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THREE MUSKETEERS: FUEL, OXYGEN AND HEAT TO PRODUCE FIRE

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ABSTRACT

Fire most commonly means flames and heat from burning, shooting a gun, or losing a job. Physical and Literal Meanings: Flames: The bright, hot light created when things burn. Destruction: A dangerous blaze that harms homes or forests. Controlled fire: A small campfire or fireplace used for warmth and cooking.

KEYWORDS: fire triangle, heat, oxygen, fuel, oxyacetylene.

INTRODUCTION

Fire is a fast chemical reaction between fuel and oxygen that creates heat and light. Fires are divided into classes based on what is burning, such as **Class A (solids), Class B (liquids), and Class C (electrical/gases)**.

Fast chemical process called combustion. It needs three things to happen: fuel, heat, and oxygen (the fire triangle). Gives off heat, light, and smoke.

Classes (Types) of Fire

1. **Class A:** Everyday solid things like wood, paper, cloth, trash, and plastics.
2. **Class B:** Flammable liquids and gases like gasoline, oil, paint, propane, and grease.
3. **Class C:** Energized electrical equipment and live wires. (In some regional rules, Class C specifically means gases, and electrical is separate).
4. **Class D:** Combustible metals like magnesium, sodium, titanium, and lithium.
5. **Class F / Class K:** Cooking oils, fats, and deep-fryer grease & Safety.

Color	Temperature
Dark red	500°C -600°C
Dull Red	600°C -800°C
Bright cherry red	800°C -1000°C
Orange	1000°C -1200°C
Bright yellow	1200°C -1400°C
White	1400°C -1600°C

Figure 1: Colour zone of fire.

Fire color depends primarily on temperature and chemical composition, with blue representing the hottest areas, orange/yellow indicating moderate heat from glowing soot, and red showing the coolest parts. **Blue (Hottest):** Reaches above 1,400°C to over 3,000°C; indicates complete and efficient combustion with plenty of oxygen. **Yellow and Orange (Moderate):** Ranges roughly from 1,000°C to 1,200°C; caused by glowing tiny carbon particles (soot) during incomplete combustion of wood or paper. **Red (Coolest):** Ranging from 525°C to 1,000°C; signals lower energy output or a restricted oxygen supply. **Green:** Produced by elements like copper or boron (such as boric acid). **Yellow-Gold:** Created by sodium compounds like regular table salt. **Bright Red:** Emitted by lithium or strontium compounds. The fire triangle shows the three things a fire needs to burn: **heat, fuel, and oxygen**. Learn more about how combustion works and how these elements interact.

Figure 2: Fire triangle.

The Three Elements: **Heat:** The energy source that gets the fire started and keeps it going. It warms up the material until it catches fire. **Fuel:** Anything that can burn, such as wood, paper, cloth, or gas. **Oxygen:** A gas in the air that feeds the fire and helps it stay alive.

Fire means a flaming state of burning, shooting a gun, or losing your job. It can also mean great passion or modern slang for something being cool. Literal and Scientific Meanings: Combustion: A fast chemical reaction between fuel and oxygen that makes heat and light. Blaze: A destructive or controlled fire in a fireplace, stove, or forest.

Fire, combustion, and ignition are linked chemical processes where ignition starts the reaction, combustion is the burning process, and fire is the visible result. Together they require fuel, oxygen, and heat.

The Fire Triangle and Ignition

Fuel: Any solid, liquid, or gas that can burn, such as wood, paper, or gas.

Oxygen: Usually from the air, which acts as the oxidizing agent to support the reaction.

Heat: The energy source that gets the fire started and keeps it going. It warms up the material until it catches fire.

Ignition, combustion, and fire are closely related stages of the same chemical process, but ignition is the starting spark or heat, combustion is the overall chemical reaction, and fire is the visible, active result.

Ignition: What it is: The exact moment a material starts to catch fire.

How it works: You add enough heat to reach a substance's lowest burning temperature (ignition point). Example: Striking a match or using a spark to light a gas stove.

Combustion: What it is: The broader chemical process where fuel mixes with oxygen.

How it works: It releases heat and can happen fast or slow (like iron rusting or food digesting, which do not make flames). Example: Burning wood, LPG gas, or slow cell changes in the body.

Fire: What it is: A fast, visible type of combustion.

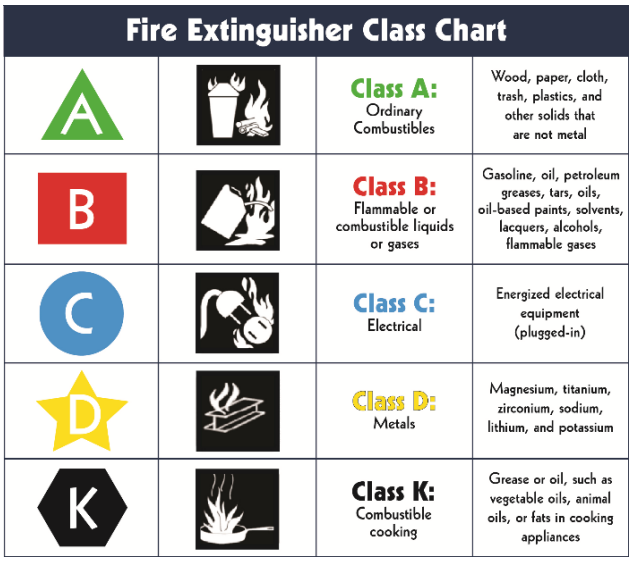

Figure 3: Fire extinguisher class.

How it works: It produces bright flames, heat, and light when gases burn in the air. Example: A campfire or a burning candle. Ash is the solid, powdery residue left behind when organic material undergoes combustion. It consists of non-combustible minerals like calcium, potassium, and magnesium that do not vaporize during a fire. **Understanding Ash and Fire:** Combustion Residue: Ash represents the solid, non-gaseous minerals remaining after material burns. Efficiency: Fine, light ash indicates an efficient burn with good airflow, while heavy chunks mean incomplete burning. Extinguishing Fires: Campfires should burn completely to ash before being drowned with water and stirred for safety.

Fire temperature ranges widely from about 300°C to nearly 3,000°C (600°F to 5,400°F), depending on what is burning. A standard match burns around 600°C to 800°C, a wood campfire reaches about 1,000°C, and an efficient gas stove

blue flame hits nearly 1,600°C (3,000°F). Common Fire Temperatures: Match flame: 600°C-800°C (1,112°F-1,472°F), Wood campfire: 600°C-1,100°C (1,112°F-2,012°F), Candle flame: 1,000°C-1,400°C (1,832°F-2,552°F), Gas stove (blue flame): 1,400°C-1,650°C (2,552°F-3,000°F), Oxyacetylene torch: Up to 3,300°C (5,972°F). Oxyacetylene is a mix of oxygen and acetylene gases that creates a very hot flame used for welding, cutting, and heating metal. Burns pure oxygen and acetylene together to reach temperatures up to 3,100°C to 3,500°C. Uses high-pressure tanks, hoses, regulators, and a hand-held torch to mix and control the gases. Adjusts gas levels to create different flame types (neutral, oxidizing, or carburizing) depending on the job. Oxy-acetylene welding is a gas welding process that uses oxygen and acetylene gases to create a hot flame reaching up to 3,200°C to melt and join metals. Essential equipment includes gas tanks, pressure regulators, hoses, and a handheld mixing torch. Cylinders: High-pressure steel tanks holding oxygen (green/black) and acetylene (red). Regulators: Control and lower the gas delivery pressure from the tanks. Hoses and Torch: Twin rubber hoses feed gases into the torch where they mix and burn at the tip. Flame Types: Neutral Flame: Equal parts oxygen and acetylene; has a clear inner cone and is best for general welding. Carburizing Flame: Excess acetylene; introduces carbon and is used for specific alloy steels. Oxidizing Flame: Excess oxygen; hot and sharp, used mainly for cutting or brass work. Safety Gear: Eye protection: Dark welding goggles (shade 5 to 9 depending on the task). Clothing: Heavy leather gloves and jackets to prevent severe burns.

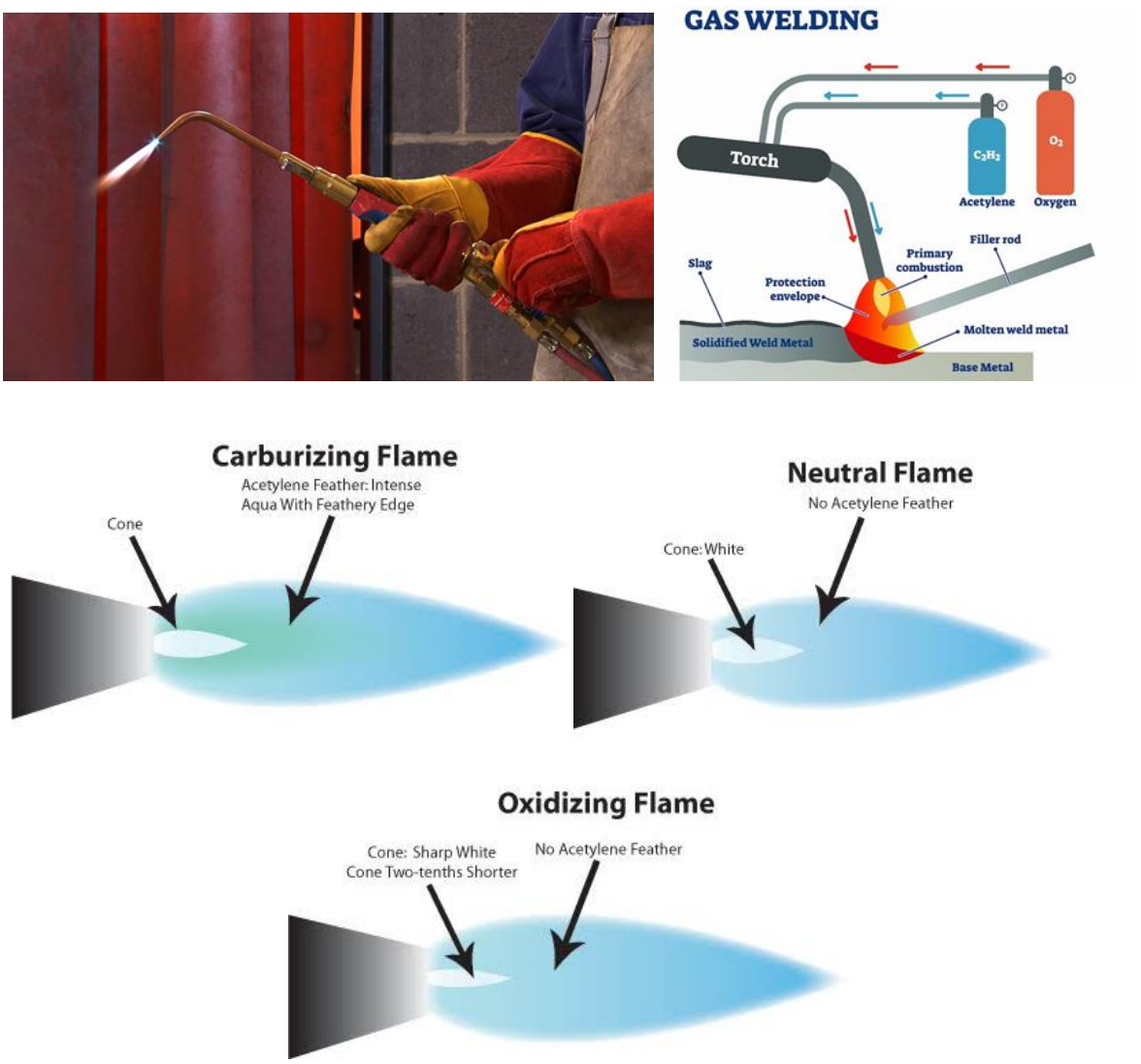

Figure 4: Welding fire.

Red and orange flames: Usually cooler (600°C to 1,000°C), meaning the burn is less complete. **Blue and violet flames:** Hotter (1,400°C to 1,650°C), showing that the fuel and oxygen are mixing and burning well.

The controlled use and invention of fire took place during the **Paleolithic period (the Old Stone Age)**, with early hominids like *Homo erectus* beginning to harness natural flames roughly 1.5 to 2 million years ago, and intentional fire-making tools appearing by 400,000 years ago. *Homo erectus* used stone tools and learned to control fire during the early Stone Age, though whether they actively struck stones to create sparks or gathered natural fire remains a key topic in human evolution. Evidence suggests they harnessed flames for cooking and warmth over a million years ago. 2 Million Years Ago: Hominid ancestors started regular interaction with and maintenance of natural fire sources. 1.5 Million Years Ago: Hearths and charred evidence emerged across African sites. 400,000 Years Ago: Deliberate fire-making technology using flint and iron pyrite developed, as evidenced at sites like Barnham in England. The Stone Age is a vast prehistoric period split into the Paleolithic, Mesolithic, and Neolithic eras, defined by the creation and use of stone tools. Lasting for millions of years, it ended between 4000 BC and 2000 BC with the rise of metalworking.

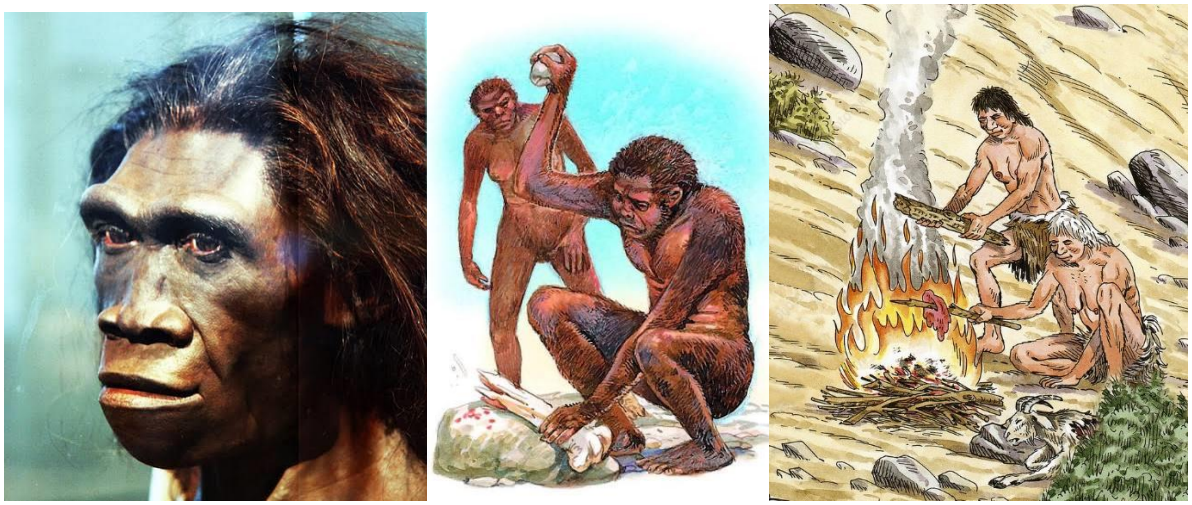

Figure 5: Stone Age.

Paleolithic (Old Stone Age): Longest era; humans lived as nomadic hunter-gatherers using basic chipped stone tools and fire.

Mesolithic (Middle Stone Age): Transitional time; saw refined tools like small microliths, fishing gear, and the beginnings of settled camps.

Neolithic (New Stone Age): Final era; introduced polished stone tools, farming, animal taming, pottery, and permanent villages. Stone Age fire was a vital tool for survival, driven by techniques like striking flint against iron pyrite and friction methods to cook food, stay warm, and build communities. Capturing Nature: Early groups first collected embers from wildfires caused by lightning. Stone and Spark: Striking sharp flint against iron-rich rocks like pyrite (fool's gold) created hot sparks. Friction: Rubbing dry wood together using a hand drill or bow drill built up heat to form an ember. Chokmoki pathor (চকমকি পাথর) is the Bengali name for flint or chert, a hard sedimentary rock known for producing sparks when struck against steel. "Chokmoki" (or Chakmak / চকমকি পাথর) is the traditional Bengali and Hindi name for flint or chert, a natural microcrystalline form of quartz (silicon dioxide, SiO_2). Key Facts and Uses: Ancient Fire-Making: Early humans used it over 2 million years ago by striking it to create sparks and ignite

fires. Scientific Classification: It is a form of cryptocrystalline quartz, also related to chert and agate. Modern and Traditional Uses: Historically used in flintlock firearms, and currently found in lighter mechanisms or decorative and metaphysical practice.

A fire extinguisher is a handheld safety tool used to stop small fires, and you use the PASS method to operate it: Pull, Aim, Squeeze, and Sweep. A fire extinguisher is a portable safety device used to put out or control small, unexpected fires. It works by releasing water, foam, gas, or powder to cool the fire, block oxygen, or stop the chemical reaction.

How to Use (PASS Method): Pull the pin at the top of the device. Aim the nozzle low at the base of the fire. Squeeze the handle or lever to release the spray. Sweep from side to side until the fire is out.

Types of Fires

Class A: Wood, paper, cloth, and trash.

Class B: Gas, oil, and paint liquids.

Class C: Live electrical wires and equipment.

Class K: Cooking oils and fats. The four basic types of portable fire extinguishers are water, foam, dry chemical, and carbon dioxide (CO_2). Each type is designed to put out specific kinds of fires.

Figure 6: Fire extinguisher in working mode.

Water Extinguishers

- Best for solid items like wood, paper, and cloth (Class A fires).
- Cools down the burning material.
- Never use on electrical fires or grease fires.

Foam Extinguishers

- Best for liquids like petrol, paint, and oil (Class B fires), and solid materials (Class A fires).
- Smothers the fire by sealing the liquid surface.
- Do not use on live electrical equipment.

Dry Chemical Extinguishers

- Multipurpose tools (often rated ABC) that use a fine powder to stop the chemical reaction of a fire.
- Works on solids, flammable liquids, and electrical equipment.
- Leaves a dusty mess that requires cleanup after use.

Carbon Dioxide (CO_2) Extinguishers

- Best for electrical equipment and flammable liquids.
- Removes oxygen and cools the area without leaving any harmful residue.
- Safe for sensitive computers and machinery.

CONCLUSION

Fires are grouped into classes based on their fuel source, and using the correct fire extinguisher is vital to put them out safely. An extinguisher is a device or tool used to put out a fire, or a small cap used to snuff out a candle flame. The main classes of fire and their matching extinguishers are detailed below. Classes of Fire: Class A: Ordinary solid combustibles like wood, paper, cloth, trash, and plastics. Class B: Flammable liquids and gases like gasoline, oil, grease, paint, and propane. Class C: Energized electrical equipment and live wiring. Class D: Combustible metals like magnesium, sodium, and titanium. Class K/F: Cooking oils, fats, and deep-fryers. Types of Fire Extinguishers: Water: Cools Class A fires; never use on electrical or grease fires. Foam & Dry Powder: Smothers Class A, B, and C fires by blocking oxygen. Carbon Dioxide (CO_2): Removes oxygen; ideal for electrical fires (Class C) without leaving a mess. Wet Chemical: Cools and blocks re-ignition; designed for cooking oil fires (Class K/F). ABC Dry Chemical: Versatile multi-purpose choice effective on solid, liquid, and electrical fires.

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