CBSE

KINETIC THEORY WS 5

Class 11 - Physics

Section A

1. One mole of an ideal monatomic gas is at an initial temperature of 300 K. The gas undergoes an isovolumetric process, acquiring 500 J of energy by heat. It then undergoes an isobaric process, losing this same amount of energy by heat. Determine the new temperature of the gas: **[1]**

   a) 316 K
   b) 343 K
   c) 301 K
   d) 333 K

2. How much heat energy in joules must be supplied to 14 g of nitrogen at room temperature to raise its temperature by 40°C at constant pressure? (Mol. wt. of N_2 = 28g, R = constant) **[1]**

   a) 50 R
   b) 80 R
   c) 60 R
   d) 70 R

3. Four liters of a diatomic ideal gas ($\gamma = 1.4$) confined to a cylinder is subject to a closed cycle. Initially, the gas is at 1.00 atm and at 300 K. First, its pressure is tripled under constant volume. Then, it expands adiabatically to its original pressure. Finally, the gas is compressed isobarically to its original volume. Find the temperature of the gas at the start of the adiabatic expansion. **[1]**

   a) 984 K
   b) 900 K
   c) 789 K
   d) 865 K

4. One mole of an ideal monoatomic gas undergoes a process described by the equation PV^3 = constant. The heat capacity of the gas during this process is **[1]**

   a) $\frac{5}{2}R$
   b) $\frac{3}{2}R$
   c) 2R
   d) R

5. 3 mole of hydrogen is mixed with 1 mole of neon. The molar specific heat at constant pressure is **[1]**

   a) $\frac{13R}{2}$
   b) $\frac{9R}{4}$
   c) $\frac{13R}{4}$
   d) $\frac{9R}{2}$

6. Four liters of a diatomic ideal gas (γ = 1.4) confined to a cylinder is subject to a closed cycle. Initially, the gas is at 1.00 atm and at 300 K. First, its pressure is tripled under constant volume. Then, it expands adiabatically to its original pressure. Finally, the gas is compressed isobarically to its original volume. What was the network done for this cycle? **[1]**

   a) 356 J
   b) 316 J
   c) 376 J
   d) 327 J

7. The ratio of the molar heat capacities of a diatomic gas at constant pressure to that at constant volume is **[1]**

   a) $\frac{7}{2}$
   b) $\frac{3}{5}$

c) $\frac{3}{2}$ d) $\frac{7}{5}$

8. Two moles of an ideal gas ($\gamma = 1.4$) expands slowly and adiabatically from a pressure of 5.00 atm and a volume of 12.0 L to a final volume of 30.0 L. What is the final pressure of the gas? **[1]**

a) 1.39 atm b) 1.09 atm

c) 1.19 atm d) 1.59 atm

9. Four liters of a diatomic ideal gas ($\gamma = 1.4$) confined to a cylinder is subject to a closed cycle. Initially, the gas is at 1.00 atm and at 300 K. First, its pressure is tripled under constant volume. Then, it expands adiabatically to its original pressure. Finally, the gas is compressed isobarically to its original volume. Determine the volume of the gas at the end of the adiabatic expansion. **[1]**

a) 8.23 litres b) 8.79 litres

c) 8.55 litres d) 8.97 litres

10. A house has well-insulated walls. It contains a volume of 100 m^3 of air at 300 K. Calculate the energy required to increase the temperature of this diatomic ideal gas by 1.00 ^oC. $\left(C_P = \frac{7}{2}R\right)$ **[1]**

a) 101 kJ b) 118 kJ

c) 139 kJ d) 131 kJ

11. A house has well-insulated walls. It contains a volume of 100 m^3 of air at 300 K. If the energy required to lift an object of mass m through a height of 2.00 m equals the energy required to increase the temperature of this air by 1.00^{o}C., what is the value of m? $\left(C_P = \frac{7}{2}R\right)$ **[1]**

a) 6.67×10^3 kg b) 6.18×10^3 kg

c) 6.03×10^3 kg d) 5.87×10^3 kg

12. Specific heat at constant volume (C_V) and at constant pressure (C_P) of an ideal gas have been reported as shown below. Which of the following sets are most reliable? **[1]**

The unit is cal $mol^{-1}K^{-1}$.

a) $C_V = 5$; $C_P = 7$ b) $C_V = 3$; $C_P = 5$

c) $C_V = 5$; $C_P = 3$ d) $C_V = 3$; $C_P = 4$

13. The heat required to increase the temperature of 4 moles of a monoatomic ideal gas from 273 K to 473 K at constant volume is **[1]**

a) 200 R b) 1200 R

c) 800 R d) 400 R

14. Two moles of an ideal gas ($\gamma = 1.4$) expands slowly and adiabatically from the pressure of 5.00 atm and a volume of 12.0 L to a final volume of 30.0 L. Find Q, W, and ΔE_{int}. **[1]**

a) 100 J, 4.88 kJ, -4.88 kJ b) 1 J, 4.22 kJ, -4.22 kJ

c) 10 J, 4.44 kJ, -4.44 kJ d) 0, 4.66 kJ, -4.66 kJ

15. Two moles of an ideal gas (γ = 1.4) expands slowly and adiabatically from the pressure of 5.00 atm and a volume of 12.0 L to a final volume of 30.0 L. What are the initial and final temperatures? **[1]**

a) 366 K, 253 K

b) 346 K, 243 K

c) 406 K, 273 K

d) 386 K, 263 K

16. One mole of monoatomic gas and three moles of diatomic gas are put together in a container. The molar specific heat (in $JK^{-1}mol^{-1}$) at constant volume (R = 8.3 $JK^{-1}mol^{-1}$) is **[1]**

a) 19.2

b) 18.9

c) 18.7

d) 17.9

17. Consider 2.00 mol of an ideal diatomic gas. Find the total heat capacity at constant volume and at constant pressure, if the molecules rotate but do not vibrate **[1]**

a) 9.45 cal/K, 13.2 cal/K

b) 9.65 cal/K, 13.5 cal/K

c) 9.95 cal/K, 13.9 cal/K

d) 9.85 cal/K, 13.7 cal/K

18. The molar specific heats of an ideal gas at constant pressure and volume are denoted by C_P and C_V respectively. If $\gamma = \frac{C_p}{C_V}$ and R is the universal gas constant, then C_V is equal to **[1]**

a) γR

b) $\frac{1+\gamma}{1-\gamma}$

c) $\frac{(\gamma-1)}{R}$

d) $\frac{R}{(\gamma-1)}$

19. One mole of an ideal monatomic gas is at an initial temperature of 300 K. The gas undergoes an isovolumetric process, acquiring 500 J of energy by heat. It then undergoes an isobaric process, losing this same amount of energy by heat. Determine the work done on the gas. **[1]**

a) 231 J

b) 123 J

c) 200 J

d) 333 J

20. Four liters of a diatomic ideal gas ($\gamma = 1.4$) confined to a cylinder is subject to a closed cycle. Initially, the gas is at 1.00 atm and at 300 K. First, its pressure is tripled under constant volume. Then, it expands adiabatically to its original pressure. Finally, the gas is compressed isobarically to its original volume. Find the temperature at the end of the cycle. **[1]**

a) 285 K

b) 276 K

c) 300 K

d) 332 K

21. If a gas has n degrees of freedom, ratio of specific heats of gas is **[1]**

a) $1 + \frac{n}{2}$

b) $1 + \frac{2}{n}$

c) $\frac{1+n}{2}$

d) $1 + \frac{1}{n}$

22. The air in a thundercloud expands as it rises. If its initial temperature was 300 K, and if no energy is lost by thermal conduction on expansion, what is its temperature when the initial volume has doubled?γ_{air} = 1.41 **[1]**

a) 257 K

b) 237 K

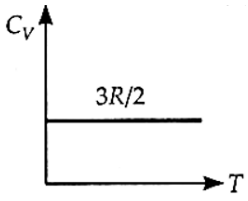
c) 247 K

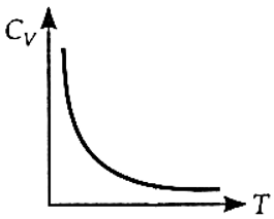
d) 227 K

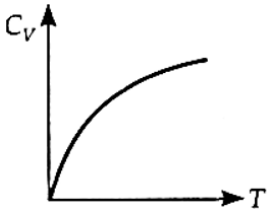
23. Graph of specific heat at constant volume for a monoatomic gas is **[1]**

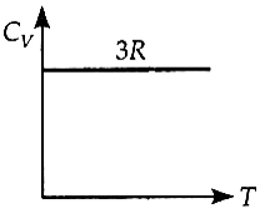
a)

b)





c) 

d) 

24. 1 mole of a monoatomic gas is mixed with 3 moles of a diatomic gas. What is the molecular specific heat of the mixture at constant volume? **[1]**

a) 18.7 J / mol K

b) 15.2 J/mol K

c) 12.5 J/mol K

d) 22.6 J/mol K

25. **Assertion:** For an ideal gas $C_P > C_V$ **[1]**

Reason: Work is done in expansion of the gas at constant pressure.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

26. **Assertion:** The ratio $\frac{C_P}{C_V}$ is more for helium gas than for hydrogen gas. **[1]**

Reason: Atomic mass of helium is more than that of hydrogen.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

27. **Assertion:** The ratio $\frac{C_P}{C_V}$ for a monoatomic gas is more than for a diatomic gas **[1]**

Reason: The molecules of a monoatomic gas have more degree of freedom than those of a diatomic gas

a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

28. **Assertion:** The molecules of a monoatomic gas possesses only three degrees of freedom of translational kinetic energy. **[1]**

Reason: Monoatomic molecule has a very small moment of inertia.

a) Assertion and reason both are correct statements and reason is correct explanation

b) Assertion and reason both are correct statements but reason is not correct

for assertion.

explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

29. **Assertion (A):** The ratio $\frac{C_P}{C_V}$ for a monoatomic gas is more than for a diatomic gas **[1]**

Reason (R): The molecules of a monoatomic gas have more degree of freedom than those of a diatomic gas.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

30. **Assertion:** C_P (molar heat capacity at constant pressure) can be less than C_V (molar heat capacity at constant volume). **[1]**

Reason: C_P - C_V = R is valid only for ideal monoatomic gases.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

31. **Assertion (A):** For an ideal gas $C_P > C_V$ **[1]**

Reason (R): Work is done in expansion of the gas at constant pressure.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

32. **Assertion:** The ratio $\frac{C_P}{C_V}$, is more for helium gas than for hydrogen gas. **[1]**

Reason: Atomic mass of helium is more than that of hydrogen.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

33. **Assertion:** A material will have only one specific heat, if and only if its coefficient of thermal expansion is equal to zero. **[1]**

Reason: An ideal gas has two specific heats (C_V. and C_P) only.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

34. **Assertion:** An ideal gas has infinitely many molar specific heats. **[1]**

Reason: Specific heat is amount of heat needed to raise the temperature of 1 mole of gas by 1 K.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

35. **Assertion (A):** A material will have only one specific heat, if and only if its coefficient of thermal expansion is equal to zero. **[1]**

Reason (R): An ideal gas has two specific heats (C_V and C_P) only.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

36. Write the values of C_P and C_V for a monoatomic gas. **[1]**

37. An isolated container containing monoatomic gas of molar mass m is moving with a velocity v_0. If the container is suddenly stopped, find the change in temperature. **[1]**

38. Is molar specific heat of a solid, a constant quantity? **[1]**

39. Should the specific heat of monoatomic gas be less than, equal to, or greater than that of a diatomic gas at room temperature? Justify your answer. **[1]**

Section B

40. **State True or False:** **[2]**

(a) Molar specific heat of a solid is a constant quantity. **[1]**

(b) The molar mass of a gas is always taken in gram. **[1]**

41. **Fill in the blanks:** **[2]**

(a) Near the room temperature the molar specific heat at constant volume is equal to _____ J $mol^{-1}K^{-1}$. **[1]**

(b) The temperature at which all metals have constant C_v is called _____ temperature. **[1]**

42. Equal masses of helium and oxygen gases are given equal quantities of heat. Which gas will undergo a greater temperature rise? **[2]**

43. Calculate the degree of freedom for monatomic, diatomic and triatomic gas. **[2]**

44. Two rigid boxes containing different ideal gases are placed on a table. Box A contains one mole of nitrogen at temperature T_0, while box B contains one mole of helium at temperature (7/3) T_0. The boxes are then put into thermal contact with each other and heat flows between them until the gases reach a common final temperature. Ignore the heat capacity of the boxes. Find the final temperature T_f of the gases in terms of T_0. **[2]**

45. The specific heat of argon at constant volume is 0.075 kcal kg^{-1} K^{-1}, then what will be its atomic weight? [Given, R =2 cal $mol^{-1}K^{-1}$] **[2]**

46. A diatomic gas is heated in a vessel to a temperature of 10000 K. If each molecule possess an average energy E_1. After sometime, a few molecule escape into the atmosphere at 300 K. Due to which, their energy changes to E_2. Calculate the ratio of $\frac{E_1}{E_2}$. **[2]**

47. In an experiment, the specific heats of some inert gases (at ordinary temperatures) are measured to be as follows: **[2]**

Gas	Atomic mass	Specific heat

	(u)	(cal g^{-1} K^{-1})
Helium	4.00	0.748
Neon	20.18	0.147
Argon	39.94	0.0760
Krypton	83.80	0.0358
Xenon	131.3	0.0226

Try to discover a regularity in the data and explain it on the basis of kinetic energy.

48. If a vessel contains 1 mole of O2 gas (molar mass 32) at temperature T. The pressure of the gas is P. What is the pressure if an identical vessel contains 1 mole of He at a temperature 2T? **[2]**

49. A gaseous mixture enclosed in a vessel contains 1 gram mole of a gas A (with γ = 5/3) and another gas B (with γ = 7/ 5) at a temperature T. The gases A and B do not react with each other and assumed to be ideal. Find the number of gram moles of B if γ for the gaseous mixture is 19/13. **[2]**

50. A vessel contains two non-reacting gases, i.e. neon (monoatomic) and oxygen (diatomic). The ratio of their partial pressures is 3 : 2. Estimate the ratio of **[2]**

    i. number of molecules and

    ii. mass density of neon and oxygen in the vessel. Molecular mass of Ne = 20.2u, molecular mass of O_2 = 32.0u.

51. Estimate the volume of a water molecule. Given density of water is 1000 kg m^{-3} and Avogadro's number = 6×10^{23} $mole^{-1}$. **[2]**

52. Determine the volume of 1 mole of any gas at s. T. P., assuming it behaves like an ideal gas. **[2]**

53. At what temperature is the root mean square speed of an atom in an argon gas cylinder equal to the r.m.s speed of a helium gas atom at- 20^0C? Given Atomic Mass of Ar = 39.9 and of He = 4.0. **[2]**

54. If one mole of a monatomic gas is mixed with 3 moles of a diatomic gas. What is the molecular specific heat of the mixture at constant volume? **[2]**

55. Find the value of internal energy of one mole of a diatomic gas, which do not show vibrational mode. Also, find the value of C_v for the sample of above gas. **[2]**

Section C

56. One mole of a monatomic gas is mixed with three moles of a diatomic gas. What is the molar specific heat of the mixture at constant volume. (R = 8.31 J mol^{-1} K^{-1}) **[3]**

57. Establish the relation between $\gamma(=\frac{C_P}{C_V})$ and degrees of freedom (n). **[3]**

58. A gaseous mixture contain 16 g of helium and 16 g of oxygen, then calculate the ratio of C_p/C_v of the mixture. **[3]**

59. Briefly explain the number of degrees of freedom per molecule of a **[3]**

    i. diatomic gas, and

    ii. polyatomic gas.

60. What is meant by the molar specific heat of a gas? The molar specific heat of hydrogen H_2 is about $\frac{5}{2}$ R in the temperature range of about 250 K to 750 K. At lower temperatures, molar specific heat of hydrogen decreases to the value typical of monoatomic gases : $\frac{3}{2}$ R. At higher temperatures, it tends to the value $\frac{7}{2}$ R. What do you think is happening? **[3]**

61. A vessel of volume $2 \times 10^{-2} m^3$ contains a mixture of hydrogen and helium at 47°C temperature and 4.15×10^5 Nm^{-2} pressure. The mass of the mixture is 10^{-2} kg. Calculate the masses of hydrogen and helium in the given mixture.

62. A gaseous mixture enclosed in a vessel consists of 1 g mole of a gas A $\left(\gamma = \frac{5}{3}\right)$ and some amount of gas B $\left(\gamma = \frac{7}{5}\right)$ at a temperature T. The gases A and B do not react with each other and are assumed to be ideal. Find the number of gram moles of the gas B, if γ for the gaseous mixture is $\left(\frac{19}{13}\right)$. **[3]**

63. Three moles of an ideal diatomic gas is taken at a temperature of 300 K. Its volume is doubled keeping its pressure constant. Find the change in internal energy of gas. **[3]**

Section D

64. i. What do you understand by specific heat capacity of water? **[5]**

ii. If one mole of ideal monoatomic gas (γ = 5/3) is mixed with one mole of diatomic gas (γ = 7/ 5). What is the value of y for the mixtures?

(here, γ represents the ratio of specific heat at constant pressure to that at constant volume)

65. Two vessels of the same size are at the same temperature. One of them contains 1 g of H_2 gas, and the other contains 1 g of N_2 gas. **[5]**

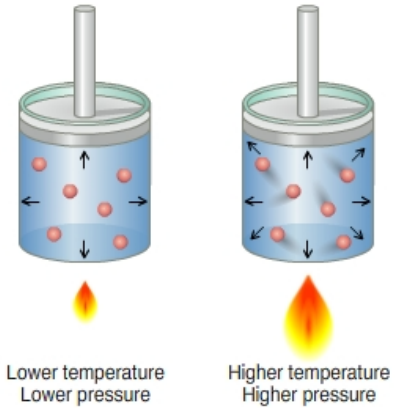
i. Which of the vessels contains more molecules?

ii. Which of the vessels is under greater pressure and why?

iii. In which vessel is the average molecular speed greater? How many times greater?

66. **Read the case study given below and answer any four subparts:** **[5]**

In a gas the particles are always in a state of random motion, all the particles move at different speed constantly colliding and changing their speed and direction, as speed increases it will result in the increase in its kinetic energy.



i. If the temperature of the gas increases from 300 K to 600K then the average kinetic energy becomes:

a. becomes half

b. becomes double

c. same

d. none of these

ii. What is the average velocity of the molecules of an ideal gas?

a. infinite

b. same

c. zero

d. none of these

iii. Cooking gas containers are kept in a lorry moving with uniform speed. The temperature of the gas molecules inside will _____

a. increase

b. decrease

c. remains same

d. none of these

iv. Find the ratio of average kinetic energy per molecule of Oxygen & Hydrogen:

a. 1:1

b. 1:2

c. 1:4

d. 4:1

v. The velocities of three molecules are 3 v, 4 v, and 5 v. calculate their root mean square velocity?

a. 4.0 v

b. 4..02 v

c. 4.04 v

d. 4.08 v