1. *Fill in the blank spaces with appropriate words given within the brackets.*

(i) *Pressure remaining constant, the ___________ (mass/volume) of an enclosed gas is directly proportional to the kelvin temperature.*

(ii) *The product of pressure and volume of a given mass of an enclosed gas at a fixed temperature is a constant quantity. This law was stated by __________ (Charles/Boyle).*

(iii) *At kelvin zero the molecular motion is ________ (zero/maximum).*

(iv) *1K rise in temperature is equal to ______ °C (1/274) rise in temperature.*

(v) *100K is equal to ___________ °C (–173°C / 100°C).*

Ans. **(i)** volume **(ii)** Boyle **(iii)** zero **(iv)** 1 **(v)** – 173°C

2. Match the statements in Column A with the statements in Column B.

Column A	*Column B*
(i)Thermometeric scale having lowest temperature zero K	*Boyle's law*
(ii) A relation between pressure and volume at constant temperature	*Perfect gas equation*
(iii) A temperature at which molecular motion stops	*Kelvin scale*
(iv) A relation between volume and temperature at constant pressure	*Kelvin zero*
(v)Relation between pressure, volume and temperature of a gas	*Charles' law*

Ans. **(i)** Kelvin scale **(ii)** Boyle's law **(iii)** Kelvin zero **(iv)** Charles' law **(v)** Perfect gas equation

3. Statements given below are incorrect. Write the correct statements.

(i) Temperature remaining constant, the volume of a fixed mass of gas is directly proportional to pressure.

(ii) Pressure remaining constant, the volume of a fixed mass of a gas is inversely proportional to celsius temperature.

(iii) The zero degree celsius is the temperature at which the molecules of a gas have zero kinetic energy.

(iv) *Rise in temperature of 1 K is equal to rise in temp of 274°C.*

(v) *The standard pressure of a gas is 760 cm of mercury.*

Ans. **(i)** Temperature remaining constant, the volume of a fixed mass of a gas is **inversely** proportional to pressure.

(ii) Pressure remaining constant, the volume of a fixed mass of a gas is **directly** proportional to kelvin temperature.

(iii) The zero **kelvin** is the temperature at which the molecules of a gas have zero kinetic energy.

(iv) Rise in temperature of 1K is equal to rise in temperature of **1°C.**

(v) The standard pressure of a gas is **76 cm** of mercury.

4. *On the basis of the kinetic model, state two special properties which differentiate gases from solids and liquids.*

Ans. Properties of gases which differentiate them from solids or liquids :

(i) The distance between any two molecules of a gas is far larger, than that of solids and liquids, with the result that the force of attraction between the molecules is almost negligible.

(ii) The molecules of a gas move constantly in a straight line, unless they collide with other molecules. These collisions are random and hence the molecules move in all possible directions in straight lines.

5. *State whether the statements given below are true or false.*

(i) *Gases exert same pressure in all directions.*

(ii) *Gases are not compressible.*

(iii) *Gases have definite shape, but no definite volume.*

(iv) *Gases diffuse easily in one another.*

(v) *Gases can occupy any amount of space.*

(vi) *Gases have higher density as compared to other states of matter.*

Ans.(i) True **(ii)** False **(iii)** False **(iv)** True **(v)** True **(vi)** False.

6. **(*a)*** *Define Boyle's law.*

(b) *State Boyle's law equation, giving the meaning of each symbol.*

(c) *The product of pressure and volume for a given mass of an enclosed gas is a constant quantity at some fixed temperature. Is this statement true? Which physical law about gases represents the above statement.*

Ans. (a) Boyle's law : The temperature of an enclosed mass of a gas remaining constant, its volume is inversely proportional to pressure.

Or

The product of pressure and volume of a given mass of an enclosed gas at a constant temperature is always a constant quantity.

(b) Boyle's law equation : $P_1V_1 = P_2V_2$

Where P_1 is initial pressure, V_1 is initial volume, P_2 is final pressure and V_2 is final volume for an enclosed gas whose temperature remains constant.

(c) The statement is true. The statement represents Boyle's law.

7. *A gas occupies 75 litres at a pressure of 700 mm of mercury. Calculate the pressure, if volume increases to 100 litres, the temperature remaining constant.*

Ans. Initial volume $(V_1) = 75\ l$.

Initial pressure (P_1) = 700 mm

Final volume (V_2) = 100 *l*.

Final pressure (P_2) **=**

$\frac{P_1V_1}{V_2} = \frac{700 \times 75}{100}$ = **525 mm of mercury.**

8. Calculate the pressure of a gas, when its volume is 750 ml, initially the gas having a volume of 1250 ml and pressure 0.8 atmospheres. Assume the temperature is constant.

Ans. Initial volume (V_1) = 1250 ml.

Initial pressure (P_1) = 0.8 atms.

Final volume (V_2) = 750 ml.

Final pressure (P_2) = $\frac{P_1V_1}{V_2} = \frac{0.8 \times 1250}{750}$ = **1.33 atms.**

9. 5 dm^3 of dry oxygen is allowed to expand to 7 m^3, when the pressure recorded is 700 mm of mercury. Find the initial pressure of the gas, assuming temperature remains constant.

Ans. Final volume (V_2) = 7 m^3

Final pressure (P_2) = 700 mm

Initial volume (V_1) = 5m^3

Initial pressure (P_1) = $\frac{P_2V_2}{V_1} = \frac{700 \times 7}{5}$ = **980 mm of mercury.**

10. At a constant temperature, a gas at a pressure of 1200 mm of mercury occupies a volume of 1500 cm3. If the volume is decreased by 30%, calculate the new pressure.

Ans. Initial volume (V_1) = 1500 cm^3

Initial pressure (P_1) = 1200 mm

Final volume (V_2) = $\left(1500 - 1500 \times \frac{30}{100}\right)$ cm^3 = 1050 cm^3

Final pressure (P_2) = $\frac{P_1V_1}{V_2} = \frac{1200 \times 1500}{1050}$ = **1714.29 mm of mercury.**

11. A dry gas occupies 224 cm3 at normal pressure. If the volume increases by 25%, find the new pressure of the gas, assuming temperature remain constant.

Ans. Initial volume $(V_1) = 224\ cm^3$

Initial pressure $(P_1) = 76$ cm of mercury

Final volume $(V_2) = \left(224 + 224 \times \frac{25}{100}\right) = 280\ cm^3$

Final pressure $(P_2) = \frac{P_1V_1}{V_2} = \frac{76 \times 224}{280} = \mathbf{60.8\ cm\ of\ mercury.}$

12. The volume of a certain gas was found to be 11.2 dm3,when the pressure was 1.5 atms. If the pressure increases by 30%, calculate the new volume of the gas.

Ans. Initial volume $(V_1) = 11.2\ dm^3$

Initial pressure $(P_1) = 1.5$ atms.

Final pressure $(P_2) = \left(1.5 + 1.5 \times \frac{30}{100}\right) = 1.95$ atms.

Final volume $(V_2) = \frac{P_1V_1}{P_2} = \frac{1.5 \times 11.2}{1.95} = \mathbf{8.615\ dm^3.}$

13. The volume of a certain gas was found to be 560 cm3, when the pressure was 600 mm. If the pressure decreases by 40 %, find the new volume of the gas.

Ans. Initial volume $(V_1) = 560\ cm^3$

Initial pressure $(P_1) = 600$ mm

Final pressure $(P_2) = \left(600 - 600 \times \frac{40}{100}\right) = 360$ mm

Final volume $(V_2) = \frac{P_1V_1}{P_2} = \frac{600 \times 560}{360} = \mathbf{933.3\ cm^3.}$

14. 10 dm3 of oxygen is contained in a vessel at a pressure of 20 atms. If another evacuated vessel of similar capacity is connected to it, calculate the common pressure of the gas in both the vessels.

Ans. Initial volume $(V_1) = 10\ dm^3$

Initial pressure $(P_1) = 20$ atms.

Final volume $(V_2) = (10 + 10) = 20\ dm^3$

Final pressure $(P_2) = \frac{P_1V_1}{P_2} = \frac{20 \times 10}{20} = \mathbf{10\ atms.}$

15. A vessel of capacity 6 dm3 contains nitrogen gas at a pressure of 152 cm of mercury. If this vessel is connected to another evacuated vessel of 3 dm3 capacity, what will be the pressure of nitrogen in both the vessels?

Ans. Initial volume (V_1) = 6 dm^3

Initial pressure (P_1) = 152 cm

Final volume (V_2) = (6 + 3) = 9 dm^3

Final pressure (P_2) = $\frac{P_1V_1}{V_2} = \frac{152 \times 6}{9}$ = **101.33 cm of mercury.**

16. **(a)** Define kelvin zero and kelvin scale of temperature.

(b) What do you understand by the term standard temperature? Express its value on the kelvin scale.

(c) Convert the following celsius temperature into kelvin. (1) – 163 °C (2) 127 °C

(d) Convert the following kelvin temperatures to celsius. (1) 210 K (2) 573 K.

Ans. (a) Absolute zero or kelvin zero : The theoretical temperature, at which the molecules of a gas have zero kinetic energy (i.e., they stop vibrating) is called kelvin zero.

Zero kelvin = – 273 °C

Kelvin scale or absolute scale of temperature : A temperature scale on which the lowest temperature is zero kelvin is called kelvin scale.

Temp. on kelvin scale = 273 + temperature on celsius scale

or K = 273 + °C

(b) 0 °C is called standard temperature. Its value on kelvin scale is 273 K.

(c) (1) Kelvin temp. = 273 + °C = 273 + (–163) = 110 K

(2) Kelvin temp. = 273 + °C = 273 + 127 = 400 K

(d) (1) Temp. in °C = K – 273 = 210 – 273 = – 63 °C

(2) Temp. in °C = K– 273 = 573 – 273 = 300 °C

17. ***(a)*** *Define Charles' law.*

b) *State Charles' law equation, stating clearly the meaning of the symbols used.*

Ans. (a) Charles' law : Pressure of a given mass of an enclosed gas remaining constant, its volume is directly proportional to its kelvin temperature**.**

(b) Charles' law equation : $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ where V_1 is initial volume, T_1 is initial temperature on the kelvin scale; V_2 is final volume and T_2 is final temperature on the kelvin scale for an enclosed gas whose pressure remains constant.

18. A gas occupies 200 cm^3 at a temperature of 27 °C and 76 mm pressure of mercury. Find its volume at –3 °C and 76 cm of mercury.

Ans. Initial volume $(V_1) = 200\ cm^3$

Initial temp. $(T_1) = (273 + 27\ °C) = 300\ K$

Final temp. $(T_2) = (273 - 3\ °C) = 270\ K$

$$\therefore \text{Final volume } (V_2) = \frac{V_1}{T_1} \times T_2 = \frac{200 \times 270}{300} = \mathbf{180\ cm^3}.$$

19. A gas at constant pressure occupies a volume of 300 cm3, at a temperature of –73 °C. Find its volume at 127 °C, pressure remaining constant.

Ans. Initial volume (V1) = 300 cm3

Initial temp. (T1) = (273 – 73°C) = 200 K.

Final temp. (T2) = (273 + 127°C) = 400 K.

$$\therefore \text{Final volume } (V_2) = \frac{V_1}{T_1} \times T_2 = \frac{300 \times 400}{200} = \mathbf{600\ cm^3}.$$

20. A gas occupies 150 cm3 at 57°C. Find the temperature to which the gas must be heated, so that its volume triples, without any change in pressure.

Ans. Initial volume $(V_1) = 150\ cm^3$

Initial temp. $(T_1) = (57\ °C + 273\ °C) = 330\ K$

Final volume $(V_2) = 3 \times 150 = 450\ cm^3$

$$\therefore \text{Final temp. } (T_2) = V_2 \times \frac{T_1}{V_1} = \frac{450 \times 330}{150} = \mathbf{990\ K}.$$

$\therefore$ Temp. in °C = (990 – 273) = **717 °C.**

21. A gas occupies a volume of 400 cm3. On heating at 127 °C its volume becomes 1600 cm^3. Find the initial temperature of the gas on Celsius scale. Assume pressure remains constant.

Ans. Final volume of gas $(V_2) = 1600\ cm^3$

Final temp. of gas $(T_2) = (273 + 127\ °C) = 400\ K$

Initial volume of gas $(V_1) = 400\ cm^3$

$$\text{Initial temperature of gas } (T_1) = \frac{V_1 \times T_2}{V_2} = \frac{400 \times 400}{1600} = 100\ K$$

$\therefore$ Temperature in °C = (100 – 273) = **–173 K.**

22. To what temperature must a gas at 127 °C be cooled, so that its volume is reduced to 1/5 of its initial volume? Assume pressure remains constant.

Ans. Let initial volume $(V_1) = x$

Initial temp. $(T_1) = (273 + 127\ °C) = 400\ K$

Final volume $(V_2) = \frac{x}{5}$

Final temp. $(T_2) = \frac{V_2}{V_1} \times T_1 = \frac{x \times 400}{5 \times x} = 80\ K$

$\therefore$ Temperature in °C = (80 – 273) = **–193 °C.**

23. At a constant pressure, a gas at –33 °C is heated to 127 °C. Find the percentage increase in volume of the gas.

Ans. Let initial volume of gas $(V_1) = x$

Initial temp. $(T_1) = (273 - 33) = 240\ K$

Final temp. $(T_2) = (273 + 127) = 400\ K$

Final volume $(V_2) = \frac{V_1}{T_1} \times T_2 = \frac{x \times 400}{240}$

$\therefore$ Increase in volume $= \frac{5}{3}x - x = \frac{2}{3}x$

$\therefore$ % age increase in volume $= \frac{2x}{3x} \times 100 =$ **66.67%.**

24. ***(a)*** *What do you understand by the term S.T.P.?*

(b) *State the perfect gas equation, stating clearly the meaning of the symbols used.*

Ans. (a) Standard temperature and pressure (S.T.P) : A temperature of 0 °C (273K) is called standard temperature and a pressure of 76 cm of mercury (760 mm of Hg) is called standard pressure.

(b) Perfect gas equation : An equation which unites Boyle's law and Charles' law is called perfect gas equation. According to this equation $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$, where P_1 is initial pressure, V_1 is initial volume and T_1 is inital temperature on kelvin scale, V_2 is final volume, P_2 is final pressure and T_2 is final kelvin temperature for an enclosed gas.

25. A gas occupies 1.12 dm^3 at a temperature of 127 °C and pressure 800 mm of mercury. Calculate its volume at S.T.P.

Ans. Initial pressure (P_1) = 800 mm   Final pressure (P_2) = 760 mm

Initial volume (V_1) = 1.12 dm^3 Final volume (V_2) = ?

Initial temp. (T_1) = (273 + 127°C) = 400 K

Final temp. (T_2) = (273 + 0) = 273 K

$$\therefore \quad V_2 = \frac{P_1V_1}{T_1} \times \frac{T_2}{P_2} = \frac{800 \times 1.12}{400} \times \frac{273}{760} = \mathbf{0.8046\ dm^3.}$$

26. A gas occupies 560 cm3 at S.T.P., find its volume when :

(a) pressure is 700 mm of mercury and temperature is 27 °C.

(b) pressure is 800 mm of mercury and temperature is –173 °C.

Ans.(a) Initial pressure (P_1) = 760 mm Final pressure (P_2) = 700 mm.

Initial volume (V_1) = 560 cm^3 Final volume (V_2) = ?

Initial temp. (T_1) = 273 K   Final temp. (T_2) = (273 + 27°C) = 300 K

$$V_2 = \frac{P_1V_1}{T_1} \times \frac{T_2}{P_2} = \frac{760 \times 560}{273} \times \frac{300}{700} = \mathbf{668.13\ cm^3.}$$

(b) Initial pressure (P_1) = 760 mm   Final pressure (P_2) = 800 mm

Initial volume (V_1) = 560 cm^3 Final volume (V_2) = ?

Initial temp. (T_1) = 273 K   Final temp. (T_2) = (273–173°C) = 100K.

$$V_2 = \frac{P_1V_1}{T_1} \times \frac{T_2}{P_2} = \frac{760 \times 560}{273} \times \frac{100}{800} = \mathbf{194.87\ cm^3.}$$

27. At 0 °C and 760 mm mercury pressure, a gas occupies a volume of 100 cm3. The Kelvin temperature of the gas is increased by 1/5, while pressure is increased by one and a half times. Calculate the final volume of the gas.

Ans. Initial pressure (P_1) = 760 mm

Final pressure (P_2) = 760 × 1.5 = 1140 mm

Initial volume (V_1) = 100 cm^3 Final volume (V_2) = ?

Initial temp. (T_1) = 273 K   Final temp. (T_2) = $(273 + \frac{1}{5} \times 273)$ = 327.6 K

$$\therefore \quad V_2 = \frac{P_1V_1}{T_1} \times \frac{T_2}{P_2} = \frac{760 \times 100 \times 327.5}{273 \times 1140} = \mathbf{79.97\ cm^3.}$$