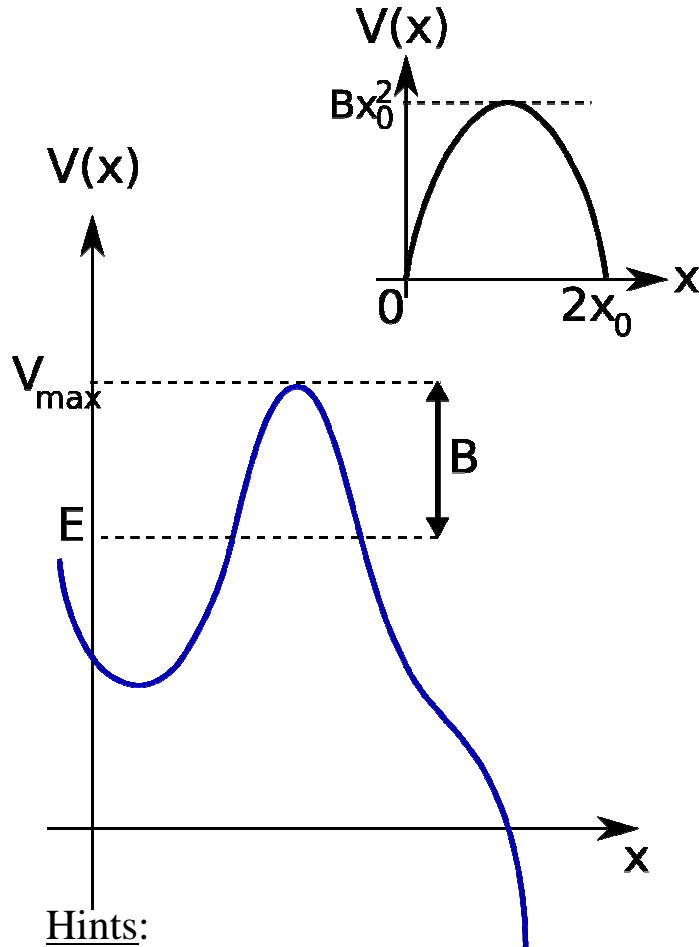


Due Date: 10-29-08

Nuclear Physics 621

Send your answer to:
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Homework 6 - Fission barriers and lifetimes



The fission barrier is sketched in the figure. We assume the daughter nucleus has $A = 100$ nucleons and energy E . We simulate the fission process by the tunneling through an inverted parabola of width $2x_0$:

$$V(x) = [x_0^2 - (x - x_0)^2]$$

Based on the lecture notes on Fission:

- 1) Show that the probability of fission is:

$$P \approx e^{-\alpha\sqrt{B}}$$

and give the expression and numerical value of α

- 2) What is the relation between the lifetime of the parent nucleus and the probability of emission ?
- 3) Suppose the top of the fission barrier is 10% lower. What is the impact on the lifetime ? Discuss your result.

Numerical data:

$$mc^2 = 1 \text{ GeV}, \hbar c = 200 \text{ MeV}\cdot\text{fm}, x_0 = 2 \text{ fm}, B = 5 \text{ MeV}\cdot\text{fm}^{-2}$$

Hints:

- 1)
$$\int \sqrt{a^2 - x^2} dx = \frac{1}{2} \left[x \sqrt{a^2 - x^2} + a^2 \text{Arcsin} \left(\frac{x}{a} \right) \right]$$

- 2) In the expression of the tunneling probability, replace the collective mass parameters $B(q)$ mentioned in class by the mass of the daughter nucleus.

$$P \approx e^{-\alpha\sqrt{B}}$$