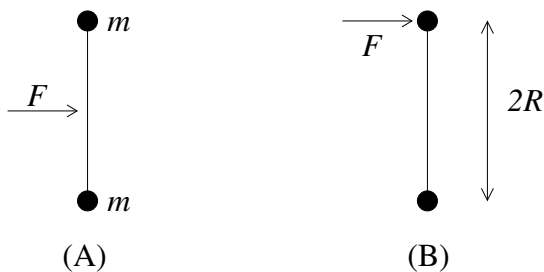


PHY509: HOMEWORK 1. (due 09/09/05)



1. A dumbbell consists of two point masses, m , connected by a massless rod of length $2R$. A constant force F is applied as shown during a very short time interval Δt . In (A), the force acts on the center of mass (CM), while in (B) the same force acts on the upper mass. We analyze in the following steps. Ignore gravity.

- (a) What is the center of mass velocity Δv after the impulse for both (A) and (B). Are they the same?
- (b) Are the kinetic energies for (A) and (B) the same? If not, which case has the larger energy? Explain.

We first study the situation for (A).

- (c) What is the kinetic energy of (A) after the time interval Δt ?
- (d) Find the displacement Δx at $t = \Delta t$. Make sure it is proportional to Δt^2 .
- (e) Calculate the work $W = \int F dx = F\Delta x$ during the time interval. It must agree with the result of (c) due to the work-energy theorem.

We now do the same for (B).

- (f) What is the kinetic energy of (B) from the CM motion after the time interval Δt ? Is it the same as the answer in (c)?
- (g) Find the angular velocity of the dumbbell with respect to the CM after the hit. What is the rotational kinetic energy?
- (h) What is the total kinetic energy, the sum of (f) and (g)?
- (i) Find the angular displacement $\Delta\theta$ right after the hit. (Make sure that $\Delta\theta \propto \Delta t^2$.) Then, what are the total displacements Δx (from the CM motion and the angular motion) of the lower and upper masses, respectively.
- (j) With the results from (i), calculate the work done by the force to the whole system, $W = \int F dx = F\Delta x_{\text{upper mass}}$, and confirm that this agrees with (h).