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Participant Handbook

Sector
Electronics

Sub-Sector
Consumer Electronics

Occupation
After Sales Service

Reference ID - **ELE/Q3105, Version 1.0**
NSQF Level 5

Field Engineer – RACW

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

Shri Narendra Modi
Prime Minister of India

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Certificate

COMPLIANCE TO

QUALIFICATION PACK - NATIONAL OCCUPATIONAL STANDARDS

is hereby issued by the

ELECTRONICS SECTOR SKILL COUNCIL OF INDIA

for

SKILLING CONTENT : PARTICIPANT HANDBOOK

Complying to National Occupational Standards of

Job Role/ Qualification Pack: **"Field Engineer - RACW"** QP No. **"ELE/Q3105, NSQF Level 5"**

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Authorised Signatory
(Electronics Sector Skill Council)

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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 Field Engineer – RACW.

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

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CEO

Electronics Sector Skills Council of India

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.

Key Learning Objectives for the specific NOS mark the beginning of the Unit/s for that NOS.

- Define matter, its states and change in states
- Explain properties of heat
- Explain types of heat transfer and energy conservation
- Explain the working of refrigerators
- Describe electric circuits
- Describe voltage, current and resistance
- Define Ohm's law
- List the different types of tools used for installing appliances
- Identify the correct methods of using tools
- Explain the working of DC refrigerator
- Explain the working of FF refrigerator
- Install DC and FF refrigerators
- Define the factors, comfort zone and heat load of ACs
- Identify the different parts and working of Window ACs
- Follow safety precautions for installation of Window ACs
- Identify the different types of washing machines
- Describe the basic functions of washing machines
- Identify the different parts of washing machines
- Install semi-automatic washing machines
- Understand customer requirements
- Interact with customers
- Suggest resolution to the problems of customers

The symbols used in this book are described below.

Symbols Used


Key Learning Outcomes


Steps


Role Play


Tips


Notes


Unit Objectives


Activity

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1. Introduction to Refrigerator, Air Conditioner and Washing Machine (RACW)

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Unit 1.1 – Basic Science Related to RACW

Unit 1.2 – Basics of Refrigerators

Unit 1.3 – Basics of Air Conditioners

Unit 1.4 – Basics of Washing Machines

Unit 1.5 – Electronic Waste (e-waste) Management

ELE/N3101, ELE/N3115
ELE/N3116, ELE/N3117

Key Learning Outcomes

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

1. Define matter, its states and change in states
2. Explain properties of heat
3. Explain types of heat transfer and energy conservation
4. Explain the working of refrigerators
5. Explain the refrigeration cycle
6. Explain the working of air conditioners
7. Identify the AC comfort zone factors
8. Identify the types of AC and basic differences between them
9. Explain the working of washing machines
10. Explain the role of a field engineer for RACW
11. Explain about e-waste and e-waste management

UNIT 1.1: Basic Science Related to RACW

Unit Objectives

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

1. Define matter, its states and change in states
2. Explain properties of heat and types of heat, to show the conversion of temperature from one scale to other
3. Explain types of heat transfer and energy conservation

1.1.1 Matter and its States

The basic working of refrigeration and air conditioning (RAC) involves changes in states of liquids and gases over different temperature ranges. Therefore, to understand the concept of RAC, first it is important to understand the basics of matter, its states and change s in its states.

Matter is defined as anything that occupies space, has length, width, height and mass. The following image shows the definition of matter as explained in the preceding statement:

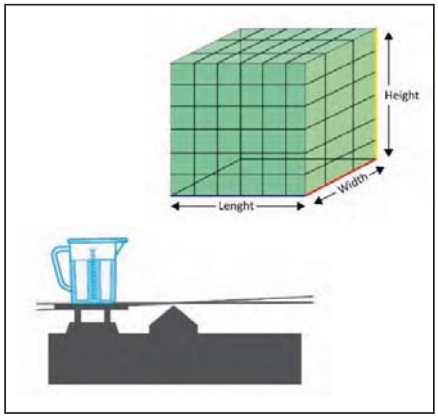

Fig 1.1.1: Definition of matter

Typically, matter is classified into three states as shown in the following figure:

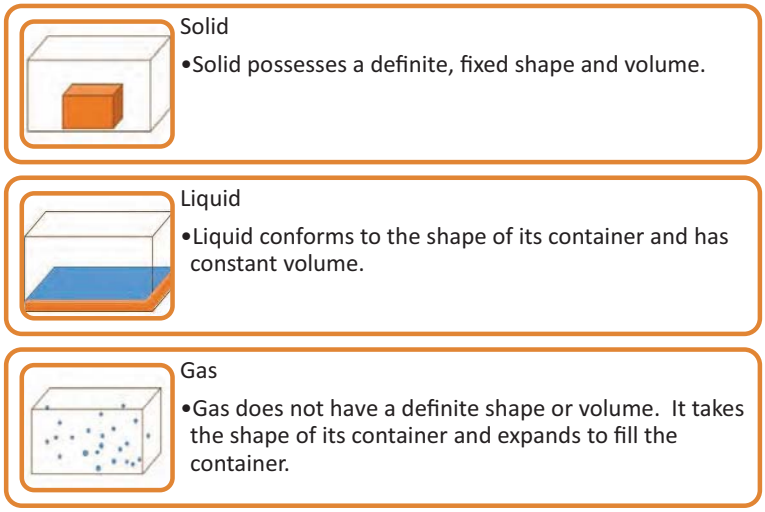

Fig. 1.1.2: States of matter

Change in States

When a state of matter is subjected to any kind of pressure or temperature change, the structure of matter and its property, change from one state to another. For example, water below zero degrees Celsius is in ice form which is solid and above 100 degrees Celsius is in steam form which is gaseous state.

The following image shows change in states as depicted in the above statement:

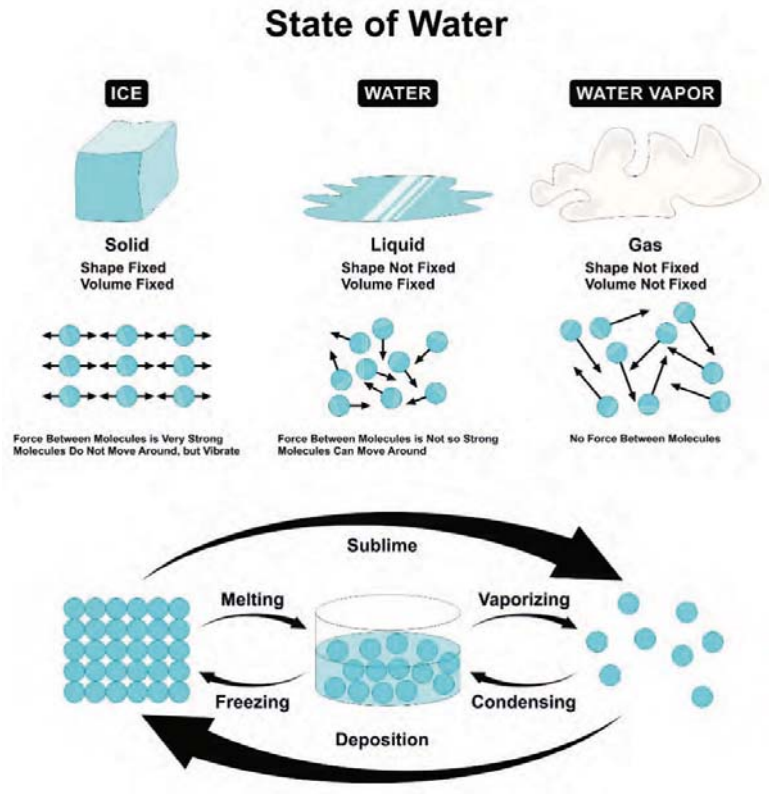

Fig 1.1.3: Change in states

The following figure defines the process of change in states based on temperature changes:

Melting	•The process in which there is a change in the state of a substance from solid to liquid, due to increase in temperature on application of heat or pressure, is known as melting.
Freezing	•The process in which there is a change in the state of a substance from liquid to solid, below the freezing temperature of the substance, is known as freezing.
Vaporisation	• The process in which there is a change in the state of a substance from liquid to gaseous (vapour), at temperatures below the boiling temperature at certain pressure, is known as vapourisation.
Condensation	• The process in which there is a change in the state of a substance from gaseous form to liquid form is known as condensation.
Sublimation	• The process in which there is a change in the state of a substance directly from solid form to gaseous form, without becoming a liquid, is known as sublimation.
Deposition	•The process in which there is a change in the state of a substance directly from gaseous form into solid form is known as deposition.

Fig. 1.1.4: Basic terms in change of states of matter

1.1.2 Heat and Transfer of Heat

Heat can be defined as a form of energy which is transmitted from a hotter object to a cooler one, as shown in the following image:

Fig. 1.1.5: Heat transfer

Temperature can be measured in terms of temperature using a thermometer. It is a measure of amount of heat (whether a substance is hot or cold). It is measured by a device known as thermometer. For measuring temperature, there are several scales and units. Most commonly used scales are the Celsius scale (denoted by °C), the Fahrenheit scale (denoted by °F) and the Kelvin scale (denoted by K).

Temperature Conversion

To convert temperature from one scale to another there are some basic standard formulae which are as shown in the following figure:

Fahrenheit scale to Celsius scale:

$$T\,(°C) = (T(°F) - 32) \times 5/9$$

Kelvin scale to Celsius scale:

$$T\,(°C) = T(K) - 273.15$$

Fig. 1.1.6: Basic standard formulae

Types of Heat

Heat can be classified into different types. The following figure shows the different types of heat:

Sensible heat

- It is the form of heat energy, which is commonly sensed by touch or measured directly with a thermometer.

Latent heat

- It is the form of heat energy, which cannot be sensed by touch or measured using a thermometer. It causes an object to change its phase.

Specific heat

- It is the ratio of the quantity of heat needed to increase the temperature of unit mass of a substance by one degree to the quantity of heat needed to increase the temperature of same mass of water by the same amount

Fig. 1.1.7: Types of heat

Latent heat which is involved while melting a solid or while freezing a liquid is known as the latent heat of fusion. Latent heat which is involved while vaporizing a liquid/solid or condensing a vapour is known as the latent heat of vaporization.

The unit for latent heat is joules or calories.

For example:

- When water is continuously boiling, the temperature stays at 100 °C until the entire amount of water evaporates. This happens because all the heat is transmitted to the liquid as latent heat of vaporization and is taken away by the vapour.
- When ice melts, the temperature stays at zero degrees C. The temperature of liquid water that results due to the latent heat of fusion is also zero degrees C.

Heat of vaporisation in a substance is in a very large amount. Hence, steam carries immense thermal energy that is released on its condensation. This quality makes water a suitable and desirable working fluid for heat engines.

Types of Heat Transfer

Heat transfer occurs in three ways, as shown in the following figure:

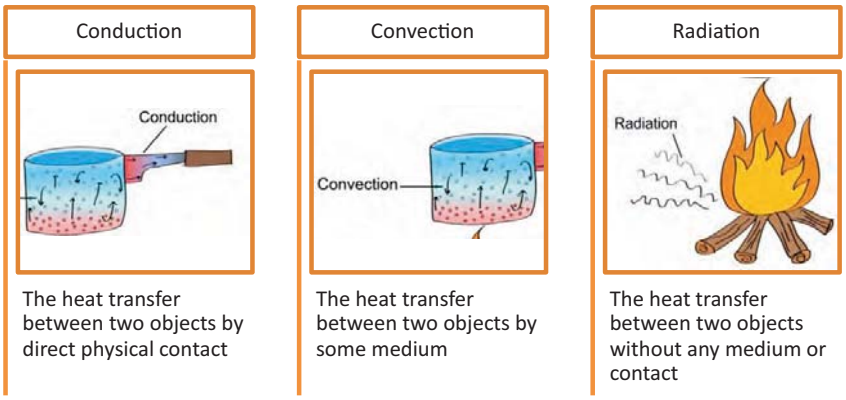

Fig.1.1.7: Types of heat transfer

1.1.3 Energy Conversion

The law of conservation of energy states that energy can be transformed from one form to another, but it cannot be created or destroyed. Energy is the capacity to perform any kind of action such as lifting or heating of an object.

Energy is used to provide heating, refrigeration, lighting or performing mechanical work.

UNIT 1.2: Basics of Refrigerators

Unit Objectives

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

1. Identify the need for refrigerators
2. Explain the working of refrigerators and basic components
3. Explain the refrigeration cycle

1.2.1 Refrigerator

A refrigerator is used to cool substances to a temperature below the temperature of the surrounding environment to preserve substances.

Refrigeration is a process of transferring the temperature from low to high temperature reservoir by removing heat which cools the substances inside the refrigerator. The following image shows a refrigerator

Fig. 1.2.1: A refrigerator

The basic principle of refrigeration is passing a liquid at low temperature continuously around an object which needs to be cooled, by taking the heat away from the object.

In refrigeration, the low temperature reduces the reproduction of bacteria and other microorganisms to reduce the spoilage rate. The temperature range for food storage is around three to five-degree C.

The technology utilizes a compartment that is thermally insulated and a heat pump which conveys the heat from the interior of the fridge to the exterior environment. It has four main components–compressor, condenser, capillary tube and evaporator.

1.2.2 Refrigeration Cycle

In the refrigeration cycle, the refrigerant liquid flows through the compressor to the condenser where the condenser fan liquefies the refrigerant. The drier then collects the refrigerant fluid and sends it to the evaporator. In the evaporator, the fluid then transfe rs the cooled fluid to the substance in the chamber. This continues through the suction and discharge line between the components to complete the refrigeration cycle. The following image shows a refrigeration cycle:

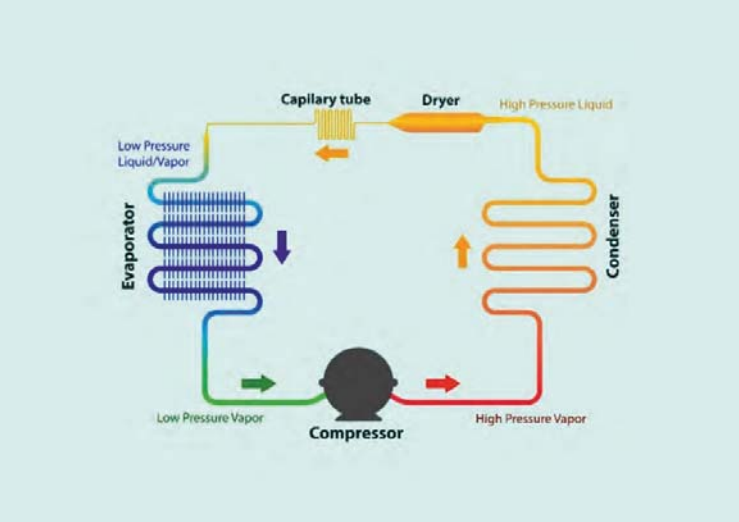

Fig. 1.2.2: A refrigeration cycle

1.2.3 Basic Components in a Refrigeration Cycle

The basic components in a refrigeration cycle are:

- Compressor
- Condenser
- Capillary Tube
- Evaporator

The following figure shows the basic components of a refrigeration cycle:

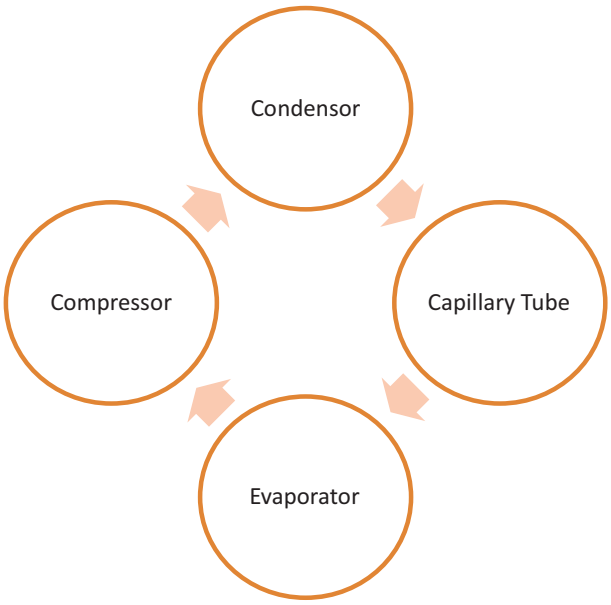

Fig. 1.2.3: Components of a refrigeration cycle

Compressor

The function of a compressor is to receive the refrigerant from the evaporator through a suction valve which is at low pressure and send it to the condenser through an exhaust valve which is at high pressure and temperature.

A compressor is utilized to increase the pressure of the refrigerant. The following image depicts a compressor:

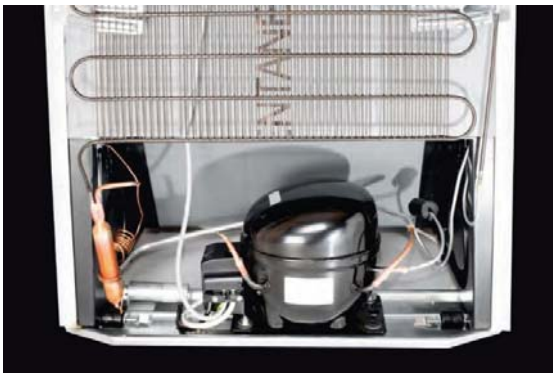

Fig. 1.2.4: A compressor

Types of Compressors:

The following image shows different types of compressors:

Reciprocating Compressor | Rotary Compressor | Scroll type Compressor

Fig. 1.2.5: Types of Compressors

In household refrigerators, reciprocating type of compressor is used.

Working of a reciprocating compressor:

The following figure shows the steps of a reciprocating compressor:

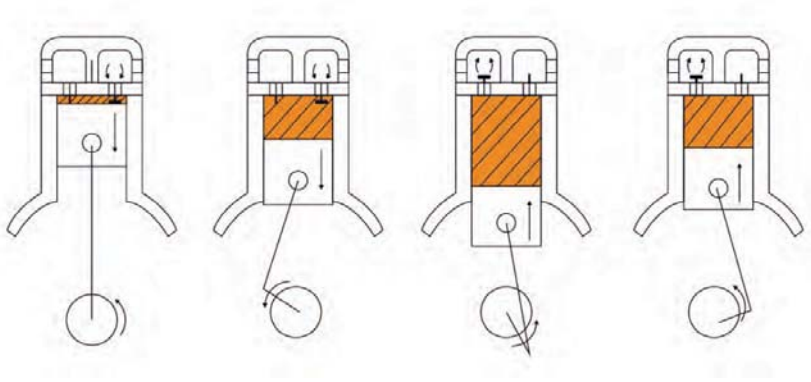

Fig. 1.2.6: Steps of a reciprocating compressor

Condenser

The condenser is also known as the heat exchange coil. The refrigerator is equipped with a condenser on the outside because the refrigerant temperature is more than the atmospheric temperature. So, the vapour is condensed to liquid state to get it at normal temperature.
The input of the condenser is the refrigerant from the compressor. This refrigerant is a vapour at a high pressure and a high temperature. The output of the condenser is the refrigerant at high-pressure and in a liquid form.

The following image shows types of condensers used in refrigerators:

Skin condenser

Wire mesh condenser

Fig. 1.2.7: Types of condensers

Capillary Tubes

Capillary tubes are used as an expansion valve which restricts the flow of liquid to reduce the pressure. These tubes are about 2 m in length and have an inside diameter of 0.6 mm which allows considerable resistance to the flow. This causes a sudden drop in pressure and temperature.

The high-pressure refrigerant in the liquid form from the condenser is the input of the capillary tubes and a low pressure refrigerant in the liquid form to the evaporator is its output.

The following image shows a capillary tube:

Fig. 1.2.8: A capillary tube

Evaporator

Evaporator is used as a heat exchanger which carries the cold refrigerant over a body and the refrigerant absorbs the heat. The liquid refrigerant expands in the evaporator.

The low-pressure refrigerant in the liquid form from the capillary tube is the input of the evaporator and a low-pressure refrigerant in the vapour form to the compressor is its output.

The following image shows an evaporator:

Fig. 1.2.9: An evaporator

The following image shows different types of evaporators:

Fin type evaporator | Roll bond evaporator | Tube plate evaporator

Fig. 1.2.10: Types of evaporators

UNIT 1.3: Basics of Air Conditioners

Unit Objectives

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

1. Explain the working of air conditioners (AC)
2. Identify the AC comfort zone factors
3. Identify the types of AC and basic differences between them

1.3.1 Air Conditioner

Air conditioners (AC) are used to attain a comfortable environment by cooling or dehumidifying rooms or any closed environment. As per the requirements of an individual, there are different types of ACs used in different conditions. The capacity of the AC is measured in tons.

There are some basic requirements for a comfort zone created by an AC.

- Fresh air supply with supply of oxygen and removal of carbon-dioxide.
- Heat removal and moisture removal.
- Sufficient air movement and air distribution in the space.
- Removing odour and dust.

Air conditioning controls the following three attributes of atmosphere in a closed environment:

Parameters	Winter	Summer
Temperature	230C~250C	190C~210C
Relative Humidity	50%~60%	35%~40%
Air movement	4.5~7.5	Air movement

Fig 1.3.1: Three attributes of atmosphere

Any heat generated from the space to the air conditioner is called “Load”.

Heat load depends on:

- Dimensions of the room
- Electrical equipment in the room
- Type of room
- Incident heat from wall/ceiling/door/windows
- Number of human beings
- Work performed by a human body

For the calculation of AC load comfort zone there are some basic parameters that need to be maintained by the AC. The following image shows the AC load calculation factors:

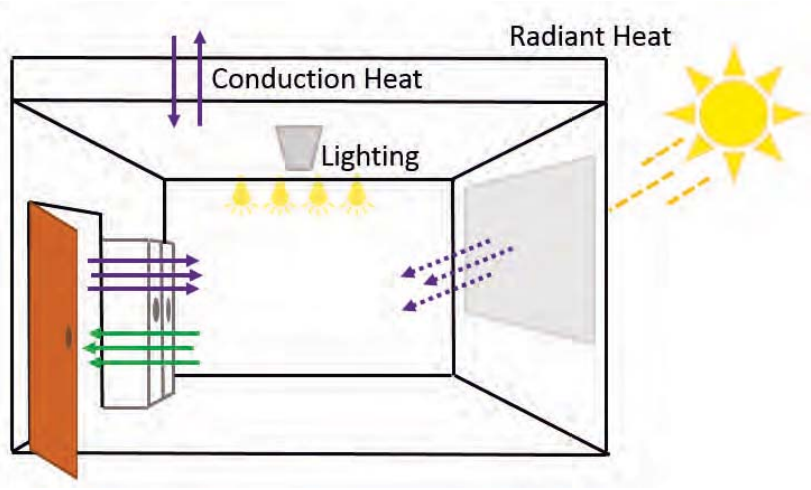

Fig. 1.3.2: AC load calculation factors

Working of Air Conditioners

Air conditioner uses a fan which distributes the conditioned air to help maintain a thermally comfortable and improved air quality environment. The AC works on the principle of refrigeration cycle.

1.3.2 Types of AC

There are different types of ACs available and the AC system used depends upon fact ors such as the dimension of the area which needs to be cooled, heat generated in the area and so on. So, it is on the technician to calculate and understand the load capacity and select an AC system appropriate for the area.

Window AC

Window AC is a unitary air conditioning system which is most commonly used for a medium sized single room. In this type of AC all the basic components of an AC system like condenser, compressor, evaporator, cooling coil etc. are installed in a single compartment. As the name suggests, this type of AC can be installed or fitted in a window slot provided in a room's wall.

The following image shows a window AC:

Fig. 1.3.3: A window AC

Split or Ductless AC

Split or ductless AC is a split AC system which is used in hotels and apartments. They are made up of an indoor and an outdoor unit. The indoor unit contains the evaporator and the cooling fan and the outdoor unit contains the compressor, expansion valve and a condenser. This type of AC gives convenience where there is no slot present in the room or the wall. These types of ACs take more space than window AC. The following image shows a split AC:

Fig. 1.3.4: A split or ductless AC

Portable AC

Portable AC is a unitary type AC system. It is an AC system which can be placed an ywhere on the floor of a room. It uses a hose vent to discharge the exhaust heat through the exterior wall of the room. The following image shows a portable AC:

Fig. 1.3.5: A portable AC