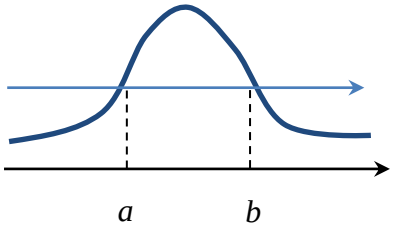
Quantum mechanics. Department of physics. 7th semester.

Lesson №15. ***Quasi-classical approximation: quasi-classical transmission coefficient***

1. Checking hometask. Get a semiclassical expression for the energy levels of the particle in a field

$$U(x) = k\,|\,x\,|, \quad k > 0.$$

2. Semiclassical barrier transmission coefficient

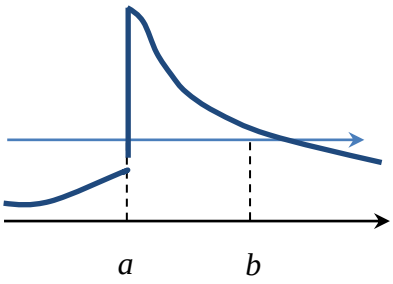


$$D \approx \exp\left(-\frac{2}{\hbar}\int_a^b |\,p(x)\,|\,dx\right). \qquad (1)$$

Necessary condition for the formula applicability (1): $D \ll 1$, more accurate condition for the applicability of the semiclassical approach:

$$\left|\lambda\!\!\!^{-}\frac{dp}{dx}\right| << |\,p\,|, \quad |\,p(x)\,| = \sqrt{2m(U(x)-E)}; \quad \lambda\!\!\!^{-} = \frac{\hbar}{|\,p(x)\,|}.$$

For barrier with one or two vertical walls formula (1) is valid in order of magnitude accurate to preexponential factor



$$D \sim \exp\left(-\frac{2}{\hbar}\int_a^b |\,p(x)\,|\,dx\right).$$

<u>Task 1.</u> Find quasi-classical transmission coefficient for $U(x) = \begin{cases} 0, & x < 0; \\ U_0\left(1 - \dfrac{x}{a}\right), & x > 0. \end{cases}$ (НКК № 9.27)

<u>Task 2.</u> Define probability of particle exit (with zero momentum) of centrally symmetric well (α–decay)

$$U(r) = \begin{cases} -U_0, & 0 \le x < r_0; \\ \dfrac{\alpha}{r}, & r > r_0. \end{cases}$$ (LL §50(2))

Hometask: ЕК Part.7 № 3-6, НКК 9.26-9.29; LL §50(3)

LL - Landau L.D., Lifshitz E.M. Quantum mechanics

НКК- Halitskii E.M., Karnakov B.M., Kohan V.I. Problems in Quantum Physics, 1981

ЕК – Elyutin P.V., Krivchenko V.D. Quantum mechanics 1976