

**Test Your fiziks concepts!****Topic: Statistical Mechanics****(For CSIR NET-JRF, GATE, JEST and TIFR Aspirants)**

**Q.** When a collection of two-level systems is in equilibrium at temperature  $T_0$ , the ratio of the population in the lower and upper levels is 2 : 1. When the temperature is changed to  $T$ , the ratio is 8 : 1. Then

(a)  $T = 2T_0$

(b)  $T_0 = 2T$

(c)  $T_0 = 3T$

(d)  $T_0 = 4T$

**Ans.: (c)**

**Solution.:**  $N = N_0 \exp\left(-\frac{E}{k_B T}\right) \Rightarrow \frac{N_1}{N_2} = \exp\left(\frac{E_2 - E_1}{k_B T_0}\right) \Rightarrow 2 = \exp\left(\frac{E_2 - E_1}{k T_0}\right)$ , and

$$8 = \exp\left(\frac{E_2 - E_1}{k T}\right) \frac{\ln 2}{\ln 8} = \frac{T}{T_0} \Rightarrow T_0 = 3T$$

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**Test Your fiziks concepts!****Topic: Mechanics****(For IIT-JAM, JEST, TIFR and CUET Aspirants)**

**Q.** Preeti reached the metro station and found that the escalator was not working. She walked up the stationary escalator in time  $t_1$ . On other days, if she remains stationary on the moving escalator, then the escalator takes her up in time  $t_2$ . The time taken by her to walk up on the moving escalator will be:

- (a)  $\frac{t_1 t_2}{t_2 - t_1}$       (b)  $\frac{t_1 t_2}{t_2 + t_1}$       (c)  $t_2 - t_1$       (d)  $\frac{t_1 + t_2}{2}$

**Ans.: (b)**

**Solution.:**

$t_1$  = time taken at stationary escalator,  $t_2$  = time taken at moving escalator

$t$  = time taken in walking up the moving escalator

$d$  = displacement of escalator,  $V_1$  = velocity of Preeti and  $V_2$  = velocity of escalator

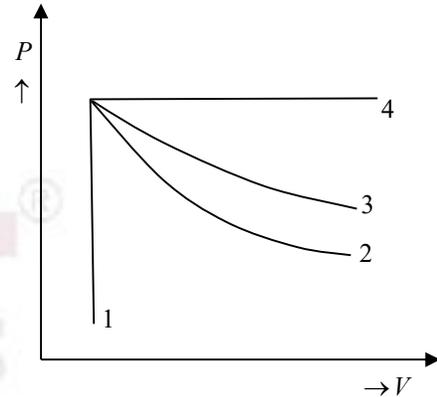
$$V_1 = \frac{d}{t_1}, V_2 = \frac{d}{t_2}, (V_1 + V_2) = \frac{d}{t} \Rightarrow \frac{d}{t_1} + \frac{d}{t_2} = \frac{d}{t} \Rightarrow t = \frac{t_1 t_2}{t_2 + t_2}$$

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**Test Your fiziks concepts!****Topic: Thermodynamics****(For PGT: KVS, NVS, DSSSB, State Education Boards, etc.)**

**Q.** An ideal gas undergoes four different processes from the same initial state as shown in the figure below. Those processes are adiabatic, isothermal isobaric and isochoric. The curve which represents the adiabatic process among 1, 2, 3 and 4 is:

- (a) 4
- (b) 1
- (c) 2
- (d) 3



**Ans.: (c)**

**Solution.:**

Curve 1: As the volume remains constant, so the process is Isochoric

Curve 2: Adiabatic curve is steeper than isothermal.

Curve 3: Curve 3 represents isothermal process.

Curve 4: Isobaric process occurs at constant pressure.

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**Test Your fiziks concepts!****Topic: Statistical Mechanics****(For CSIR NET-JRF, GATE, JEST and TIFR Aspirants)**

**Q.** Consider  $N$  non-interacting, distinguishable particles in a two-level system at temperature  $T$ . The energies of the levels are  $0$  and  $\varepsilon$ , where  $\varepsilon > 0$ . In the high temperature limit ( $k_B T > \varepsilon$ ), what is the population of particles in the level with energy  $\varepsilon$ ?

- (a)  $\frac{N}{2}$                       (b)  $N$                       (c)  $\frac{N}{4}$                       (d)  $\frac{3N}{4}$

**Ans.: (a)**

**Solution.:** 
$$P(\varepsilon) = \frac{\exp\left(-\frac{\varepsilon}{kT}\right)}{1 + \exp\left(-\frac{\varepsilon}{kT}\right)}$$

population of particle in the level with energy  $\varepsilon$  is 
$$NP(\varepsilon) = N \frac{\exp\left(-\frac{\varepsilon}{kT}\right)}{1 + \exp\left(-\frac{\varepsilon}{kT}\right)}$$

For ( $k_B T > \varepsilon$ ), 
$$NP(\varepsilon) = N \frac{\exp\left(-\frac{\varepsilon}{kT}\right)}{1 + \exp\left(-\frac{\varepsilon}{kT}\right)} = N \frac{1}{1+1} = \frac{N}{2}$$

**Note:**

For detailed solutions, visit the **Free Download** section at [www.physicsbyfiziks.com](http://www.physicsbyfiziks.com)

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**Test Your fiziks concepts!****Topic: Mechanics****(For IIT-JAM, JEST, TIFR and CUET Aspirants)**

**Q.** A stone falls freely under gravity. It covers distances  $h_1, h_2$  and  $h_3$  in the first 5 seconds, the next 5 seconds and the next 5 seconds respectively. The relation between  $h_1, h_2$  and  $h_3$  is:

(a)  $h_1 = h_2 = h_3$

(b)  $h_1 = 2h_2 = 3h_3$

(c)  $h_1 = \frac{h_2}{3} = \frac{h_3}{5}$

(d)  $h_2 = 3h_1$  and  $h_3 = 3h_2$

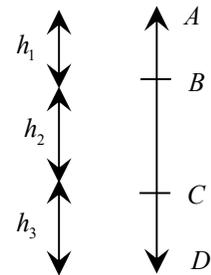
**Ans.: (c)****Solution.:**

Here initial velocity is zero  $AB = h_1 = \frac{1}{2}g(5)^2 \Rightarrow h_1 = 125 \text{ m } (\because u = 0)$

$$h_2 = BC = \frac{1}{2}g[10^2 - 5^2] \Rightarrow h_2 = 375 \text{ m}$$

$$h_3 = CD = \frac{1}{2}g[15^2 - 10^2] \Rightarrow h_3 = 625 \text{ m}$$

$$h_1 : h_2 : h_3 = 125 : 375 : 625 = 1 : 3 : 5 \Rightarrow h_1 = \frac{h_2}{3} = \frac{h_3}{5}$$

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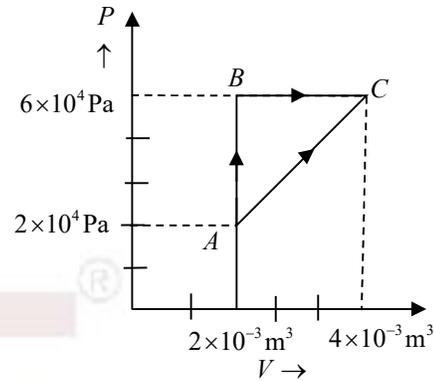
## Test Your fiziks concepts!

### Topic: Thermodynamics

(For PGT: KVS, NVS, DSSSB, State Education Boards, etc.)

**Q.** Figure below shows two paths that may be taken by a gas to go from a state  $A$  to a state  $C$ . In process  $AB$ , 400 J of heat is added to the system and in process  $BC$ , 100 J of heat is added to the system. The heat absorbed by the system in the process  $AC$  will be:

- (a) 500 J                      (b) 460 J  
(c) 300 J                      (d) 380 J



**Ans.: (b)**

**Solution.:** In cyclic process ABCA,

$$\Delta U_{\text{cyclic}} = 0 \Rightarrow Q_{\text{cyclic}} = W_{\text{cyclic}}$$

$Q_{AB} = +400$  J is the heat absorbed in process  $AB$

$Q_{BC} = +100$  J is the heat absorbed in process  $BC$

Area under loop =  $+W$  (clockwise);  $Q_{AB} + Q_{BC} - Q_{CA} = \text{closed loop area.}$

$$400 + 100 - Q_{CA} = \frac{1}{2} \times (2 \times 10^{-3}) \times 4 \times 10^4 \Rightarrow 400 + 100 - Q_{AC} = 40 \Rightarrow Q_{AC} = 460 \text{ J}$$

**Note:**

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