PHYSICS

BOOKS - HC VERMA PHYSICS (ENGLISH)

KINETIC THEORY OF GASES

Objective I 1

1. Which of the following paramenters is the same for molecules of all gases at a given temperature?

A. (a)mass

B. (b)Speed

C. (c)Momentum

D. (d)Kinetic energy.

Answer: D

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2. A gas behaves more closely as an ideal gas at (a)low pressure and low temperature. (b)low pressure and high temperature (c) high pressure and low temperature (d) high pressure and high temperature

A. (a)low pressure and low temperature

B. (b)low pressure and high temperature

C. (c)high pressure and low temperature

D. (d)high pressure and high temperature.

Answer: B

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3. The pressure of an ideal gas is written as $p = \frac{2E}{3V}$.Here E refers to

A. (a)translational kinetic energy

B. (b)rotational kinetic energy

C. (c)vibrational kinetic energy

D. (d)total kinetic energy.

Answer: A

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4. The energy of a given sample of an ideal gas depends only on its

A. (a)volume

B. (b)pressure

C. (c) density

D. (d)temperature

Answer: D

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5. Which of the following gases has maximum rms speed at a given temperature?

A. (a)hydrogen

B. (b)nitrogen

C. (c)oxygen

D. (d)carbon dioxide

Answer: A

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6. The mean square speed of the molecules of a gas at absolute temperature T is proportional to

A. (a)(1)/(T)

B. (b)sqrtT

C. (c)T

D. (d)T^(2)

Answer: C

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7. Suppose a container is evacuated to leave just one molecule of a gas in it. Let v_{mp} and v_{av} represent the most probable speed and the average speed of the gas, then

A. (a)$v_a > v_{rms}$

B. (b)$v_a < v_{rms}$

C. (c)$v_a = v_{rms}$

D. (d)v_{rms} is underfined.

Answer: C

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8. The rms speed of oxygen at room temperature is about 500m/s. The rms speed of hydrogen at the same temperature is about

A. (a)$125ms^{-1}$

B. (b)$2000ms^{-1}$

C. (c)$8000ms^{-1}$

D. (d)$31ms^{-1}$

Answer: B

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9. The pressure of a gas kept in an isothermal container is 200Kpa. If half the gas is removed from it, the pressure will be

A. (a)$100kPa$

B. (b)$200kPa$

C. (c)$400kPa$

D. (d)$800 kPa$

Answer: A

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10. The rms speed of oxygen molecules in a gas in a gas is v. If the temperature is doubled and the oxygen molecules dissociate into oxygen atoms, the rms speed will become

A. (a)v

B. (b)$v\sqrt{2}$

C. (c)$2v$

D. (d)$4v$

Answer: C

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11. The quantity(pV)/(kt) represents

A. (a)mass of the gas

B. (b)kinetic energy of the gas

C. (c)number of moles of a the gas

D. (d)number of molecules in the gas.

Answer: D

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12. There is some liquid in a closed bottle. The amount of liquid is continuously decreasing. The vapor in the remaining part

A. (a)must be saturated

B. (b)must be unsaturated

C. (c)may be saturated

D. (d)there will be no vapour.

Answer: B

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13. There is some liquid in a closed bottle. The amount of liquid remains constant as time passes. The vapor in the remaining part.

A. (a)must be saturated

B. (b)must be unsaturated

C. (c)may be unsaturated

D. (d)there will be no vapour.

Answer: A

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14. Vapor is injected at a uniform rate in a closed vessel which was initially evacuated. The pressure in the vessel

A. (a)increases continuously

B. (b)decreases continuously

C. (c)first increases and then decreases

D. (d)first increases and then becomes constant.

Answer: D

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15. A vessel A has volume V and a vessel B has volume 2V. Both contain some water which has constant volume. The pressure in the space above water is p_a for vessel A and p_b for vessel B.

A. (a)$p_a = p_b$

B. (b)$p_a = 2p_b$

C. (c)$p_b = 2p_a$

D. (d)$p_b = 4p_a$

Answer: A

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Objective I 2

1. Consider a collision between an argon molecule and a nitrogen molecule in a mixture of argon and nitrogen kept at room temperature. Which of the following are possible?

A. (a)The kinetic energies of both the molecules increase.

B. (b)the kinetic energies of both the molecules decrease.

C. (c)Kinetic energy of the oxygen molecule increases and that of the hydrogen molecule decreases.

D. (d)The kinetic energy of the hydrogen molecule increases and that of the oxygen molecule decreases.

Answer: C::D

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2. Consider a mixture of oxygen and hydrogen kept at room temperature, As compared to a hydrogen molecule an oxygen molecule hits the wall

A. (a)with greater average speed

B. (b)with smaller average speed

C. (c)with greater average kinetic energy

D. (d)with smaller average kinetic energy.

Answer: B

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3. Which of the following quantities is zero on an average for the molecules of an ideal gas in equilibrium?

A. (a)Kinetic energy

B. (b)Momentum

C. (c)denesity

D. (d)speed

Answer: B

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4. keeping the number of moles, volume and temperature the same, which of the following are the same for all ideal gases?

A. (a)Rms speed of a molecule

B. (b)Density

C. (c)pressure

D. (d)Average magnitude of momentum.

Answer: C

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5. Which of the following quantities is the same for all ideal gases at the same temperature?

A. (a)the kinetic energy of 1 mole

B. (b)The kinetic energy of 1 g

C. (c)The number of molecules in 1mole

D. (d)The number of molecules in 1g.

Answer: A::C

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6. Consider the quantity $\frac{MkT}{pV}$ of an ideal gas where M is the mass of the gas. It depends on the

A. (a)temperature of the gas

B. (b)volume of the gas

C. (c)pressure of the gas

D. (d)nature of the gas

Answer: D

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Exercise

1. Calculate the volume of 1 mole of an ideal gas at STP.

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2. Find the number of molecules of an ideal gas in a volume of $1.000 cm^3$ at STP.

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3. Find the number of molecules in $1cm^3$ of an ideal gas at $0^\circ C$and at a pressure of $10^{-5}mm$ of mercury.

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4. Caculate the mass of $1cm^3$ of oxygen kept at STP.

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5. Equal masses of air are sealed in two vessels, one if volume $V_0$and the other of volume $2V_0$.If the first vessel is maintained at a temperature 300K and the other at 600K, find the ratio of the pressures in the two vessels.

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6. An electric bulb of volume 250cc was sealed during manufacturing at a pressure of 10^{-3}mm of mercury at 27°C. Compute the number of air molecules contained in the bulb.Avogadro constant $= 6 \times 10^{23} mol^{-1}$, density of mercury $= 13600 kgm^{-3}$ and $g = 10 ms^{-2}$.

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7. A gas cylinder has walls that can bear a maximum pressure of 1.0×10^{6} Pa. It contains a gas at 8.0×10^{5}Pa and 300K. The cylinder is steadily heated. Neglecting any change in the volume calculate the temperature at which the cylinder will break.

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8. 2g of hydrogen is sealed in a vessel of volume $0.02m^{3}$and is maintained at 300K. Calculate the pressure in the vessel.

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9. The density of an ideal gas is $1.25 \times 10^{-3} gcm^{-3}$ at STP. Calculate the molecular weight of the gas.

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10. The temperature and pressure at Simla are $15.0^{\circ} C$ and 72.0cm of mercury and at Kalka these are $35.0^{\circ} C$ and 76.0 cm of mercury. Find the ratio of air density at Kalka to the air density at Simla.

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11. Shows a cylindrical tube with adiabatic walls and fittled with a diathermic separetor. The separetor can be slid in the tube by and external mechanism. An ideal gas is injected into the two sides at equal pressures and equal temperatures. The separetor remaons in equilibrium at the middle. It is now slid to pisition where it devides the tube in the ratio of 1:3. Find the ratio of the pressures in the two parts of the vessel.

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12. Find the rms speed of hydrogen gas at 300K. Find the temperature at which the rms speed is double the speed calculated in the previous part.

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13. A sample of 0.177g of an ideal gas occupies $1000cm^3$ at STP. Caculate the rms speed of gas molecules.

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14. The average translational kinetic energy of air molecules is $0.040eV\left(1eV = 1.6 \times 10^{-19}J\right)$. Calculate the temperature of the air. Blozmann constant $K = 1.38 \times 10^{-23}JK^{-1}$.

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15. Consider a sample fo oxygen at 300K. Find the average time taken by a molecule to travel a distance equal to the diameter of the earth.

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16. Find the average magnitude of linear momentum of a helium molecule in a sample of helium gas at $0^\circ C$. Mass of a helium molecule $= 6.64 \times 10^{-27} kg$and Blotzmann constant $= 1.38 \times 10^{-23} JK^{-1}$.

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17. The mean speed of the molecules of a hydrogen sample equals the mean speed of the molecules of a helium sample. Calculate the ratio of the temperature of the hydrogen sample to the temperature of the helium sample.

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18. At what temperature the mean speed of the molecules of hydrogen gas equals the escape speed from the earth?

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19. Find the ratio of the mean speed of hydrogen molecules to the mean speed of nytrogen molecules in a sample containing a mixture of the two gases.

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20. Shows a vessel partitioned by a fixed diathermoc separator. Different ideal gases are filled in the two parts. The rms speed of the molecules in the left part . The rms speed of the molecules in the right part. Calculate the ratio of the mass of a molecule in the left part to the mass of a molecule in thej right part.

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21. Estimate the number of collisions per second suffered by a molecule in a sample of hydrogen at STP.The mean free path (average distance covered by a molecule between successive collisions)=1.38xx10^(-5)cm.`

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22. Hydrogen gas is contained in a closed vessel at 1atm(100kPa) and 300K.(a) Calculate the mean speed of the molecules. (b) Suppose the molecules strike the wall with this speed making an average angle of 45° with it. How many molecules strike each squre metre of the wall per second?

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23. Air is pumped into an automobile tyre's tube up to pressure pf 200kPa in the morning when the air temperature is $20^\circ C$. During the day the temperature rises to $40^{\circ} C$ and the tube expand by 2%. Calculate the pressure of the air in the tube at this temperature.

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24. Oxygen is filled in a closed metal jar of volume $1.0 \times 10^{-3} m^3$ at a pressure of $1.5 \times 10^5 Pa.$ and temperature 400K.The jar has a small leak in it. The atmospheric pressure is 1.0×10^5Pa and the atmospheric temperature is 300K. Find the mass of the gas that leaks out by time the pressure and the temperature inside the jar equlise with the surrounding.

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25. An air bubble of radius 2.0mm is formed at the bottom of a 3.3m deep river. Calculate the radius of the bubble as it comes to the surface. Atmospheric pressure $= 1.0 \times 10^5 Pa$ and desnity of water`=1000kg m^(-3).

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26. Air is pumped into the tubes of a cycle rickshaw at a pressure of 2atm. The volume of each tube at this pressure is $0.002m^3. o \ne ofthetubes \ge tspunctured$ and $thevloumeofthetubereduce$ 0.0005m^(3)`.How many moles of air have leaked out? Assume that the temperature remains constant at 300K abd that the air behaves asan ideal gas.

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27. 0.040g of He is kept in a closed container initially at $100.0^{\circ} C$. The container is now heated. Neglecting the expansion of the container, Calculate the temperature at which the inernal energy is increased by 12J.

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28. During an experiment, an ideal gas is found to obey an additional law pV^2=constant. The gas is initially at a temperature T and volume V. Find the temperature when it expands to a volume 2V.

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29. A vessel contains 1.60g of oxygen and 2.80g of nitrogen. The temperature is maintained at 300K and the voume of the vessel is $0.166m^3$. Find the pressure of the mixture.

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30. A vertical cylinder of height 100cm contains air at a constant temperature. The top is closed by a friction less light piston. The atmospheric pressure is equal to 75 cm of mercury. Mercury is slowly poured over the piston. Find the maximum height of the mercury column that can be put on the piston.

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31. Shows two vessel A and B with rigid walls containing ideal gases. The pressure, temperature and the volume are $P_A, T_A, V \in thevesselA$ and $P_B, T_B, V \in thevesselB. Thevesselsaremo$

(P)/(T)=(1)/(2)((P_(A))/(T_(A))+(P_(B))/(T_(B))`

when equilibrium is archieved .

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32. A container of volume 50cc contains air (mean molecular weight =28.8g) and is open to atmosphere where the pressure is 100kPa. The container is kept in a bath containing melting ice $(0^\circ C. (a) F \in dthemassoftheair \in theconta \in erwhenthermaleqi\underline{i}brium$

(100^(@)C)`. Find the mass of air in the container. (C) The container is mow closed and placed in the melting-ice bath. Find the pressure of the air when thermal equilibrium is reached .

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33. A uniform tube closed at aone end, contains a pellet of mercury 10cm long. When the tube is lept vertically with the closed-end upward, the length of the air column trapped is 20cm. Find the length of the air column trapped when the tube is inverted so that the closed-end goes down. Atmospheric pressure`=75cm of mercury.

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34. A glass tube sealed at both ends is 100cm long, It lies horizontally with the middle 10cm containing mercury. The two ends of the tube contain air at $27^\circ C$and at a pressure 76cm of mercury. The air column on one side is maintained at $0^\circ C$and the other side is maintained at $127^\circ C$. Calculate the length of the air column on the cooler side. neglect the changes in the volume of mercury and of the glass.

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35. An ideal gas is trapped between a mercury column and the closed-end of a narrow vertical tube of uniform base containing the cloumn. The upper end of the tube is open to the atmosphere. the atmosphric pressure equals 76cm of mercury. The lenghts of the mercury column respectively. What will be the length of the air column when the tube is tilted slowly in a vertical plane through an angle of 60°? Assume the temperature to remain constant.

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36. Shows a cylindrical tube of length 30cm which is partitioned by a tight-fitting separator.The separator is very weakly conducting and can freely slide along the Tube. Ideal gases are filled in the two parts of the vessel. In the beginning, the temperature in the parts A and B are 400K and 100K respectively. The separator slides to a momentary equilibrium position of the separator,reached after a long time.

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37. A vessel of volume V_0 contains an ideal gas at pressure $p_0$and temperature T. Gas is continuously pumped out of this vessel at a constant volume-rate $d\frac{V}{dt} = r$ keeping the temperature constant, The pressure inside the vessel. Find (a) the pressure of the gas as a function of time,(b) the time taken before half the original gas is pumped out.

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38. One mole of an ideal gas undergoes a process

$$p = \frac{p_0}{1 + \left(\frac{V}{V_0}\right)^2}$$

where $p_0$and V_0 are constants. Find temperature of the gaas when $V = V_0$.

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39. Show that the internal energy of the air (treated as an ideal gas) contained in a room remains constant as the temperature changes between day and night. Assume that the atmospheric pressure around remains constant and the air in the room maintains this pressure by communicating with the surrounding through the windows, doors, etc.

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40. Figure shows a cylindrical tube of radius 5cm and length 20cm. It is closed by a tight-fitting cork. The friction coefficient between the cork and the tube is 0.20. The tube contains an ideal gas at a pressure of 1atm and a temperature of 300K. The tube is slowly heated and it is found that the cork pops out when the temperature reaches 600K. Let dN denote the magnitude of the normal contact force exerted by a small length dl of the cork along the periphery (see the figure). Assuming that the temperature pf the gas is uniform at any instant, calculate(dN)/(dl).

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41. shows a cylindrical tube of cross-sectional area A fitted with two frictionless pistons. The pistons are connected to each other by a metallic wire. Initially, the temperature of the gas is $T_0$and its pressure is $p_0$which equals the atmospheric pressure, (a)What is the tention in the wire? (b)What will be the tention if the temperature is increased to `2T_(0)?

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42. Figure shows a large closed cylindrical tank containing water, Initially the air trapped above the water surface has a height $h_0$and pressure $2p_0$ where p_0 is the atmospheric pressure. There is a hole in the wall of tank at a depth $h_1$below the top from which water comes out. A long vertical tube is connected as shown. (a) Find the height h_2 of the water in the long tube above the top initially. (b) Find the speed with which water comes out of hole.(c)Find the height of the water in the long tube above the top when the water stops coming out of the hole.

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43. An ideal gas is kept in a long cylindrical vessel fitted with a frictionless piston of cross-sectional area $10cm^2$ and weight 1kg.The vessel itself is kept in a big chamber containing air at atmospheric pressure 100kPa. The length of the gas column is 20cm.if the chamber is now completely evacuated by an exhaust pump, what will be the length of the gas column? Assume the tempaerature to remain constant throughout the process.

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44. An ideal gas is kept in a long cylindrical vessel fitted with a frictionless piston of cross-sectional area $10cm^2$and weight 1kg. The length of the gas column in the vessel now taken into a spaceship revolving round the earth as satellite. The air pressure in the spaceship is maintained at 100kPa. Find the length of the gas column in the cylinder.

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45. two glass bulbs of equal volume are connected by a narrow tube and are filled with a gas at $0(\circ)C$ at a pressure of 76cm of mercury. One of the bulbs is then placed in melting ice and the other is placed in a water bath maintained at $62^{\circ} C$.What is the new value of the pressure inside the bulbs? The volume of the connecting tube is neigligible.

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46. The weather report reads, "Temperature $20^{\circ} C$: Relative humidity 100%".What is the dew point?

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47. The condition of air in a closed room is described as follows. Temperature $= 25^{\circ} C$,relative humidity=60%, pressure=104 kPa. If all the water vapour is removed from the room without changing the tempareture what will be the new pressure?The saturation vapour pressure at $25^\circ C = 3.2 kPa$.

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48. The temperature and the dew point in an open room are $20^\circ C$ and $10^\circ C$.if the room temperature drops to $15^\circ C$,what will be the new dew point?

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49. Pure water vapour is trapped in a vessel of volume $10 cm^3$. The relative humidity is 40%. The vapour is compressed slowly and isothermally.find the volume of the vapour at which it will start condendsing.

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50. A barometer tube is 80 cm long (above the mercury reservoir). It reads 76 cm in a particular day. A small amount of water is introduced in the tube and the reading drops to 75.4 cm. Find the relative humidity in the space above the mercury column if the saturation vapor pressure at the room temperature is 1.0cm.

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51. Using figure, find the boiling point of methyl alcohol at 1 atm (760 mm of mercury) and at 0.5 atm.

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52. The human body has an average temperature of $98^{\circ} F$. Assume that vapor pressure of the blood in the veins behaves like that of pure water. Find the minimum atmospheric pressure which is necessary to prevent the blood from boiling. Use figure for the vapor pressures.

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53. A glass contains some water at room temperature $20^\circ C$.Refrigerated water is added to it slowly. When the temperature of the glass reaches $10^\circ C$, small droplets condense on the outer surface. Calculate the relative humidity in the room. The boiling point of water at a pressure of 17.5mm of mercury is $20^\circ C$ and at 8.9mm of mercury is $10^\circ C$.

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54. $50m^3$ of saturated vapour is cooled down from $30^\circ C$to $20^\circ C. F \in dthemassofthewatercondensed. The|o|lutehumidityofsatur$

30g m^(-3)at30^(@)C and 16g m^(-3) at 20^(@)C`.

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55. A barometer correctly reads the atmospheric pressure as 76cm of mercury. Water droplets are slowly introduced into the barometer tube by a dropper. The height of the mercury column first decreases and then become constant. If the saturation vapour pressure at the atmospheric temperature is 0.80cm of mercury, find the height if the mercury column when it reaches its minimum value.

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56. 50cc of oxygen is collected in an inverted gas jar over water.The atmospheric pressure is 99.4 kPa and the room tempareture is $27^{\circ} C$. The water level in the jar is same as the level outside . The saturation vapour pressure at $27^{\circ} C$ is 3.4kPa. Calculate the number of moles of oxgen collected in the jar.

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57. A faulty barometer contains certains amount of air and saturated water vapour . It reads 74.0cm when the atmospheric pressure is 76.0cm of mercury and reads 72.10cm when the atmospheric pressure is 74.0cm of mercury.Saturation vapour pressure at air temperature =1.0cm of mercury. Find the length of the baromerer tube above the mercury level in the reservoir.

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58. On a winter day, the outside temperature is $0^{\circ} C$ and relative humidity 40%.The air from outside comes into a room and is heated to $20^{\circ} C. W \hat{i} stherelativehumidity \in ther\infty m? The saturated vapour pressu$ 0^(@)C$is4.6mmofmercury$ and at20^(@)C`it is 18mm of mercury.

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59. The tempareture and humdity of air are $27^{\circ} C$ and 50% on a particular day. Calculate the amount of vapour that should be added to 1 cubic metre of air to saturate it. The saturation vapour pressure is 3600Pa.

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60. The temperature and the relative humidity are 300K and 20% in a room of volume $50m^3$. The floor is washed with water , some of water sticking on the floor. Assuming no communication with the surrounding, find the relative humidity when the floor dries. The changes in temperature and pressure may be neglected. Saturation vapour pressure at $300K = 3.3kPa$.

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61. The temperature and the relative humidity are $300K$ and 20% in a room of volume $50m^3$. The floor is washed with water, $500g$ of water sticking on the floor. Assuming no communication with the surrounding, find the relative humidity when the floor dries. The changes in temperature and pressure may be neglected. Saturation vapour pressure at $300K = 3.3kPa$.

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62. A bucket full of water is placed in a room at $15^\circ C$ with initial relative humidity 40%. The volume of the room is $50m^3$.(a) How much water will evaporated? The saturation vapour pressure of water at $15^\circ C$and $20^\circ C$ are 1.6kPa and 2.4 kPa respectively.

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Questions For Short Answer 1

1. When we place a gas cylinder on a van and the van moves, does the kinetic energy of the molecules increase? Does the temperature increase?

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2. While gas fron a cooking gas cylinder is used, the pressure does not fall appreciably till the last few minutes. Why?

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3. Do you expect the gas in a cooking gas cylinder to obey the ideal gas equation?

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4. Can we define the temperature of(A)vacuum,(B)a single molecule?

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5. Comment on the following statement: the temperature of all the molecules in a sample of a gas is the same.

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6. Consider a gas of neutrons. Do you expect it to behave much better as an ideal gas as compared to hydrogen gas at the same pressure and temperature?

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7. A gas is keptin a rigid cubical container. If a load of 10kg us put on the top of the container, does the pressure increase?

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8. If it were possible for a gas in a container to reach the temperature 0K, its pressure would be zero. Would the molecules not collide with the walls? Would they not transfer momentum to the walls?

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9. It is said that the assumptions of kinetic theory are good for gases having low densities. Suppose a container is evacuated so that only one molecule is left in it. Which of the assumptions of kinetic theory will not be valid for such a situation? Can we assign a temperature to this gas?

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10. A gas is kept in an enclosure. The pressure of the gas is reduced by pumping out some gas. Will the temperature of the gas decreases by Charles's law?

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11. explain why cooking is faster in a pressure cooker.

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12. If the molecules were not allowed to collide among themselves, would you expect more evaporation or less evaporation?

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13. Is it possible to boil water at room tempareture say $30^\circ C$? If we touch a flask containing water boiling at this temperature, will it be hot?

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14. When you come out of a river after a dip, you feel cold Explain.

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Others

1. Calculate the rms speed of nitrogen at STP (pressure $= 1$ atm and temperature $= 0^0 C$. The density of nitrgoen in these conditions is $1.25 kgm^{-3}$

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2. If the rms speed of nitrogen molecules is $490ms^{-1}$at 273 K, find the rms speed of hydrogem molecules at the same temperature.

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3. calculate the number of moleculesin each cubic metre of a gas at 1 atm and $27^{\circ}C$.

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4. Find the rms speed of oxygen molecules in a gas at 300K.

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5. A vessel of volume $8.0 \times 10^{-3}m^{3}$ contains an ideal gas at 300K and 200kPa. The gas is allowed to leak till the pressure falls to 125kPa.

Calculate the amount of the gas (in moles) leaked assuming that the temperature remains constant.

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6. A vessel of volume $2000cm^3$ contains 0.1mol of oxygen and 0.2mol of carbon dioxide. If the temperature of the mixture is 300K, find its pressure.

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7. A mixture if hydrogen and oxygeb hs volume $2000cm^{(3)}$, temperature 300K, pressure 100kPa and mass 0.76g.Calculate the masses of hydrogen and oxygen in the mixture.

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8. The mercury manometer consists if two unequal arms of equal cross section `1 cm^(2) and lenghths 100cm and 50cm. The two open ends are sealed with air in the tube at a pressure of 80cm of mercurey. Some amount of mercury is now introduced in the manometer through the stopcock connected to it. If mercury rises in the shorter tube to a lenght 10cm in steady state, find the length of the mercury column risen in the longer tube.

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9. An ideal gas has pressure p_0, volume V_0 and temperature T_0. It is taken an isochoric process till its pressure is doubled. It is now isothermally expanded to get the original pressure. Finally , the gas is isobarically compressed to its original volume V_0. (a) Show the process on a p-V diagram. (b) What is the tempertaure in the isothermal part of the process? (c) What is the volume at the end of the isothermal part of the process?

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10. A cyclic process ABCA shown in the V-T diagram is performed with a constant mass of an ideal gas. Show the same process on a p-V diagram, In the figure, CA is parallel to the V-axis and BC is parallel to the T-axis.`

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11. Two closed vessels of equal volune contain air at 105kPa, 300K and are connected through a narrow tube. If one of the vessels is mow maintained at 300K and the other at 400K, what will be the pressure in the vessels?

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12. A Vessel contains 14g of hydrogen and 96g if oxygen at STP. (a) Find the volume of the vessel. (b) Chemical reaction is induced bu passing electric spark in the vessel till one of the gases is consumed, The

temperature is brought back to its starting value 273K. Find the pressure in the vessel.

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13. A barometer reads 75cm if mercury. When $2.0cm^3$ of air at atmospheric pressure is introduced into space above the mercury level, the volume of this space cecones $50cm^3$. find the length by which the mercury column desecds.

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14. A barometer tube is 1 m long and $2cm^2$ in cross section. Mercury stands to a height of $75cm$ in the tube. When a small amount of oxygen is introduced in the space above the mercury level, the level falls by 5cm. Calculate the mass of the oxygen is introduced. Room temperature=$27^\circ C$, g=10 m s_(-2) $\text{and } density \text{ if } mercury =$ 13600kg m^(-3)`.

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15. Show a vertical cylindrical vesse seperated in two parts by a frictionless piston free to move along the length of vessel. The length of the cylilender is 90 cm and the piston divides the cylinder in the ratio of 5:4. Each of the two parts of the vessel contains 0.1 mole of an ideal gas. The temoerature of the gas is 300K in each part. Calculate the mass of the piston.(figure)

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16. Show a cylindrical tube of volume V_(0) divided in two parts by a frictionless separator. The walls of the tube are adiabatic but the separator is conducting, Ideal gases ate filled in the two parts. When the swparator is kept in the middle, the pressure are p_(1) and p-(2) in the left part and the right part respectively. The separator is slowly slid and is released at a position where it can stay in equilibrium. Find the volumes if the two parts. (figure)

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17. A thin tube of uniform cross section is sealed at both ends. It lies horizontally, the middle 5cm containing mercury and the parts on its two sides containing air at the same pressure p. when the tube is held at and angle of $60_{\circ}$ with the vertical, the length of the air column above and belw the mercury pellet are 46cm and 44.5cm respectively. Calculate the ressure - in centimeters of mercury, The timperature of the system is kept at $30_{\circ}C$.

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18. An ideal monatonic gas is confined in a cylinder by a spring-loaded piston of cross section $8.0 \times 10^{-3}m^2$. initially the gas is at 300K and occupies a volume of $2.4 \times 10^{-3}m^{-3}$ and the sprinng is in its relaxed state. The gas is heated by a small heater until the piston moves out slowly by 0.1m. Calculate the final tempreture of the gas. The force constant if the spring is $8000Nm^{-1}$,and the atmospheric pressure is $1.0 \times 10^5 Nm^{-2}$. the cylinder and the piston are thermally insulated. The piston and the spring are massless and there is no friction between the piston and the cylinder. Neglect any heat-loss through the lead wires of the heater. The heat capacity of the heater coil is negligible. assume the spring to be massless

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19. Assume that the temperature remains essentially constant in the upper part of the atmosphere. Obtain an expression for the variation in pressure in the upper atmosphere with height h, and the mean molecular weight of air is M.

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20. A horizontal tube of length l closed at both ends contains an ideal gas of molecular weight M, The tube is roatated at a constant angular velocity ω about a vertical axis passing through an end. Assuming the temperature to be uniforme and constant, show that

$p_2 = p_1 e^{\frac{M\omega^2 l^2}{2RT}}$, where p_(2) and p_(1)denote the pressures at the free end and the fixed end respetively.

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21. A barometer tube contains a mixture of air and saturated water vopour in the space above the mercury column. It reads 70cm when the actual atmospheric pressure is 76cm of mercury. The saturation vapour pressure at roon tempature is1.0 cm of mercury, The tube is now lowered in the reservoir till the space above the mercury cloumn is reduced to half its origina volume. Find the reading of the barometer. Assume that the temperature remains constant.

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22. Find the mass of water vapour per cubic metre of air at temperature 300K and rekative humidity 50%. The saturation vapour pressure at 300K is 3.6kPa and the gas constant $R = 8.3 JK^{-1} mol^{-1}$.

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23. The temperature and the relative humidity of air are $20^{\circ}c$ and 80% on a certain day. Find the fraction of the mass of water vapour that will condense if the temperature falls to $5^{\circ}C. The saturation vapour pressure are 17.5mm$ and 6.5mm of mercury at `20^(@)c and 5 degree C respectively.

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24. A vessel containing water is put in a dry sealed room of volume $76m^3$ at a temperture of $15^{\circ}C$. The saturation vapour pressure of water at $15^{\circ}C$. is 15mm of mercury. How much water will evaporate before the water is in equilibrium with the vapour?

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25. A jar contains a gas and a few drops of water at absolute temperture `T_(1). The pressure in the jar is 830mmof mercuryand 25mmof mercury. The temperature of the jar is reduced by 1%. The saturation vapour pressures of water at the two temperatures are 30mm of murcury and 25mm of mercury. Calculate the new pressue in the jar.

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26. Calculate the mass of 1 litre of moist air at $27^\circ C$when the barometer reads 753.6mm of mercury and the dew point is $16.1^2 C$. Saturation vapour pressure of water at $16.1^\circ = 13.6 mm$of mercury, density of air at STP =0.001293g/(cc)^(-1), density of saturated water vapour at STP=0.000808g/(cc)^(-1).

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