Expressing const from (2) and plugging into (1), we get:

$$p = 2\,\frac{\int_{\delta_0}^{\infty} e^{-a^2\delta^2}\,d\delta}{\int_{-\infty}^{\infty} e^{-a^2\delta^2}\,d\delta} = \left[\begin{array}{ll} t = a\delta\ ; & \delta=\delta_0 \Rightarrow t = a\delta_0 \\ dt = a\,d\delta\ ; & \delta=\pm\infty \Rightarrow t=\pm\infty \end{array}\right]$$

$$= \frac{2\cancel{\tfrac{1}{a}}\int_{a\delta_0}^{\infty} e^{-t^2}\,dt}{\cancel{\tfrac{1}{a}}\int_{-\infty}^{+\infty} e^{-t^2}\,dt} = \frac{2\int_{a\delta_0}^{\infty} e^{-t^2}\,dt}{\sqrt{\pi}}$$

Now, from the formula given in the problem,

$$2x\,e^{x^2}\int_{x}^{\infty} e^{-t^2}\,dt \approx 1 \quad \text{if } x \gg 1$$

Set $x = a\delta_0 = \sqrt{\frac{4}{N}}\,\delta_0 = \sqrt{\frac{2}{10^{22}}}\,10^{12} = \sqrt{2}\times 10^{-11}\times 10^{12} = 14.14 \gg 1$.

So, the above formula will give us:

$$\int_{a\delta_0}^{\infty} e^{-t^2}\,dt \approx \frac{1}{2(a\delta_0)\,e^{(a\delta_0)^2}}, \text{ so}$$

$$p \approx \frac{\cancel{2}}{\sqrt{\pi}\,\cancel{2}(a\delta_0)\,e^{(a\delta_0)^2}} = \frac{1}{\sqrt{\pi}\,14.14\,e^{14.14^2}} = \cancel{\frac{0.0282}{e^{400}}}\ \frac{0.0399}{e^{200}}$$

Now, $e^{200} = 10^{\lg(e^{200})} = 10^{200\lg e} = 10^{200\cdot 0.434} = \cancel{10^{173.718}} = 10^{86.859}$

$= 10^{\cancel{173+0.718}\ 86+0.859} = 10^{\cancel{0.718}\ 0.859}\,10^{\cancel{173}\ 86} = \cancel{5.22\times 10^{173}}$ ~~so~~ 7.23×10^{86}, so

$$\cancel{p \approx 5.4\times 10^{-176}}$$ very small!

$$p \approx 5.5\times 10^{-89}$$