Computational Physics II
Quiz 1

UCSD PHYS 142/242
Due: Friday, January 10, 2025, 8:00pm

Policies

Please work on the quiz individually.

Submission Instructions

Please submit your quiz as a single .pdf file to Gradescope under "Quiz 1".

1 Classical action [20 Points]

Relevant materials: Week 1 lectures

A free electron is moving in one dimension between position $x_A = 0$ at time t_A and position $x_B = 0.15 \times 10^{-8}$ cm at time t_B. The mass of the electron is $m = 0.5\,\mathrm{MeV}/c^2 = 9.1 \times 10^{-28}$ g where $c = 3 \times 10^{10}$cm/s is the speed of light. The electron is moving with (constant) velocity $v = 0.15c$.

Problem A [10 points]: Show that the classical action $S = \int_{t_A}^{t_B} L dt$ for a free particle ($L = \frac{1}{2}m\dot{x}^2$) is given by

$$S = \frac{m}{2}\frac{(x_B - x_A)^2}{t_B - t_A} = \frac{mv(x_B - x_A)}{2}. \tag{1}$$

Evaluate the action S in units of MeV s or $\mathrm{cm}^2\,\mathrm{g/s}$.

Problem B [5 points]: Evaluate the action S in units of $\hbar = h/(2\pi) = 6.5822 \times 10^{-22}\,\mathrm{MeV\,s} = 1.0546 \times 10^{-27}\,\mathrm{cm}^2\,\mathrm{g/s}$.

Problem C [5 points]: Evaluate the action S if the electron mass was 1 g and the separation between x_A and x_B was 1 cm. Evaluate S again in units of $\hbar$, like in (B). What is the most striking difference between the two results in (B) and (C) in $\hbar$ units? What does this mean for the classical limit of quantum mechanics, i.e. why do we not need to sum over all paths in classical mechanics?