CBSE

THERMODYNAMICS WS 5

Class 11 - Physics

Section A

1. What amount of heat must be supplied to 2.0×10^{-2} kg of nitrogen (at room temperature) to raise its temperature by 45 ^{o}C at constant pressure? (Molecular mass of N_2 = 28; R = 8.3 J mol^{-1} K^{-1}.) **[1]**

   a) 904 J
   b) 974 J
   c) 954 J
   d) 934 J

2. If C_p and C_v are the specific heats for a gas at constant pressure and at constant volume respectively, then the relation C_p - C_v = R is exact for: **[1]**

   a) ideal gas at all pressures and real gas at moderate pressure
   b) ideal gas and nearly true for real gases at moderate pressure
   c) ideal gas and nearly true for real gases at high pressure
   d) ideal and real gases at all pressures

3. For hydrogen gas C_p - C_V = a and for oxygen gas C_p - C_V = b, so the relation between a and b is given by: **[1]**

   a) a = b
   b) a = 4b
   c) 16b = a
   d) a = 16b

4. For a certain gas, the ratio of specific heats is given to be γ = 1.5. For this gas: **[1]**

   a) $C_v = \frac{5R}{J}$
   b) $C_v = \frac{3R}{J}$
   c) $C_p = \frac{3R}{J}$
   d) $C_p = \frac{5R}{J}$

5. Heat capacity of a substance is infinite. It means: **[1]**

   i. heat is given out
   ii. heat is taken out
   iii. no change in temperature, whether heat is taken in or given out
   iv. all of these

   a) Option ii
   b) Option iii
   c) Option iv
   d) Option i

6. The molar specific heat at constant pressure of an ideal gas is $\frac{7R}{2}$. The ratio of specific heat at constant pressure to that at constant volume is: **[1]**

   a) $\frac{9}{7}$
   b) $\frac{8}{7}$
   c) $\frac{7}{5}$
   d) $\frac{5}{7}$

7. Heat capacity of a substance depends on **[1]**

   a) the temperature of the substance
   b) the mass of the substance

c) Both the mass of the substance and the temperature of the substance

d) Neither the mass of the substance nor the temperature of the substance

8. The temperature of m moles of a gas changes from T_1 to T_2 at pressure P. If C_P is given of the gas, what is change in entropy? **[1]**

a) $nC_p\left(\frac{T_1}{T_2}\right)$

b) $nC_P \ln\left(\frac{T_2}{T_1}\right)$

c) $nC_P\left(\frac{T_2}{T_1}\right)$

d) $nC_P \ln\left(\frac{T_1}{2T_2}\right)$

9. 4.0 g of a gas occupies 22.4 litres at NTP. The specific heat capacity of the gas at constant volume is 5.0 $JK^{-1}mol^{-1}$. If the speed of sound in this gas at NTP is 952 ms^{-1}, then the heat capacity at constant pressure is (Take gas constant R = 8.3 JK^{-1} mol^{-1}) **[1]**

a) 75 JK^{-1} mol^{-1}

b) 7.0 J K^{-1} mol^{-1}

c) 8.5 JK^{-1} mol^{-1}

d) 8.0 JK^{-1} mol^{-1}

10. The molar heat capacity in a process of a diatomic gas, if it does a work of $\frac{Q}{4}$ when a heat of Q is supplied to it, is: **[1]**

a) $\frac{2R}{5}$

b) $\frac{10R}{3}$

c) $\frac{6R}{7}$

d) $\frac{5R}{2}$

11. Universal gas constant is: **[1]**

a) $C_P + C_V$

b) $\frac{C_P}{C_V}$

c) $\frac{C_V}{C_P}$

d) $C_P - C_V$

12. **Assertion (A):** The ratio of specific heat of a gas at constant pressure and specific heat at constant volume for a diatomic gas is more than that for a monatomic gas. **[1]**

Reason (R): The molecules of a monatomic 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) Both A and R are false.

13. **Assertion (A):** Snow is better insulator than ice. **[1]**

Reason (R): Snow contain air packet and air is good insulator of heat.

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.

14. **Assertion (A):** Specific heat of a body is always greater than its thermal capacity. **[1]**

Reason (R): Thermal capacity is the heat required for raising temperature of unit mass of the body through unit degree.

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) Both A and R are false.

15. **Assertion (A):** A gas has a unique value of specific heat. **[1]**

Reason (R): Specific heat is defined as the amount of heat required to raise the temperature of unit mass of the substance through unit degree.

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.

16. **Assertion (A):** The ratio of specific heat of gas at constant pressure and specific heat at constant volume is more for helium gas than for hydrogen gas. **[1]**

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

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.

17. **Assertion:** The specific heat of a gas in an adiabatic process is zero but it is infinite in an isothermal process. **[1]**

Reason: Specific heat of a gas is directly proportional to heat exchanged with the system and inversely proportional to change in temperature.

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.

18. **Assertion (A):** Specific heat capacity and molar specific heat capacity both have same units. **[1]**

Reason (R): Specific heat capacity and molar specific heat capacity both do not depend on mass.

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.

19. Find the values of two molar specific heats of nitrogen. Given, γ = 1.41 and R =8.31 J $mol^{-1}K^{-1}$. **[1]**

20. Explain why the coolant in a chemical or a nuclear plant (i.e., the liquid used to prevent the different parts of a plant from getting too hot) should have high specific heat? **[1]**

21. Calculate the difference between two specific heats of 1 g of nitrogen. Given molecular weight of nitrogen = 28 and J = 4.2×10^7 erg cal^{-1}. **[1]**

22. Calculate the difference between the two principal specific heats of 1 g of helium gas at S.T.P. Given atomic weight of helium = 4 and J = 4.186 J cal^{-1} and R = 8.31 J mol^{-1} K^{-1}. **[1]**

23. Calculate the specific heat at constant volume for a gas. Given specific heat at constant pressure is 6.85 cal mol^{-1} K^{-1}, R = 8.31 $Jmol^{-1}$ K^{-1} and J = 4.18 $Jcal^{-1}$. **[1]**

24. A liquid is being converted into steam at its boiling point. What will be the specific heat of the liquid at this time? **[1]**

25. Why a gas has two principal specific heat capacities? **[1]**

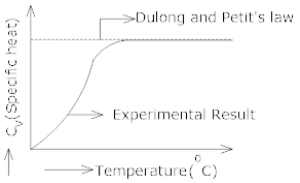
26. How many specific heat does a gas possess? **[1]**

27. Can the specific heat of gas be negative? **[1]**

28. Of what physical significance is the difference between the two principal specific heat capacities and their ratio? **[1]**

Section B

29. **State True or False:** **[2]**
    (a) At a given temperature, the specific heat of a gas at constant pressure is always greater than its specific heat at constant volume. **[1]**
    (b) A gas can possess an infinite number of specific heat. **[1]**
30. Write the expressions for C_v, and C_p of a gas in terms of gas constant R and γ where $\gamma = C_p/C_V$ **[2]**
31. Find molar specific heat for the process $p = \frac{a}{T}$ for a monoatomic gas. **[2]**
32. Two bodies of specific heats c_1 and c_2 having same heat capacities are combined to form a single composite body. What is the specific heat of the composite body? **[2]**
33. Find the ratio of $\frac{\Delta a}{\Delta U}$ and $\frac{\Delta Q}{\Delta W}$ in an isobaric process. The ratio of molar specific heats, $\frac{C_p}{C_V} = \gamma$. **[2]**
34. The difference between two specific heats of a gas is 5000 J kg^{-1} K^{-1} and the ratio of specific heats is 1.6. Find the two specific heats. **[2]**
35. Compare the formula $C_p - C_v = R$ for an ideal gas with the thermodynamic relation $\Delta U = \Delta Q - P\Delta V$. **[2]**
36. Define two principal specific heats of a gas. Which is greater and why? **[2]**
37. Calculate the difference between two principal specific heats of 1g of helium gas at N. T. P. Given Molecular weight of Helium = 4 and J = 4.186 J/cal and Universal Gas constant, R = 8.314J / mole / K? **[2]**
38. Calculate difference in specific heats for 1 g of air at S.T.P. Given density of air at S.T.P. is 1.293 g $litre^{-1}$, J = 4.2 $\times$ 10^7 erg cal^{-1}. **[2]**
39. Why is there a difference in the specific heat curve as given by Delong's petit law and the experimental result at low temperatures? **[2]**



40. If for a gas, $\frac{R}{C_V}$ = 0.67 then which gas is this:- monatomic, diatomic and triatomic? **[2]**
41. Calculate C_p for air, given that C_v =0.162 cal g^{-1} k^{-1} and density of air at N.T. P is 0.001293 g/cm^3? **[2]**
42. Calculate the ratio of specific heats for nitrogen, given that specific heat at constant pressure is 0.236 cal g^{-1} K^{-1} and density at S.T.P is 0.001234 g cm^{-3}. **[2]**
43. The specific heat of argon at constant pressure is 0.127 and ratio of specific heats is 1.667. Calculate the value of J. One litre of argon weighs 1.786 g at N.T.P. **[2]**
44. Mole of helium is contained in a container at S.T.P. How much heat energy is needed to double the pressure of the gas, keeping the volume Constant? Heat capacity of gas is 3 J g^{-1} K^{-1}. **[2]**

Section C

45. One mole of an ideal monatomic gas occupies a volume of 1.0 $\times$ 10^{-2} m^3 at a pressure of 2.0 $\times$ 10^5 N/m^2. **[3]**
    i. What is the temperature of the gas?
    ii. The gas undergoes a quasi-static adiabatic compression until its volume is decreased to 5.0 $\times$ 10^{-3} m^3. What is the new gas temperature?
    iii. How much work is done on the gas during the compression?
    Take $\gamma = \frac{5}{3}$ and R = 8.31 J/mol K

46. 1 mole of a monoatomic gas is mixed with 3 moles of a diatomic gas. What is the molar specific heat capacity of the mixture at constant volume? **[3]**

47. A geyser heats water flowing at the rate of 3.0 liters per minute from 27 °C to 77 °C. If the geyser operates on a gas burner, what is the rate of consumption of the fuel if its heat of combustion is 4.0×10^4 J/g? **[3]**

48. A vessel of volume 0.2 m^3 contains hydrogen gas at temperature 300 K and pressure 1 bar. Find the heat required to raise the temperature of gas to 400 K. The molar heat capacity of hydrogen at constant volume is 20.9 J mol^{-1} K^{-1}. **[3]**

49. 3 mol of an ideal gas at 300 K is isothermally expanded to five times its initial volume and heated at this constant volume so that the pressure is raised to its initial value before expansion. In the whole process, heat supplied to the gas is 83.14 kJ. Calculate ratio C_p/C_v for the gas. [$\log_e 5 = 1.61$ and R = 8.31 J $mol^{-1}K^{-1}$] **[3]**

50. A 0.20 Kg aluminum block at 80^0C is dropped in a copper calorimeter of mass 0.05 Kg containing 200 cm^3 of ethyl alcohol at 20^0C. What is the final temperature of the mixture? Given Density of ethyl alcohol = 0.81 g | cm^3 ; specific heat of ethyl alcohol = 0.6 cal /g / ^{0}C ; specific heat of copper = 0.094 cal /g / ^{0}C, specific heat of Al = 0.22 cal / g / ^{0}C? **[3]**

51. Show that $C_P - C_V = R$ where C_P = specific heat at constant pressure; C_V = specific heat at constant volume and R = Universal Gas constant for an ideal gas. **[3]**

52. Specific heat of argon at constant pressure is 0.125 cal g^{-1} K^{-1} and at constant volume is 0.075 cal g^{-1} K^{-1}. Calculate the density of argon at STP. Given J = 4.18×10^7 erg cal^{-1} and normal pressure = 1.01×10^6 dyne cm^{-2}. **[3]**

53. If half mole of helium is contained in a container at S.T.P. How much heat energy is needed to double the pressure of the gas, keeping the volume of the gas constant? Given specific heat of gas = 3J $mol^{-1}K^{-1}$. **[3]**

54. i. Why a gas has two principal specific heat capacities? **[3]**
ii. Which one is greater and why?
iii. Of what significance is the difference between these two specific heat capacities and their ratio?

55. If for hydrogen $C_P - C_V = a$ and for oxygen $C_P - C_V = b$ where C_P & C_V refer to specific heat at constant pressure and volume then what is the relation between a and b? **[3]**

56. For air, specific heat at constant pressure is 0.237 cal $g^{-1}{}^\circ C^{-1}$ and specific heat at constant volume is 0.169 cal $g^{-1}{}^\circ C^{-1}$, density of air = 0.001293 g cm^{-3} at S.T.P. Calculate the value of J. **[3]**

57. If half mole of helium is contained in a container at S. T. P. How much heat energy is needed to double the pressure of the gas, keeping the volume of the gas constant? Given specific heat of gas = 3J|g|K. **[3]**

Section D

58. i. Two bodies at different temperatures T_1 and T_2 if brought in thermal contact do not necessarily settle to mean temperature $\frac{(T_1 + T_2)}{2}$ **[5]**
ii. The coolant in a chemical or a nuclear plant (i.e., the liquid used to prevent the different parts of a plant from getting too hot) should have high specific heat.
iii. Air pressure in a car tyre increases during driving.
iv. The climate of a harbour town is more temperate than that of a town in a desert at the same latitude.

59. An ideal gas has a specific heat at a constant pressure, $C_p = (\frac{5}{2})$ R. The gas is kept in a closed vessel of volume 0.0083 m^3 at a temperature of 300 K and a pressure of 1.6×10^6 Nm^{-2}. An amount of 2.49×10^4 J of heat **[5]**

energy is supplied to the gas. Calculate the final temperature and pressure of the gas.

Section E

60. **Fill in the blanks:** **[8]**

(a) A liquid is being converted into steam. The specific heat of the liquid during the process is _____. **[1]**

(b) The unit of specific heat capacity is _____. **[1]**

(c) Specific heat of a gas is _____ during an adiabatic change. **[1]**

(d) C_V is _____ than C_p and the difference between the two specific heats is equal to the amount of heat equivalent to the work performed by the gas during expansion at constant _____. **[1]**

(e) The unit of heat capacity is _____. **[1]**

(f) The amount of heat required to change the temperature of a unit mass of a substance by unity is known as _____ of heat substance. **[1]**

(g) Specific heat of a gas is _____ during an isothermal change. **[1]**

(h) The amount of heat required to raise the temperature of one gram mole of a substance through a unit is called _____ capacity of the substance. **[1]**