

## UNIT 1: FUNDAMENTALS

### PART 1: READING COMPREHENSION:

#### 1.1. Reading text: Fundamentals:

#### A. FUNDAMENTAL OF AIR CONDITIONER:

##### 1. What is air conditioning?

An air conditioning is defined as the process of treating air so as to control simultaneously its humidity, cleanness, distribution as well as temperature to meet the requirement or the conditioned space. It is a part of refrigeration in a wide sense.

##### 2. Basic principles of air - conditioning

Most air conditioner uses the evaporation of a refrigerant, like Freon, to provide cooling. The mechanics of the Freon evaporation cycle are the same as in an air conditioner. Air conditioning systems are based on four principles. First, the compressor compresses cool Freon gas, causing it to become hot, high-pressure Freon gas (red in the diagram above). Second, this hot gas runs through a set of coils so it can dissipate its heat, and it condenses into a liquid. Third, the Freon liquid runs through an expansion valve, and in the process it evaporates to become cold, low-pressure Freon gas (light blue in the diagram above). Fourth, this cold gas runs through a set of coils that allow the gas to absorb heat and cool down the air inside the building.

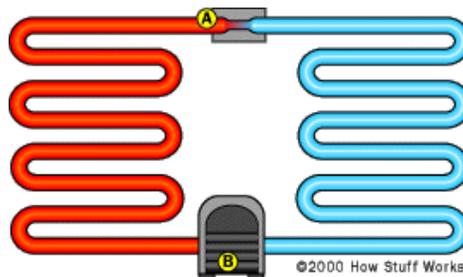


Figure 1 Diagram of a typical air conditioner

Most air conditioning systems have five mechanical components such as a compressor, a condensor, an evaporator coil, a blower and a chemical refrigerant.

#### B. FUNDAMENTAL OF REFRIGERATOR:

##### 1. What is refrigeration?

Refrigeration is defined as the process of reducing and remaining the temperature of a space or material below the temperature of a space or material below the temperature of the surroundings.

##### 2. Refrigerants

Refrigerants are fluids that change their state upon the application or removal of heat within a system and, in this act of change, absorb or release heat to or from an area or substance. Fluid which is suitable for as a refrigerant need to have the following properties

including: inexpressive, non explosive, non poisonous, non flammable, non corrosive, stable (inert), high latent heat of vaporization, easy to vaporize and condense and easy to detect leaks. Today fluorinated hydrocarbon refrigerants are being used almost exclusively in air-conditioning system.

### 3. Basic principles of refrigeration

The principle of refrigeration is to remove heat from one area (i.e inside your fridge) and locate it to another area (i.e. outside of your fridge). Air is not brought in from the outside of the fridge the heat is absorbed by the evaporator inside the fridge which has refrigerant inside it, this refrigerant at low pressure is at low temperature inside the evaporator so the heat from the product inside the fridge is absorbed by the evaporator which has a fan to circulate the air around the fridge. Then the refrigerant is pushed around the pipe work by the compressor to the condenser where the refrigerant is hot from the heat out of the fridge. The outside air is absorbed by the ambient air so when coming back into the evaporator, it can absorb more heat and expel it into the ambient air. Normally a refrigeration system consists of 5 main components: a compressor, a condenser, an expansion device or capillary tube and an evaporator.

The mechanics of the Freon evaporation cycle are the same as in an air conditioner. Air conditioning systems are based on four principles. First, the compressor compresses cool Freon gas, causing it to become hot, high-pressure Freon gas (red in the diagram above). Second, this hot gas runs through a set of coils so it can dissipate its heat, and it condenses into a liquid. Third, the Freon liquid runs through an expansion valve, and in the process it evaporates to become cold, low-pressure Freon gas (light blue in the diagram above). Fourth, this cold gas runs through a set of coils that allow the gas to absorb heat and cool down the air inside the building.

#### 1.2. Comprehension check:

**\* Task 1: Choose A, B, C or D which best completes each sentence:**

- Refrigerants are being used almost exclusively in today air - conditioning system such as  
A. water      B. fluorinated hydrocarbon      C. methyl chloride      D. air
- In the third principle of air conditioning systems, the hot gas runs through..... before evaporating to become cold, low-pressure Freon gas.  
A. a set of coils      B. evaporator coil      C. capillary tube      D. expansion device

**\* Task 2: Indicate whether the sentence or statement is true or false. WRITE (T) OR (F):**

- When two substances of different temperatures are brought in contact with each other, heat will flow from the colder substance to the warmer substance.
- Freon in the compressor remains in the gas state.
- When a gas is compressed, it heats up, but when a gas expands, it cools down.
- The warm gas passed through the condenser, where it heats the surroundings and cools the down.

5. There are 4 major components in a refrigerator such as a compressor, a condenser, an expansion device.

**\* Task 3: Answer the questions:**

1. How does air - conditioning work?
2. What are four basic principles of refrigeration?
3. Which properties does a refrigerant need to have?
4. How many principles are air - conditioning system based on?
5. What refrigerants are widely used in today air - conditioning system?

**PART 2: LANGUAGE WORK:**

**Grammar:** Present simple

Form: Present Simple Tense

(+) Positive: S + V- infinitive + O

S + V(s/es)+ O

(-) Negative: S + don't + V-infinitive + O

S + doesn't + V-infinitive + O

(?) Question:

+ Yes/No question:

Do/Does + S + V-infinitive + O?

+ Wh-question:

Wh- + do/does + S + V-infinitive +O?

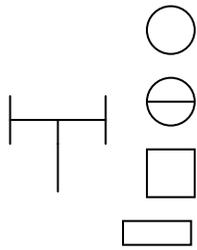
**Practice:**

**\* Task 1: Describing shapes**

+ Study these nouns and adjectives for describing the shapes of objects:

	noun	adjective	shape	noun	adjective
onal	circle	circular		sphere	spherical
	semi-circle	semi-circular		cylinder	cylindrical
	square	square		tube	tubular
	rectangle	rectangular		—	rectangular
lines			edges		
		straight			rounded
		curved			pointed

+ Describe the shapes of the following objects as examples:



An H - shaped antenna



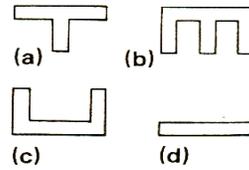
A square wave



a saw - tooth wave



1. A ceramic capacitor



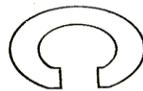
2. Transformer laminations



3. an electrolytic capacitor



4. an antenna



5. a magnet



6. a cable conduit



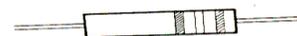
7. a carbon brush



8. a capacitor



9. a motor pole shoe



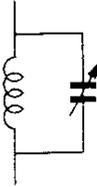
10. a resistor

**\* Task 2: Describing position and connection:**

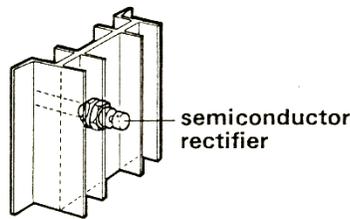
When describing the position of a component or how it is connected in a circuit, phrases of this pattern are used:

*Be + past participle + preposition*

Example:



1. The tuning capacitor **is connected across** the coil



2. The semiconductor rectifier **is mounted on** the heat sink

*Be + past participle + preposition*

Complete each sentence using an appropriate phrase from this list:

Wound round

located within

Connected across

applied to

Mounted on

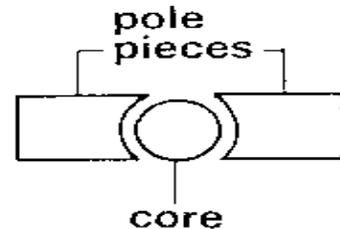
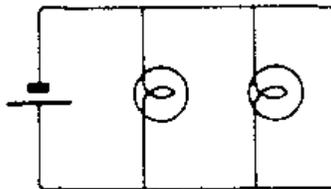
connected to

Wired to

connected between

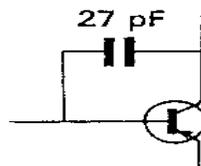
1. The bulbs are.....the battery

2. The core is .....the pole pieces

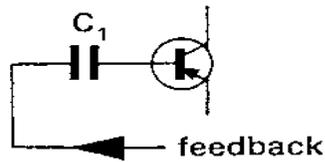


3. The 27pF capacitor is .....the collector and the base

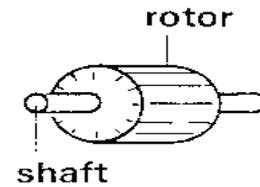
4. The antenna is .....the coil



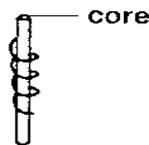
5. Feedback voltage is .....the base of the transistor through  $C_1$



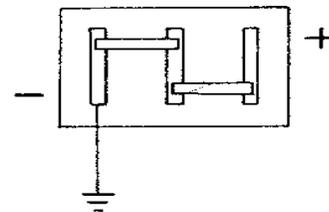
6. The rotor is .....the shaft



7. The coil is .....an iron core



8. The negative pole of the battery.....earth



**\* Task 3: Put the set of words and phrases given into the correct order to make meaningful sentences:**

1. Most/ uses /air /conditioner/ the /refrigerant/ like /evaporation/Freon.
2. Freon/ liquid/ the/ an/ through/ valve/ expansion.
3. system/ of/ 5/ consists/ refrigeration/ a/ normally.
4. cold/ runs/ a/ set/ the/ of/ coils/ through/ that/ gas/ the/ allow/ absorb/ heat/ to.

**\* Task 4: Translate the sentences into Vietnamese:**

1. A refrigerant is a heat carrier to move heat from a room to be cooled to the outside.
2. When the temperature outside begins to climb, many people seek the cool comfort of indoor air conditioning.
3. Refrigerant is drawn from the evaporator and pumped to the condenser by the compressor.
4. Refrigeration is the process of removing heat from an area or a substance and is usually done by an artificial means of lowering the temperature, such as the use of ice or mechanical refrigeration.
5. Mechanical refrigeration is defined as a mechanical system or apparatus so designed and constructed that, through its function, heat is transferred from one substance to another.

**\* Task 5: Translate the sentences into English:**

1. Làm lạnh và điều hòa không khí được sử dụng để làm mát sản phẩm hoặc môi trường của tòa nhà. Hệ thống làm lạnh và điều hòa không khí hấp thụ nhiệt từ nơi cần làm mát và truyền nhiệt hấp thụ ra khu vực khác, có nhiệt độ cao hơn.

2. Sự làm lạnh thực hiện theo 3 nguyên lý: Thứ nhất, nếu chất lỏng được làm nóng, nó sẽ chuyển thành khí hoặc hơi. Khi khí này được làm lạnh, nó lại trở lại trạng thái lỏng. Thứ hai, nếu một khí có thể giãn nở được, nó sẽ lạnh đi. Nếu một chất khí được nén, nhiệt độ của nó tăng lên. Thứ ba, chất lỏng giữ ở áp suất thấp hơn áp suất xung quanh, nó có thể sôi.
3. Một hệ thống làm lạnh thông thường gồm 4 thành phần chính: máy nén, dàn ngưng, van giãn nở hoặc ống mao dẫn và dàn bay hơi.

## **PART 3: FURTHER READING**

### **Domestic Refrigerators:**

Most domestic refrigerators are of two types - either a single door fresh food refrigerator or a two-door refrigerator - freezer combination. Most refrigerators use R - 22 refrigerant, normally maintaining temperatures of 0°F in the freezer compartment and about 35°F to 45°F in the refrigerator compartment.

#### **Single Door Fresh Food Refrigerator:**

A single door fresh food refrigerator consists of an evaporator placed either across the top or in one of the upper corners of the cabinet. The condenser is on the back of the cabinet or in the bottom of the cabinet below the hermetic compressor. During operation, the cold air from the evaporator flows by natural circulation through the refrigerated space. The shelves inside the cabinet are constructed so air can circulate freely past the ends and sides, eliminating the need for a fan. This refrigerator has a manual defrost, which requires that the refrigerator be turned off periodically (usually overnight) to enable the buildup of frost on the evaporator to melt.

#### **Two - Door Refrigerator-Freezer Combination:**

The two - door refrigerator-freezer combination is the most popular type of refrigerator. It is similar to the fresh food refrigerators in construction and the location of components except it sometimes has an evaporator for both the freezer compartment and the refrigerator compartment. Also, if it is a frost - free unit, the evaporators are on the outside of the cabinet. Because of the two separate compartments (refrigerator - freezer) and the larger capacity, these types of refrigerators use forced air (fans) to circulate the air through the inside of both compartments. The two - door refrigerator also has one of the following three types of evaporator defrost systems: manual defrost, automatic defrost, or frost -free. Today, the two - door refrigerator-freezer combination is widely used in almost houses.

## UNIT 2: COMPRESSORS

### PART 1: READING COMPREHENSION:

#### **1.1. Reading text: Compressors:**

The refrigeration system consists of four basic components including the compressor, the condenser, the liquid receiver, the evaporator, and the control devices. The compressor is one of indispensable components for any refrigeration system to operate.

The main purpose of refrigeration compressors is to withdraw the heat-laden refrigerant vapor from the evaporator and compress the gas to a pressure that will liquefy in the condenser. Compressors are designed depending upon the application and type of refrigerant. According to the principle of operation, there are three types of compressors: reciprocating, rotary, and centrifugal. Many refrigerator compressors have components besides those normally found on compressors, such as unloaders, oil pumps, mufflers, and so on.

#### **External Drive Compressor:**

An external drive or open-type compressor is bolted together. Its crankshaft extends through the crankcase and is driven by a flywheel (pulley) and belt, or it can be driven directly by an electric motor. A leak proof seal must be maintained where the crankshaft extends out of the crankcase of an open - type compressor. The seal which holds the pressure developed inside of the compressor prevents refrigerant and oil from leaking out and air and moisture from entering the compressor. Two types of seals are used such as the stationary bellows seal and the rotating bellows seal while an internal stationary crankshaft seal consists of a corrugated thin brass tube (seal bellows) fastened to a bronze ring (seal guide) at one end and to the flange plate at the other.

#### **Hermetic Compressor:**

In the hermetically sealed compressor, the electric motor and compressor are both in the same airtight (hermetic) housing and share the same shaft. After assembly, the two halves of the case are welded together to form an airtight cover. The compressor, in this case, is a double - piston reciprocating type, whereas, other compressors may be of the centrifugal or rotary types. Cooling and lubrication are provided by the circulating oil and the movement of the refrigerant vapor throughout the case. The advantages of the hermetically sealed unit (elimination of pulleys, belts and other coupling methods, elimination of a source of refrigerant leaks) are offset somewhat by the inaccessibility for repair and generally lower capacity.

#### **1.2. Comprehension check:**

**\* Task 1: Choose A, B, C or D which best completes each sentence:**

1. The main function of a compressor is to:

A. condense the high - pressure refrigerant vapor into liquid refrigerant and make it easier to vaporize.

*B. reduce and maintain temperature of a space or material below the temperature of a space or material below the temperature of the surroundings.*

*C. withdraw the heat-laden refrigerant vapor and compress the gas to a pressure that will liquefy.*

*D. change cool refrigerant back into liquid form.*

2. Select the appropriate type of compressor to handle oil or water aerosol contamination.

There are three types of compressors classified according to the principle of operation—reciprocating, rotary, and centrifugal.

*A. Separator filter    B. Particulate filter    C. Coalescing filter    D. Adsorption filter*

3. A bronze ring is also called:

*A. seal bellows    B. stationary bellows    C. rotating bellows    D. seal guide*

4. The hermetically sealed unit remains some drawbacks:

*A. elimination of pulleys, belts, other coupling methods and a source of refrigerant leaks*

*B. inaccessibility for repair and*

*C. lower capacity*

*D. B and C are all correct*

5. A component which has the functions as holding the pressure increased inside of the compressor and preventing refrigerant and oil from leaking out and air and moisture from entering the compressor is:

*A. the seal    B. the oil pump    C. the muffler    D. the crankshaft*

**\* Task 2: Indicate whether the sentence or statement is true or false. WRITE ( T ) OR ( F ):**

1. There are three types of compressors used in refrigeration systems.

2. One of drawbacks of a hermetic compressor is difficult to repair.

3. A refrigeration compressor has one purpose to compress the gas to a pressure that will liquefy in the condenser.

4. Seals in an external drive compressor has four types.

5. In a hermetic compressor, a piston is often a centrifugal or a rotary type.

**\* Task 3: Answer the questions**

1. How many types of seals does an External Drive Compressor has?

2. What are the two drawbacks of a hermetic compressor?

3. What are main components in the refrigeration system?

4. How are cooling and lubrication provided for the Hermetic Compressor?

5. What are differences between the External Drive Compressor and the Hermetic Compressor?

## PART 2: LANGUAGE WORK

### Relative Clause (1):

We use relative clauses to give additional information about something without starting another sentence. By combining sentences with a relative clause, your text becomes more fluent and you can avoid repeating certain words.

### How to Form Relative Clauses:

Imagine, a girl is talking to Tom. You want to know who she is and ask a friend whether he knows her. You could say:

A girl is talking to Tom. Do you know the girl?

That sounds rather complicated, doesn't it? It would be easier with a relative clause: you put both pieces of information into one sentence. Start with the most important thing – you want to know who the girl is.

Do you know the girl ...

As your friend cannot know which girl you are talking about, you need to put in the additional information – the girl is talking to Tom. Use „the girl“ only in the first part of the sentence, in the second part replace it with the relative pronoun (for people, use the relative pronoun „who“). So the final sentence is:

Do you know the girl **who** is talking to Tom?

### Relative Pronouns:

relative pronoun	use	example
Who	subject or object pronoun for people	I told you about the woman <i>who</i> lives next door.
Which	subject or object pronoun for animals and things	Do you see the cat <i>which</i> is lying on the roof?
Which	Referring to a whole sentence	He couldn't read <i>which</i> surprised me.
Whose	possession for people animals and things	Do you know the boy <i>whose</i> mother is a nurse?
Whom	object pronoun for people, especially in non-defining relative clauses (in defining relative clauses we colloquially prefer <i>who</i> )	I was invited by the professor <i>whom</i> I met at the conference.
that	subject or object pronoun for people, animals and things in defining relative clauses ( <i>who</i> or <i>which</i> are also possible)	I don't like the table <i>that</i> stands in the kitchen.

**Subject Pronoun or Object Pronoun?**

Subject and object pronouns cannot be distinguished by their forms - who, which, that are used for subject and object pronouns. You can, however, distinguish them as follows:

If the relative pronoun is followed by a verb, the relative pronoun is a *subject pronoun*. Subject pronouns must always be used.  
the apple **which** is lying on the table

If the relative pronoun is not followed by a verb (but by a noun or pronoun), the relative pronoun is an *object pronoun*. Object pronouns can be dropped in defining relative clauses, which are then called *Contact Clauses*.  
the apple (**which**) *George* lay on the table

**Relative Adverbs:**

A relative adverb can be used instead of a relative pronoun plus preposition. This often makes the sentence easier to understand.

This is the shop **in which** I bought my bike.  
→ This is the shop **where** I bought my bike.

relative adverb	meaning	use	example
When	in/on which	refers to a time expression	the day <i>when</i> we met him
Where	in/at which	refers to a place	the place <i>where</i> we met him
Why	for which	refers to a reason	the reason <i>why</i> we met him

**\* Task 1: Put the set of words and phrases given into the correct order to make meaningful sentences.**

1. system/ of/ four/ the/ basic/ including/ refrigeration/ the/ compressor/ condenser/ the/ liquid receiver/ the/ evaporator/ the/ devices/ the/ control.
2. in/ external/ seals/ compressor/ four/ has/ types/ an.
3. types/ are/ types/ used/ as/ the/ two/ bellows/ seal/ stationary/ and/ seal/ bellows/ the/ rotating.

**\* Task 2: Combine the following sentences, using relative pronouns.**

Examples:

1. Starter motor brushes are made of carbon.
2. The carbon contains copper

1 + 2: Starter motor brushes are made of carbon *which contains copper*

3. Industrial consumers are supplied at higher voltages than domestic consumers
4. These consumers use large quantities of energy
  - 3+4. Consumers who use large quantities of energy are supplied are higher voltages than domestic consumers.
5. 33kV lines are fed to intermediate substations
6. In the intermediate substations the voltage is stepped down to 11kV
  - 5+6: 33kV lines are fed to intermediate substations *where the voltage is stepped down to 11 kV*

***Now link these sentences. Make the second sentence in each pair a relative clause.***

1. The coil is connected in series with a resistor  
The resistor has a value of 240 ohms
2. The supply is fed to a distribution substation  
The supply is reduced to 415 V in the distribution substation
3. Workers require a high degree of illumination  
The workers assemble very small precision instruments
4. Manganin is a metal  
This metal has a comparatively high resistance
5. The signal passes to the detector  
The signal is rectified by the detector
6. A milliammeter is an instrument  
The instrument is used for measuring small currents
7. Workers require illumination of 300 lux  
The workers assemble heavy machinery
8. Armoured cables are used in places  
There is a risk of mechanical damage in these places

**\* Task 3: Reason and result connectives 1**

Study the examples:

1. Copper is used for cables
2. Copper is a good conductor
- 1+2. Copper is used for cables because it is a good conductor
3. The flow of electrons through an insulator is very small
4. The flow can be ignored
- 3 + 4: The flow of electrons through an insulator is very small, *therefore* it can be ignored.

*Use because or therefore to link these sentences into one as the above examples:*

Soft iron is used in electromagnets. Soft iron can be magnetized easily.

1. The voltage is 250V and the current is 5A. The resistance is 50 ohms.
2. PVC is used to cover cables. PVC is a good insulator.
3. Transistors can be damaged by heat. Care must be taken when soldering transistors.
4. Capacitance is usually measured in microfarads or picofarads. The farad is too large a unit.
5. Output transistors are mounted on a heat sink. Output transistors generate heat.
6. It is easy to control the speed of dc motors. Dc motors are used when variable speeds are required.
7. A cathode ray tube screen glows when an electron beam strikes it. The screen is coated with a phosphor.

**\* Task 4: Use the suggested words to join the following groups of sentences:**

1. *or*

Circuits can be protected from excessive currents by a fuse.

Circuits can be protected from excessive currents by a circuit breaker.

2. *however*

A fuse is the simplest and cheapest protection.

For accurate and repetitive operation a circuit breaker is used.

3. *which*

The simplest circuit breaker consists of a solenoid and a switch with contacts.

The contacts are held closed by a latch.

4. *thus energizing*

The current from the supply line flows through the switch and solenoid coil.

This energizes the solenoid.

5. *which, therefore*

At normal currents the pull of the solenoid on the latch will not overcome the tension of the spring.

The spring holds the latch in place.

The switch remains closed.

6. *if*

The current rises to a dangerous level.

The pull of the solenoid on the latch increases.

7. *and*

The increased pull overcomes the latch spring tension.

The increased pull pulls the latch towards the solenoid.

8. *which*

This releases the switch contacts.

The switch contacts are pulled apart by a spring.

*9. as*

The circuit is now broken.

The unit is protected.

*10. when*

The fault in the supply or unit is put right.

The latch can be reset.

**\* Task 5: Translate the sentences into Vietnamese:**

1. The designs of compressors vary, depending upon the application and type of refrigerant.
2. Oil from the crankcase lubricates the surfaces of the seal guide and seal ring.
3. Two types of seals are used—the stationary bellows seal and the rotating bellows seal.
4. The refrigeration system consists of four basic components such as the compressor, the condenser, the liquid receiver, the evaporator, and the control devices.
5. If there is liquid in the vapor as it enters the compressor, this can be harmful to the compressor.

**\* Task 6: Translate the sentences into English:**

1. Thiết bị làm lạnh hấp thụ là một máy tạo ra nước lạnh bằng cách sử dụng nhiệt như hơi, nước nóng, khí, dầu, vv... Nước lạnh được tạo ra dựa trên nguyên tắc là dung dịch (tức là môi chất lạnh, bốc hơi ở nhiệt độ thấp) hấp thụ nhiệt từ xung quanh khi bốc hơi. Nước tinh khiết được sử dụng làm môi chất lạnh và dung dịch lithi bromua (LiBrH<sub>2</sub>O) được sử dụng làm chất hấp thụ.
2. Môi chất lạnh (nước) bay hơi ở nhiệt độ khoảng 40C trong điều kiện chân không 754 mm Hg ở thiết bị bay hơi. Nước lạnh đi qua ống của bộ trao đổi nhiệt trong thiết bị bay hơi và truyền nhiệt cho môi chất lạnh đã hoá hơi.
3. Khi đã mua máy nén, bảo trì hiệu quả là yếu tố then chốt giúp tối ưu hoá mức tiêu thụ năng lượng.
4. Để máy nén hoạt động hiệu quả, tỷ suất nén phải thấp, để giảm áp suất và nhiệt độ đẩy.
5. Với những thiết bị ứng dụng nhiệt độ thấp có tỷ suất nén cao, và cần dải nhiệt độ rộng, sử dụng máy nén pittông đa cấp hoặc máy nén ly tâm/trục vít thường được ưa chuộng hơn và mang tính kinh tế hơn (do hạn chế trong thiết kế thiết bị).

**PART 3: FURTHER READING****Open Types of Compressors**

Some of the duties you may perform in maintaining this and other open-type compressors are discussed in this lesson.

**Shaft Bellows Seal**

Refrigerant leakage often occurs at the shaft bellows seal with consequent loss of charge. Install a test gauge in the line leading from the drum to the compressor. Attach a refrigerant drum to the suction end of the shutoff valve outlet port. Apply the proper amount

of pressure, as recommended in the manufacturer's instructions. Test for leaks with a halide leak detector around the compressor shaft, seal gasket, and seal nut. Slowly turn the shaft by hand. When a leak is located at the seal nut, replace the seal plate, gasket, and seal assembly; when the leak is at the gasket, replace the gasket only. Retest the seal after reassembly.

#### Valve Obstructions

Obstructions, such as dirt or corrosion, may be formed under seats of suction or discharge valves.

When the suction side is obstructed, the unit tends to run continuously or over long periods. Connect the gauge manifold and start the unit. This pressure gauge (HI) will not indicate an increase in pressure.

**UNIT 3: COMMISSIONING AND MAINTENANCE****PART 1: READING COMPREHENSION:*****1.1 Reading text: COMMISSIONING AND MAINTENANCE:***

The commissioning of a refrigeration or air - conditioning plant starts from the stage of static completion and progresses through the setting – to - work procedure and regulation to a state of full working order to specified requirements. Commissioning is the completion stage of a contract, when the contractor considers that the plant is in a correct state to hand over to the purchaser for acceptance and payment

Maintenance is the effort required to ensure that a commissioned plant continues to deliver correct performance, and includes inspections designed to detect signs of deterioration prior to any noticeable effects.

The work of commissioning must be under the control of a single competent authority, whether it be the main contractor, a consultant or the user. It can happen that when building specifications are written, they split the responsibilities to sub - contractors with the presumption that everything will be exactly as specified after commissioning, which it rarely is. With no one responsibility for the total operation of the cooling system it can be found that it operates, but in an unsatisfactory manner - for example, frequent cycling instead of steadily operating at reduced capacity.

Complex systems need to have follow - up on the initial commissioning at low, medium and high load (warm, medium and cold ambient) to ensure proper and energy efficient operation. To include this as a responsibility in the contract is very cost - effective.

The commissioning engineer will require details and ratings of all major items of the plant and copies of any manufacturer's instructions on setting to work and operating their products. If this information is not to hand, the work will be delayed. The following stages may be identified in a commissioning process.

The installation should be initially checked to ensure that it is in accordance with the specified design. The next stage is to preset as many controls and protection devices as possible

The refrigerant charge and system operation should be checked and set for the complete range of load and ambient conditions. Follow - up tests may be required to cover a range of ambient conditions. The refrigerant charge should have been added according to the weight specified, and additional charge should not be required. When the system has been operating for a sufficiently long period, conditions in the cooled space can be checked against specification, and other typical points to watch for include evaporator superheat and refrigerant distribution, excessive pressure drops, compressor oil levels, correct condensing pressure. The operation of pressure controls such as evaporator pressure regulator and condensing pressure controls together with defrost systems can be checked.

In the final commissioning stage, readings are taken and recorded and compared with the specification and design figures. Some final adjustments to air flows, secondary fluid flows, etc. may be necessary

## Grammar: Relative Clauses 2

### Defining Relative Clauses

Defining relative clauses (also called *identifying relative clauses* or *restrictive relative clauses*) give detailed information defining a general term or expression. Defining relative clauses are not put in commas.

Imagine, Tom is in a room with five girls. One girl is talking to Tom and you ask somebody whether he knows this girl. Here the relative clause defines which of the five girls you mean.

Do you know the girl who is talking to Tom?

Defining relative clauses are often used in definitions

A seaman is someone who works on a ship.

Object pronouns in defining relative clauses can be dropped. (Sentences with a relative clause without the relative pronoun are called *Contact Clauses*.)

The boy (**who/whom**) we met yesterday is very nice.

### Non-Defining Relative Clauses

Non-defining relative clauses (also called *non-identifying relative clauses* or *non-restrictive relative clauses*) give additional information on something, but do not define it. Non-defining relative clauses are put in commas.

Imagine, Tom is in a room with only one girl. The two are talking to each other and you ask somebody whether he knows this girl. Here the relative clause is non-defining because in this situation it is obvious which girl you mean.

Do you know the girl, who is talking to Tom?

Note: In non-defining relative clauses, *who/which* may not be replaced with *that*.

Object pronouns in non-defining relative clauses must be used.

Jim, who/whom we met yesterday, is very nice.

### How to Shorten Relative Clauses?

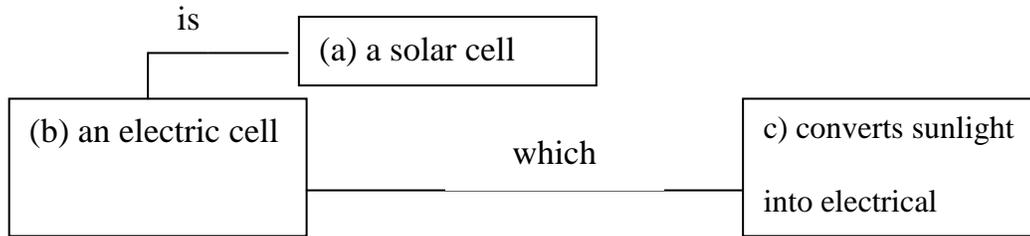
Relative clauses with *who, which, that* as subject pronoun can be replaced with a participle. This makes the sentence shorter and easier to understand.

I told you about the woman *who lives* next door. – I told you about the woman *living* next door.

Do you see the cat *which is lying* on the roof? – Do you see the cat *lying* on the roof?

### \* Task 1: Making definitions.

One use of defining relative clauses is to make definitions. Study this diagram.



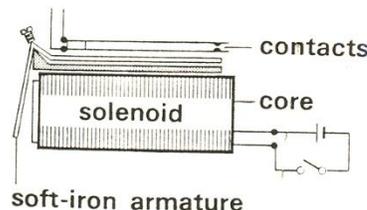
We can make a definition of a solar cell by joining (a), (b) and (c)  
***A solar cell is an electric cell which converts sunlight into electrical energy.***

Combine (a), (b) and (c) to make correct sentences as the above Examples:

(a)	(b)	(c)
1. A generator	A material	- Measures light
2. An insulator	An instrument	- Readily releases electrons
3. An alternating current	A current	- Flows first in one direction, then in the other
4. A direct current	A device	- Does not readily release electrons
5. A resistor		Impedes the flow of current in a circuit
6. A conductor		- Measures current
7. A light meter		- Converts mechanical energy into electrical energy
8. An ammeter		- Flows in one direction only

**\* Task 2: Adding information to a passage:**

Use non-defining relative clauses to add extra information to this paragraph about a relay. This extra information is given below the paragraph. Then translate it into Vietnamese:



Electric relays (1).....utilize the magnetic effect of a current in a solenoid. One of the most common types (2) .....consists of a solenoid with a soft-iron core. When energized by a suitable dc current, the solenoid attracts an armature (3) ..... The armature is pivoted in such a way that it pushed together or pulls apart a set of contacts (4)

..... These contacts (5) ..... control one or more circuits. Normally these circuits draw a much heavier current than the relay coil itself.

1. Electric relays are widely used in telecommunications
2. The most common type of relay is known as the hinged armature relay
3. The armature is also made of soft iron
4. The sets of contacts are mounted on the body of the relay
5. The contacts are often made of platinum.

**\* Task 3: Combine the following sentences, using relative clauses or reduced relative clauses:**

1. In Britain electrical energy is fed to the National Grid. The energy is generated in power stations.
2. The energy passes through a transformer. The transformer steps up the voltage to 132, 25, or 400kV.
3. The transmission lines are usually arranged in groups of three overhead conductors. The lines carry the supply. The overhead conductors are suspended from porcelain insulators.
4. Energy from power stations may be fed to the Grid by underground cables. The power stations are located in built-up areas.
5. For voltages up to 400 kV cables are used. These cables contain oil under low pressure.

**\* Task 4: Reason and result connective 2:**

We learned that **BECAUSE** links a statement and a reason and that **THEREFORE** links a statement and a result. The following connectives can also be used:

Statement	reason
-----------	--------

Since /As/ For the reason that

Statement	result
-----------	--------

Hence/Consequently/For this reason

Example:

*Dc motors are used for cranes, for the reason that their speed can be finely controlled.*

*The current rose above the maximum. Consequently the circuit breaker opened.*

*Copper is often used for cables since it is a good conductor.*

Now link these ideals with either reason, result or qualification connectives:

1. Conventional current flow is from positive to negative. In fact electrons flow from negative to positive.
2. Alternators are preferred to dynamos for cars. Alternators give higher outputs at low speeds.
3. Dirt and dust reduce effective light. Lamps must be kept clean.

4. Squirrel cage motors are simple, cheap and strong. Squirrel cage motors are used for many general duties.
5. It is convenient to describe magnetic lines of force. In reality magnetic lines of force do not exist.
6. Transistorized equipment is easily portable. Transistors can operate from battery voltages.
7. Ultrasonic welding is better than heat welding. The materials are not distorted.
8. Watchmakers work with very small parts. Watchmakers require a lot of light.

**\* Task 5: Join the following group of sentences to make 10 longer sentences.** You may omit words and make whatever changes you think are necessary in the word order and punctuation of the sentences.

1. A zinc case is used as a container for the cell. The zinc case is used as the negative electrode.
2. A carbon rod forms the negative electrode. The carbon rod is in the centre of the cell.
3. The space between the zinc case and the carbon rod is filled with a paste of ammonium chloride. The paste is used as an electrolyte.
4. The electrolyte is a paste and not a liquid. This type of cell is called a dry cell.
5. The paste also contains manganese dioxide. The manganese dioxide prevents gas being formed.
6. The cell is sealed with a cap. The cap is made of metal or plastic. The cap is to prevent the paste coming out.
7. A small space is left below the cap. Gas formed by the cell can collect in the space.
8. Dry cells are usually enclosed in a cardboard case. An additional metal jacket may be added. The jacket makes the cell leakproof.
9. Leakproof cells are often preferred. The electrolyte cannot leak out.
10. Leaking electrolyte may damage the equipment. The cells are installed in the equipment.

### **PART 3: FURTHER READING:**

#### **FAULT - FINDING**

System faults fall into two general classes: the sudden catastrophe of a mechanical breakdown and the slow fall-off of performance which can be detected as a malfunction in its early stages, but will also lead to a breakdown if not rectified. Identification of the first will be obvious. To track down the cause of a malfunction is more complicated.

Fault tracing is seen as a multi-step process of deduction, ending in normal operation again and a record of the incident to inform other operatives. The steps are as follows:

1. Detection, i.e. detection of abnormal operation.
2. Knowledge of the system to track down the cause.
3. Observation of exact operating conditions.
4. Identification of the fault.

5. Decision: what to do? how? when? can it be left?
6. Action to rectify the fault.
7. Test: is it now normal?
8. Record note in log, for future information.

An experienced technician will often know where to look, and more sophisticated tools, which give immediate indication of superheat, and sub-cooling, for example, are now becoming available. Often refrigeration systems show dynamic characteristics that are difficult to follow if not visualized in graphs.

**UNIT 4: AIR – CONDITIONING****PART 1: READING COMPREHENSION:*****1.1. Reading text: Air – conditioning:*****A. Basic Principles of Air Conditioning:****1. Principles of cooling**

Heat is a form of energy and every object on earth has some heat energy. The less heat an object has, the colder we say it is. Cooling is the process of transferring heat from one object to another. When an air - conditioning system cools, it is actually removing heat and transferring it somewhere else. There are two forms of heat energy: sensible heat and latent heat.

Sensible heat is the form of heat energy which is most commonly understood because it is sensed by touch or measured directly with a thermometer. Latent heat cannot be sensed by touch or measured with a thermometer. Latent heat causes an object to change its properties.

**2. Change of state**

An object that changes from a solid to a liquid or liquid to vapor is referred to as a change of state. When an object changes state, it transfers heat rapidly.

**Humidity**

Moisture in the air is called humidity. The ability of air to hold moisture directly relates to its temperature. The warmer air is, the more moisture it is capable of holding. Relative humidity is the percentage of moisture in the air compared to the amount of moisture it can hold. Humidity is also a form of latent heat. When air contains more humidity, it has more latent heat.

**Refrigerant**

Refrigerants are substances used by air conditioners to transfer heat and create a cooling effect. Air - conditioning systems use specially formulated refrigerants designed to change state at specific temperatures providing optimum cooling.

**B. Air - conditioning Systems:**

In general, all air - conditioning systems have four major components, including: compressor, condenser, metering device and evaporator. Refrigerant is drawn from the evaporator and pumped to the condenser by the compressor. The compressor also pressurizes the refrigerant vapor so that it will change state (condense) readily. The high - pressure refrigerant vapor releases heat through the condenser coils as it condenses into liquid refrigerant which makes it easier to vaporize. The metering device restricts the flow of liquid refrigerant from the condenser to the evaporator. As refrigerant passes through the metering device, its pressure decreases. The low - pressure liquid refrigerant absorbs heat as it vaporizes in the evaporator coils.

**1.2 Comprehension check:****\* Task 1: Choose A, B, C or D which best completes each sentence**

1. ....is the form of heat energy which is sensed by touch or measured directly with a thermometer.

A. *Latent heat*                      B. *Sensible heat*                      C. *Radiant heat*                      D. *Geothermal*

2. Air - conditioning systems use specially formulated ..... designed to change state at specific temperatures providing optimum cooling.

A. *sensible heat*                      B. *water*                      C. *refrigerants*                      D. *vapour*

3. ....absorbs heat as it vaporizes in the evaporator coils.

A. *the high - pressure liquid refrigerant*

B. *the low - pressure liquid refrigerant*

C. *the metering device*

D. *the high - pressure refrigerant vapor*

4. .... absorbs heat as it vaporizes in the evaporator coils.

A. *the low - pressure liquid refrigerant*

B. *the high - pressure refrigerant vapor*

C. *the high - pressure refrigerant vapor*

D. *the low - pressure refrigerant vapor*

5. Which is the percentage of moisture in the air compared to the amount of moisture it can hold?

A. *high humidity*                      B. *low humidity*                      C. *relative humidity*                      D. *very low humidity*

**\* Task 2: Indicate whether the sentence or statement is true or false. WRITE ( T ) OR ( F ):**

1. The compressor also pressurizes the refrigerant vapor so that it will change state (condense) readily.

2. Sensible heat cannot be sensed by touch or measured with a thermometer.

3. Latent heat is the form of heat energy which is most commonly understood because it is sensed by touch or measured directly with a thermometer.

4. The metering device allows the flow of liquid refrigerant from the condenser to the evaporator.

5. Humidity is also a form of sensible heat.

**\* Task 3: Answer the following questions:**

1. What are principles of air - conditioning?

2. How many kinds of heat energy does an air - conditioning system have?

3. How to measure the latent heat?

4. What do refrigerants use for?

5. What are four main components in all common air - conditioning systems?

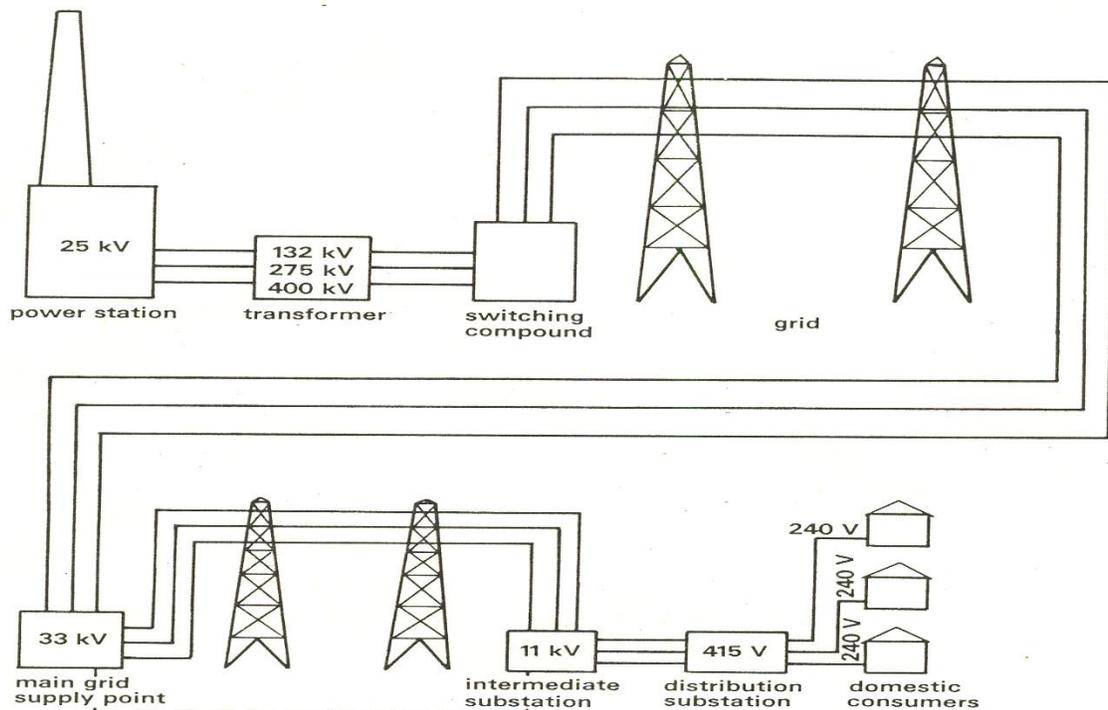
**PART 2: LANGUAGE WORK:****\* Task 1: Describing sequence**

To make the correct sequence of a number of events clear, we often use sequence words like these:

a. First/ b. then / c. next / d. after that/ e. finally

Among them, *a* and *e* must come **FIRST** and **LAST** respectively, but these others can be used in any order and can be repeated.

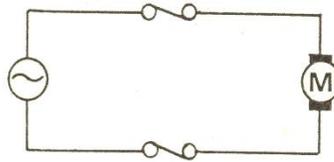
These following sentences describe the distribution of power from the power station to the consumer. And the diagram which follows them shows it. Put these sentences in the correct order and mark this order using sequence words.



- It is fed to distribution substations where it is reduced to 415 V, 3 phase and 240 V, 1 phase.
- It is stepped up by a transformer to 132, 275 or 400 kV for long-distance distribution.
- It is distributed via the grid system to main grid supply points where it is stepped down to 33kV for distribution to heavy industry.
- It is distributed to the domestic consumer.
- In the UK, electrical energy is generated at power stations at 25 kV.
- It passes via the switching compound to the grid.
- It is distributed via overhead or underground cables to intermediate substations where it is further reduced to 11 kV for light industry.

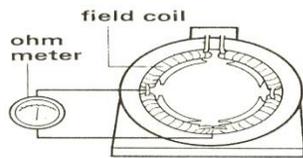
**\* Task 2: Writing instructions as explanations**

Study these instructions. They explain how to disconnect the supply to the motor in a circuit.

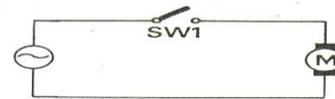


1. Disconnect the supply BY WITHDRAWING THE FUSES.
2. TO DISCONNECT the supply, WITHDRAW the fuses.

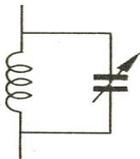
Now write instructions like the examples above to explain how to do the following.



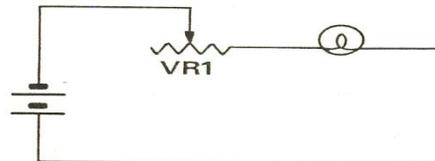
1. Check the field coils.



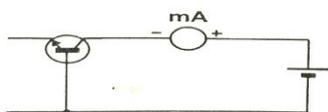
2. Start the motor.



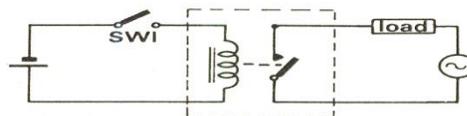
3. Change the frequency of the tuned circuit.



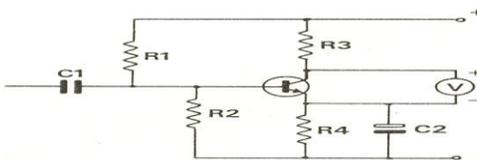
4. Dim the light.



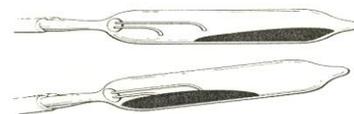
5. Measure the collector current.



6. Supply power to the load.



7. Measure the collector-emitter



8. Operate the mercury relay

**\* Task 3: Put the set of words and phrases given into the correct order to make meaningful sentences:**

1. a/ state/ change/ of/ an/ changes/ from/ a/ liquid/ vapor/ a/ solid/ a/ to/.
2. heat/ latent/ an/ causes/ to/ change/ properties/ its/ object.
3. the/ process/ cooling/ transferring/ from/ one/ of/ another/ object/ heat.

**\* Task 4: Translate the sentences into Vietnamese**

1. Refrigerants are substances used by air conditioners to transfer heat and create a cooling effect. Air-conditioning systems use specially formulated refrigerants designed to change state at specific temperatures providing optimum cooling. Portables use a refrigerant called R-22 or HCFC-22. HCFC stands for hydrochloro fluorocarbon. This is currently the most common refrigerant used by air-conditioning systems.
2. Many of the current forms of refrigerants used today are being phased out based on concern for depletion of the ozone layer. Portables use R - 22, which has been deemed acceptable for use by the EPA until the year 2010. By that time, an ozone - friendly refrigerant that can be easily substituted for R - 22 will be readily available.
3. An air conditioner is basically a refrigerator without the insulated box. It uses the evaporation of a **refrigerant**, like Freon, to provide cooling. The mechanics of the **Freon** evaporation cycle are the same in a refrigerator as in an air conditioner. According to the Merriam - Webster Dictionary Online, the term Freon is generically "used for any of various nonflammable fluorocarbons used as refrigerants and as propellants for aerosols."

**\* Task 5: Translate the sentences into English:**

1. Chu trình làm lạnh nén hơi dựa trên nguyên tắc chất lỏng được nén ở nhiệt độ nhất định sẽ lạnh hơn khi chúng được giãn nở.
2. Với mức thay đổi áp suất phù hợp, khí nén sẽ nóng hơn nguồn làm mát của chúng ta (ví dụ như không khí bên ngoài) và khí giãn nở sẽ lạnh hơn nhiệt độ lạnh chúng ta mong đạt được.
3. Có rất nhiều loại môi chất lạnh sử dụng trong hệ thống nén hơi. Nhiệt độ làm mát mong muốn sẽ quyết định việc lựa chọn chất lỏng. Các môi chất lạnh thường được sử dụng là tập hợp các flocacbon được clo hóa (CFCs, còn gọi là các Freon): R - 11, R - 12, R - 21, R - 22 và R - 502.

## **PART 3: FURTHER READING**

### **Air conditioner maintenance**

Central air conditioners have two separate components: the condenser and the evaporator. The condenser unit is usually located outside the house on a concrete slab. The evaporator coil is mounted in the plenum or main duct junction above the furnace. Most central air conditioners are connected to a home's forced - air distribution system. Thus, the same motor, blower, and ductwork used for heating are used to distribute cool air from the

air conditioning system. When a central air conditioner is operating, hot air inside the house flows to the furnace through the return - air duct. The hot air is moved by the blower across the cooled evaporator coil in the plenum and is then delivered through ducts to cool the house. When the air conditioner works but the house doesn't cool, the problem is probably in the distribution system. Both the evaporator and the condenser are sealed. Therefore, a professional service person should be called for almost any maintenance other than routine cleaning. Central air conditioners should be professionally inspected and adjusted before the beginning of every cooling season.

**Caution:**

Before doing any work on an air conditioning system, make sure the power to the system, both to the condenser and to the evaporator assembly, is turned off.