CHEMISTRY

NCERT - FULL MARKS

CHEMISTRY(TAMIL)

GASEOUS STATE

Problem

1. Calculate the partial pressures N_2 and H_2 in a mixture of two moles of N_2 and two moles

of H_2 at STP.

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2. If a gas diffuses at the rate of one-half as fast as O_2, find the molecular mass of the gas.

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3. 75 ml of gas A effuses through a pin hole in 73 seconds the same volume of SO_2 under

indential conditions effuses in seconds. Calculate the molecular mass of A.

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4. 7.5g of a gas occupies a volume of 5.6 litres at $0^{\circ}C$ and 1atm pressure . The gas is

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5. Vanderwaal's constants for hydrogen chloride gas are a = 3.67 atm lit^{-2} and b =

40.8 ml mol^{-1}. Find the critical temperature and critical pressure of the gas.

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6. The critical temperature of hydrogen gas is $33.2^{\circ}C$ and its critical pressure is 12.4 atm. Find out the values of a' and b' for the gas.

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Self Test

1. Calculate the partial pressures of O_2 and H_2 in a mixture of 3 moles of O_2 and 1 mole of H_2 at S.T.P.

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2. If a gas diffuses at the rate of one quarter as fast as N_2 . Find the molecular mass.

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3. 75 ml of gas A effuses through a pin hole in 73 seconds the same volume of SO_2 under indential conditions effuses in seconds. Calculate the molecular mass of A.

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Questions Choose The Correct Answer

1. A curve drawn at constant temperature is called an isotherm. This shows relationship

between

A. P and $\frac{1}{V}$

B. PV and V

C. P and V

D. V and $\frac{1}{P}$

Answer:

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2. The temperature of a steel rod is 330K. Its temperature in 0° C is

A. Above which it can no longer remain in the gaseous state

B. Above which it can not be liquified by pressure

C. At which it solidifies

D. At which volume of gas becomes zero.

Answer:

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3. If a gas expands at constant temperature.

A. Number of molecules of the gas decreases

B. The kinetic energy of the molecules decreases

C. The kinetic energy of the molecules decreases

D. The kinetic energy of the molecules increases

Answer:

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4. The molecules of a gas A travel four times faster than the molecules of gas B at the same temperature. The ratio of molecular weight (M_A / M_B) will be

A. $\frac{1}{16}$

B. 4

C. $\frac{1}{4}$

D. 16

Answer:

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Questions B Fill In The Blanks

1. The correction term for pressure deviation is .....in the Vanderwaal equation of state.

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2. The relation between inversion temperature and Vanderwaal's constants a' and b' is _____

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3. To liquefy Helium _____ method is exclusively used

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4. The adiabatic expansion of a real gas results in _____

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5. The rate of diffusion of gas is _____to square root of both _____ and molecular mass.

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Questions D Write In One Or Two Sentence

1. Write the mathematical expression for Boyle's law.

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2. Give the correction factors for the volume and pressure deviation for a Vanderwaal's gas.

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3. A sample of an ideal gas escapes into an evacuated container, there is no change in the kinetic energy of the gas. Why?

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4. What is the change in temperature when a compressed real gas is allowed to expand adiabatically through a porous plug

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5. State Boyle's law and Charles law.

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6. What are measurable properties of gases?

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7. What is the molar volume of nitrogen at 500K and 600 atm according to ideal gas law?

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8. Define Graham's law of diffusion.

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9. Give the values of R-gas constant in calories and Joules.

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10. What are the units of Vanderwaals constants a' and b' ?

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11. Write the significance of Vanderwaal's constants

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12. Write the limitations of vanderwaal equation of state.

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13. Define Joule-Thomson effect

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14. What is meant by inversion temperature ?

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Questions E Explain Briefly On The Following

1. At $27^{\circ}C$, H_2 is leaked through a tiny hole into a vessel for 20 minutes Another unknown gas at the same T and P as that of H_2 is leaked

through the same hole for 20 minutes. After effusion of the gas, the mixture exerts a pressure of 6 atm. The H_2 content of the mixture is 0.7 moles. If volume of the container is 3 litres what is the molecular weight of unknown gas ?

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2. Calculate the pressure exerted by 5 moles of CO_2 in one litre vessel at 47°C using Vanderwaal's equation. Also report the

pressure of gas if it behaves ideally in nature. Given that a=3.592 atm $lit^2 mol^{-2}$. b = 0.0427 lit mol^{-1}

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3. Calculate the total pressure in a 10 L cylinder which contains 0.4 g of helium, 1.6 g of oxygen and 1.4 g of nitrogen at 27°C. Also calculate the partial pressures of He gas in the cylinder. Assume Ideal behaviour for gases.

R = 0.082 L atm $k^{-1} mol^{-1}$

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4. The critical constants for water are $374^{\circ}C$, 218 atm and 0.0566 litre mol^{-1}. Calculate a' and b' of water

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5. Vanderwaal's constant in litre atmosphere per mole for carbon dioxide are a = 3.6 and b = 4.28×10^{-2}. Calculate the critical

temperature and critical volume of the gas. R = 0.0820 lit atm $K^{-1}. Mol^{-1}$

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6. Explain the causes for deviation for real gases from ideal behaviour.

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7. Deduce the relationship between critical constants and Vanderwaal's constants.

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8. Describe Linde's process of liquefaction of gases with neat diagram.

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9. Describe Claude's process of liquefaction of gases with neat diagram.

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10. What is meant by adiabatic demagnetisation? Explain its use in liquefaction of gases.

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Evaluate Yourself

1. Freon-12, the compound widely used in the refrigerator system as coolant causes depletion of ozone layer. Now it has been replaced by eco-friendly compounds. Consider

$1.5dm^3$ sample of gaseous Freon at a pressure of 0.3 atm. If the pressure is changed to 1.2 atm. at a constant temperature, what will be the volume of the gas increased or decreased?

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2. Inside a certain automobile engine, the volume of air in a cylinder is $0.375dm^3$, when the pressure is 1.05 atm. When the gas is compressed to a volume of $0.125dm^3$ at the

same temperature, what is the pressure of the compressed air?

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3. A sample of gas has a volume of $3.8dm^3$ at an unknown temperature. When the sample is submerged in ice water at $0^\circ C$, its volume gets reduced to $2.27dm^3$. What is its initial temperature?

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4. An athlete in a kinesiology research study has his lung volume of 7.05 dm3 during a deep inhalation. At this volume the lungs contain 0.312 mole of air. During exhalation the volume of his lung decreases to $2.35dm^3$. How many moles of air does the athlete exhale during exhalation? (assume pressure and temperature remain constant)

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5. A small bubble rises from the bottom of a lake where the temperature and pressure are $8^{\circ}C$ and 6.4 atm. to the water surface, where the temperature is $25^{\circ}C$ and pressure is 1 atm. Calculate the final volume in (mL) of the bubble, if its initial volume is 2.1 mL.

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6. A mixture of He and O_2 were used in the 'air' tanks of underwater divers for deep dives.

For a particular dive $12dm^3$ of O_2 at 298 K, 1 atm. and $46dm^3$ of He, at 298 K, 1 atm. were both pumped into a $5dm^3$ tank. Calculate the partial pressure of each gas and the total pressure in the tank at 298 K

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7. A sample of solid $KClO_3$ (potassium chlorate) was heated in a test tube to obtain O_2 according to the reaction

$2KClO_3 \rightarrow 2KCl + 3O_2$

The oxygen gas was collected by downward displacement of water at 295 K. The total pressure of the mixture is 772 mm of Hg. The vapour pressure of water is 26.7 mm of Hg at 300K. What is the partial pressure of the oxygen gas?

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8. A flammable hydrocarbon gas of particular volume is found to diffuse through a small hole in 1.5 minutes. Under the same conditions

of temperature and pressure an equal volume of bromine vapour takes 4.73 min to diffuse through the same hole. Calculate the molar mass of the unknown gas and suggest what this gas might be, (Given that molar mass of bromine = 159.8 g/mole)

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9. Critical temperature of $H_2O, NH_3,$ and CO_2 are $647.4, 405.5$ and $304.2K$, respectively. When

we start cooling from a temperature of 700 K which will liquefy first and which will liquefy finally?

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Evaluation Multiple Choice Questions

1. Gases deviate from ideal behavior at high pressure. Which of the following statement(s) is correct for non-ideality?

A. at high pressure the collision between the gas molecule become enormous

B. at high pressure the gas molecules move only in one direction

C. at high pressure, the volume of gas become insignificant

D. at high pressure the intermolecular interactions become significant

Answer: D

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2. Rate of diffusion of a gas is

A. directly proportional to its density

B. directly proportional to its molecular weight

C. directly proportional to its square root of its molecular weight

D. inversely proportional to the square root of its molecular weight

Answer: D

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3. Which of the following is the correct expression for the equation of state of van der Waals gas?

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

B. $\left(P+\frac{na}{n^2V^2}\right)(V-nb)=nRT$

C. $\left(P+\frac{an^2}{V^2}\right)(V-nb)=nRT$

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

Answer: C

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4. When an ideal gas undergoes unrestrained expansion, no cooling occurs because the molecules

A. are above inversion temperature

B. exert no attractive forces on each other

C. do work equal to the loss in kinetic energy

D. collide without loss of energy

Answer: B

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5. Equal weights of methane and oxygen are mixed in an empty container at 298 K. The fraction of total pressure exerted by oxygen is

A. $1/3$

B. $1/2$

C. $2/3$

D. $1/3 \times 273 \times 298$

Answer: A

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6. The temperatures at which real gases obey the ideal gas laws over a wide range of pressure is called

A. Critical temperature

B. Boyle temperature

C. Inversion temperature

D. Reduced temperature

Answer: B

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7. In a closed room of $1000m^3$ a perfume bottle is opened up. The room develops a smell. This is due to which property of gases?

A. Viscosity

B. Density

C. Diffusion

D. None

Answer: C

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8. A bottle of ammonia and a bottle of HCl connected through a long tube are opened

simultaneously at both ends. The white ammonium chloride ring first formed will be

A. At the center of the tube

B. Near the hydrogen chloride bottle

C. Near the ammonia bottle

D. Throughout the length of the tube

Answer: B

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9. The value of universal gas constant depends upon

A. Temperature of the gas

B. Volume of the gas

C. Number of moles of the gas

D. units of Pressure and volume.

Answer: D

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10. The value of the gas constant R is

A. $0.082 dm^3$ atm.

B. $0.987 \quad \text{cal mol}^{-1} K^{-1}$

C. $8.3 \quad \text{J mol}^{-1} K^{-1}$

D. $8 \quad \text{erg mol}^{-1} K^{-1}$

Answer: C

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11. Use of hot air balloon in sports at meteorological observation is an application of

A. Boyle's law

B. Newton's law

C. Kelvin's law

D. Brown's law

Answer: A

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12. The table indicates the value of van der Waals constant 'a' in $\left(dm^3\right)^2 \ \text{atm mol}^{-2}$

Gas	O_2	N_2	NH_3	CH_4
a	1.360	1.390	4.170	2.253

The gas which can be most easily liquefied is

A. O_2

B. N_2

C. NH_3

D. CH_4

Answer: C

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13. Consider the following statements

i) Atmospheric pressure is less at the top of a mountain than at sea level

ii) Gases are much more compressible than solids or liquids

iii) When the atmospheric pressure increases the height of the mercury column rises Select the correct statement

A. I and II

B. II and III

C. I and III

D. I, II and III

Answer: D

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14. Compressibility factor for CO_2 at 400 K and 71.0 bar is 0.8697. The molar volume of CO_2 under these conditions is

A. $22.04dm^3$

B. $2.24dm^3$

C. $0.41dm^3$

D. $19.5dm^3$

Answer: C

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15. If temperature and volume of an ideal gas is increased to twice its values, the initial pressure P becomes

A. 4P

B. 2P

C. P

D. 3P

Answer: C

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16. At identical temperature and pressure, the rate of diffusion of hydrogen gas is $3\sqrt{3}$ times

that of a hydrocarbon having molecular formula C_nH_{2n-2}. What is the value of n ?

A. 8

B. 4

C. 3

D. 1

Answer: B

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17. Equal moles of hydrogen and oxygen gases are placed in a container, with a pin-hole through which both can escape what fraction of oxygen escapes in the time required for one-half of the hydrogen to escape. (NEET phase 1)

A. $3/8$

B. $1/2$

C. $1/8$

D. $1/4$

Answer: C

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18. The variation of volume V, with temperature T, keeping pressure constant is called the coefficient of thermal expansion ie $\alpha = \frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_P$. For an ideal gas α is equal to

A. T

B. $1/T$

C. P

D. none of these

Answer: B

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19. Four gases P, Q, R and S have almost same values of 'b' but their 'a' values (a, b are Vander Waals Constants) are in the order $Q < R < S < P$. At a particular temperature,

among the four gases the most easily liquefiable one is

A. P

B. Q

C. R

D. S

Answer: A

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20. Maximum deviation from ideal gas is expected from (NEET)

A. $CH_4(g)$

B. $NH_3(g)$

C. $H_2(g)$

D. $N_2(g)$

Answer: B

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21. The units of Vander Waals constants 'b' and 'a' respectively

A. $molL^{-1}$ and $Latm^2mol^{-1}$

B. mol L and L atm mol^2

C. $mol^{-1}L$ and $L^2atmmol^{-2}$

D. none of these

Answer: C

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22. Assertion : Critical temperature of CO_2 is 304K, it can be liquefied above 304K.

Reason : For a given mass of gas, volume is to directly proportional to pressure at constant temperature

A. both assertion and reason are true and reason is the correct explanation of assertion

B. both assertion and reason are true but reason is not the correct explanation of

assertion

C. assertion is true but reason is false

D. both assertion and reason are false

Answer: D

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23. What is the density of N_2 gas at $227^\circ C$ and 5.00 atm pressure ? $\left(R = 0.082 L atm K - 1 mol^{-1}\right)$

A. $1.40g/L$

B. $2.81g/L$

C. $3.41g/L$

D. $0.29g/L$

Answer: C

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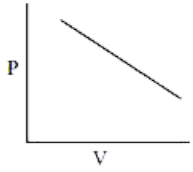
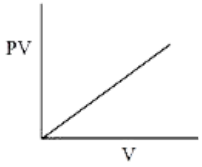
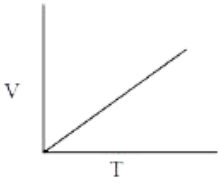
24. Which of the following diagrams correctly describes the behaviour of a fixed mass of an ideal gas ? (T is measured in K)

A. 

B. 

C. 

D. All of these

Answer: C

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25. 25g of each of the following gases are taken at $27^{\circ}C$ and 600 mm Hg pressure. Which of these will have the least volume ?

A. HBr

B. HCl

C. HF

D. HI

Answer: D

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Evaluation Answer These Questions Briefly

1. A sample of gas at $15^{\circ}C$ at 1 atm. has a volume of $2.58dm^3$. When the temperature is raised to $38^{\circ}C$ at 1 atm does the volume of the gas increase? If so, calculate the final volume.

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2. A sample of gas has a volume of $8.5dm^3$ at an unknown temperature. When the sample is

submerged in ice water at $0^{\circ}C$, its volume gets reduced to $6.37dm^3$. What is its initial temperature?

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3. Of two samples of nitrogen gas, sample A contains 1.5 moles of nitrogen in a vessel of volume of $37.6dm^3$ at 298K, and the sample B is in a vessel of volume $16.5dm^3$ at 298K. Calculate the number of moles in sample B.

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4. Sulphur hexafluoride is a colourless, odourless gas, calculate the pressure exerted by 1.82 moles of the gas in a steel vessel of volume $5.43dm^3$ at $69.5^\circ C$, assuming ideal gas behaviour

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5. Argon is an inert gas used in light bulbs to retard the vaporization of the tungsten filament. A certain light bulb containing argon

at $1.2atm$ and $18^{\circ}C$ is heated to $85^{\circ}C$ at constant volume. Calculate its final pressure in atm.

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6. A small bubble rises from the bottom of a lake where the temperature and pressure are $6^{\circ}C$ and 4 atm. to the water surface, where the temperature is $25^{\circ}C$ and pressure is 1 atm. Calculate the final volume in (mL) of the bubble, if its initial volume is 1.5 mL.

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7. Hydrochloric acid is treated with a metal to produce hydrogen gas. Suppose a student carries out this reaction and collects a volume of $154.4 \times 10^{-3} dm^3$ of a gas at a pressure of 742 mm of Hg at a temperature of 298 K. What mass of hydrogen gas (in mg) did the student collect?

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8. It takes 192 sec for an unknown gas to diffuse through a porous wall and 84 sec for N_2 gas to effuse at the same temperature and pressure. What is the molar mass of the unknown gas?

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9. A tank contains a mixture of 52.5 g of oxygen and 65.1 g of CO_2 at 300 K the total pressure in the tanks is 9.21 atm. Calculate the

partial pressure (in atm.) of each gas in the mixture.

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10. A combustible gas is stored in a metal tank at a pressure of 2.98 atm at $25^{\circ}C$. The tank can withstand a maximum pressure of 12 atm after which it will explode. The building in which the tank has been stored catches fire. Now predict whether the tank will blow up

first or start melting? (Melting point of the metal = 1100 K).

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