1 Center of Mass
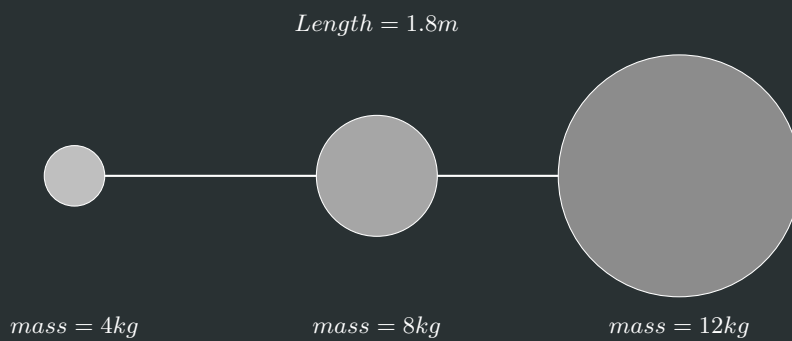
1.1 Discrete

$$R_{cm} = \frac{1}{M_{total}} \sum_{n=1}^{N} m_n r_n \tag{1}$$

Find a point in the center of a group of points.

1.1.1 Example one

$$Length = 1.8m$$

$$mass = 4kg \qquad mass = 8kg \qquad mass = 12kg$$

$$x_{cm} = \frac{x_1 m_1 + x_2 m_2 + x_3 m_3}{m_1 + m_2 + m_3}$$

$$x_{cm} = \frac{(0)(4) + (.9)(8) + (1.8)(12)}{4 + 8 + 12}$$

1.1.2 Example Two

m	x	y	v_x	v_y
1	7.8	-2.8	3.2	-4.2
2	7.8	-3.7	-5.2	5.2
3	7.8	-5.7	-6.2	2.2
4	7.8	2.7	4.2	-3.2

$$x_{cm} = \frac{x_1 m_1 + x_2 m_2 + x_3 m_3 + x_4 m_4}{m_1 + m_2 + m_3 + m_4}$$

1.2 Example Three

Square 1, 4kg   Square 2, 1kg

1.3 Continuous

$$R_{cm} = \frac{1}{M_{total}} \int \vec{r}\, dm$$

1.4 COM of multiple objects

2 Momentum

$$\boxed{\vec{P} = m\vec{v}} \tag{2}$$

Different version of Newtons law.

2.1 Eleastic Collisons

- Conservation of linear Momentum
- conservation of mechanical energy
- kinetic energy of the system is conserved,
- kinetic energy of the individual bodies can change
- ex. Billiard ball collisions

2.2 Inelastic Collisions

- Mechanical energy not conserved
- conservation of linear Momentum
- loss of energy: sound, heat, Elastic, Etc
- bodies stick together
- paintball

In a closed system, no momentum will be lost.

- Friction is typically not considered
- typically the system will have a net force