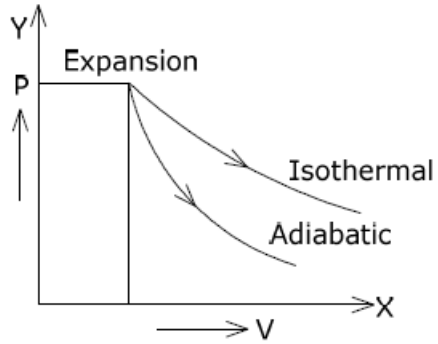
# Class XI

## Thermodynamics worksheet 2

1. Draw a p – v diagram for isothermal and adiabatic expansion? 1

Ans.




2. State zeroth law of thermodynamics? 1

Ans. When the thermodynamic system A and B are separately in thermal equilibrium with a third thermodynamic system C, then the system A and B are in thermal equilibrium with each other also.

3. Can a gas be liquefied at any temperature by increase of pressure alone? 2

Ans. No, a gas can be liquefied by pressure alone, only when temperature of gas is below its critical temperature.

4. A certain gas at atmospheric pressure is compressed adiabatically so that its volume becomes half of its original volume. Calculate the resulting pressure? 2

Ans.

$Given: \quad V_1 = V \qquad V_2 = \frac{V}{2}$

$P_1 = 0.76 m\, of\ Hg\ column$

$To\ find: P_2 = ?$

$Sol^n:$

$As\ the\ change\ is\ adiabatic$

$P_1 V_1^{\gamma} = P_2 V_2^{\gamma}$

$$P_2 = P_1\left(\frac{V_1}{V_2}\right)^{\gamma} = 0.76\left(\frac{V}{\frac{V}{2}}\right)^{1.4} = 0.76\times(2)^{1.4}$$

$= 2 m\, of\ Hg\ column$

$P_2 = \rho g h = 13.6\times10^3\times9.8\times2 = 2.67\times10^5\ Nm^{-2}$

5. Why is conversion of heat into work not possible without a sink at lower temperature? 2

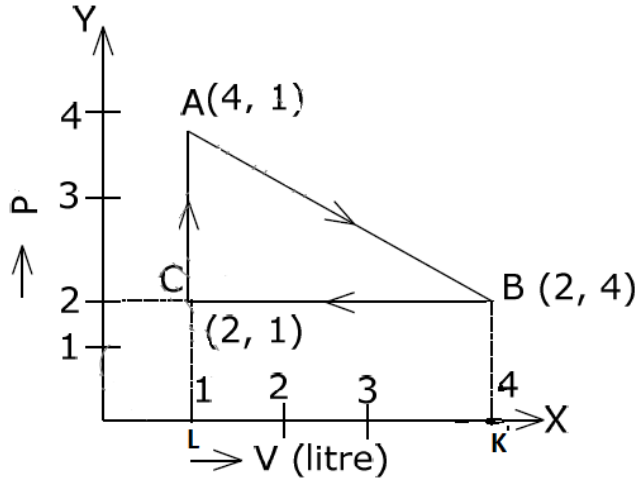
Ans. For converting heat energy in to work continuously a part of heat energy absorbed from the source has to be rejected. The heat energy can be rejected only to a body at lower temperature which is sink, so we require a sink to convert heat into work.

6. Write the sign conventions for the heat and work done during a thermodynamic process? 3

Ans. (a) When heat is supplied to a system dQ is taken positive but when heat is supplied by a system, dQ is taken negative.

(b) When a gas expands, dW is taken as positive but when a gas compresses, work done is taken as negative.

7. Deduce the work done in the following complete cycle? 3




Ans. $W_{AB} = Area\ ABKLA$

$= Area\ \Delta ABC + Area\ BKLC$

$= \frac{1}{2} \times BC \times AC + BC \times CL$

$= \frac{1}{2} \times (4-1) \times 10^{-3} \times (4-2) + (4-1) \times 10^{-3} \times (2-0) \quad \left[\because BC = 3l = 3 \times 10^{-3} m^3\right]$

$= \frac{1}{2} \times 3 \times 10^{-3} \times 2 + 3 \times 10^{-3} \times 2$

$= 9 \times 10^{-3} J$

$W_{BC} = -Area\ BCLK = -KL \times LC = -3 \times 10^{-3} \times 2 = -6 \times 10^{-3} J$

$W_{CA} = 0J \quad \left[\because As\ there\ is\ no\ change\ in\ volume\ of\ gas\right]$

$W = W_{AB} + W_{BC} + W_{CA} = 9 \times 10^{-3} - 6 \times 10^{-3} = 3 \times 10^{-3} J$

8 One kilogram molecule of a gas at 400k expands isothermally until its volume is doubled. Find the amount of work done and heat produced?

$V_1 = V$

$V_2 = 2V$

$T = 400K$

$R = 8.3 \times 10^{-3} J.mol^{-1}.K^{-1}$

$W = 2.303RT \log_{10}\left(\frac{V_2}{V_1}\right)$

$= 2.303 \times 8.3 \times 10^{-3} \times 400 \times \log_{10}\left(\frac{2V}{V}\right)$

$= 2.303 \times 8.3 \times 10^{-3} \times 400 \times \log_{10}(2)$

$= 2.303J$

$= \frac{2.303}{4.2} cal. = 0.548 cal.$