

## M06T.1 - Interacting Particles on a Line

### Problem

Consider a system of  $N$  classical particles on a line with Hamiltonian

$$H = \frac{p_1^2}{2m} + U_1(x_1) + \sum_{i=2}^N \frac{p_i^2}{2m} + U(x_i - x_{i-1}).$$

The potential between neighboring particles is of the form:

$$U(y) = \begin{cases} +\infty, & \text{if } y < 0; \\ -U_0, & \text{if } 0 \leq y \leq a; \\ 0, & \text{if } a < y. \end{cases}$$

Here both  $U_0$  and  $a$  are positive. A constant force  $f$  is applied to the rightmost particle  $i = N$ .

- Compute the mean length,  $\langle x_N \rangle$ , of the system as a function of  $N, T$ , and  $f$ .
- Obtain the high and low temperature limits of the result from part a).