

Answer on Question #81260 Physics / Optics

Evaluate the expectation value of r for the wave function $\psi(\mathbf{r}) = (\pi a^3)^{-\frac{1}{2}} \exp(-r/a)$.

Solution:

The expectation value

$$\begin{aligned}\langle r \rangle &= \int \psi^*(\mathbf{r}) r \psi(\mathbf{r}) d\mathbf{r} \\ &= \frac{1}{\pi a^3} \int \exp\left(-\frac{2r}{a}\right) r d\mathbf{r} = \frac{4\pi}{\pi a^3} \underbrace{\int_0^\infty \exp\left(-\frac{2r}{a}\right) r^3 dr}_{3a^4/8} = \frac{4}{a^3} \times \frac{3a^4}{8} = \frac{3}{2} a\end{aligned}$$

Answer: $\langle r \rangle = \frac{3}{2} a$

Answer provided by <https://www.AssignmentExpert.com>