8 TEMPERATURE

OBJECTIVES

At the end of topic, students should be able to:

- construct a device for measuring the temperature of a body;
- use the variation of :
- gas pressure with temperature,
- the expansion of solid, liquid and or gas with temperature,
- electrical resistance of a material with temperature to measure temperature of a body.
- describe the absolute scale of temperature and explain the meaning of the absolute zero of temperature.
- convert a given temperature on the Celsius scale to a temperature on the Kelvin scale.

Measurement of temperature

Thermometer is the instrument used for the measurement of temperature. The expansion of the liquid inside the thermometer is the physical attribute used to measure temperature precisely. This is because the judgement of temperature by the thermometer is not affected by feeling. There are many types of thermometer, each using different types of thermometric (physical) property of a substance to measure temperature. **Thermometric property of a thermometer is the physical property of the substance used by the thermometer to measure temperature.** Practical thermometers use changes in their thermometric properties to determine the temperature of the body. Some examples of thermometric properties used by thermometers are:

â€¢ Changes in the length of liquid thread in the stem of liquid-in-glass thermometer (expansion).

â€¢ Changes in the resistance of the thermometric substance.

â€¢ Changes in the gas pressure kept at constant volume.

â€¢ Changes in the e.m.f. or current between two junctions of different metals placed at different temperatures.

Thermometers are named using the thermometric property

employed in the measurement of temperature. Table 8.1 shows different types of thermometers, the thermometric property used to measure temperature and their advantages.

Fixed points and temperature scales

In all scale of temperatures, two temperatures are chosen as fixed points.

A fixed point is the temperature of pure melting substance or pure boiling substance at normal atmospheric pressure.

	Name of thermometer	Thermometric substance	Thermometric (physical) property	Advantage
1.	Liquid-in-glass thermometer	Alcohol or mercury	Changes in length of liquid thread in the stem of the thermometer as temperature changes.	It is portable and easy to use.
2.	Gas thermometer	Gas	Changes in the pressure of a gas at constant volume.	Accurate measurement of temperature and measures wider ranges of temperature.
3.	Thermocouple thermometer	Two different metals	Changes in the e.m.f. between the junctions of two different metals kept at different temperatures.	Quick response to changes in temperature and wider ranges of temperature (This is the best thermometer for industrial work).
4.	Resistance thermometer	Resistance wire	Changes in the electrical resistance of a wire due to rise in temperature	It responds to small changes in temperature, very accurate and measurewider ranges in temperature
5.	Pyrometer		Colour changes of radiation from hot bodies.	It measures temperature without being in contact with the hot body
6.	Bimetallic thermometer	Two different metals	Expansion or contraction of bimetallic strips as temperature changes	

Table 8.1: Types of thermometer, thermometric substances and their advantages

The fixed points chosen should always be constant no matter the temperature change. Once the two fixed points on a thermometer are chosen, the interval between them is divided into 100 equal parts.

The upper or higher fixed point is the temperature of pure boiling substance at normal atmospheric pressure.

The lower fixed point is the temperature of pure melting substance at normal atmospheric pressure.

The scale of temperature is the graduation on the body of a thermometer which enables temperature to be read directly.

The atmospheric pressure is the pressure exerted on us by the surrounding air or atmosphere. The standard atmospheric pressure is 760mm Hg.

Many scales of temperature exist but the two most popular scales of temperature used today are the **Celsius** scale and the **Kelvin** scale of temperatures.

The Celsius scale of temperature

The Celsius scale of temperature defines two fixed points:

The ice point (0Â°C) is the temperature of pure melting ice at normal atmospheric pressure. It is the lower fixed point of the on the Celsius scale.

The steam point (100Â°C) is the temperature of pure water boiling at normal atmospheric pressure. This is the upper or higher fixed point on the Celsius scale.

Once these two fixed points are marked on a thermometer, the interval between them is divided into 100 equal parts. One division on a Celsius scale represents 1Â°C.

How to find the lower fixed point

The thermometer is dipped upright in a pure melting ice in a funnel. The mercury level in the stem contracts until it is constant. A sharp object is used to mark the level of the mercury in the stem. This is the lower fixed point or the ice point (Â°C).

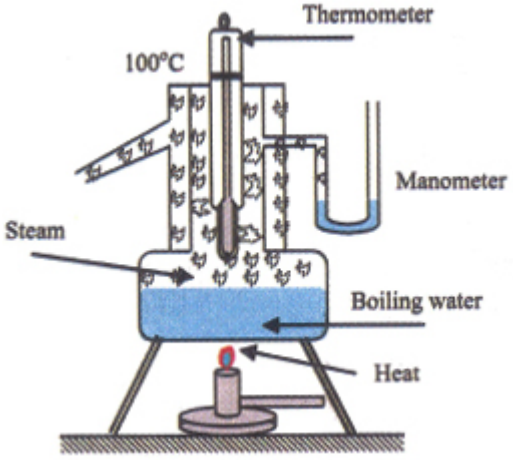


Figure 8.1: Hypsometer

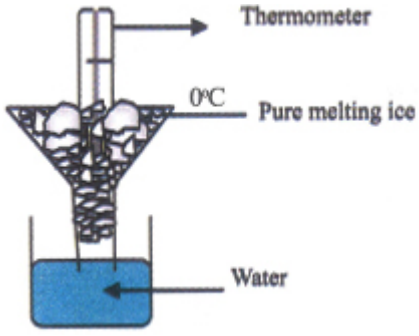


Fig 8.2: Determination of lower fixed point of the thermometer

How to find the upper fixed point

Hypsometer is used to find the upper or higher fixed point of a thermometer. It consists of a metal vessel with a double wall and a manometer to measure the pressure of the steam. The thermometer to be marked is placed in the steam above the boiling water in the inner vessel. When the thermometer bulb is heated by the steam, the level of mercury in the stem rises. A mark is made on the glass where the mercury level is constant. This is the upper fixed point of the thermometer.

- **The double wall** of the hypsometer is used to keep the steam temperature constant at 100Â°C.
- **The manometer** is used to keep the pressure of the steam constant at 760 mmHg.
- **The thermometer** is suspended in the steam above the boiling water. This is done ensure that the upper fixed point is 100Â°C.

Absolute zero and Kelvin temperature scale

The Kelvin scale of temperature is widely accepted temperature scale because it is not based on human assumptions but on experimental facts. The kinetic energy and the speed of a body decrease with fall in its temperature. The minimum possible temperature a body can be cooled to is approximately – 273Â°C. This is called **absolute zero** (0 K).

Absolute zero (0 K) is the temperature at which the molecules of the substance have the lowest possible energy (the speed of the molecules is zero or the molecules stop their motion completely).

The lowest possible temperature on the Kelvin scale of temperature or lower fixed point is – 273Â°C or 0 K. The upper fixed point is the triple point of water or approximately 273 K. Triple point of water is the temperature when water, vapour and ice exist together. It is about 0.16Â°C.

The ice point on Kevin scale of temperature is 273 K and the steam point is 373 K. The interval between the ice and steam point is divided into 100 equal parts, ***therefore one division on Kevin scale is 1 K.***

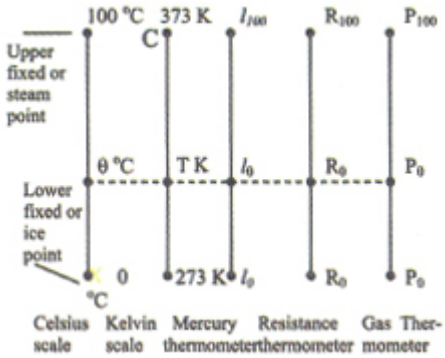


Figure 8.3: Link between temperature scales

Link between Celsius and Kevin temperature scales

Using the fixed points of these temperature scales, we can establish a link between them.

Taking simple ratios of the lengths on the line on the temperature scales gives:

$$\frac{XY}{XZ}=\frac{AB}{AC} \Rightarrow \frac{\theta}{100}=\frac{T-273}{373-273}=\frac{T-273}{100}$$

$$\therefore \quad \theta = T-273$$

$$\Rightarrow \qquad T=273+\theta$$

T= Absolute temperature measured in Kelvin (K)

θ = Temperature measured in degree Celsius (°C)

15 °C = 273+ 15 = 288 K

73 °C = 273 + 73 = 346 K

352 K = 352 – 273 = 79 °C

891 K = 891 – 273 = 618 °C

The length of mercury in a thermometer, the pressure of a gas in a gas thermometer and resistance of a wire in a resistance thermometer are related to temperature q in degree Celsius as follows:

$$\frac{\theta}{100}=\frac{l_\theta - l_0}{l_{100}-l_0}=\frac{R_\theta - R_0}{R_{100}-R_0}=\frac{P_\theta - P_0}{P_{100}-P_0}$$

$$\theta=\frac{l_\theta - l_0}{l_{100}-l_0}\times 100=\frac{R_\theta - R_0}{R_{100}-R_0}\times 100=\frac{P_\theta - P_0}{P_{100}-P_0}\times 100$$

$$\theta=\frac{l_\theta - l_0}{l_{100}-l_0}\times 100^oC$$

ll_{100} = length of mercury thread at steam point

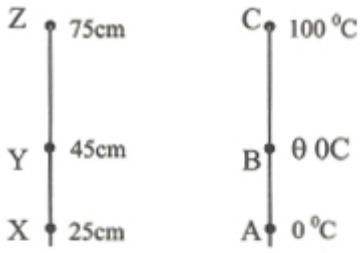
l_0 = length of mercury thread at ice point

l_q length of mercury thread at a given temperature *(q).*

Worked example

The ice and steam points of an unmarked thermometer are 25 cm and 75 cm respectively. What is the temperature in degree Celsius (Â°C) if the length of the mercury thread is 20 cm above the ice point?

Solution



$$\frac{XY}{XZ} = \frac{AB}{AC}$$

$$\frac{45-25}{75-25} = \frac{\theta - 0}{100-0}$$

$$\frac{20}{50} = \frac{\theta}{100}$$

$$\theta = 40\ ^{\circ}C$$

Alternatively,

$$\theta = \frac{l_\theta - l_0}{l_{100} - l_0} \times 100 = \frac{45-25}{75-25} \times 100$$

$$\theta = \frac{20}{50} \times 100 = 40\ ^{0}C$$

Summary

â€¢ **Temperature** is the degree of hotness or coldness of a substance.

â€¢ For an ideal gas, absolute temperature is proportional to the average kinetic energy of its molecules.

â€¢ Increase in average kinetic energy of the molecules of the substance is proportional to the rise in its temperature.

â€¢ **Thermometric property** of a thermometer is the physical property of the substance used by the thermometer to measure temperature.

â€¢ **A fixed point** is the **temperature** of pure melting substance or pure boiling substance at normal atmospheric pressure. The **upper or higher fixed point** is the temperature of pure boiling substance at normal atmospheric pressure while the **lower fixed point is the temperature** of pure melting substance at normal atmospheric pressure.

â€¢ The **scale of temperature** is the graduation on the body of a thermometer, which enables temperature to be read directly.

â€¢ **Absolute zero (0 K)** is the temperature at which the molecules of the substances have the lowest possible energy (the speed of the molecules is zero or the molecules stop their motion completely).

â€¢ The **ice point** on Kelvin scale of temperature is 273 K and the steam point is 373 K.

Practice Questions 13a

1. Two pieces of metals rubbed against each other become hot. What is the source of the heat energy produced?
2. Heat is energy transferred due to temperature difference. Explain.
3. The resistance of a platinum resistance thermometer is 30Î© at ice point, 40Î© at steam point and 34.5Î© on certain hot day. What is the temperature of the day on Celsius temperature scale?
4. (a) Name four physical (thermometric) properties of a substance that may be used to measure temperature
   (b) Name the thermometer which uses the property named above and give one advantage of each thermometer named.
5. Use kinetic theory to explain the following terms (i) heat (ii) temperature (iii) rise in temperature.
6. State the differences between heat and temperature of body.
7. (a) Explain the following terms:
   (i) Fixed points of a thermometer.
   (ii) Scale of temperature.
   (b) State the lower and the higher fixed points on the Celsius scale of temperature.
   (c) How are the Celsius and the Kelvin scale of temperature related?
8. What do you understand by the term absolute zero? Why is it used as the lower fixed point on Kelvin scale of temperature?
9. (a) Explain what you understand by **steam** and **ice points** on a Celsius scale of temperature.
   (b) Describe an experiment to determine the upper fixed point of a thermometer.
   (c) State two precautions taken to ensure accurate results.
10. (a) State the relationship between Celsius and Kelvin scales of temperature.
    (b) The ice and steam points on a thermometer that is not graduated are 50 mm and 300 mm respectively. The room temperature on the scale of this thermometer on a certain day is 125 mm; calculate the room temperature on the Celsius scale of temperature.
11. The pressure of a gas at 100Â°C is 2.50 Pa and at 20Â°C, the pressure is 1.55 Pa. Calculate the temperature on a day the pressure is 1.90 Pa.

THERMOMETERS

OBJECTIVES

At the end of topic, students should be able to:

- construct a device for measuring the temperature of a body;
- select liquids suitable for use in liquid-in-glass thermometers from a given list of liquids and their properties.

Thermometers are used to measure temperature of substances. The most popular type of thermometer is the liquid-in-glass thermometer. In this section, you will know more about liquid-in-glass thermometers.

Construction of liquid-in-glass thermometer

To construct a liquid-in-glass thermometer a capillary tube with a fine (narrow) bore is used. One end of the capillary tube is heated in a flame to make it soft and air blown in from the other end to increase the size of the bulb. The bulb of the thermometer is filled with the liquid whose thermometric property is used to measure temperature. Care is taken to ensure that air bubbles are not trapped in the liquid.

A good thermometer should be sensitive to small changes in temperature. The following features make a thermometer more sensitive.

- **Fine or narrow bore:** a thermometer becomes sensitive if the bore is narrow. Sensitivity means that the thermometer responds fast to small changes in temperature.
- **Thin wall of the glass bulb:** the wall of the glass bulb is thin to allow heat to pass with ease to the liquid inside the bulb.
- **Cylindrical shape of the bulb:** the glass bulb is cylindrical in shape to expose greater liquid surface to heat and to allow the thermometer to enter through different holes.

Properties of a good thermometric liquid

A good thermometric liquid should have the following properties:

1. **Linear or uniform expansion and contraction** of the liquid as the temperature changes.
2. **High conductivity:** a good thermometric liquid must be a good conductor of heat.
3. **High sensitivity:** the liquid used in a thermometer must be sensitive to small changes in temperature.
4. **Wider range of temperature:** a good thermometric liquid should be able to measure wide range of temperatures.
5. **Easy visibility:** a good thermometric liquid should be easily seen or opaque that is, it should be read easily without difficulty.
6. **Not wetting the glass walls:** a good thermometric liquid must not wet the glass wall.
7. **Low vaporizing point:** thermometric liquid must not vaporize

easily.

Any liquid that satisfies these conditions can be used in a thermometer to measure temperature. **Mercury** and **alcohol** are the best thermometric liquids. Each has its own merits and demerits.

Advantages of mercury over alcohol as a thermometric liquid

Mercury is better than alcohol as a thermometric liquid because:

1. Mercury thermometer measures higher temperatures compared to alcohol thermometer. Mercury boils at 360Â°C while alcohol boils at only 78Â°C.
2. Mercury does not wet or stick to the glass surface while alcohol wets the glass surface.
3. Mercury is coloured and can be read easily but alcohol is colourless and difficult to read.
4. Mercury is better conductor of heat when compared to alcohol.
5. Mercury has low vaporization compared to alcohol.

Advantages of alcohol over mercury as a thermometric liquid

1. Alcohol thermometer measures lower temperatures better than mercury thermometer. The freezing point of alcohol is – 144Â°C while that of mercury is – 39Â°C.
2. Alcohol thermometer is more sensitive to changes in temperature than mercury thermometer. This is because alcohol expands faster than mercury for the same rise in temperature.

Why water is a bad thermometric liquid

1. The expansion of water is irregular.
2. The expansion range of water is short. Water boils at 100Â°C and freezes at 0Â°C.
3. Water wets or sticks to the glass surface.
4. Water vaporizes easily.
5. Water is colourless. It is difficult to read water thermometer.
6. Water is a poor conductor of heat.

Types of liquid-in-glass thermometer

Three types of liquid-in-glass thermometers are:

- â€¢ The laboratory thermometer
- â€¢ The clinical thermometer
- â€¢ The Sixâ€™s maximum and minimum thermometers.

The laboratory thermometer

The thermometric liquid used in this thermometer is mercury and is

widely used in the laboratory to measure temperatures. Figure 6.5 is a laboratory thermometer. The features of the thermometer are:

- â€¢ Cylindrical bulb and narrow bore which make the thermometer sensitive to small changes in temperature.
- â€¢ A vacuum formed above the mercury thread to allow the mercury to expand and contract undisturbed.
- â€¢ Celsius scale of temperature with the ice point at 0Â°C and steam point at 100Â°C.

  When the thermometer is heated, the mercury inside expands and is forced out of the bulb into the narrow capillary bore. The position of the mercury thread up the stem is the temperature of the body where the thermometer is placed.

Figure 8.4: Laboratory thermometer

The clinical thermometer

Mercury is the thermometric fluid in the clinical thermometer.

The clinical thermometer uses the expansion or contraction of mercury inside a narrow bore to measure accurately the temperature of the human body. 37Â°C is the temperature of a healty human being. A clinical thermometer has the following special features.

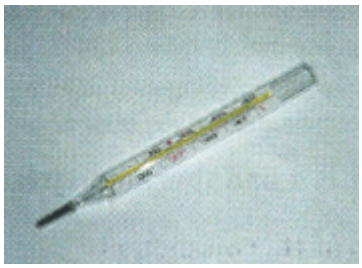


Figure 8.5: Clinical thermometer

- â€¢ **Scale with short temperature range:** The temperature range is from 35Â°C to 45Â°C. the accuracy of a clinical thermometer is 0.1Â°C.
- â€¢ **Very narrow (fine) bore:** the capillary bore of a clinical thermometer is very narrow to make it respond to small changes in temperatures.

â€¢ **Narrow constriction:** near the bulb is a narrow constriction, which prevents the mercury from returning to the bulb when the thermometer is removed from the body. Constriction helps the medical workers to read the temperature of the patient when the thermometer is removed from his body.

When a clinical thermometer is placed under the patientâ€™s tongue or armpit, the mercury in the bulb is warmed and it expands. The force of expansion forces the mercury past the constriction.

To return the mercury back to the bulb, the thermometer is shaken or jerked. Clinical thermometers should not be sterilized in boiling water. This is because the temperature of boiling water (100Â°C) is far more than the maximum temperature (45Â°C) of the clinical thermometer. If the thermometer is sterilized in boiling water, it will break because of over expansion.

Sixâ€™s maximum and minimum thermometers

Sometimes, it is necessary to know the maximum and minimum temperatures of the day. Sixâ€™s maximum and minimum thermometers are used to measure the dayâ€™s maximum and minimum temperatures. The thermometer was invented by James Six. The features of Sixâ€™s maximum and minimum thermometers include:

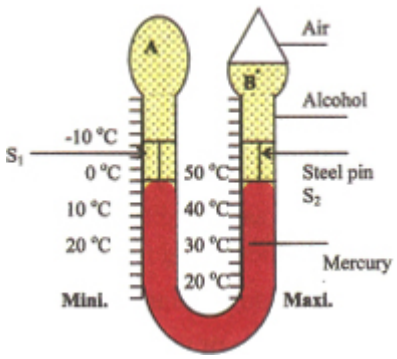


Figure 8.6: Sixâ€™s maximum and minimum

â€¢ U-shaped capillary stem, which contains both mercury and alcohol as thermometric liquids.

â€¢ Small steel pins S1 and S2 which can be adjusted by a magnet to reset the thermometer.

â€¢ Two temperature scales to indicate the maximum and minimum temperatures of the day.

During the day, the temperature rises, the thermometric liquid expands. Alcohol expands more than the mercury for the same temperature rise, therefore the expanded alcohol in bulb A presses on the mercury making it to push the pin S2 upward. The position of the pin S2 at the end of the day is the maximum temperature. In the night the temperature falls, the alcohol in bulb Î’ contracts and pushes the mercury round to push up the steel pin S1. The position of the pin S1 is the minimum temperature of the day.

To use the thermometer again, a magnet is used to bring the steel pins to their normal positions or in touch with the mercury thread.

Other types of thermometers

(a) Thermocouple thermometer

The thermocouple works on the principle that electric current or voltage is produced across the junctions of two different wires when there is a temperature difference between them. It has two junctions: the cold junction kept at 0Â°C is used as the reference point and the hot junctionor temperature measuring junction, is used to probe the temperature of the body where it is placed. The current or voltage is measured with a galvanometer calibrated in degree Celsius since increase in voltage is proportional to temperature change.

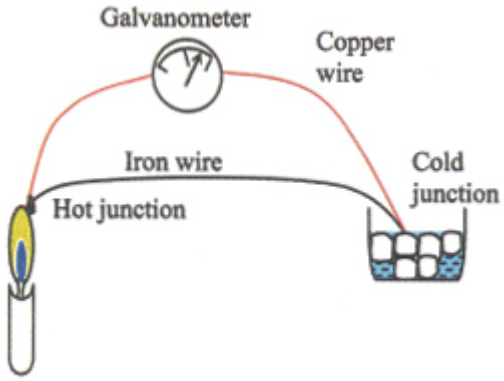


Fig 8.7: Thermocouple thermometer

The advantage of a thermocouple is that it responds fast to changes in temperature and is used to measure rapidly changing temperature.

(b) Platinum resistance thermometer

The resistance thermometer uses the linear variation in the resistance of a platinum wire as the temperature changes to measure temperature. If the resistance of the platinum resistance wire at 0Â°C is Ro, the resistance at 100Â°C is R 100 and the resistance at temperature Ã¨Â°C is R_q, then the temperature equivalent of R_q in Celsius temperature scale is

$$\theta = \frac{R_\theta - R_0}{R_{100} - R_0} \times 100$$

The advantages of a resistance thermometer are:

- **â€¢** very accurate in measuring temperature between – 200Â°C to 1200Â°C.
- **â€¢** sensitive to small changes in temperature.
- **â€¢** measures wide range of temperatures.

The disadvantage of a resistance thermometer is that it takes time to reach the temperature of the body which it tends to measure.

(c) Gas thermometers

Gas thermometers use the changes in pressure of a gas at constant volume to measure temperature. The gases used are dry air, nitrogen gas or helium gas because they behave like ideal gas. When these gases are warmed at constant volume, their change in pressure is proportional to the rise in temperature. The changes in pressure can be converted to temperature in degree Celsius or Kelvin. Gas thermometers give accurate temperature measurements and are very good for research work. The disadvantages are; it is bulky (difficult to move about) and required skill to use.

Summary

â€¢ Thermometers are used to measure temperature of substances.

â€¢ The features which make a thermometer sensitive are Fine or narrow bore, thin wall of the glass bulb and cylindrical shape of the bulb.

â€¢ Different types of thermometer includes; liquid-in-glass thermometer, gas thermometer, resistance thermometer, and thermocouple thermometer.

Practice questions 6b

1. What is a thermometer? Give four types of thermometer and state the advantage of each thermometer named.
2. (a) State five qualities of a good thermometric liquid.
   (b) Why is water not a good thermometric liquid?
3. (a) With the aid of a labelled diagram, describe a clinical thermometer.
   (b) What characteristics of a clinical thermometer make it respond fast to small changes in temperature.
4. (a) State three advantages of mercury over alcohol as a thermometric liquid;
   (b) Explain why a mercury thermometer cannot measure any temperature less than – 40Â°C.
5. Describe the structure of a thermocouple and state its advantages over the liquid-in-glass thermometer as a temperature measuring device.

Past questions

1. A platinum resistance thermometer has a resistance of 4 Î© at 0Â°C and 12 Î© at 100Â°C. Assuming that the resistance changes uniformly with temperature, calculate the resistance of the thermometer when the temperature is 45Â°C

A. 6.0 Î©
B. 6.4 Î©
C. 7.6 Î©
D. 8.4 Î©
E. 16.0 Î© **NECO**

2. The ice and the steam points of a certain thermometer are – 20Â° and 100Â° respectively. Calculate the Celsius temperature corresponding to 70Â° on the thermometer.
   A. 84.0Â°C
   B. 75.0Â°C
   C. 64.0Â°C
   D. 58.0Â°C **WASSCE**
3. The purpose of the constriction in a clinical thermometer is to
   A. prevent the mercury from expanding beyond the bulb.
   B. prevent the mercury from falling back into the bulb until required.
   C. enable the mercury to expand slowly.
   D. serve as the lower limit of the scale to be read. **WASSCE**
4. Which of the following statements about a gas thermometer and the liquid-in-glass thermometer is correct?
   A. Mercury thermometers cannot be calibrated against a constant gas thermometer.
   B. Mercury thermometers are much more accurate than the gas thermometers.
   C. Gas thermometers have a wider temperature range than mercury thermometers.
   D. Gas thermometers are less cumbersome than mercury-in-glass thermometers. **WASSCE**
5. Absolute zero temperature can be defined as the temperature
   A. at which the average kinetic energy of its particles making up a body is zero.
   B. at which pure water changes to ice at standard atmospheric pressure.
   C. of zero degree on the Celsius scale.
   D. at which pure water and steam co-exist. **WASSCE**
6. Mercury has an advantage over other liquids as thermometric liquid because it
   A. has low expansively.
   B. has higher conductivity.
   C. Vaporises easily.
   D. has relatively low freezing point. **WASSCE**

7. An ungraduated thermometer reads 2.0 cm and 12.0 cm at ice and steam points respectively. Determine the true temperature in Kelvin, when the thermometer reads 5.0 cm.

   A. 303.0 K
   B. 300.0 K
   C. 278.0 K
   D. 30.0 K

   WASSCE

8. A resistance thermometer has a resistance of 20 Î© at 0Â°C and 85 Î© at 100Â°C. If its resistance is 52 Î© in a medium, calculate the corresponding temperature.

   A. 49.2Â°C
   B. 60.6Â°C
   C. 80.0Â°C
   D. 84.7Â°C

   WASSCE

9. A short response time is obtained in a liquid-in-glass thermometer when the

   A. bulb is large and thick-walled.
   B. bulb is small and thick-walled.
   C. stem is long and thin.
   D. liquid is of high density and bore is large.
   E. bulb is thin-walled and the liquid is a good conductor of heat.

   NECO

10. Which of the following statements is the reason for using alcohol in preference to mercury as a thermometric liquid in cold regions?

    A. Alcohol is more sensitive to heat than mercury.
    B. Alcohol is transparent while mercury is opaque.
    C. The temperature range between the freezing and boiling points of alcohol is less than that of mercury.
    D. The freezing point of alcohol is lower than that of mercury.

    WASSCE

11. A faulty thermometer indicates – 0.4Â°C and 100.6Â°C at the ice and steam points respectively. What is the reading of this in a liquid whose true temperature is 80Â°C?

    A. 80.4Â°C
    B. 80.8Â°C
    C. 84.0Â°C
    D. 88.8Â°C

    WASSCE

12. An object is heated from 30Â°C to 57Â°C. The increase in its temperature on the Kelvin scale is

    A. 17 K
    B. 27 K
    C. 81 K

    WAEC

D. 246 K
E. 300 K

13. The sensitivity of a mercury-in-glass thermometer can be increased by
A. increasing the diameter of the bore.
B. decreasing the size of the bulb.
C. reducing the diameter of the bore.
D. holding the tip when in use.
E. increasing the length of the bore. **WAEC**

14. The average kinetic energy of the molecules of a perfect gas is directly propor-tional to the
A. pressure exerted by the gas
B. volume of the gas molecules
C. Kelvin temperature of the gas
D. volume of the gas container
E. Celsius temperature of the gas **WAEC**

15. Which statement about the concept of temperature is **NOT** true?
A. Temperature decides the direction of heat flow between two bodies.
B. Temperature is a measure of coldness of a body.
C. Temperature is a vector quantity.
D. Temperature is a measure of hotness of a body.
E. Temperature scales include Fahrenheit, Celsius and Kelvin. **NECO**

16. The clinical thermometer differs from other mercury-in-glass thermometers because it has
I a constriction
II a wide range
III a short range
IV a narrow bore.
Which of the above are correct?
A. I and II only.
B. I and III only.
C. III and IV only.
D. I, II and III only.
E. I, III and IV only. **NECO**

17. In the study of physics, temperature and heat are often confused with each other. Which of the following statements correctly defines these two elements?
A. Temperature is a measure of the average kinetic energy of the molecules of the substance.
B. Heat is a measure of the total kinetic energy of the **JAMB**

molecules in a system.

C. Different materials require different amounts of heat to cause a given change in temperature.

D. All of the above.

E. A and B only.

18. From the kinetic theory of gases, temperature is a

A. form of energy and is proportional to the total kinetic energy of the molecules.

B. form of energy and is proportional to the total kinetic average of the molecules.

C. physical property and is proportional to the total kinetic energy of the molecules.

D. physical property and is proportional to the average kinetic energy of the molecules. **JAMB**

19. The absolute temperature of a perfect gas is proportional to the average

A. potential energy of the molecules.

B. separation between the molecules.

C. kinetic energy of the molecules.

D. velocity of the molecules. **JAMB**

20. Absolute zero temperature is defined as the temperature at which

A. thermal motion ceases.

B. the temperature of a gas is 273Â°C.

C. ice melts.

D. the volume of gas is maximum.

E. the pressure of a real gas is maximum. **WAEC**

Essay questions

21. (a) Distinguish between *temperature* and *heat*. State the units in which they are measured.

(b) State two physical properties used for measuring temperature.

(c) (i) Describe with the aid of a diagram, how the upper fixed point is determined for a mercury-in-glass thermometer. State oneprecaution to ensure accurate results

(ii) State one advantage, which a constant volume gas thermometer has over other thermometers and one reason why it is seldom used as an every day laboratory instrument.

WAEC

22. Explain why it is not advisable to sterilize a clinical thermometer in boiling water at normal atmospheric pressure.

WAEC

23. (a) Distinguish between *heat and temperature.*

(b) State two physical properties of substances which may be used to measure temperature.

(c) State **two** reasons why mercury is preferred to alcohol as a thermometric liquid.

(d) (i) Describe how a mercury-in-glass thermometer is calibrated.

(ii) State two precautions necessary to obtain an accurate result.

WAEC

24. (i) Name four qualities of a good thermometer.

(ii) State one advantage which a constant volume gas thermometer has over other thermometers and one reason why it is seldom used as an every day laboratory instrument.

(iii) The pressure at the ice point for a constant volume gas is 4.81 Ã— 10^4 Pa while that at the steam point is 6.48 Ã— 10^4 Pa. What pressure will this thermometer indicate at 50Â°C?

WASSCE

25. (a) Distinguish between quantity of heat in a given body and the temperature of the same body. What factors determine quantity of heat possessed by a body?

(b) State three possible ways, other than by expansion, in which the addition of heat can affect a substance.

WAEC

26. (a) Define the terms

(i) *ice point*

(ii) *steam point.*

(b) (i) What is meant by *thermometric property?*

(ii) State **three** thermometric properties.

(c) The resistance in the element in a platinum resistance thermometer is 6.750 Î© at 0Â°C, 7.750 Î© at 100Â°C and 6.900 Î© at room temperature. Determine the room temperature on the scale of the resistance thermometer.

WASSCE