



## 3

## CARBON AND ITS COMPOUNDS

You see and use a variety of objects such as diamond rings, burnt paper, smoke coming out of the chimney, pencils, shoe polish, electrodes etc. every day. You will be surprised to know that the same element is used in the making of all these things. You try to name it. You might have guessed it right. Carbon is present in all of this. Carbon is found in many substances such as black matter obtained from burning of paper, or smoke of motor or bus. Carbon is found in the pencil marks (handwriting), coal or wood coal etc. Let us now get more information about this element because these elements are very important for us. In this lesson you will also read about some compounds and fuels of carbon.



### OBJECTIVES

After reading this lesson you will be able to:

- know carbon, its types and uses; And
- fuel, types of fuel to explain fuel conservation.



Notes

### 3.1 CARBON

Carbon is the 12th element found in abundant quantities in the Earth's upper layer (surface). In nature it is found in both independent and combined states. On the surface of the earth, it is found independently in the form of coal, diamonds and graphite. It is present in combined form as compounds and through the form of nature in petroleum. Carbon is such a wonderful element, which is present in millions of types of compounds.

Carbon is a non-metal. Non-metal is the element whose oxides dissolve in water to form acids. Let us prove by an experiment that carbon is a non-metallic element.

#### Wood Charcoal

This type of coal can be obtained from wood, sugar and bones. Coal is formed when these substances are heated in the absence of air. Coal obtained from wood is called lump charcoal, coal obtained from sugar is sugar charcoal, and coal obtained from animal bones is bones charcoal. They all have different qualities. Let's get information about each of these.

1. **Lump coal** - It is a black perforated solid. It absorbs gases so it is used to make gas masks.



#### ACTIVITY 3.1

**What you need to do:** Prove that carbon is a nonmetal.

**What you need:** Metal plate, charcoal, brazier, wide-mouth bottle, lid, red and blue litmus paper.

**Notes**

**How to do it:** Take a plate of metal and put burning coal on it. Burn the bottle with a wide mouth on the coal for about five minutes. Now lift the bottle and place it directly above the table. Close the mouth of the bottle with a lid. Add a little water to the bottle and shake it with the mouth closed. Put blue and red litmus paper inside the bottle. Did you see any change? Write down what you noticed.

**What you noticed:** The gas that comes out of the burning coal dissolves in the water. And this gas solution made in water turns blue litmus paper into red.

**What you learnt:** Burning of charcoal in the air creates an oxide, which can be called acidic in nature because charcoal is incomplete and contains carbon, so we can call carbon as a non-metal.



Fig. 3.1 Carbon is a nonmetal



Notes

2. **Bone Charcoal** - This color remains. It is used to remove the brown color of sugar and make it white when making sugar from sugarcane.

3. **Sugar Charcoal** - This is the most pure form of carbon. It is mainly used to derive metals from their oxides.

Zinc Oxide Carbon (sugar charcoal) Zinc carbon monoxide

Sugar charcoal can be obtained by removing water from sugar.

**ACTIVITY 3.2**

**What you need to do:** To obtain sugar charcoal in your home.

**What you need:** One tablespoon, sugar, burner or fireplace

**What do you need to do:** Take some sugar in a tablespoon. Heat the spoon over a flame. Write down what you noticed.

**What you noticed:** The sugar first melts, then turns brown and finally blackens and dries. A black ash-like remnant remains. This residue is only sugar charcoal.

**What You Learnt:** Charcoal can be obtained by heating sugar.

**Coke**

Coke is obtained by heating coal in the absence of air. During this process, the black residue remains. It is a good fuel compared



to coal. Can you guess why? Because it does not emit smoke on burning. It is used to obtain metals from metal oxides.

### **Kajal (black like carbon)**

The carbon that gathers after the flame of smoke is called kajal (carbon soot). A few years ago the practice of burning kerosene oil in lamps was common. When we burn kerosene, a lot of black smoke gets collected on the glass chimney of the lamp. This kajal or soot is used to make printer ink, carbon paper, shoe polish and black paint (coal-tar). It is also used to make filters in the rubber tires of buses and tractors.

### **Coal**

Coal is a fossil fuel. In ancient times, coal has been formed millions of years after the big trees and plants were buried in the earth. Due to high pressure and high temperature inside the earth, coal was slowly formed from the plant. This coal is hard and black solid. It mainly consists of carbon. Apart from carbon, it also contains many other compound substances. Hydrogen and Oxygen is also there. In our country coal is found in the states of Jharkhand, West Bengal, Chhattisgarh and Orissa etc. Coal is used in homes and industries.

## **3.2 TYPES OF CARBON**

Carbon is found in two forms- (1) crystalline (crystal-forming) and (2) amorphous (shapeless)

crystalline atoms arranged in an order. Diamond and graphite are two crystalline forms of carbon.



Notes

## Diamond

Each atom of the carbon in the diamond is attached to the other four carbon atoms by the attraction force. Diamonds have a three-dimensional (solid) structure. Due to this firm structure, the diamonds are very hard substances.



Fig. 3.2 Diamond Structure

The diamonds are found about 150 km below the surface of the earth. Where the heat and pressure are very high. In our country, diamonds are found in Madhya Pradesh and Andhra Pradesh.

## Graphite

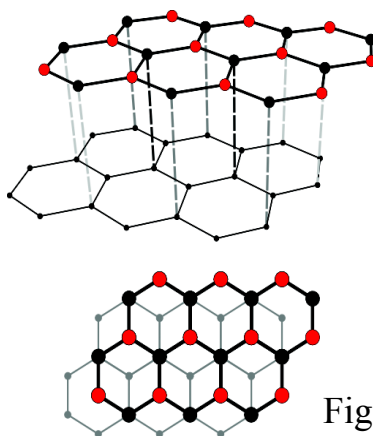


Fig. 3.3 Graphite composition

The carbon atoms in graphite are arranged as layers (one above the other). The force between these layers is less. This can cause the layers to slide over each other. Hence graphite is soft and smooth to touch.



Notes

## Comparison of diamond and graphite

Although both diamond and graphite are similar to carbon, the properties of diamond and graphite are compared in Table 3.1.

Table 3.1: Comparison of properties of diamond and graphite

	Properties	Diamond	Graphite
1.	Color	Colorless	Dark grey
2.	Hardness	Highly hard	Soft
3.	Density	Heavy	light
4.	Paper and scratch	Makes marks on paper	Makes marks on paper
5.	Combustion	Carbon dioxide is formed when ignited in air at high temperature.	Carbon dioxide gas is released when ignited in air at a lower temperature than diamond.
6.	Use	Used in making jewellery for its machines for its hardness.	Used as lubricants in fast luster and in drill moving vehicles. It is soft and smooth.

## Carbon dioxide

Carbon dioxide is 0.03 percent of the total volume of air. This gas is produced by burning of fuel, by respiration and by rotting of animals and plants (vegetables) etc. and is added to the atmosphere. The concentration of this gas remains constant (fixed) in the atmosphere, as it is used by plants in the process of photosynthesis.



Notes

**Uses**

1. Carbon dioxide is used in fire extinguishers.
2. Dry ice is also called dry carbon dioxide, which is used for refrigeration.
3. Carbon dioxide is also used in cold beverages.

The presence of carbon dioxide can be determined by the following tests:

1. When carbon dioxide gas flows into lime water, its color becomes milky.
2. When a burning stick is taken to a jar filled with carbon dioxide, carbon dioxide does not help its combustion process like a firefighter.

**Carbon monoxide**

We often read the news in the newspapers that on seeing it in the morning it was found that some people were found dead in a closed room, who were sleeping by burning coal in the fireplace. Have you ever tried to find out the reason why this happened? This happened because the burning of coal produces carbon monoxide, which is a toxic gas, and also a certain amount of air exchange in closed rooms. If there is one percent of carbon monoxide in the room, it can cause death.

When coke is burnt with a certain amount of air, carbon monoxide is produced.



**Properties:**

It is colorless, odorless gas. This is why it is not easily detected. Coal gas, which is used as an industrial fuel, is also carbon monoxide.

It is used to obtain metals from metal oxides.

Metal Oxide Carbon Monoxide Metal Carbon Dioxide

How can we feel the presence of carbon monoxide? Carbon monoxide burns with blue flame and gives carbon dioxide. Carbon dioxide can also be tested, which turns lime water milky.

**Hydrocarbons**

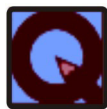
Hydrocarbons are compounds of hydrogen and carbon. They are found in petroleum and natural gases. Methane ( $\text{CH}_4$ ), Ethane ( $\text{C}_2\text{H}_6$ ), propane ( $\text{C}_3\text{H}_8$ ) and butane ( $\text{C}_4\text{H}_{10}$ ) are some examples of hydrocarbons. The first 4 are hydrocarbon gases, the next 13 are liquids, and the rest are solid

**Uses of hydrocarbons**

Hydrocarbons are used as fuel. Natural gas mainly consists of methane. The residuals of plants and animals are used to make left gas, which is mainly methane gas. Methane gas is also known as marsh gas, because it is formed by decomposition of fauna and flora in marshy areas. Butane is brought into liquid state by pressure and (LPG) (liquid petroleum gas) is filled into the cylinder.



Notes

**INTEXT QUESTIONS 3.1**

1. Make pairs of the following:

- |                   |                               |
|-------------------|-------------------------------|
| (i) diamond       | (a) marking on paper          |
| (ii) graphite     | (b) filter of rubber tires    |
| (iii) animal coal | (c) good source of coal       |
| (iv) kajal        | (d) Brown sugar               |
| (v) coke          | (e) Extremely harsh substance |

2. Fill in the blanks by selecting the correct words.

- (I) When we burn the paper in the air, a black substance is left. This substance is called.
- (ii) Carbon is a..... (metal / nonmetal).
- (iii) Which is the carbon oxide that helps in obtaining pure metal from metal oxides?

**3.3 FUEL**

We use wood, cow dung cakes, kerosene (kerosene), bio gas or (LPG) gas in the stove for cooking. Scooters and buses run on diesel, petrol and (CNG) roads. In the fields, the tractor also runs on diesel. Thermal power plant burn coals to generate electricity. A substance that produces energy (heat) on burning is called fuel. Therefore, wood, cow dung, kerosene, biogas, diesel, coal etc. are called fuel.



Notes

## Classification of fuels

According to the physical state of fuels, they are classified as solid, liquid and gas fuels. .

- 1. Solid fuel** - Examples of solid fuels are wood, cow dung, coal, coke and wax. Even today, coal is an important solid fuel. Coal is also called fossil fuel, because millions of years ago, the trees of the forest were buried in the bottom layer of the earth and became coal due to high temperature and high pressure. Around half of the energy consumed around the world comes from coal. In rural areas, about 80 percent of the required energy is obtained from wood, waste material obtained from agriculture and cow dung. Coal is mostly used in the energy generating and steel industries.



Fig. 3.4 Solid Fuel

- 2. Fluid Fuel** - If you have Gasoline (Petrol), Kerosene and Diesel etc. Must have seen These are all liquid fuels. Do you know how they came to be under the earth? These are also called fossil fuels. Millions of years ago, sea creatures and plants were buried in the soil. There was a process of bacteria inside the Earth at high temperature and high pressure, due to



which the carbon compounds present in the body of plants and animals were converted into petroleum.

Petroleum is found in the middle of rocks deep inside the earth. Crude petroleum is pumped out of the well by a pump, which is a dark colored fluid, as it is used in many industries. Therefore, is also called black gold. In further classes you will study the process of achieving this. Apart from petrol, other substances from petroleum like petroleum gas, kerosene, diesel, lubricating oil And naphtha etc. are also obtained.



Fig. 3.5 Fluid Fuel

- 3. Gaseous Fuel:** Natural Gas, Coal Gas and LPG (Liquified Petroleum gases) are gaseous fuels. They are highly flammable



Fig. 3.6 liquid gas



Notes

and produce a large amount of heat upon burning. Methane is a major component of natural gas. In Mumbai, gas is sent directly to homes by pipeline. Nowadays, CNG (Compressed Natural Gas) is being used as fuel in vehicles in Delhi. Biogas is obtained by decomposition of dung, plant and fodder etc. It is a good fuel that is used in villages.

### Fuel selection

If you have to choose a fuel, then what things will you keep in mind? If you know about cow dung, wood, kerosene, coal and LPG etc. then how will you be able to choose which is the best fuel for cooking in the kitchen? The fuel you choose to use, you first of all see that it gives more energy.

This is possible only when you try to burn the same amount of different types of fuel, then you can compare the ability of different fuels to generate energy. Thermal value is known to determine the energy generating capacity. When a fuel is completely burnt, the energy it produces is the thermal value of that fuel. Thermal values of some common fuels in kilojoules / gram units are given in Table 3.2.

Table 3.2: Thermal values of some fuels

Fuel	- Thermal values (kilojoules / gram)
Wood	- 17
Coal	- 33
Biogas	- 40



## Notes

Alcohol	- 44
Diesel	- 44
Kerosene	- 43
Petrol	- 48
LPG	- 50
Natural Gas	- 55
Hydrogen Gas	- 150

From the table above it can be determined that the solids have lower thermal energy values, whereas gaseous fuels have the highest and liquid fuels have higher thermal solids and gas fuels have lower thermal energy.

Hydrogen gas has the highest thermal value. However, it is also not used as domestic fuel. You know, why do they do it? They do so because it explodes when it is lit in the presence of air.

The following points are kept in mind while choosing fuel:

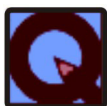
- They should not leave any ash or soot while burning.
- Do not pollute on burning and do not leave smoke and poisonous gases etc.
- It can be easily obtained and stored.
- Its ignition temperature should be appropriate (not less or not more), the heat at which the substance can catch fire. The combustion temperature of petrol is low while the combustion temperature of coal is high.



### **Preservation of fuels**

Coal and petroleum are mainly fossil fuels. The amount of fossil fuels is limited, which will be exhausted in a hundred years. Therefore, to avoid such a situation, we should also use other sources of energy. Some measures to conserve fossil fuels are:

1. Use the appropriate burner and stove while cooking.
2. Incomplete combustion of fuel should be stopped. Incomplete combustion destroys the fuel and pollutes the air due to the formation of carbon monoxide. Carbon monoxide is a toxic gas and soot is also produced by incomplete combustion. The burning of fuel with a blue flame indicates complete combustion.
3. Extinguish gas burners when not in use.
4. Suitable utensils for cooking should be used such that cooking in a pressure cooker saves fuel.
5. Must use renewable sources. Solar cooker should be used whenever possible.



### **INTEXT QUESTIONS 3.2**

1. Make the following pairs:

Column A - Column B

- |                          |                |
|--------------------------|----------------|
| (i) Wood                 | (a) Fluid fuel |
| (ii) Kerosene (Kerosene) | (b) Gas fuel   |





- |                   |                    |
|-------------------|--------------------|
| (iii) LPG         | (c) 30 KJ joule/gm |
| (iv) Black gold   | (d) Solid fuel     |
| (v) Thermal value | (e) Petroleum      |

2. Fill in the blanks with the help of appropriate words
- (i) Any substance that produces energy on burning is called.....
- (ii) Coal is called ..... fuel.
3. Write down and select the correct fuel from the list below.  
diesel, hydrogen gas, LPG, wood, kerosene
- (i) Fuel used in tractors .....
- (ii) Fuel used in domestic gas cylinders .....
- (iii) Fuel with lowest heat value .....
- (iv) Fuel with the highest heat value
- (v) Fuel used in the stove .....

### 3.4 CONBUSTION

You must have noticed that when we burn coal or wood in a burner or a stove, we see that the coal becomes extreme heat (burning lava) while burning. After some time we see that when the burner cools down, the coal finishes and the ash remains. What happens to the coal on burning?

Coal gets converted into carbon dioxide and ash on burning. Therefore, on burning, the composition of the burning substance





changes, that is, the burning substance changes into another substance. This is called combustion. In this way, we can say that combustion is a chemical change in which heat and light are produced simultaneously and the composition of the burning substance is changed. Burning of paper, petrol, dry leaves and grass are some examples of combustion. Burning substances are called flammable substances, such as petrol.

Those substances which do not burn are called inflammable substances like water. All substances produce heat and light upon burning. When we press the switch of a bulb, it starts illuminating. We get light from it and if we touch that bulb, we find that the illuminated bulb also produces heat. But do you think that the fluorescence of an electric bulb is a combustion process? Although, both heat and light are produced when the electric bulb is fluorescent. However, this is not a combustion process, as there is no chemical change. No new substance is formed in it.

### **Conditions of combustion**

Come, let us talk about some experiences of our daily life and know the essential conditions of combustion.

- If we lit a matchstick and took it near the petrol, it immediately catches fire and starts burning, but the same burning stick does not bring change to any material like water, stone, glass etc. These substances do not burn at all, because combustion takes place only in the presence of flammable substances.



## Notes

- We often see that to lit a pressurized stove we take a burning stick near to the kerosene oil filled in a bowl under the burner to burn and the oil catches fire.
- We also see that in order to burn coal in the fireplace, first we have to heat a lot by burning paper or cloth soaked with kerosene, so that it attains heat from burning.

If the burning fire is covered, the air and the supply of oxygen is consequently exhausted, which extinguishes the fire. In this way, oxygen is also necessary for burning.

Now we can say that three conditions are necessary for combustion, (Figure 3.6).

- Presence of flammable substance
- resumption of combustion heat
- Constant supply of combustion nutrients (usually air)

Just as three sides are required to form a triangle, in the absence of these three conditions, combustion cannot take place, as shown in the following diagram.

### Fire extinguishers

We know that fire is highly used in our daily life. But sometimes and especially when it gets out of control, it proves disastrous. Therefore, it is necessary for us to be aware of the measures and means of controlling fire.

- We know that small fires can be extinguished by covering them with a lid.

**Notes**

- When there is a fire in a person's clothes, they are covered with thick blankets and rolled on the floor. We often see that when a fire spreads over a large area, people extinguish the fire by throwing water and sand. It is extinguished by covering the fire or throwing water on it.
- Covering you with a lid or sand or throwing water on it does not fulfill any one or more of the three conditions required for combustion, which results in the fire being extinguished.
- You will also see that when the fire of coal or any other fire in the pot is well covered with a lid, the fire does not get air and the fire is extinguished.

Based on the above examples and their explanations, a device was used to extinguish the fire. You must have seen fire extinguishers installed at petrol pumps, big buildings, cinema halls and other public places.

(A) The executive principle of fire extinguishers is based on one of the following three conditions:

- cooling the fire to below its ignition temperature, or
- exhausting the supply of combustion nutrients, or
- cooling the fire as well as exhausting the air supply .

(B) There are many types of fire extinguishers according to the type of fire that is used.

The table below gives the types of fire extinguishers, their executive principles and the nature of the fire they control.



Notes

Table 3.3: Type of fire extinguishing equipment, executive principle and nature of fire extinguished

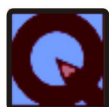
	Type of fire extinguisher	Executive principle	Nature of fire extinguished
1.	Water	Cooling the material down to its ignition temperature	All types of fires except fire caused by electrical and flammable liquids
2.	Soda acid	Exhaust air supply	all types of fires other than electrical and ignited liquids fires
3.	Foaming	exhaust air supply	ignited liquids fires
4.	Carbon	tetrachloride or pyrene exhausting air supply	electrical fire

The most commonly used fire extinguisher is soda-acid. The percentage amount of carbon dioxide in the air is converted into a combustion barrier by this fire extinguisher. How is it done? In this fire, sodium bicarbonate solution and sulfuric acid are separated from each other in a cylinder. When the cylinder is overturned and slammed on the floor, the two react together in a chemical reaction, resulting in carbon dioxide.

This increases the percentage of carbon dioxide already present in the air by about 15% by releasing out of the carbon dioxide

cylinder. In this way air combustion is not nutritious and the fire is extinguished.

These types of fire extinguishers are placed in theaters, multi-storey buildings and large factories. These fire extinguishers are not suitable for extinguishing fire by flammable substances.



### INTEXT QUESTIONS 3.3

1. Fill in the blanks:

- (i) The substance which does not burn when heated is called .....
- (ii) Two examples of substances which do not burn when heated are ..... and .....
- (iii) The combustion temperature of kerosene is \_\_\_\_\_ from the burning temperature of water and \_\_\_\_\_ from the combustion temperature of petrol.
- (iv) If the combustion temperature of a substance is high, \_\_\_\_\_ quantity of heat is required to burn it.
- (v) Combustion ..... changes.



### WHAT HAVE YOU LEARNT

- Carbon is an element, it is a nonmetal.
- Carbon is found in both free and combined states in nature. Wood coal, coke, and coal are different amorphous forms of carbon and graphite and diamond are crystalline types of carbon.

Notes



- Diamond is colorless and extremely hard material and graphite is non-metal which is a conductor of heat.
- Hydrocarbons are only compounds made of carbon and hydrogen.
- Methane is also known as marsh gas.
- Butane is in liquid state due to pressure in LPG.
- The volume of carbon dioxide in air is about 0.03% and the concentration of carbon dioxide is fixed in the air by photosynthesis.
- When coal is burnt in a quantity of air, carbon monoxide is produced. It is poisonous.
- Energy is released when fuel is burnt. Fuels can be classified as solid, liquid and gas fuels.
- One can compare the energy efficiency of different fuels with the energy obtained by burning each fuel.
- In the combustion process, light and heat are produced simultaneously. In this, the substance is heated to its ignition temperature. This reaction is very fast.
- The minimum temperature at which a substance starts burning is called its combustible temperature.
- Those substances which burn fast are called flammable substances and those which do not burn at all are called inflammable substances.
- Three conditions are necessary for combustion - (1) presence

**Notes**

of flammable material, (2) recovery of combustion heat, and (3) continuous supply of good combustion nutrients.

- The tools developed to extinguish the fire are called fire extinguishers. The working principles of different types of fire extinguishers operate on one or more of the following terms.

(1) Removing the flammable substance, (2) Stopping the supply of air, and (3) Cooling the flammable substance below the burning temperature.

**TERMINAL QUESTIONS**

1. Which is the 12th element found in the Earth's surface?
2. Why is carbon considered a wonder element?
3. Is carbon metal or nonmetal?
4. Which type of coal can absorb colored substances?
5. Which is the purest form of charcoal (coal)?
6. Why is coke considered a better fuel than coal?
7. Which type of carbon works in the filler of rubber tires?
8. Name four more elements that are found in coal other than carbon.
9. Name two examples of crystalline types of carbon.
10. Compare the following properties of diamond and graphite:
  - (i) electrical conductivity
  - (ii) hardness
  - (iii) color



11. Why is the methane called marsh gas?
12. How is the concentration of carbon dioxide in the atmosphere constant?
13. How can you identify if carbon dioxide gas is present in the atmosphere?
14. When coal is burnt in a fixed amount of air, then carbon which oxides are made?
15. Define fuel and explain why coal and petroleum are called fossil fuels?
16. What are Hydrocarbons? Name two hydrocarbons.
17. Which fuel has the highest thermal value - solid, liquid or gas?
18. How are fuels classified? Give two examples of each.
19. What are the two characteristics of good fuel?
20. Why is hydrogen gas not used as domestic fuel?
21. What are the disadvantages of incomplete combustion of fuel?
22. Describe the two ways in which you can conserve fuel?
23. Fill in the blanks with the help of appropriate words:
  - (i) Aqueous solution of carbon dioxide turns \_\_\_\_\_ litmus red.
  - (ii) The perforated type of carbon is \_\_\_\_\_ .



**Notes**

- (iii) There are many types of kajal (carbon black) out of which \_\_\_\_\_ is the purest form of coal.
- (iv) \_\_\_\_\_ is obtained by heating in the absence of air.
- (v) \_\_\_\_\_ type of carbon is used to make shoe polish.
- (vi) Diamond and graphite are two \_\_\_\_\_ of carbon.
- (vii) To burn diamond at high temperature is \_\_\_\_\_.
- (viii) Liquid petroleum gas is a \_\_\_\_\_.
- (ix) Marsh gas is called \_\_\_\_\_ gas.
- (x) The first 4 hydrocarbons are \_\_\_\_\_ (solid / liquid).
- (xi) Solid carbon dioxide is called \_\_\_\_\_.
- (xii) Petrol is obtained by \_\_\_\_\_ of petroleum.
- (xiii) \_\_\_\_\_ is being used as fuel to run buses in Delhi.
- (xiv) An ideal fuel should have a combustion temperature of \_\_\_\_\_.

**ANSWERS TO INTEXT QUESTIONS****3.1**

1. (i) - d, (ii) - a, (iii) - d, (iv) - b, (v) - c
2. (i) kajal (ii) nonmetal
3. carbon monoxide



Notes

**3.2**

1. (i) - d, (ii) - a, (iii) - c, (iv) -, (v) - c
2. (i) fuel (ii) solid
3. (i) diesel (ii) LNG, (iii) wood, (iv) hydrogen gas, (v) Kerosene

**3.3**

1. (i) Flammable substance, (ii) Water and air, (iii) More, less, (iv) more, (v) chemical

