Chapter: 7
Density and Temperature

Short Response Questions

Q1. Two liquids A and B, have densities 1 g/mL and 1.2 g/mL respectively. When both liquids are poured into a container, one liquid floats on top of the other. Which liquid is on top, and why?

The liquid with lower density floats on top. Therefore, liquid A with a density of 1 g/mL will float on top of liquid B, which has a higher density of 1.2 g/mL. This occurs because denser liquids displace less volume and sink, while lighter liquids displace more volume and rise.

Q2. Write a method to find the volume and density of a human body?

To determine the volume and density of the human body, the displacement method can be used. First, submerge the body in a graduated container filled with water and measure the volume of displaced water. This volume represents the volume of the body. The density can be calculated by dividing the mass of the body (measured using a scale) by the volume obtained through displacement.
Density = Mass / Volume

Q3. How is plasma the fourth state of matter? Give a reason.

Plasma is considered the fourth state of matter because it consists of ionized particles, including free electrons and positively charged ions. Unlike solids, liquids, and gases, plasma is electrically conductive and responds to electromagnetic fields. Plasma exists at extremely high temperatures or low pressures, such as in stars, neon lights, and lightning, making it distinct from the other states of matter.

Q4. Why water is not used in liquid in glass thermometers?

Water is not used in liquid-in-glass thermometers because it freezes at 0°C and boils at 100°C, which limits its temperature range. Additionally, water has a high surface tension and evaporates at a lower temperature than liquids like mercury or alcohol. Mercury and alcohol, on the other hand, have wider temperature ranges and better thermal expansion properties for accurate temperature measurements.

Q5. Can we increase internal energy of a substance without increasing its temperature?

Yes, internal energy of a substance can be increased without changing its temperature. This can be done through a process like work being done on the substance (e.g., compressing a gas) or by adding energy in the form of potential energy, like during phase transitions (e.g., melting or boiling), where the substance absorbs heat without a change in temperature.

Q6. Why are fixed point scales required for thermometers? What difficulties are there when setting fixed points for thermometer scales?

Fixed point scales are required for thermometers to ensure accurate and reproducible temperature measurements. The fixed points, like the freezing and boiling points of water, provide reference temperatures to calibrate the thermometer. Difficulties include variations in the purity of the substance being used (e.g., water with impurities might freeze or boil at slightly different temperatures), and environmental factors such as pressure, which can alter the boiling point of liquids.

Q7. Mercury is replaced with alcohol in liquid in glass thermometers. Discuss the possible change in sensitivity and range of thermometer.

When mercury is replaced with alcohol in liquid-in-glass thermometers, the sensitivity generally increases. Alcohol expands more easily than mercury, allowing it to detect smaller changes in temperature. However, the range of the thermometer is reduced because alcohol freezes at a lower temperature than mercury and can also boil at lower temperatures. Therefore, while alcohol improves sensitivity, it limits the range of temperature measurement compared to mercury.

Q8. Why -273.15°C temperature is called absolute zero? Can we achieve this temperature?

-273.15°C, also called absolute zero, is the temperature at which all particle motion ceases. At this temperature, a substance has minimum possible energy, and its particles are at their lowest energy state. Absolute zero is the lowest theoretical temperature and cannot be achieved because as temperature approaches this point, the system would require infinite energy to remove the remaining heat.

Q9. Why thermocouple thermometer is suitable to measure high temperatures but not liquid in glass thermometer? Why is a thermocouple thermometer good for measuring high temperatures but a liquid in glass thermometer is not?

A thermocouple thermometer is suitable for measuring high temperatures because it uses the voltage difference generated between two different metals when heated, which can measure a wide range of temperatures, including very high ones. In contrast, liquid-in-glass thermometers are limited by the temperature at which the liquid (like mercury or alcohol) evaporates or freezes, making them unsuitable for very high temperatures.

Q10. Can we increase the sensitivity of a liquid-in-glass thermometer without changing its range?

Yes, the sensitivity of a liquid-in-glass thermometer can be increased by using a thinner capillary tube. A narrower tube allows the liquid to rise or fall more quickly in response to small temperature changes. Additionally, choosing a liquid with a higher coefficient of expansion can also increase sensitivity without altering the thermometer's range.

Q11. One student claims to have constructed a more sensitive liquid in glass thermometer. How can her claim be verified?

The claim can be verified by comparing the sensitivity of the student's thermometer with a standard thermometer. This can be done by observing how quickly the liquid in the thermometer reacts to small temperature changes. If the liquid in the student's thermometer moves more rapidly than in the standard thermometer for the same temperature change, then it is indeed more sensitive.

Q1. Define density. Describe methods to determine densities of regular and irregular-shaped solids, liquids, and gases.

Density is defined as the mass per unit volume of a substance. It is a physical property that expresses how much matter is packed into a given space. The formula for density is:

$$\text{Density}(\rho) = \frac{\text{Mass}}{\text{Volume}}$$

For **liquids**, density is measured by using a graduated cylinder to measure volume and a balance to measure mass. The method involves placing the empty cylinder on a balance, measuring its mass, adding the liquid, measuring its volume, and then calculating density by dividing the mass by the volume.

For **regularly shaped solids**, such as cubes or cuboids, the volume is calculated using geometrical formulas (e.g., Volume of a cube = side^3). The mass is measured with a balance, and density is calculated using the same formula.

For **irregularly shaped solids**, the **displacement method** is used. The object is submerged in a measuring cylinder filled with water, and the volume displaced by the object is used to determine its volume. The mass is measured using a balance, and density is calculated as the mass of the object divided by the displaced volume.

For **gases**, density is usually measured by determining the mass of a known volume of gas under controlled conditions, typically using a gas syringe and a balance. The mass and volume are used to calculate the gas's density.

Q2. How would you distinguish between solids, liquids, and gases on the basis of attractive forces between particles and the motion of particles?

The main distinction between solids, liquids, and gases is the **strength of the attractive forces** between particles and their **motion**:

1. **Solids**: Particles in solids are tightly packed, and the attractive forces between them are very strong. As a result, the particles can only vibrate about their fixed positions. Solids have a definite shape and volume.

2. **Liquids**: In liquids, the attractive forces between particles are weaker than in solids, allowing the particles to move past each other. This enables liquids to flow and adopt the shape of their container, but they maintain a definite volume.

3. **Gases**: Gases have very weak attractive forces between particles, allowing them to move freely and quickly in all directions. Gas particles are far apart and fill the entire volume of their container, so gases have neither a fixed shape nor volume.

The difference in the behavior of particles in these states accounts for the observed differences in their physical properties like density, shape, and volume.

Q3. Describe two different physical properties that vary with temperature and explain how these properties can be used to measure temperature.

1. **Expansion of Liquids**: When liquids are heated, they tend to expand. The expansion of liquids like mercury or alcohol is uniform with temperature. This property is used in **liquid-in-glass thermometers**. As the temperature rises, the liquid expands and moves up the tube, indicating the temperature.

2. **Change in Electrical Resistance**: The electrical resistance of certain materials, such as metals, increases with temperature. This is because the vibrations of

atoms in a conductor increase with heat, making it harder for electrons to flow. This property is used in **resistance thermometers** or **thermistors**, where the change in resistance is measured to determine temperature.

Both properties depend on the temperature and are predictable, making them useful for accurate temperature measurement.

Q4. Describe the construction and working of different types of gas thermometers.

There are two main types of gas thermometers: **constant volume gas thermometers** and **constant pressure gas thermometers**.

1. **Constant Volume Gas Thermometer**: In this thermometer, the volume of the gas is kept constant while the temperature is measured. The temperature is determined by measuring the pressure of the gas, as the pressure is directly proportional to the temperature of the gas (according to **Gay-Lussac's Law**: $P \propto T$ at constant volume). The gas in the thermometer is usually contained in a bulb connected to a pressure gauge.
2. **Constant Pressure Gas Thermometer**: In this type, the pressure of the gas is kept constant, and the volume is allowed to change. The temperature is determined by measuring the volume of the gas, as the volume is inversely proportional to the temperature (according to **Charles's Law**: $V \propto T$ at constant pressure). As the temperature increases, the gas expands, and the volume can be measured to find the temperature.

Both types of thermometers rely on the behavior of gases and can be used to measure temperatures in scientific applications with high accuracy.

Q5. Analyze how the structure of a liquid-in-glass thermometer can be modified to improve its performance. Give a detailed answer.

The performance of a liquid-in-glass thermometer can be improved by modifying its structure in the following ways:

1. **Diameter of the Tube**: The sensitivity of the thermometer increases when the diameter of the capillary tube is reduced. A smaller diameter tube allows the liquid to rise or fall more quickly in response to small changes in temperature, thus increasing the sensitivity.
2. **Nature of the Liquid Used**: Using liquids with a higher coefficient of expansion, like **mercury** or **alcohol**, improves sensitivity. These liquids expand more readily with heat compared to others like water, making them more responsive to temperature changes.

3. **Size of the Bulb**: The **size of the bulb** in the thermometer affects its range. A larger bulb contains more liquid, which allows the thermometer to cover a wider temperature range. It also helps in minimizing fluctuations due to temperature changes.

4. **Type of Glass**: The type of glass used in constructing the thermometer affects its linearity. **Borosilicate glass**, which has a more uniform expansion, ensures that the thermometer remains linear across its range. This improves the accuracy of the readings.

These modifications ensure that the thermometer can respond quickly to small changes in temperature, extend its measurable range, and maintain accuracy throughout its scale.
