

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

**Q.** A monatomic crystalline solid comprises of  $N$  atoms, out of which  $n$  atoms are in interstitial positions. If the available interstitial sites are  $N'$ , then number of possible microstates is

(a)  $\frac{(N' + n)!}{n!N!}$

(b)  $\frac{N!}{n!(N+n)!} \frac{N'!}{n!(N'+n)!}$

(c)  $\frac{N!}{n!(N'-n)!}$

(d)  $\frac{N!}{n!(N-n)!} \frac{N'!}{n!(N'-n)!}$

**Ans.: (d)**

**Solution.:** Total number of atoms =  $N$ , Total number of interstitial sites =  $N'$   
atoms at interstitial positions =  $n$

The number of ways to choose which  $n$  atoms (out of  $N$ ) moves to interstitial sites

$$= \frac{N!}{n!(N-n)!}$$

The number of ways to place these  $n$  atoms into the  $N'$  interstitial sites

$$= \frac{N'!}{n!(N'-n)!}$$

Thus, total number of possible microstates is =  $\frac{N!}{n!(N-n)!} \frac{N'!}{n!(N'-n)!}$

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

**Q.** Two planets  $P_1$  and  $P_2$  having masses  $M_1$  and  $M_2$  revolve around the Sun in elliptical orbits, with time periods  $T_1$  and  $T_2$  respectively. The minimum and maximum distances of planet  $P_1$  from the Sun are  $R$  and  $3R$  respectively, whereas for planet  $P_2$  these are  $2R$  and  $4R$ , respectively, where  $R$  is a constant. Assuming  $M_1$  and  $M_2$  are much smaller than the mass of the Sun, the magnitude of  $\frac{T_2}{T_1}$  is

- (a)  $\frac{2}{3}\sqrt{\frac{2M_1}{3M_2}}$       (b)  $\frac{3}{2}\sqrt{\frac{3M_2}{2M_1}}$       (c)  $\frac{3}{2}\sqrt{\frac{3}{2}}$       (d)  $\frac{2}{3}\sqrt{\frac{2}{3}}$

**Ans.: (c)****Solution.:** For  $P_1$  :  $2a_1 = 4R \Rightarrow a_1 = 2R$ ; For  $P_2$  :  $2a_2 = 6R \Rightarrow a_2 = 3R$ 

$$\therefore T^2 \propto a^3 \Rightarrow \frac{T_2}{T_1} = \left(\frac{a_2}{a_1}\right)^{3/2} = \left(\frac{3R}{2R}\right)^{3/2} = \left(\frac{3}{2}\right)^{3/2} = \frac{3}{2}\sqrt{\frac{3}{2}}$$

option (c) is correct.

## Test Your fiziks concepts!

### Topic: Thermodynamics

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

**Q.** A Centigrade and a Fahrenheit thermometer are dipped in boiling water. The water temperature is lowered until the Fahrenheit thermometer registers  $140^{\circ}\text{F}$ . What is the fall in temperature as registered by the centigrade thermometer?

- (a)  $80^{\circ}\text{C}$                       (b)  $60^{\circ}\text{C}$                       (c)  $40^{\circ}\text{C}$                       (d)  $30^{\circ}\text{C}$

**Ans.: (c)**

**Solution.:** Using  $\frac{F - 32}{180} = \frac{C}{100}$ ,  $\Rightarrow \frac{140 - 32}{180} = \frac{C}{100} \Rightarrow C = 60^{\circ}\text{C}$

As the temperature of boiling water =  $100^{\circ}\text{C}$

fall in temperature =  $100 - 60 = 40^{\circ}\text{C}$



0	$\varepsilon$	$2\varepsilon$	$E_{Total} = 4\varepsilon$	$E_A$	$E_B$
AAA	–	BB	$4\varepsilon$	0	$4\varepsilon$
AAB	–	AB	$4\varepsilon$	$2\varepsilon$	$2\varepsilon$
ABB	–	AA	$4\varepsilon$	$4\varepsilon$	0
BB	AA	A	$4\varepsilon$	$4\varepsilon$	0
AB	AB	A	$4\varepsilon$	$3\varepsilon$	$\varepsilon$
AB	AA	B	$4\varepsilon$	$2\varepsilon$	$2\varepsilon$
AA	AB	B	$4\varepsilon$	$\varepsilon$	$3\varepsilon$
AA	BB	A	$4\varepsilon$	$2\varepsilon$	$2\varepsilon$
B	AAAB	–	$4\varepsilon$	$3\varepsilon$	$\varepsilon$
A	AABB	–	$4\varepsilon$	$2\varepsilon$	$2\varepsilon$

For system A,  $E_{A\text{Total}} = 23\varepsilon$ ;  $\langle E_A \rangle = \frac{23\varepsilon}{10} = 2.3\varepsilon$

For system B,  $E_{B\text{Total}} = 17\varepsilon$ ;  $\langle E_B \rangle = \frac{17\varepsilon}{10} = 1.7\varepsilon$

$$\langle E \rangle = \langle E_A \rangle + \langle E_B \rangle = 2.3\varepsilon + 1.7\varepsilon = 4\varepsilon$$

$\therefore$  Average energy of system A is  $2.3\varepsilon$ . So (b) is correct.

## Test Your fiziks concepts!

### Topic: Mechanics

(For IIT-JAM, JEST, TIFR and CUET Aspirants)

**Q.** A planet is in a highly eccentric orbit about a star. The distance of its closest approach is 300 times smaller than its farthest distance from the star. If the corresponding speeds are  $v_c$  and  $v_f$ , then  $v_c / v_f$  is

- (a)  $\frac{1}{300}$                       (b)  $\frac{1}{\sqrt{300}}$                       (c)  $\sqrt{300}$                       (d) 300

**Ans.: (d)**

**Solution.:** Using conservation of angular momentum

$$mv_c r_c = mv_f r_f \Rightarrow \frac{v_c}{v_f} = \frac{r_f}{r_c} = \frac{300r_c}{r_c} = 300$$

## Test Your fiziks concepts!

### Topic: Thermodynamics

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

**Q.** The value of coefficient of volume expansion of glycerin is  $5 \times 10^{-4} / K$ . The fractional change in the density of glycerin for a rise of  $40^\circ\text{C}$  in its temperature, is:

- (a) 0.010                      (b) 0.015                      (c) 0.020                      (d) 0.025

**Ans.: (c)**

**Solution.:** We know that, for volumetric expansion:  $V = V_0(1 + \gamma\Delta T)$

$$\therefore \text{Volume}(V) = \frac{\text{Mass}(M)}{\text{Density}(d)} ; \frac{M}{d} = \frac{M}{d_0}(1 + \gamma\Delta T)$$

$$\Rightarrow d = d_0(1 - \gamma\Delta T) \Rightarrow d = d_0 - d_0\gamma\Delta T \Rightarrow \frac{d_0 - d}{d_0} = \gamma\Delta T$$

$$\text{Fractional change in density} = \frac{\Delta d}{d_0} = 5 \times 10^{-4} \times 40 = 0.020$$