EXERCISE - O

Ideal gas equation & problems

1. Which one of the following statements is not correct about the three states of matter i.e. solid, liquid and gaseous
(A) Molecules of a solid possess least energy whereas those of a gas possess highest energy
(B) The density of solid is highest whereas that of gases is lowest
(C) Gases, like liquids possess definite volumes
(D) Molecules of a solid possess vibratory motion

CSM091

2. Kinetic energy of molecules is highest in
(A) Gases (B) Solids (C) Liquids (D) Solutions

CSM092

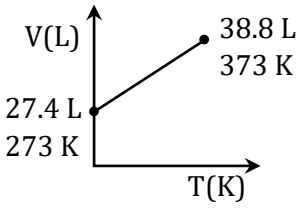
3. Pressure of a gas in a vessel can be measured by
(A) Barometer (B) Manometer (C) Stalgometer (D) All the above

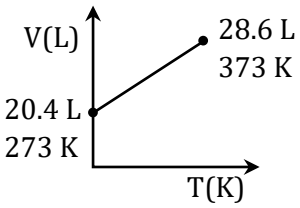
CSM093

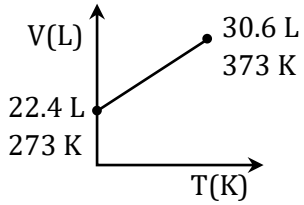
4. Which one of the following statements is wrong for gases
(A) Gases do not have a definite shape and volume
(B) Volume of the gas is equal to the volume of the container confining the gas
(C) Confined gas exerts uniform pressure on the walls of its container in all directions
(D) Mass of the gas cannot be determined by weighing a container in which it is enclosed

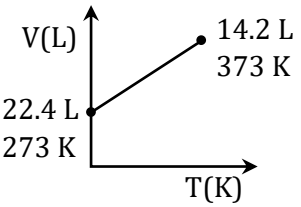
CSM094

5. Which one of the following V, T plots represents the behaviour of one mole of an ideal gas at one atm ?

(A) 

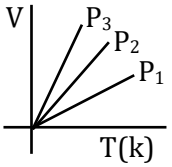
(B) 

(C) 

(D) 

CSM095

6. The volume-temperature graph of a given mass of an ideal gas at constant pressure are shown below. What is the correct order of pressures



(A) $P_1>P_3>P_2$ (B) $P_1>P_2>P_3$ (C) $P_2>P_3>P_1$ (D) $P_2>P_1>P_3$

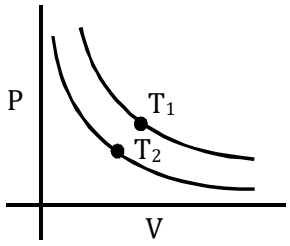
CSM096

7. 400 cm^3 of oxygen at 27°C were cooled to –3°C without change in pressure. The contraction in volume will be :-

(A) 40 cm^3 (B) 30 cm^3 (C) 44.4 cm^3 (D) 360 cm^3

CSM097

8. According to graph, which is true :-

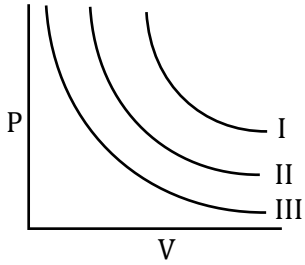


(A) $T_1 > T_2$ (B) $T_1 < T_2$ (C) $T_1 = T_2$ (D) None of these

CSM098

Problem related with piston/SPM

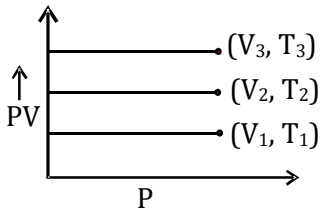
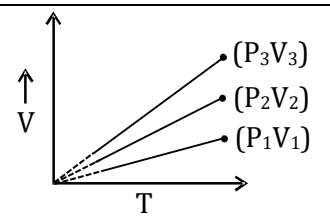
9. I, II, III are three isotherms respectively at T_1, T_2 and T_3 as shown in graph. Temperature will be in order:

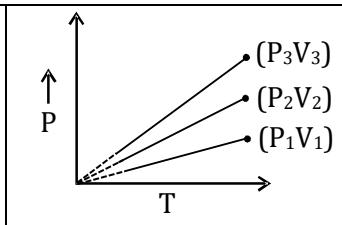
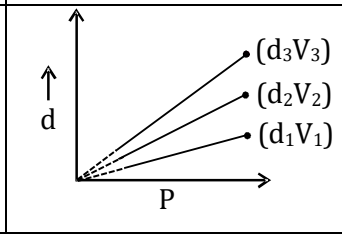


(A) $T_1 = T_2 = T_3$ (B) $T_1 < T_2 < T_3$ (C) $T_1 > T_2 > T_3$ (D) $T_1 > T_2 = T_3$

CSM101

10. For a fixed amount of the gas match the two column :

	Column – I		**Column – II**
(A)		(p)	$T_1 > T_2 > T_3$
(B)		(q)	$P_1 > P_2 > P_3$

(C)		(r)	$V_1 > V_2 > V_3$
(D)		(s)	$d_1 > d_2 > d_3$

(A) (A – q, s) ; (B - s) ; (C – p, r) ; (D - p) (B) (A - s) ; (B - q, s) ; (C - r) ; (D - p, r)
(C) (A - r) ; (B - q, s) ; (C - q) ; (D - r, s) (D) (A - q) ; (B - r, s) ; (C - r) ; (D - r, s)

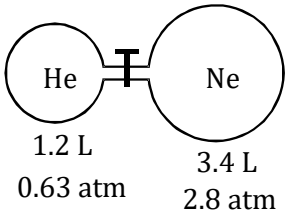
CSM102

11. 56 g of nitrogen and 96 g of oxygen are mixed isothermally and at a total pressure of 10 atm. The partial pressures of oxygen and nitrogen (in atm) are respectively :-

(A) 4, 6 (B) 5, 5 (C) 2, 8 (D) 6, 4

CSM103

12. Consider the following apparatus. Calculate the partial pressure of helium after the opening valve. The temperature remains constant at 16°C.



(A) 0.164 atm (B) 1.64 atm (C) 0.328 atm (D) 1 atm

CSM104

Graham's law of Diffusion

13. Which gas effuses fastest under identical conditions -

(A) N_2 (B) O_2 (C) Cl_2 (D) CH_4

CSM111

14. A gas X diffuses three times faster than another gas Y the ratio of their densities i.e., $D_x : D_y$ is

(A) $\frac{1}{3}$ (B) $\frac{1}{9}$ (C) $\frac{1}{6}$ (D) $\frac{1}{12}$

CSM112

15. A 4 : 1 molar mixture of He & CH_4 kept in a vessel at 20 bar pressure. Due to a hole in the vessel, gas mixture leaks out. What is the composition (in mole ratio) of mixture effusing out initially -

(A) 8 : 1 (B) 4 : 1 (C) 1 : 4 (D) 4 : 3

CSM113

16. Two grams of hydrogen diffuse from a container in 10 minutes. How many grams of oxygen would diffuse through the same container in the same time under similar conditions

(A) 0.5 g (B) 4 g (C) 6 g (D) 8 g

CSM114

17. Match the following (where U_{rms} = root mean square speed, U_{av} = average speed, U_{mp} = most probable speed)

List I		List II	
(a)	U_{rms} / U_{av}	(i)	1.22
(b)	U_{av} / U_{mp}	(ii)	1.13
(c)	U_{rms} / U_{mp}	(iii)	1.08

(A) (a)-(iii), (b)-(ii), (c)-(i) (B) (a)-(i), (b)-(ii), (c)-(iii)
(C) (a)-(iii), (b)-(i), (c)-(ii) (D) (a)-(ii), (b)-(iii), (c)-(i)

CSM115

18. If a gas expands at constant temperature then :
(A) No. of gaseous molecule decreases (B) kinetic energy of molecule decreases
(C) K.E. remain same (D) K.E. increases

CSM116

19. Average K.E. of CO_2 at 27°C is E. The average kinetic energy of N_2 at the same temperature will be
(A) E (B) 22E (C) E/22 (D) $E/\sqrt{2}$

CSM117

20. Four particles have speed 2, 3, 4 and 5 cm/s respectively. Their rms speed is :
(A) 3.5 cm/s (B) 3 cm/s (C) 4 cm/s (D) 3.67cm/s

CSM118

21. Temperature at which most probable speed of O_2 becomes equal to root mean square speed of N_2 is [Given : N_2 at 427°C]
(A) 732 K (B) 1200 K (C) 927 K (D) 800 K

CSM119

22. The density ratio of O_2 and H_2 is 16 : 1. The ratio of their U_{rms} at constant pressure is :-
(A) 4 : 1 (B) 16 : 1 (C) 1 : 4 (D) 1 : 16

CSM120

23. The average speed of an ideal gas molecule at 27°C is 0.3 m/s. The average speed at 927°C will be -
(A) 0.6 m/s (B) 0.3 m/s (C) 0.9 m/s (D) 3.0 m/s

CSM121

Kinetic theory of gases

24. Collision frequency (Z) of gas at a particular pressure.
(A) Decreases with the rise in temperature (B) Increases with the rise in temperature
(C) Decreases initially and then increases (D) Unpredictable

CSM123

25. At constant volume, Z_{11} is directly proportional to -
(A) $\sqrt{P}$ (B) P (C) T^2 (D) T

CSM124

26. Calculate the mean free path in CO_2 at 27° C and a pressure of 10^{-9} bar.
[molecular diameter = 500 pm]
[Given: $R = \frac{25}{3}$ $Jmol^{-1}k^{-1}$; $\sqrt{2} = 1.4$; $\pi = \frac{22}{7}$; $N_A = 6 \times 10^{23}$]
(A) 3.78×10^5 cm (B) 3.78×10^4 cm (C) 3.78×10^3 cm (D) 6.78×10^3 cm

CSM125

27. 3 Litre mixture of C_2H_6 and C_3H_8 produce 8 litre CO_2 of complete combustion. Find the volume of C_2H_6 in mixture :-

(A) 2L (B) 1L (C) 1.5L (D) 2.5L

CSM126

28. 10 mL of gaseous hydrocarbon on combustion gives 40 mL of $CO_2(g)$ and50 mL of H_2O (vapour). The hydrocarbon is

(A) C_4H_5 (B) C_8H_{10} (C) C_4H_8 (D) C_4H_{10}

CSM127

29. When 20 ml of mixture of O_2 and O_3 is heated, the volume becomes 29 ml and disappears in alkaline pyrogallol solution. What are the volume percent of O_2 in the original mixture?

(A) 90% (B) 10% (C) 18% (D) 2%

CSM128

30. 20 mL of a mixture of CO and H_2 were mixed with excess of O_2 and exploded & cooled. There was a volume contraction of 23 mL. All volume measurements correspond to room temperature (27°C) and one atmospheric pressure. Determine the volume ratio V_1: V_2 of CO and H_2 in the original mixture

(A) 6.5 : 13.5 (B) 5 : 15 (C) 9 : 11 (D) 7 : 13

CSM129

31. An alkene upon combustion produces $CO_2(g)$ and $H_2O(g)$. In this combustion process if there is no volume change occurs then the no. of C atoms per molecule of alkene will be :

(A) 2 (B) 5 (C) 3 (D) 4

CSM130

Vander Waal's gas equation

32. Vander Waal's constant '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

CSM134

33. In the Vander Waal's equation which will have highest value of 'a'.

(A) CH_4 (B) He (C) NH_3 (D) H_2

CSM135

34. In Vander Waal's equation of state of the gas law, the constant 'b' is a measure of :

(A) intermolecular repulsions (B) intermolecular attraction

(C) volume occupied by the molecules (D) intermolecular collisions per unit volume

CSM136

35. Pressure of real gas is less than the pressure of ideal gas because :

(A) No. of collisions increases (B) Definite shape of molecule

(C) K.E. of molecule increases (D) Inter molecular forces

CSM137

36. The correct expression for the Vander Waals equation of state is :

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

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

CSM138

37. At relatively high pressure, Vander Waals' equation reduces to :

(A) PV = RT (B) $PV=RT+\frac{a}{V}$

(C) PV = RT + Pb (D) $PV=RT-\frac{a}{V^2}$

CSM139

38. When does a real gas show behaviour same as ideal gas:

(A) At low temperature and low pressure (B) At high temperature and high pressure

(C) At low temperature and high pressure (D) At high temperature and low pressure

CSM140

39. A real gas obeying Vander Waal's equation will resemble ideal gas, if the :

(A) constants a & b are small (B) a is large & b is small

(C) a is small & b is large (D) constant a & b are large

CSM141

40. If 'V' is actual volume of 1 molecule of gas then, excluded volume (b) of 1 mole of gaseous molecule is -

(A) $4\ N_AV$ (B) N_AV (C) V/N_A (D) V

CSM142

Compressibility factor

41. At low pressure the Vander Waals equation is reduced to -

(A) $Z=\frac{pV_m}{RT}=1-\frac{a}{RTV_m}$ (B) $Z=\frac{pV_m}{RT}=1+\frac{a}{RT}p$

(C) $pV_m = RT$ (D) $Z=\frac{pV_m}{RT}=1-\frac{a}{RT}$

CSM143

42. A gas obeys P(V – b) = RT. Which of the following are correct about this gas?

I. Isochoric curves have slope = $\frac{R}{V-b}$

II. Isobaric curves have slope $\frac{R}{P}$ and intercept b.

III. For the gas compressibility factor = $1+\frac{Pb}{RT}$

IV. The attraction forces are overcome by repulsive forces.

(A) I (B) II, III (C) III (D) I, II, III, IV

CSM144

43. Consider the equation $Z = \frac{PV}{RT}$, Which of the following statements is correct :

(A) When Z > 1 real gas are easier to compress
(B) When Z = 1 real gas are easier to compress
(C) When Z > 1 real gas are difficult to compress
(D) When Z < 1 real gas are difficult to compress

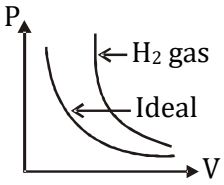
CSM145

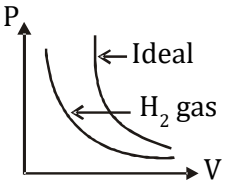
44. The third virial coefficient of a He gas is 4×10^{-2} (lit/mol)^2, then what will be volume of 2 mole He gas at 1 atm 273K (273K > TB)

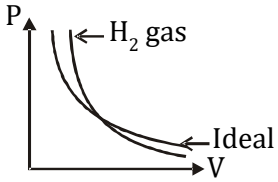
(A) 22.0 lit (B) 44.0 lit (C) 44.8 lit (D) 45.3 lit

CSM146

45. The correct graph to H_2 gas it :

(A) 

(B) 

(C) 

(D) All of these

CSM147

46. The volume of gas A is twice than that of gas B. The compressibility factor of gas A is thrice than that of gas B at same temperature. The pressures of the gases for equal number of moles are :

(A) $2P_A = 3P_B$ (B) $P_A = 3P_B$ (C) $P_A = 2P_B$ (D) $3P_A = 2P_B$

CSM148

47. Compressibility of real gas will be less than ideal gas when
(T = temp. of gas T_b = boyle's temperature of gas)

(A) At very high pressure when $T > T_b$ (B) At very high pressure when $T < T_b$
(C) At low pressure when $T > T_b$ (D) At low pressure when $T < T_b$

CSM149

Liquification & Critical Constants of Gas

48. Which gas can be easily liquefied ?
given 'a' for $NH_3 = 4.17$, $CO_2 = 3.59$, $SO_2 = 6.71$, $Cl_2 = 6.49$

(A) NH_3 (B) Cl_2 (C) SO_2 (D) CO_2

CSM153

49. From the below data what would be the decreasing order of liquefaction of these gases ?

Gases :	H_2	N_2	NH_3	CO_2
Critical temperature :	33.2 K	126 K	405.5 K	304.1 K

(A) NH_3, CO_2, N_2, H_2 (B) CO_2, NH_3, H_2, N_2 (C) NH_3, N_2, H_2, CO_2 (D) H_2, N_2, CO_2, NH_3

CSM154

50. Liquefaction of H_2 and He is difficult, why ?

(A) Critical temperature are too low
(B) Critical temperature are too high
(C) Statement is wrong
(D) Only H_2 can be liquified

CSM155

51. The values of critical temperatures of following gasses are given:

Gases :	H_2	He	O_2	N_2
TC(K)	33.2	5.2	154.3	126

From the above data arrange the given gases in the increasing order of ease of their liquification.

(A) O_2, N_2, H_2, He
(B) He, N_2, O_2, H_2
(C) He, H_2, N_2, O_2
(D) H_2, N_2, O_2, He

CSM156

52. Which of following statement (s) is true

I. Slope of isotherm at critical point is maximum.
II. Larger is the value of T_C easier is the liquification of gas.
III. Vander Waals equation of state is applicable below critical temperature at all pressure.

(A) only I
(B) I & II
(C) II & III
(D) only II

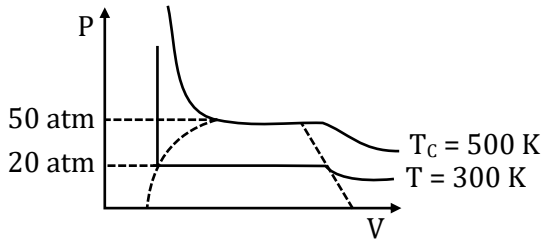
CSM157

53. If the critical constants for a hypothetical gas are V_C = 150 cm^3 mol^{-1}. P_C = 50 atm and T_C = 300K. Then the radius of the molecule is: [Take R = $\frac{1}{12}$ Ltr atm mol^{-1} K^{-1}]

(A) $\left(\frac{75}{2\pi N_A}\right)^{1/3}$
(B) $\left(\frac{75}{8\pi N_A}\right)^{1/3}$
(C) $\left(\frac{3}{\pi N_A}\right)^{1/3}$
(D) $\left(\frac{3}{256\pi N_A}\right)^{1/3}$

CSM158

54. For a real gas the P-V curve was experimentally plotted and it had the following appearance. With respect to liquefaction. Choose the correct statement.



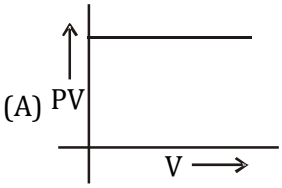
(A) at T = 500 K, P = 40 atm, the state will be liquid.
(B) at T = 300 K, P = 50 atm, the state will be gas
(C) at T < 300 K, P > 20 atm, the state will be gas
(D) at 300 K < T < 500 K, P > 50 atm, the state will be liquid.

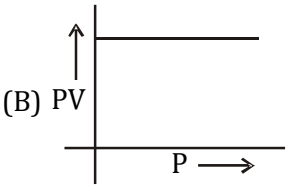
CSM159

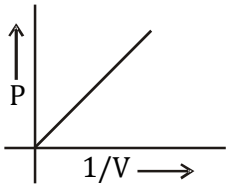
MULTIPLE CORRECT TYPE QUESTIONS

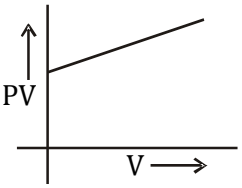
Problem related with piston/SPM

55. For gaseous state at constant temperature which of the following plot is correct ?

(A) 

(B) 

(C) 

(D) 

CSM105

56. In a closed rigid container, 3 mol of gas A and 1 mol of gas B are mixed at constant temperature. If 1 mol of another gas C at same temperature is introduced and all gases are considered to be non-reacting, then

(A) Partial pressure of gases A and B remain unaffected due to introduction of gas C.

(B) Ratio of total pressure before and after mixing of gas 'C' is $\frac{3}{5}$.

(C) If the total pressure of gas mixture before introducing gas 'C' is 20 atm, then the total gas pressure after mixing 'C' will be 25 atm.

(D) If data of option 'C' are used, then partial pressure of gas 'C' will be 5 atm.

CSM106

Kinetic theory of gases

57. Choose the correct statement(s) among the following -

(A) The mean free path (λ) of gaseous molecules is directly proportional to temperature of gas at constant volume

(B) The mean free path (λ) of gaseous molecules is inversely proportional to pressure of gas at constant volume

(C) The mean free path (λ) of gaseous molecules is directly proportional to volume of gas at constant T

(D) The mean free path (λ) of gaseous molecules is directly proportional to volume of gas at constant P

CSM131

Liquification & Critical Constants of Gas

58. Which of the following statements are correct ?

(A) It is not possible to compress a gas at a temperature below T_C

(B) At a temperature below T_C, the molecules are close enough for the attractive forces to act and condensation occurs

(C) No condensation takes place above T_C

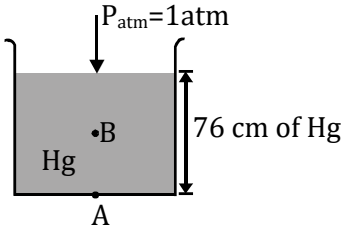
(D) Boyle's temperature always greater than T_C

CSM160

EXERCISE - S

Ideal Gas

1. An open tank is filled with Hg upto a height of 76cm.



Find the pressure at the bottom (A) of the tank. (If atmospheric pressure is 1 atm)

CSM099

2. A gas occupies 100.0 mL at 50°C and 1 atm pressure. The gas is cooled at constant pressure so that volume is reduced to 50.0 mL. What is the final temperature of the gas.

CSM100

3. Two vessels whose volumes are in the ratio 2 : 1 contain nitrogen and oxygen at 2500 mm and 1000 mm pressures respectively when they are connected together what will be the pressure of the resulting mixture (in meters) ?

CSM107

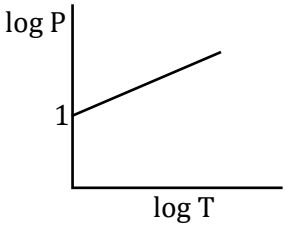
4. On a certain humid day, the mole fraction of water vapor in air at 25°C is 0.0287. If total pressure of air is 0.977 bar, calculate the partial pressure of water in air.

CSM108

5. A closed container containing O_2 and some liquid water was found to exert 740 mm pressure at 27°C. What will be the final pressure (in mm of Hg) if volume is reduced to half.
(consider volume of liquid water negligible, Given Aqueous tension of H_2O = 20 mm of Hg)

CSM109

6. In constant volume container of 0.821 litre, log P vs log T is plotted as shown in graph. Calculate number of moles of ideal gas present in container :



CSM110

7. The rates of diffusion of two gases A and B are in the ratio 1 : 4. If the ratio of their masses present in the mixture is 2 : 3. The ratio of their mole fraction is : ($9^{1/3}$ = 2.08)

CSM122

8. If V mL of a gaseous hydrocarbon, after explosion with excess of oxygen, showed a contraction of 2.5 V mL and a further contraction of 2 V mL with caustic potash, Find the number of H-atom in 1 molecule of hydrocarbon.

CSM132

9. The number of bimolecular collisions per cm^3 per second is Z_{11}. At constant temperature, by how much will Z_{11} change if the pressure is tripled in the vessel ?

CSM133

10. The compression factor (compressibility factor) for one mole of a Vander Waals' gas at 0° C and 100 atmosphere pressure is found to be 0.5. Assuming that the volume of a gas molecule is negligible, calculate the Van der Waals' constant 'a'.

CSM150

11. The Vander Waals constant for O_2 are a = 1.642 atm L^2 mol^{-2} and b = 0.04 L mol^{-1}. Calculate the temperature at which O_2 gas behaves ideally for longer range of pressure.

CSM151

12. Calculate molecular diameter for a gas if its molar excluded volume is 3.2 π ml. (in nanometer). Give the answer by multiplying with 10. (Take $N_A = 6.0 \times 10^{23}$)

CSM152

13. Critical constant of A gas

When pressure is increases at constant temp volume of gas decreases

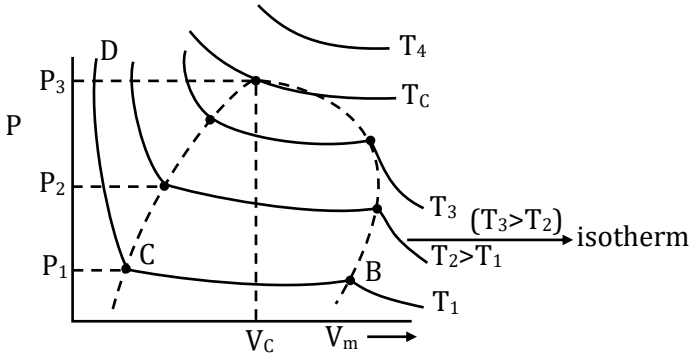
AB $\rightarrow$ gases, BC $\rightarrow$ vapour + liquid, CD $\rightarrow$ liquid

critical point : At this point all the physical properties of liquid phase will be same as the physical properties in vapour such as, density of liquid = density of vapour

T_C or critical temp : Temperature above which a gas cannot be liquified

P_C or critical pressure : minimum pressure which must be applied at critical temp to convert the gas into liquid.

V_C or critical volume : volume occupied by one mole of gas at T_C & P_C



If the ratio of PV_m & RT for a real gas is $\frac{x}{24}$ at a temp where $\left(\frac{\partial P}{\partial V_m}\right)$ = 0. The find value of 10x.

CSM161

14. The critical temperature and critical pressure of a gas are 31°C and 728 atmospheres respectively. Calculate the constants 'a' and 'b'.

CSM162

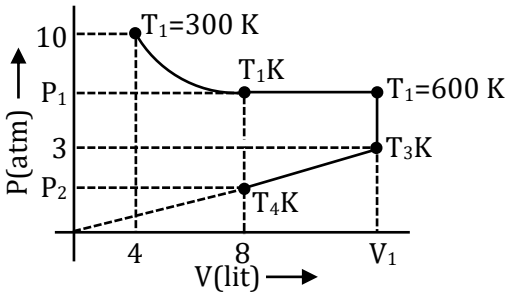
15. The degree of dissociation is 0.4 at 400K and 1 atm for the gaseous reaction :

$2HI(g) \rightarrow H_2(g) + I_2(g)$.

Assume ideal behaviour of all the gases, calculate the density (in gm/litre) of mixture at 400K and 1 atm **[At. wt. of Iodine = 127 ; Use R = 0.08 atm-litre/K-mole]**

CSM163

16. Fixed mass of a gas is subjected to the changes as shown is diagram, calculate T_3, T_4, P_1, P_2 and V_1 as shown is diagram. Considering gas obeys PV = nRT equation.



CSM164

17. A balloon containing 1 mole air at 1 atm initially is filled further with air till pressure increases to 3 atm. The initial diameter of the balloon is 1 m and the pressure at each state is proportion to diameter of the balloon. Calculate :

(a) No. of moles of air added to change the pressure from 1 atm to 3 atm.

(b) balloon will burst if either pressure increases to 7 atm or volume increases to 36p m3. Calculate the number of moles of air that must be added after initial condition to burst the balloon.

CSM165

18. One mole of NH_4Cl (s) is kept in an open container & then covered with a lid. The container is now heated to 600 K where all NH_4Cl (s) dissociates into NH_3 & HCl (g). The Volume of the container is 24.6 litres Assume that outside air is at 300 K and 1 atm pressure.

(i) What will be the final pressure (in atm) of gases inside the container.

(ii) Find whether the lid would stay or bounce off if it can with stand a pressure difference of 5.5 atm.

CSM166

19. One mole of an ideal gas is subjected to a process in which $P = \frac{1}{8.2}V$ where P is in atm & V in litre.

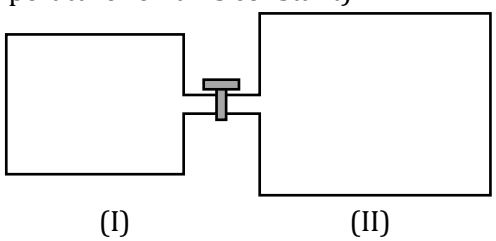
If the process is operating from 1 atm to finally 3 atm (no higher pressure achieved during the process) then what would be the maximum temperature (in °C) obtained.

CSM167

20. A compound exists in the gaseous state both as a monomer (A) and dimer (A_2). The molecular weight of the monomer is 48. In an experiment, 96 g of the compound was confined in a vessel of volume 33.6 litres and heated to 273° C. Calculate the pressure (in atm) developed, if the compound exists as a dimer to the extent of 50 per cent by weight, under these conditions.

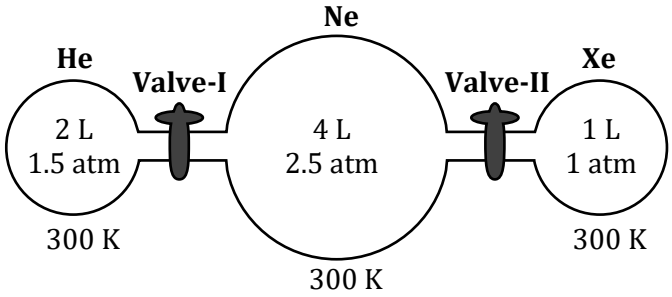
CSM168

21. Two container (I) & (II) with volume 2 litre & 3 litre are separated through a stopcock as shown in the diagram. Container (I) contains three gases A, B, & C with mole ratio 1 : 2 : 3 and total pressure 30 atm. If stopcock is opened then, calculate the pressure (in atm) of gas C in container (II). (Assume temperature remains constant)



CSM169

22. For the following diagram, calculate final pressure (in atm) when both valves are opened. Given that temperature (T) is same for each container.



CSM170

23. At 30°C dry air [75% N_2 + 25% O_2] is placed over H_2O (l) at 800 torr combined pressure of all 3 gases. If pressure is gradually increased isothermally to 1560 torr, then calculate partial pressure of O_2 at high pressure, in torr. [$V.P_{H_2O} = 40$ torr at 30°C].

CSM171

24. 16 gm of O_2 was filled in a container of capacity 8.2 lit. at 300 K. Calculate

(i) Pressure exerted by O_2 gas, in atm

(ii) Total pressure (in atm) of mixture of O_2 and O_3, if 50 % of oxygen is converted into ozone at same temperature.

(iii) Total pressure (in atm) exerted by gases, if 50% of oxygen is converted into ozone (O_3) at temperature 50 K.

CSM172

25. To an evacuated vessel with movable piston under external pressure of 1 atm., 0.1 mol of He and 1.0 mol of an unknown compound (vapour pressure 0.68 atm. at 0°C) are introduced. Considering the ideal gas behaviour, the total volume (in litre) of the gases at 0°C is close to

CSM173

26. Find the number of diffusion steps required to separate the isotopic mixture initially containing some amount of H_2 gas and 1 mol of D_2 gas in a container of 3 litre capacity maintained at 24.6 atm & 27 °C to the final mass ratio $\left(\frac{w_{D_2}}{w_{H_2}}\right)$ equal to $\frac{1}{4}$.

CSM174

27. The average speed of molecules in a sample of ozone gas is $1.8^4 \times 10^4$ cm s^{-1}. The average translational kinetic energy per molecules is xJ. The value of $\frac{x}{2} \times 10^{22}$ is

(Given : $N_A = 6 \times 1023$; $\sqrt{\frac{8}{3\pi}} = 0.92$)

CSM175

28. H_2 gas is kept inside a container A and container B each having volume 2 litre under different conditions which are described below. Determining the missing values with proper unit.
[R = 8 J mol^{-1} K^{-1} and $N_A = 6 \times 10^{23}$, N = No. of molecules]

Parameter	Container A	Container B
P	(i) ----------	1 atm
T	300 K	600 K
N	6×10^{20}	(ii) ----------
Total Average KE	(iii) ----------	(iv) ----------
Ratio U_{mps}	(v) ----------	
Ratio Z_{11}	(vi) ----------	

CSM176

Real Gas

29. The density of mercury is 13.6 g/cm^3. Estimate the value of 'b' (in cm^3/ mole). (Hg = 200)

CSM177

30. The molarity of O_2 gas at 72 atm and 300K is 6M. Calculate the value of Z for O_2.
(Use : R = 0.08 atm-litre/K-mole).

CSM178

31. Calculate the amount of He (in gm) present in the 10 litre container at 240 atm and 300K. Given value of "b" for He is 0.08 dm^3 mol^{-1}. (R = 0.08 atm lit mol^{-1} K^{-1})

CSM179

32. For a real gas (mol. mass = 30) if density at critical point is 0.40 g/cm^3 and its $T_c = \frac{10^4}{41}$ K, then calculate Van der Waals constant a (in atm L^2mol^{-2}).

CSM180

33. Calculate the volume (in L) occupied by 0.2 mole of a Vander waal gas at 27°C and 0.082 atm.
[a = 4.10 L^2 atm mol^{-2}, b = $\frac{1}{6}$ $Lmol^{-1}$]

CSM181

34. At what pressure (in atm) and 127°C, the density of O_2 gas becomes 1.6 g/L ?
[a = 4.0 atm L^2 mol^{-2}, b = 0.4 $Lmol^{-1}$, R = 0.08 L - atm/ K-mol]

CSM182

EXERCISE - JEE (Advanced) PYQ

1. The compressibility of a gas is less than unity at STP. Therefore : **[JEE (Advanced) 2000]**

(A) $V_m > 22.4$ L (B) $V_m < 22.4$ L (C) $V_m = 22.4$ L (D) $V_m = 44.8$ L

CSM071

2. The r.m.s. velocity of hydrogen is $\sqrt{7}$ times the r.m.s. velocity of nitrogen. If T is the temperature of the gas : **[JEE (Advanced) 2000]**

(A) $T(H_2) = T(N_2)$ (B) $T(H_2) > T(N_2)$ (C) $T(H_2) < T(N_2)$ (D) $T(H_2) = \sqrt{7}\,T(N_2)$

CSM072

3. The pressure of a fixed amount of an ideal gas is proportional to its temperature. Frequency of collision and their impact both increase in proportion to the square root of temperature. True/False. **[JEE (Advanced) 2000]**

CSM073

4. The root mean square velocity of an ideal gas at constant pressure varies with density as : **[JEE (Advanced) 2001]**

(A) d^2 (B) d (C) $d^{1/2}$ (D) $1/d^{1/2}$

CSM074

5. The average velocity of gas molecules is 400 m/sec. Calculate its (rms) velocity at the same temperature. **[JEE (Advanced) 2003]**

CSM075

6. Positive deviation from ideal behaviour takes place because of. **[JEE (Advanced) 2003]**

(A) molecular interaction between atoms and $\frac{PV}{nRT} > 1$

(B) molecular interaction between atoms and $\frac{PV}{nRT} < 1$

(C) finite size of atoms and $\frac{PV}{nRT} > 1$

(D) finite size of atoms and $\frac{PV}{nRT} < 1$

CSM076

7. The ratio of the rate of diffusion of helium and methane under identical condition of pressure and temperature will be : **[JEE (Advanced) 2005]**

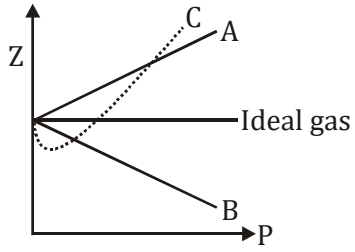
(A) 4 (B) 2 (C) 1 (D) 0.5

CSM077

8. For a real gas obeying Vander Waal's equation, a graph is plotted between PV_m (y-axis) and P(x-axis) where V_m is molar volume. Find y-intercept of the graph. **[JEE (Advanced) 2005]**

CSM078

9.



where $Z = \frac{PV}{nRT}$,

a = Vander Waal's constant for pressure correction

b = Vander Waal's constant for volume correction

Pick the only incorrect statement **[JEE (Advanced) 2006]**

(A) for gas A, if a = 0, the compressibility factor is directly proportional to pressure

(B) for gas B, if b = 0, the compressibility factor is directly proportional to pressure

(C) for gas C, $a \neq 0$, $b \neq 0$, it can be used to calculate a and b by giving lowest P value and its intercept with Z = 1.

(D) slope for all three gases at high pressure (not shown in graph) is positive.

CSM079

10. Match gases under specific conditions listed in Column I with their properties / laws in Column II. Indicate your answer by darkening the appropriate bubbles of the 4 × 4 matrix given in the ORS.

Column I	**Column II**
(A) Hydrogen gas (P = 200 atm, T = 273 K)	(P) Compressibility factor ≠ 1
(B) Hydrogen gas (P ~ 0, T = 273 K)	(Q) Attractive forces are dominant
(C) CO_2 (P = 1 atm, T = 273 K)	(R) PV = nRT
(D) Real gas with very large molar volume	(S) P (V– nb) = nRT

[JEE (Advanced) 2007]

(A) (A) → (P), (R); (B) → (P); (C) → (R), (Q); (D) → (Q)

(B) (A) → (Q), (S); (B) → (Q); (C) → (R), (S); (D) → (P)

(C) (A) → (R), (S); (B) → (S); (C) → (P), (R); (D) → (S)

(D) (A) → (P), (S); (B) → (R); (C) → (P), (Q); (D) → (R)

CSM080

11. A gas described by Vander Waals equation **[JEE (Advanced) 2008]**

(A) behaves similar to an ideal gas in the limit of large molar volumes

(B) behaves similar to an ideal gas in the limit of large pressures

(C) is characterised by Vander Waals coefficients that are dependent on the identity of the gas but are independent of the temperature

(D) has the pressure that is lower than the pressure exerted by the same gas behaving ideally

CSM081

12. The term that corrects for the attractive forces present in a real gas in the Vander Waals equation is **[JEE (Advanced) 2009]**

(A) nb (B) $\frac{an^2}{V^2}$ (C) $-\frac{an^2}{V^2}$ (D) –nb

CSM082

13. At 400 K, the root mean square (rms) speed of a gas X (molecular weight = 40) is equal to the most probable speed of gas Y at 60 K. The molecular weight of the gas Y is **[JEE (Advanced) 2009]**

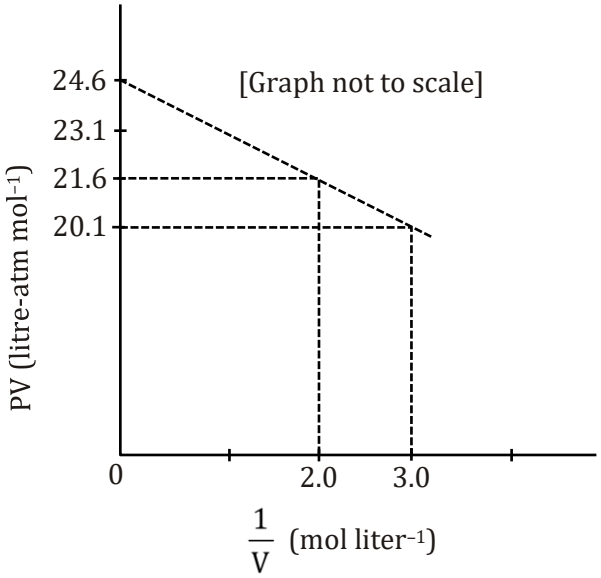
CSM083

14. To an evacuated vessel with movable piston under external pressure of 1 atm., 0.1 mol of He and 1.0 mol of an unknown compound (vapour pressure 0.68 atm. at 0°C) are introduced. Considering the ideal gas behaviour, the total volume (in litre) of the gases at 0°C is close to

[JEE (Advanced) 2011]

CSM084

15. For one mole of a Vander Waals gas when b = 0 and T = 300 K, the PV vs. 1/V plot is shown below. The value of the Vander Waals constant a (atm. liter^2 mol^{-2}) is **[JEE (Advanced) 2012]**

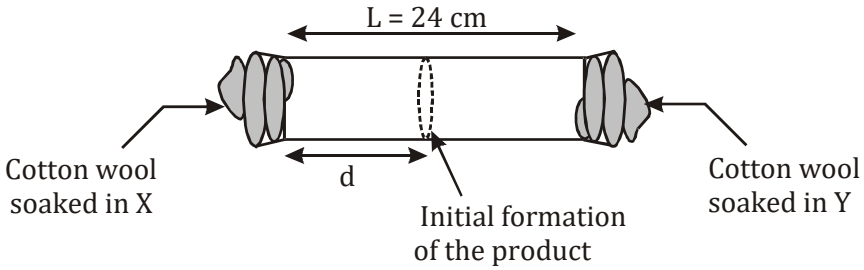


(A) 1.0 (B) 4.5 (C) 1.5 (D) 3.0

CSM085

Paragraph for Question 16 & 17

X and Y are two volatile liquids with molar weights of 10g mol^{-1} and 40g mol^{-1} respectively. Two cotton plugs, one soaked in X and the other soaked in Y, are simultaneously placed at the ends of a tube of length L = 24 cm, as shown in the figure. The tube is filled with an inert gas at 1 atmosphere pressure and a temperature of 300K. Vapours of X and Y react to form a product which is first observed at a distance d cm from the plug soaked in X. Take X and Y to have equal molecular diameters and assume ideal behaviour for the inert gas and the two vapours.



16. The value of d in cm (shown in the figure), as estimated from Graham's law, is –

[JEE (Advanced) 2014]

(A) 8 (B) 12 (C) 16 (D) 20

CSM086

17. The experimental value of d is found to be smaller than the estimate obtained using Graham's law. This is due to – **[JEE (Advanced) 2014]**

(A) Larger mean free path for X as compared to that of Y

(B) Larger mean free path for Y as compared to that of X

(C) Increased collision frequency of Y with the inert gas as compared to that of X with the inert gas

(D) Increased collision frequency of X with the inert gas as compared to that of Y with the inert gas

CSM087

18. A closed tank has two compartments A and B, both filled with oxygen (assumed to be ideal gas). The partition separating the two compartments is fixed and is a perfect heat insulator (Figure 1). If the old partition is replaced by a new partition which can slide and conduct heat but does NOT allow the gas to leak across (Figure 2), the volume (in m^3) of the compartment A after the system attains equilibrium is____. **[JEE (Advanced) 2018]**

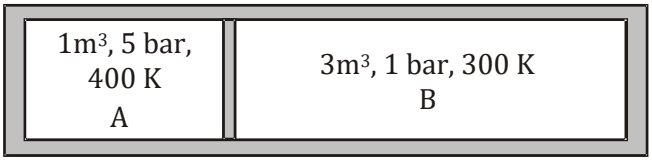


Figure 1

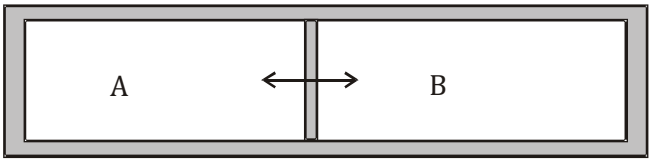


Figure 2

CSM088

19. Which of the following statement(s) is (are) correct regarding the root mean square speed (U_{rms}) and average translational kinetic energy (ε_{av}) of a molecule in a gas at equilibrium? **[JEE (Advanced) 2019]**

(A) U_{rms} is doubled when its temperature is increased four times

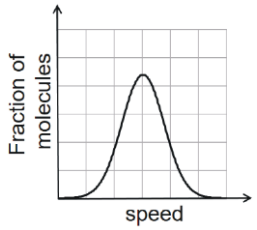
(B) ε_{av} at a given temperature does not depend on its molecular mass

(C) U_{rms} is inversely proportional to the square root of its molecular mass

(D) ε_{av} is doubled when its temperature is increased four times

CSM089

20. If the distribution of molecular speeds of a gas is as per the figure shown below, then the ratio of the most probable, the average and the roots mean square speeds, respectively, is **[JEE (Advanced) 2020]**



(A) 1 : 1 : 1 (B) 1 : 1 : 1.224 (C) 1 : 1.128 : 1.224 (D) 1 : 1.128 : 1

CSM090

JEE (Advanced) Practice Paper

This paper is for yourself practice and assessment the discussion of this paper is optional though you can see PDF solutions or video solutions or solutions in hardcopy whichever is provided.

SECTION–I

- This section contains **SIX** questions.
- Each question has FOUR options (A), (B), (C) and (D). ONLY ONE of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories:

Full Marks : +3, if only the bubble corresponding to the correct option is darkened.

Zero Marks : 0, if none of the bubbles is darkened.

Negative Marks : –1 in all other cases

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1. 5 L of a sample of a gas at 27°C and 1 bar pressure is compressed to a volume of 1000 mL keeping the temperature constant. The percentage increase in pressure is :

(A) 100 %
(B) 400 %
(C) 500 %
(D) 80 %

CSM051

2. A gaseous reaction,

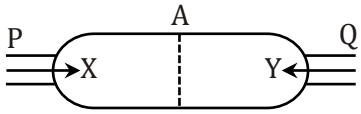
$3A \longrightarrow 2B$

is carried out in a 0.082 litre closed container initially containing 1 mole of gas A. After sufficient time a curve of P (atm) vs T (K) is plotted and the angle with x-axis was found to be 42.95°. The degree of association of gas A is **[Given : tan 42.95 = 0.8]**

(A) 0.4
(B) 0.6
(C) 0.5
(D) 0.8

CSM052

3. 3 mole of gas "X" and 2 moles of gas "Y enters from end "P" and "Q" of the cylinder respectively. The cylinder has the area of cross-section A, shown as under –

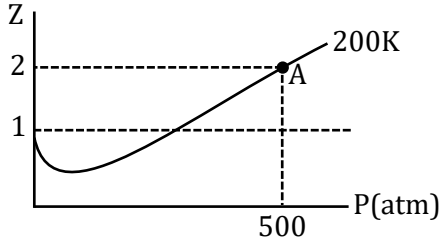


The length of the cylinder is 150 cm. The gas "X" intermixes with gas "Y" at the point A. If the molecular weight of the gases X and Y is 20 and 80 respectively, then what will be the distance of point A from Q?

(A) 75 cm
(B) 50 cm
(C) 37.5 cm
(D) 90 cm

CSM053

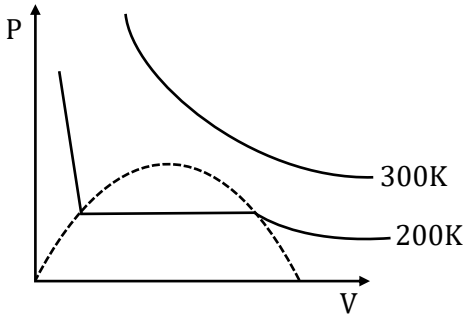
4. 'Z' v/s 'P' graph is plotted for 1 mole of hypothetical gas. The volume of gas at point 'A' is [R = 0.08 atmL/mole-K]



(A) 0.01 L (B) 0.09 L (C) 0.064 L (D) 0.64 L

CSM054

5. 'P' v/s 'V' graph is plotted for 1 mole of hypothetical gas. Range of a/b for this gas in (atm-L/mole). [R = 0.08 atm- litre / mole-K]



(A) $54 < \left(\frac{a}{b}\right) < 81$ (B) $27 < \left(\frac{a}{b}\right) < 42$ (C) $40 < \left(\frac{a}{b}\right) < 65$ (D) $13.5 < \left(\frac{a}{b}\right) < 40.5$

CSM055

6. The % by volume of C_4H_{10} in a gaseous mixture of C_4H_{10}, CH_4 and CO is 40. When 200 ml of the mixture is burnt excess of O_2. find volume (in ml) of CO_2 produced.

(A) 220 (B) 340 (C) 440 (D) 560

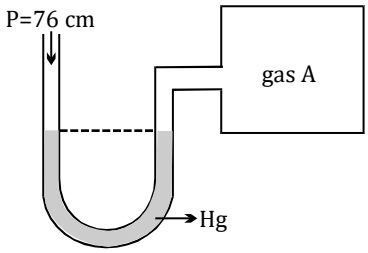
CSM056

SECTION-II

- This section contains **SIX** questions.
- Each question has **FOUR** options for correct answer(s). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct option(s).
- For each question, choose the correct option(s) to answer the question.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks	: +4, if only (all) the correct option(s) is (are) chosen.
Partial Marks	: +3, if all the four options are correct but ONLY three options are chosen.
Partial Marks	: +2, if three or more options are correct but ONLY two options are chosen, both of which are correct options.
Partial Marks	: +1, if two or more options are correct but ONLY one option is chosen and it is a correct option.
Zero Marks	: 0, if none of the options is chosen (i.e. the question is unanswered).
Negative Marks	: –2 in all other cases.

7. An open ended mercury manometer is used to measure the pressure exerted by a trapped gas as shown in the figure. Initially manometer shows no difference in mercury level in both columns as shown in diagram.



After sparking 'A' dissociates according to following reaction

$$2A(g) \longrightarrow 3B(g) + 2C(g)$$

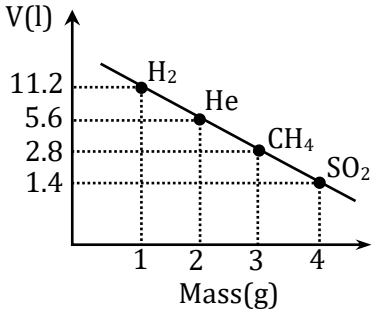
If pressure of Gas "A" decreases to 0.8 atm. Then (Assume temperature to be constant and is 300 K)

(A) total pressure increased by 1.3 atm (B) total pressure increased by 0.3 atm

(C) total pressure increased by 22.3 cm of Hg (D) difference in mercury level is 228 mm.

CSM057

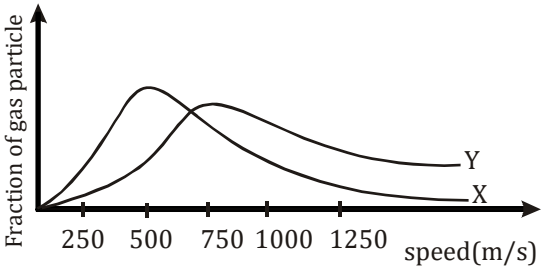
8. At 1 atm and 273°C following is graphical representation of volume occupied by different gases. Which is not correctly matched ?



(A) H_2 (B) He (C) CH_4 (D) SO_2

CSM058

9. The graph below shows the distribution of molecular speed of two ideal gases X and Y at 200K. on the basis of the below graph identify the correct statements –



(A) If gas X is methane, then gas Y can be CO_2

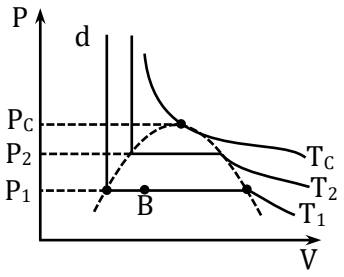
(B) Fraction of molecules of X must be greater than Y in a particular range of speed at 200K

(C) Under identical conditions rate of effusion of Y is greater than that of X

(D) The molar kinetic energy of gas X at 200K is equal to the molar kinetic energy of Y at 200K

CSM059

10. Select the correct statements on the basis of curve given above for real gas (A)



(A) For 1 mol $V_C = \frac{48}{3}\pi r^3 \times N_A$

(B) Difference in densities of liquid and gas at T_2 & P_2 is less than that at T_1 and P_1

(C) At temperature T_C and pressure P_C density of gas & liquid becomes almost equal

(D) At point 'B' substance A exist in liquid state only

CSM060

11. A mixture of $C_3H_8(g)$ & O_2 having total volume 100 ml in a Eudiometry tube is sparked & it is observed that a contraction of 45 ml is observed what can be the composition of reacting mixture.

(A) 15 ml **C_3H_8** & **85 ml O_2**

(B) 25 ml **C_3H_8** & **75 ml O_2**

(C) 45 ml **C_3H_8** & **55 ml O_2**

(D) 55 ml **C_3H_8** & **45 ml O_2**

CSM061

12. 100 ml mixture of CO and CO_2 mixed with 30 ml of O_2 and sparked in eudiometer tube. The residual gas after treatment with aq. KOH has a volume of 10 ml which remains unchanged when treated with alkaline pyrogallol. If all the volumes are under the same conditions, point out correct options(s):

(A) The volume of CO that reacts, is 60 ml

(B) The volume of CO that remains unreacted, is 10 ml

(C) The volume of **O_2** that remains unreacted, is 10 ml

(D) The volume of **CO_2** that gets absorbed by aq. KOH, is 90 ml.

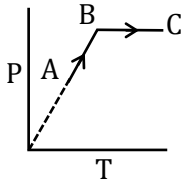
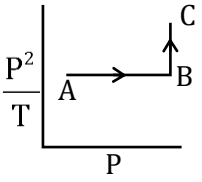
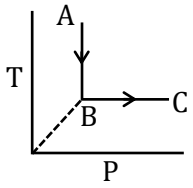
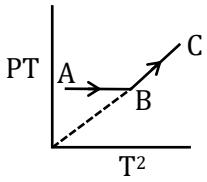
CSM062

SECTION–III

- This section contains **a** questions.
- **Each question has matching lists.** The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**
- For each question, marks will be awarded in one of the following categories :

Full Marks	: +3, if only the bubble corresponding to the correct option is darkened.
Zero Marks	: 0, if none of the bubbles is darkened.
Negative Marks	: –1 in all other cases.

13. The following graphs are plotted for an ideal gas taken from state A to state B and then to state C, maintaining volume constant.

Column-I		Column-II	
(P)		(1)	Moles first increases and then further increases
(Q)		(2)	Moles first remains constant and then decreases
(R)		(3)	Moles first decreases and then remains constant
(S)		(4)	Moles first decreases and then increases

(A) P → 3; Q → 2; R → 4; S → 1
(B) P → 2; Q → 4; R → 1; S → 3
(C) P → 3; Q → 4; R → 1; S → 2
(D) P → 2; Q → 3; R → 1; S → 4

CSM063

SECTION–IV

- This section contains **A** question of matching type.
- This section contains **One** table (having 3 columns and 4 rows)
- Based on table, there are **THREE** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories :

Full Marks : +3 if only the bubble corresponding to the correct option is darkened.
Zero Marks : 0 if none of the bubbles is darkened.
Negative Marks : –1 in all other cases.

Answer Q.14, Q.15 and Q.16 by appropriately matching the information given in the three columns of the following table. The following column gives the value of Vander Waal's constant 'a' and 'b' for some gases (not necessarily in order)

Column-1 (Gases)		Column-2 $a\left(\frac{atm \times l^2}{mol^2}\right)$		Column-3 b(l/mole)	
(P)	NH_3	(I)	0.0346	(i)	0.037
(Q)	H_2O	(II)	4.17	(ii)	0.0238
(R)	He	(III)	5.53	(iii)	0.03049
(S)	C_5H_{12}	(IV)	19.2	(iv)	0.15

14. Which of the following is correct match

(A) P → II → i (B) Q → I → ii (C) R → IV → iii (D) S → II → iv

CSM064

15. Which among the gases in column I is most easily liquified ?

(A) P (B) Q (C) R (D) S

CSM065

16. Using appropriate data from the above column find critical temperature of C_5H_{12} gas

(A) 462 K (B) 310 K (C) 1224 K (D) 2 K

CSM066

SECTION-V

- This section contains **a** paragraph.
- Based on each paragraph, there are **TWO** questions.
- Each question has **FOUR** options (A), (B), (C) and (D) **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories :

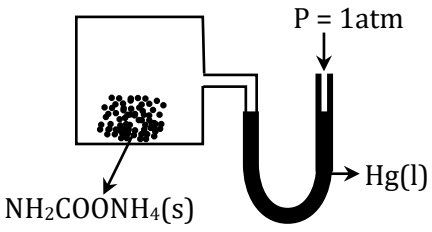
Full Marks : +3, if only the bubble corresponding to the correct answer is darkened.

Zero Marks : 0 in all other cases.

Paragraph for Questions 17 and 18

A manometer attached to 36 litre flask contains some inert gas & ammonium carbamate [$NH_2COONH_4(s)$] having no difference in mercury level initially as shown. $NH_2COONH_4(s)$decomposed completely on heating according to reaction

$$NH_2COONH_4(s) \rightarrow 2NH_3(g) + CO_2(g)$$



.

If same amount of $NH_2COONH_4(s)$ is decomposed completely in separate container and produced $NH_3(g)$, required 500 ml of $\frac{2M}{3}H_3PO_4$ solution for complete neutralisation. During the process temperature remains at 300K. [R= 0.08 atm-litre $mole^{-1}$ K^{-1}, 1atm = 76 cm of Hg]

17. Number of moles of $CO_2(g)$ produced is

(A) 0.75 (B) 1.50 (C) 1.00 (D) 0.50

CSM067

18. The difference in height of Hg column (in mm) after complete decomposition of $NH_2COONH_4(s)$ is:

(A) 760.00 (B) 750.00 (C) 700.00 (D) 730.00

CSM068

SECTION–VI

- This section contains **TWO** questions.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g. 6.25, 7.00, –0.33, –.30, 30.27, –127.30, if answer is 11.36777..... then both 11.36 and 11.37 will be correct).
- Answer to each question will be evaluated according to the following marking scheme:

  Full Marks : +3, if ONLY the correct numerical value is entered as answer.

  Zero Marks : 0 in all other cases.

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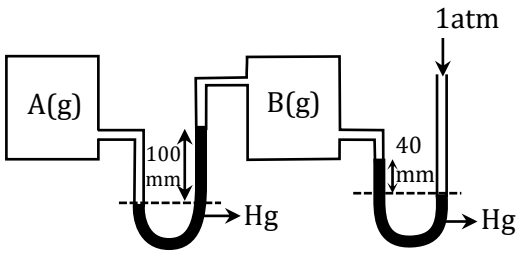
19. Calculate the change in pressure (in atm) when 2 mol of NO and 16 gm O_2 in a 6.25 litre originally at 27°C react to produce the maximum quantity of NO_2 possible according to the reaction,

$2NO(g) + O_2(g) \rightarrow 2NO(g)$ (Take R = $\frac{1}{12}$ litre atm / mol K)

CSM069

20. At 300 K, two gases are filled in two equal sized containers as given.



What will be the pressure of A(g) (in mm of Hg).

CSM070

Answer Key

EXERCISE - O

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	C	A	B	D	C	B	A	A	C	B
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	D	A	D	B	A	D	A	C	A	D
Que.	21	22	23	24	25	26	27	28	29	30
Ans.	B	C	A	A	A	C	B	D	B	D
Que.	31	32	33	34	35	36	37	38	39	40
Ans.	A	D	C	C	D	D	C	D	A	A
Que.	41	42	43	44	45	46	47	48	49	50
Ans.	A	D	C	D	A	A	D	C	A	A
Que.	51	52	53	54	55	56	57	58		
Ans.	C	B	D	D	ABC	ACD	CD	BCD		

EXERCISE - S

Ideal Gas

1. (2) **2.** (–111.5) **3.** (2) **4.** (0.028)

5. (1460) **6.** (100) **7.** (0.347) **8.** (6)

9. (9) **10.** (1.256) **11.** (500) **12.** (2)

13. (9) **14.** (0.36 and 0.00428) **15.** (4.00)

16. (T_3 = 360.00, T_4 = 90.00, P_1 = 5.00, P_2 = 1.50, V_1 = 16.00)

17. **a.** (80.00), **b.** (1295.00) **18.** **i.** (6.00), **ii.** (No) **19.** (627.00) **20.** (2.00)

21. (6.00) **22.** (2.00) **23.** (380.00)

24. **i.** (1.50), **ii.** (1.25), **iii.** (0.20 or 0.21) **25.** (7.00) **26.** (4.00)

27. (8.00)

28. **i.** (0.012 atm), **ii.** (2.50×10^{22}), **iii.** (3.60 J), **iv.** (300.00 J), **v.** ($1 : \sqrt{2}$), **vi.** (1 : 2500)

Real Gas

29. (58.82) **30.** (0.50) **31.** (222.22) **32.** (1.68 or 1.69)

33. (60.00) **34.** (1.62)

EXERCISE - JEE (Advanced) PYQs

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	B	C	T	D	434.17	C	B	RT	B	D
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	ACD	B	4	7	C	C	D	2.22	ABC	B

JEE (Advanced) Practice Paper

Section-I	**Q.**	**1**	**2**	**3**	**4**	**5**	**6**
	A.	B	B	C	C	A	C
Section-II	**Q.**	**7**	**8**	**9**	**10**	**11**	**12**
	A.	BD	ABCD	CD	ABC	AB	ABD
Section-III	**Q.**	**13**					
	A.	B					
Section-IV	**Q.**	**14**	**15**	**16**			
	A.	A	D	A			
Section-V	**Q.**	**17**	**18**				
	A.	D	A				
Section-VI	**Q.**	**19**	**20**				
	A.	2.00	820.00				