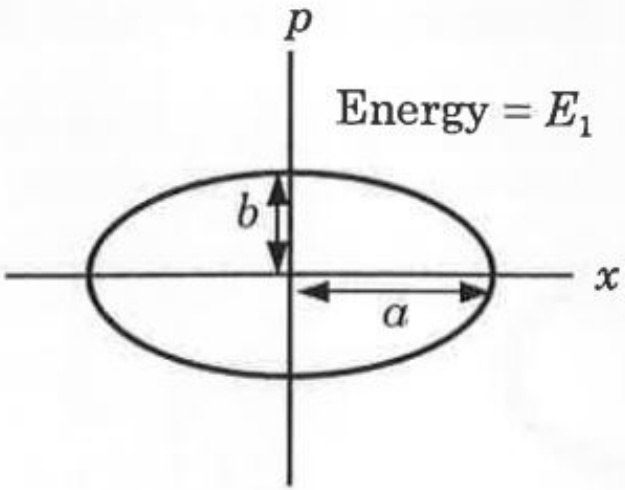
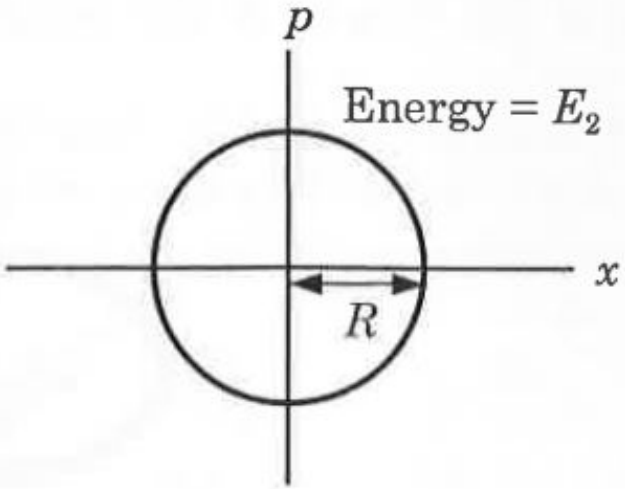
Q.11 Two independent harmonic oscillators of equal mass are oscillating about the origin with angular frequencies ω_1 and ω_2 and have total energies E_1 and E_2, respectively. The variations of their momenta p with positions x are shown in the figures. If $\frac{a}{b} = n^2$ and $\frac{a}{R} = n$, then the correct equation(s) is(are)





(A) $E_1\omega_1 = E_2\omega_2$ (B) $\frac{\omega_2}{\omega_1} = n^2$ (C) $\omega_1\omega_2 = n^2$ (D) $\frac{E_1}{\omega_1} = \frac{E_2}{\omega_2}$

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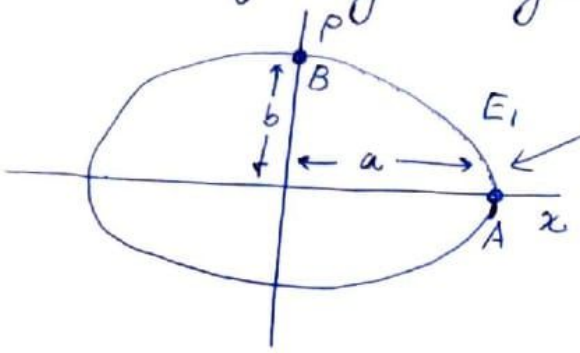
Let us firstly analyse the graph.



Point 'A' represents maximum value of 'x' – Amplitude

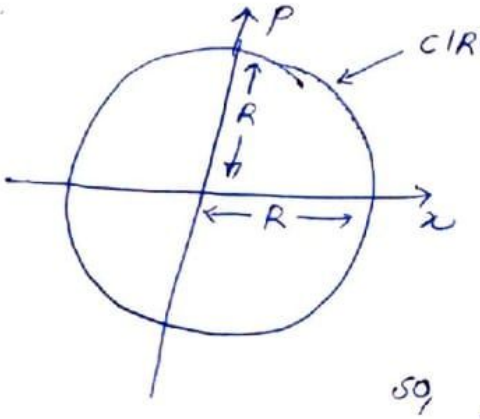
$\boxed{a = A_1}$

Point 'B' represents maximum value of momentum 'p' which implies maximum velocity

$V_{max} = \omega_1 A_1$

$P_{max} = \boxed{b = m\omega_1 A_1}$

* Same Mass



so, $\boxed{R = A_2}$ and $\boxed{R = m\omega_2 A_2}$

LET US FIND $\frac{\omega_2}{\omega_1}$

so, $\frac{R}{b} = \frac{m\omega_2 A_2}{m\omega_1 A_1} = \frac{\omega_2}{\omega_1} \times \frac{R}{a}$

$\boxed{E = \frac{1}{2} m\omega^2 A^2}$ $\Rightarrow$ $\boxed{\frac{\omega_2}{\omega_1} = \frac{a}{b} = n^2}$ { OPTION (b) CORRECT }

NOW LET US FIND $\frac{E_1}{E_2} = \frac{m\omega_1^2 A_1^2}{m\omega_2^2 A_2} = \frac{1}{n^4} \times \frac{a^2}{b^2} = \frac{1}{n^4} \times n^2 = \frac{1}{n^2}$

so, $\frac{E_2}{E_1} = n^2 = \frac{\omega_2}{\omega_1}$ $\Rightarrow$ $\boxed{\frac{E_2}{\omega_2} = \frac{E_1}{\omega_1}}$ { OPTION (d) CORRECT }