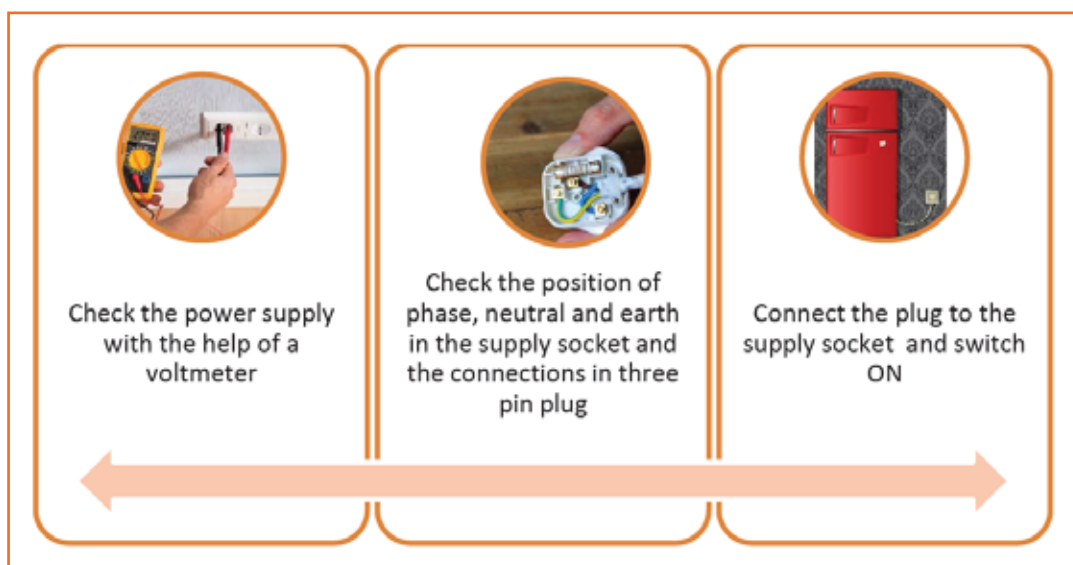


Fig 2.2.10 Connecting with power supply

The thermostat should be switched on to normal position as shown in the following image:



Fig 2.2.11 Setting temperature

Adjust the refrigerator and freezer temperature settings and allow the temperature a few hours to cool down. It takes two to three hours for the temperature in the refrigerator to stabilize. Observe the compressor and fan for some time.

Complete the Documentation

After completing the installation at the site, the technician should complete the documentation to record the details related to installation. Along with completing the documentation, the field technician should tell the customer about some do's and don'ts for using the refrigerator such as, keep the area near the product clean and dry. The field technician should also tell the customer about important pages to be referred to from the owner's manual.

2.2.4 Operation of Refrigerator (DIOS)

Suggestion for Energy Saving

- For the most efficient use of energy, make sure that door bins, drawers and shelves are assembled properly.
- Ensure there is sufficient space between stored foods. This allows cold air to be circulated evenly and lowers electricity bills.
- Store hot food only after it has cooled in order to prevent dew or frost.
- When storing food in the freezer compartment, set the freezer temperature lower than the temperature indicated on the food.
- Do not set the temperature of the appliance lower than needed.
- Do not put food near the temperature sensor of the fridge compartment. Keep a distance of at least 3 cm from the sensor.
- Note that a temperature rise after defrosting has a permissible range in the appliance specifications.

If you wish to minimise the impact on the food storage due to a temperature rise, seal or wrap the stored food in several layers.

- The automatic defrosting system in the appliance ensures that the compartment remains free of ice buildup under normal operating conditions.

Storing Foods Effectively

- Food may freeze or spoil if stored at the wrong temperature. Set the refrigerator to the correct temperature for the food being stored.
- Store frozen food or refrigerated food inside sealed containers.
- Check the expiration date and label (storage instructions) before storing food in the appliance.
- Do not store food for a long period of time if it spoils easily at a low temperature.
- Do not place unfrozen food in direct contact with food that is already frozen. It could be necessary to reduce the quantity to be frozen if freezing every day is anticipated.
- Place the refrigerated food or frozen food in each fridge or freezer compartment immediately after purchasing.
- Store raw meat and fish in suitable containers in the refrigerator, so that it is not in contact with or drip onto other food.
- Refrigerated foods and other food items can be stored on top of the vegetable drawer.
- Avoid refreezing any food which has been completely thawed. Freezing any food which has been completely thawed again will lower its taste and nutrition.
- Do not overfill the appliance. Cold air cannot circulate properly if the appliance is overfilled.
- Cool hot food before storing. If too much hot food is placed inside, the internal temperature of the appliance can increase and negatively affect other foods stored in the appliance.

Control Panel and Functions

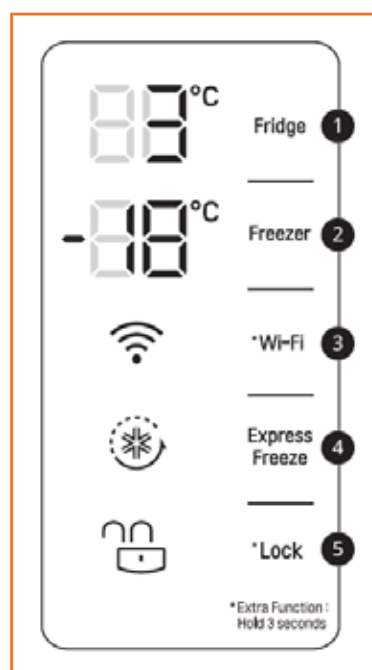


Fig 2.2.12 Control panel

1. Fridge

- ☐ Press this button repeatedly to select a desired temperature between 0 °C and 6 °C.
- ☐ The initial fridge temperature is 3 °C.

2. Freezer

- ☐ Press this button repeatedly to select a desired temperature between -24 °C and -16 °C.
- ☐ The initial freezer temperature is -18 °C.

3. Wi-Fi: This button allows the appliance to connect to a home Wi-Fi network. Refer to Smart Functions for information on the initial setup of the smart application.

4. Express Freeze: This function can quickly freeze a large amount of ice or frozen foods.

- ☐ This function is enabled and disabled in turn each time you press the button.
- ☐ This function automatically terminates after a specific period has passed.

5. Lock: This locks the buttons on the control panel.

- ☐ To lock the control panel buttons, press and hold the Lock button for 3 seconds until the lock icon appears and the function is activated.
- ☐ To disable the function, press and hold the Lock button for 3 seconds until the unlock icon appears and the function is deactivated.

Smart functions

The smart application allows to communicate with the appliance using a smartphone.

Smart Application Features

Communicate with the appliance from a smartphone using the convenient smart features.

- **Smart Diagnosis:** If there is a problem while using the appliance, this smart diagnosis feature will help to diagnose the problem.
- **Settings:** Allows to set various options on the appliance and in the application.

Installing the Smart Application

1. Connect customer smartphone to the wireless router.
2. Search for smart application from the Google Play Store or Apple App Store on a smartphone. Follow instructions to download and install the application.
3. Allow the appliance to connect to a home Wi-Fi network. The Wi-Fi icon shows the status of the appliance's network connection. The icon illuminates when the appliance is connected to the Wi-Fi network.
4. Run the application and follow the instructions in the application to register the appliance.



Fig 2.2.13 Connecting with wifi

5. Press and hold the Wi-Fi button for 3 seconds to temporarily turn it off. Run the application and follow the instructions in the application to register the appliance.

Scan the QR code or click on the link to watch related videos



<https://www.youtube.com/watch?v=R4ILGFFT60k>
Installation and operation of automatic refrigerator (DIOS)

UNIT 2.3: Troubleshooting and Repairing of Refrigerator (DIOS)

Unit Objectives



At the end of this unit, participants will be able to:

1. Demonstrate procedure of troubleshooting and repairing of faults in refrigerator (DIOS).

2.3.1 Troubleshooting and Repairing of Problems in Refrigerator (DIOS)

A Multiskill Technician should have the knowledge and skill to repair all kinds of refrigerators. He should be able to diagnose and troubleshoot the problem. He should carry out repairs according to the requirements of that particular model.

It is very important for a technician to correctly identify the fault in the refrigerator. Wrong identification of fault will lead to waste of time and money and it can also cause damage to the equipment.

The following figure shows the steps for identifying the fault:

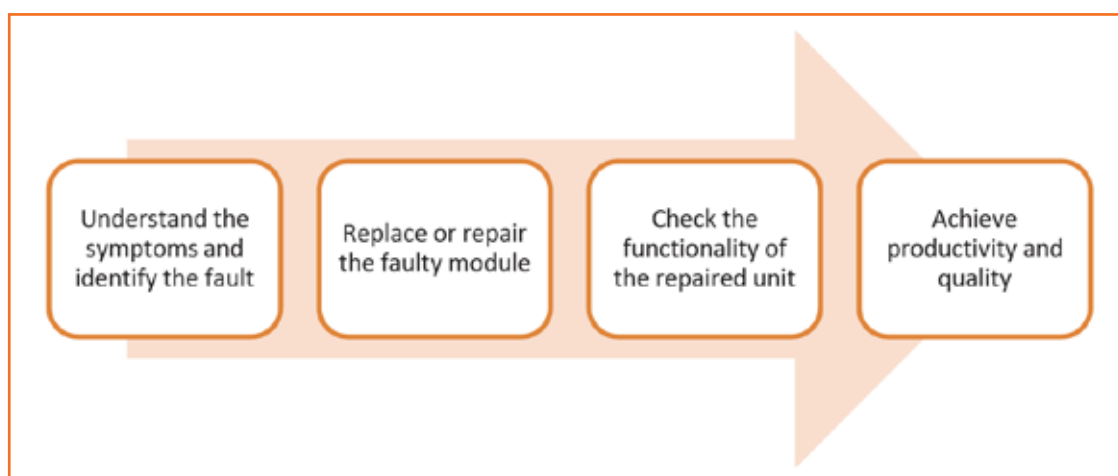


Fig 2.3.1 Identifying fault in equipment

The following table represents the common problems in the working of a refrigerator (DIOS) along with their solutions:

Cooling

Symptoms	Possible Cause & Solution
There is no refrigeration or freezing.	Is there a power interruption? Check the power of other appliances.
	Check the power of other appliances. Plug the power plug in the outlet properly.
	A fuse in your home may be blown or the circuit breaker tripped. Or the appliance is connected to a GFCI (Ground Fault Circuit Interrupter) outlet, and the outlet's circuit breaker has tripped. - Check the main electrical box and replace the fuse or reset the circuit breaker. Do not increase fuse capacity. If the problem is a circuit overload, have it corrected by a qualified electrician. - Reset the circuit breaker on the GFCI. If the problem persists, contact an electrician.
There is poor refrigeration or freezing.	Is the fridge or freezer temperature set to its warmest setting? Set the fridge or freezer temperature to a colder setting.
	Is the appliance in direct sunlight, or is it near a heat generating object such as cooking oven or heater? Check the installation area and reinstall it away from heat generating objects.
	Did you store hot food without cooling it first? Cool the hot food first before putting it in the fridge or freezer compartment.
	Did you put in too much food? Maintain an appropriate space between food.
	Are the appliance doors completely closed? Completely close the door and make sure that stored food is not obstructing in the door.
	Is there enough space around the appliance? Adjust the installation position to make enough space around the appliance.

Symptoms	Possible Cause & Solution
The appliance contains a bad smell.	Is the fridge or freezer temperature set to 'Warm'?
	Set the fridge or freezer temperature to a colder setting.
	Did you put in food with a strong smell?
	Store foods with strong smells in sealed containers.
	Vegetables or fruit may have spoiled in the drawer.
	Throw away rotten vegetables and clean the vegetable drawer. Do not store vegetables too long in the vegetable drawer.

Condensation & Frost

Symptoms	Possible Cause & Solution
There is condensation inside the appliance or on the bottom of the vegetable drawer cover.	Did you store hot food without cooling it first?
	Cool the hot food first before putting it inside the fridge or freezer.
	Did you leave the appliance door open?
	Although the condensation will disappear soon after you close the appliance door, you can wipe it with a dry cloth.
	Do you open and close the appliance door too frequently?
	Condensation can form due to the temperature difference from the outside. Wipe out the dampness with a dry cloth.
	Did you put warm or moist food inside without sealing it in a container?
	Store food in a covered or sealed container.
Frost has formed in the freezer compartment.	Doors may not be closed properly.
	Check if the food item inside the appliance is blocking the door and make sure that the door is tightly closed.
	Did you store hot food without cooling it first?
	Cool the hot food first before putting it in the fridge or freezer compartment.

Symptoms	Possible Cause & Solution
	Is the air entry or exit of the freezer compartment blocked? Make sure that air entry or exit is not blocked so that the air can circulate inside.
	Is the freezer compartment overfilled? Maintain an appropriate space between items.
Frost or condensation has formed inside or outside the appliance.	Did you open and close the appliance door frequently or is the appliance door improperly closed? Frosts or condensation can form if the outside air penetrates inside the appliance.
	Is the installation environment humid? Condensation can appear on the exterior of the appliance if the installation area is too humid or on a humid day such as a rainy day. Wipe off any moisture with a dry cloth.
The side or front of the appliance is warm.	There are anti condensation pipes fitted to these areas of the appliance to reduce condensation forming from around the door area. The heat releasing pipe to prevent condensation is installed on the front and side of the appliance. You may feel it particularly hot right after the appliance is installed or during the summer. You can be assured that this is not a problem and is quite normal.
There is water inside or outside of the appliance.	Is there water leakage around the appliance? Check if the water has leaked from a sink or another place.
	Is there water on the bottom of the appliance? Check if the water is from the thawed frozen food or a broken or dropped container.

Parts & Features

Symptoms	Possible Cause & Solution
The appliance door is not closed tightly.	Is the appliance leaning forward? Adjust the front feet to raise the front side slightly.
	Were the shelves properly assembled? Refit the shelves if needed.
	Did you close the door with excessive force? If you apply too much force or speed when closing the door, it may remain briefly open before closing. Make sure that you do not slam the door closed. Close the door gently.
It is difficult to open the appliance door.	Did you open the door right after you closed it? If you try to open the appliance door within one minute after you closed it, you may have difficulties because of the pressure inside the appliance. Try to open the appliance door again in a few minutes so that the internal pressure stabilizes.
Door mullion does not fold in and out properly.	Are front levelling legs extended, the appliance level, and doors aligned? Once the door baskets are filled, the doors may become misaligned, preventing the door mullion or the Auto Open Door function from working properly. Extend both front levelling legs fully so they are in firm contact with the floor. Follow the instruction in the Door Alignment section to raise the left fridge door until the door mullion is once again working properly. Adjust the right fridge door so it aligns with the left fridge door.
The inside lamp in the appliance does not turn on.	Lamp failure Close the door and re-open. If the lamp does not turn on, please contact the LG Electronics customer information centre. Do not attempt removal of the lamp.

Noises

Symptoms	Possible Cause & Solution
The appliance is noisy and generates abnormal sounds.	Is the appliance installed on a weak floor or improperly levelled? • Install the appliance on a solid and flat area.
	Does the rear of the appliance touch the wall? • Adjust the installation position to allow enough clearance around the appliance.
	Are objects scattered behind the appliance? • Remove the scattered objects from behind the appliance.
	Is there an object on top of the appliance? • Remove the object on top of the appliance.
Clicking noises	The defrost control will click when the automatic defrost cycle begins and ends. The thermostat control (or appliance control on some models) will also click when cycling on and off. • Normal Operation
Rattling noises	Rattling noises may come from the flow of appliance, the water line on the back of the unit (for plumbed models only), or items stored on top of or around the appliance. • Normal Operation
	Appliance is not resting evenly on the floor. • Floor is weak or uneven or levelling legs need to be adjusted. See the Door Alignment section.
	Appliance with linear compressor was moved while operating. • Normal operation. If the compressor does not stop rattling after three minutes, turn the power to the appliance off and then on again.
Whooshing noises	Evaporator fan motor is circulating air through the fridge and freezer compartments. • Normal Operation
	Air is being forced over the condenser by the condenser fan. • Normal Operation

Symptoms	Possible Cause & Solution
Gurgling noises	Appliance flowing through the cooling system. Normal Operation
Popping noises	Contraction and expansion of the inside walls due to changes in temperature. Normal Operation
Vibrating	If the side or back of the appliance is touching a cabinet or wall, some of the normal vibrations may make an audible sound. To eliminate the noise, make sure that the sides and back do not make any contact with any wall or cabinet.

Wi-Fi

Symptoms	Possible Cause & Solution
Your home appliance and smartphone are not connected to the Wi-Fi network.	The password for the Wi-Fi that you are trying to connect to is incorrect. Find the Wi-Fi network connected to your smartphone and remove it, then register your appliance on smart application.
	Mobile data for your smartphone is turned on. Turn off the Mobile data of your smartphone and register the appliance using the Wi-Fi network.
	The wireless network name (SSID) is set incorrectly. The wireless network name (SSID) should be a combination of English letters and numbers. (Do not use special characters.)
	The router frequency is not 2.4 GHz. Only a 2.4 GHz router frequency is supported. Set the wireless router to 2.4 GHz and connect the appliance to the wireless router. To check the router frequency, check with your Internet service provider or the router manufacturer.
	The distance between the appliance and the router is too far. If the distance between the appliance and the router is too far, the signal may be weak and the connection may not be configured correctly. Move the location of the router so that it is closer to the appliance.

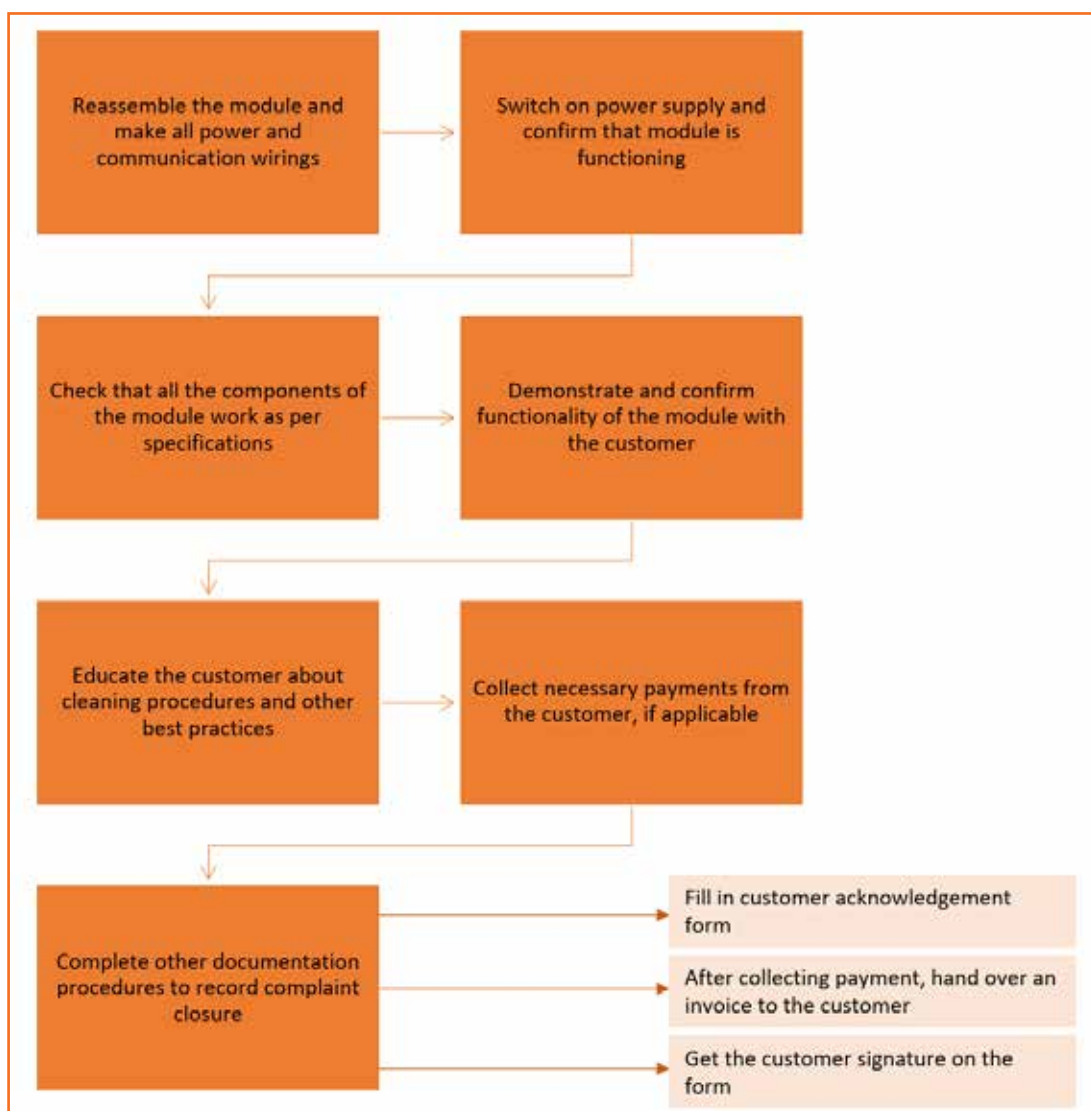
Replacing Faulty Module

In case the technician is unable to repair the components or fix the fault, or if the components cannot be replaced at customer's site, then the faulty module/component is sent to the service centre. The field technician then collects the functional module from the service centre and replaces the defective component at the customer's site.

Confirming Functionality of the Repaired Module

After the faulty module has been repaired or replaced, check the new module with testing equipment such as multimeter and ammeter. This is done to ensure that the module is working fine with the other parts of the refrigerator.

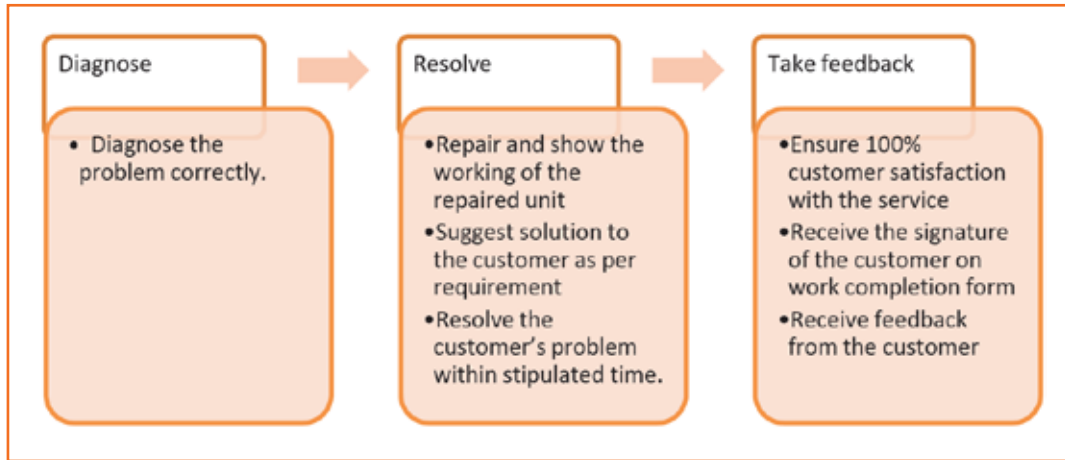
The following figure shows the steps for confirming functionality of the repaired module:



Achieving Productivity and Quality as per Company's Norms

To achieve productivity and quality as per company standards, a technician should follow the working instructions given by the company.

The following figure shows the steps for achieving productivity and quality practise the following:



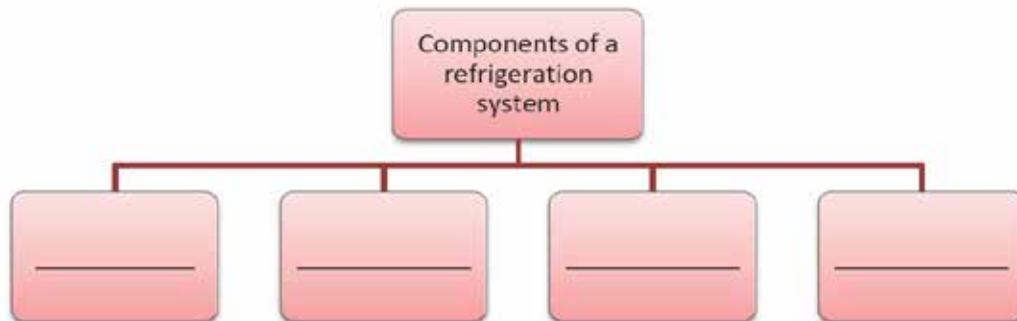
Notes

[illegible]

Exercise



1. Write the basic components of a refrigeration system in the space provided in the following figure.

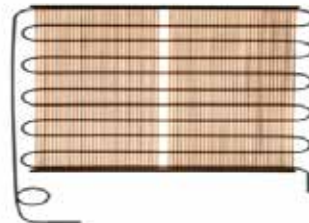


2. Identify the components of a refrigerator unit and write their names in the space given below their images.









3. Perform a check of wiring of a refrigerator as per the wiring diagram of refrigerator.

Equipment Used:

1. Wiring diagram of a refrigerator
2. Refrigerator unit
3. PPE such as safety shoes and safety gloves
4. Electrical tester.

3. Install and Repair Washing Machine



Unit 3.1 – About Washing Machines

Unit 3.2 – Installation and Operation of Automatic Washing Machine

Unit 3.3 – Troubleshooting and Repairing of Automatic Washing Machine



Key Learning Outcomes



At the end of this module, participant will be able to:

1. Identify the different types of washing machines
2. Describe the features and functionalities of different parts of a washing machine
3. Identify the various washing cycles
4. Demonstrate procedure of installing an automatic washing machine
5. Demonstrate how to setup and use the features of automatic washing machine
6. Demonstrate procedure of troubleshooting and repairing of faults in automatic washing machine
7. Identify the different types of washing machines
8. Describe the features and functionalities of different parts of a washing machine
9. Identify the various washing cycles
10. Demonstrate procedure of installing an automatic washing machine
11. Demonstrate how to setup and use the features of automatic washing machine
12. Demonstrate procedure of troubleshooting and repairing of faults in automatic washing machine

UNIT 3.1: About Washing Machines

Unit Objectives



At the end of this unit, participants will be able to:

1. Identify the different types of washing machines
2. Describe the features and functionalities of different parts of a washing machine
3. Identify the various washing cycles

3.1.1 Washing Machine

Washing machine is the machine used to wash the various types of clothes without applying any physical efforts. With washing machine, you don't have to rub the clothes with hand or squeeze them to remove the water from them. The washing machine is also called as clothes washer or simply the washer. The washing machine enables you to wash your clothes automatically without having to supervise its operation. All you have to do is put the clothes in the machine and select the wash mode. The washing machine automatically takes in the amount of water and detergent required and it also automatically sets the timer for washing, rinsing and drying as per the selected mode and the amount of clothes.



Fig 3.1.1 Washing machine

Working of washing machine

The washing process of a washing machine comes under the working of washing machine. Different parts of a washing machine play different roles in the washing process of clothes. The washing process of washing machine comprises of the points as described below.

Filling Process

- In this, water is filled inside the drum washer depending upon the quantity of clothes to be washed.
- Hot or cold water flow is controlled by the solenoid valve.

Agitating Process

- In this process, clothes are rotated up and down by the agitator which is fixed inside the drum washer.
- Agitator moves clothes back and forth, up and down inside the washer

Draining Process

- In this, water is drained out from the washing machine during spin cycle with the help of drain pump.



Fig 3.1.2 Working of washing machine

- With the help of drain hose, water is forced out to reach the bend of drain hose and then out of the drain.

Rinsing Process

- After the clothes are agitated, they are rinsed in clean water to remove detergent.
- Rinse cycle depends on the load of the washing machine.

Spinning Process

- After the above processes, spin cycle comes into action.
- In this, after clothes are rinsed in clean water, spin motor removes extra water from the clothes and dries them.

3.1.2 Types of Washing Machine

Washing machines are classified depending upon their features and functionalities.

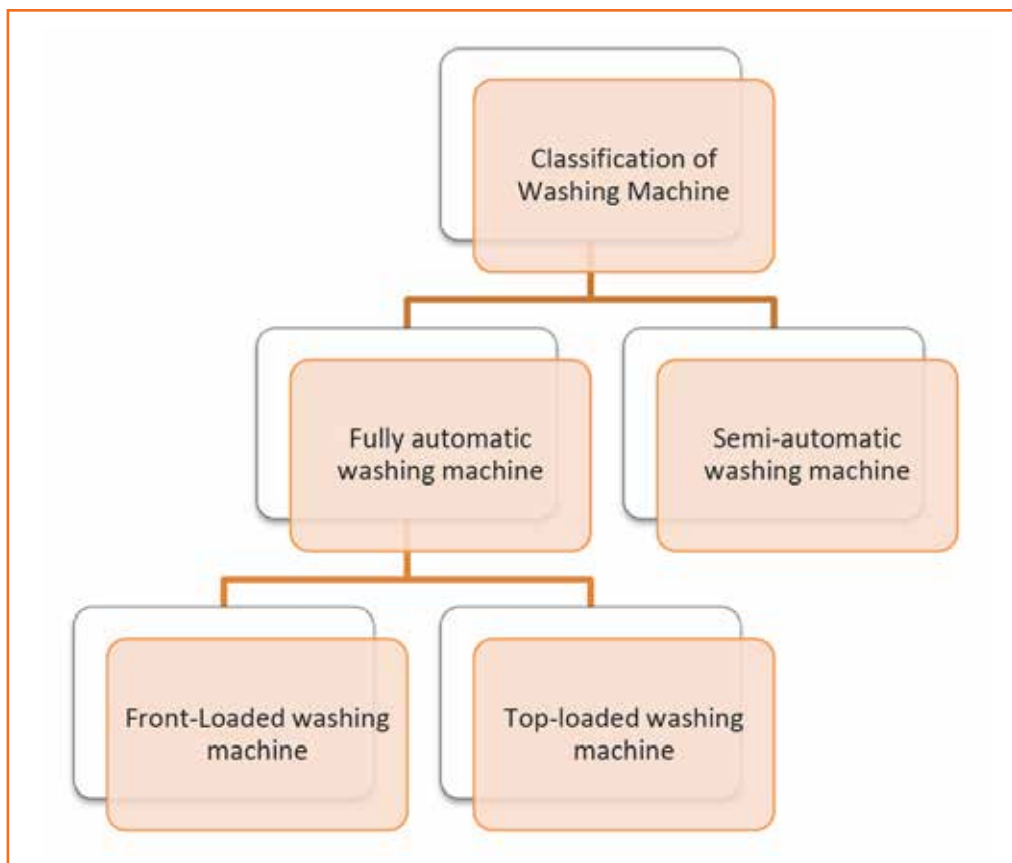


Fig 3.1.3 Classification of washing machines

The explanation for these machines is as follows:

- **Fully automatic Machine:** This type of machine works automatically in different cycles. From filling process till spinning process, it doesn't require any manual handling. It sets the temperature

of water and also drains off water. In this each cycle begins automatically after the previous cycle ends. It is further divide into:

- ☐ Top-Loading washing machine
- ☐ Front-Loading washing machine

The following table describes the differences between front load and top load washing machine based on their features and functionalities -

Top-Loading	Front-Loading
Top loading washing machine is a midrange and economical machine.	Front Loading washing machine is a premium machine.
Top loading machines are easier to move, and the lid opens from the topside.	Front loading washing machines are heavier than the top loading ones and their lid is operated from the front side.
In this type of a washing machine, clothes can be added in between the washing process.	Once the washing process has started, a front-loading machine cannot be stopped.
Top Loading machines give moderate performance.	Front loading machines give better performance.
In top loading machines, the maintenance cost is low	As this machine has some serviceable parts, its maintenance cost is high

- **Semi-automatic washing machine:** This machine works manually, and it is better than fully automatic machine as it saves water and detergent. It consists of two tubs:

- ☐ Wash Tub
- ☐ Spin Tub

In wash tub, it agitates the clothes and in this, we can fill the water according to the requirement and conditions. Drain process is also done manually by rotating the drain switch.

In spin tub, extra water from the clothes is removed by setting the time period for which it will rotate.



Fig 3.1.4 Semi-automatic washing machine

3.1.3 Basic Components of Washing Machines

A washing machine contains several parts which work together to complete the washing of the laundry.

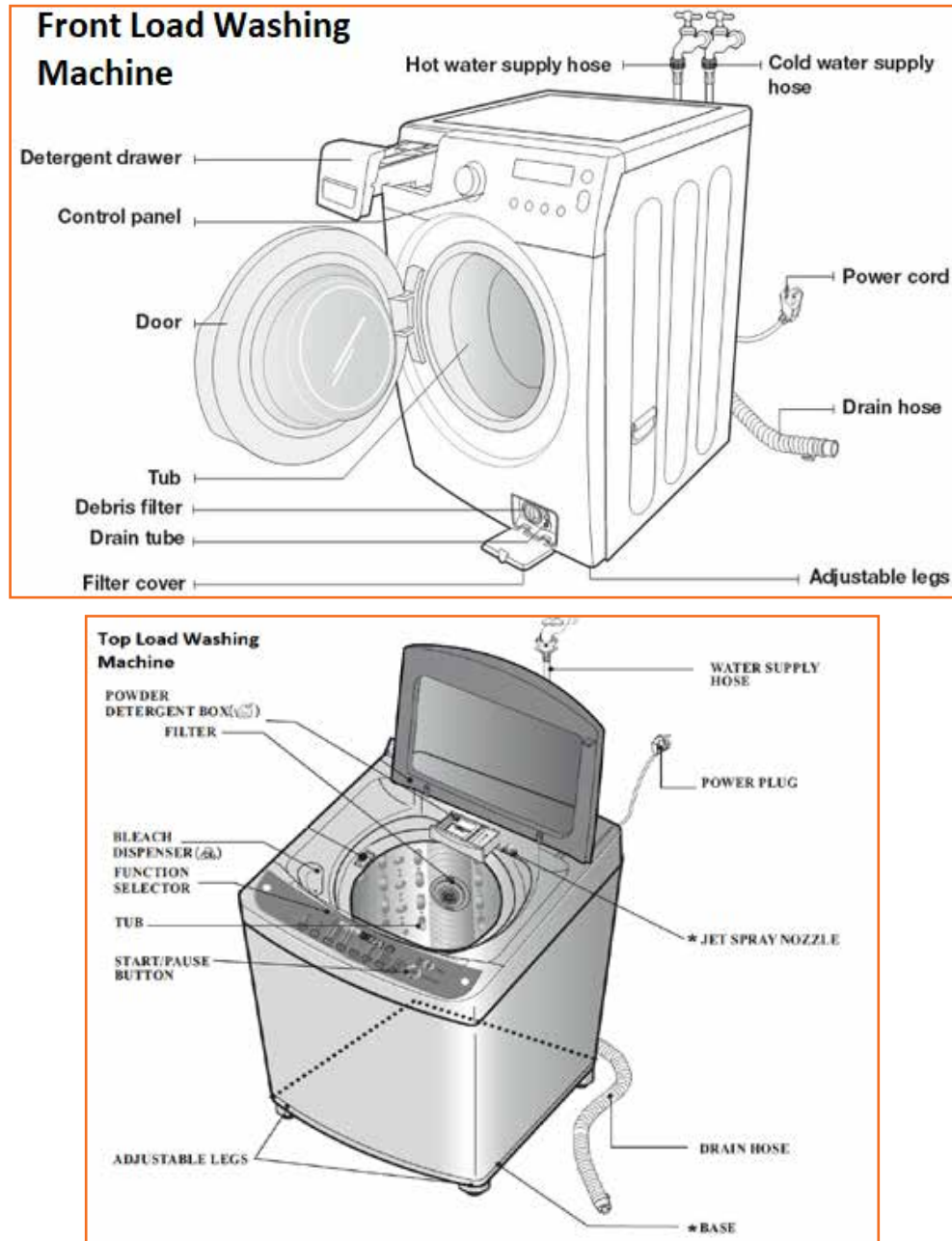


Fig 3.1.5 Components of Front load and Top load washing machine

Basic parts of a washing machine are:

1. **Drain pipe/hose:** The drain hose exits the washing machine toward the bottom and travels up to the nearby sink or standpipe. It drains the dirty water from the washing machine and is usually made of corrugated plastic.



2. **Water inlet control valves:** The water inlet valve is in the back of the washer, toward the top. It has one port for hot water and one for cold. Some front load models only have one port for cold water and an internal heater to warm the water up to temperature. The inlet valve opens and closes when it receives electrical signals from the washer, letting water enter the tub at the right times during a cycle.



3. **Tub/Drum:** Most washing machines have an inner and outer tub. The inner tub is called a wash basket in top load washers and a drum in front load washers. The outer tub remains stationary and holds the wash basket or drum, catching the wash water so it can be drained out. The wash basket or drum is the part of the washer that holds the clothes and rotates to wash them. They can be plastic, porcelain or stainless steel.

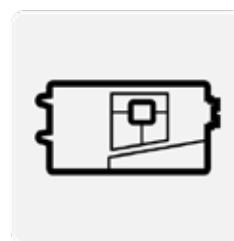


4. **Washing machine motor:** The washing machine motor powers the movement that causes your agitator, discs or drum to rotate as machine runs through a cycle. The washer motor usually sits at the bottom of the washer in top load models and the back in front load models. The most common type of motors used in washers are direct drive or belt drive.

- ☐ The direct drive motor is attached directly to the wash basket,
- ☐ while the belt drive motor sits independently and uses a belt to turn the wash basket.



5. **Printed circuit board:** The printed circuit board (PCB) is the brains of the washing machine. It commands the control panel and wash cycles, as well as firing off the different electronic parts that are needed for your washer to do its job. The PCB is also responsible for water levels, how much detergent is dispensed and other functions washing machine may have.



6. **Timer:** Timers on washing machines can either be set manually or automatically, and will set the wash time for your laundry cycles. Not all washers come with a timer, so your washer may not have this feature.



7. **Control panel:** All settings and wash cycles will be controlled on this panel, which is either on top or front of the washing machine.

8. **Heating element:** When using cycles that will run either warm or hot water, this element heats up the water to the desired temperature. Note: Heating elements are model dependent.

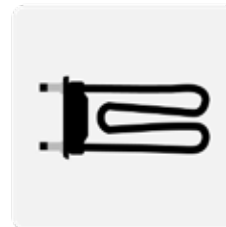


Table 3.1.1 Components of washing machine

UNIT 3.2: Installation and Operation of Automatic Washing Machine

Unit Objectives



At the end of this unit, participants will be able to:

1. Demonstrate procedure of installing an automatic washing machine
2. Demonstrate how to setup and use the features of automatic washing machine

3.2.1 Installation of Automatic Washing Machine

Check Customer Requirements

A field technician is responsible for the installation or repair/maintenance of the automatic washing machine. When work is allocated, it is important to understand and analyse the requirement before going ahead with the plan of action or visiting the customer's site.

Unpacking the Washing Machine

There are certain steps involved in complete unpacking and taking out a washing machine. The following steps involved in a placing washing machine set up -

1. Open the packaging of the new product
2. Cut bands around the cardboard covering of the washing machine
3. Remove the cardboard covering from the washing machine, using scissors or a knife
4. Take out the appliance/modules carefully
5. Check the parts/components inside the package
6. Take out the accessories from the box

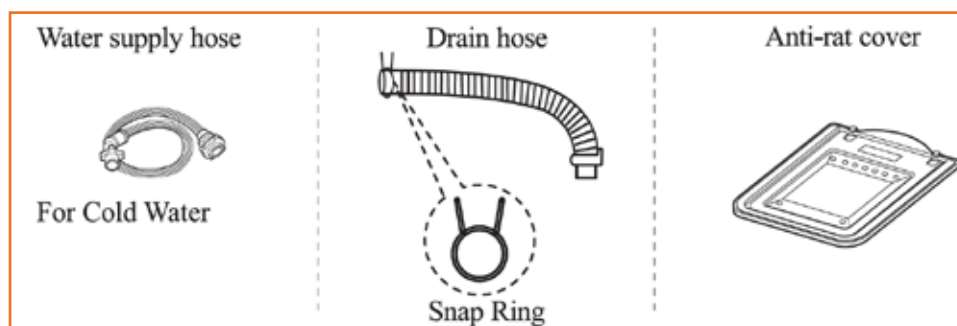


Fig 3.2.1 Accessories with washing machine

Installation of machine

1. Before placing the machine, seek input from the customer
2. Read installation manual to set the washing machine at a suitable distance from the water tank
3. Remove the transport pins from its wash drum

4. Place the machine on a flat and firm floor. Ensure that the machine is placed against an exterior wall



Fig 3.2.2 Levelling of washing machine

5. If surface is not flat enough use stands with adjustable legs or use proper packing.
6. Place the machine on a stand as instructed by the company in the installation manual and ensure that it is in an obstruction-free area.
7. Install the anti-rat cover firmly in washing machine.

- ❑ In case of top load machine, antirrat cover has to fix at back side of machine.

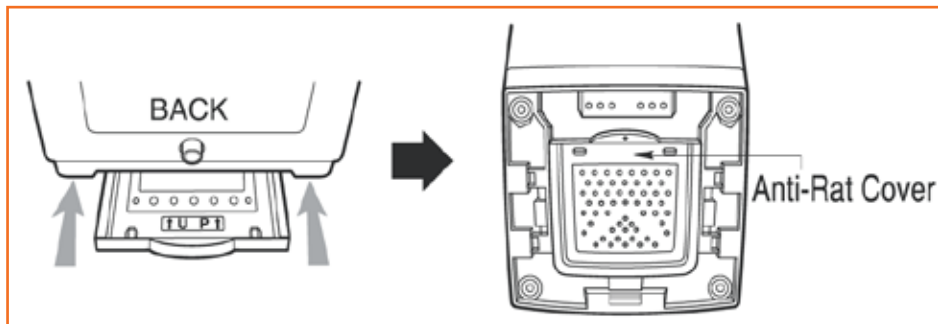


Fig 3.2.3 Fixing anti-rat cover

- ❑ In case of front load machine, antirrat cover has to fix below the machine.

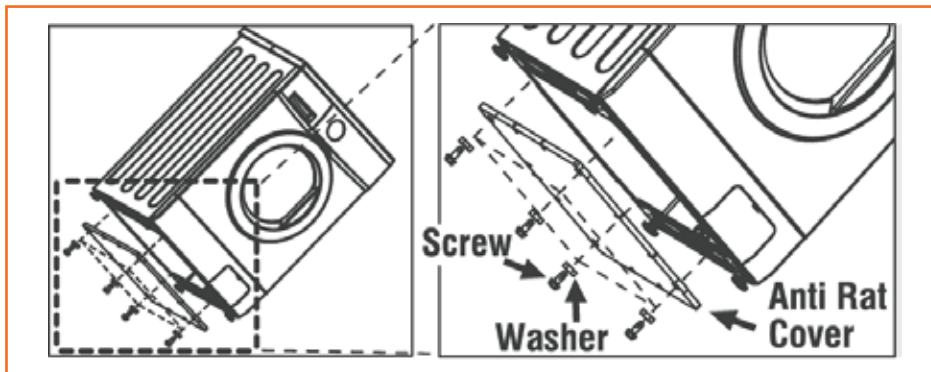


Fig 3.2.4 Fixing anti-rat cover

8. Insert the power plug into the electrical socket with proper earthing.

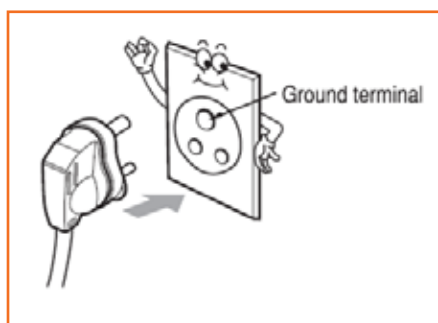


Fig 3.2.5 Connecting with power supply

Drain hose installation

1. Fix the snap ring to the drain hose.
2. Align the drain hose with drain outlet.
3. Push the hose towards the body of the machine and release the snap ring.

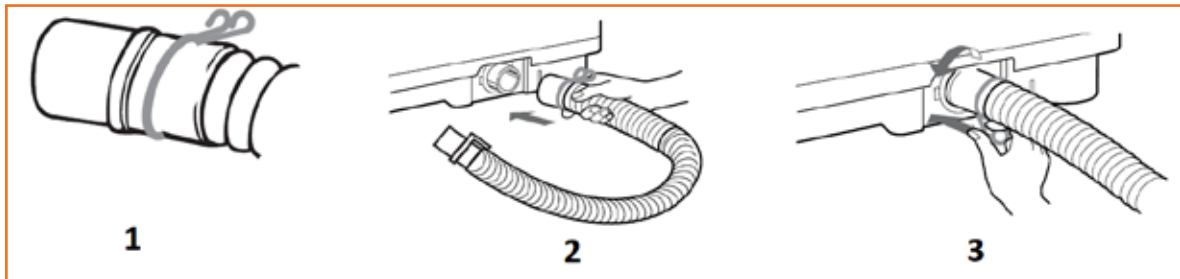


Fig 3.2.6 Installing drain hose

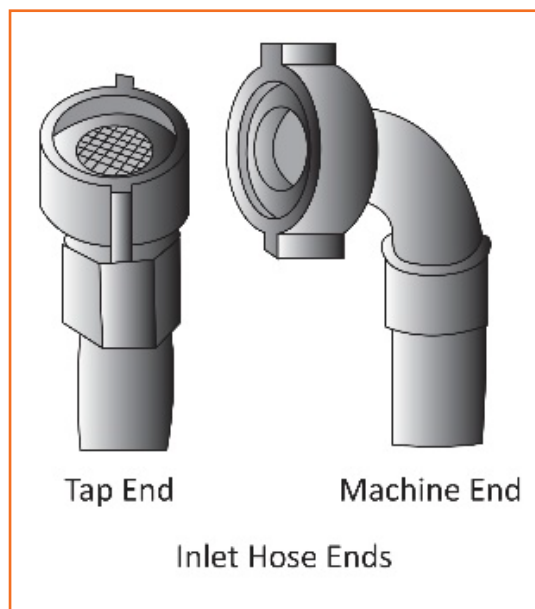
Water supply hose installation:

Fig 3.2.7 Inlet hose connector

1. Both the ends of the inlet hoses are connected to the taps.
 - ☐ For installing inlet hose, first separate the middle connector from inlet hose.
 - ☐ Now fix the connector to the tap.
 - ☐ Now connect the inlet hose back with the middle connector.

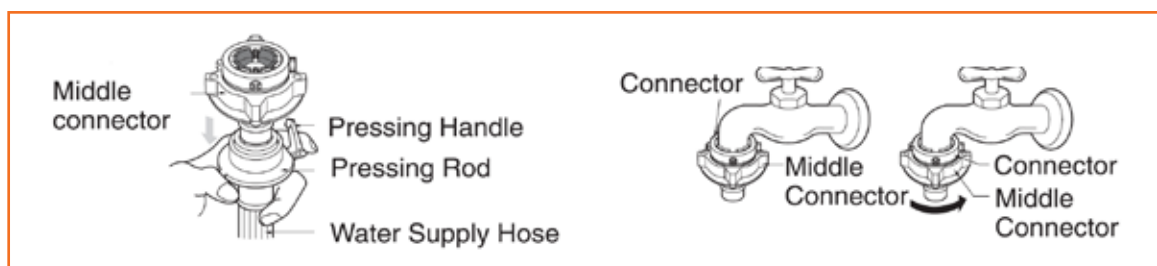


Fig 3.2.8 Installing inlet hose

- If the inlet hoses are colour coded, then the red end is connected to the hot end and the blue end is connected to the cold end.

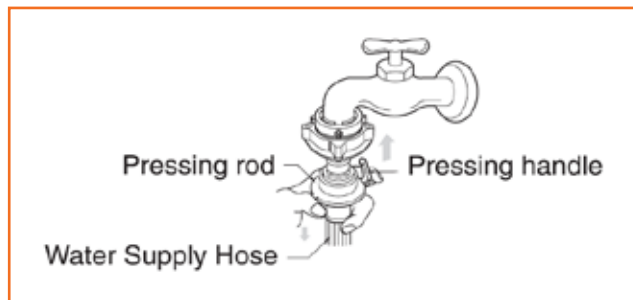


Fig 3.2.9 Installing inlet hose

- The inlet hoses with elbow ends are connected to the respective hot and cold inlet valves of the machine.



Fig 3.2.10 Wring connection of inlet hose

- The minimum requirement for the height of the taps in washing machines is 1150 mm.
- After installation, check the water leakage in connection by opening the tap.

Check the Functioning

After installing all the required accessories of the washing machine, it is mandatory to check the working of the appliance, to identify problems (if any) and to ensure its smooth functioning.

A technician can achieve productivity and quality in work by educating the customer about the proper place where the machine is to be installed as per the guidelines mentioned in the installation manual given by the company. Also, the technician should tell the customer about the use of the voltage regulators and to switch off the machine during voltage fluctuations.

Use of control panel

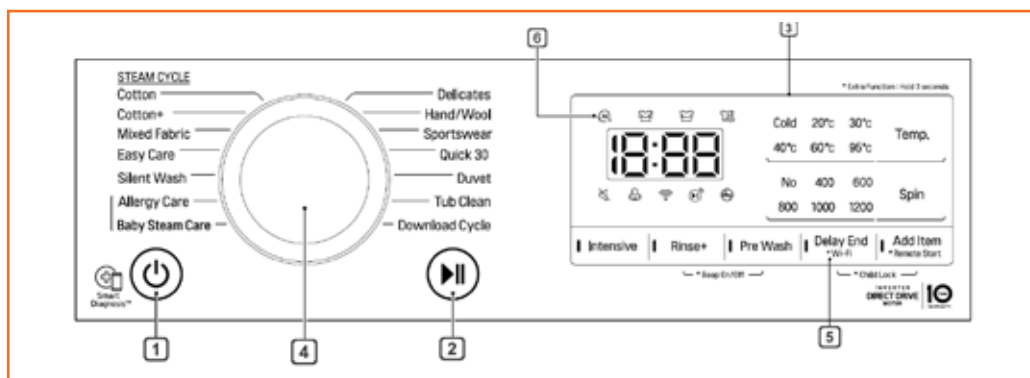


Fig 3.2.11 Control panel

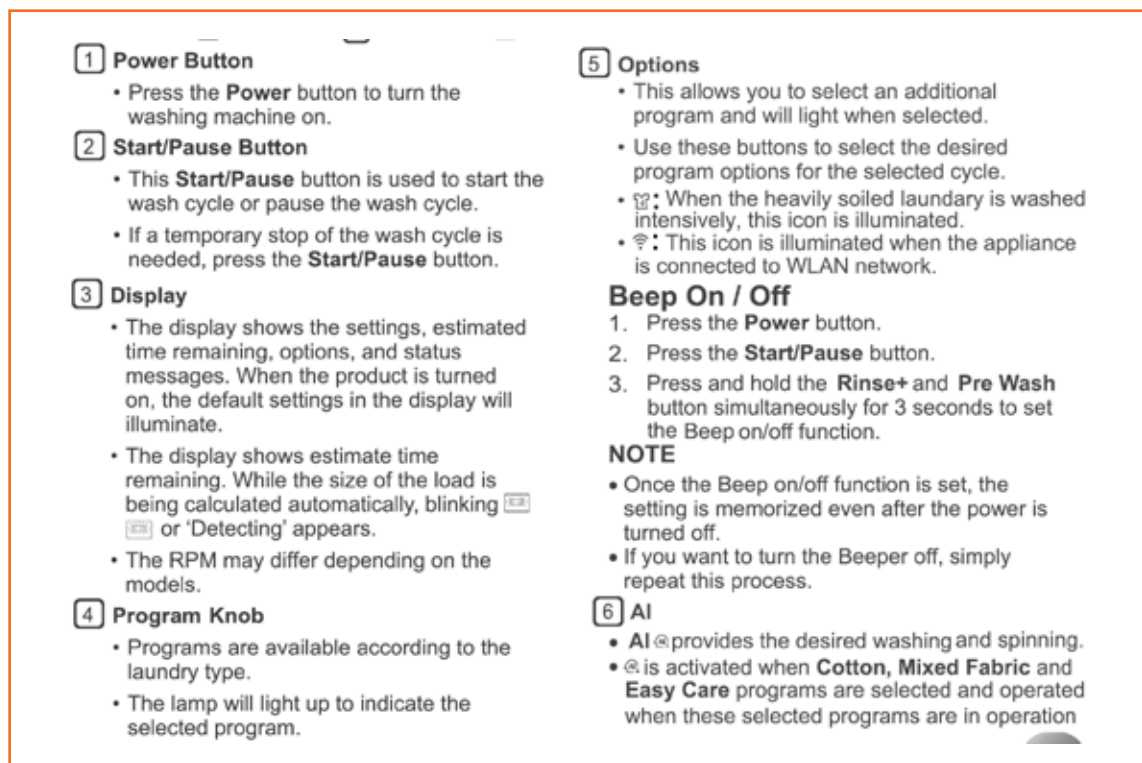


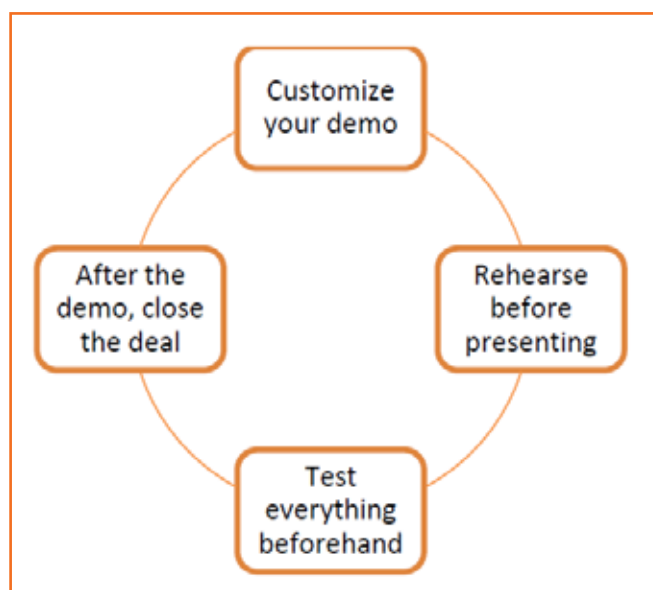
Fig 3.2.11 Control panel features

Providing Guidance to the Customer

Demonstrating a product is a way of promoting or showing the operation of equipment to the users. The goal of demonstrating the workability of equipment is to make them aware of the operation of that equipment and answer their queries related to its operation.

There is nothing better than a good demonstration session. It is only after a demonstration (demo) that the users understand the operation of particular equipment.

There are a few rules which must be considered while preparing for the demo. The following figure lists these rules -



In addition, it is the responsibility of a technician to make the customers aware of the user manual and tell them how to read it.

It can be a user manual which contains instructions for the installation of a washing machine or it may be a help book giving solutions to common problems that may arise with equipment.

Take Feedback from Customer

Just like it is essential to address issues within the facility, it is also important to get feedback of the customer. The customer is always special, and the customer's feedback is the most important thing for an organization.



Fig 3.2.12 Feedback collection

Scan the QR code or click on the link to watch related videos



<https://www.youtube.com/watch?v=l6RoRmA9GEM>
Installation and operation of automatic washing machine

UNIT 3.3: Troubleshooting and Repairing of Automatic Washing Machine

Unit Objectives



At the end of this unit, participants will be able to:

1. Demonstrate procedure of troubleshooting and repairing of faults in automatic washing machine.

3.3.1 Troubleshooting and Repairing of Problems in Automatic Washing Machine

A Multiskill Technician should have the knowledge and skill to repair all kinds of washing machines. He should be able to diagnose and troubleshoot the problem. He should carry out repairs according to the requirements of that particular model.

It is very important for a technician to correctly identify the fault in the washing machine. Wrong identification of fault will lead to waste of time and money and it can also cause damage to the equipment.

The following table represents the common problems in the working of a washing machine along with their solutions -

Symptom	Possible Cause	Solution
Rattling and clanking noise Thumping sound Vibrating noise	Foreign objects such as coins or safety pins maybe in drum or pump. Heavy wash loads may produce a thumping sound. This is usually normal. Have all the transit bolts and packing been removed? Are all the feet resting firmly on the ground?	• Stop washer and check drum and drain filter. • If noise continues after washer is restarted, call your authorised service centre. • If sound continues, washer is probably out of balance. Stop and redistribute wash load. • If not removed during installation. Refer to Installation guide for removing transit bolts. • Wash load may be unevenly distributed in drum. Stop washer and rearrange wash load.

Symptom	Possible Cause	Solution
Water leaks	Fill hoses or drain hose are loose at tap or washer. House drain pipes are clogged. Water supply is not adequate in area. Water supply tap is not completely open. Water inlet hose(s) are kinked. The filter of the inlet hose(s) clogged. Drain hose is kinked or clogged. The drain filter is clogged.	• Check and tighten hose connections. • Unclog drain pipe. Contact plumber if necessary. • Too much detergent or unsuitable detergent may cause excessive foaming which may result in water leaks. • Check another tap in the house. • Fully open tap. • Straighten hose. • Check the filter of the inlet hose. • Clean and straighten the drain hose. • Clean the drain filter
Washer does not start Washer will not spin	Electrical power cord may not be plugged in or connection may be loose. House fuse blown, circuit breaker tripped, or a power outage has occurred. Water supply tap is not turned on. Check that the door is firmly shut.	• Make sure plug fits tightly in wall outlet. • Reset circuit breaker or replace fuse. • Do not increase fuse capacity. • If problem is a circuit overload, have it corrected by a qualified electrician. • Turn on water supply tap. • Close the door and press the Star/Pause button. After pressing the Star/Pause button, it may take a few moments before the clothes washer begins to spin. The door must lock before spin can be achieved. • Add 1 or 2 similar items to help balance the load. • Rearrange load to allow proper spinning

Symptom	Possible Cause	Solution
Door does not open		Once machine has started, the door can not be opened for safety reasons. Check if the "Door Lock" icon is illuminated. You can safely open the door after the "Door Lock" icon turns off.
Wash cycle time delayed		- The washing time may vary by the amount of laundry, water pressure, water temperature and other usage conditions. - If the imbalance is detected or if the suds removing program works, the wash time shall be increased.
Fabric softner overflow	Too much softener may cause an overflow.	- Follow softener guidelines to ensure appropriate amount is used. - Do not exceed the maximum fill line.
Softeners dispensed too early		- Close the dispenser drawer slowly. - Do not open the drawer during the wash cycle.
Dry problem	Check water supply tap.	- Do not overload. Check that the washing machine is draining properly to extract adequate water from the load. - Clothes load is too small to tumble properly. Add a few towels. - Turn off water supply tap.

Symptom	Reason	Solution
	Water supply is not adequate in area.	Check another tap in the house.
	Water supply taps are not completely open.	Fully open tap .
	Water supply hose(s) are kinked.	Straighten hose(s).
	The filter of the supply hose(s) are clogged.	Check the filter of the supply hose.
	Load is too small.	Add 1 or 2 similar items to help balance the load.
	Load is out of balance.	Add 1 or 2 similar items to help balance the load.
	The appliance has an imbalance detection and correction system. If individual heavy articles are loaded (e.g. bath mat, bath robe, etc.) this system may stop spinning or even interrupt the spin cycle altogether.	Rearrange load to allow proper spinning.
	If the laundry is still too wet at the end of the cycle, add smaller articles of laundry to balance	Rearrange load to allow proper spinning.
	Drain hose is kinked or clogged.	Clean and straighten the drain hose.
	The drain filter is clogged.	Clean the drain filter.
	Ensure door is not open.	Close the door completely. If dE, dE 1, dE 2 is not released, call for service.

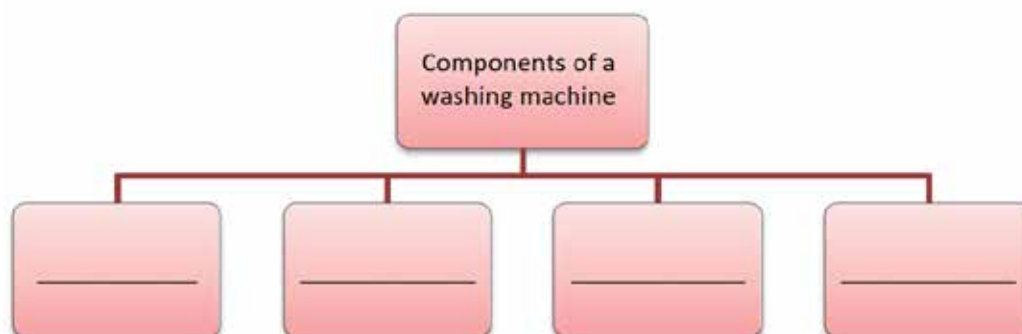
Symptom	Reason	Solution
	Control error	Unplug the power plug and call for service.
	Water overfills due to the faulty water valve.	- Close the water tap. - Unplug the power plug. - Call for service.
	Malfunction of water level sensor.	- Close the water tap. - Unplug the power plug. - Call for service.
	Over load in motor.	Allow the washing machine to stand for 30 minutes to allow the motor to cool, then restart the cycle.
	Is supply/drain hose or drain pump frozen?	Supply warm water into the drum and unfreeze drain hose and drain pump. Wet a towel in warm water and apply to supply hose.
	Water leaks.	Call for service.
	Does not dry	Call for service.

Table 3.3.1 Common problems and their solutions in automatic washing machine

Exercise



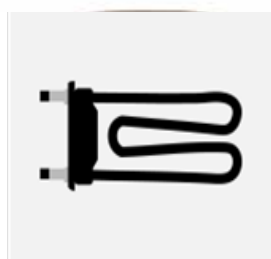
1. Write the basic components of a washing machine in the space provided in the following figure.



2. Identify the components of a washing machine and write their names in the space given below their images.









3. Perform a check of water leaks in a automatic washing machine .



4. Install and Repair Dishwasher

Unit 4.1 – About Dishwasher

Unit 4.2 – Installation and Operation of Dishwasher

Unit 4.3 – Troubleshooting and Repairing of Dishwasher



Key Learning Outcomes



At the end of this module, participants will be able to:

1. Describe use and function of dishwasher
2. List parts of a dishwasher
3. Demonstrate procedure of installing a dishwasher
4. Demonstrate how to setup and use the features of dishwasher
5. Demonstrate servicing of dishwasher
6. Demonstrate procedure of troubleshooting and repairing of faults in dishwasher

UNIT 4.1: About Dishwasher

Unit Objectives



At the end of this unit, participants will be able to:

1. Describe use and function of dishwasher
2. List parts of a dishwasher

4.1.1 Dishwasher

Dishwashers are a great alternative to handwashing dishes. They can save energy, time, and water. They are intricate pieces of machinery composed of many parts that work together to help achieve the best result and clean dishes.

Basically, a dishwasher cleans and rinses dirty dishes. You have to load the dishes, add detergent, set the proper washing cycles and turn it on, but the dishwasher accomplishes a whole series of functions by itself. A dishwasher -

- Adds water
- Heats the water to the appropriate temperature
- Automatically opens the detergent dispenser at the right time
- Shoots the water through spray arms to get the dishes clean
- Drains the dirty water
- Sprays more water on the dishes to rinse them
- Drains itself again
- Heats the air to dry the dishes off, if the user has selected that setting



Fig 4.1.1 Dishwasher

In addition, dishwashers monitor themselves to make sure everything is running properly. A timer (or a small computer) regulates the length of each cycle. A sensor detects the water and air temperature to prevent the dishwasher from overheating or damaging your dishes. Another sensor can tell if the water level gets too high and activates the draining function to keep the dishwasher from overflowing. Some dishwashers even have sensors that can detect the dirtiness of the water coming off the dishes. When the water is clear enough, the dishwasher knows the dishes are clean.

4.1.2 Components of a Dishwasher

The dishwasher parts diagram below shows the general parts of a dishwasher.

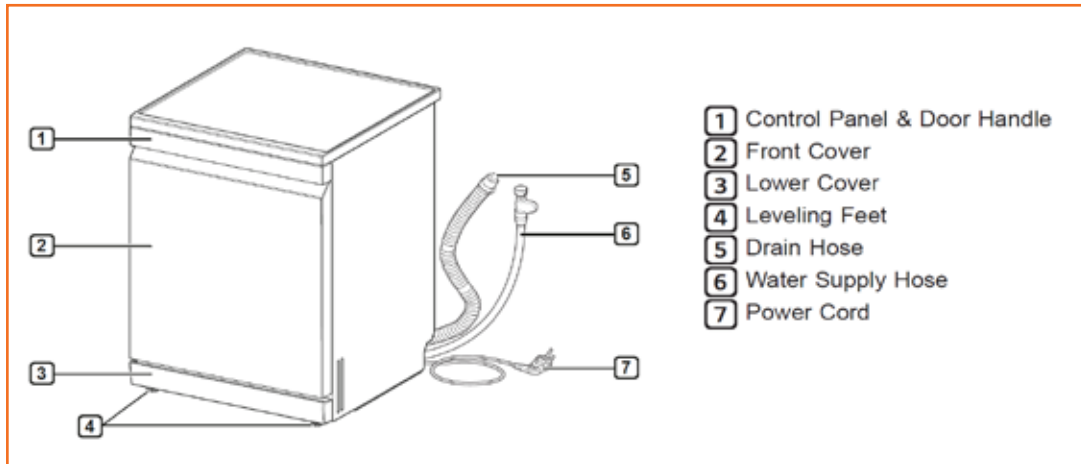


Fig 4.1.2 Components of dishwasher

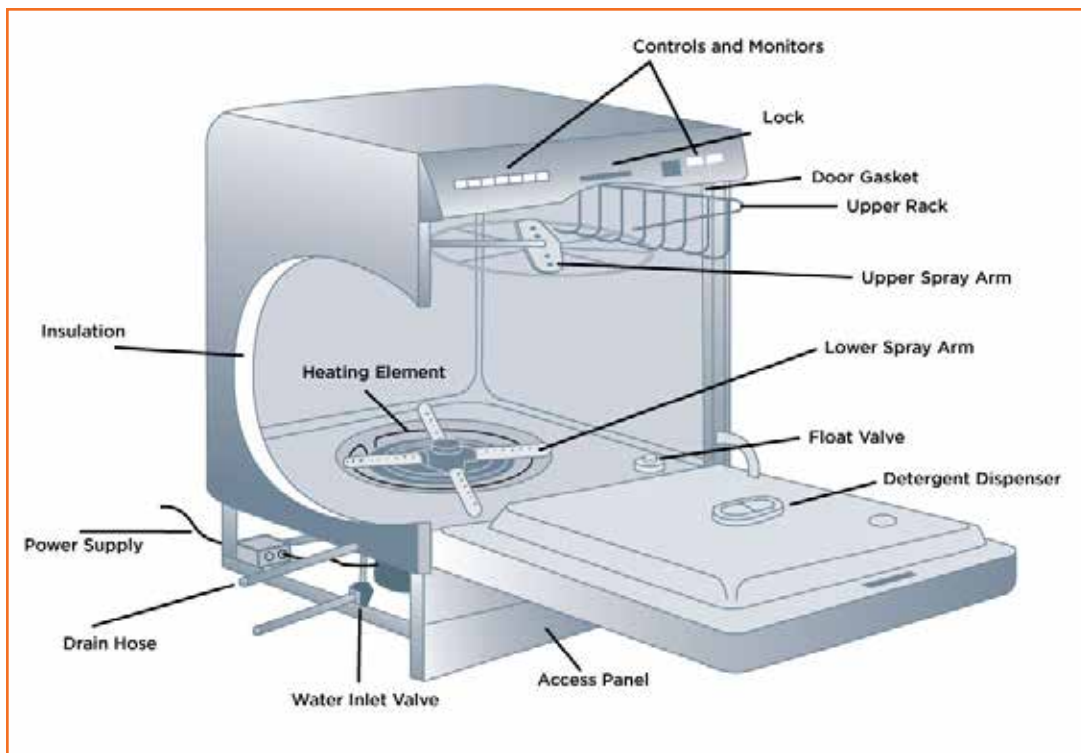


Fig 4.1.3 Components of dishwasher

Main Tub: One of the largest and most prominent parts of the dishwasher, the main tub takes up most of the space on a dishwasher part diagram. It's where cleaning the dishes happens and where most of the parts are held. The tub varies in size based on the dishwasher's capacity and can hold multiple racks.

Rack, Rack Supports, and Accessories: A dishwasher tub usually contains two racks, but larger models can have a third rack for items such as smaller dishes and cups.

Each rack is made to be durable and withstand water, heat, and weight. It's connected to the tub with a rack support system, which typically includes



Fig 4.1.4 Rack

a track, a few wheels to get it rolling, and a stopper to prevent the rack from getting ejected from the tub.

Tub Gasket and Outside Connections: The main tub has a large rubber gasket running around the edges that seals it when the door is closed. The gasket prevents water from leaking. If you notice water leaking from the dishwasher, check to see if the gasket on the tub or the door is deteriorated or detached.

The tub also has insulating elements that protect the surroundings from the heat inside. Additionally, the tub holds the latches that connect it to the external parts of the dishwasher.

Spray Arms: The spray arms rotate and blast hot water around the tub to help ensure the dishes are cleaned evenly. Some models feature a spraying tower on the bottom rack that dispenses water instead.

Heating Element: The heating element heats the water and dries the dishes after they've been washed. It's located at the bottom of the tub.



Fig 4.1.5 Spray arms

Float Bulb and Float Switch Located on the bottom of the tub, the float bulb prevents the dishwasher from overflowing. When it floats sufficiently, it will trigger the float switch, which cuts off the water supply.

Door: The door of the dishwasher is vital to keeping the water inside the dishwasher. It also holds all the dishwasher controls.

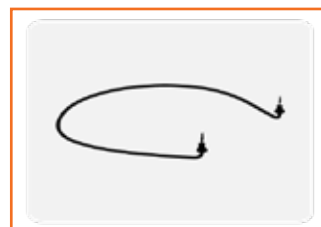


Fig 4.1.6 Heating element

Door Gasket: The door has a gasket running alongside its bottom, which seals the dishwasher when the door is closed. It can deteriorate and leak over time.

Latch and Switch: The door latch, as its name suggests, latches the door onto the main tub. The latch may also act as a switch, allowing the machine to turn on only when the door is closed.



Fig 4.1.7 Door latch

Control Panel: The control panel can be located on the front of the door or on top of the door panel and is the main control centre for operating the dishwasher. It is usually composed of buttons or pads and may have an LCD or touchscreen. It may also indicate errors and failing dishwasher components.



Fig 4.1.8 Control panel

Timer: Depending on dishwasher parts diagram, the timer (assuming time display) is typically located on the top of the door when it is opened, on the front of the door near the top, or in some rare products, projected onto the floor. It controls the washing cycles. If the dishwasher appears stuck on some cycles, the timer may be faulty.

Cycle Selector: The cycle selector is typically located on the control panel or on top of the dishwasher itself. The selector controls how long the dishwasher will run and how much water is used.



Fig 4.1.9 Timer

Detergent Holder and Dispenser: Usually located on the inner door panel, the detergent holder is one of the essential parts of dishwasher machines. The holder may sometimes fail to open properly, preventing the detergent from being dispensed into the machine.

Rinse Aid Dispenser: While not universal to all dishwasher models, the rinse aid dispenser's purpose is to add surfactants to the final rinse water for improved drying performance and fewer spots on items like glassware. It's usually located on the inner door panel.

Vent: A dishwasher vent is typically located on the door, with the vent grill located on the inside door panel. The vent is responsible for exhausting the hot air during the drying cycle.

Silverware Basket: The silverware basket holds utensils. It can often be found on the inner door panel, but some dishwasher models have a detachable basket that sits on, or hangs from, the rack. It's usually made of plastic and can deteriorate due to exposure to hard water.

Inner Workings: The motor and piping elements are located below the main tub.

Motor: The motor converts electrical energy into kinetic energy to power the washing arms. It's located under the main tub, usually between the wash arm and the pump. The motor is one of the more commonly replaced parts, as it can be prone to breaking over time. The motor is typically connected to the pump as a single assembled piece.

Water Pump: It pumps water in and out of the machine. The pump is rarely disassembled but instead replaced as a whole.

Wash Impeller: The wash impeller, also called a pump impeller, pressurizes water to the spray arms and is located inside the pump assembly.

Filtration system: Dishwasher filter is usually located on the bottom corner of the tub, underneath the lower rack. The filter will help protect the pump from clogging with large food particles, as well as filtering out the dirty water.

Drain Pump: The drain pump pushes water from the dishwasher into the drain pipe. It has a seal to prevent water from leaking under the dishwasher.

Thermostat: The thermostat can be located under the tub or in the doors. Its main task is to regulate the water temperature.

Water Intake Valve: The intake valve controls water flow into the dishwasher. It's usually in a corner behind the kick plate. The water intake valve opens when the dishwasher needs water, and water pressure does the rest, pushing water into the holding basin.



Fig 4.1.10 Detergent holder



Fig 4.1.11 Silverware basket

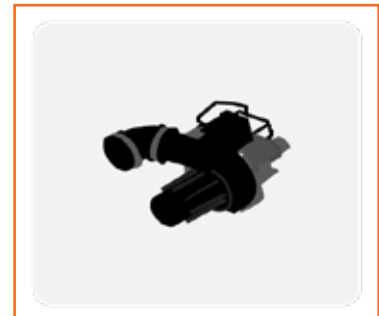


Fig 4.1.12 Water pump



Fig 4.1.13 Filtration

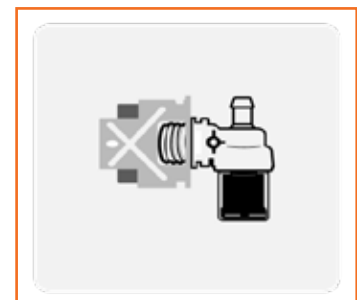


Fig 4.1.14 Water intake valve

Drain Hose: The drain hose connects the dishwasher to the house's plumbing.

Macerator: The macerator is responsible for chopping up small food items and helps to reduce the size of larger soil particles. It's part of the pump mechanism.

Thermal Fuse: The fuse helps prevent the dishwasher from overheating the water. It's mounted below the main tub. A blown fuse needs to be replaced but can point to a problem with heat regulation.

UNIT 4.2: Installation and Operation of Dishwasher

Unit Objectives



At the end of this unit, participants will be able to:

1. Demonstrate procedure of installing a dishwasher
2. Demonstrate how to setup and use the features of dishwasher

4.2.1 Site Requirements for Installation

The first step of an installation process is to conduct a site survey and ensure that it meets all the requirements. The selected site should comply with all the safety codes and should not interfere with normal movement of people.

The following are the site requirements of installing a dishwasher:

- Select a well-ventilated place which is near to the tap water or kitchen sink.
- Avoid installing the dishwasher in outdoor place, damp area and keep away from direct sunlight, dust and direct water splashing. This could cause product malfunctioning.
- Place on a firm, level place

After checking the site requirements, the next step is to check the power supply at the location site.

The following are the power requirements for installation:

- Ensure that voltage and electrical wiring is appropriate
- Use a separate socket for dishwasher
- Ensure wall socket is properly earthed
- Place the dishwasher close to the electrical outlet
- Try to avoid use of an extension cord

4.2.2 Installation Process

Before starting the installation, following tools are necessary, depending on each particular installation:

- Safety goggles
- Pliers
- Power drill
- Hole saws
- Adjustable wrench

- Screwdriver
- Standard level
- Tube cutting shears
- Dishwasher installation kit
- Supply lines/dishwasher connector
- Wire connectors and wire terminals

The installation process consists of unpacking the unit, disposing the packing material and installing the dishwasher at the designated place.

Unpacking dishwasher

To protect the dishwasher from any kind of damage, it is properly packed and delivered. Once it is transported from the delivery truck, it needs to be carefully unpacked.

The following are the tools that are needed for unpacking and handling a dishwasher -



Fig 4.2.1 Requirmeents for installation

Steps for unpacking and installing a dishwasher:

1. Unbox the box by keeping it on a smooth and fair surface. Remove the packing strip and cut the tapings on the upper face with the help of a knife or sharp object.
2. Tilt the box and remove the tapings applied on the base with the same sharp object.
3. Take out all the accessories from the box.

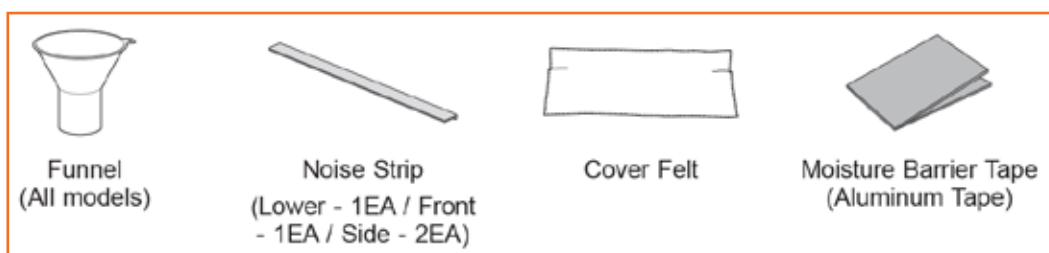


Fig 4.2.2 Accessories with dishwasher

Note: Accessory items may vary depending upon model.

4. Now, hold the thermocol sheet (polystyrene base), remove the box. Gently, keep the dishwasher horizontally, remove the thermocol sheets from both ends. Once you have removed out the thermocol sheet carefully and gently, remove the poly packing. Handle the product with care. Now you are ready for the core installation process.

Preparing Cabinet Opening

- Select a location as close to the sink as possible for ease of connection to the water and drain pipes.
- To ensure drainage, the appliance should not be installed more than 1 meter away from the sink.
- If the appliance is installed in a corner, allow minimum clearance of at least 50 mm between the appliance and an adjacent cabinet or wall.
- Before sliding the appliance into the installation opening, all necessary height adjustments should be made using a spanner.

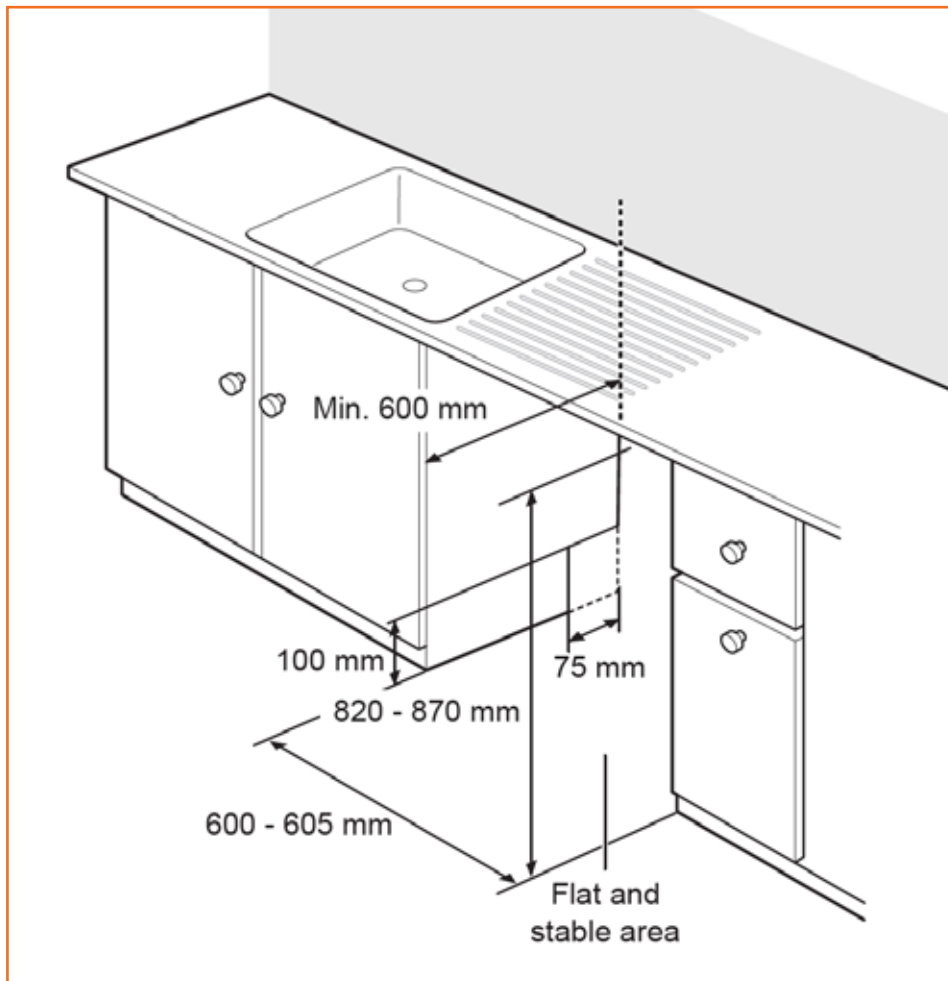


Fig 4.2.3 Area requirements for dishwasher installation

- Drill holes into the dishwasher side of the sink cabinet, if needed for the dishwasher's electric wiring, water inlet, and drain tube.



Fig 4.2.4 Drilling holes

Attaching the noise strip to the appliance base

To reduce noise attach the strip to the appliance base.

1. Lay down the appliance and pull on both the hooks at the bottom of the lower cover.
2. Pull on the lower cover to remove it.
3. Remove the double-sided tape on the back of the felt and attach it to the front side of the appliance's bottom.
4. Remove the double-sided tape from the lower and front strips.
5. Attach the black coloured lower strip to the bottom of the lower cover.
6. Attach the white coloured front strip to the top of the lower cover.
 - ❑ The length of the front strip is longer than the lower cover. Attach the front strip so that the overhang is equal on both sides of the lower cover.
7. Attach lower cover with strip onto the appliance.

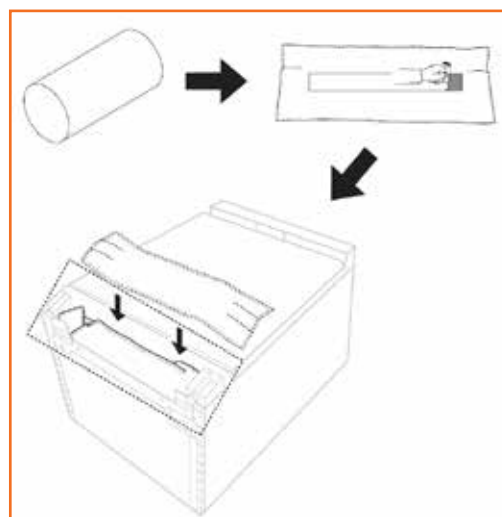


Fig 4.2.5 Attaching noise strip

Removing the top cover

If the height of the opening is below 850 mm, follow these instructions.

1. Remove the 2 screws on the back.
2. Pull the top cover backwards after removing the two screws and then lift it up to remove it.
3. Remove the locating pins on the top by using a screw driver.

Note: When the appliance is correctly leveled, there should be no slant, stickiness or rubbing sound when the door is opened.

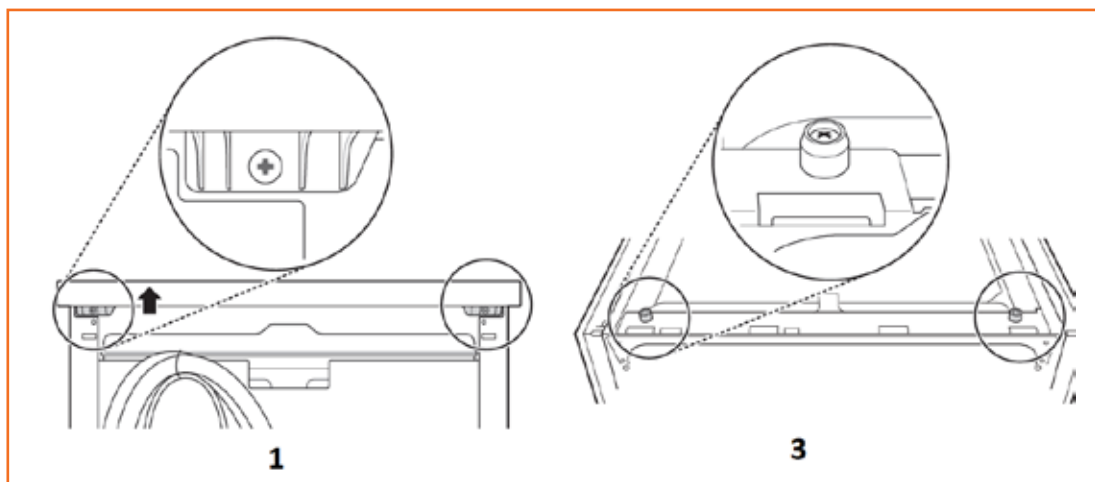


Fig 4.2.6 Removing top cover

Installing Moisture Barrier Tape (On Some Models)

When the appliance is installed without the top cover, the counter top underside may be damaged by steam or condensation when the door is opened.

Install the moisture barrier tape to the underside of counter top to protect the counter top from condensation when the appliance opened.

1. Clean and dry the underside of the counter top on which the tape will be attached.
2. Remove the protective film from the tape.
3. Install the tape to the underside of the counter top.

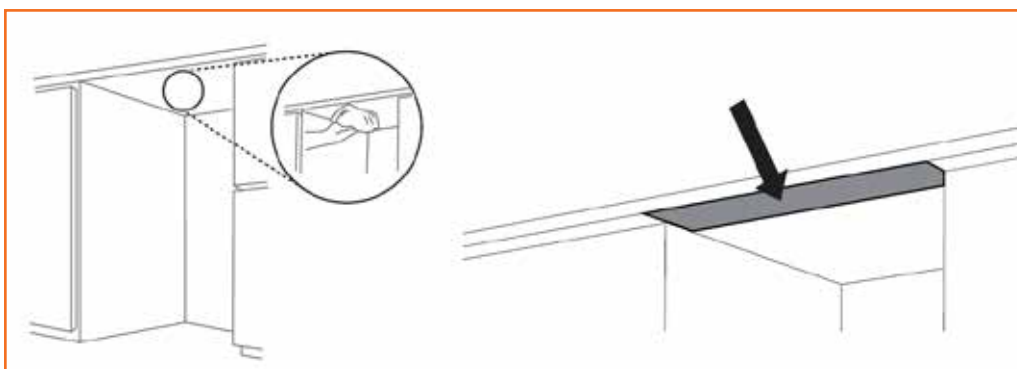


Fig 4.2.7 Installing moisture barrier tape

Levelling the Appliance

Levelling the appliance prevents unnecessary leakage and poor washing. Place the appliance on a solid, level floor. Do not install the appliance on an elevated surface.

If the appliance is not properly level, adjust all levelling feet as necessary. Turn them clockwise to raise and counter-clockwise to lower until the



Fig 4.2.8 Levelling of appliance

appliance no longer wobbles, both front-to-back and side-to-side and corner-to-corner.

Connecting Lines in the Sink Cabinet

1. Turn off the water supply line in the sink cabinet. Dishwashers normally connect to the water supply line under the kitchen sink. Reach into the sink cabinet and turn the water shutoff valve clockwise, then open the faucet to let any excess water drain.
2. Connect the dishwasher's water supply line to the water line or tap. Run thread seal tape (often called Teflon tape) clockwise over the threads of the open outlet, hand-tighten the supply line on the outlet, then use a wrench to tighten the supply line another quarter-to-half turn.

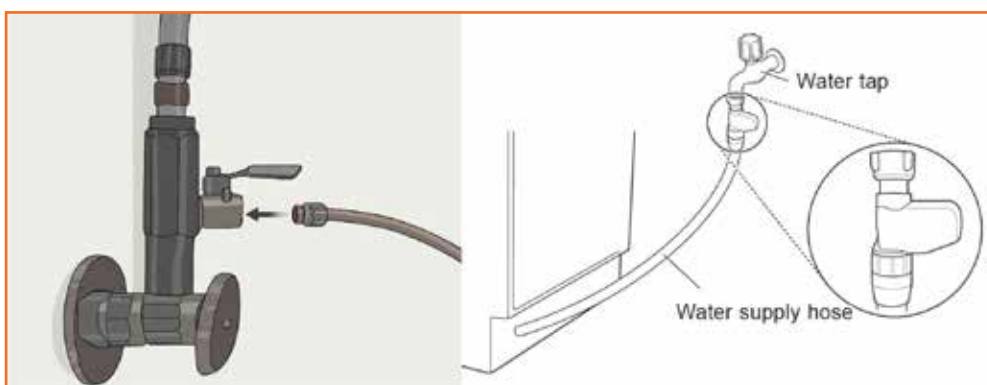


Fig 4.2.9 Connecting water supply line

3. Install a dishwasher drain hose to the sink's drainpipe.

- ❑ If the end of the drain hose does not fit to the drain line, use a drain extension kit (optional) that is resistant to heat and detergent.
- ❑ Check the waste spigot when initially installing. An error can occur when the waste spigot below the sink is not drilled out properly. To connect the drain hose, drill out at least a 15 mm diameter hole in the waste spigot before connecting and securing.

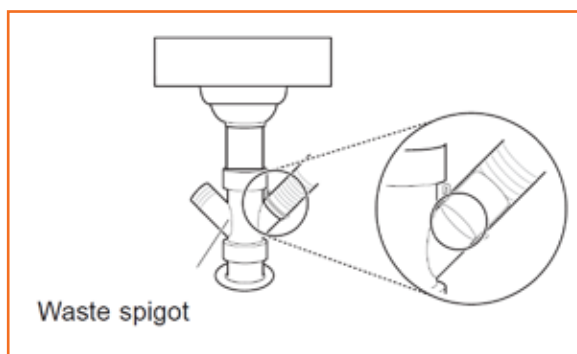


Fig 4.2.10 Installing drain hose

4. Strap the drain pipe under the sink so it's elevated above the tailpiece. Wrap a piece of plumber's strapping around the drain pipe and secure the strapping near the top of the under-sink cabinet with a screw or nail. This will create an upward arch in the drain pipe that rises above the tailpiece

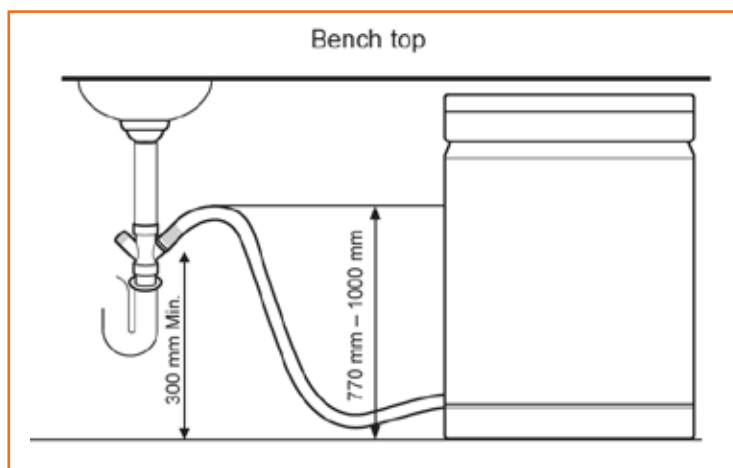


Fig 4.2.11 Installing drain hose

connection. This arch prevents drain water from backing up into the dishwasher.

5. Connect the appliance to an earthed socket in accordance with the current wiring regulations, protected by a minimum 15 amp circuit breaker or time delay fuse.
6. Slide the dishwasher into place and fine-tune its height and positioning. Push, wiggle, and maneuver the bulky appliance into the cabinet bay until the front of the dishwasher is flush with the front of the surrounding cabinets. When it's in place, check that the unit is level with the underside of the countertop and at the proper height. Use the front feet to make slight adjustments as needed.

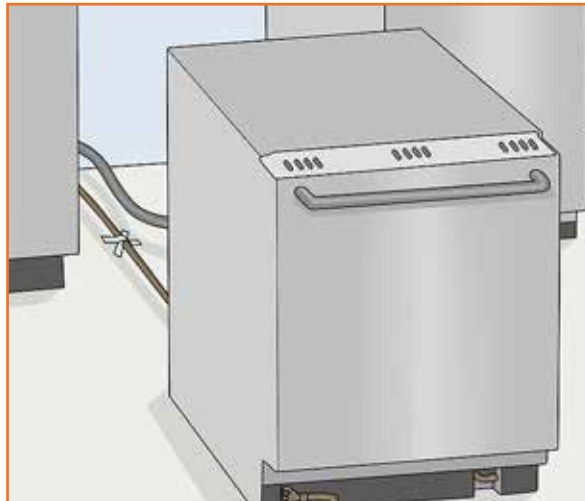


Fig 4.2.12 Placing dishwasher

Final Check

1. Turn on electrical power.
2. Turn on house water supply.
3. The door should open and close smoothly and without harsh noises, if the unit has been leveled correctly.
4. Run the appliance on a Rinse cycle to verify proper operation and check for leaks.

4.2.3 Operation of Dishwasher

After the installation process, technician has to explain the operation, security features and use of control panel of dishwasher:

1. Press the power button. The unit will turn on and check the indicators.
2. Check that there is rinse aid and dishwasher salt present. Refill the rinse aid and the salt, if the corresponding icons illuminate.
3. Open the door and check the filters. Always clean the filter either after a wash or before a wash so that it does not impair the washing performance.
4. Ensure the spray arms are rotating properly.

5. Load the dishes in the rack.
6. Add the proper amount of detergent powder to the dispenser.
7. Set and start the programme.

Control Panel

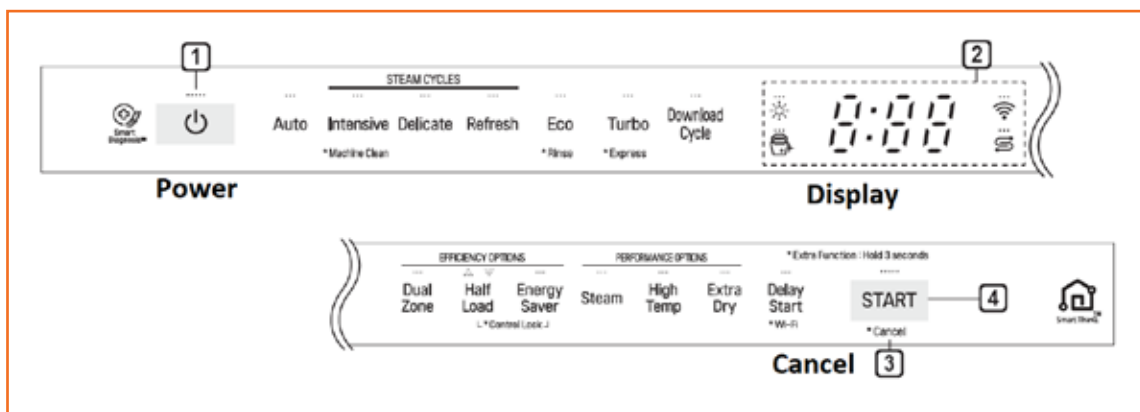


Fig 4.2.13 Control panel

Cycles

- **Auto:** This cycle senses the soil amount and water clarity and optimizes the wash to achieve the best cleaning. The wash time may vary depending on the soil level.
- **Intensive:** This cycle is for heavily soiled dishes and dishes with hardened on soil. The Heavy cycle defaults to the strongest spray intensity and uses it to wash heavily soiled dishes.
- **Delicate:** Use this cycle to clean delicate items such as fine china and stemware.
- **Refresh:** This cycle freshens up and warms dishes that have been unused for a long time.
- **Eco:** It provides the most efficient energy and water consumption for a good washing performance and drying result on a normally soiled load and as it uses very little energy.
- **Turbo:** This cycle will clean moderately soiled dishes using slightly more energy and water.
- **Download Cycle:** Use a dedicated cycle downloadable via Wi-Fi or NFC. (depending on model).
- **Machine Clean:** This cycle is for cleaning the inside of the appliance. Use the cycle without dishes in the appliance. It eliminates residual soils, odor, white spots, and other dirt.
- **Rinse:** This cycle is a quick rinse only for dishes that will not be washed immediately. The cycle rinses dishes that have excess soil to soften dried on residue. Rinsing the dishes helps prevent odors in the appliance. Do not use detergent with the Rinse function.
- **Express:** This cycle will quickly clean lightly soiled dishes.

Loading the Dishwasher

For effective washing performance, always follow the instructions.

- Remove large particles of food debris from plates including bones etc. before loading. Always rinse off plates when loading if they are not to be washed immediately.
- Items with burnt on food should be soaked prior to loading in the appliance.

- Deep based items should be placed upside down.
- Plastic items will not dry well, compared to other items.
- Make sure that all items do not touch each other.

Do not wash the following items.

- Copper or anodised aluminium
- Hand painted silver or gold leaf crockery
- Wood or bone handled utensils
- Iron or non rust proof utensils
- Plastic items which are not appliance safe
- Expensive ware such as silver and dishes with golden rings
- Fragile item such as crystal glasses

Scan the QR code or click on the link to watch related videos



<https://www.youtube.com/watch?v=9UUyDUhw7-Q>
Installation of dishwasher

UNIT 4.3: Troubleshooting and Repairing of Dishwasher

Unit Objectives

At the end of this unit, participants will be able to:

1. Demonstrate servicing of dishwasher
2. Demonstrate procedure of troubleshooting and repairing of faults in dishwasher

4.3.1 Servicing of Dishwasher

Cleaning the Exterior

The exterior of the appliance can be cleaned with a soft damp cloth or sponge, then dried with a soft cloth. If the appliance has a stainless steel exterior, use a stainless steel cleaner.

Cleaning the Interior

Clean the interior of the appliance with a soft, damp cloth or sponge to remove food and dirt particles.

Food residue may be stuck in the narrow gaps inside the appliance after completion of washing. Wipe off all food residue.

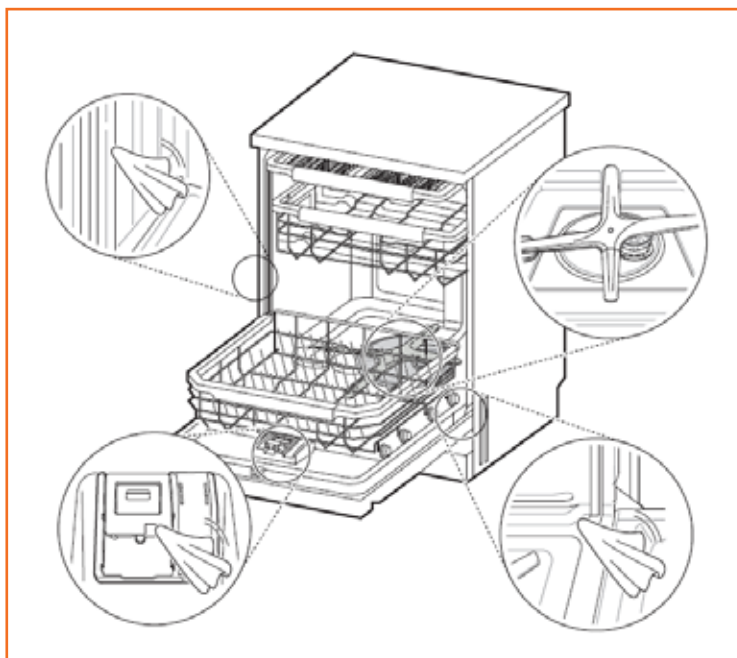


Fig 4.3.1 Cleaning of dishwasher interior

Cleaning the Filters

1. Remove the lower rack and position the bottom spray arm so a wider vee is open to the front.
2. Turn the inner filter counter-clockwise and take out the assembled inner filter and

stainless steel filter.

3. Clean the filters with a soft brush under running water. Reassemble the filters before reinstalling them.

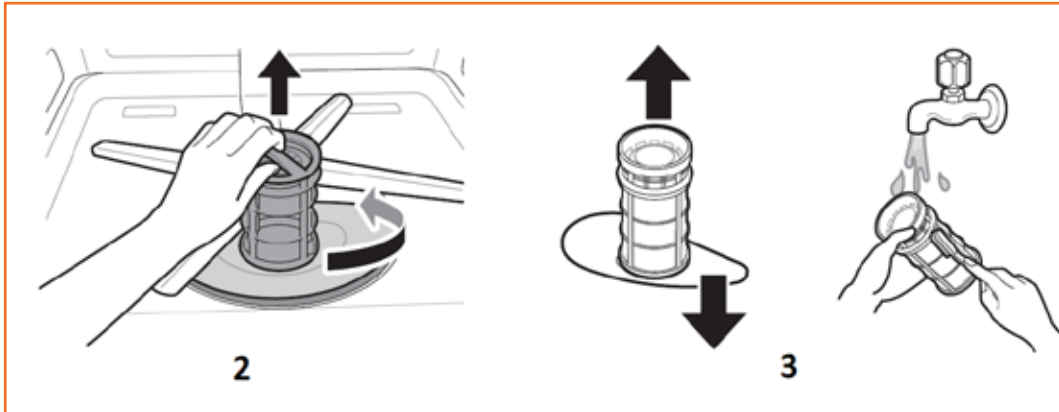


Fig 4.3.2 Cleaning of filter

4. To replace the assembled filters, position the spray arm so the wider vee is toward the front. Fit the filters back into the filter holder and secure them by turning the inner filter clockwise until it clicks into place.

Cleaning the Lower Spray Arm

1. Make sure that the water jet holes are not blocked by food particles.
2. If any food residue blocks the spray arm holes, remove it with a pin or any sharp tool.

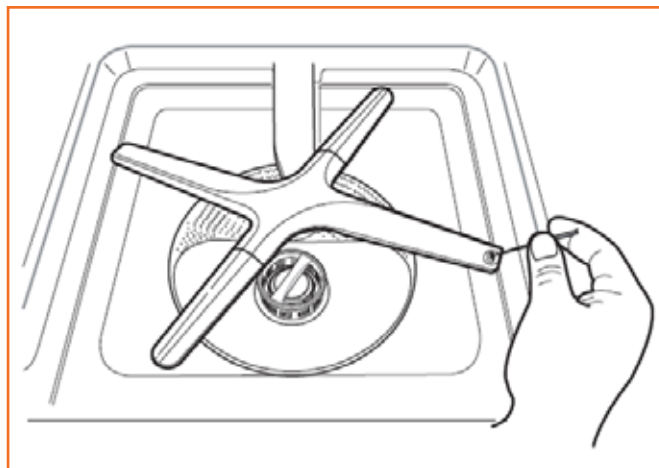


Fig 4.3.3 Cleaning lower spray arm

Cleaning the Upper Spray Arm

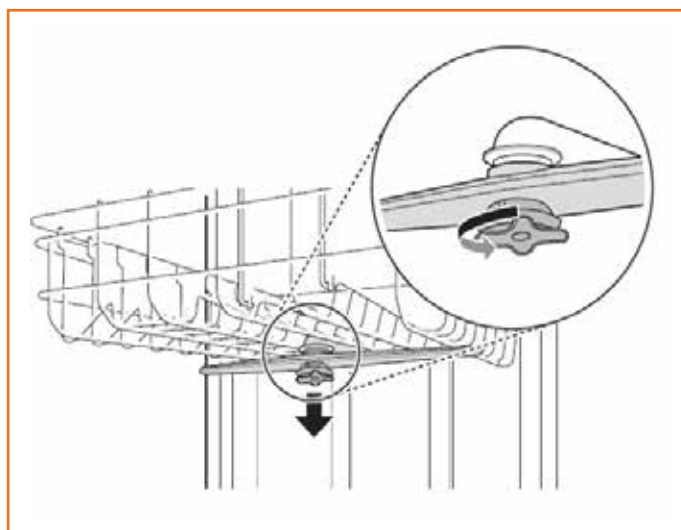


Fig 4.3.4 Cleaning upper spray arm

1. Pull the upper rack forward. Make sure that the water jet holes are not blocked by food particles.
2. When cleaning is necessary, remove the upper spray arm by turning the nut on the bottom of the spray arm.
3. Remove food particles by rinsing or shaking the spray arm.
4. If any food residue blocks the spray arm holes, remove it with a pin or any sharp tool.
5. After removing the food residue, clean the spray arms holes under running water.
6. After cleaning the upper spray arm, fix it back into place.
7. After assembly, check whether the spray arms rotate freely.

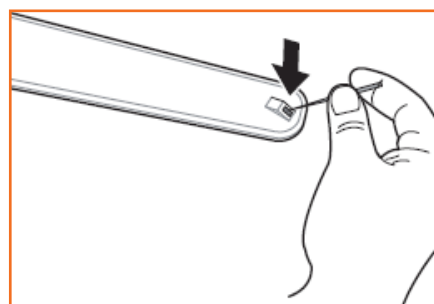


Fig 4.3.5 Cleaning spray arm holes

Cleaning the Water Supply Hose Filter

1. Unplug the appliance.
2. Turn off the water tap.
3. Unscrew the water supply hose.
4. Remove the seal and the plastic filter with a pair of small pliers or scissor grips.
5. Refit the filter and gasket and make sure that it is sitting correctly.
6. Refit and secure the water supply hose in reverse order.

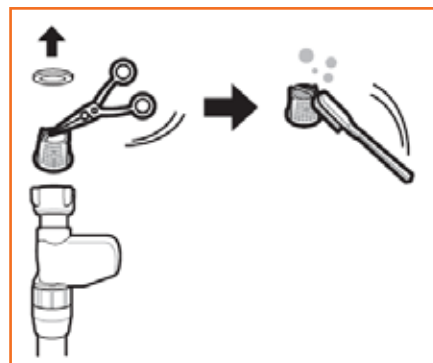


Fig 4.3.6 Cleaning water supply hose filter

4.3.2 Troubleshooting and Repairing of Faults

There are many different ways that a dishwasher would go wrong. Each issue has multiple possible causes. Let's take a look at the possible causes and solutions for the dishwasher problems.

Problem	Possible Cause	Solutions
Appliance will not operate.	Door is not completely closed.	Level the appliance again.
	Power supply or power cord is not connected.	Connect the power supply or cord properly.
	When the Control Lock feature is activated, the display code will show on the display.	Deactivate the Control Lock button. Press and hold Half Load and Energy Saver simultaneously for 3 seconds to activate or deactivate Control Lock.
	Fuse is blown or circuit breaker tripped.	Replace the fuse or reset the circuit breaker.
Appliance continuously beeps when the door is opened, during or right after a cycle has completed.	The contents of the appliance are hot and care should be used when placing your hands inside the appliance.	Close the door until the appliance and dishes have cooled down. The beeping will stop if the door is closed or the interior temperature has cooled.
Water remains in sump after completion of cycle.	Drain hose is kinked or clogged.	Adjust hose or clear blockage.
	Water may remain if the power supply was lost before normal end of the course or was manually disconnected.	Re-start the course.
Sprays arms do not rotate smoothly.	Holes of spray arms are blocked by food particles.	Clean the holes of spray arms.
Upper rack is crooked.	Rack is poorly adjusted.	See the Height Adjustable Upper Rack section.
Lamps do not illuminate.	Power is not connected.	Connect power supply.
There is excessive foam inside the appliance.	Failure to use the detergent exclusive for appliance.	Use the detergent exclusive for appliance.
	An excessive amount of rinse may cause foam.	Reduce the rinse aid dispensing level.

Problem	Possible Cause	Solutions
Detergent is left in the detergent dispenser.	Unbalanced upper rack.	Adjust the left/right height of the upper rack.
	Detergent may not be dispensed because poor stacking of the dishes prevents automatic opening of the detergent dispenser.	Correctly arrange the dishes and always dry out the dispenser before adding new detergent so that it does not clump together.
Water leaks outside the appliance.	The door may not be closed due to tilted appliance. In this case a water leak may occur.	Check the leveling by adjust the leg.
	Wrong installation of drainage hose may cause water leak.	Check the connecting part of drainage hose.
	If the power is off, a water leak may be caused by a poor connection to the tap.	Check the connection water supply hose.
Cloudiness on glassware.	Combination of excessive detergent and hard water.	Use less detergent and use a rinse aid to minimize the problem. Check the setting of softening system.
Black or gray marks on dishes.	Aluminum items rubbing dishes during cycle.	Reposition the dishes.
Yellow or brown film on inside surfaces of appliance.	Coffee or tea stains.	Eliminate the stain by using a stain removal product.
Yellow water remains inside the dishwasher	When initially using the appliance, Yellow water may generate in the water softener tank.	This is a normal condition, and it is harmless to humans. It disappears after 1~3 cycles.

Problem	Possible Cause	Solutions
Spots and filming on dishes.	Wrong amount of detergent used.	Use the recommended amount of detergent.
	Overloading.	Do not overload the appliance.
	Improper loading.	See the Operation section.
	Insufficient water pressure.	Water pressure should be between 20 and 80 psi.
	Insufficient detergent.	Add the recommended amount of detergent. See the Operation section.
	Rinse aid dispenser is empty.	Refill rinse aid dispenser.
	The water softener has no salt or insufficient the salt.	Check whether there is the salt in the water softener.
	Water hardness level may be set too low.	Increase the hardness level setting value.
	The rinse aid may be insufficient.	Refill the rinse aid or increase the dispensing level.
	Hard water buildup in the tub	Remove all dishes, cutlery basket and cutlery basket holder from appliance. Only racks should remain in tub. For best results, use citric acid powder (can be found in canning sections of most grocery stores or online). Measure 3 tablespoons (45 g) of citric acid powder. Fill main wash compartment with measured powder. If you cannot find citric acid powder, pour approximately $\frac{3}{4}$ - 1 $\frac{1}{4}$ cups (200-300mL) of white vinegar into shallow bowl and place in upper rack. Run Auto cycle. Do not use detergent. When the cycle finish, run it again.

Problem	Possible Cause	Solutions
Odor	The previous cycle was stopped before completion and residual water remains in the appliance.	Turn on the power, run the Cancel cycle option to remove the residual water, then run the Quick cycle using detergent but with the appliance empty.
	There is food in the bottom of the unit or in the filter.	Clean the filter and the interior according to the Maintenance section of the owner's manual.
	Unwashed dishes are left in the unit for a long time.	Cycle with one cup of white vinegar in an appliance safe glass or bowl placed on the upper rack. (Vinegar is an acid, and with constant use it could damage your appliance.)
Food soil remains on dishes.	Improper cycle selection.	Select correct cycle based on soil level and type of dishware being washed.
	Water temperature is too low.	Check water supply connection or water heater setting.
	Dishwashing detergent was not used.	Use recommended detergent.
	Low inlet water pressure.	Water pressure should be between 20 and 80 psi.
	Water jet holes on spray arms blocked.	Clean the spray arms.
	Improper loading of dishes.	Make sure dishes do not block spray arm rotation or interfere with detergent dispenser.
	Filters are clogged.	Clean filters.
	Too much Unremoved food debris on dishes.	Large particles of food residues should be removed from the dishes before starting wash.

Problem	Possible Cause	Solutions
Noise	Some level of noise is normal during operation.	Detergent cover opening. Drain pump at the beginning of drain cycle.
	The appliance is not level.	Adjust leveling feet.
	Nozzle arm knocking against dishes.	Reposition the dishes.
	Water pressure is too high.	Adjust water pressure.
Dishes don't dry.	Rinse agent dispenser empty.	Check and refill the rinse agent dispenser if empty. For better drying result, slightly open the door after operation.
	Tablets used may not have a built in rinse aid. This will reduce the drying performance.	Change to a tablet that includes a rinse agent (contact the tablet manufacturer if unsure). Alternatively, you can use a liquid rinse agent in the dispenser if the tablets don't have a rinse agent-built in.
	A cycle without the Extra Dry option was selected.	Select a cycle that defaults to the Extra Dry option.

Error Codes

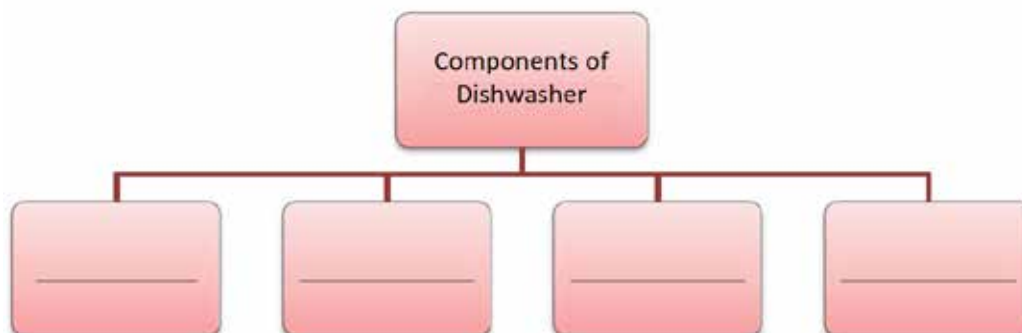
Problem	Possible Cause	Solutions
	Water inlet problem.	Check for a clogged, kinked or frozen water supply hose. Check water supply.
 Waste spigot is clogged. Remove knockout on waste spigot. Filters are clogged. Clean Filters.	Drainage Problem.	Check for a clogged, kinked or frozen drain hose.

 To remove detergent residue in the tub, pour approximately 100~200 ml of milk into a shallow bowl, place it to the upper rack and then run the appliance on the Auto cycle. Failure to level appliance. Make sure that the appliance is properly leveled.	This is caused by improper detergent, such as liquid dish soap.	Do not use hand dishwashing liquids. Only use detergents which are designed for use in automatic dishwashers.
	Heater circuit failure.	If the voltage exceeds 300V, heater operation is temporarily stopped to prevent heater burnout. If this is repeated for a long time, an HE error may occur.
	Excessive Water supplied.	Call for service if the same problem occurs again.
	Water leakage problem.	
	Thermistor failure	
	Motor trouble	
	Vario motor trouble	

Exercise



1. Write the basic components of a dishwasher in the space provided in the following figure.

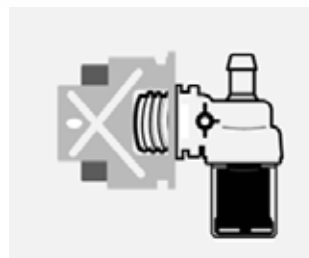


2. Identify the components of a dishwasher and write their names in the space given below their images.









3. Perform a check of water leaks in a dishwasher.

5. Install and Repair Air Conditioner and Water Purifier



Unit 5.1 – About Air Conditioner (AC)

Unit 5.2 – Installation and Repairing of Window AC

Unit 5.3 – Installation and Repairing of Split AC

Unit 5.4 – About Water Purifier

Unit 5.5 – Installation and Operation of Water Purifier

Unit 5.6 – Troubleshooting and Repairing of Water Purifier



Key Learning Outcomes



At the end of this module, participants will be able to:

1. Define the factors for air conditioning
2. Define heat load and comfort zone of ACs
3. Describe the types of ACs
4. Demonstrate procedure of installing a window AC
5. Demonstrate troubleshooting and repairing of window AC
6. Demonstrate procedure of installing a split AC
7. Demonstrate troubleshooting and repairing of split AC
8. Describe use and function of water purifier
9. List parts of a water purifier
10. Demonstrate procedure of installing a water purifier
11. Demonstrate how to setup and use the features of water purifier
12. Demonstrate procedure of troubleshooting and repairing of faults in water purifier

UNIT 5.1: About Air Conditioner (AC)

Unit Objectives

At the end of this unit, participants will be able to:

1. Define the factors for air conditioning
2. Define heat load and comfort zone of ACs
3. Describe the types of ACs

5.1.1 Factors for Air Conditioning

Air conditioning typically means modifying (cooling or heating) the air inside a closed environment. This modification is affected by four factors, as shown in the following diagram -

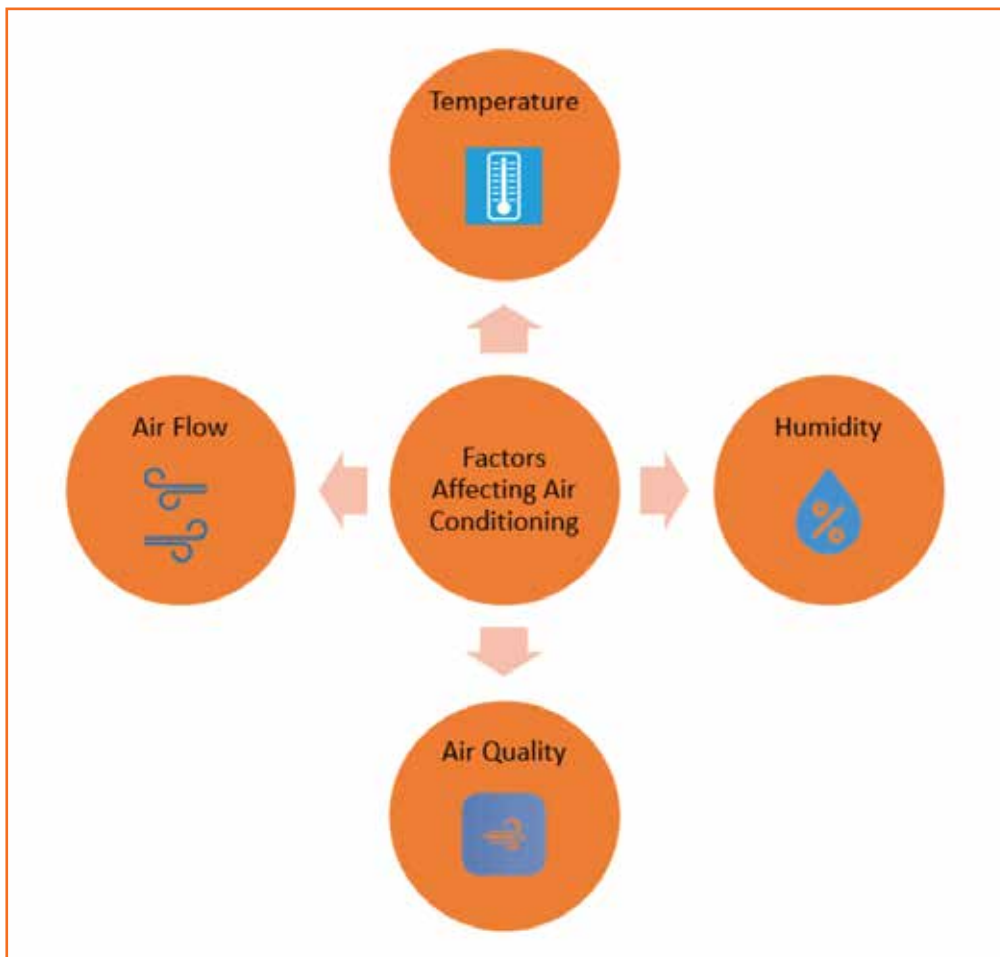


Fig 5.1.1 Factors affecting air conditioning

The preceding factors decide the working of the ACs as well as how effective the ACs would be in that closed environment.

For example, typically, ACs should lower the temperature in summers and increase the temperature in winters for a closed room or space. The decrease in temperature is done by removing the humidity and heat that is generated by the environment and living beings (such as humans and their pets) existing in that environment. ACs should also work to improve the air quality, by removing odour and dust particles suspended in the air due to heat. Lastly, ACs need to ensure that there is proper air movement and circulation to avoid any suffocation due to air modification.

5.1.2 Heat Loads and Comfort Zones

Any physical activity, running home or commercial appliances, lighting, sun light/rays, open windows and other factors, which contribute to heat generation in a confined space or room is called heat load, as shown in the following image -

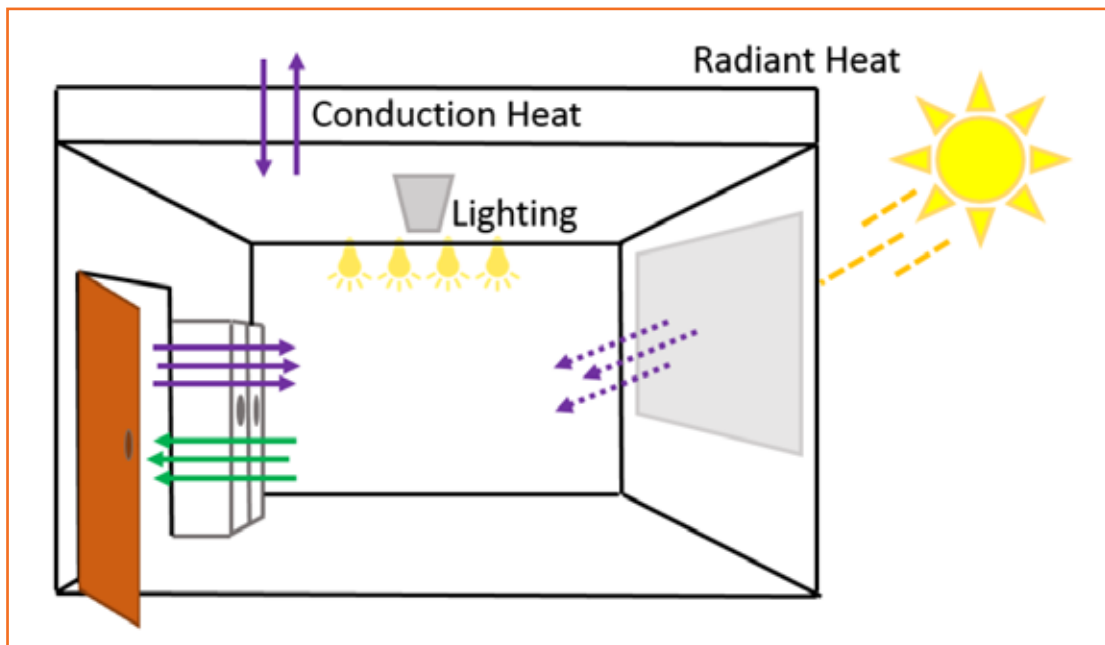


Fig 5.1.2 Heat loads

Typically, the following factors in a home or office environment contribute to the heat load:

- Area of the space
- Running appliances (such as computers)
- Entry area for sun rays/light, such as windows, ceilings and so on
- People
- Activity/movement in the room, such as moving furniture, frequent opening of the door/windows and so on
- Artificial light used to illuminate the room

The capacity of ACs needed to cool the room/space, depends on the preceding factors.

Higher is the number and intensity of these factors, more is the capacity of the AC needed to cool the room.

The capacity of ACs is measured in terms of ton, which means the amount of heat that an air conditioner can remove from a confined space within an hour.

Comfort zone is achieved when the internal conditions, air and environment, of a room or closed space is controlled to maintain a comfortable temperature for the occupants irrespective of the outdoor weather or temperature, as shown in the following image -



Fig 5.1.3 Comfort zone

5.1.3 Types of ACs

There are primarily two types of ACs used in a home and office environment:

- Window ACs, as shown in the following image -

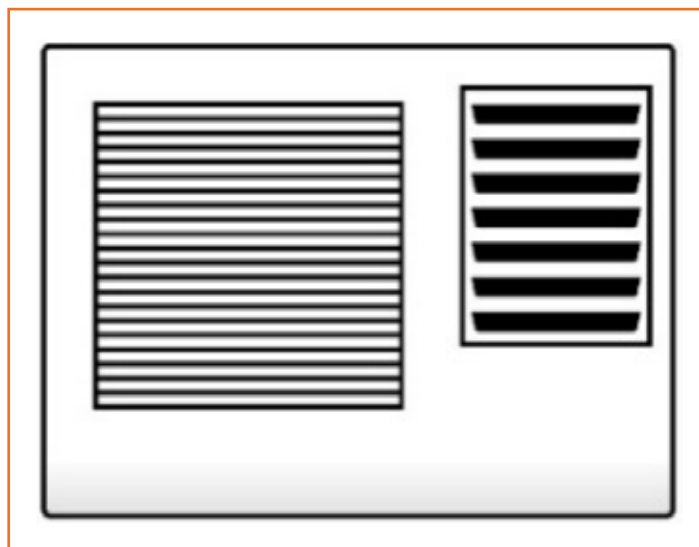


Fig 5.1.4 Window AC

- Split ACs, as shown in the following image -

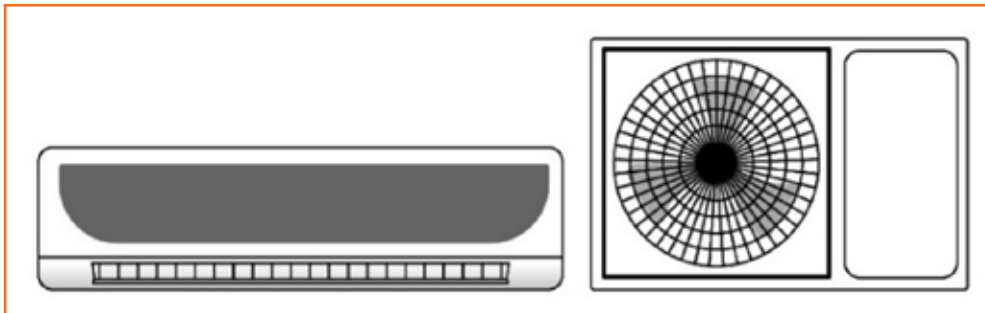


Fig 5.1.5 Split AC

The working of the ACs, window or split used in homes or offices, is shown in the following diagram:

The ACs shown in the preceding images work on a principle of reverse cycle or heat pumps.

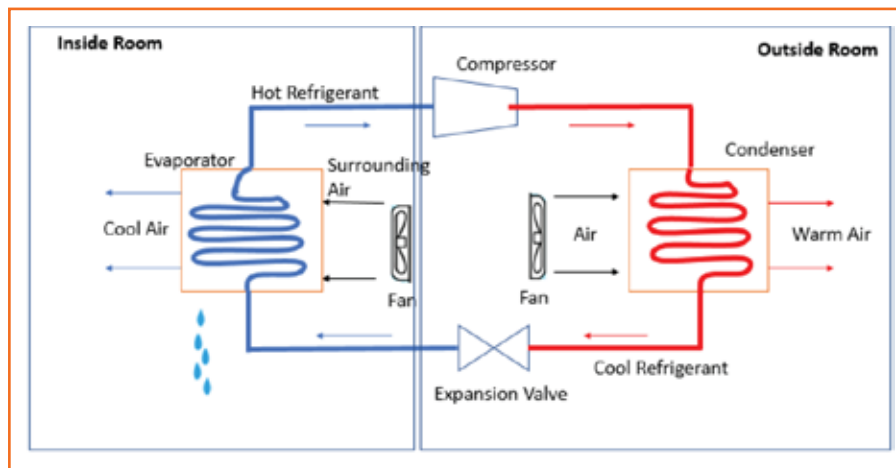


Fig 5.1.6 Working of AC

They work by taking the heat from the air outside and transferring it into a closed space. These ACs use a refrigerant to cool the air that is being transferred inside. An additional feature that these ACs may have to filter the air inside. Every AC contains a compressor inside its unit that is used for compressing and pumping the refrigerant gas. The following figure shows the steps of a refrigeration cycle -

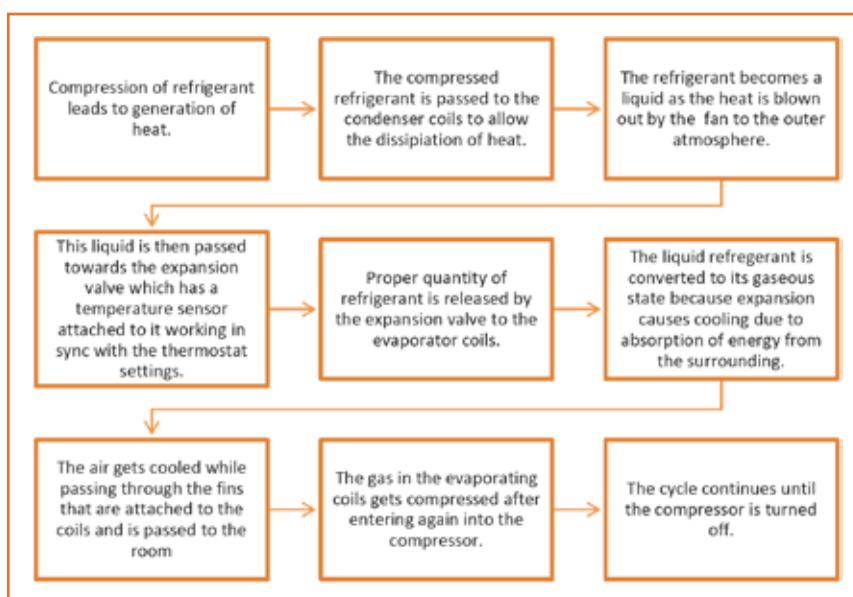


Fig 5.1.7 Steps of refrigeration cycle

Heat is drawn by the air conditioner from the indoor and is released to the outdoor. The indoor plays as a source and the outdoor acts as a heat sink.

UNIT 5.2: Installation and Repairing of Window AC

Unit Objectives



At the end of this unit, participants will be able to:

1. Demonstrate procedure of installing a window AC
2. Demonstrate troubleshooting and repairing of window AC

5.2.1 Parts of a Windows AC

Before going for installation of a window AC at a customer site, ensure that the instructions shown in the following figure

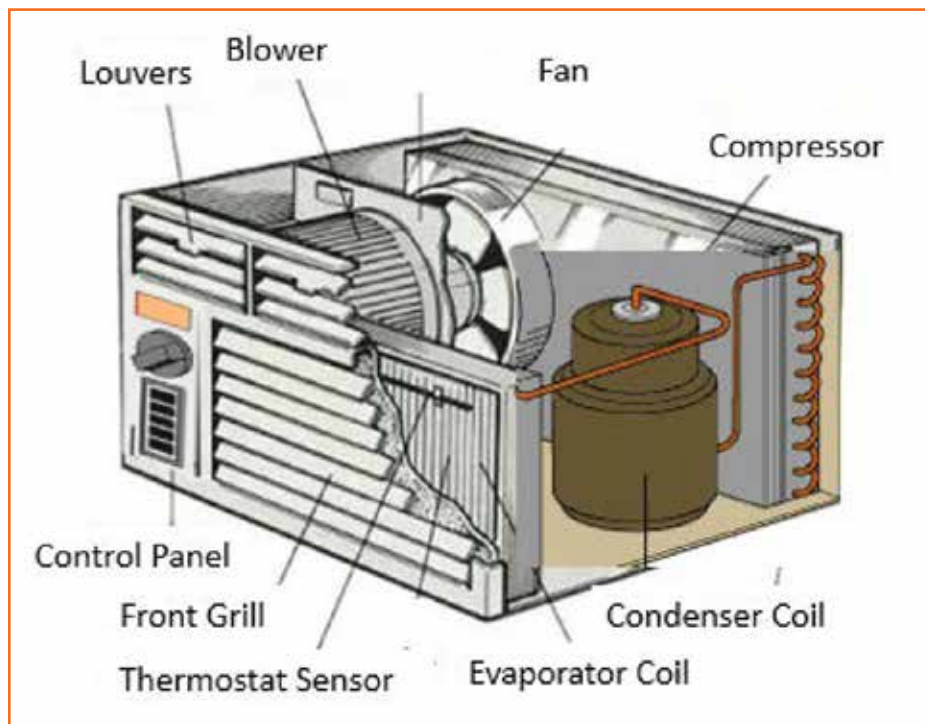


Fig 5.2.1 Parts of a window AC

- **Compressor:** The compressor used in window air conditioner is of hermetic type. The refrigerant vapour is compressed to high pressure and temperature in the condenser.
- **Air-cooled condenser:** It is used to cool the high-pressure high temperature refrigerant vapour. It is continuous coil made of copper tubing. A propeller type fan is used to draw the necessary air from atmosphere to cool the refrigerant.
- **Capillary tube:** It is an expansion device. It is used to reduce the pressure and temperature of the refrigerant.
- **Evaporator:** It is cooling coil made of copper. A centrifugal blower is installed behind the coil to deliver cool air from the evaporator to the room. The blower also sucks warm air from the room

and sends it to the evaporator through a Filter.

- Fan Blower is a centrifugal evaporator blower to discharge the cool air to the room.
- Control Panel is used to control the temperature and speed of the blower fan. A thermostat is used to sense the return air temperature and another one to monitor the temperature of the coil. Type of control can be mechanical or electronic type.
- **Filter:** Drier is used to remove the moisture from the refrigerant.
- Drain Pan is used to contain the water that condensate from the cooling coil and is discharged out to the outdoor by gravity.
- Condenser Coil is used to reject heat from the refrigeration to the outside air.
- Propeller Fan is used in air-cooled condenser to help move the air molecules over the surface of the condensing coil.
- Fan Motor has a double shaft where the indoor blower and outdoor propeller fan are connected together.
- **Expansion Valve:** In between the condenser and evaporator, there is another little gadget called an expansion valve. As the refrigerant is now a liquid, it will be unable to absorb the heat. In the expansion valve, the refrigerant expands into gas after facing a drop in pressure and is also rapidly cooled. This gaseous, cooled refrigerant then goes into the evaporator coils to repeat the air conditioning process.
- **Refrigerant:** It is the substance that actually does the cooling. It runs within a network of copper or steel tubes within the air conditioner and has certain properties that make it able to be compressed and expanded to cool or heat a room. Common refrigerants include R32, R-410A and R-22, the latter of which is slowly becoming obsolete.
- **Thermostat:** The thermostat is responsible for maintaining your desired indoor temperature. This is where you inform your AC unit of your cooling preference, and it accordingly switches the AC on or off to maintain the best indoor temperature. With in-built temperature and humidity sensors, it can easily read your room's temperature.

5.2.2 Pre-requisites for Installation

Before going for installation of a window AC at a customer site, ensure that the instructions shown in the following figure are performed -

- Carry all tools and personal protective gear required, neatly organized
- Check that all tools and equipment, such as a drill, is working properly
- Ensure all the units have been delivered before visiting the site
- Check the packing to see if it is proper and has not been tampered or damaged
- Carefully unpack the unit and its parts, such as remote, grill, filter, and so on
- Wear insulated shoes for installation

- Ensure there is a step ladder available if installation is to be installed at a height

Before starting the installation, following tools are necessary:

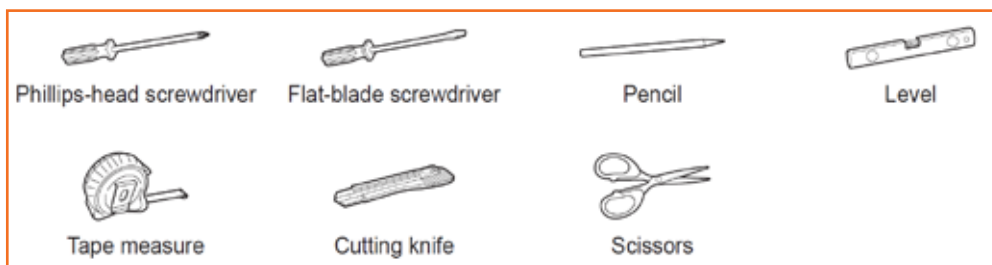


Fig 5.2.2 Tools required during installation

Before installation, ensure you have carefully examined the site for installation and checked all conditions for installations, such as proper availability of space for indoor and outdoor unit, proper electrical points available, proper window/hole in wall available, and so on.

The installation of a window AC looks similar to the one shown in the following diagram and the specified dimensions should be maintained while installing -

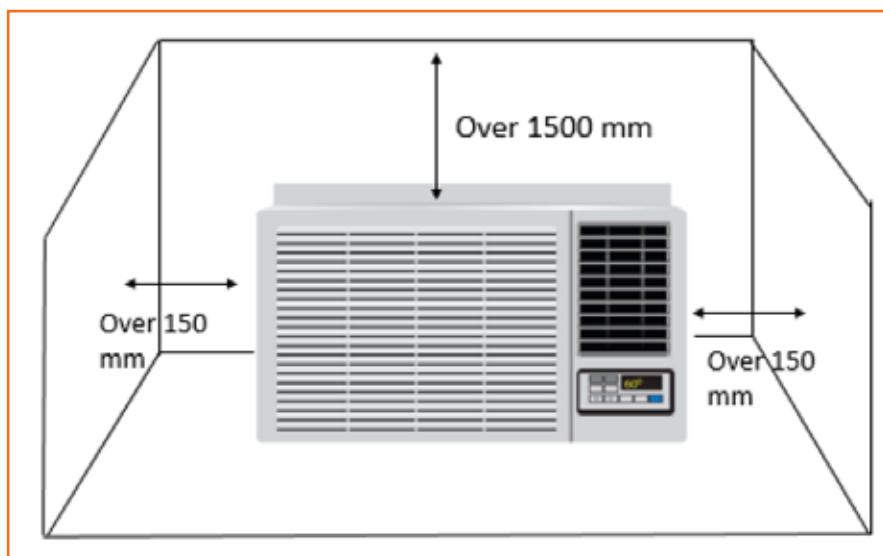


Fig 5.2.3 Specification of dimensions of the AC unit

The installation process consists of unpacking the unit, disposing the packing material and installing the window AC at the designated place.

The installation of a window AC looks similar to the one shown in the following diagram and the specified dimensions should be maintained while installing -

Unpacking window AC

To protect the window AC from any kind of damage, it is properly packed and delivered. Once it is transported from the delivery truck, it needs to be carefully unpacked.

The following are the tools that are needed for unpacking and handling a window AC:



Fig 5.2.4 Requirements for handling AC

Steps for unpacking and installing a window AC:

1. Unbox the box by keeping it on a smooth and fair surface. Remove the packing strip and cut the tapings on the upper face with the help of a knife or sharp object.
2. Tilt the box and remove the tapings applied on the base with the same sharp object.
3. Take out all the accessories from the box.

Note: Accessory items may vary depending upon model.

4. Now, hold the thermocol sheet (polystyrene base), remove the box. Gently, keep the window AC horizontally, remove the thermocol sheets from both ends. Once you have removed out the thermocol sheet carefully and gently, remove the poly packing. Handle the product with care. Now you are ready for the core installation process.
5. Check and understand the symbols on the package to know about the cautions and warnings related to the installation. The symbols along with their meanings are shown in the following images -

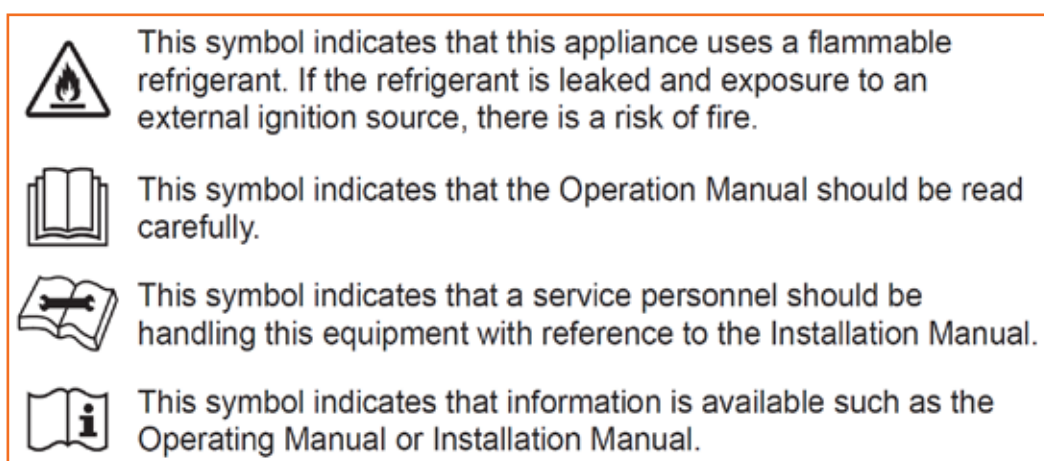


Fig 5.2.5 Safety warning on packaging

5.2.3 Installation Process

Circuit Breaker Installation

A circuit breaker must be installed between the power source and the unit if the plug is not used.

Note: Circuit breaker should be as per AC capacity.

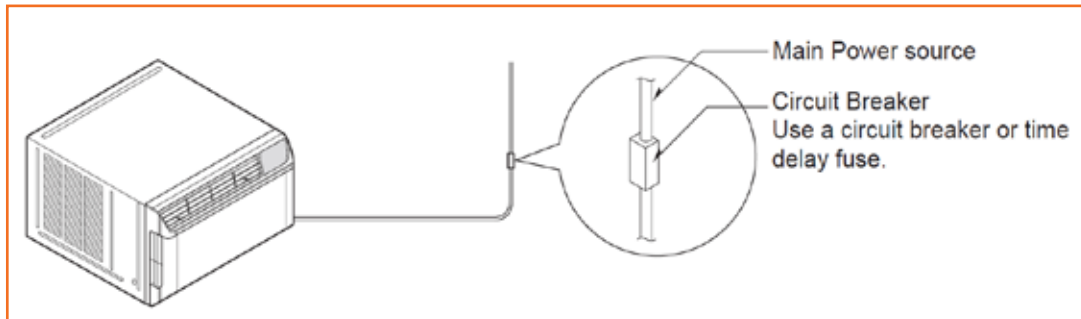


Fig 5.2.6 Installing circuit breaker

Installation of the Unit

- Measure the space for installation to assure a good fit. The air conditioner must be installed firmly into place to prevent vibration and noise.
- Avoid exposure to direct sunlight.
- Remove all obstacles from the rear of the unit. There must be at least 50 cm (20 in.) of cleared space around the rear of the unit. Obstacles restricting the airflow may reduce the cooling efficiency of the unit.

The unit should be installed with a slight tilt towards the outside to allow condensed water to drain. (About 10~15 mm or 1/4 bubble with Level).

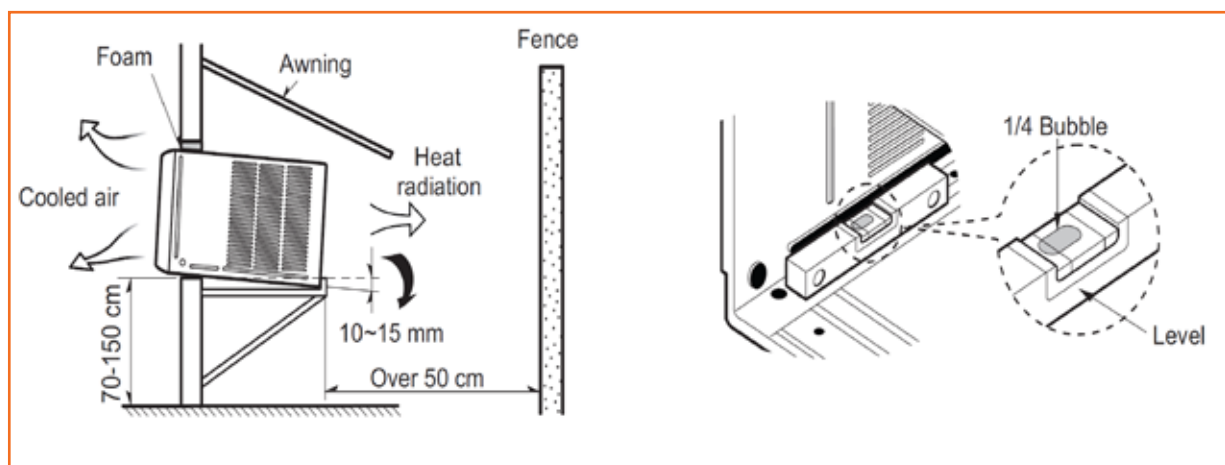


Fig 5.2.7 Installing AC unit

Preparation of the Cabinet

1. Remove 4 screws which fasten the cabinet at both sides and at the back. (Keep the screws for later use.)
2. Slide the unit from the cabinet by gripping the base pan handle and pulling forward while bracing the cabinet.

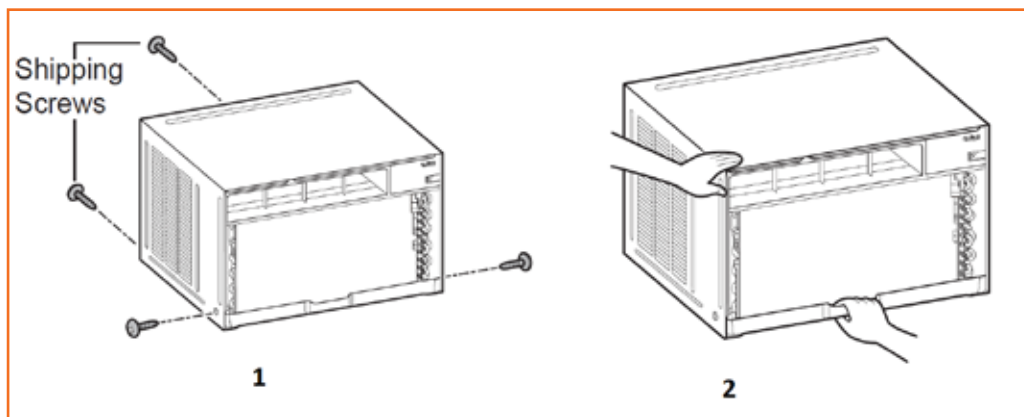


Fig 5.2.8 Preparing cabinet

Installation of drainage

The base-pan may overflow due to high humidity. To drain the excess water, remove the drain cap from the base pan of the unit and secure the Drain Pan.

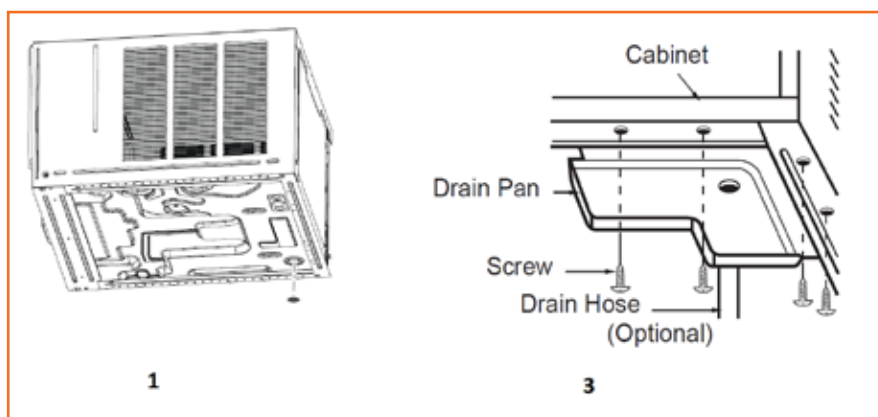


Fig 5.2.9 Installation of drainage

1. Remove the rubber cap from the hole under the base-pan.
2. Install the drain pan over the corner of the cabinet with 2-4 screws.
3. Connect the drain hose to the outlet located on the bottom of the drain pan.

Installation of unit

1. Remove the AC carefully from its packaging.
2. Remove the glass/grill from the window where the AC needs to be installed.
3. Ensure that the hole/window is as per the dimensions required by the AC. If the hole/window is bigger, then apply proper wooden panelling or insulation around it to make it fit for the AC's size.

4. Analyse the frame of the hole/window to ensure that it has enough strength for holding the weight of the AC unit.
5. Fix the outer casing of the AC to the frame of the window. Ensure that it is firm and properly fixed. The casing needs to be fixed strongly so that it can take the whole weight of the AC.

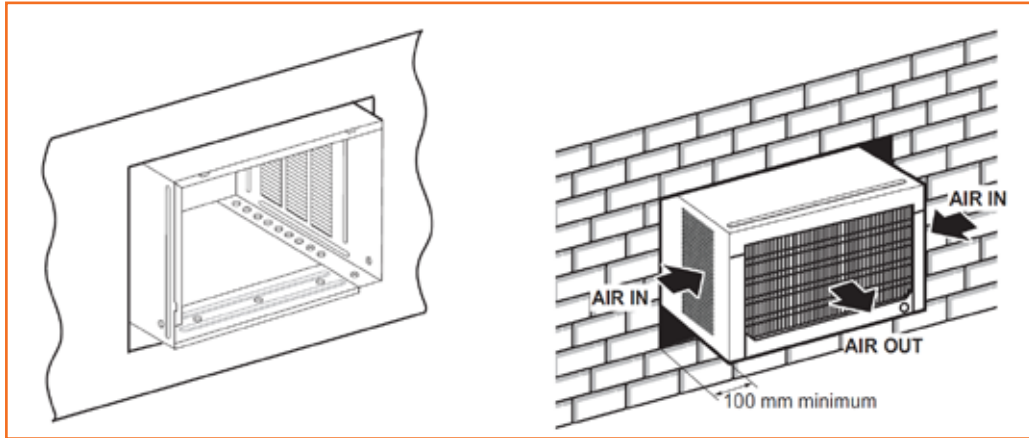


Fig 5.2.10 Fixing AC in cabinet

6. In case the hole is in a wall, then the casing needs to be fitted into the wall by drilling strong holes in the wall and securing the casing with strong screws.
7. Also, ensure that the casing is tilted at a small angle (2-3 degrees) on the outside (back of the AC). This would ensure that the dew collected from the cooling coil is drained outside from the drain tray and pipe.
8. Using a colleague help, pick up the main AC unit and slide it in the casing carefully. Reinstall the 2 screws removed earlier on each side of the case.
9. Connect the electrical wires to the control panel.

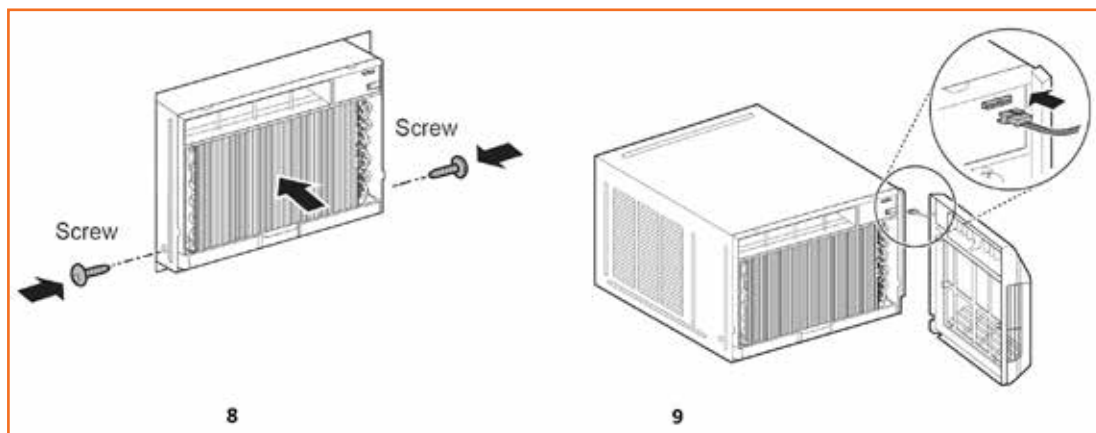


Fig 5.2.11 Installing AC

10. Attach the front grille assembly to the cabinet by inserting the grille tabs into the slots on the front of the cabinet. Push the grille in until it snaps into place.

11. Open the air inlet grille and secure the front grille assembly with 2 screws.

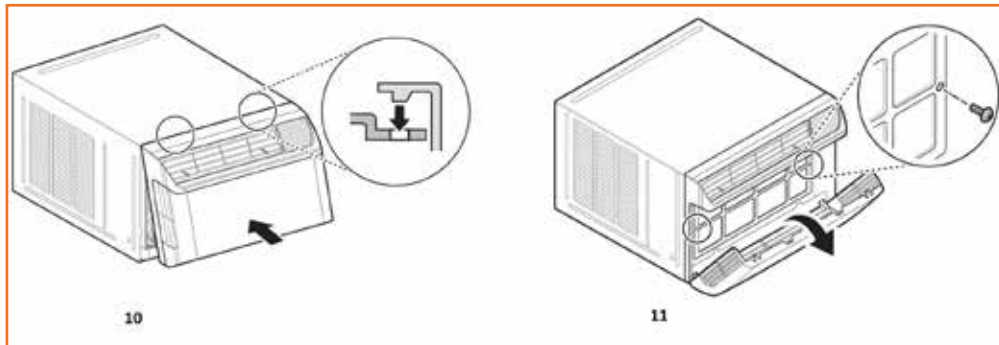


Fig 5.2.12 Installing AC

12. Connect the power supply to the AC's cord. Check if the AC is working.

5.2.4 Test-run a Window AC

After installation of the AC, it is important to check if the AC is functioning properly and if it's controls (such as the remote) is also working properly. Moreover, you should also explain the basic functions of the AC to the customer after installation.

To test-run the AC, perform the following steps:

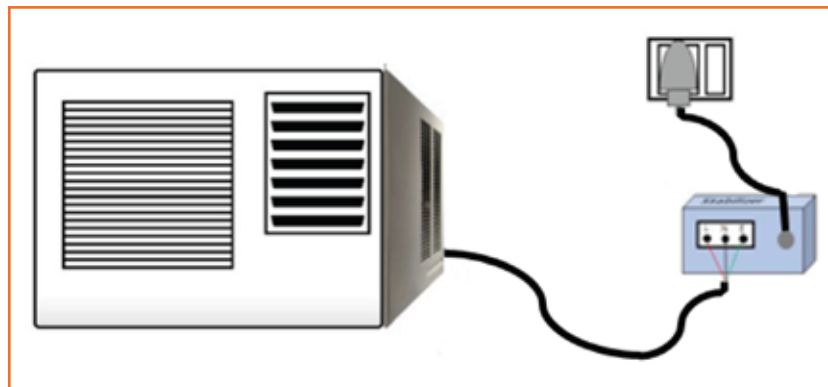


Fig 5.2.13 Electrical wiring of AC unit

1. Ensure all electrical wiring has been done and the main power cord of the AC has been plugged in to the power point, as shown in the image.



Fig 5.2.14 Setting temperature

2. Ensure that all front grills and filters have been properly placed.
3. Switch on the AC and set the temperature at 18°C as shown in the figure -

Let the AC run for 15-20 minutes.



Fig 5.2.15 Using control panel

4. Check the functioning of the front control panel.
5. Check the functioning of the remote control and all its buttons.



Fig 5.2.16 Using remote control

6. Check the cooling effect in the room after 15-20 minutes.
7. **Check the following temperatures:**
 - i. Outdoor unit should be approx. 42°C
 - ii. Grill should be approx. 9°C

5.2.5 Using Window AC Control Panel and Remote Control

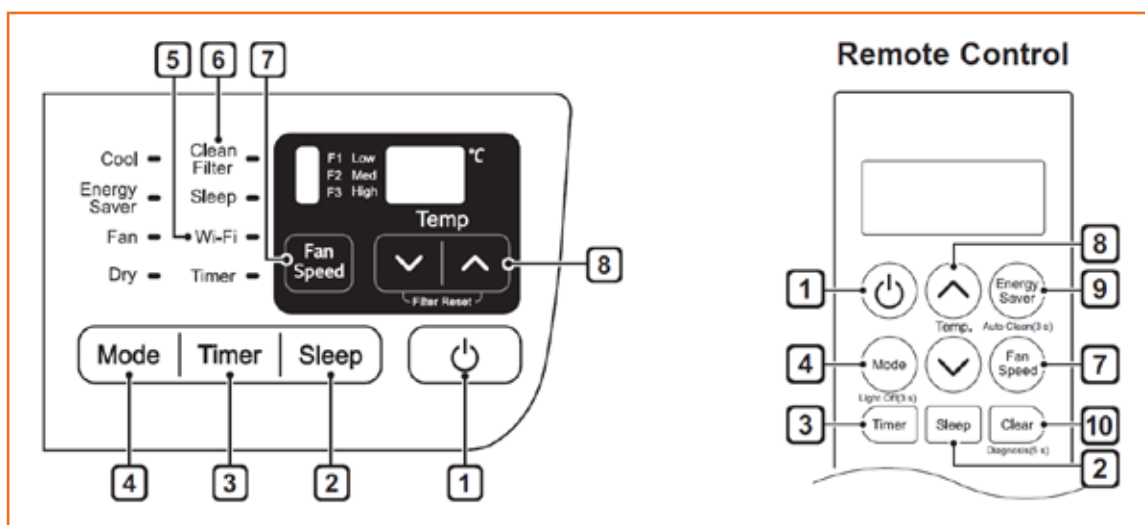


Fig 5.2.17 Control panel

1. **Power:** Press to turn the air conditioner ON or OFF.
2. **Sleep Mode:** This mode keeps operating noise to a minimum and turns the air conditioner off after a set time. The timer can be set from 1 to 7 hours.
3. Delay ON/OFF Timer
 - ☐ Delay ON - When the air conditioner is off, set it to automatically turn on from 1 to 24 hours later, at its previous mode and fan settings.
 - ☐ Delay OFF - When the air conditioner is on, set it to automatically turn off from 1 to 24 hours later.
4. **Operation Mode:** Press the Mode button to cycle between 4 types of air conditioner operation: Energy Saver / Cool / Fan / Dry.
5. **Wi-Fi (Optional):** Enables connection of the air conditioner to the home Wi-Fi.
6. **Clean Filter:** The Clean Filter LED lights up to notify you that the filter needs to be cleaned. After cleaning the filter, press Temp and together on the control panel to turn off the Clean Filter light.
7. **Fan Speed:** Press to set the Fan Speed to Low (F1), Medium (F2) or High (F3).
8. **Temperature Control:** The thermostat monitors room temperature to maintain the desired temperature.
9. **Energy Saver:** In this mode the compressor and fan turn off when the set temperature is achieved. Approximately every 3 minutes the fan turns on to allow the unit sensor to accurately determine if more cooling is needed.
10. **Clear:** Cancel Sleep and Timer settings.

Note: The feature may be changed according to the type of model.

Visit the below link to see the video on use of remote control for operating an AC

<https://www.lg.com/in/support/product-help/CT20150054-20152688166849>

5.2.6 Servicing of Window AC

An AC requires servicing and repairs due to wear and tear with usage. Improper maintenance also leads to requirement for repair. The following figure lists some categories of issues with ACs -



Fig 5.2.18 Some categories of issues with ACs

The following figure lists some specific symptoms that indicate the air conditioner needs a servicing:

- Water drips from the front panel
- Air comes out from the vents, but does not cool down to specified temperature
- AC unit does not turn on
- There is ice visible on the coils
- Water leaks from the drain channel

Steps for servicing of Window AC

Before cleaning or performing maintenance, disconnect the power supply and wait until the fan stops.

Cleaning the Air Filter

1. Remove the air filter from the front grille by pulling the filter forward and then up slightly.

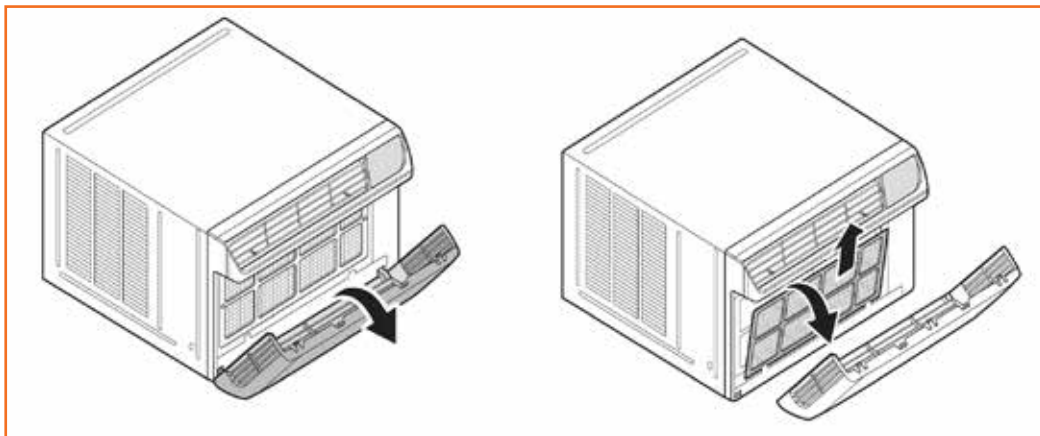


Fig 5.2.19 Removing air filter

2. Wash the filter using lukewarm water.
3. Gently shake the excess water from the filter.
4. Dry the filter in the shade.
5. Insert the filter into the Front grille.
6. Clean Filter - Press Temp up and down button together

Cleaning the Air Conditioner

- Wipe the front grille and inlet grille with a cloth dampened



Fig 5.2.20 Cleaning of air filter

in a mild detergent solution.

- Wash the cabinet with mild soap or detergent and lukewarm water, then polish using liquid appliance wax.

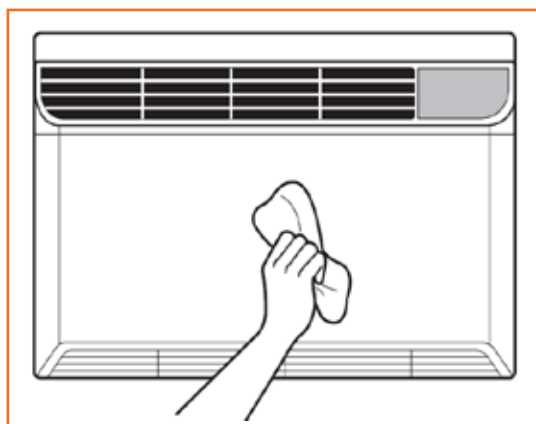


Fig 5.2.21 Cleaning AC unit

5.2.7 Testing of Faulty Components

Testing Electronic Components

A field technician should start with testing the various modes of operation to check which components of the window AC are operating fine or not. The following figure shows the steps of checking various components -



Fig 5.2.22 Checking of various components

Testing the Compressor

In window AC units, rotary compressors are generally used. A field technician needs to follow the steps to test the compressor.

1. Check the power outlet to make sure it is working well.
2. Turn the power off and take out the unit's terminal cover by removing the mounting screws located at the four corners of the front of the air conditioner unit. Ensure that the terminals and wires are not damaged.
3. Check the compressor to make sure that there is no cracked valve inside it.
4. Test the electrical terminals using a multimeter. A typical unit has three terminals; C, R, and S. The continuity between every two terminals (C - R, C - S, and R - S) should be tested.
 - ☐ Check the wire connections and if the wire is found faulty, replace it.
 - ☐ If the resistance is higher (higher than 30 ohms), check if the compressor is hot. If so, it may be that the internal overload is open and wait for the compressor to cool down.
 - ☐ If the resistance is high but the unit is cool, it indicates that the compressor motor is bad.
5. Check the resistance of each of the terminals to the compressor's body. If the resistance reading is low, it signifies that the motor is grounded and the compressor needs a replacement.

Testing of inverter compressor

An inverter type compressor functioning can be check by following steps -

- Disconnect the compressor from the inverter board, then check all 3 windings for continuity byusing a multimeter. The windings should be of equal resistance.
- Using an insulation resistance tester, you should also check that the windings pass an insulation resistance test against earth/ground.

If the compressor passes electrical testing, then you can run it from the inverter board

Testing Capacitor of AC

The following figure lists the steps to test the capacitor of a window AC -

1. Unplug the unit and remove it from its window mounting.
2. Remove the screws safely.
3. Locate the capacitors near compressor or fan motor -
 - ☐ Run capacitors (oil-filled capacitors are round or oval in shape and silver in colour).
 - ☐ Start capacitors (electrolytic capacitor are round and tubular in shape and black in colour).
4. Let the capacitor discharge by shorting its terminals together.
5. Remove the wires from the capacitor.
6. Test the capacitor terminals with multimeter.s

5.2.8 Troubleshooting and Repairing of Window AC

A technician needs to perform the following steps before starting the repairing -



Fig 5.2.23 Troubleshooting steps

If the appliance does not function properly or does not function at all, check the following -

Normal sounds you may hear

1. **High Pitched Chatter:** Today's high efficiency compressors may have a high-pitched chatter during the cooling cycle.
2. **Sound of Rushing Air:** At the front of the unit, you may hear the sound of rushing air being moved by the fan.
3. **Gurgle/Hiss:** Gurgling or hissing noise may be heard due to refrigerant passing through evaporator during normal operation.
4. **Vibration:** Unit may vibrate and make noise because of poor wall or window construction or incorrect installation.
5. **Pinging or Swishing:** Droplets of water hitting condenser during normal operation may cause pinging or swishing sounds.

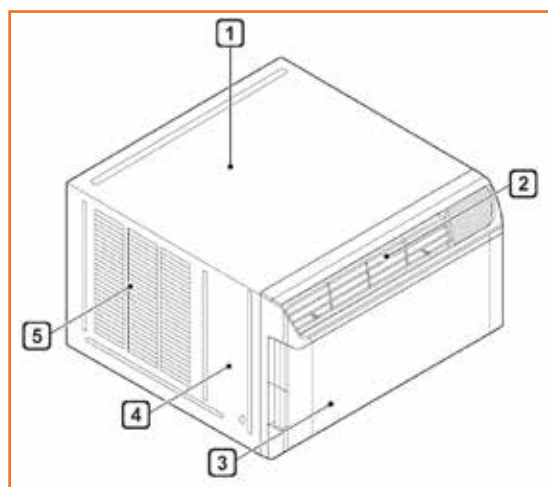


Fig 5.2.24 Sounds in a AC

The following table lists some AC problems and their possible troubleshooting steps:

Problem	Possible Causes & Corrective Action
Air conditioner does not start.	The air conditioner is unplugged. Make sure the air conditioner plug is pushed completely into the outlet.
	The fuse is blown/circuit breaker is tripped. Check the house fuse/circuit breaker box and replace the fuse or reset the breaker.
	Power failure. If power failure occurs, turn the mode control to off. When power is restored, wait 3 minutes to restart the air conditioner to prevent tripping of the compressor overload.

Problem	Possible Causes & Corrective Action
Air conditioner does not cool as it should.	Airflow is restricted. Make sure there are no curtains, blinds, or furniture blocking the front of the air conditioner.
	The temp control may not be set correctly. Set the desired temperature to a level lower than the current temperature.
	The air filter is dirty. Clean the filter at least every 2 weeks.
	The room may have been hot. When the air conditioner is first turned on, you need to allow time for the room to cool down.
	Cold air is escaping. Check for open floor registers and cold air returns.
	Cooling coils have iced up. See 'Air conditioner freezing up' below.
Air conditioner freezing up.	The cooling coils are iced over. Ice may block the air flow and obstruct the air conditioner from properly cooling the room. Set the Fan Speed High at Fan or Cool mode.
Water drips outside.	Hot, humid weather. This is normal.
Water drips Indoors.	The air conditioner is not tilted to the outside. For proper water disposal, make sure the air conditioner slants slightly from the cabinet front to the rear.
Water collects in base pan.	Moisture removed from air and drains into base pan. This is normal for a short period in areas with little humidity; normal for a longer period in very humid areas.

Problem	Possible Causes & Corrective Action
Air conditioner turns on and off rapidly.	Dirty air filter - air restricted. Clean air filter.
	Outside temperature extremely hot. Refer to installation instructions or check with installer.
Noise when unit is cooling.	Air movement sound. This is normal. If too loud, set to lower FAN Speed.
	Window vibration - poor installation. Refer to installation instructions or check with installer.
Room too cold.	Set temperature too low. Increase set temperature.
The air conditioner is not connecting to the Wi-Fi.	The Wi-Fi router is too far from the air conditioner. Move the router closer to the air conditioner or purchase and install a Wi-Fi router (signal booster).
	You do not have permission to use the router or it is incompatible. Make sure you are selecting the correct wireless router from the list. The router must be set to 2.4 GHz.

Scan the QR code or click on the link to watch related videos



www.youtube.com/watch?v=Ee5nPungbGM
Installation of window AC



www.lg.com/in/support/product-help/CT20150054-20152688166849
Operating AC by remote control

UNIT 5.3: Installation and Repairing of Split AC

Unit Objectives



At the end of this unit, participants will be able to:

1. Demonstrate procedure of installing a split AC
2. Demonstrate troubleshooting and repairing of split AC

5.3.1 Parts of a Split AC

The main reasons for split air conditioner are getting popular are their elegant looks and silent operation. There are two units in a split AC -

- **Indoor unit:** It is installed inside the room which cools the room.
- **Outdoor unit:** It is installed in open space outside the room at a convenient location for installation and maintenance.

Apart from the two units there is copper tubing that connects them.

The following figure lists the parts of a split air conditioner:

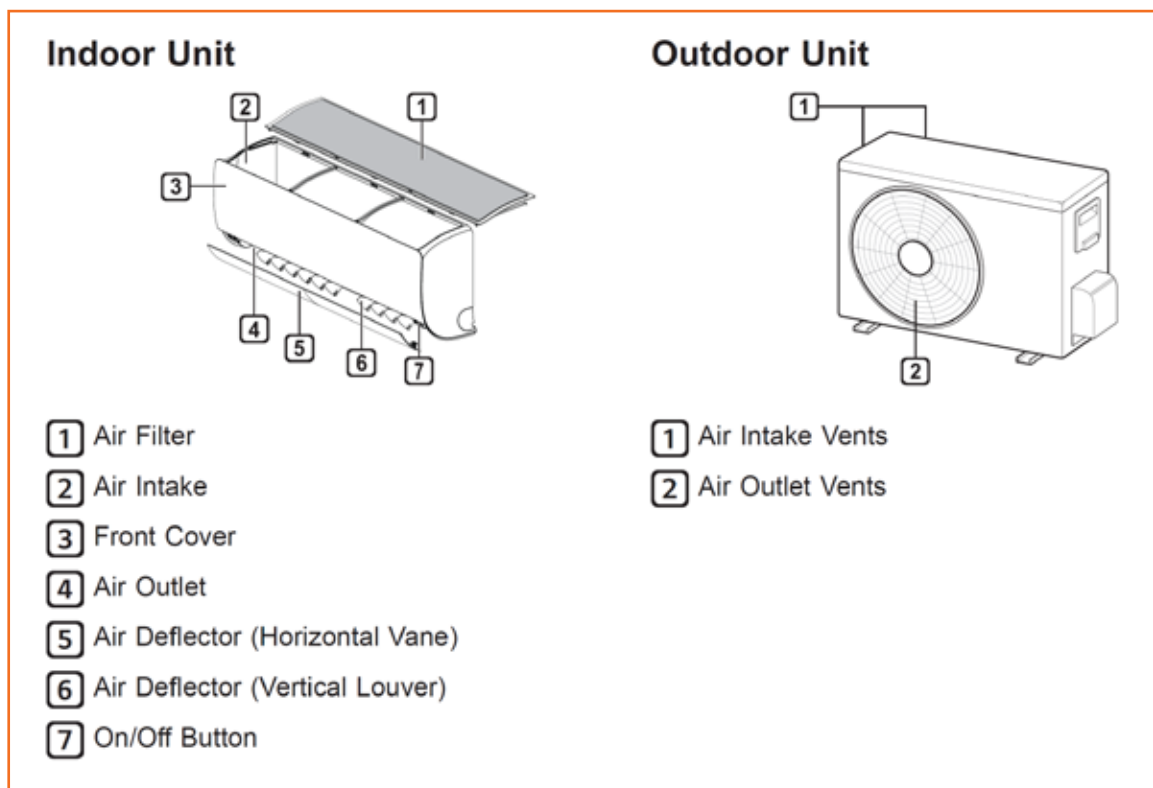


Fig 5.3.1 Components of split AC

Outdoor Unit

A great amount of heat is generated inside in outdoor unit by the compressor and the condenser.

There should be sufficient air flow around the unit. The following figures show the outdoor unit of a split AC -

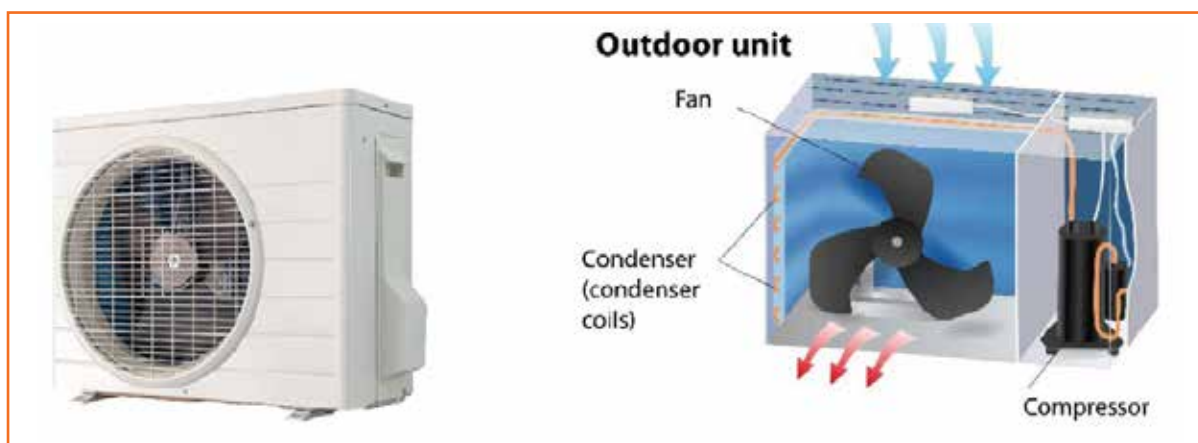


Fig 5.3.2 Outdoor unit of a split AC

- **Compressor:** The compressor increases the pressure of the refrigerant by compressing it and sends to the condenser. Compressors are of hermetically sealed type in which the motor used for driving the shaft is not visible externally.
- **Condenser:** The condenser is the coiled copper tubing covered with the aluminium fins and contains one or more rows based on air conditioning unit size. It allows the refrigerant with high temperature and pressure received from the compressor to give up the heat. The copper and aluminium let the heat from the refrigerant be removed at faster rate.
- **Condenser Cooling Fan:** The condenser cooling fan located in front of the condenser coil and compressor, is driven by a motor and has three or four blades. With the rotation of the blades the fan absorbs the air from the outside and with the aluminium fins blows the air over the condenser and the compressor and thus cool them. The hot air is passed to the open space allowing air circulation.
- **Expansion Valve:** It is generally a copper capillary tubing with many rounds of coils. It allows a sudden drop of temperature and pressure of the refrigerant coming from the condenser.

Indoor Unit

The indoor unit of the split AC is comprised of a box type housing encloses the important parts. The following figure lists the types of indoor units -

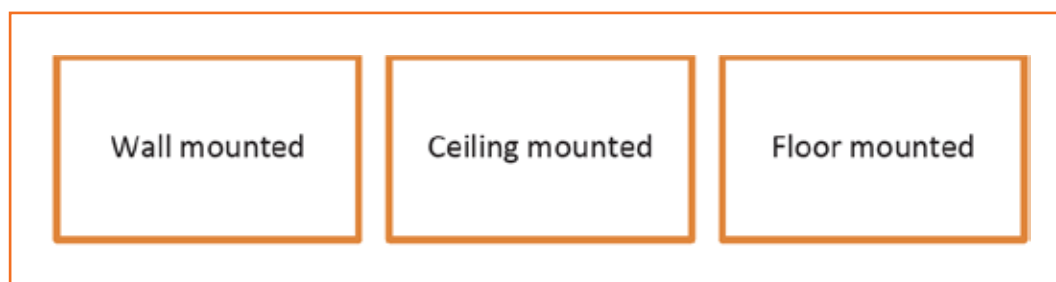


Fig 5.3.3 Types of indoor unit of a split AC

The following figure shows the indoor unit of a split AC:

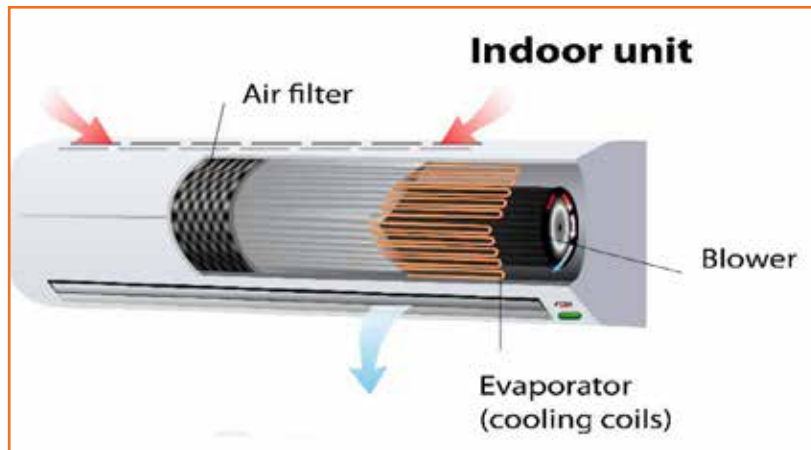


Fig 5.3.4 Indoor unit of a split AC

- **Evaporator Coil or the Cooling Coil:** It is comprised of several turns of a coil in one or more rows. The number of rows is based on the capacity of the conditioning system. The coil is encapsulated with aluminium fins so that maximum amount of heat can be transferred to the air inside the room from it. The following figure shows the working of the evaporating coil:

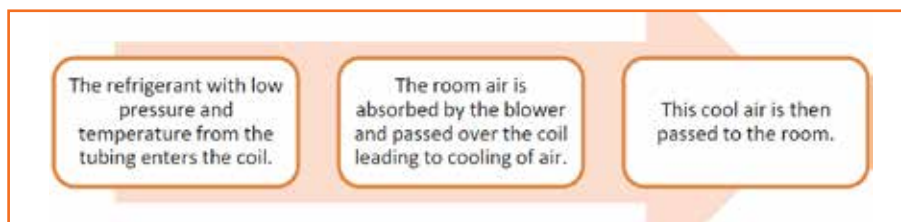


Fig 5.3.5 Working of the evaporating coil

The temperature of the refrigerant inside the evaporating coil rises after the heat is absorbed from the room air. It passed through the copper tubing to the compressor of the outdoor unit. The refrigerant tubing of both sides are encapsulated with the insulation tape.

- **Air Filter:** The air filter allows supply of clean air to a room by removing dirt particles from it. The room air is passed through the air filter before it is passed to the cooling coil.
- **Cooling Fan or Blower:** It pulls in the warm and dirty air from the room and blows out cool and clean air. The fan speed can be changed as it is connected to a small motor having multiple speed options.
- **Drain Pipe:** When the room air is passed over the cooling coil, the air temperature reaches below the dew point temperature. This results in forming of dew drops on the surface of the cooling coil due to condensation of the water vapor present in the air. These water drops are accumulated inside the indoor unit. A drain pipe is connected from the space to an external place outside where water can easily be disposed-off.
- **Louvers or Fins:** Cool air is supplied by the cooling fan into the room through the louvers that allow changing the direction of the air as per the requirements. The following figure lists the types of louvers:

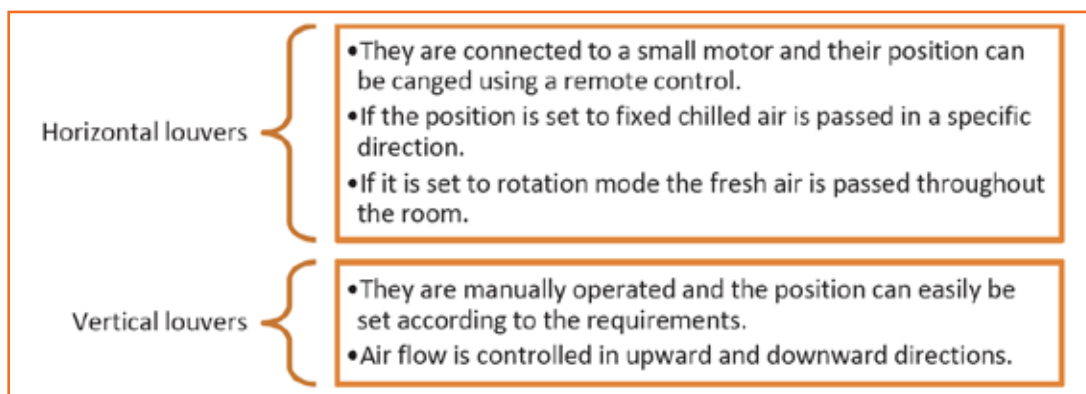


Fig 5.3.5 Two types of louvers

- **Refrigerant Piping or Tubing:** The refrigerant piping comprised of copper tubing, connects the outdoor and indoor unit. It is flexible enough to be coiled easily.

The low pressure and low temperature refrigerant go from the expansion valve to the copper tubing, that is also connected to the cooling coil at the other end. The following figure shows the connection of indoor and outdoor unit through refrigerant tubing -

The distance between the two units (indoor and outdoor) should be less as there is some loss of the cooling effect when the refrigerant flows through the tube.

The tubing is covered with the insulation as it is exposed to the atmosphere which may be high temperature. The cooling effect will be lost if the tubing is not covered.

There is another refrigerant tubing connecting the units for the refrigerant to travel from evaporating coil to the compressor. Both the tubing are covered using an insulation tape.

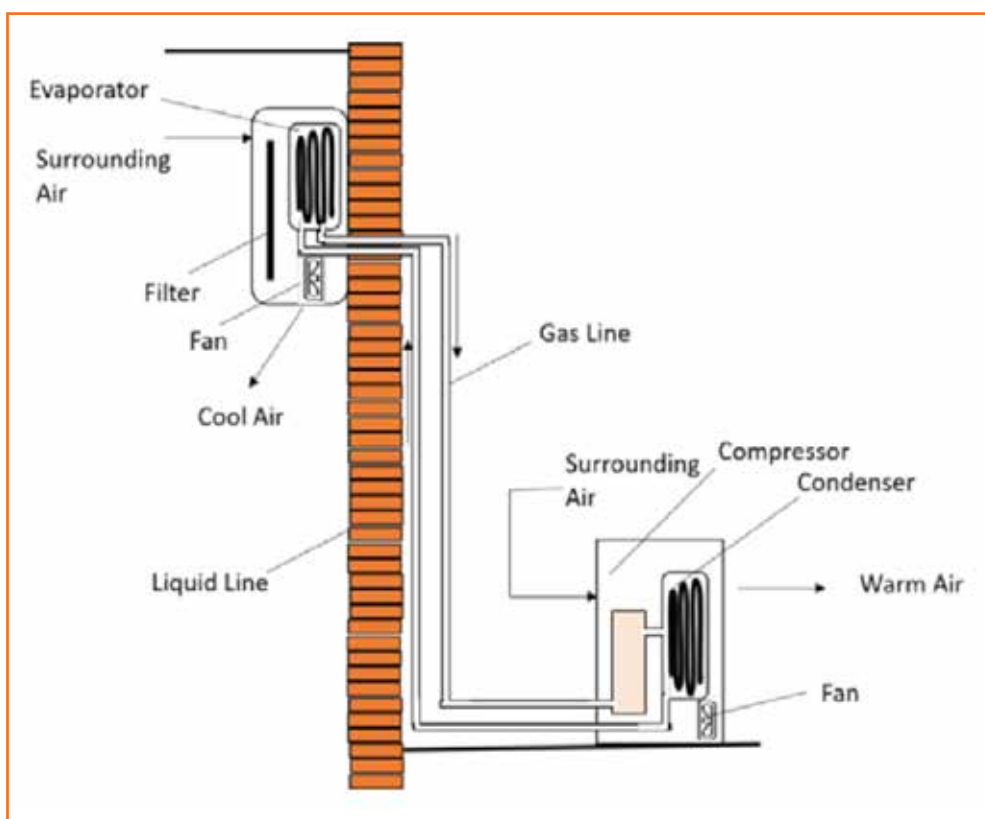


Fig 5.3.6 Connection of indoor and outdoor unit through refrigerant tubing

5.3.2 Pre-requisites for Installation

Before going for installation of a split AC at a customer site, ensure that the instructions shown in the following figure are performed:

- Carry all tools and personal protective gear required, neatly organized
- Check that all tools and equipment, such as a drill, is working properly
- Ensure all the units have been delivered before visiting the site
- Check the packing to see if it is proper and has not been tampered or damaged
- Carefully unpack the unit and its parts, such as remote, indoor unit, outdoor unit, filter, and so on
- Ensure there is a step ladder available if installation is to be installed at a height

Before starting the installation, following tools are necessary:

Tools required: Digital Clamp Multi Meter, Screw Driver, Pinch plier, Plier/Pilas, Nose Plier, L Key Set, Screw Wench, Gauge Manifold, Vacuum Pump, Swaging Tool, Flaring Tool, Level, Mini Gas Welding Machine, Drill Machine, Measuring Tape, Hammer etc.

Before installation, ensure you have carefully examined the site for installation and checked all conditions for installations, such as proper availability of space for indoor and outdoor unit, proper electrical points available, proper window/hole in wall available, and so on.

Unpacking split AC

To protect the split AC from any kind of damage, it is properly packed and delivered. Once it is transported from the delivery truck, it needs to be carefully unpacked.

The following are the tools that are needed for unpacking and handling a split AC:



Fig 5.3.7 Requirements for handling

Steps for unpacking and installing a split AC:

1. Unbox the box by keeping it on a smooth and fair surface. Remove the packing strip and cut the tapings on the upper face with the help of a knife or sharp object.
2. Tilt the box and remove the tapings applied on the base with the same sharp object.
3. Take out all the accessories from the box.

Note: Accessory items may vary depending upon model.

4. Now, hold the thermocol sheet (polystyrene base), remove the box. Gently, keep the split AC horizontally, remove the thermocol sheets from both ends. Once you have removed out the thermocol sheet carefully and gently, remove the poly packing. Handle the product with care.

Now you are ready for the core installation process.

5. Check and understand the symbols on the package to know about the cautions and warnings related to the installation. The symbols along with their meanings are shown in the following images -

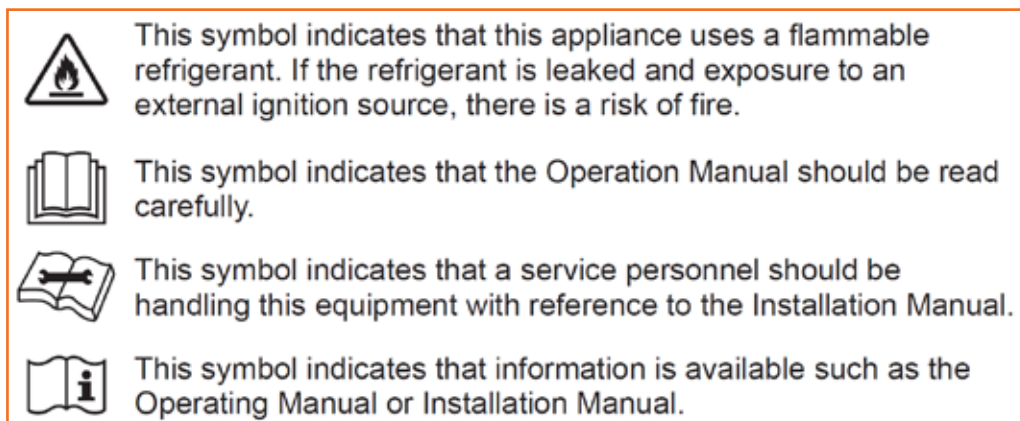


Fig 5.3.8 Safety warnings

5.3.3 Installation Process

The first step to install a split AC is to select the best location for the installation. The following figure lists the points to be considered for location of an AC -

- Do not install the unit at such a location where there is a heat source nearby
- Ensure there are no obstacles in air circulation
- Ensure there is proper ventilation on all sides
- Ensure there is easy access to drainage
- Do not install the conditioning unit near the entrance or exit doorway
- Make sure that the unit is accessible for maintenance

Indoor Unit Installation

The steps of installation of indoor unit are as follow -

1. Select an appropriate location for the unit as shown in the following figure.
2. Fix the mounting plate to the wall inside the room and secure it with screws as shown in the following figure

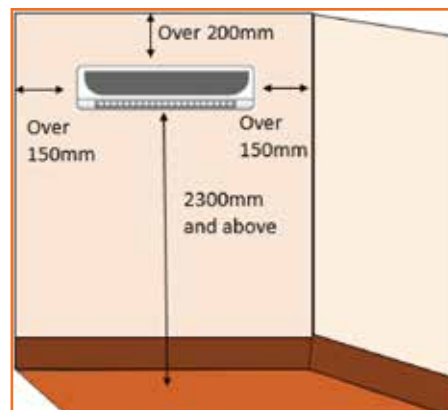


Fig 5.3.9 Indoor unit installation location

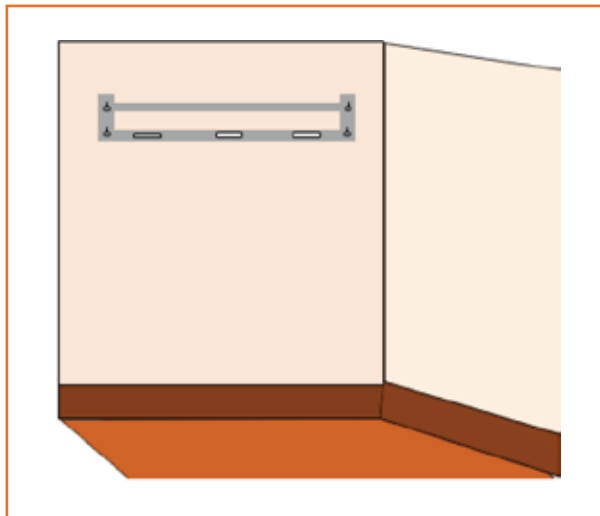


Fig 5.3.10 Secure the mounting plate

- ☐ Hold the mounting plate against the wall.
- ☐ Use a level to check whether the plate is levelled horizontally.
- ☐ Fix it to the wall by drilling holes in the wall at appropriate spots.
- ☐ Insert anchors into the drilled holes and secure the plate to the wall using tapping screws.

3. To fit the piping, drill a hole in the wall as shown in the following figure -

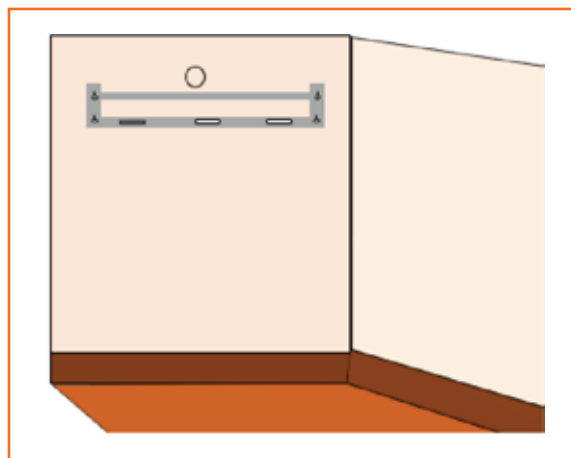


Fig 5.3.11 Drill a hole for piping

- ☐ Drill a hole having a diameter of around 7.5 cm through the wall. Hole location to be decided as per actual installation condition
 - ☐ Make sure that the slope of the hole towards the exterior is kept downward so that adequate drainage is possible.
 - ☐ Insert a flexible flange through the hole.
4. Make sure that the electrical connections are proper -
- ☐ Remove the cover by lifting the front panel of the unit.
 - ☐ Ensure that the wires are connected to the terminals of the screw.

5. Connect the pipes:

- ❑ Run the piping towards the hole.
- ❑ Cut a length from the PVC pipe that is shorter than the length between the wall surfaces of the interior and the exterior side (around 6 mm).
- ❑ Place the cap on the end of the PVC pipe that is inside the room.
- ❑ Couple the drain pipe, the copper pipes and the power cables together using an electrical tape as shown in the following figure

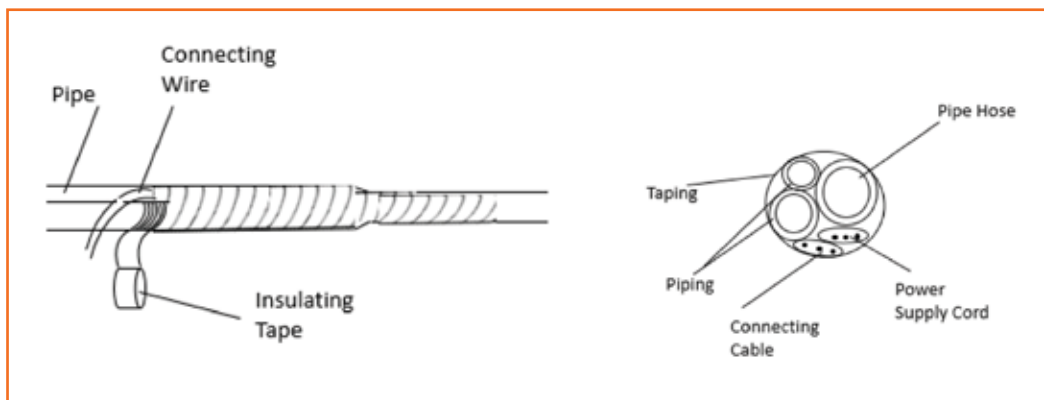


Fig 5.3.12 Connecting pipes

- ❑ Tighten the connection by using 2 wrenches, working in opposite directions to secure the pipe to the indoor unit and attach the drainage pipe to the base of the indoor unit.
- ❑ Run the pipes and cables coupled together through the hole making sure that the water is drained in a proper place by the drainage pipe, and the drain hose is sloping downward for efficient drainage, as shown in the following figure -

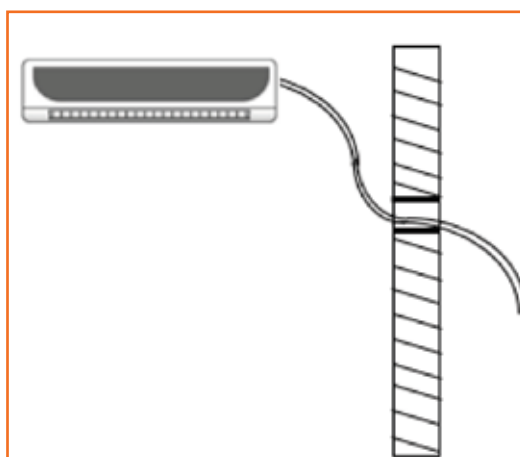


Fig 5.3.13 Direction of drain hose

The following images show some examples of incorrect installation

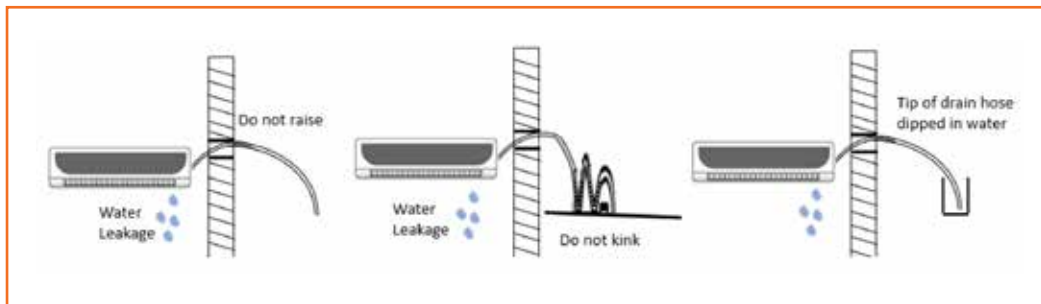


Fig 5.3.14 Examples of incorrect installation

6. Secure the indoor unit by pressing it against the mounting plate, as shown in the following figures:

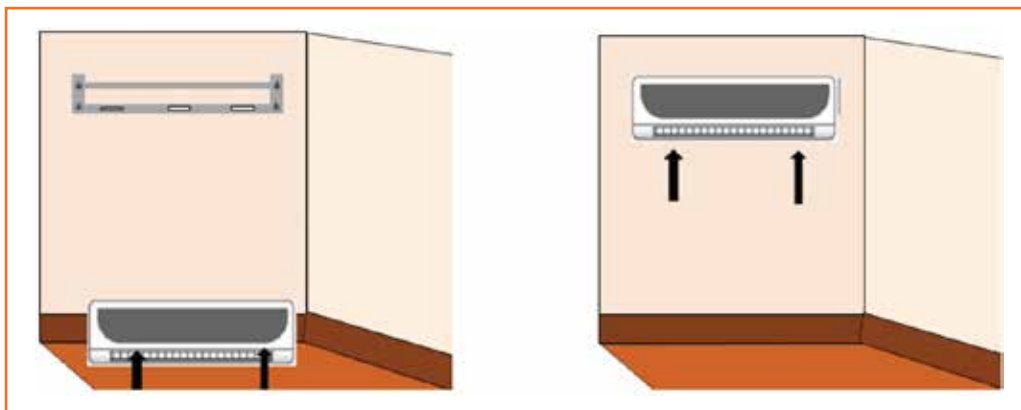


Fig 5.3.15 Secure the indoor unit

Outdoor Unit Installation

The steps of installation of outdoor unit are as follows -

1. Select an appropriate location for the unit, as shown in the following figure



Fig 5.3.16 Outdoor unit location

2. Hold the mounting plate against the outside wall
 - ☐ Secure it properly.
 - ☐ Ensure that it is in a level position.

- ☐ Provide rubber cushioning under the feet of the unit so that vibration is minimized.
3. Connect the wires.
 - ☐ Remove the cover and connect the cables and wires consulting the wiring diagram and following the manufacturer's instructions to connect the cable wires.
 - ☐ Use a cable clamp to fasten the cables.
 - ☐ Replace the cover.
 4. Fasten the flare nuts to the pipes on the outdoor unit, as shown in the following figure



Fig 5.3.17 Connecting electric wires



Fig 5.3.18 Secure flare nuts

Completing the Installation of a Split Air Conditioner

After the installation of the indoor and outdoor units of the split AC, the given steps should be followed -

1. Check the amount of air and the humidity of the refrigerant circuit, performing the following steps -
 - ☐ Detach the caps from the service port and the valves (both 2 way and 3 way).
 - ☐ Attach the hose of a vacuum pump to the service port.
 - ☐ Turn the vacuum pump on.
 - ☐ Switch the vacuum pump off after closing the low-pressure knob.
 - ☐ Check whether the valves and joints have any leak
 - ☐ Replace the caps after disconnecting the vacuum.

Note: Do the vacuum duration for approx. 5-10 minutes or as per the requirement. Keep the pumping pressure at moderate level.

The following figure shows removing air and humidity



Fig 5.3.19 Remove air and humidity

2. Use insulating covering and insulating tape to wrap the joints of the piping, as shown in the following figure



Fig 5.3.20 Wrap piping joints with insulating tape

3. Use clamps to affix the piping to the wall and use expanding polyurethane foam to seal the hole in the wall.

5.3.4 Test-run a Split AC

It is important to measure and record the test run properties to check whether the unit is installed properly, and to store the information after completing installation for further service. The following figure shows the items to be measured -

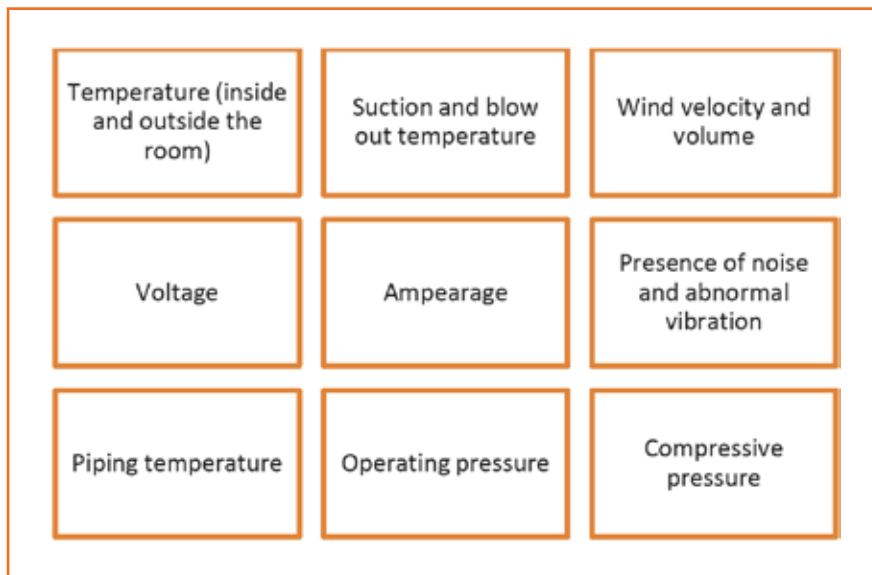


Fig 5.3.21 Items to be measured

In addition to the preceding items, the structure and appearance of the unit should also be checked to ensure that it complies with the standards. The following figure shows the checks that need to be performed

- Check air circulation is adequate
- Check water is draining smoothly
- Check refrigerant and drain piping is properly insulated
- Check refrigerant is not leaking
- Check remote control switch is functioning properly
- Check there is no fault in wiring
- Check terminal screws are not loose

The following figure shows the tasks that the technician needs to do after completing the installation:

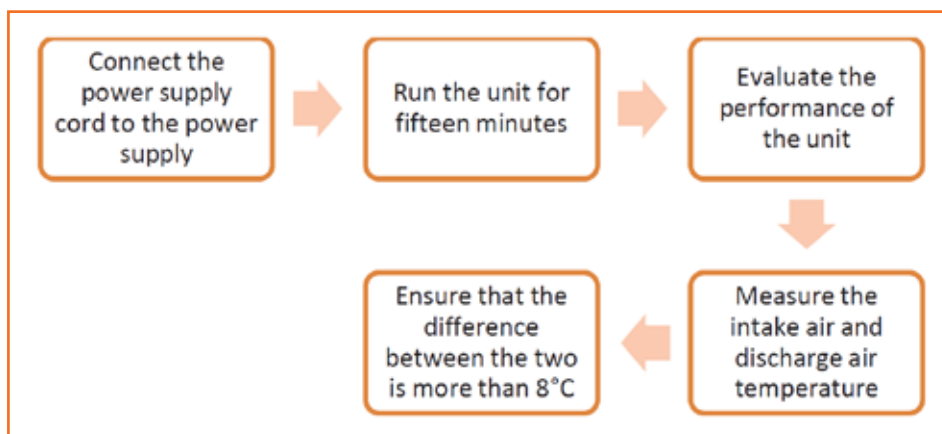


Fig 5.3.22 Tasks to be performed after installation

5.2.5 Operating Split AC

Point the remote control towards the signal receiver at the right side of the air conditioner to operate it.

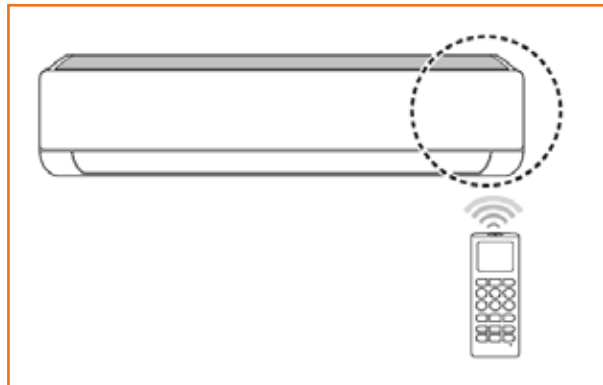


Fig 5.3.23 Using remote control

You can use the ON/OFF button of the indoor unit to operate the air conditioner when the remote control is unavailable.

1. Open the front cover or horizontal vane.
2. Press the ON/OFF button.

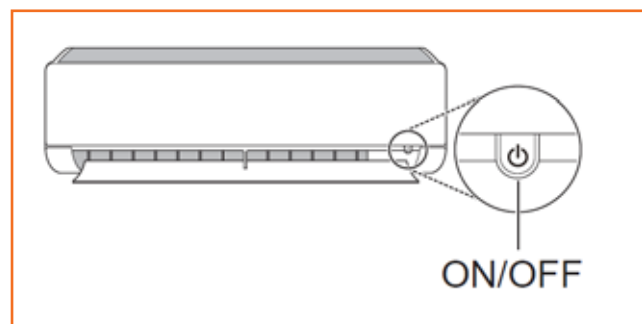


Fig 5.3.24 Starting AC

Using Wireless Remote Control

You can operate the air conditioner more conveniently with the remote control.

1 Button	2 Display Screen	Description
	-	To turn on/off the air conditioner.
	88°C	To adjust the desired room temperature in cooling, heating or auto changeover mode.
Mode		To select the cooling mode.
		To select the heating mode.
		To select the dehumidification mode.
		To select the fan mode.
		To select the auto changeover/auto operation mode.
*5-in-1/ H*Capa	HC	To change room temperature quickly.
Fan Speed		To adjust the fan speed.
		To adjust the air flow direction vertically or horizontally.

Fig 5.3.25 Remote control

5.3.6 Servicing Split ACs

While servicing an AC, the field technician should take the following precautions:

- While working with electrical parts and connection, switch off the power at the main power box.
- Keep fingers as well as clothing away from the moving parts.
- Clean the site after installation is finished, ensuring that there are no metal scraps of wiring left inside the unit which is being serviced.

Dry Servicing

Dry servicing refers to quick servicing of the AC which should be done every six months. Wet servicing is detailed cleanup of the AC units that should be done once in a year.

Steps for Dry Servicing

For indoor unit the steps for dry servicing are as follow -

1. Open the cover and take the filter out as shown in the figure



Fig 5.3.26 Taking the filter out

2. Clean the coil to remove the dust by using a brush as shown in the following figure



Fig 5.3.27 Cleaning the dust

3. Wash the filters as shown in the following figure and put them back in their places.



Fig 5.3.28 Washing the filter

The technician should also clean the outdoor unit to remove the dust and check the drainage pipe. The following figure shows cleaning of outdoor unit



Fig 5.3.29 Cleaning of outdoor unit

Wet servicing

The steps for cleaning the indoor unit are as follow -

1. Remove the cover and the filters and then remove the front cabinet after unscrewing it as shown in the following figure



Fig 5.3.30 Remove the front cabinet

2. Hang the wash bag around the indoor unit especially the fan coil unit as shown in the following figure -



Fig 5.3.31 Hanging the wash bag around the indoor unit

3. Spray the cleaning agent on the rotary blades and coils and wash them after 10-15 minutes. The following figure shows cleaning the indoor unit



Fig 5.3.32 Cleaning the indoor unit

4. Remove the bag filled with water.

5. Wash the filter, front cover and the front cabinet and then fix them to the proper place. The following figure shows washing on front cover



Fig 5.3.33 Washing front cover

The steps for servicing the outdoor unit are as follow:

1. Open the main connection cover and measure the voltage and current as shown in the figure



Fig 5.3.34 Measuring voltage and current

2. Measure pressure of the service valve using manifold gauge. The following figure shows measuring of pressure



Fig 5.3.35 Measuring pressure using manifold gauge

3. Remove the wires after switching off the power.

4. Remove the fan unscrewing it using T spanner. The following figure shows the parts of outside unit



Fig 5.3.36 Parts of outside unit

5. Remove fan motor and cover the outdoor connection box.



Fig 5.3.37 Covering the connection box

6. Spray coil cleaner and wash the coil and compressor and clean the outdoor body and other parts.
7. Wash the fan and let it dry.
8. Fix the parts to their correct position.

5.3.7 Troubleshooting and Repairing of Split AC

A technician needs to perform the following steps before starting the repairing:



Fig 5.3.38 Diagnosing steps

The following table lists some AC problems and their possible troubleshooting steps

Symptoms	Possible Causes & Solution
The air conditioner does not work normally.	Burning smell and strange sounds are coming from the unit. Turn off the air conditioner, switch OFF, or disconnect the power supply, and contact the service center.
	Water leaks from the indoor unit even when the humidity level is low. Turn off the air conditioner, switch OFF, or disconnect the power supply, and contact the service center.
	The power cable is damaged or it is generating excessive heat. Turn off the air conditioner, switch OFF, or disconnect the power supply, and contact the service center.
	A switch, a circuit breaker (safety, ground), or a fuse is not operated properly. Turn off the air conditioner, switch OFF, or disconnect the power supply, and contact the service center.
	The unit generates an error code from its self-diagnosis. Turn off the air conditioner, switch OFF, or disconnect the power supply, and contact the service center.
The air conditioner does not work.	The air conditioner is unplugged. Check whether the power cord is plugged into the outlet or the power isolators are switched on.
	A fuse exploded, or the power supply is blocked. Replace the fuse or check if the circuit breaker has tripped.
	A power failure has occurred. Turn off the air conditioner when a power failure occurs. When the power is restored, wait 3 minutes, and then turn on the air conditioner.
	The voltage is too high or too low. Check if the circuit breaker has tripped.

Symptoms	Possible Causes & Solution
	The air conditioner was turned off automatically at a preset time. Turn the air conditioner on.
	The battery setting in the remote controller is incorrect. Make sure that the batteries are inserted correctly in your remote controller. If the batteries are placed correctly, but the air conditioner still does not operate, replace the batteries and try again.
The air conditioner does not emit cool air.	Air is not circulating properly. Make sure that there are no curtains, blinds, or pieces of furniture blocking the front of the air conditioner.
	The air filter is dirty. Clean the air filter once every 2 weeks. See “Clean the Air Filter” for more information.
	The room temperature is too high. In summer, cooling the indoor air fully may take some time. In this case, select the H’Capa to cool the indoor air quickly.
	Cold air is escaping from the room. Make sure that no cold air is escaping through the ventilation points in the room.
	The desired temperature is higher than the current temperature. Set the desired temperature to a level lower than the current temperature.
	There is a heating source nearby. Avoid using heat generators like electric ovens or gas burners while the air conditioner is in operation.
	Fan Mode is selected. During Fan Mode, air blows from the air conditioner without cooling or heating the indoor air. Switch the operation mode to cooling operation.
	Outside temperature is too high. The cooling effect may not be sufficient.

Symptoms	Possible Causes & Solution
The fan speed cannot be adjusted.	Auto Operation Mode is selected. In some operation modes, you cannot adjust the fan speed. Select an operation mode in which you can adjust the fan speed.
The temperature cannot be adjusted.	The Fan Mode is selected. In some operation modes, you cannot adjust the temperature. Select an operation mode in which you can adjust the temperature.
The air conditioner stops during operation.	The air conditioner is suddenly turned off. The Timer Function may have timed out, which turns the unit off. Check the timer settings.
	A power failure has occurred during operation. Wait for the power to come back. If you have the Auto Restart function enabled, your unit will resume its last operation several minutes after power is restored.
The indoor unit is still operating even when the unit has been turned off.	The Auto Clean function is being operated. Allow the Auto Clean function to continue since it removes any remaining moisture inside the indoor unit. If you do not want this feature, you can turn the unit off.
The air outlet on the indoor unit is discharging mist.	The cooled air from the air conditioner makes mist. When the room temperature decreases, this phenomenon will disappear.
Water leaks from the outdoor unit.	In the heating operations, condensed water drops from the heat exchanger. This symptom requires installing a drain hose under the base pan. Contact the installer.
There is noise or vibration.	A clicking sound can be heard when the unit starts or stops due to movement of the reversing valve. Creaking sound: The plastic parts of the indoor unit creak when they shrink or expand due to sudden temperature changes. Flowing or Blowing sound: This is the flow of refrigerant through the air conditioner. These are normal symptoms. The noise will stop.

Symptoms	Possible Causes & Solution
The indoor unit gives off an odor.	Odors (such as cigarette smoke) may be absorbed into the indoor unit and discharged with airflow. If the smell does not disappear, you need to wash the filter. If this does not work, contact the service center to clean your heat exchanger.
The air conditioner does not emit warm air.	When Heating Mode starts, the vane is almost closed, and no air comes out, even though the outdoor unit is operating. This symptom is normal. Please wait until the unit has generated enough warm air to blow through the indoor unit.
	The outdoor unit is in Defrosting Mode. In Heating Mode, ice/frost is built up on the coils when the outside temperature falls. This function removes a layer of frost on the coil, and it should finish in approximately 15 minutes.
	Outside temperature is too low. The heating effect may not be sufficient.

Scan the QR code or click on the link to watch related videos

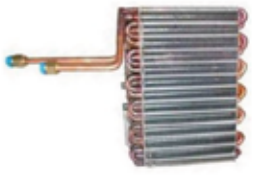


<https://www.youtube.com/watch?v=xtkf3Oaru-A>
Installation of split AC

Exercise



1. Match the components of an AC with the corresponding alphabets as per their placement in the air conditioning cycle given in the diagram below the table and also write their names:

Components	Position in the Diagram
	A
	B
	C
	D

UNIT 5.4: About Water Purifier

Unit Objectives

At the end of this unit, participants will be able to:

1. Describe use and function of water purifier
2. List parts of a water purifier

5.4.1 Water Purifier

Water purification is the process of removing undesirable chemicals, organic and inorganic materials, and biological contaminants from water so it is safe for use. A water purifier treats water using one or more purification methods to make it safe.

Clean water is essential for healthy living, and water purifiers are a great way to remove contaminants to improve the quality of your tap water. However, not all water purifiers are the same. Modern water purifiers come with a range of advanced technologies to remove organic and inorganic impurities present in water. There are several different types of water purification methods, and there's also filtration which is entirely different.

Depending on the water purification methods water purifiers are classified into 5 types.

1. RO Water Purifier

RO water purifiers are the most commonly used purifiers and are based on the principle of reverse osmosis. They make use of the membrane technology to eliminate contaminants such as salts, heavy metals and germs dissolved in water. The following image shows an RO water purification.

RO water purifier most effective to purify hard, salt water contains dissolved solids and chemicals. The only RO water purifier is

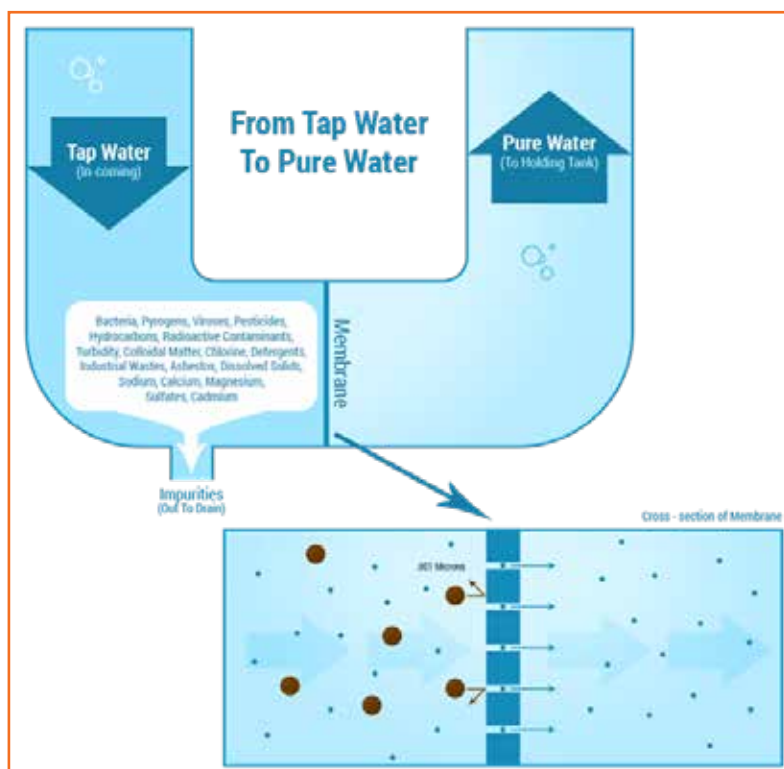


Fig 5.4.1 RO water purification

capable to remove metal particles like arsenic, fluoride, lead, chlorine, nitrates and sulphates.

Advantages of RO water purifier

- RO water purifier removes dissolved solids, metal particles like arsenic, fluoride and lead. Along with this RO water purifier is capable to remove waterborne diseases causing microorganisms like bacteria, viruses. Germs dead bodies are flushed out, so that purified water free from germs dead bodies.
- RO water purifier improves the taste and odour of water by removing the contaminants that causing bad taste and odour.
- RO water purifier is safe, cost effective and easy to maintain.

Disadvantages of RO water purifier

- RO water purifier requires electricity to run. Even it needs running water with optimum water pressure.
- RO water purifier produces lots of waste water. Whatever dissolved solids, germs are flushed through the drain along with wastewater. To purify 10 liters of water RO water purifier produces approximately 5 liter waste water which have to be drained out.

2. UV Water Purifier

UV water purifiers use ultraviolet rays to kill all germs, bacteria and microbes dissolved in water. A small mercury lamp is placed inside the purifier, which produces high frequency short wave UV radiations. When water passes through this element, it is exposed to the UV light which kills all the living organisms.

Separate filters then remove the dead germs.

UV purifiers are used in residences, breweries, water stores, restaurants and municipalities. The following image shows the working of UV water purifiers -

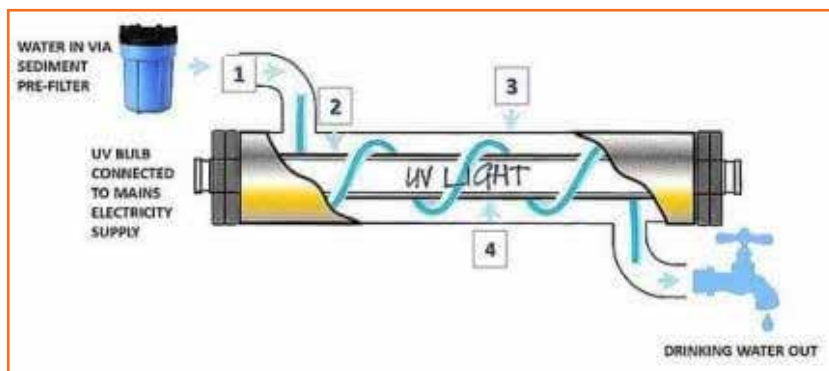


Fig 5.4.2 UV water purification

UV water purifier is ideal for low TDS (Total Dissolved Solids) water like lakes, river water. UV water purifiers incapable to treat hard water, which has high TDS level. Just as a UF water purifier, UV water purifier does not remove chemicals like chlorine, arsenic, fluoride present in water.

Advantages of UV water purifier

- **Low maintenance cost.** Change the UV lamp once in a year or when it stops working.

- **High purification rate.** UV water purifier capable to deliver 2 to 4 liters of purified water within a minute. Whereas other RO, UF, Activated Carbon water purifier takes several minutes to purify one liter water.
- **Low energy consumption.** UV water purifier uses electricity as much as an electric bulb use.
- **Very less manual cleaning.** If you have a UV water purifier with storage tank, it requires to clean twice in a week, whereas without storage tank water purifier need almost no manual cleaning.
- **Does not alter the water taste.** UV water purifier does not use any chemicals, or any semi permissible membrane. Therefore, water taste does not alter.
- **UV keep essential minerals.** Does not remove, change the human essential mineral present in water.

Disadvantages of UV water purifier

- **Germs bodies remains in purified water.** UV water purifier kills water borne disease causing bacteria, viruses and other pathogens, but their dead bodies still remain in purified drinking water. In case of fewer germs not exposed to UV light and remains live or redevelop and reproduce their population and makes water impure.
- **UV does not improve water taste or colour.** Using UV water purifier, before and after purification taste and color does not alter. If treating water has a bad smell, odor than have to use the Activated Carbon water purifier with a combination of UV water purifier.
- **Does not effective on turbid, mud water.** Undissolved Solids like sand, mud and other organic solid matter becomes an obstacle to pass UV light through the water.
- **UV water purifier not purifies hard water.** UV water purifier designed for purifying low TDS (Total Dissolved Solids) lake, river water.
- **UV water purifier not removes toxic chemicals.** UV light exposure does not effect on chemicals like chlorine, fluoride.

3. UF (UltraFiltration) Water Purifier

UF water purifiers use membranes similar to an RO membrane but with larger pores. They remove all germs and bacteria from water but do not remove dissolved salts or solids. They are suitable in homes where the water supplied is not very hard and has less dissolved salts. The process of purification in a UF purifier is shown in the following image -

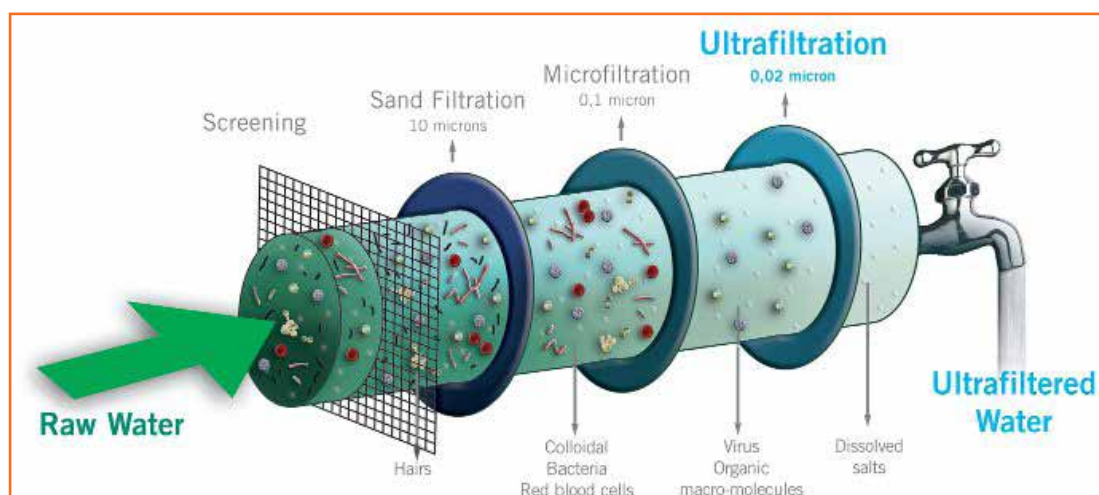


Fig 5.4.3 UF water purification

UF water purifier is ideal for the places where presence of chemical contamination is low, because UF does not remove chemicals present in water, it is only capable to block, remove germs like bacteria and viruses.

The important thing is to remember that UF does not work with hard water. As UF does not remove dissolved salts present in hard water, as a result before and after purification, water is still hard.

Advantages of UF water purifier

- Works without electricity. Just poured raw water in the upper storage tank and purified water collected in the lower storage tank. No need to bother about water pressure.
- Work in low water pressure conditions.
- Does not use chemicals. UF uses hollow membranes to block bacteria and viruses.
- Filter muddy water also. UF is capable to remove mold and germs from water, whereas other water purifiers like UV are incapable to purify muddy water.
- No germs' dead bodies in purified water. Whatever germs like viruses, bacteria are blocked in UF membrane. Purified water is free from their dead bodies, whereas other water purifiers like UV, even after purification germs' dead bodies are floating in purified water which can further contaminate water.
- Long life span. As UF membrane blocks germs and during manual cleaning these trapped germs are flushed out. UF membrane can be cleaned thousands of times. Pesticides, chemicals are not able to damage UF hollow membranes. In good conditions, UF membrane can be used up to 3 to 5 years.

Disadvantages of UF water purifier

- Unable to remove dissolved impurities such as arsenic, lead, nitrates and fluorides
- Ineffective as compared to an RO water purifier as it cannot block dissolved salts and solids
- Good only for water with low TDS

4. Activated Carbon Water Purifier

Activated carbon is carbon with a positive charge added to it. When water flows over it, the negative ions of contaminants get attracted to the surface of the activated carbon filter. Activated carbon water purifiers can remove volatile organic compounds, pesticides, herbicides, chlorine and other chemicals found in tap water. This makes the water safe to drink.

Advantages of Activated Carbon

- Removes diseases causing pesticides and toxic chemicals like Chlorine.
- Removes heavy metal particles
- Makes water smells and tastes good.
- Activated carbon helps to improve RO membrane life by blocking chlorine and other particles which are damaging the RO membrane.

Disadvantages of Activated Carbon

- Activated Carbon does not remove dissolved salts which causing hardness of water.
- Does not remove bacteria and viruses. The worst thing is improper maintenance causing higher growth of bacteria on the Activated Carbon surface. In case, activated carbon water purifier not in use for a long time, microorganisms like bacteria and viruses starts growing on the activated carbon surface.



Fig 5.4.4 Carbon filter

5. Gravity Based Water Purifiers

Gravity based water purifiers are based on the principle of gravity. The water flows from a higher compartment over the filters to a lower compartment. They do not require electricity and use either chemical based, UF based or ceramic cartridge based filters to purify water.



Fig 5.4.5 A gravity based purifier

Advantages of gravity based purifier

- Removes impurities and germs from muddy water
- Environmental friendly
- Does not require electricity to purify water
- Suitable for soft water
- Portable and easy to install

Disadvantages of gravity based purifier

- Unable to remove dissolved impurities such as arsenic, lead, nitrates and fluorides
- Ineffective as compared to an RO water purifier as it cannot block dissolved salts and solids
- Good only for water with low TDS

5.4.2 Components of Water Purifier

There are various components involved in a Reverse Osmosis system. The functions of the components that play an integral part in the RO system are as follows -

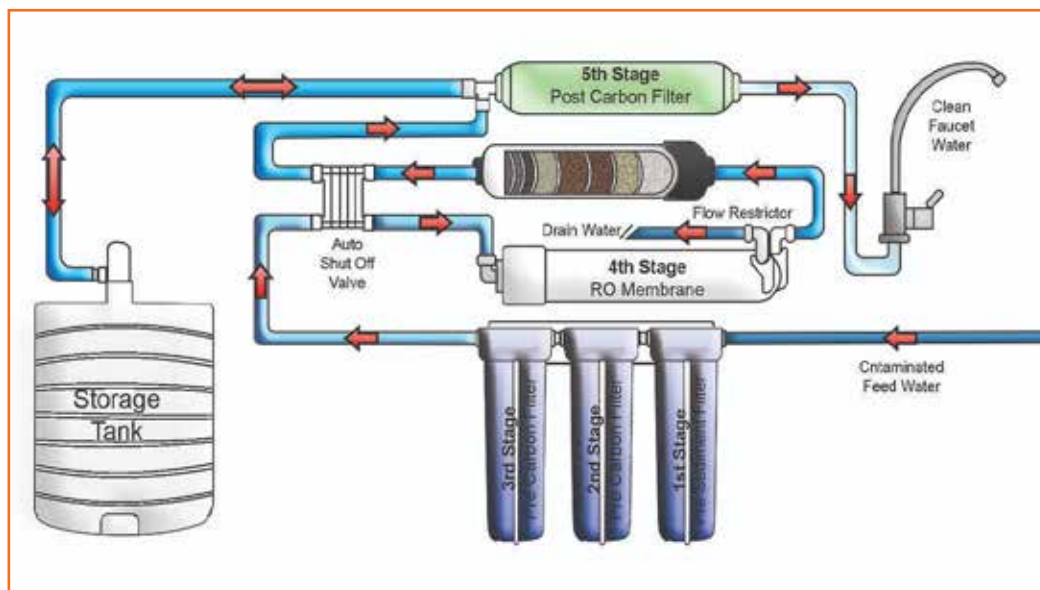


Fig 5.4.6 Basic components of a RO water purifier

1. **Water Supply Connector:** A water supply connector also known as a feed water supply adapter connects to the house cold water supply as the source of water to the reverse osmosis filter. It may include a variety of fittings, valves, and saddle valves that are available to best match the plumbing configuration.
2. **Pressure Regulator (optional):** A pressure regulating valve is used to protect the pre-filter housings from high pressure and water hammer.
3. **Sediment Pre-filter:** The sediment cartridge removes sand, grit, precipitated mineral particles,

insoluble iron oxide and other debris that can clog the reverse osmosis membrane surface or plug the drain flow restrictor, causing reduced water production.

4. **Carbon Filter for Chlorine Removal:** Drinking water is disinfected by city utilities to prevent growth of harmful bacteria, viruses and other microorganisms that can cause serious illnesses and/or death. The carbon filter removes chlorine and protects the membrane downstream of it.
5. **Auto Shut-off Valve (ASO Control Valve):** Conserves water by eliminating the drain flow when the tank is full. Main purpose of the ASO valve is to control the water supply to the reverse osmosis membrane. When the pressurized storage tank fills 2/3 of the feed pressure, ASO valve cuts off the water supply to the membrane and waits until the tank is drained down to 1/3 of the feed pressure before turning water back on.
6. **Reverse Osmosis Membrane:** RO Membrane is an important component of the system. The membrane helps in removing contaminants from water. Water enters into the storage tank after this purification stage.
7. **Check Valve:** Check valve prevents pressurized filtered water in the storage tank from flowing back and rupturing the RO membrane when the ASO valve turns off the feed water pressure to the membrane.
8. **Storage Tank:** The pressure tank in a RO system stores filtered water from the membrane permeate and provides water under pressure when the drinking water faucet is turned on.
9. **Post-Filters:** Before water stored in the storage tank runs out of the Reverse Osmosis faucet, it enters through the final post-filters. It is actually a carbon filter. Carbon filters help remove bad odors from the water that you drink and also improve the taste of water.
10. **Drain Line:** The drain line is used to drain out the waste water which consists of dirt and other contaminants.
11. **Drinking Water Faucet:** It is a controllable tap to direct water flow and is typically installed on the kitchen sink.
12. **Ultra Violet Disinfection System:** Ultra Violet disinfection usually involves a UV lamp. UV lamp provides pure and safe drinking water. The UV light used in this process is a high-powered UV which is also known as UV-C or germicidal UV. UV-C rays penetrate into the body of pathogens to deactivate them. These rays have the ability to kill 99.9% of the microorganisms.
13. **Ultra-Filtration System:** Ultra-Filtration process uses hydrostatic pressure to force water against a semi-permeable membrane. This semi-permeable membrane helps in removing bacteria and different types of microorganisms and bad odor in the water.
14. **Optional RO Components:** Optional Reverse Osmosis components include pressure booster pumps, pH balancing post filters, TDS water quality monitors etc.



Fig 5.4.7 RO membrane

5.4.3 Functioning of RO Water Purifier

The following diagram shows the flow of water in an RO purifier -

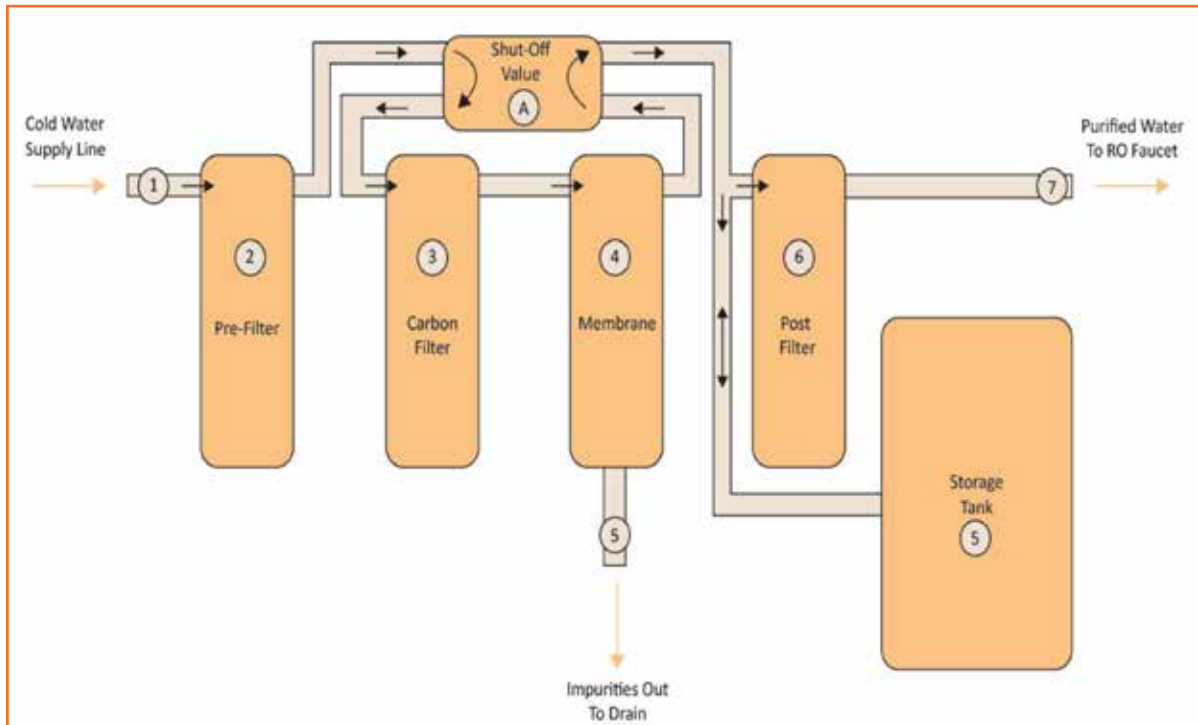
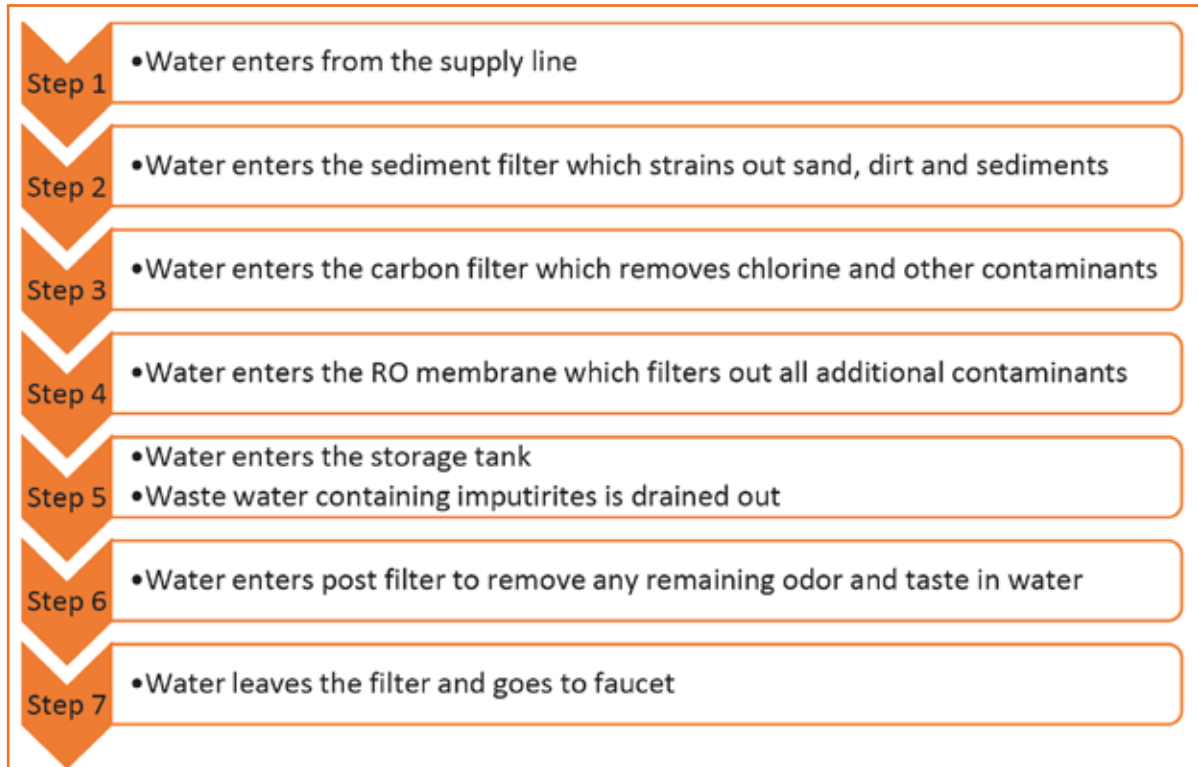


Fig 5.4.8 Water flow in an RO water purifier

The following figure explains the steps involved in the functioning of an RO water purifier -



Multi stage filtration process:

The RO water purifier has different stages of filtering the raw water.



Fig 5.4.9 Multi stage filtration process

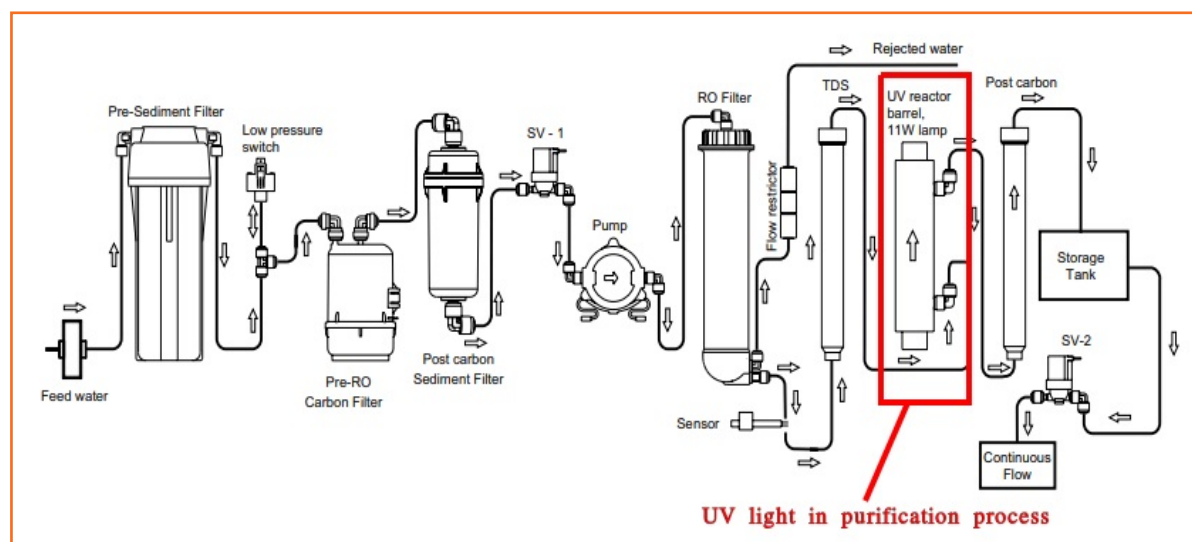


Fig 5.4.10 Multi stage filtration process

1. **Pre-filter / Sediment Filter:** RO purification process starts with pre-filter, which is the first step in purifying water. The filter helps in removing larger sediment and even reduce chlorine from the water. The filter has a bed that catches all the unwanted dirt particles as soon as the water flows through the system. The water moves into the filter and leaves the sediment behind, as a result, the water coming out would be free from particulate. It cannot remove pathogen elements, heavy metals, and even micro-organisms.
2. **Carbon Filter:** Followed by pre-filter, the next stage is the carbon filter, which is commonly used to absorb natural organic compounds, taste and odor compounds. The filter also removes synthetic organic chemicals in drinking water and make it fit for consumption.
3. **Ultrafiltration:** The next process of filtration that the RO purifier has is UF. It is a type of hollow

fibre membrane through which water is forced to pass leaving the impurities behind and delivering pure and clean water.

4. **Reverse Osmosis (RO):** It is the Reverse Osmosis (RO) system that offers a multi-stage filtration of water by combining sediment, active carbon, and UV/UF in the complete purification of raw water. An RO water purifier not only removes the solid impurities but even improves the taste of water, thus offering water that is safe for consumption. RO filters are recommended for places where the TDS level of water is high and the water has a high content of dissolved minerals.
5. **TDS Controller:** During the reverse osmosis purification process, an essential mineral also gets removed and to retain the same TDS controller is added in the water purifiers. The work of this controller is that it can retain the lost minerals in water and make it suitable for consumption.
6. **UV filtration:** RO water purifier also comes with a UV lamp that helps in disinfecting bacteria from the water by killing all the harmful pathogens present in the water. The high-power UV ray destroys the illness-causing microorganisms by attacking their genetic core, thereby eliminating their ability to reproduce. The ultimate work of a UV lamp is to destroy 99.99% of harmful microorganisms from the water, thereby making it safe for consumption.
7. **Post carbon filter:** The final stage of RO purification process is the addition of post carbon filter. Water passes through stage gets more filtered and if any odour is still present in the feed water it gets removed. Passing through this stage would ensure that you are receiving 100% pure and safe water that is free from any kind of contamination/impurities.

UNIT 5.5: Installation and Operation of Water Purifier

Unit Objectives



At the end of this unit, participants will be able to:

1. Demonstrate procedure of installing a water purifier
2. Demonstrate how to setup and use the features of water purifier

5.5.1 Site Requirements for Installation

The first step of an installation process is to conduct a site survey and ensure that it meets all the requirements. The selected site should comply with all the safety codes and should not interfere with normal movement of people.

The following are the site requirements of installing a water purifier:

- Select a well-ventilated place which is near to the tap water
- Avoid installing the water purifier in outdoor place, damp area and keep away from direct sunlight, dust and direct water splashing. This could cause product malfunctioning.
- Place on a firm, level place

After checking the site requirements, the next step is to check the power supply at the location site.

The following are the power requirements for installation:

- Ensure that voltage and electrical wiring is appropriate
- Use a separate socket for water purifier and ensure that wall socket is properly earthed
- Place the water purifier close to the electrical outlet
- Check water pressure of 35 -860 kPa / 5.6 to 124.7 Psi

5.5.2 Installation Process

Before starting the installation, following tools are necessary, depending on each particular installation-



Fig 5.5.1 Tools required during installation

The installation process consists of unpacking the unit, disposing the packing material and installing the water purifier at the designated place.

Unpacking water purifier

To protect the water purifier from any kind of damage, it is properly packed and delivered. Once it is transported from the delivery truck, it needs to be carefully unpacked.

Steps for unpacking a water purifier:

1. Unbox the box by keeping it on a smooth and fair surface. Remove the packing strip and cut the tapings on the upper face with the help of a knife or sharp object.
2. Tilt the box and remove the tapings applied on the base with the same sharp object.
3. Take out all the accessories from the box.

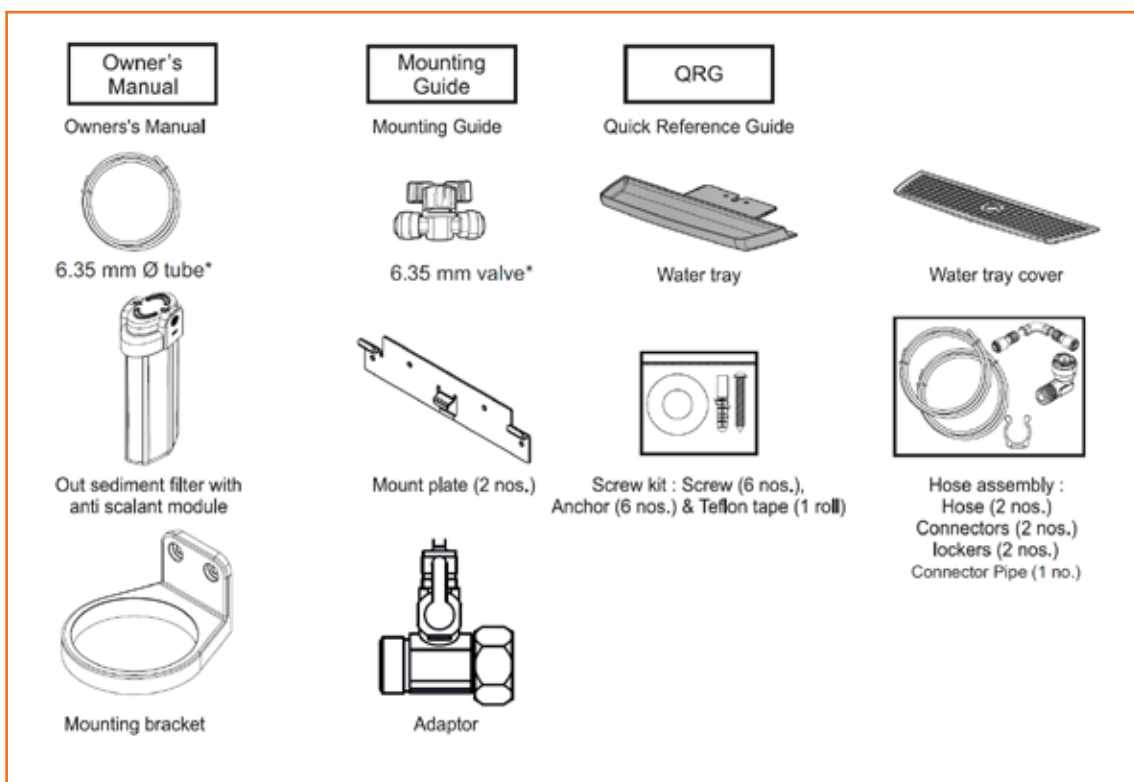


Fig 5.5.2 Accessories in a water purifier

Note: Accessories in box may differ for different models and brands

4. Now, hold the thermocol sheet (polystyrene base), remove the box. Gently, keep the water purifier horizontally, remove the thermocol sheets from both ends. Once you have removed out the thermocol sheet carefully and gently, remove the poly packing. Handle your product with care. Now you are ready for the core installation process.

Installing water purifier

Plumbing operations -

1. Choose the area where the water purifier needs to be fitted.

Observe and analyze the space including its advantages and disadvantages. Choose the space keeping in view that RO can be repaired and serviced easily. Don't place in the area near direct sunlight or moisture. Never place it just above the water taps as drilling can damage pipelines.

2. Check for the TDS level of the tap water and pressure of water flow on the tap using Pressure Gauge.

- ☐ Take a glass of tap water and check for TDS level of water which should be below 2000 Parts Per Million (PPM) using TDS Meter. If Total Dissolved Solids (TDS) Level is above 2000 PPM it can damage RO membrane and the tap water is not recommended for drinking purpose.
- ☐ Check the pressure of water tap using pressure gauge and it should be in between 0.3 Kg/sqcm to 2 Kg/sqcm. To get this value, the tank height should be over 1 meter above from purifier. Reduce the pressure if the value is above 2 Kg/sqcm and if pressure is less than 0.3Kf/sqcm, recommend booster pump installation with the unit.



Fig 5.5.3 Installation of water purifier

- ☐ Check for signs of contaminated water or dust particles or yellow stains in the sinks, in any of these cases, use Pre-filters and do check for rust and leakages in kitchen pipelines.

3. Remove the water tap and insert the diverter.

Install the water purifier in the facility of normal water supply only. Close the water supply line from main water tank. Remove the water tap attached to the water supply (normal water) using pipe wrench. Apply Teflon tape on the end of water diverter so that there is no leakage. Place the external thread exactly at the vacant spot where you removed your valve. Tighten it by using the pipe wrench.



Fig 5.5.4 Diverter

4. Fix the water tap and diverter.

Now, apply the Teflon tape on the back end of water tap and fix it using pipe wrench on the other side of the diverter valve. Remove the nut from up ends and place a thin white pipe over the top of the diverter valve.

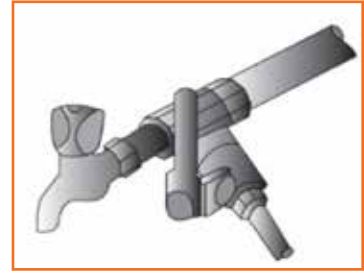


Fig 5.5.5 Diverter connected on tap

Mounting operations:

1. Drill holes to hang the purifier.

Make sure that you are placing the purifier on the right position so that it may not be too near or too far from the reach of consumers. Use leveller to mark brackets for drilling.

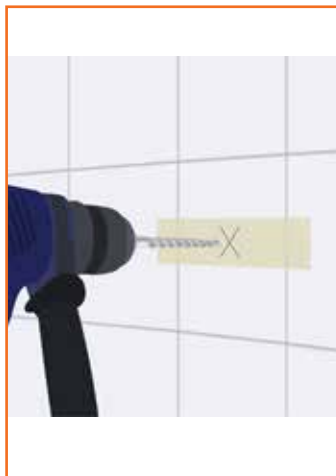
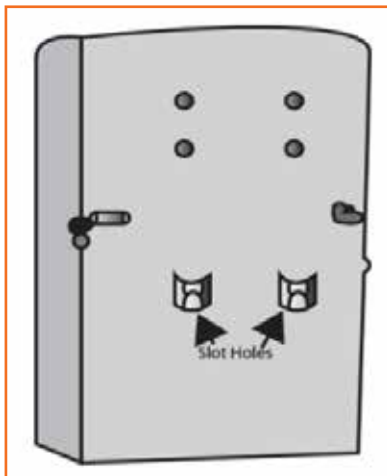


Fig 5.5.6 Drilling holes and inserting plastic inserts in wall

2. Insert the plastic inserts and mounting bracket.

Using drill, make holes in the wall carefully. Make holes a deep bit to ensure that plastic inserts can be easily placed in it. Place the plastic inserts using hammer inside the holes and using self-tapping screws, fix the mounting bracket properly.

Water connection operations:

1. **Remove the back cover of the purifier and open the dead blocks.**

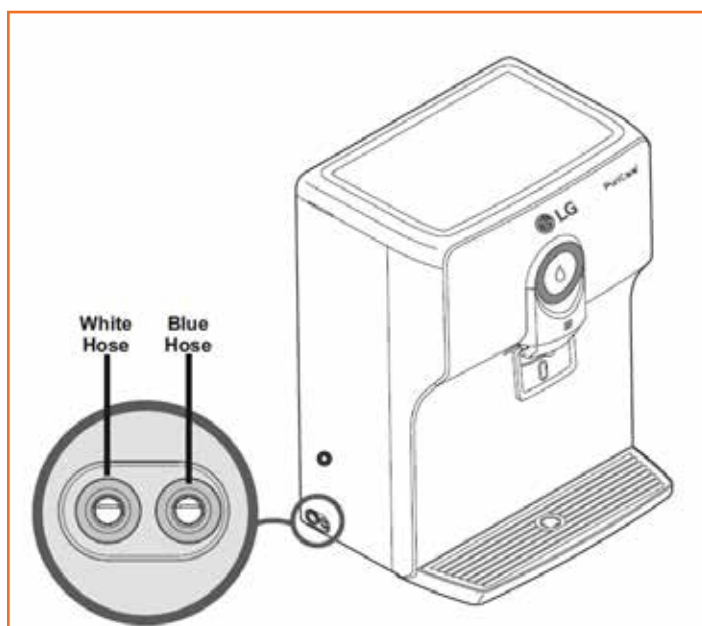


Fig 5.5.7 Hose connections in water purifier

Remove the back cover of the purifier by unscrewing the four nuts on the cabinet. Carefully, remove all the dead plugs of the purifier from the back. Remove the tie crossed over the membranes and filters using knife or sharp object without harming the core hardware.

2. **Attach the jointer between the purifier membranes to the drain pipe using jointers.**

Attach a mutual and joint outlet between overflow and reject outlet using pipes and jointers. Cut the pipes and attach them to the nobs of overflow and reject outlet bases and connect them using jointer placed it between. It is very important so that in future if water purifier malfunctions, at that time, the water may drain from the drainpipe without harming the internal spheres and creating complexity.



Fig 5.5.8 Connecting hoses

3. Plug in the Blue pipe from the Water purifier to the waste water outlet and install it in the sink.
4. Plug in the White pipe in the inlet port on Purifier and water supply tap.
5. Now mount the purifier on mounting bracket and fix it properly.
6. Connect the power cord in the power socket



Fig 5.5.9 Correct ways of installation

Starting water purifier

1. Now open the water supply valve and as well as the electricity socket (by closing the circuit or switching the plugged circuit ON).
2. After installation, fill the storage tank and drain out the unclear or yellowish water from the sediment filter when the tank is full. Make sure that the process gets completed. It will take about 5 to 15 minutes depending upon the quality and atmospheric conditions of the tap water and ultimately, the area.

It is very important because if you don't do it, at that time, the impure yellowish/blackish water may go and detoxicate/damage the carbon and purifier filters of the purifier or it may also, effect or reduce the activity or durability of water purifier.

3. **Final check of all the connections.**

Make sure everything is attached properly and there is no leakage inside the purifier structure. Check for all the connections, jointers, points and nobs so as to ensure the maximum and proper productivity. Attach the pipes in original state as they should be. Also, make sure to connect all the parts properly and carefully. Remember to plug in the setup by switching ON the electricity and the first full tank is not suitable for drinking purpose.

5.5.3 Operation of Water Purifier

After the installation process, technician has to explain the operation, security features and use of control panel of purifier.

Using control panel

Icons on control panel

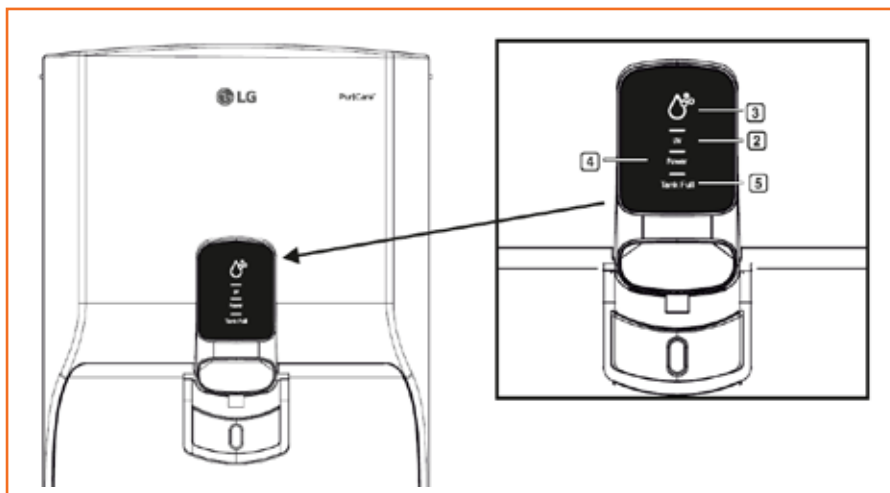


Fig 5.5.10 Control panel

1 Water level indicator

The water level of the storage tank is displayed in 3 levels.

- The icon is divided into 3 levels according to the water level, and as more indication Light turn on, the water level becomes higher. However, the water level cannot be adjusted discretionally.

**2 UV Sterilizing indicator***

Purified water is sterilized by the UV LED. Blue color indicates that UV sterilization is ON & White color indicates that UV sterilization is OFF.

3 Filter Change Indicator **

When the color of indicator changes from blue to amber, this indicates that it is time for preventive maintenance service.

4 Power Indicator*

The Power LED glows to indicate ON condition of Water Purifier.

5 Tank Full Indicator*

When the water storage tank gets filled up completely then Tank full indicator will turn ON.

Operation of water purifier

Open the faucet, purified water will come out.



Fig 5.5.11 Using water purifier

Scan the QR code or click on the link to watch related videos



<https://www.youtube.com/watch?v=GXZ5i5s5FOI>

Installation of water purifier

UNIT 5.6: Troubleshooting and Repairing of Water Purifier

Unit Objectives



At the end of this unit, participants will be able to:

1. Demonstrate servicing of water purifier.
2. Demonstrate procedure of troubleshooting and repairing of faults in water purifier.

5.6.1 Servicing of Water Purifier

Cleaning of water tank

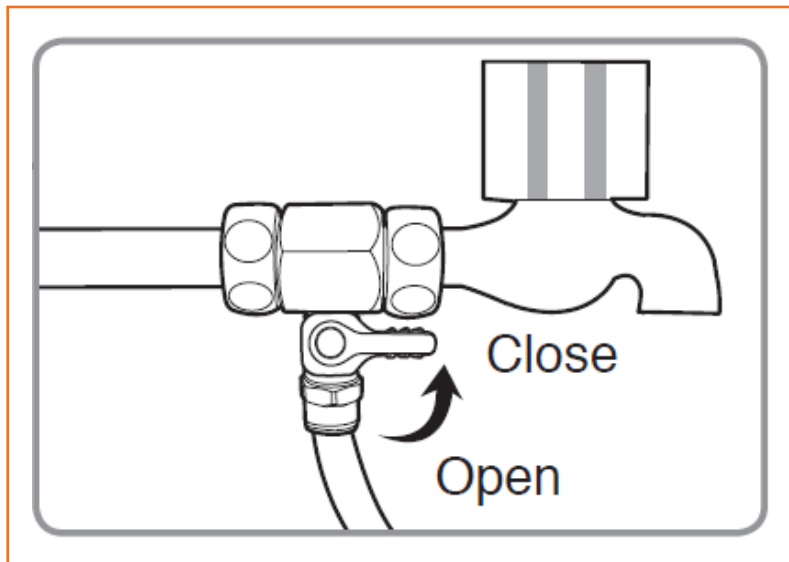


Fig 5.6.1 Closing inlet water valve

1. Close the tap water valve.
2. Drain the water inside the stage tank entirely using the drain hose and water outlet.



Fig 5.6.2 Draining water from water purifier

3. Unplug the power cord
4. Open the top cover by lifting it upward and unlock the cover of the storage tank.

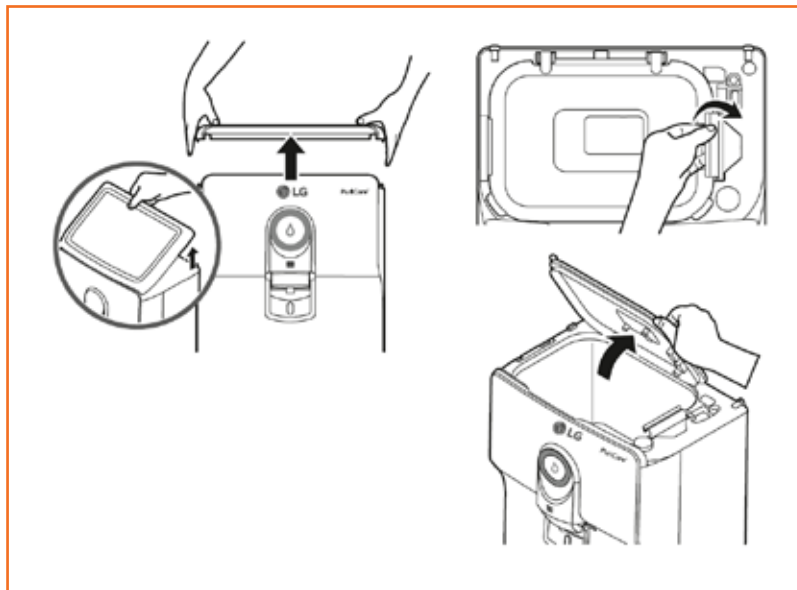


Fig 5.6.3 Opening top cover

5. Wipe the surface of the tank with soft cloth. Do not use any chemical or detergent. If chemical or detergent is not washed completely, this may be harm to human body.

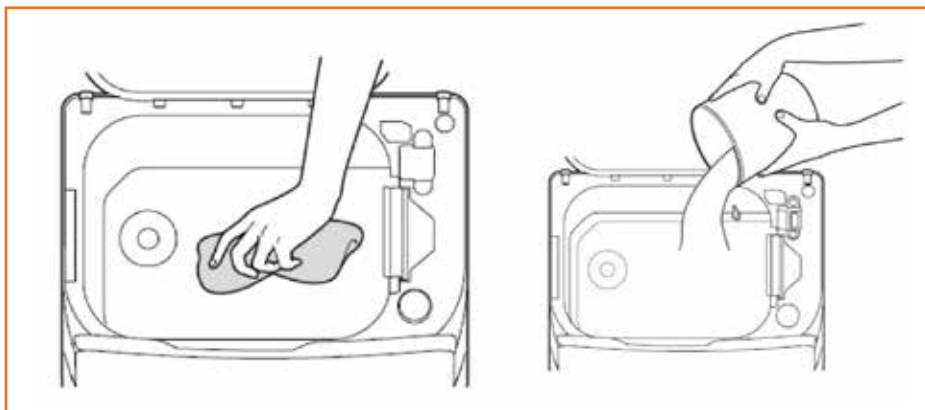


Fig 5.6.4 Cleaning water tank

6. Rinse the storage tank clearly with the prepared purified water and then drain the water completely.
7. Insert and lock the storage tank cover

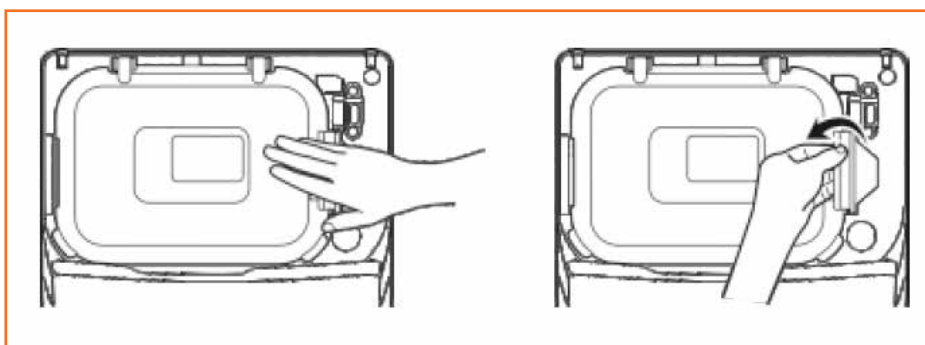


Fig 5.6.5 Fixing tank cover

- Put the top cover back, connect the power cord, and open the supply valve of original water.

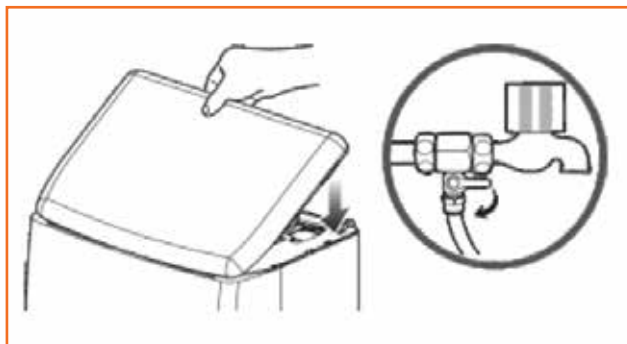


Fig 5.6.6 Fixing top cover

Changing filter

- Close the tap water valve.
- Drain the water inside the stage tank entirely using the drain hose and water outlet.



Fig 5.6.8 Draining water from water purifier

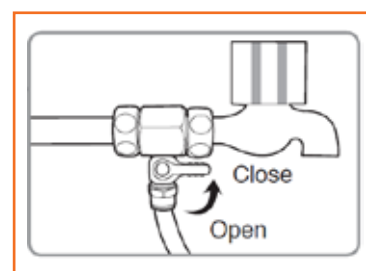


Fig 5.6.7 Closing inlet water valve

- Unplug the power cord
- Open the top or back cover of purifier and remove the filter cover.

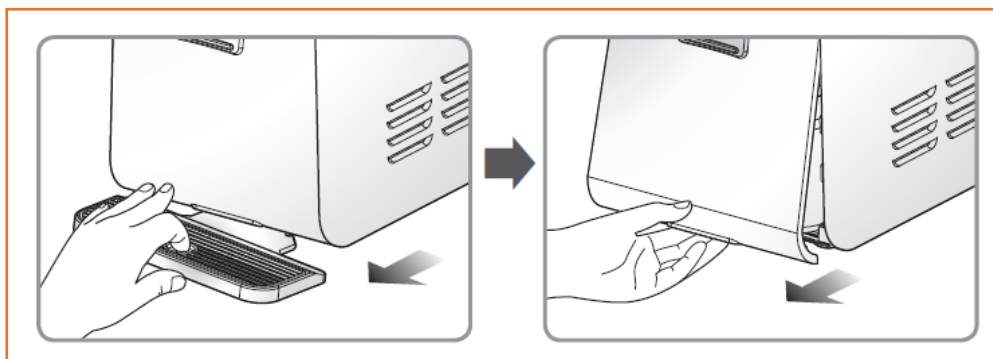


Fig 5.6.9 Opening top or back cover

5. Wash the filter that needs to be replaced, and then change the filter.

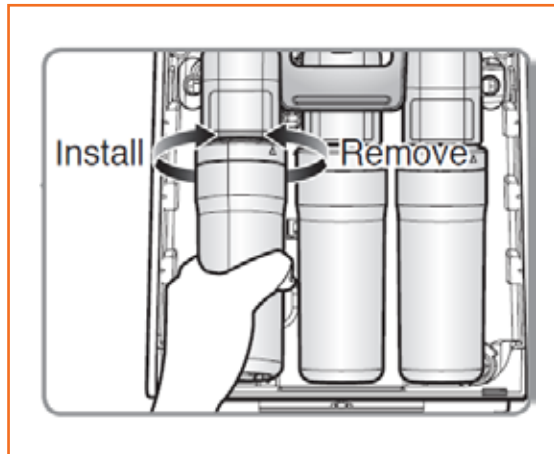


Fig 5.6.10 Replacing filters

6. Fit the top part of the filter cover to the groove and push it upward for closing.

5.6.2 Troubleshooting and Repairing of Faults

There are many different ways that a water purifier would go wrong. Each issue has multiple possible causes. Let's take a look at the possible causes and solutions for the water purifier problems.

Problem	Cause	Solution
Not Enough /No water from Tap	Blocked or closed feed water input	Open or unblock valve
	Blocked sediment/carbon filter	Replace filters
	Closed tank valve	Open valve
	Blocked drain flow restrictor	Replace drain flow restrictor
	Membrane housing valve stuck	Replace check valve
	Malfunctioning automatic shut-off valve	Replace automatic shutoff valve
	Membrane polluted	Replace membrane
Low pressure from water outlet tap/faucet	Incorrect air pressure in storage tank	• Empty storage tank • Find the air valve stem and add air till all water is removed • Pressurize the tank to 8 PSI

Problem	Cause	Solution
		- Reinstall the tank - Turn on the feed supply
	Blocked post carbon filter	Replace post carbon filter
	Partially closed tank valve	Open valve
	Faulty faucet	Replace faucet
High TDS in output water	Blocked pre-filter	Replace pre-filter
	Incorrectly sealed membrane	Install the membrane correctly
	Exhausted membrane	Replace membrane
	Output and drain water lines reversed	Swap the connections
	Malfunctioning automatic shut-off valve	Replace automatic shut-off valve
	Dirty post-carbon filter	Clean/replace post-carbon filter
Bad taste or odour	Blocked post carbon filter	Replace post carbon filter
	Exhausted membrane	Replace membrane
	Dirty storage tank	Clean storage tank
	Water in storage tank left for a long time	Drain and clean storage tank
Leaking membrane housing	Leak in threaded end cap	- Lubricate O-ring and tighten cap - Replace O-ring if leak continues
	Leak in cap or body of housing	- Check housing/cap for cracks - Replace if cracked or damaged
Leaking filter housing	Improper O-ring seating	- Seat O-ring in groove - If dirty, clean and lubricate O-ring

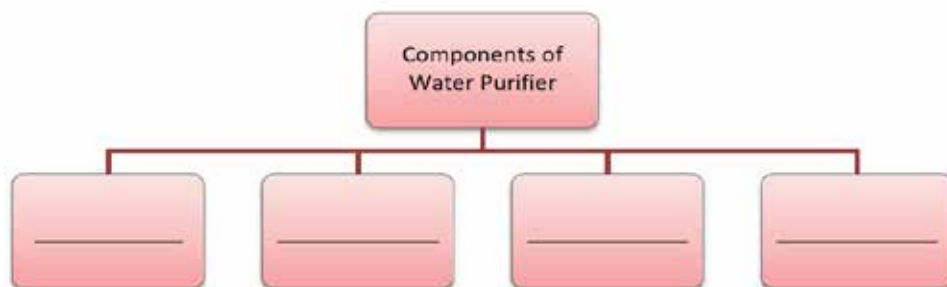
Problem	Cause	Solution
		Replace if cracked or damaged
	Housing cap loose	Hand tighten cap properly
	Damaged housing	Replace if cracked or damaged
Leaking fitting	Damaged or cracked fitting	Replace fitting
	Improper tubing or thread installation	Check and correct tubing and thread installation
System continuously running	Automatic shut-off valve not working	Replace Automatic shut-off valve
	Low incoming water pressure	Increase water pressure to 40 psi
	Low air pressure in storage tank	Increase air pressure to 5 - 7 psi when empty
	Damaged storage tank	Replace storage tank
	Worn out flow restrictor	Replace flow restrictor
	Incorrectly installed membrane	Check membrane installation
Milky water	New System or filters	Air in lines - will go way with use
	Water supply	High oxygen content - will go way with use
	Bad membrane	- Check TDS of water - Replace membrane
Noisy drain/ faucet	Air gap faucet	Check air gap is properly installed
	Drain tube	Check drain line for loops, bends, dips or kinks

Table 5.6.1 Common problems and their solutions in water purifier

Exercise



1. Write the basic components of a water purifier in the space provided in the following figure.



2. Identify the components of a water purifier and write their names in the space given below their images.



6. Perform Gas Charging in Refrigerator and AC



Unit 6.1 – Gas Charging in Refrigerator

Unit 6.2 – Gas Charging in AC



Key Learning Outcomes



At the end of this module, participants will be able to:

1. List the properties of refrigerant
2. Identify the types of refrigerants
3. Demonstrate procedure of filling gas in refrigerator
4. Demonstrate procedure of filling gas in AC

UNIT 6.1: Gas Charging in Refrigerator

Unit Objectives

At the end of this unit, participants will be able to:

1. List the properties of refrigerant
2. Identify the types of refrigerants
3. Demonstrate procedure of filling gas in refrigerator

6.1.1 Refrigerant

A refrigerant is a chemical compound that is used in the refrigeration cycle to transfer heat from one area to another. For ages, people have been using certain substances such as ice, water, brine and air as natural refrigerants to bring down the temperature of an area or substance. Refrigerants are used in all cooling devices such as refrigerators, freezers and air conditioners.

Most commonly used commercial refrigerants are chlorofluorocarbons (CFCs), ammonia, sulphur dioxide and non-halogenated hydrocarbons.

Refrigerants can be classified into two broad categories as shown in the following figure

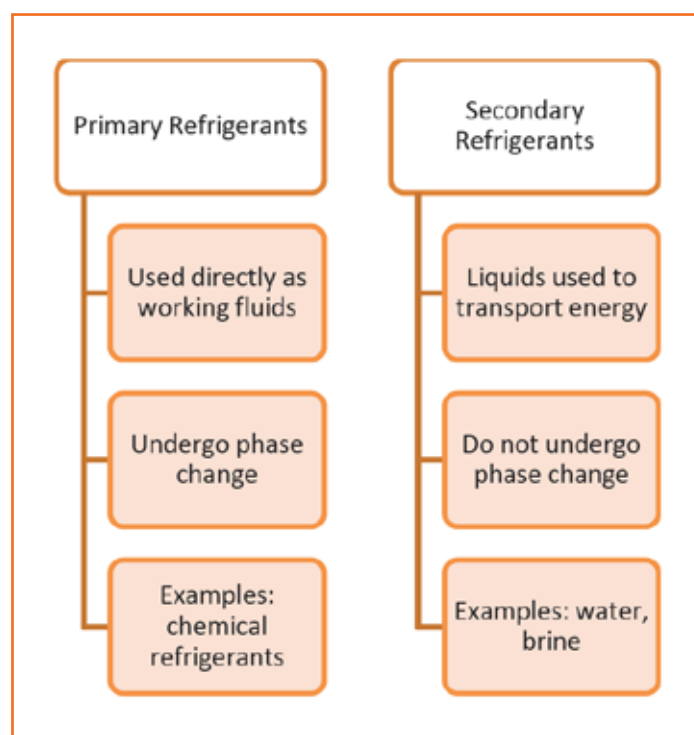


Fig 6.1.1 Categories of refrigerants

Properties of Refrigerants

An ideal refrigerant should satisfy certain thermodynamic, chemical and physical properties to be able to be used safely and efficiently in refrigerating equipment. In addition, they should not pose any danger to

health and property. The following figure shows the properties that an ideal refrigerant should possess -

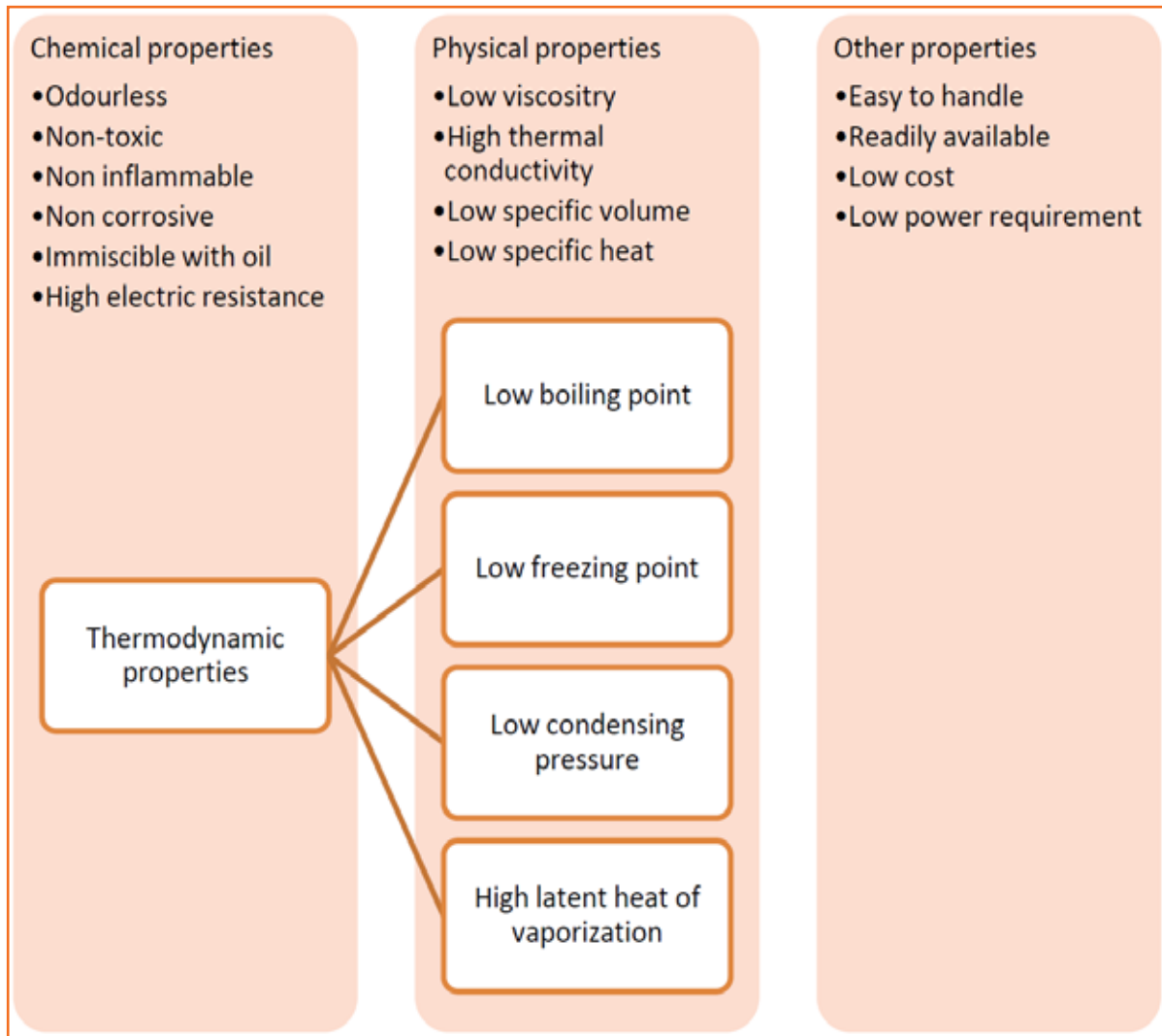


Fig 6.1.2 Properties of refrigerants

Selection of Refrigerants

Even though a variety of refrigerants are available commercially now days, no one refrigerant has proved to be ideal under all circumstances. In some applications a non-toxic, non-inflammable refrigerant is a must but in other application these two characteristics might not be that important. Therefore, when selecting an appropriate refrigerant care must be taken to choose the one which has properties closest to ideal refrigerant for that application.

6.1.2 Types of Refrigerants

There are two main categories in which refrigerants are divided. These are shown in the following figure:

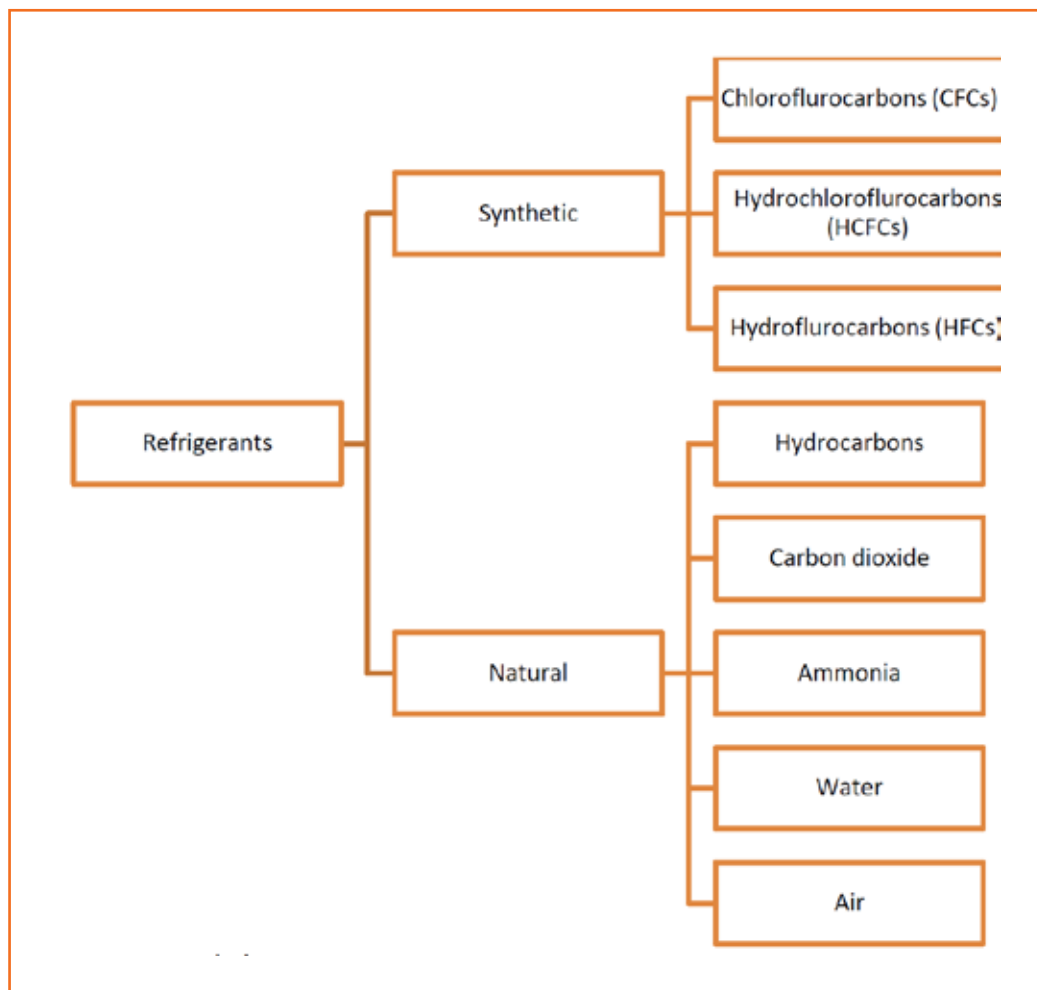


Fig 6.1.3 Types of refrigerants

Synthetic Refrigerants

Synthetic Refrigerants are man-made refrigerants. They are very harmful to the environment and have led to ozone depletion and a rise in global warming.

Chlorofluorocarbons (CFCs)

CFC is an organic compound that is made up of Chlorine, Fluorine and Carbon. They were developed in the 1930s and were used in nearly all households, commercial, industrial and automotive industries. CFCs are chemically very stable. They are compatible with most substances. They are non-toxic, non-flammable and non-reactive. The most common CFC refrigerants are R11, R12, R13, R13B1, R113, R114, R500, R502 and R503. However, it was discovered that chlorine in CFC is damaging the ozone layer leading to its depletion. Therefore, their use has been prohibited since 1987 by the Montreal protocol.

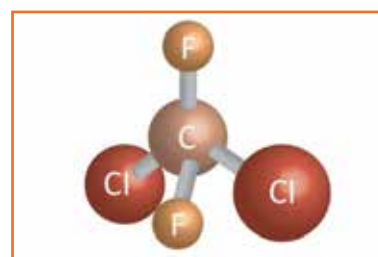


Fig 6.1.4 Chlorofluorocarbon (CFC)

Hydrochlorofluorocarbons (HCFCs)

HCFC is an organic compound that is made up of Hydrogen, Chlorine, Fluorine and Carbon. They too have been widely used since 1930s in household, commercial, industrial and automotive industries. They are energy-efficient, low-in-toxicity and cost effective. They are less stable than CFCs but are equally compatible with most substances. The most common HCFC refrigerants are R22, R123 and R124. They are less damaging to the ozone layer and have helped to bring down the CFC consumption by 75%. However, their main drawback is that they are strong greenhouse gases.

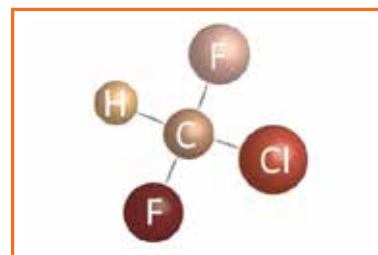


Fig 6.1.5 Hydrochlorofluorocarbon (HCFC)

Hydrofluorocarbons (HFCs)

HFC is an organic compound that is made up of Hydrogen, Fluorine and Carbon. They have been widely used since 1990s in all applications that were initially using CFCs and HCFCs. HFCs are chemically very stable. They are compatible with most substances. The most common HFC refrigerants are R134a, R32, R125 and R143a. As they do not contain chlorine, they pose no damage to the ozone layer. However, their main drawback is that they are strong greenhouse gases.

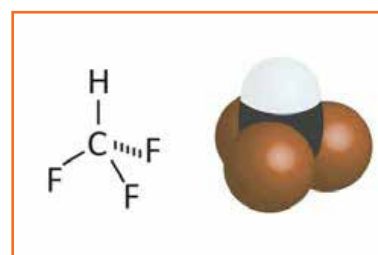


Fig 6.1.6 Hydrofluorocarbon (HFC)

Natural Refrigerants

Natural Refrigerants are present in nature and do not need to be artificially created. As they have no impact either on ozone layer or on global warming, they are considered safe and cost-effective refrigerant.

Hydrocarbons (HCs)

HFC is an organic compound that is made up of Hydrogen and Carbon. They were widely used until 1930s and have been reapplied since 1990s. HCs are chemically very stable and are compatible with most substances. The most common HC refrigerants are R600A, R290, R1270 and their blends. They pose no damage to the ozone layer.

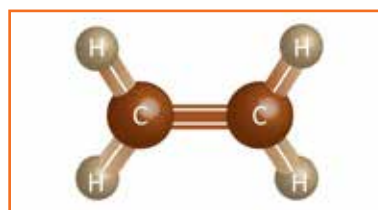


Fig 6.1.7 Hydrocarbon (HC)

Ammonia (NH₃, R717)

Ammonia is an organic compound that is made up of Hydrogen and Nitrogen. It has been widely used as refrigerant since 1800s and is at present used for commercial refrigeration and chillers. It is chemically stable but reacts with carbon dioxide, water or copper. It is very cost effective and easily available. It has no impact on ozone layer.

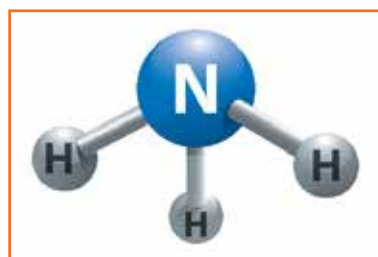


Fig 6.1.8 Ammonia

Carbon dioxide (CO₂, R744)

Carbon dioxide is an organic compound that is made up of Carbon and Oxygen and has been widely used as a refrigerant in 1800s and then reapplied from 1990s. It is used in industrial refrigeration, cold storage and hot-water pumps. It is chemically very stable and compatible with most substances. It is

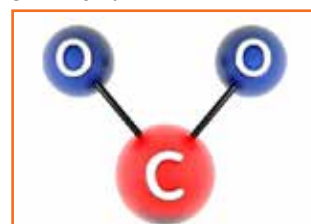


Fig 6.1.9 Carbon dioxide

non-inflammable and has low toxicity. It is very cost effective and easily available. It has no impact on ozone layer.

The following table shows the properties of different types of refrigerants used in commercial applications

Refrigerant		Description	Image
CFC	R12	Known by the Dupon brand name, freon Colourless and odourless Non-inflammable, non-toxic, non-poisonous, non-corrosive and non-irritating Used with reciprocating, rotary and centrifugal compressor Has high ODP Phased out to be replaced by R134a Colour code: White	
HFCF	R22	Suitable for installations requiring low evaporating temperature Used with reciprocating, rotary and centrifugal compressors Non-inflammable, non-poisonous, non-corrosive and non-irritating Colour Code: Green	
	R290	Highest latent heat Largest vapour density Miscible in oil Compatible with copper Low vapour pressure Saves up to 20% energy	
HFC-32 (CH ₂ F ₂)	R32	R32 is a single component refrigerant. It is easier to handle because it doesn't separate and utilises familiar technology, keeping costs similar. R32 is also low-toxic, is difficult to ignite and does not explode. It's a colorless odorless, mildly flammable gas which is insoluble in water.	

Refrigerant		Description	Image
HFC	R134a	Eco-friendly Used as replacement for R12 Non-inflammable, non-toxic, non-poisonous, non-corrosive and non-irritating Used with reciprocating, rotary, screw and centrifugal compressors Colour Code: Light Blue	
HC	R600a	Most common refrigerant for refrigerators Colourless and odourless Inflammable Colour code: Orange	
HC Blend	R410a	Blend of R32 and R125 Ozone friendly Does not contain chlorine Chemically stable Non-inflammable, non-poisonous Colour code: Pink	

Table 6.1.1 Properties of refrigerants

6.1.3 Gas Charging Process in Refrigerator

The following items are required during the gas charging process:

Refrigerant cylinder with refrigerant, gauge manifold for R-134a with 3 set of flexible hoses, adjustable spanner or wrench, ratchet wrench, charge valve or access valve for charging port, small tube cutter, pinch-off tool, oxy-acetylene welding equipment and soap solution for leak test.

Steps in Recharging of Refrigerant

The motor compressor must be off before recharging operation. It should be clear that the tube system is already perfectly vacuumed. The flexible hoses /fittings are still connected to the low- and high-pressure ports.

1. Remove the vacuum pump and connect the mid-port of the gauge manifold (yellow) to the refrigerant cylinder (R-134a).

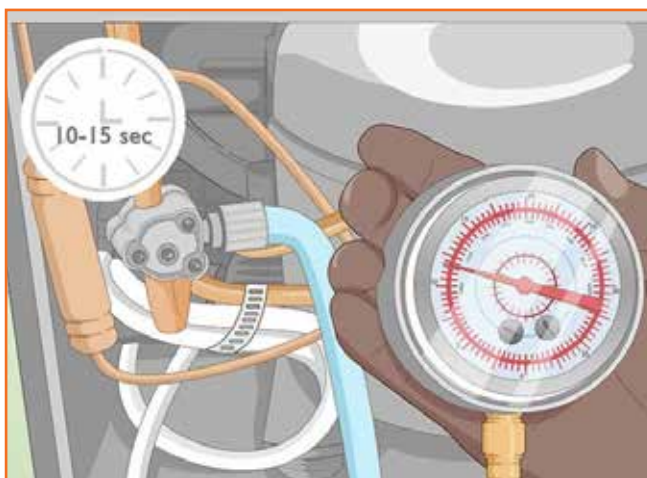


Fig 6.1.10 Connecting flowmeter

2. Open the refrigerant cylinder valve let a small amount flushed out to release few contaminations of air during hose connections.
3. Place the cylinder upside-down for liquid recharging operation.
4. Open the high side valve of the gauge letting the liquid enters until the approximate 75% of its factory setting weight. Shut-off the refrigerant cylinder valve.

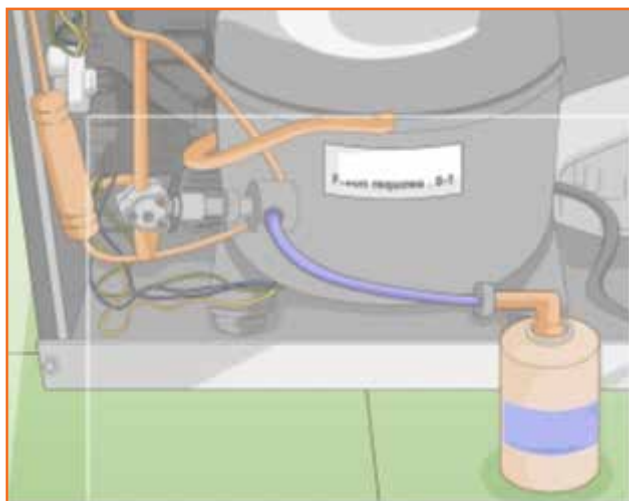


Fig 6.1.11 Connecting gas cylinder

WHY SHUT-OFF? There are still more liquid inside the hose that could possibly be wasted if you complete the recharge amount. That is also the recommended not to use longer hoses that cause to contain more liquid during recharging process.

5. Then slowly open again the high side valve to let liquid inside the red hose to complete the recharging process until you meet the desired weight.

You need to remove the hoses connections on 2 ports.

6. First, Pinch-off the high side port near the filter/drier.
7. Open the high-side and low-side of the gauge manifold to let the liquid refrigerant trapped from red hose going to the low-side suction valve.
8. Close both valve of the gauge manifold.
9. Cut the high-side tube, pinch-off end and braze with silver filling.
10. Second, pinch-off the low-side service port near the motor compressor.
11. Cut the low-side copper tube service port, pinch-off end and braze with silver filling.
12. Leak test the connection and brazes using soap solution, search for bubble that is sign of leakage.
13. Carefully fix the tubing in place under the cover of the refrigerator back side for protection.

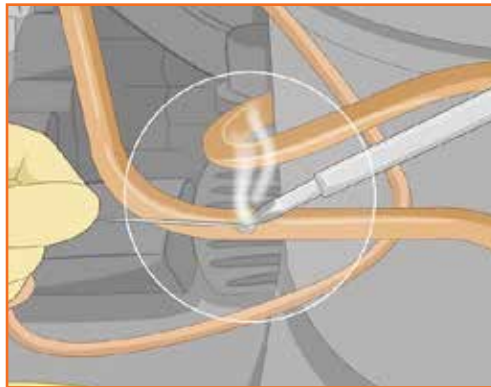


Fig 6.1.12 Brazing of copper pipes

14. Finally, run the motor to test the cooling operation. You can use a thermometer to measure the evaporative temperature. Typical refrigerator's freezing temperature measures about -15 to -17 degrees Celsius.

UNIT 6.2: Gas Charging in AC

Unit Objectives

At the end of this unit, participants will be able to:

1. Demonstrate procedure of filling gas in AC

6.2.1 Gas Charging in AC

Requirements for gas charging in AC

- R-22, R32 or R410A refrigerant
- Refrigerant gauge set
- Blue, red, and yellow hoses
- Electronic leak detector

Steps for filling gas in AC

1. Choose the right refrigerant for your unit. Check AC manufacturer's operating guide to find out which refrigerant unit needs. If you don't have the operating guide, check the electrical control box or the unit's cabinet for the information. The 2 most common refrigerants are R-22, R32 and R410A.
2. Protect eyes, skin, and lungs when working with refrigerant. Wear safety goggles and thick gloves when handling Freon. Never directly inhale any refrigerant; doing so can lead to sudden death.
3. Check the AC or manufacturer manual for information about quantity of gas need to fill. Measure the weight of gas and maintain required amount of gas in the cylinder.

Note: Gas quantity may vary for different model and type

4. Turn off your AC unit at the thermostat and breaker. Go to the thermostat that operates your air conditioner. Turn it to the "off" position.
5. Hook up the refrigerant gauges to the valve connections. There are 3 valve connections attached to your unit's hardware, with a valve on each side (left and right). Attach the gauge with the blue hose to the low-pressure valve on the left side. Attach the gauge with the red hose to the high-pressure valve on the right side.

Leave the center valve open for now; that is where you'll connect the yellow hose to feed the refrigerant into the system.



Fig 6.2.1 Refrigerant

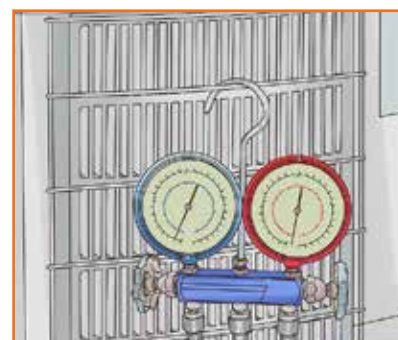


Fig 6.2.2 Connecting flowmeter

6. Turn the AC unit back on and wait about 15 minutes. After you turn the AC back on, the unit will need to run for several minutes so that it can stabilize itself. You won't get an accurate reading on the refrigerant gauges until the AC has stabilised.
 7. Open the canister of refrigerant by twisting the spout on the bottom. Attach the yellow hose to the refrigerant canister's valve and attach the other end to the middle valve connection on your gauge. There will be a small knob on the bottom of the refrigerant canister. Twist it several times to open the refrigerant.
 8. Open the blue low-pressure valve on the left side. Open it for a few seconds, then close it. Open it for a few more seconds, then close it again. Continue doing this. You want to slowly allow small amounts of the refrigerant into the unit at a time until the required amount of gas filled in it.
 9. Watch the gauge until you reach the required amount of gas. Use the gauge to monitor the gas quantity filled, so you know when to shut the valve.
 10. Turn off the valve and disconnect the gauge set. Disconnect all of the hoses and the gauge set from the AC unit.
- Since the unit is running during this process, there's no need to restart your unit after adding refrigerant.
11. Perform an electronic leak test to ensure safe operation.



Fig 6.2.3 Connecting gas cylinder

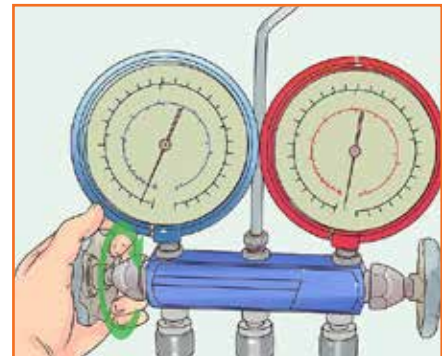


Fig 6.2.4 Measuring gas pressure

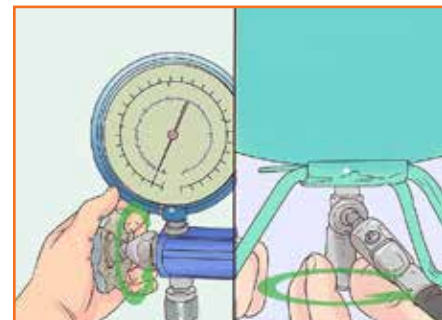


Fig 6.2.5 Filling gas



Fig 6.2.6 Electronic leak test

Scan the QR code or click on the link to watch related videos



<https://www.youtube.com/watch?v=149IW7dB3sM>

Gas charging in AC

Exercise



Write the name of the refrigerant gas below each of the following images as per the colour of the refrigerant gas cylinder shown in the image.











ANNEXURE - QR Codes

S.No.	Chapter No.	Unit No.	Topic Name	Page No.	QR code(s)	URL
1	Chapter 2: Install and Repair Refrigerator	Unit 2.2 – Installation and Operation of Refrigerator (DIOS)	Installation and operation of DIOS refrigerator	48		https://www.youtube.com/watch?v=R4ILG-FFT60k
2	Chapter 3: Install and Repair Washing Machine	Unit 3.2 – Installation and Operation of Automatic Washing Machine	Installation and operation of automatic washing machine	72		https://www.youtube.com/watch?v=l6RoR-mA9GEM
3	Chapter 4: Install and Repair Dish Washer	Unit 4.2 – Installation and Operation of Dish Washer	Installation of Dish Washer	94		https://www.youtube.com/watch?v=9UUy-DUhw7-Q
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