•2 Figure 9-35 shows a three-particle system, with masses $m_1 = 3.0$ kg, $m_2 = 4.0$ kg, and $m_3 = 8.0$ kg. The scales on the axes are set by $x_s = 2.0$ m and $y_s = 2.0$ m. What are (a) the x coordinate and (b) the y coordinate of the system's center of mass? (c) If m_3 is gradually increased, does the center of mass of the system shift toward or away from that particle, or does it remain stationary?

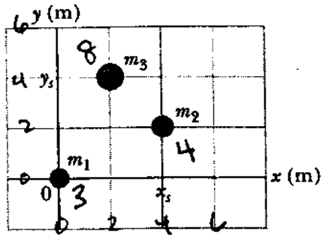


Fig. 9-35 Problem 2.

a) $M_{Tot}\, x_{cm} = m_1 x_1 + m_2 x_2 + m_3 x_3$

$15\, x_{cm} = 3 \cdot 0 + 4 \cdot 4 + 8 \cdot 2$

$= 32$

$x_{cm} = 32/15$ m

b) $M_{Tot}\, y_{cm} = m_1 y_1 + m_2 y_2 + m_3 y_3$

$15\, y_{cm} = 3 \cdot 0 + 4 \cdot 2 + 8 \cdot 4$

$= 40$

$y_{cm} = 40/15$ m

c) Shifts toward m_3

(think about $m_3 \to \infty$)

••5 What are (a) the x coordinate and (b) the y coordinate of the center of mass for the uniform plate shown in Fig. 9-38 if $L = 5.0$ cm?

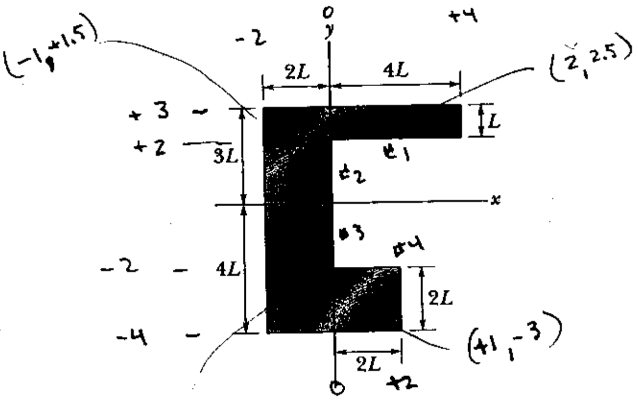


Fig. 9-38 Problem 5.

Do our calculations in units of "L"

The material density will not matter – will cancel out so we will take mass ∝ area

$m_1 = 4$ $m_3 = 8$ $M_{Tot} = 22$

$m_2 = 6$ $m_4 = 4$

$M_{Tot}\, x_{cm} = 4(+2) + 6(-1) + 8(-1) + 4(+1)$

$22\, x_{cm} = -2$

$x_{cm} = -2/22 \xrightarrow{\times 5\text{ cm}} -\frac{10}{22}$ cm

$M_{Tot}\, y_{cm} = 4(2.5) + 6(+1.5) + 8(-2) + 4(-3)$

$22\, y_{cm} = -5$

$y_{cm} = \frac{-5}{22} \xrightarrow{\times 5\text{ cm}} -\frac{25}{22}$ cm

••13 A shell is shot with an initial velocity $\vec{v}_0$ of 20 m/s, at an angle of $\theta_0 = 60°$ with the horizontal. At the top of the trajectory, the shell explodes into two fragments of equal mass (Fig. 9-42). One fragment, whose speed immediately after the explosion is zero, falls vertically. How far from the gun does the other fragment land, assuming that the terrain is level and that air drag is negligible?

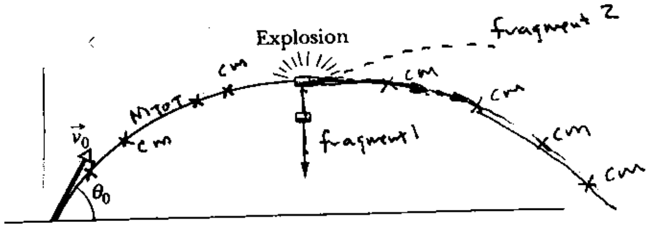


Fig. 9-42 Problem 13.

The motion of the cm is uneffected by the INTERNAL explosion

First calculate where the cm lands

$x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$

$x_0 = 0$

$v_{0x} = 20\cos 60° = 10$

$a_x = 0$

$x = 10t$

On ground when $y = 0$

$y = y_0 + v_{0y}t + \frac{1}{2}a_y t^2$

$y_0 = 0$

$v_{0y} = 20\sin 60° = 17.32$

$a_y = -9.8$

$y = 17.32t + \frac{1}{2}(-9.8)t^2$

$0 = 17.32t - 4.9t^2$

~~$t = \frac{-17.32 \pm \sqrt{17.32^2 - 4(-4.9)0}}{}$~~

$0 = (17.32 - 4.9t)\,t$

$t = 0,\ 3.535$ sec

$x = 10(0.3535)$
$= 35.35$ m

We are told the fragment 1 lands directly below the top of the trajectory. Need to find this location

$v_x = v_{0x} + a_x t$

$v_{0x} = 10$

$a_x = 0$

$v_x = 10$

$v_y = v_{0y} + a_y t$

$v_{0y} = 17.32$

$a_y = -9.8$

$v_y = 17.32 + (-9.8)t$

At top when $v_y = 0$

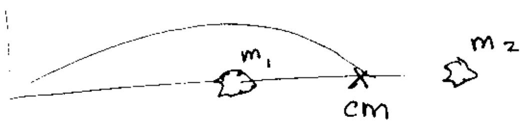
$0 = 17.32 - 9.8t$

$t = 1.77$ sec

then

$x = 10t$
$= 10(1.77) = 17.7$ m

Now on to finding where the 2nd fragment landed.



Equal masses.

$M_{TOT}\,x_{cm} = m_1 x_1 + m_2 x_2$

$(m + m)\,35.35 = m(17.7) + m\,x_2$

$2(35.35) = 17.7 + x_2$

$x_2 = 53.0$ m