CBSE

THERMODYNAMICS WS 3

Class 11 - Physics

Section A

1. The P-T relation for an adiabatic expansion is: **[1]**

   a) $P^{1-\gamma}T^{\gamma}$ = constant

   b) $P^{\gamma-1}T^{\gamma}$ = constant

   c) $P^{\gamma}T^{1-\gamma}$ = constant

   d) $P^{\gamma}T^{\gamma-1}$ = constant

2. Mechanical equivalent of heat is equal to the amount of **[1]**

   a. work done to produce 1 cal heat

   b. a conversion factor between calorie and joule

   c. Both work done to produce 1 cal heat and a conversion factor between calorie and joule

   d. Neither Both work done to produce 1 cal heat nor a conversion factor between calorie and joule

   a) Statement (i) is correct.

   b) Statement (iii) is correct.

   c) Statement (ii) is correct.

   d) Statement (iv) is correct.

3. A gas expands under constant pressure P from volume V_1 to V_2. The work done by the gas is: **[1]**

   a) $P\left(V_1^{\gamma} - V_2^{\gamma}\right)$

   b) P(V_2 - V_1)

   c) P(V_1 - V_2)

   d) $P\left(\frac{1}{V_1} - \frac{1}{V_2}\right)$

4. A thermodynamic system undergoes a process in which its internal energy decreases by 500 J. If, at the same time, 220 J of work is done on the system, what is the energy transferred to or from it by heat? **[1]**

   a) Q = -700 J

   b) Q = -740 J

   c) Q = -730 J

   d) Q = -720 J

5. The change in internal energy, when a gas is cooled from 927° to 27°, is: **[1]**

   a) 100 %

   b) 75 %

   c) 200 %

   d) 300 %

6. If the ratio of specific heat of a gas at constant pressure to that at constant volume is γ, the change in internal energy of a mass of gas, when the volume changes from V to 2 V at constant pressure P, is: **[1]**

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

   b) PV

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

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

7. The internal energy change in a system that has absorbed 2 kcal of heat and done 500 J of work is: **[1]**

   a) 7900 J

   b) 5400 J

   c) 6400 J

   d) 8900 J

8. Choose the state variable from the given options. **[1]**

a) Heat
b) Work
c) All of these
d) Internal energy

9. The heat of 100 J is added to a gaseous system whose internal energy is 40 J, then the amount of external work done will be: **[1]**

a) 60 J
b) 140 J
c) 40 J
d) 70 J

10. A sample of 0.1g of water at 100°C and normal pressure ($1.013 \times 10^5 Nm^{-2}$) requires 54 cal of heat energy to convert to steam at 100°C. If the volume of the steam produced is 167.1 cc, the change in internal energy of the sample, is: **[1]**

a) 84.5 J
b) 104.3 J
c) 42.2 J
d) 208.7 J

11. **Assertion:** Equal masses of helium and oxygen gases are given equal quantities of heat. There will be a greater rise in the temperature of helium as compared to that of oxygen. **[1]**
Reason: The molecular weight of oxygen is more than the molecular weight of helium.

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.

12. **Assertion (A):** By doing some work on the system, we can change the internal energy of a system. **[1]**
Reason (R): If work is done by the system, its internal energy may decrease.

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.

13. **Assertion:** On removing the valve, the air escaping from a cycle tube becomes cool. **[1]**
Reason: On removing the valve, the gas expands suddenly and does work at the expense of its internal energy.

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.

14. **Assertion:** Change in internal energy is zero if the temperature is constant, irrespective of the process being cyclic or non-cyclic. **[1]**
Reason: For all process change in internal energy $\Delta U = nC_V\Delta T$ is independent of path.

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
d) Assertion is wrong statement but reason is

wrong statement. correct statement.

15. **Assertion (A):** Work and heat are two equivalent form of energy. **[1]**

Reason (R): Work is the transfer of mechanical energy irrespective of temperature difference, whereas heat is the transfer of thermal energy because of temperature difference 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.

16. **Assertion (A):** Thermodynamics deals with the concepts of heat and temperature. **[1]**

Reason (R): The temperature of an ideal gas depends on its molecular kinetic energy.

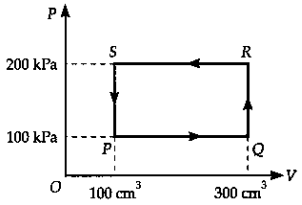
a) Both A and R are true and R is the correct explanation of A.

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. A thermodynamic system is taken through the cycle PQRSP process. The net work done by the system is: **[1]**



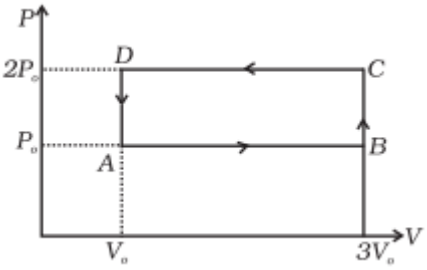
a) -374 J

b) -20 J

c) 400 J

d) 20 J

18. An ideal gas undergoes cyclic process ABCDA as shown in given P-V diagram (Fig.). The amount of work done by the gas is **[1]**



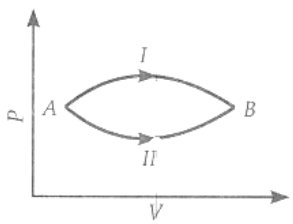
a) $6P_o\ V_o$

b) $-2\ P_0\ V_o$

c) $+ 4\ P_o\ V_o$

d) $+ 2\ P_o\ V_o$

19. A gas at state A changes to state B through paths I and II shown in the figure. The changes in internal energy are ΔU_1 and ΔU_2 respectively. Then **[1]**



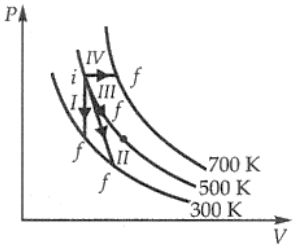
a) $\Delta U_1 < \Delta U_2$

b) $\Delta U_1 = \Delta U_2$

c) $\Delta U_1 > \Delta U_2$

d) $\Delta U_1 = \Delta U_2 = 0$

20. Thermodynamic processes are indicated in the following diagram: **[1]**



Match the following:

Column I	**Column II**
(a) Process I	(i) Adiabatic
(b) Process II	(ii) Isobaric
(c) Process III	(iii) Isochoric
(d) Process IV	(iv) Isothermal

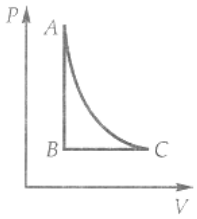
a) (a) - (iii), (b) - (iv), (c) - (ii), (d) - (i)

b) (a) - (iv), (b) - (ii), (c) - (i), (d) - (iii)

c) (a) - (i), (b) - (iii), (c) - (iv), (d) - (ii)

d) (a) - (iii), (b) - (i), (c) - (iv), (d) - (ii)

21. The state of a gas in a cylinder is represented by the pV diagram as shown below. **[1]**



The gas can be taken through either the cycle ABCA, or the reverse cycle ACBA Which of the following statements about the work done on or by the gas incorrect?

i. In both cases, the same amount of net work is done by the gas

ii. In both cases, the same amount of net work is done on the gas

iii. In cycle ABCA net work is done by the gas, in cycle ACBA the same amount of net work is done on the gas

iv. In cycle ABCA net work is done on the gas, in cycle ACBA the same amount of net work is done by the gas

a) Option ii

b) Option iv

c) Option iii

d) Option i

22. What is the nature of P-V diagram for isobaric and isochoric processes? **[1]**

23. Why can a ship not use the internal energy of seawater to operate its engine? **[1]**

24. By what methods can the internal energy of an ideal gas be changed? Give examples. **[1]**

25. Whose molecules: liquid water at 0^oC or ice at 0^oC have greater potential energy? Give reason. **[1]**

26. Out of a solid, liquid and gas of the same mass and at the same temperature, which one has the greatest internal energy? Which one least? Justify. **[1]**

27. Heat equivalent to 50 joule is supplied to a thermodynamic system and 10 joule work is done on the system. What is the change in the internal energy of the system in the process? **[1]**

28. Is it possible to increase the temperature of a gas without giving it heat? **[1]**

29. A gas has two principal specific heats. Which one is greater and why? **[1]**

30. Plot a graph between internal energy U and Temperature (T) of an ideal gas. **[1]**

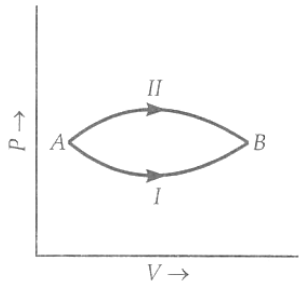
31. When air of the atmosphere rises up, it cools. Why? **[1]**

32. What is the difference between heat and work? **[1]**

33. If no external energy is supplied to an expanding gas, will the gas do any work? If yes, then what will be the source of energy? **[1]**

34. When ice melts, then change in internal energy is greater than the heat supplied, why? **[1]**

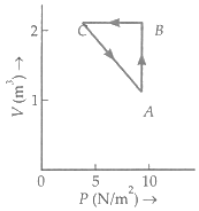
35. A system goes from state A to B via two processes I and II, as shown in Figure. How are ΔU_1 and ΔU_2 (the changes in internal energies in processes I and II) related to each other? **[1]**



36. When is the heat supplied to a system equal to the increase in its internal energy? **[1]**

37. Explain why air pressure in a car tyre increases during driving. **[1]**

38. An ideal gas is taken through the cycle A $\rightarrow$ B $\rightarrow$ C $\rightarrow$ A, as shown if Figure. If the net heat supplied to the gas in the cycle is 5 J, what is the work done by the gas in process C $\rightarrow$ A? **[1]**



39. Why water at the base of a waterfall is slightly warmer than at the top? **[1]**

40. Can a ship be moved with the energy of the sea water? **[1]**

41. Heat is supplied to a system, but its internal energy does not increase. What is the process involved? **[1]**

42. The internal energy of compressed gas is less than that of the rarefied gas at the same temperature. Why? **[1]**

43. Is the internal energy of a gas a function of pressure? Comment. **[1]**

44. How does the internal energy of an ideal gas differ from that of real gas? **[1]**

45. Why a gas is cooled when it expand? **[1]**

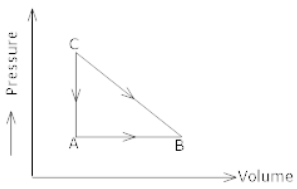
46. Is it possible to convert internal energy into work? **[1]**

47. How do you justify that when a body is being heated at melting point, the temperature remains Constant? **[1]**

48. What is a cyclic process? What is the change in internal energy of a system after it completes one cycle of such a process? **[1]**

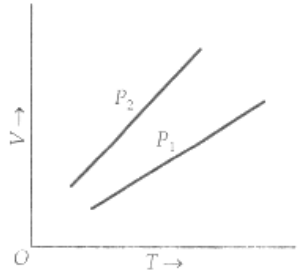
Section B

49. Consider the cyclic process ABCA on a sample 2 mol of an ideal gas as shown. The temperature of the gas at A and B are 300K and 500K respectively. Total of 1200 J of heat is drawn from the sample. Find the work done by the gas in part BC. **[2]**



50. A gas mixture consists of 2 moles of oxygen and 4 moles of argon at temperature T. If we neglect all vibration modes, find the total energy of the system. **[2]**

51. The volume versus temperature T graphs for a certain amount of a perfect gas at two pressures P_1 and P_2 are shown in Figure. Which one is greater - P_1 or P_2? **[2]**



52. A person of mass 60 kg wants to lose 5 kg by going up and down a 10 m high stairs. Assume he burns twice as much fat while going up than coming down. If 1 kg of fat is burnt on expending 7000 kcal calories, how many times must he go up and down to reduce his weight by 5 kg? **[2]**

53. Why does the density of solid | liquid decreases with rise in temperature? **[2]**

54. When a bore is made with a small drill in a hard board, the drill becomes very hot. But when the bore is made in a soft board, the drill does not become so hot. Why? **[2]**

55. 1 kg of water at 373 K is converted into steam at the same temperature. The volume of 1 cm^3 of water becomes 1671 cm^3 on boiling. Calculate change in the internal energy of the system, if heat of vaporisation is 540 cal g^{-1}. Given standard atmospheric pressure = 1.013×10^5 Nm^{-2}. **[2]**

56. Write the sign conventions for the heat and work done during a thermodynamic process. **[2]**

57. Why does absolute zero not correspond to zero energy? **[2]**

58. Is it possible to increase the temperature of a gas without adding heat to it? Explain. **[2]**

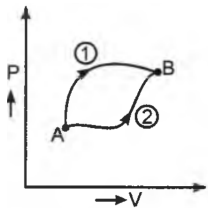
Section C

59. 1 g of water at 100° C is converted into steam at the same temperature. If the volume of steam is 1671 cm^3, find the change in the internal energy of the system. Latent heat of steam = 2256 Jg^{-1}. Given 1 atmospheric pressure = 1.013×10^5 Nm^{-2}. **[3]**

60. A ball is dropped on a floor from a height of 2cm. After the collision, it rises up to a height of 1.5m. Assuming that 40% of mechanical energy lost goes to thermal energy into the ball. Calculate the rise in temperature of the ball in the collision. Specific heat capacity of the ball is 800J/k. Take g = $10m/s^2$. **[3]**

61. 1.0 m^3 of water is converted into 1671 m^3 of steam at atmospheric pressure and 100°C temperature. The latent heat of the vaporization of water is 2.3×10^6 J kg^{-1}. If 2.0 kg of water be converted into steam at atmospheric pressure and 100°C temperature, then how much will be the increase in its internal energy? Density of water 1.0×10^3 kg m^{-3}, atmospheric pressure = 1.01×10^5 Nm^{-2}. **[3]**

62. A system goes from A to B by two different paths in the P - V diagram as shown in Figure. Heat given to the system in path 1 is 1000 J. The work done by the system along path 1 is more than path 2 by 100 J. What is the heat exchanged by the system in path 2? **[3]**



63. 5 moles of oxygen are heated at constant volume from 10°C to 20°C. What will be the change in the internal energy of the gas? The gram molecular specific heat of oxygen at constant pressure, C_p = 8 cal $mole^{-1}$ $°C^{-1}$ and **[3]**

$R = 8.36$ J mole^{-1} °C^{-1}.

64. Two rods A and B are of equal length. Each rod has its ends at temperatures T_1 and T_2. What is the condition that will ensure equal rates of flow of heat through the rods A and B? **[3]**

Section D

65. **State True or False:** **[4]**

(a) A ship can use the internal energy of seawater to operate its engine. **[1]**

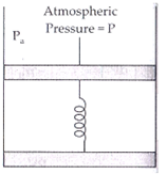
(b) The internal energy of an ideal gas is a function of pressure. **[1]**

(c) A ship could be moved with the energy of the sea water. **[1]**

(d) Internal energy of a real gas depends only on temperature of the gas. **[1]**

Section E

66. Consider one mole of perfect gas in a cylinder of unit cross section with a piston attached (Figure). A spring (spring constant *k*) is attached (unstretched length L) to the piston and to the bottom of the cylinder. Initially the spring is unstretched and the gas is in equilibrium. A certain amount of heat Q is supplied to the gas causing an increase of volume from V_o to V_1. **[5]**



i. What is the initial pressure of the system?

ii. What is the final pressure of the system?

iii. Using the first law of thermodynamics, write down a relation between Q, P_a, V_1, V_0 and k.

Section F

67. **Fill in the blanks:** **[6]**

(a) In thermodynamics, heat and work are not _____. **[1]**

(b) The area of a closed curve on a P-V diagram gives _____ in a _____ process. **[1]**

(c) If a gas expands, work is done _____ the gas and is taken as _____. **[1]**

(d) If a gas is compressed, work is done _____ the gas and is taken as _____. **[1]**

(e) Internal energy of an ideal gas is purely _____ in nature. **[1]**

(f) A plot between the pressure of the gas and its volume is called _____ diagram. **[1]**