New Simplified Chemistry Class 9 ICSE Solutions Study of Gas Laws

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Viraf J Dalal Chemistry Class 9 Solutions and Answers

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Exercise

Question 1.(1988)
"When stating the volume of a gas the pressure and temperature should also be given". Why ?
Answer:
Volume of a gas under goes significant change if its pressure or temperature is slightly changed.

Question 1.(1989)
Define or state : Boyle's Law
Answer:
Boyle's Law : "Temperature remaining constant the volume of a given mass of dry gas is inversely proportional to its pressure."

$$V \propto \frac{1}{P} = T = \text{Constant}$$

Question 2.(1989)
Express Kelvin Zero in °C
Answer:
Kelvin zero or absolute zero = — 273°C.

Question 1.(1992)

A fixed volume of a gas occupies 760cm^3 at 27° C and 70cm of Hg. What will be its vol. at s.t.p. [637 cm^3]

Answer:

P_1 = 70 cm of Hg
V_1 = 760 cm^3
T_1 = 27°C = (27 + 273) K

P_2 = 76 cm of Hg
V_2 = ?
T_2 = 273 K

Using the gas equation, $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$$\frac{70 \times 760}{300} = \frac{76 \times V_2}{273}$$

$$\therefore V_2 = \frac{70 \times 760 \times 273}{300 \times 76} = 637 \text{ cm}^3$$

Question 1.(1993)

State : Boyle's Law

Answer:

Boyle's Law : "Temperature remaining constant the volume of a given mass of dry gas is inversely proportional to its pressure."

$$V \propto \frac{1}{P} = T = \text{Constant}$$

Question 1.(1995)

At 0°C and 760 mm Hg pressure, a gas occupies a volume of 10Q cm^3. The Kelvin temperature (Absolute temperature) of the gas is increased by one-fifth while the pressure is increased one and a half times. Calculate the final volume of the gas. [80 cc.]

Answer:

Initial conditions

P_1 = 760
V_1 = 100
T_1 = 0 + 273 = 273 K

Final conditions

$P_2 = 760 \times \frac{3}{2} = (380 \times 3)$
V_2 = ?
$T_2 = 273 \times \frac{1}{5} + 273$
$= 273 \times \frac{6}{5}$

Using gas equation $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$$\therefore V_2 = \frac{P_1V_1T_2}{T_1P_2}$$

$$V_2 = \frac{760 \times 100}{273 \times 380 \times 3} \times \frac{273 \times 6}{5} = 80\text{c.c}$$

Question 1.(1996)

The pressure on one mole of gas at s.t.p. is doubled and the temperature is raised to 546 K. What is the final volume of the gas ? [one mole of a gas occupies a volume of 22.4 litres at stp.] [22.4 ltrs.]

Answer:

One mole of gas occupies a volume of 22.4 lit. at s.t.p.

$\therefore V_1 = 22.4$ lit. $\qquad V_2 = ?$

$P_1 = 1$ atm. $\qquad P_2 = 2$ atm.

$T_1 = 273$ K $\qquad T_2 = 546$ K

Using gas equation $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$$V_2 = \frac{P_1V_1T_2}{T_1P_2} = \frac{1\times22.4\times546}{273\times2} = 22.4 \text{ lits.}$$

Question 1.(1997)

Is it possible to change the temperature and pressure of a fixed mass of gas without changing its volume. Explain your answer.

Answer:

No, it is not possible as change of any one of the parameters (pressure or temperature) has significant effect on volume.

Additional Questions

Question 1.

What volume will a gas occupy at 740 mm pressure which at 1480 nun occupies 500 cc ? [Temperature being constant] [1000 cc]

Answer:

$P_1V_1 = P_2V_2$

$1480 \times 500 = 740 V_2$

$$\therefore V_2 = \frac{1480\times500}{740} = 1000 \text{c.c}$$

Question 2.

The volume of a given mass of a gas at 27°C is 100 cc. To what temperature should it be heated at the same pressure so that it will occupy a volume of 150 cc ?[177°C]

Answer:

$V_1 = 100$ cc $\qquad V_2 = 150$ cc

$T_1 = 27 + 273 = 300$ K $\qquad T_2 = ?$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \therefore T_1V_2 = V_1T_2 \therefore T_2 = \frac{T_1V_2}{V_1}$$

$$\therefore T_2 = \frac{150\times300}{100} = 450 \text{ K}$$

$$\therefore T_2 = 450 - 273 = 177°\text{C}$$

Question 3.

A fixed mass of a gas has a volume of 750 cc at—23°C and 800 mm pressure. Calculate the pressure for which its volume will be 720 cc. The temperature being —3°C. [900mm]

Answer:

$V_1 = 750cc$ $\quad$ $V_2 = 720cc$

$T_1 = -23 + 273 = 250K$ $\quad$ $T_2 = -3 + 273 = 270K$

$P_1 = 800 \text{ mm}$ $\quad$ $P_2 = ?$

Using gas equation $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$$P_2 = \frac{P_1V_1T_2}{T_1P_2} = \frac{800\times750\times270}{250\times720}$$

$P_2 = 900 \text{ mm}$

Question 4.

What temperature would be necessary to double the volume of a gas initially at s.t.p. if the pressure is decreased by 50% ? [0°C]

Answer:

$P_1 = 1 \text{ atm}$ $\quad$ $P_2 = 1 \times \frac{50}{100} = \frac{1}{2} \text{ atm.}$

$V_1 = xcc$ $\quad$ $V_2 = 2xcc$

$T_1 = 273K$ $\quad$ $T_2 = ?$

Using gas equation $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$$\therefore T_2 = \frac{P_2V_2T_1}{P_1V_1}$$

$$T_2 = \frac{1}{2} \times \frac{2x\times273}{1\times x} = 273K$$

$T_1 = 273 - 273 = 0°C$

Question 5.

A gas cylinder having a capacity of 20 litres contains a gas at 100 atmos. How many flasks of 200 cm^3 capacity can be filled from it at 1 atmos. pressure if the temperature remains constant ? [10,000]

Answer:

$V_1 = 20 \text{ lits.} = 20{,}000cc$ $\quad$ $V_2 = ?$

$P_1 = 100 \text{ atm.}$ $\quad$ $P_2 = 1 \text{ atm.}$

At constant temperature

$P_1V_1 = P_2V_2$

$$V_2 = \frac{P_1V_1}{P_2} = \frac{100\times20000}{1} = 2000000cc$$

$\therefore$ Number of flasks of capacity 200cc

$n \times 200 = 2000000$

$$n = \frac{2000000}{200} = 10000 \text{ flasks}$$

Question 6.

A certain mass of gas occupied 850 ml at a pressure of 760 mm of Hg. On increasing the pressure it was found that the volume of the gas was 75% of its initial value. Assuming constant temperature, find the final pressure of the gas? [1013.33 mm of Hg]

Answer:

$V_1 = 850$ ml $\qquad V_2 = 850 \times \frac{75}{100} = \frac{850 \times 3}{4}$ ml

$P_1 = 760$ mm of Hg $\qquad P_2 = ?$

At constant temperature $P_1V_1 = P_2V_2$

$$\therefore P_2 = \frac{P_1V_1}{V_2} = \frac{760 \times 850 \times 4}{850 \times 3}$$

$$P_2 = \frac{3040}{3} = 1013.33 \text{ mm of Hg}$$

Question 7.

It is required to reduce the volume of a gas by 20% by compressing it at a constant pressure. To do so, the gas has to be cooled. If the gas attains a final temperature of 157°C, find the initial temperature of the gas ? [264.5°C]

Answer:

Initial conditions $\qquad$ Final conditions

$V_1 = x$cc (suppose) $\qquad V_2 = \frac{80}{100}x = \frac{4}{5}x$cc

$T_1 = ?$ $\qquad T_2 = 157 + 273 = 430$K

At constant pressure $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

$$\therefore T_1 = \frac{V_1T_2}{V_2} = \frac{x \times 430}{\frac{4}{5}x} = \frac{430 \times 5}{4}$$

$$T_1 = 537.5\text{K} = 537.5 - 237 = 264.5°\text{C}$$

Question 8.

At a given temperature the pressure of a gas reduces to 75% of its initial value and the volume increases by 40% of its initial value. Find this temperature if the initial temperature was —10°C. [3.15°C]

Answer:

$P_1 = 1$ atm. $\qquad P_2 = \frac{75}{100} \times 1 = \frac{3}{4}$ atm.

$V_1 = x$cc (suppose) $\qquad V_2 = \frac{140}{100}x = \frac{7}{5}x$

$T_1 = -10 + 273 = 263K$ $T_2 = ?$

Using gas equation $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$$\therefore T_2 = \frac{P_2V_2T_1}{P_1V_1} = \frac{3}{4} \times \frac{7x}{5} \times \frac{263}{1 \times x} = \frac{5523}{20}$$

$$T_2 = \frac{552.3}{2} = 276.15K = 276.15 - 273$$

$$\therefore T_2 = 3.15°C$$

Study Of Gas Laws – Unit Test Paper 7

Q.1. Name or state the following :

Question 1.
The law which states that pressure remaining constant the volume of a given mass of dry gas is directly proportional to its absolute [Kelvin] temperature.
Answer:
Charle's Law.

Question 2.
The law which studies the relationship betweeir pressure of a gas and the volume occupied by it at constant temperature.
Answer:
Boyle's Law.

Question 3.
An equation used in chemical calculations which gives a simultaneous effect of changes of temperature and pressure on the volume of a given mass of dry gas
Answer:
Gas equation.

Question 4.
The standard pressure of a gas in cm. of mercury corresponding to one atmospheric pressure.
Answer:
76 cm.

Question 5.
The absolute temperature value corresponding to 35°C.
Answer:
35 + 273 = 308K

Q.2. Give reasons for the following :

Question 1.

Gases unlike solids and liquids exert pressure in all directions.

Answer:

Impact of gas molecules with high velocity causes pressure to be exerted on the walls.

Question 2.

Gases have lower densities compared to solids or liquids.

Answer:

Gases have low densities as the inter-molecular distance between the molecules of gases is very large.

$$\text{Pressure on the wall} = \frac{\text{Force exerted on the wall}}{\text{Total area of the container wall}}$$

Question 3.

Temperature remaining constant the product of the vol. & the press, of a given mass of dry gas is a constant.

Answer:

According to Boyle's Law $V \propto \frac{1}{p}$

$$V = K.\frac{1}{p}$$

$\therefore$ $P \times V = K$ = a constant

$\therefore$ Product of volume and pressure of a given mass of dry gas is constant. [at constant temperature]

Question 4.

All temperatures on the Kelvin scale are in positive figures.

Answer:

All temperatures on the Kelvin scale are in positive figures.

The temperature -273°C = OK [Absolute zero or zero Kelvin]

Hence it may be negative or positive on Celsius scale, it is always positive on Kelvin as 0°C = 0 + 273 = 273K

30°C = 30 + 273 = 303 K

– 70°C = – 70+ 273;= 203 K

– 273°C = – 273 + 273 = 0K

Question 5.

Volumes of gases are converted into s.t.p. conditions and then compared.

Answer:

Volumes of gases are converted into s.t.p. conditions and then compared as

volumes of gases change with temperature and pressure – hence a standard value of temperature and pressure is chosen to which gas volumes are referred.

Q.3. Calculate the following :

Question 1.

Calculate the temperature to which a gas must be heated, so that the volume triples without any change in pressure. The gas is originally at 57"C and having a volume 150 cc.

Answer:

V_1 = 150cc V_2 = 3 × 150cc
T_1 = (57 + 273) = 330K T_2 = ?

At constant pressure $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ ∴ $T_2 = \frac{V_2 T_1}{V_1}$

$$T_2 = \frac{(3 \times 150) \times 330}{150} = 990K = 990 - 273 = 717°C$$

Question 2.

A gas 'X' at -33°C is heated to 127° C at constant pressure. Calculate the percentage increase in the volume of the gas.

Answer:

Let V_1 = xcc V_2 = ?
T_1 = -33 + 273 = 240K T_2 = 127 + 27. = 400K

At constant pressure $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

$$\therefore V_2 = \frac{V_1 T_2}{T_1} = \frac{x \times 400}{240} = \frac{5x}{3} cc$$

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

$$\therefore \% \text{ increase} = \frac{2x}{3x} \times 100 = \frac{200}{3} = 66\frac{2}{3}\%$$

Question 3.

Calculate the volume of a gas 'A' at s.t.p., if at 37°C and 775 mm of mercury pressure, it occupies a volume of 9 1/2 litres.

Answer:

Original conditions

$T_1 = 37 + 273 = 310K$

$P_1 = 775$ mm

$V_1 = 9\frac{1}{2}$ litres

Final conditions

$T_2 = 273K$

$P_2 = 760$ mm

$V_2 = ?$

Using gas equation $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$$\therefore V_2 = \frac{P_1V_1T_2}{T_1P_2}$$

$$V_2 = \frac{775 \times 19 \times 273}{310 \times 2 \times 760} = 17\frac{1}{16} \text{ litres}$$

Question 4.

Calculate the temperature at which a gas 'A' at 20°C having a volume, of 500 cc. will occupy a volume of 250 cc.

Answer:

Initial conditions

$T_1 = 20 + 273 = 293K$

$V_1 = 500$ c.c

Final conditions

$T_2 = ?$

$V_2 = 250$ cc

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \therefore T_2 = \frac{T_1V_2}{V_1} = \frac{293 \times 250}{500}$$

$$T_2 = 146.5K = 146.5 - 273 = -126.5°C$$

Question 5.

A gas 'X' is collected over water at 17°C and 750 mm. pressure. If the volume of the gas collected is 50 cc., calculate the volume of the dry gas at s.t.p. [at 17°C the vapour pressure is 14 mm.]

Answer:

Initial conditions

$T_1 = 17 + 273 = 290K$

$P_1 = 750$ mm $- 14$ mm

$V_1 = 50$ cc

Final conditions

$T_2 = 273K$

$P_2 = 760$ mm

$V_2 = ?$

Using gas equation $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$$\therefore V_2 = \frac{P_1V_1T_2}{T_1P_2} = \frac{736 \times 50 \times 273}{290 \times 760} = 45.58$$

$\Rightarrow 45.6$ cc

Q.4. Assuming temperature remaining constant calculate the pressure of the gas in each of the following :

Question 1.

The pressure of a gas having volume 1000 cc. originally occupying 1500 cc. at 720 mm. pressure.

Answer:

$P_1 = 720$ mm $\quad P_2 = ?$

$V_1 = 1500$ cc $\quad V_2 = 1000$ cc

At constant temperature $P_1V_1 = P_2V_2$

$$\therefore P_2 = \frac{P_1V_1}{V_2} = \frac{720 \times 1500}{1000} = 1080 \text{ mm}$$

Question 2.

The pressure of a gas having volume 100 lits. originally occupying 75 dm^3 at 700 mm. pressure.

Answer:

$P_1 = 700$ mm $\quad P_2 = ?$

$V_1 = 75$ dm^3 $\quad V_2 = 100$ lits But 1 dm^3 = 1 litre

$\therefore V_2 = 100$ dm^3

At constant temperature $P_1V_1 = P_2V_2$

$$\therefore P_2 = \frac{P_1V_1}{V_2} = \frac{700 \times 75}{100} = 525 \text{ mm}$$

Question 3.

The pressure of a gas having volume 380 lits. originally occupying 800 cm^3 at 76 cm. pressure.

Answer:

$V_1 = 800$ cm^3 $\quad V_2 = 380$ lit. $= 380 \times 1000$ cm^3

$P_1 = 76$ cm $\quad P_2 = ?$

At constant temperature $P_1V_1 = P_2V_2$

$$\therefore P_2 = \frac{P_1V_1}{V_2} = \frac{76 \times 800}{380 \times 1000} = 0.16 \text{ cm of Hg}$$

Question 4.

The pressure of a gas having volume 1800 ml. originally occupying 300 ml. at 6 atms. pressure.

Answer:

$V_1 = 300$ ml $\quad V_2 = 1800$ ml

$P_1 = 6$ atm. $\quad P_2 = ?$

At constant temperature $P_1V_1 = P_2V_2$

$$\therefore P_2 = \frac{P_1V_1}{V_2} = \frac{6 \times 300}{1800} = 1 \text{ atm.}$$

Question 5.

The pressure of a gas having volume 1500 cm^3 originally occupying 750 cc. at 5 ats. pressure.

Answer:

$V_1 = 750$ cc $\quad V_2 = 1500$ cc

$P_1 = 5$ atm. $\quad P_2 = ?$

At constant temperature $P_1V_1 = P_2V_2$

$$\therefore P_2 = \frac{P_1V_1}{V_2} = \frac{5 \times 750}{1500} = \frac{5}{2} = 2.5 \text{ atm.}$$

Q.5. Calculate the following :

Question 1.
The temp, at which 500 cc. of a gas 'X' at temp. 293K occupies half it's original volume [pressure constant].

Answer:

$V_1 = 500$ cc $\quad V_2 = \frac{500}{2} = 250$ cc

$T_1 = 293K \quad T_2 = ?$

At constant pressure

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$\therefore T_2 = \frac{T_1V_2}{V_1} = \frac{293 \times 250}{500} = 146.5K$$

$$= 146.5 - 273 = -126.5°C$$

Question 2.
The volume at s.t.p. occupied by a gas "Y" originally occupying 760 cc. at 300K and 70 cm. press, of Hg.

Answer:

$P_1 = 70$ cm $\quad P_2 = 76$ cm

$V_1 = 760$ cc $\quad V_2 = ?$

$T_1 = 300K \quad T_2 = 273K$

Using gas equation $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$$\therefore V_2 = \frac{P_1V_1T_2}{T_1P_2} = \frac{70 \times 760 \times 273}{300 \times 76} = 637$$

$$\therefore V_2 = 637 \text{ c.c}$$

Question 3.
The volume at s.t.p. occupied by a gas 'Z' originally occupying 1.57 dm^3 at 310.5K and 75 cm. press. of Hg.

Answer:

Initial conditions

$V_1 = 1.57\ dm^3$

$P_1 = 75\ cm$

$T_1 = 310.5K$

Final conditions

$V_2 = ?$

$P_2 = 76\ cm$

$T_2 = 273K$

Using gas equation $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$$\therefore\ V_2 = \frac{P_1V_1T_2}{T_1P_2} = \frac{75 \times 1.57 \times 273}{310.5 \times 76} = 1.36\ dm^3$$

Question 4.

The volume at s.t.p. occupied by a gas 'Q' originally occupying 153.7 cm^3 at 287K and 750 mm. pressure [vapour pressure of gas 'Q' at 287K is 12 mm of Hg.]

Answer:

Initial conditions

$V_1 = 153.7\ cm^3$

$P_1 = 750\ mm - 12 = 738\ mm$

$T_1 = 287K$

Final conditions

$V_2 = ?$

$P_2 = 760\ mm$

$T_2 = 273K$

Using gas equation $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$$\therefore\ V_2 = \frac{P_1V_1T_2}{T_1P_2} = \frac{738 \times 153.7 \times 273}{287 \times 760} = 141.707\ cm^3$$

Question 5.

The temperature to which a gas 'P' has to be heated to triple it's volume, if the gas originally occupied 150 cm^3 at 330K [pressure remaining constant].

Answer:

$T_1 = 330K$

$V_1 = 150\ cm^3$

$T_2 = ?$

$V_2 = 3 \times 150 = 450\ cm^3$

At constant pressure $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

$$\therefore\ T_2 = \frac{T_1V_2}{V_1} = \frac{330 \times 450}{150} = 990K$$

$$\Rightarrow\ T_2 = 990 - 273 = 717^\circ C$$

Q.6. Fill in the blanks with the correct word, from the words in bracket :

Question 1.

If the temperature of a fixed mass of a gas is kept constant and the pressure is increased, the volume correspondingly ____ [increases / decreases]

Answer:

If the temperature of a fixed mass of a gas is kept constant and the pressure is increased, the volume correspondingly **decreases.**

Question 2.
If the pressure of a fixed mass of a gas is kept constant and the temperature is increased, the volume correspondingly ____ [increases / decreases]
Answer:
If the pressure of a fixed mass of a gas is kept constant and the temperature is increased, the volume correspondingly **increases.**

Question 3.
1 dm3 of a gas is equal to ____ [1 litre / 100ml. / 100 cc.]
Answer:
1 dm3 of a gas is equal to **1 litre.**

Question 4.
All the temperature on the kelvin scale are in ____ figures [negative positive]
Answer:
All the temperature on the kelvin scale are in **positive** figures.

Question 5.
At -273°C the volume of a gas is theoretically ____ [272 cc. / 0 cc. / 274 cc.]
Answer:
At -273°C the volume of a gas is theoretically **0 cc.**

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