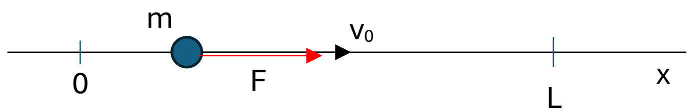
Solution work by $F(t) = F_0 e^{-\frac{t}{\tau}}$



a) $W = \int_0^L \vec{F} \, . d\vec{s} = \int_0^L F_0 e^{-\frac{t}{\tau}} \, dx$

Particle velocity is $v_0 = const$. Thus, trajectory $x(t) = v_0 t$ since at $t = 0 \rightarrow x = 0$
Consequently: $x = L \rightarrow t = \frac{L}{v_0}$

Thus, we can write for the amount of work done:

$$W = \int_0^{\frac{L}{v_0}} F_0 e^{-\frac{t}{\tau}} \cdot v_0 dt = F_0 v_0 \left[-\tau e^{-\frac{t}{\tau}} \right]_0^{L/v_0} = F_0 v_0 \tau \left(1 - e^{-\frac{L}{v_0 \tau}} \right)$$

b) We note: $W > 0$ and naively, we could expect that the kinetic energy of the particle would have increased. But that isn't the case: it started with $E_{kin} = \frac{1}{2} m v_0^2$ and it kept this along the entire path as it is given that the particle is traveling with a constant velocity. From this last statement, we immediately learn, that there must be a second force acting on the particle. This force is exactly equal and opposite to F at all times! Otherwise, the particle would accelerate and change its velocity. Consequently, this second force also perform work on m, the amount is exactly -W and thus the total work done on the particle is zero which reflects that the particle does not change its kinetic energy.