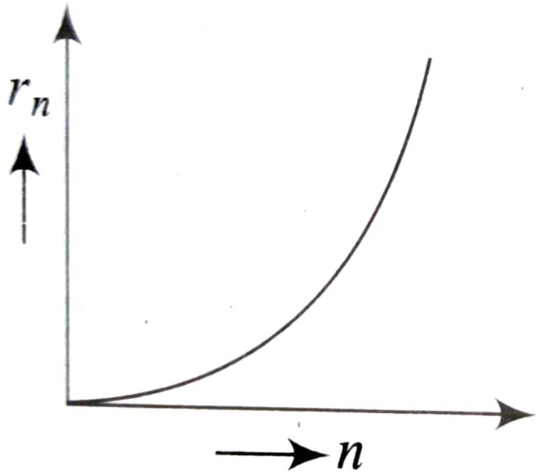
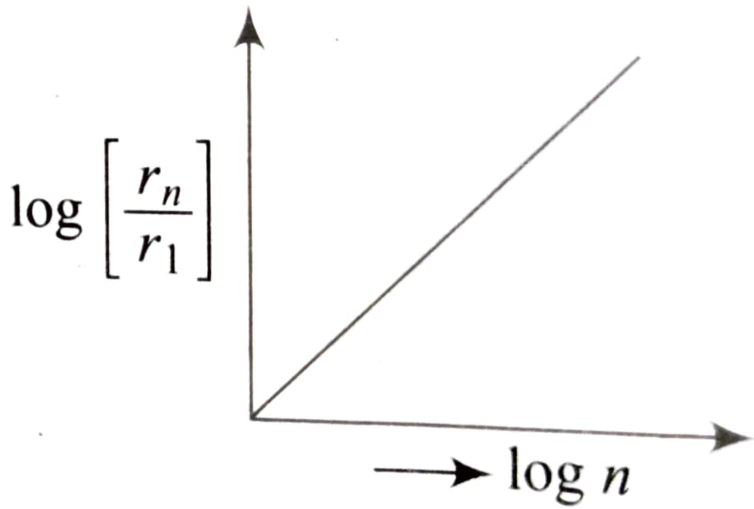
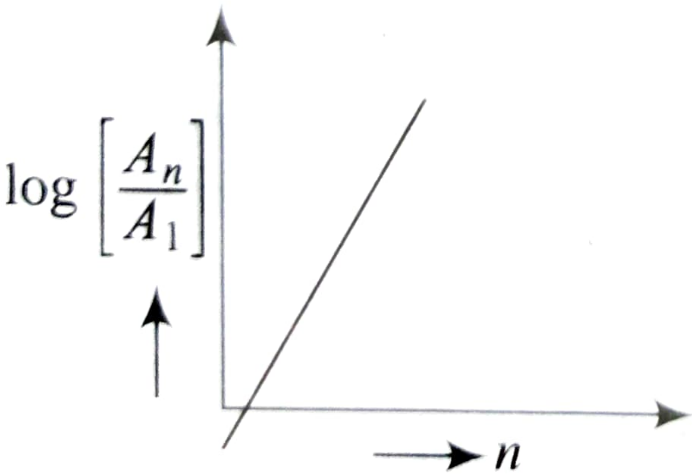
2. If, in a hydrogen atom, radius of nth Bohr orbit is r_n, frequency of revolution of electron in nth orbit is f_n, and area enclosed by the nth orbit is A_n, then which of the following graphs are correct?



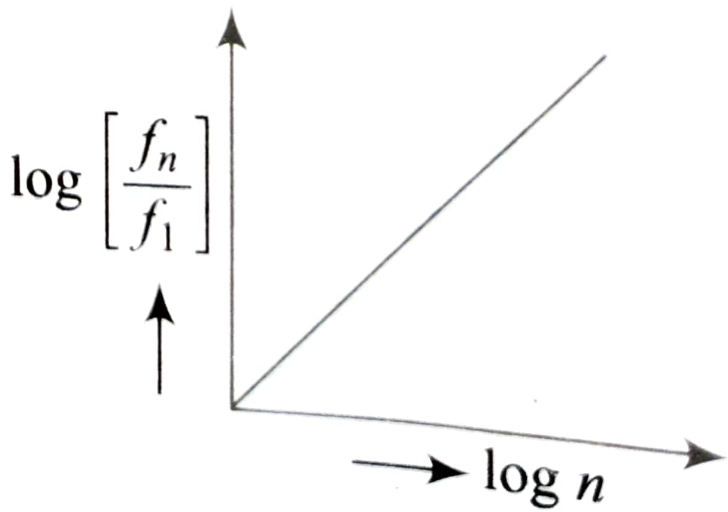
a.



b.



c.



d.

a., b., c. Since in hydrogen atom $r_n \propto n^2$, therefore graph between r_n and n will be a parabola through origin and having increasing slope. Therefore, option (a) is correct. Since, $r_n \propto n^2$, therefore

$r_n/r_1 = n^2$

Hence, $\log (r_n/r_1) = 2 \log n$

It means, graph between $\log (r_n/r_1)$ and $\log n$ will be a straight line passing through origin and having positive slope ($\tan \theta = 2$). Therefore, option (b) is also correct. If radius of an orbit is equal to r, then area enclosed by it will be equal to $A = \pi r^2$.

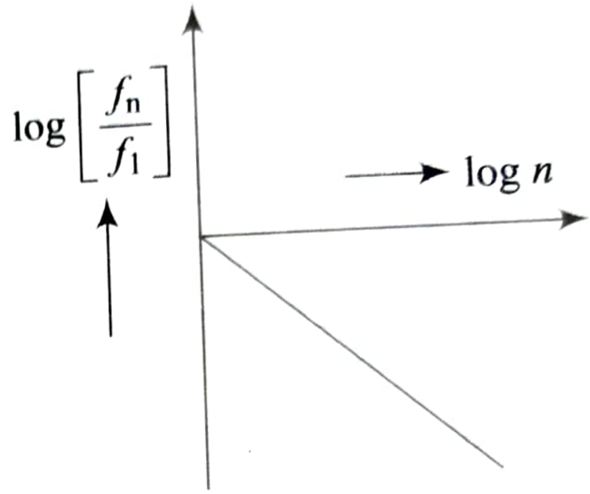


Fig. S4.11

Since $r_n \propto n^2$, therefore $A_n \propto n^4$

Hence, $\dfrac{A_n}{A_1} = n^4$ or $\log\left(\dfrac{A_n}{A_1}\right) = 4 \log n$

It means, graph between $\log (A_n/A_1)$ and $\log n$ will be a straight line passing through origin and having positive slope ($\tan \theta = 4$). Therefore, option (c) is also correct.

If frequency of revolution of electron is f, then its angular velocity will be equal to $\omega = 2\pi f$. Hence, its angular momentum will be equal to $I\omega = mr^2\omega$. But according to Bohr's theory, it is equal to $nh/2\pi$, therefore,

$$mr^2 (2\pi f) = \frac{nh}{2\pi} \quad \text{or} \quad f = \frac{nh}{4\pi^2 mr^2}$$

Since $r \propto n^2$, therefore $f \propto \dfrac{1}{n^3}$

Hence, $\dfrac{f_n}{f_1} = \dfrac{1}{n^3}$ or $\log\left(\dfrac{f_n}{f_1}\right) = 3 \log n$

It means, graph between $\log (f_n/f_1)$ and $\log n$ will be a straight line passing through origin and having negative slope, $\tan \theta = -3$. Hence, it will be as shown in figure. Hence, the option (d) is wrong.