PHYSICAL CHEMISTRY

DPP

DAILY PRACTICE PROBLEMS

DPP No. 57

Total Marks : 64

Max. Time : 65 min.

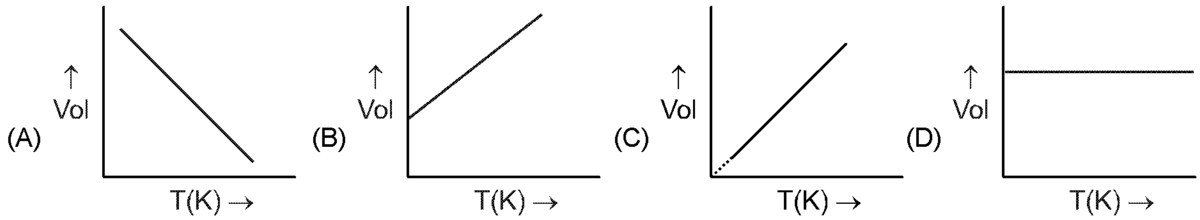
Topic : Gaseous State

Type of Questions		**M.M., Min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.20	(3 marks, 3 min.)	[60, 60]
Subjective Questions ('–1' negative marking) Q.21	(4 marks, 5 min.)	[4, 5]

1. At constant temperature, if pressure of an ideal gas increases by 1 %, the percentage decrease of volume is :
(A) 1 % (B) 100/101% (C) 1/101% (D) 1/100%

2. A sample of ideal gas occupies 100 ml at 27°C and 740 mm pressure. When its volume is changed to 80 ml at 740 mm pressure, the temperature of the gas will be :
(A) 21.6 °C (B) 33°C (C) – 33°C (D) – 21.6°C

3. The correct representation of Charles' law is given by :



4. The ratio of fraction pressure of a gaseous component to the total pressure of the gas mixture is equal to :
(A) mass fraction of the component (B) mole fraction of the component
(C) mass % of the component (D) mole % of the component

5. Same mass of CH_4 and H_2 is taken in a container. The partial pressure caused by H_2 (where total pressure is P) is:
(A) $\frac{8}{9}P$ (B) $\frac{1}{9}P$ (C) $\frac{1}{2}P$ (D) $\frac{3P}{4}$

6. The molecular weight of a gas which diffuse through a porous plug at 1/6th of the speed of hydrogen under identical conditions is :
(A) 12 (B) 72 (C) 36 (D) 24

7. The densities of hydrogen and oxygen are 0.09 and 1.44 g L^{-1} under same T and P conditions. If the rate of diffusion of hydrogen is 1, then that of oxygen in the same units will be :
(A) 4 (B) 1/4 (C) 16 (D) 1/16

8. 50 ml of hydrogen diffuses out through a small hole from a vessel in 20 minutes. The time needed for 40 ml of oxygen to diffuse out under identical conditions is :
(A) 4 min (B) 64 min (C) 96 min (D) 48 min

9. At the same temperature and pressure, which of the following gases will have the highest average translational kinetic energy per mole ?
(A) Hydrogen (B) Oxygen (C) Methane (D) All have the same value

10. The ratio among most probable speed, average speed and root mean square speed is given by :
(A) $2 : 8/\pi : 3$ (B) $8/\pi : 2 : 3$ (C) $\sqrt{8/\pi} : \sqrt{2} : \sqrt{3}$ (D) $\sqrt{2} : \sqrt{8/\pi} : \sqrt{3}$

11. The average translational kinetic energy for 14 grams of nitrogen gas at 127°C is nearly :
(A) 25 J (B) 50 J (C) 2500 J (D) 5000 J

12. The temperature at which rms speed of SO_2 molecules is half that of He molecules at 300 K is :
(A) 75 K (B) 600 K (C) 2400 K (D) 1200 K

13._ A real gas most closely approaches the behaviour of an ideal gas at :
(A) 15 atm and 200 K (B) 1 atm and 273 K (C) 0.5 atm and 500 K (D) 15 atm and 500 K

14. An ideal gas can't be liquefied because :
(A) its critical temperature is always above 0°C.
(B) its molecules are relatively smaller in size.
(C) it solidifies before becoming a liquid.
(D) forces operative between its molecules are zero.

15._ The compressibility factor for an ideal gas is :
(A) 0 (B) 1 (C) 3/8 (D) ∞

16._ The Vander Waal's parameters for gases W,X,Y and Z are :

Gas	$a\,(\text{atm L}^2\,\text{mol}^{-2})$	$b\,(\text{L mol}^{-1})$
W	4.0	0.027
X	8.0	0.030
Y	6.0	0.032
Z	12.0	0.027

Which of these gases has the highest critical temperature ?
(A) W (B) X (C) Y (D) Z

17. Densities of two ideal gas samples containing same gas are in the ratio 1 : 2 and their temperatures are in the ratio 2 : 1. Then the ratio of their respective pressure is :
(A) 1 : 1 (B) 1 : 2 (C) 2 : 1 (D) 4 : 1

18. The root mean square speed of an ideal gas at constant pressure varies with density (d) as :
(A) d^2 (B) d (C) $\sqrt{d}$ (D) $1/\sqrt{d}$

19. A 4 : 1 molar ratio mixture of helium and methane is contained in a vessel at 10 bar pressure. Due to a hole in the vessel, the gas mixture leaks out. The molar ratio composition of the mixture effusing out initially is :
(A) 8 : 1 (B) 16 : 1 (C) 32 : 1 (D) 6 : 1

20. A 4.0 dm^3 flask containing N_2 at 4.0 bar was connected to a 6.0 dm^3 flask containing helium at 6.0 bar, and the gases were allowed to mix isothermally. Then the total pressure of the resulting mixture will be :
(A) 4.8 bar (B) 5.2 bar (C) 5.6 bar (D) 5.4 bar

21. A mixture of formic acid and oxalic acid is heated with concentrated H_2SO_4. The gases produced are collected and on its treatment with KOH solution, the volume of the gas decreased by one-sixth. Calculate the molar ratio of the two acids in the original mixture.

Answer Key

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1.	(B)	**2.**	(C)	**3.**	(C)	**4.**	(B)	**5.**	(A)
6.	(B)	**7.**	(B)	**8.**	(B)	**9.**	(D)	**10.**	(D)
11.	(C)	**12.**	(D)	**13.**	(C)	**14.**	(D)	**15.**	(B)
16.	(D)	**17.**	(A)	**18.**	(D)	**19.**	(A)	**20.**	(B)
21.	4 : 1								

Hints & Solutions

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1. $PV = \left(P + \frac{1}{100}P\right) V_2$

$$V_2 = \frac{PV}{\frac{101}{100}P} \quad \Rightarrow \quad V_2 = \frac{100}{101}V$$

% decrease (% कमी) $= \dfrac{\frac{100}{101}V}{V} = \dfrac{100}{101}\%$

2. $V_1 = 100$ ml $\qquad V_2 = 80$ ml

$T_1 = 300$ K $\qquad T_2 = ?$

$P_1 = 740$ mm $\qquad P_2 = 740$ mm

Applying charles law $V \propto T$

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

$$\frac{100}{300} = \frac{80}{T_2}$$

$$T_2 = \frac{300 \times 80}{100} = 240\text{ K} = 24 - 273 = 240 - 273^\circ\text{C} = -33^\circ\text{C}.$$

3. $V \propto T$ (at constant n and P).

4. Apply Dalton's law of partial pressure

Initially $\quad n_1 = \dfrac{P_1V}{RT} = \dfrac{100 \times V}{RT} \quad ; \quad n_2 = \dfrac{P_2V}{RT} = \dfrac{400 \times V}{RT}$

5. $P.P_{H_2} = \frac{\frac{w}{2}}{\frac{w}{2}+\frac{w}{16}} \times P \quad \Rightarrow \quad P.P_{H_2} = \frac{8}{9}P$

6. $\frac{1}{6} = \sqrt{\frac{2}{x}}$ (Where X is molecular weight of gas)

$\frac{1}{36} = \frac{2}{x}$

$x = 72$

7. $\frac{r_{H_2}}{r_{O_2}} = \sqrt{\frac{d_{O_2}}{d_{H_2}}}$

$\frac{1}{r_{O_2}} = \sqrt{\frac{1.44}{0.09}}$

$r_{O_2} = \sqrt{\frac{1}{16}}$

$r_{O_2} = \frac{1}{4}$

8. $\frac{\frac{50}{20}}{\frac{40}{t}} = \sqrt{\frac{32}{2}}$

$\frac{50t}{20 \times 40} = 4$

$t = 64$ min.

9. K.E. $\propto$ T

(T will same)

10. $V_{mps} : V_{av} : V_{rms}$

$\Rightarrow \sqrt{\frac{2RT}{M}} : \sqrt{\frac{8RT}{\pi M}} : \sqrt{\frac{3RT}{M}} \quad \Rightarrow \quad \sqrt{2} : \sqrt{8/\pi} : \sqrt{3}$

11. Average K.E. for one mole $= \frac{3}{2}RT$

Average K.E. for 14 g of N_2 $\left(\frac{1}{2}\text{mole}\right) = \frac{3}{2} \times \frac{8.314}{2} \times 400 = 2494$ J.

12. $\frac{V_{rms,SO_2}}{V_{rms,He}} = \sqrt{\frac{T_{SO_2}}{T_{He}} \times \frac{M_{He}}{M_{SO_2}}}$

$$\frac{1}{2} = \sqrt{\frac{T_{SO_2}}{300} \times \frac{4}{64}}$$

$$4 = \frac{T_{SO_2}}{300}$$

$$T_{SO_2} = 1200\ K$$

13._ A real gas approaches the behaviour of ideal gas when the pressure is low and the temperature is high.

15._ For ideal gas, compressibility actor (Z) = 1.

16._ $T_c = \frac{8a}{27Rb}$. Thus $T_c \propto \frac{a}{b}$

17. $PV = nRT = \frac{w}{M}RT$

or $P = \frac{w}{V}\frac{RT}{M} = \frac{dRT}{M}$

Thus $P \propto d$, $P \propto T$. Hence,

$$\frac{P_1}{P_2} = \frac{d_1}{d_2} \times \frac{T_1}{T_2} = \frac{1}{2} \times \frac{2}{1} = 1 : 1.$$

18. $U_{rms} = \sqrt{\frac{3RT}{M}}$ using ideal gas equation,

$PV = nRT = \frac{w}{M}RT$; $\frac{RT}{M} = \frac{RV}{w} = \frac{P}{d}$ where d is the density of the gas

$\therefore$ $U_{rms} = \sqrt{\frac{3P}{d}}$ at constant pressure, $U_{rms} \propto \frac{1}{\sqrt{d}}$

19. Pressure of helium = 8 bar

Pressure of CH_4 = 2 bar

$$\frac{r_{He}}{r_{CH_4}} = \frac{P_1}{P_2}\sqrt{\frac{M_{CH_4}}{M_{He}}} = \frac{8}{2}\sqrt{\frac{16}{4}} = \frac{8}{1} = 8 : 1$$

20. At constant temperature,

$P_1 V_1 + P_2 V_2 = P_3 (V_1 + V_2)$

(4.0 bar) (4.0 dm^3) + (6.0 bar) (6.0 dm^3) = P_3 (4.0 + 6.0 dm^3)

or $P_3 = \frac{16+36}{10} = \frac{52}{10} = 5.2$ bar.

21. $HCOOH \longrightarrow H_2O + CO$

a mole		0	0
		a	a

$H_2C_2O_4 \longrightarrow H_2O + CO + CO_2$

b mole		0	0	0
		b	b	b

H_2O absorb by H_2SO_4 and CO_2 absorbed by KOH

volume of CO_2 / total volume = b/a + 2b = 1/6

a/b = 4/1

the molar ratio of HCOOH and $H_2C_2O_4$ is 4 : 1.