Chapter C4: Particles and Systems

C4.1: Systems of Particles

1. Particles are tiny.
2. A system is a collection of particles with a boundary.
3. Internal interactions are interactions between particles or objects in a systems.

C4.2: Conservation of Momentum

1. The total momentum of a system is just the sum of the momenta of the objects in the system. This is Eq. (C4.1).
2. If a system experiences no external interactions, then its total momentum is conserved; $\vec{p}_{\text{tot}}$ does not change.

C4.3 Center of Mass

1. Eq. (C4.2), Eq. (C4.3) and Eqs. (C4.4a–c) are identical. They are different ways of writing the same thing.

2. The equation that defines the center of mass is the equation for a *weighted average*.

$$\text{average test score } = \frac{1}{N}\left(s_1 + s_2 + \cdots s_N\right) \ .$$

$$\text{average test score weighted by height } = \frac{1}{h_1 + h_2 + \cdots h_N}\left(h_1 s_1 + h_2 s_2 + \cdots h_N s_N\right) \ .$$

C4.4: How the Center of Mass Moves

1. A system's momentum can be found via the velocity of its center of mass: $\vec{p}_{\text{tot}} = M\vec{v}_{\text{CM}}$. This is Eq. (C4.14).
2. "A system's center of mass responds to its external interactions exactly as a point particle would respond to those interactions." (p. 71)

C4.5: Inertial Reference Frames

The main point here is that we should choose our reference frames such that they're non-accelerating. If some of the technical details seem a little strange, don't worry.

C4.6: Interactions with the Earth

The earth is way bigger than you.

Center of Mass Practice

1. A 20 kg and a 60 kg object are 2 m apart. What is the center of mass of the two-object system?

2. Determine the center of mass of the system shown in Fig. (1). Express your answer in both coordinate and magnitude-direction form.

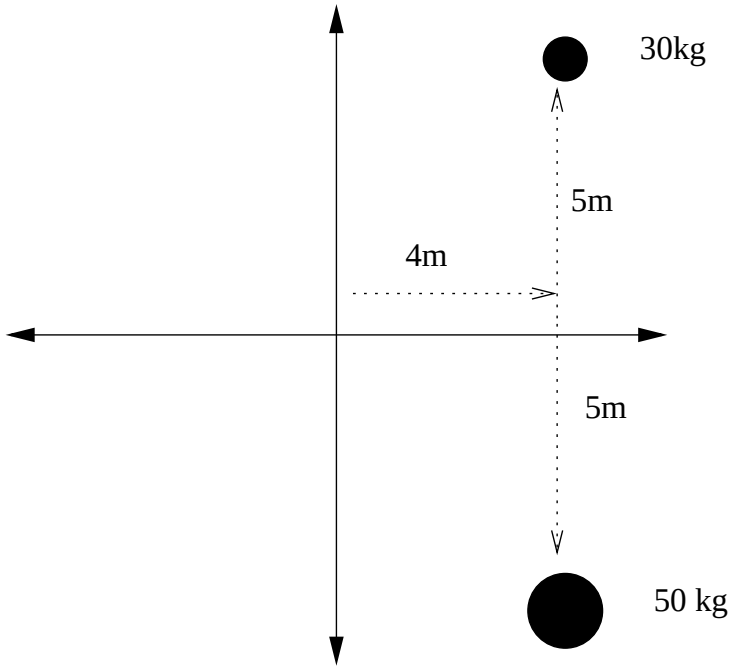

Figure 1: