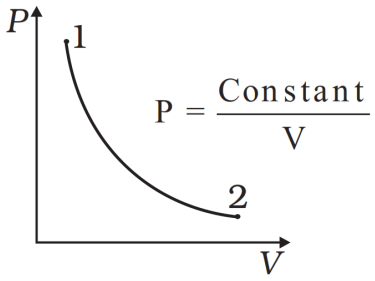
KD EDUCATION ACADEMY [9582701166]

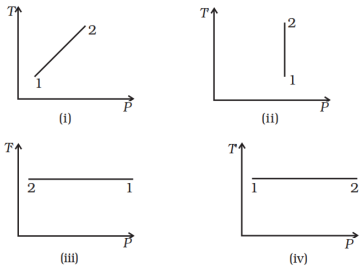
Time : 5 Hour | STD 11 Science Physics | Total Marks : 200

kd 90+ ch-11 thermodynamics

* **Choose The Right Answer From The Given Options.[1 Marks Each]** **[16]**



1. Consider P-V diagram for an ideal gas shown in: Out of the following diagrams which represents the T-P diagram?



(A) (iv) (B) (ii) (C) (iii) (D) (i)

2. An engine has an efficiency of $\frac{1}{6}$ when the temperature of sink is reduced by 62°C, its efficiency is doubled, temperature of the source is:

(A) 37°C. (B) 62°C. (C) 99°C. (D) 124°C.

3. If 150J of heat is added to a system and the work done by the system is 110J, then change in internal energy will be:

(A) 40J. (B) 110J. (C) 150J. (D) 260J.

4. For a gas, $\gamma = 1.4$. Then Atomicity, C_P and C_V of the gas are:

(A) Monoatomic, $\frac{5}{2}R, \frac{3}{2}R$ (B) Monoatomic, $\frac{7}{2}R, \frac{5}{2}R$

(C) Diatomic, $\frac{7}{2}R, \frac{5}{2}R$ (D) Triatomic, $\frac{7}{2}R, \frac{5}{2}R$

5. Specific heat capacity depends on:

(A) Nature of the substance. (B) On its mass.

(C) On its temperature. (D) Both (a) and (c).

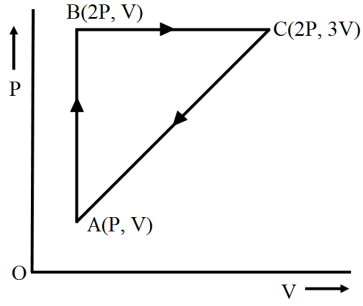
6. An ideal gas having molar specific heat capacity at constant volume is $\frac{3}{2}R$ the molar specific heat capacities at constant pressure is:

(A) $\frac{1}{2}R$ (B) $\frac{5}{2}R$ (C) $\frac{7}{2}R$ (D) $\frac{9}{2}R$

7. If m is the mass, θ is temperature and 'a' is specific heat, then thermal capacity K is given by:

(A) $K = ms\theta$ (B) $K = m\theta$ (C) $K = \frac{ms}{\theta}$ (D) $K = ms$

8. An ideal gas is taken through a cycle ABCA as shown in Fig. The work done during the cycle is:



(A) $\frac{1}{2}PV$ (B) 2PV (C) 4PV (D) PV

9. The SI unit of mechanical equivalent of heat (J) is:

(A) Joule/ calorie. (B) Calorie.

(C) Calorie × erg. (D) Erg/ calorie.

10. An ideal heat engine exhausting heat at 27°C is to have 25% efficiency. It must take heat at:

(A) 127°C. (B) 227°C.

(C) 327°C. (D) 673°C.

11. A system is provided with 200 cal of heat and the work done by the system on the surroundings is 40J. Then, its internal energy:

(A) Increases by 600J.

(B) Decreases by 800J.

(C) Increases by 800J.

(D) Decreases by 50J.

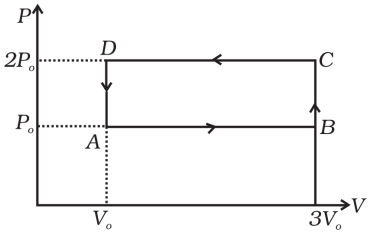
12. 110J of heat are added to a gaseous system and its internal energy increases by 40J, then the amount of work done is:

(A) 150J (B) 70J (C) 110J (D) 40J

13. In an adiabatic change, the pressure P and temperature T of a diatomic gas are related by the relation $P \propto T^c$ where c equals:

(A) $\frac{5}{3}$ (B) $\frac{2}{5}$ (C) $\frac{3}{5}$ (D) $\frac{7}{2}$

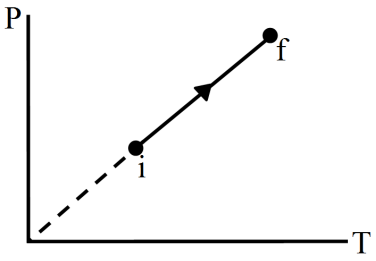
14. An ideal gas undergoes cyclic process ABCDA as shown in given PV diagram. The amount of work done by the gas is:

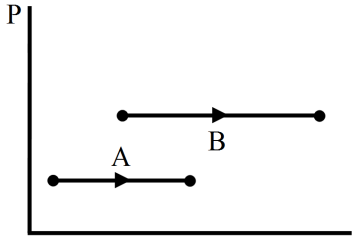


(A) $6P_0V_0$ (B) $-2P_0V_0$ (C) $+2P_0V_0$ (D) $+4P_0V_0$

15. An ideal gas goes from the state i to the state fas shown in figure. The work done by the gas during the process:

a. Is positive.
b. Is negative.
c. Is zero.
d. Cannot be obtained from this information.

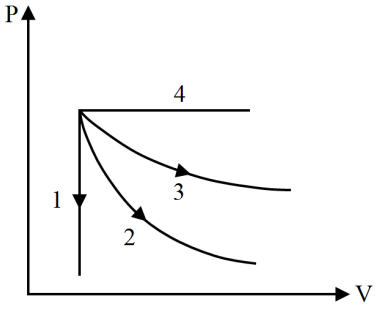




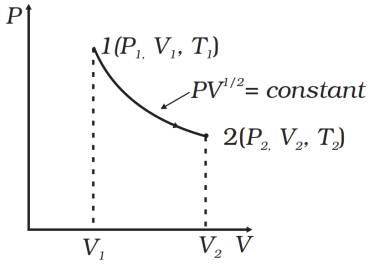
16. Consider two processes on a system as shown in figure. The volumes in the initial states are the same in the two processes and the volumes in the final states are also the same. Let ΔW_1 and ΔW_2 be the work done by the system in the processes A and B respectively.
    a. $\Delta W_1 > \Delta W_2$.
    b. $\Delta W_1 = \Delta W_2$.
    c. $\Delta W_1 < \Delta W_2$.
    d. Nothing can be said about the relation between ΔW_1 and ΔW_2.

*** Given Section consists of questions of 2 marks each.** **[28]**

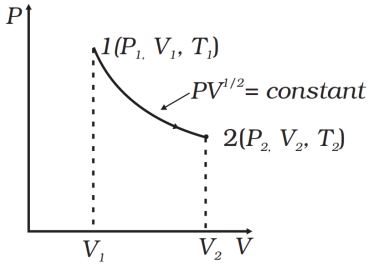
17. Air pressure in a car tyre increases during driving. Explain.
18. Calculate the fall in temperature of helium initially at 15°C, when it is suddenly expanded to 8 times of its volume. Given $\gamma = \frac{5}{3}$.
19. A steam engine intakes steam at 200°C and after doing work exhausts it directly in air at 100°C. Calculate the percentage of heat used for doing work. Assume the engine to be an ideal engine.
20. Identify and name the thermodynamic processes marked as 1, 2, 3 and 4 as shown in figure.



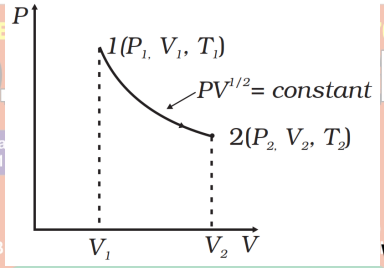
21. A carnot engine absorbs 100 calories per cycle from its source at 1600K. Its efficiency is 60%. Find the temperature of the sink and work done per cycle. Given J = 4.2J/ cal.
22. Two samples of gas initially at the same temperature and pressure are compressed from volume V to $\frac{V}{2}$. One sample is compressed isothermally and the other adiabatically. In which case will the pressure be higher? Explain.
23. Temperature in the freezer of a refrigerator is being maintained at -13°C and room temperature on a particular day was 42°C. Calculate the coefficient of performance of the refrigerator.

24. Consider a P-V diagram in which the path followed by one mole of perfect gas in a cylindrical container is shown in Fig. 

Find the work done when the gas is taken from state 1 to state 2.

25. Consider a P-V diagram in which the path followed by one mole of perfect gas in a cylindrical container is shown in Fig. 

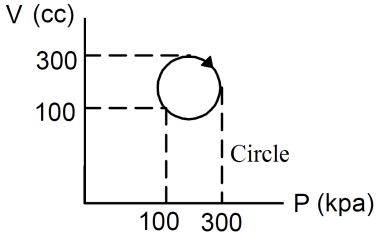
Find the work done when the gas is taken from state 1 to state 2.

26. Consider a P-V diagram in which the path followed by one mole of perfect gas in a cylindrical container is shown in Fig. 

What is the ratio of temperature $\frac{T_1}{T_2}$, if $V_2 = 2V_1$?

27. An ideal gas is taken from an initial state i to a final state f in such a way that the ratio of the pressure to the absolute temperature remains constant. What will be the work done by the gas?

28. A gas is enclosed in a cylindrical vessel fitted with a frictionless piston. The gas is slowly heated for some time. During the process, 10J of heat is supplied and the piston is found to move out 10cm. Find the increase in the internal energy of the gas. The area of cross section of the cylinder = $4cm^2$ and the atmospheric pressure = 100kPa.

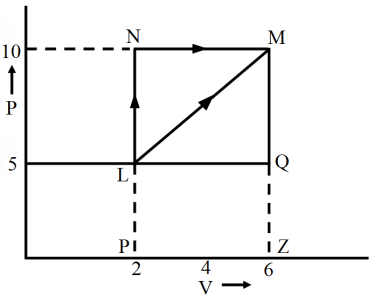
29. Calculate the heat absorbed by a system in going through the cyclic process shown in figure. 

30. The pressure of a gas changes linearly with volume from 10kPa, 200cc to 50kPa, 50cc.
    a. Calculate the work done by the gas.
    b. If no heat is supplied or extracted from the gas, what is the change in the internal energy of the gas?

*** Given Section consists of questions of 3 marks each.**

31. During India-Pakistan war, a soldier discovered that his lead bullet just melted when stopped by an obstacle. Calculate the velocity of the bullet if its temp. was 47.6°C. Given: melting point of lead = 327°C. Specific heat of lead = 0.03 cal $g^{-1}°C^{-1}$, latent heat of fusion of lead = 6 cal g^{-1} and J = 4.2×10^7 erg car^{-1}. Assume that no heat is lost.

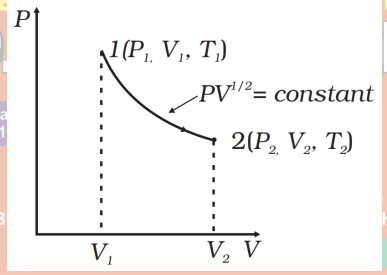
32. An ideal gas changes its state from L to M by two path LNM and LM.



i. Is the work done same for two paths?

ii. The internal energy of gas at L is 20J and the amount of heat needed to change its state through LM is 400J. What is the internal energy of gas at M?

33. Consider a P-V diagram in which the path followed by one mole of perfect gas in a cylindrical container is shown in Fig. Given the internal energy for one mole of gas at temperature T is (3/2) RT, find the heat supplied to the gas when it is taken from state (1) to (2) with $V_2 = 2V_1$.



34. 200J of work is done on a gas to reduce its volume by compressing it. If this change is done under adiabatic conditions, find out the change in internal energy of the gas and also the amount of heat absorbed by the gas.

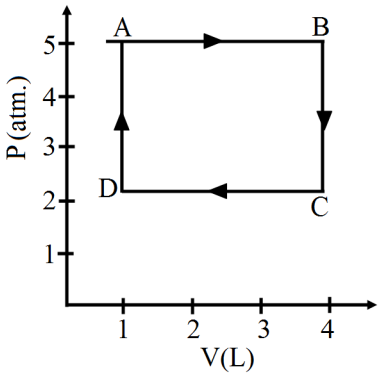
35. Prove that the slope of P-V graph for an adiabatic process is γ times that of the isothermal process.

36. Two Carnot engines A and B are operated in series. The first one A receives heat at 800K and rejects to a reservoir at temperature T K The second engine B receives the heat rejected by the first engine and in turn rejects to a heat reservoir at 300K. Calculate the temperature T K for the following cases.

i. When the outputs of the two engines are equal.

ii. When the efficiencies of the two engines are equal.

37. One mole of an ideal gas undergoes a cyclic change ABCD. From the given diagram, calculate the net work done in the process. 1 atmosphere = 10° dyne



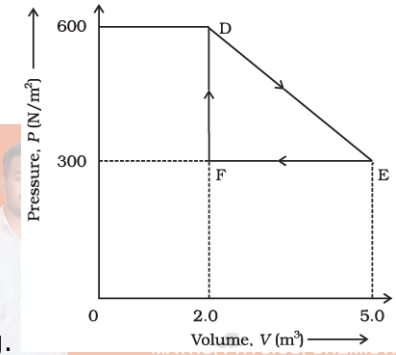
cm^{-2}.

38. Calculate the fall in temperature when a gas initially at 72°C is expanded suddenly to eight times its original volume. Given $y = \frac{5}{3}. (\because V_2 = 8x \text{ c.c.})$

39. State first law of thermodynamics. What are its limitations? Why $C_p > C_v$?

40. A refrigerator is to maintain eatables kept inside at 9°C. If room temperature is 36°C, calculate the coefficient of performance.

41. A thermodynamic system is taken from an original state to an intermediate state by the linear process shown in Fig. Its volume is then reduced to the original value from E to F by an isobaric process. Calculate the total work done by the gas from D to E to F.

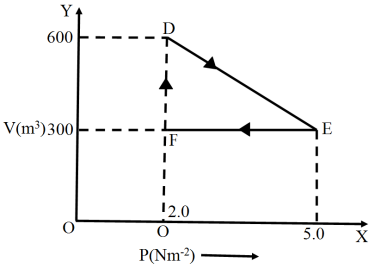


42. A refrigerator transfers 250J heat per second from -23°C to 25°C. Find the power consumed, assuming no loss of energy.

43.

i. Describe a Carnot's cycle.

ii. A thermodynamic system is taken from an original state to an intermediate state by the linear process shown in below figure. Its volume is then reduced to the original value from E to F by an isobaric process. Calculate the work done by the gas from D to E to F.

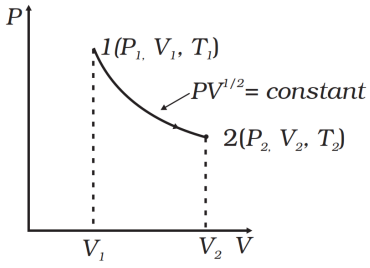


44. The temperature of equal masses of three different liquids A, B and C are 12°C, 19°C and 28°C respectively. The temperature when A and B are mixed is 16°C. When B and C are mixed, the temperature is 23°C. What would be the temperature when A and C are mixed?

45. What are 'Super heated water' and 'Super cooled vapour'?

46. State law of equi-partition of energy. Use this law to calculate specific heats of monoatomic, diatomic and triatomic gases.

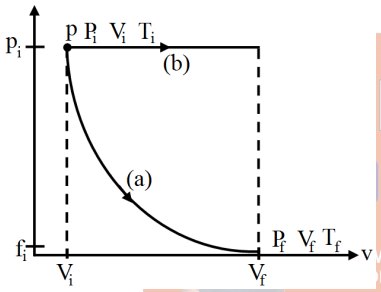
47. Consider a P-V diagram in which the path followed by one mole of perfect gas in a cylindrical container is shown in Fig.



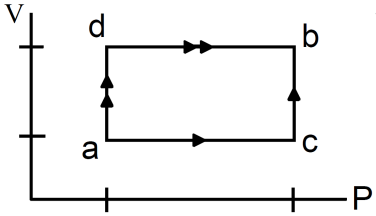
Given the internal energy for one mole of gas at temperature T is (3/2) RT, find the heat supplied to the gas when it is taken from state (1) to (2) with $V_2 = 2V_1$.

48. The initial state of a certain gas is (P_i , V_i , T_i). It undergoes expansion till its volume becoms V_f . Consider the following two cases:
    a. The expansion takes place at constant temperature.
    b. The expansion takes place at constant pressure.

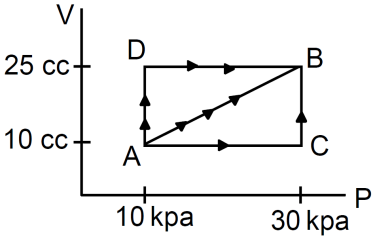
Plot the P-V diagram for each case. In which of the two cases, is the work done by the gas more?



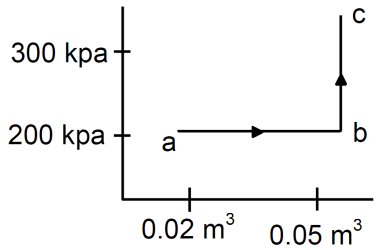
49. When a system is taken through the process abc shown in figure. 80J of heat is absorbed by the system and 30J of work is done by it. If the system does 10J of work during the process adc, how much heat flows into it during the process?



50. Figure. shows three paths through which a gas can be taken from the state A to the state B. Calculate the work done by the gas in each of the three paths.



51. A substance is taken through the process abc as shown in figure. If the internal energy of the substance increases by 5000J and a heat of 2625cal is given to the system,



calculate the value of J.

*** Given Section consists of questions of 5 marks each.** **[85]**

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

53. In an experiment on the specific heat of a metal, a 0.20kg block of the metal at 150°C is dropped in a copper calorimeter (of water equivalent 0.025kg) containing 150 c.c. of water at 27°C. The final temperature is 40°C. Calculate the specific heat of the metal. If heat losses to the surroundings are not negligible, is your answer greater or smaller than the actual value of specific heat of the metal?

54. A Carnot engine is working between ice point and steam point. It is desired to increase its efficiency by 20% (a) by changing temperature of hot reservoir alone, (b) by changing temperature of colder reservoir only. Calculate the change in temperature in each case.

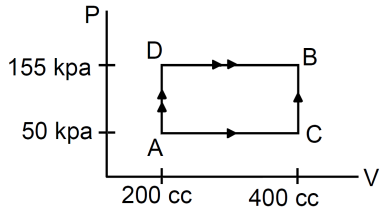
55. A lead bullet penetrates into a solid object and melts. Assuming that 50% of the K.E. was used to heat it, calculate the initial speed of the bullet. The initial temperature of bullet is 27°C and its melting point is 327°C. Latent heat of fusion of lead = 2.5×10^4J kg^{-1} and specific heat capacity of lead = 125J $kg^{-1}K^{-1}$.

56. Calculate the heat required to convert 0.6kg of ice at -20°C, kept in a calorimeter to steam at 100°C at atmospheric pressure. Given the specific heat capacity of ice = 2100J $kg^{-1}K^{-1}$, specific heat capacity of water is 4186J $kg^{-1}K^{-1}$, latent heat of ice = 3.35×10^5J kg^{-1}, and latent heat of steam = 2.256 × 106J kg^{-1}.

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

58. In a refrigerator one removes heat from a lower temperature and deposits to the surroundings at a higher temperature. In this process, mechanical work has to be done which is provided by an electric motor. If the motor is of 1KW power, and heat is transferred from –3°C to 27°C, find the heat taken out of the refrigerator per second assuming its efficiency is 50% of a perfect engine.

59. 50cal of heat should be supplied to take a system from the state A to the state B through the path ACB as shown in figure. Find the quantity of heat to be supplied to take

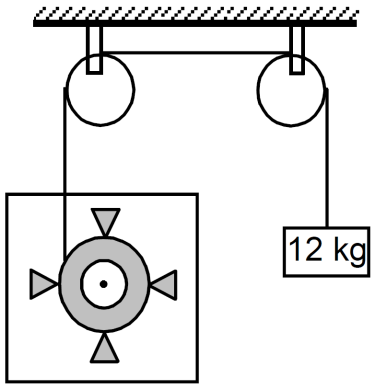


it from A to B via ADB.

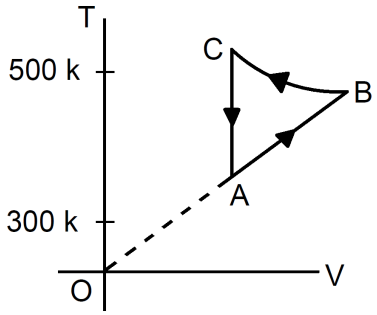
60. A thermally insulated, closed copper vessel contains water at 15°C. When the vessel is shaken vigorously for 15 minutes, the temperature rises to l 7°C. The .mass of the vessel is 100g and that of the water is 200g. The specific heat capacities of copper and water are 420Jkg^{-1} K^{-1} and 4200Jkg^{-1} K^{-1} respectively. Neglect any thermal expansion.
    a. How much heat is transferred to the liquid-vessel system?
    b. How much work has been done on this system?
    c. How much is the increase in internal energy of the system?

61. A 100kg block is started with a speed of 2.0ms^{-1} on a long, rough belt kept fixed in a horizontal position. The coefficient of kinetic friction between the block and the belt is 0.20.
    a. Calculate the change in the internal energy of the block-belt system as the block comes to a stop on the belt.
    b. Consider the situation from a frame of reference moving at 2.0ms^{-1} along the initial velocity of the block. As seen from this frame, the block is gently put on a moving belt and in due time the block starts moving with the belt at 2.0ms^{-1} Calculate the increase in the kinetic energy of the block as it stops slipping past the belt.
    c. Find the work done in this frame by the external force holding the belt.

62. Figure. shows a paddle wheel coupled to a mass of 12kg through fixed frictionless pulleys. The paddle is immersed in a liquid of heat capacity 4200JK^{-1} kept in an adiabatic container. Consider a time interval in which the 12kg block falls slowly through 70cm.
    a. How much heat is given to the liquid?
    b. How much work is done on the liquid?
    c. Calculate the rise in the temperature of the liquid neglecting the heat capacity of the container and the paddle.



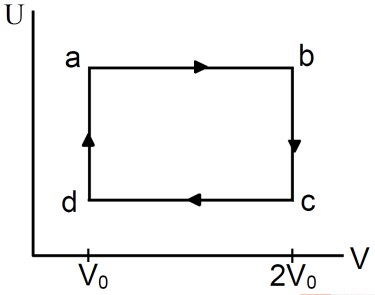
63. Consider the cyclic process ABCA, shown in figure. performed on a sample of 2.0 mol of an ideal gas. A total of 1200J of heat is withdrawn from the sample in the process. Find



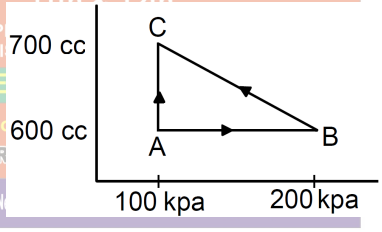
the work done by the gas during the part BC.

64. Calculate the increase in the internal energy of 10g of water when it is heated from 0°C to 100°C and converted into steam at 100kPa. The density of steam= 0.6kg/ m^{-3}. Specific heat capacity of water = 4200J/ $kg^{-1}°C^{-1}$ and the Jatent heat of vaporization of water = $2.25 \times 10^6 J/kg^{-1}$.

65. Figure. shows the variation in the internal energy U with the volume V of 2.0mol of an ideal gas in a cyclic process abcda. The temperatures of the gas at b and c are 500K and 300K respectively. Calculate the heat absorbed by the gas during the process.



66. A gas is taken through a cyclic process ABCA as shown in figure. If 2.4 cal of heat is given in the process, what is the value of J?



67. A gas is initially at a pressure of 100kPa and its volume is $2.0m^3$. Its pressure is kept constant and the volume is changed from $2.0m^3$ to $2.5m^3$. Its volume is now kept constant and the pressure is increased from 100kPa to 200kPa. The gas is brought back to its initial state, the pressure varying linearly with its volume.
    a. Whether the heat is supplied to or extracted from the gas in the complete cycle?
    b. How much heat was supplied or extracted?

68. Find the change in the internal energy of 2kg of water as it is heated from 0°C to 4°C. The specific heat capacity of water is 4200Jkg^{-1} K^{-1} and its densities at 0°C and 4°C are 999.9kgm^{-3} and 1000kgm^{-3} respectively. Atmospheric pressure = 10^{-6}Pa.

*** Case study based questions** **[8]**

69. When a tyre bursts, the air coming out is cooler than the surrounding air. Explain.

70. When we rub our hands they become warm. Have we supplied heat to the hands?

----- "Itni shiddat se maine tumhe (success) paane ki koshish ki hai,ki har zarre ne mujhe tumse milane ki saazish ki hai -----