DPP - Daily Practice Problems

Name : ______ **Date :** ______

Start Time : ______ **End Time :** ______

CHEMISTRY 09

SYLLABUS : Real gases, deviation from ideal behaviour, compressibility factor, Van der Waal's equation, liquefaction of gases, critical constant and liquid state

Max. Marks : 120 **Time : 60 min.**

GENERAL INSTRUCTIONS

- The Daily Practice Problem Sheet contains 30 MCQ's. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.
- You have to evaluate your Response Grids yourself with the help of solution booklet.
- Each correct answer will get you 4 marks and 1 mark shall be deduced for each incorrect answer. No mark will be given/ deducted if no bubble is filled. Keep a timer in front of you and stop immediately at the end of 60 min.
- The sheet follows a particular syllabus. Do not attempt the sheet before you have completed your preparation for that syllabus. Refer syllabus sheet in the starting of the book for the syllabus of all the DPP sheets.
- After completing the sheet check your answers with the solution booklet and complete the Result Grid. Finally spend time to analyse your performance and revise the areas which emerge out as weak in your evaluation.

DIRECTIONS (Q.1-Q.21) : There are 21 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d), out of which ONLY ONE choice is correct.

Q.1 Van der Waals equation of state is obeyed by real gases. For n moles of a real gas, the equation is :

(a) $\left(\frac{P}{n}+\frac{na}{V^2}\right)\left(\frac{V}{n-b}\right)=RT$

(b) $\left(P+\frac{a}{V^2}\right)(V-b)=nRT$

(c) $\left(P+\frac{na}{V^2}\right)(nV-b)=nRT$

(d) $\left(P+\frac{n^2a}{V^2}\right)(V-nb)=nRT$

Q.2 A gas is said to behave like an ideal gas when the relation PV/T = constant. When do you expect a real gas to behave like an ideal gas

(a) when the temperature is low

(b) when both the temperature and pressure are low

(c) when both the temperature and pressure are high

(d) when the temperature is high and pressure is low

Q.3 Pressure exerted by 1 mole of methane in a 0.25 litre container at 300 K using van der Waal's equation (given a = 2.253 atm lit^{2}mol^{-2}, b = 0.0428 lit mol^{-1}) is

(a) 82.82atm (b) 152.51atm

(c) 190.52 atm (d) 70.52atm

RESPONSE GRID 1. ⓐⓑⓒⓓ 2. ⓐⓑⓒⓓ 3. ⓐⓑⓒⓓ

Space for Rough Work

Q.4 When an ideal gas undergoes unrestrained expansion, no cooling occurs because the molecules
(a) are above the inversion temperature
(b) exert no attractive force on each other
(c) do work equal to loss in kinetic energy
(d) collide without loss of energy

Q.5 Van der Waal's constants 'a' and 'b' are related with ----- respectively
(a) Attractive force and bond energy of molecules
(b) Volume and repulsive force of molecules
(c) Shape and repulsive forces of molecules
(d) Attractive force and volume of the molecules

Q.6 At low pressure, the van der Waal's equation is reduced to
(a) $Z = \frac{PV_m}{RT} = 1 - \frac{a}{VRT}$ (b) $Z = \frac{PV_m}{RT} = 1 + \frac{b}{RT}P$
(c) $PV_m = RT$ (d) $Z = \frac{PV_m}{RT} = 1 - \frac{a}{RT}$

Q.7 The Van der Waal's parameters for gases W, X, Y and Z are given below:
Which one of these gases has the highest critical temperature?

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

(a) W (b) X (c) Y (d) Z

Q.8 The critical temperature of H_2O is higher than that of O_2 because the H_2O molecule has
(a) fewer electrons than O_2 (b) two covalent bonds
(c) V-shape (d) Dipolemoment

Q.9 However great the pressure, a gas cannot be liquefied above its
(a) Boyle temperature (b) Inversion temperature
(c) Critical temperature (d) Room temperature

Q.10 The Van der Waal's constant 'a' for the gases O_2, N_2, NH_3 and CH_4 are 1.3, 1.390, 4.170 and 2.253 L^2 atm mol^{-2} respectively. The gas which can be most easily liquefied is
(a) O_2 (b) N_2 (c) NH_3 (d) CH_4

Q.11 Weight of 112 ml of oxygen at NTP on liquefaction would be
(a) 0.32 g (b) 0.64 g (c) 0.16 g (d) 0.96 g

Q.12 Positive deviation from ideal behaviour takes place because of
(a) Molecular interaction between atoms and $PV/nRT > 1$
(b) Molecular interaction between atoms and $PV/nRT < 1$
(c) Finite size of atoms and $PV/nRT > 1$
(d) Finite size of atoms and $PV/nRT < 1$

Q.13 The compressibility factor of a gas is less than 1 at STP. Its molar volume V_m will be
(a) $V_m > 22.42$ L (b) $V_m < 22.42$ L
(c) $V_m = 22.42$ L (d) None of these

Q.14 Which of the given sets of temperature and pressure will cause a gas to exhibit the greatest deviation from ideal gas behaviour
(a) 100° C and 4 atm (b) 100° C and 2 atm
(c) – 100° C and 4 atm (d) 0°C and 2 atm

Q.15 A gas has a density of 2.68 g/L at STP. Identify the gas
(a) NO_2 (b) Kr (c) COS (d) SO_2

Q.16 An ideal gas obeying kinetic theory of gases can be liquefied if
(a) its temperature is more than critical temperature T_c
(b) its pressure is more than critical pressure P_c
(c) its pressure is more than P_c at a temperature less than T_c
(d) it cannot be liquefied at any value of P and T

Q.17 Which set of conditions represents easiest way to liquefy a gas
(a) Low temperature and high pressure
(b) High temperature and low pressure
(c) Low temperature and low pressure
(d) High temperature and high pressure

RESPONSE GRID	4. ⓐⓑⓒⓓ	5. ⓐⓑⓒⓓ	6. ⓐⓑⓒⓓ	7. ⓐⓑⓒⓓ	8. ⓐⓑⓒⓓ
	9. ⓐⓑⓒⓓ	10. ⓐⓑⓒⓓ	11. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ	13. ⓐⓑⓒⓓ
	14. ⓐⓑⓒⓓ	15. ⓐⓑⓒⓓ	16. ⓐⓑⓒⓓ	17. ⓐⓑⓒⓓ	

Space for Rough Work

Q.18 Adiabatic demagnetisation is a technique used for
- (a) Adiabatic expansion of a gas
- (b) Production of low temperature
- (c) Production of high temperature
- (d) None of these

Q.19 The term that corrects for the attractive forces present in a real gas in the van der Waals equation is

(a) nb (b) $\frac{an^2}{V^2}$ (c) $-\frac{an^2}{V^2}$ (d) $-nb$

Q.20 When the temperature is increased, surface tension of water
- (a) increases
- (b) decreases
- (c) remains constant
- (d) shows irregular behaviour

Q.21 When the temperature is raised, the viscosity of the liquid decreases. This is because
- (a) volume of the solution decreases
- (b) increase in temperature increases the average kinetic energy of the molecules which overcomes the attractive forces between them
- (c) covalent and hydrogen bond forces decrease
- (d) attraction between the molecules increases

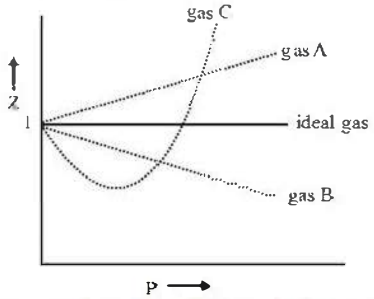
DIRECTIONS (Q.22-Q.24) : In the following questions, more than one of the answers given are correct. Select the correct answers and mark it according to the following codes:

Codes :

(a) 1, 2 and 3 are correct
(b) 1 and 2 are correct
(c) 2 and 4 are correct
(d) 1 and 3 are correct

Q.22 Refer to the figure given :

Which of the following statements is correct?



- (1) For gas A, $a = 0$ and Z will linearly depend on pressure
- (2) Gas C is a real gas and we can find 'a' and 'b' if intersection data is given
- (3) All van der Waal gases will behave like gas C and give positive slope at high pressure
- (4) For gas B, $b = 0$ and Z will linearly depend on pressure

Q.23 A gas described by van der Waals equation –
- (1) behaves similar to an ideal gas in the limit of large molar volumes
- (2) behaves similar to an ideal gas in limit of large pressures
- (3) is characterised by van der Waals coefficients that are dependent on the identity of the gas but are independent of the temperature
- (4) has the pressure that is lower than the pressure exerted by the same gas behaving ideally

Q.24 Which of the following is correct for critical temperature?
- (1) It is the highest temperature at which liquid and vapour can coexist
- (2) Beyond the critical temperature, there is no distinction between the two phases and a gas cannot be liquefied by compression
- (3) At critical temperature (T_c) the surface tension of the system is zero
- (4) At critical temperature the gas and the liquid phases have different critical densities

RESPONSE GRID					
	18. ⓐⓑⓒⓓ	19. ⓐⓑⓒⓓ	20. ⓐⓑⓒⓓ	21. ⓐⓑⓒⓓ	22. ⓐⓑⓒⓓ
	23. ⓐⓑⓒⓓ	24. ⓐⓑⓒⓓ			

Space for Rough Work

DIRECTIONS (Q.25-Q.27) : Read the passage given below and answer the questions that follows :

1 mole of CCl_4 vapours at 77°C occupies a volume of 35 litre. Van der Waal's constants are $a = 20.39\ L^2\ atm\ mol^{-2}$ and $b = 0.1383\ L\ mol^{-1}$.

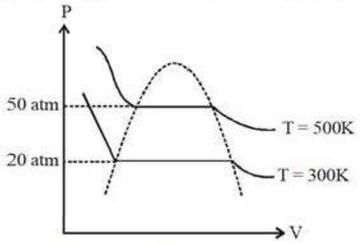
Q.25 Calculate Z under low pressure region –

(a) 0.98 (b) 0.90 (c) 0.84 (d) 0.80

Q.26 Calculate Z under high pressure region –

(a) 1.20 (b) 1.30 (c) 1.25 (d) 1.004

Q.27 For a real gas the P-V curve was experimentally plotted, and it had the following appearance with respect to liquification. Choose the correct statement.



(a) At T = 500 K, P = 40 atm, the state will be liquid

(b) At T = 300 K, P = 50 atm, the state will be gas

(c) At T < 300 K, P > 20 atm, the state will be gas

(d) At 300 K < T < 500 K, P > 50 atm, the state will be liquid

DIRECTIONS (Q. 28-Q.30) : Each of these questions contains two statements: Statement-1 (Assertion) and Statement-2 (Reason). Each of these questions has four alternative choices, only one of which is the correct answer. You have to select the correct choice.

(a) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(b) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.

(c) Statement -1 is False, Statement-2 is True.

(d) Statement -1 is True, Statement-2 is False.

Q.28 Statement 1 : 4.58 mm and 0.0098° C is known to be triple point of water.

Statement 2 : At this pressure and temperature all the three states i.e., water, ice and vapour exist simultaneously.

Q.29 Statement 1 : Compressibility factor for hydrogen varies with pressure with positive slope at all pressures.

Statement 2 : Even at low pressures, repulsive forces dominate hydrogen gas.

Q.30 Statement 1 : Van der Waal's equation is applicable only to non-ideal gases.

Statement 2 : Ideal gases obey the equation PV = nRT.

RESPONSE GRID

25. ⓐⓑⓒⓓ 26. ⓐⓑⓒⓓ 27. ⓐⓑⓒⓓ 28. ⓐⓑⓒⓓ 29. ⓐⓑⓒⓓ
30. ⓐⓑⓒⓓ

DAILY PRACTICE PROBLEM SHEET 9 - CHEMISTRY			
Total Questions	30	Total Marks	120
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	40	Qualifying Score	64
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

Space for Rough Work

DAILY PRACTICE PROBLEMS

CHEMISTRY SOLUTIONS

09

1. (d)
2. (d) PV = nRT is an ideal gas equation it is allowed when the temperature is high and pressure is low.
3. (a) $\left(P + \frac{n^2a}{V^2}\right)(V - nb) = nRT$

$$\left(P + \frac{2.253}{0.25 \times 0.25}\right)(0.25 - 0.0428) = 0.0821 \times 300$$

or $(P + 36.048)(0.2072) = 24.63$

$P + 36.048 = 118.87$

$P = 82.82$ atm.

4. (b) Ideal gas has no attractive force between the particles.
5. (d) Van der Waal's equation is :

$$\left(p + \frac{an^2}{V^2}\right)(v - nb) = nRT$$

where 'a' is a measure of the magnitude of attractive forces among the molecules of the gas.

'b' is a measure of effective size of gas molecules.

Its value is equal to four times the actual volume of gas molecules.

6. (a) When pressure is low

$$\left[P + \frac{a}{V^2}\right](V - b) = RT$$

or $PV = RT + Pb - \frac{a}{V} + \frac{ab}{V^2}$

or $\frac{PV}{RT} = 1 - \frac{a}{VRT}$

$$Z = 1 - \frac{a}{VRT}$$

$$\left\{\because \frac{PV}{RT} = Z\right\}$$

7. (d) From the given gases, critical temperature of Z is highest. This is obtained by using the relation below:

$$T_c = \frac{8a}{27Rb} \Rightarrow T_c = \frac{8 \times 12}{27 \times 0.0821 \times 0.027} = 1603.98\text{ K}$$

8. (d) Polar molecules (like H_2O) have dipole moment. As a result, intermolecular forces of attraction are greater and so is the critical temperature.
9. (c) Above critical temperature, substances are existing in gaseous state, since a gas cannot be liquefied above it.
10. (c) Value of constant 'a' is highest for NH_3 than other gases, $\therefore$ NH_3 can be most easily liquefied $\because T_c \propto$ 'a'
11. (c) 22400 ml is the volume of O_2 at NTP

$\therefore$ at NTP, 22400 ml of O_2 weighs = 32g

$\therefore$ 112 ml of O_2 at NTP will weigh $= \frac{32}{22400} \times 112$

$= 0.16$ g of O_2

12. (c) For positive deviation: $PV = nRT + nPb$

$$\Rightarrow \frac{PV}{nRT} = 1 + \frac{Pb}{RT}$$

Thus, the factor nPb is responsible for increasing the PV value. Above ideal value, b is actually the effective volume of molecule. So, it is the finite size of molecules that leads to the origin of b and hence positive deviation at high pressure.

13. (b) $Z = \frac{PV}{nRT}$

$Z < 1$ (given)

$\therefore \frac{PV}{nRT} < 1$ or $PV < nRT$ or $V < \frac{nRT}{P}$

or, $V < \frac{1\text{mole} \times 0.0821\text{L atm K}^{-1}\text{mol}^{-1} \times 273\text{K}}{1\text{ atm}}$

or, $V < 22.4$L

14. (c) Gas deviate from ideal gas behaviour to real gas (according to Van der Waal's) at low temperature and high pressure.
15. (c) $d = \frac{M}{V} \Rightarrow M = d \times V$

$M = 2.68 \times 22.4$ at N.T.P.

$M = 60.03$ gm

M. wt. of $COS = 12 + 16 + 32 = 60$

16. (d) Absence of intermolecular attraction in an ideal gas cannot can't cause liquefaction at any value of P and T.
17. (a) A gas can be liquefied by cooling (i.e. low T) or by applying pressure or the combined effect of both. By cooling (or decreasing T), the K.E. of molecules decreases, they become slower. On increasing the pressure, the molecules come close together. Both these factors bring molecules closer, increase their intermolecular forces of attraction and hence, help in liquefaction of the gas.
18. (b) Adiabatic demagnetisation is a technique of liquefaction of gases in which temperature is reduced.

19. **(b)** Correction factor for attractive force for n moles of real gas is given by the term mentioned in (b).

20. **(b)** Upon increase of temperature the internal energy of water or any system increases resulting in decrease in intermolecular forces and hence decrease in surface tension. Surface tension decreases with increase in mobility due to increase in temperature.

21. **(b)**

22. **(a)** For gas A, $a = 0, Z = 1+\frac{Pb}{RT}$ implies Z varies linearly with pressure.

For gas B, $b = 0, Z = 1-\frac{a}{VRT}$. Hence, Z does not vary linearly with pressure.

Given the intersection data for gas C, it is possible to find the values of 'a' and 'b'. All van der Waal gases, like gas C, give positive slope at high pressures.

23. **(d)** Van der Waals equation is

$$\left(P+\frac{n^2a}{V^2}\right)(V-nb) = nRT \quad \text{[For n moles of a gas]}$$

a, b are van der Waals constants

The ideal gas equation is $PV = nRT$ [For n moles of a gas]

where P is pressure exerted by ideal gas and V is volume occupied by ideal gas.

In van der Waals equation the term $\left(P+\frac{n^2a}{V^2}\right)$ represents the pressure exerted by the gas and $(V-nb)$ the volume occupied by the gas. At low pressure, when the gas occupies large volume the intermolecular distance between gaseous molecules is quite large and in such case there is no significant role played by intermolecular forces and thus the gas behaves like an ideal gas thus (1) is correct

Under high pressure the intermolecular distance decreases and the intermolecular forces play a significant role and the gas shows a devation from ideal behaviour.

Thus (2) is *not* correct.

The van der Waals coefficients defined on the nature of gas and are independent of temperature so (3) is correct.

The pressure $\left(P+\frac{n^2a}{V}\right)$ is not lower than P so (4) is not correct.

Hence the correct answer is (1, 3).

24. **(a)**

25. **(a)** In low pressure region, the van der Waal's equation changes to

$$\left(P+\frac{a}{V_m^2}\right)V_m = RT \quad \text{or} \quad PV_m + \frac{a}{V_m} = RT$$

$$\text{or} \quad \frac{PV_m}{RT} + \frac{a}{RTV_m} = 1$$

$$\text{or} \quad Z = 1-\frac{a}{RTV_m} = 1-\frac{20.39}{0.0821\times350\times35} = 0.98$$

26. **(d)** In high pressure region, the van der Waal's equation change to

$P(V_m - b) = RT \quad \text{or } PV_m - Pb = RT$

$$\text{or} \quad Z = 1+\frac{Pb}{RT} \qquad \text{.........(1)}$$

$$\text{or} \quad P = \frac{RT}{V_m - b} \qquad \text{.........(2)}$$

From eq. (1) and eq. (2)

$$Z = 1+\frac{b}{(V_m - b)} = 1+\frac{0.1383}{35-0.1383} = 1.004$$

27. **(d)** Inside the dome showing graph, state is liquid.

28. **(a)**

29. **(a)** In case of H_2, compressibility factor increases with the pressure. At 273 K, $Z > 1$ which shows that it is difficult to compress the gas as compared to ideal gas. In this case repulsive forces dominate.

30. **(b)** In real gases, the intermolecular forces of attraction and the volume occupied by the gas molecules cannot be neglected.