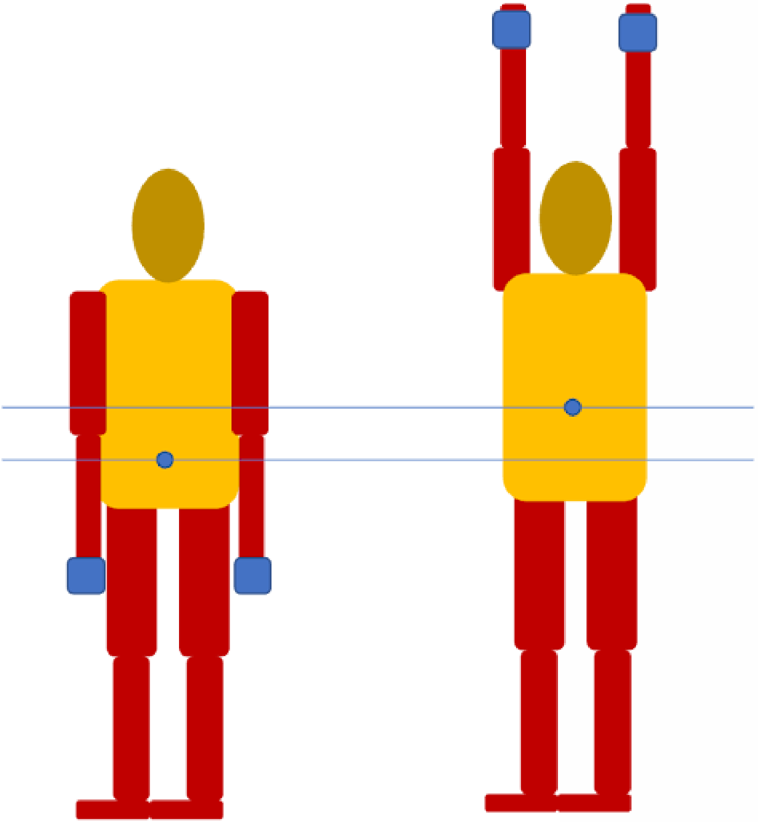


Grade 11S – Physics

Unit Two: Mechanics

Chapter 9: System of Particles

Prepared & Presented by: Mr. Mohamad Seif


Quiz
Time

Quiz System of particles 20 min

Consider two particles: A of mass $m_1 = 3kg$ its position vector is given by $\vec{r}_A = -3t\vec{i} + 3t^2\vec{j}$ and B of mass $m_2 = 2kg$ whose position vector is given by $\vec{r}_B = 2t\vec{i} - 2t^2\vec{j}$ in SI units.

Studying Particle A:

1. Calculate the position of A at t=0, 1, and 2 seconds.
2. Determine the equation of trajectory of A.
3. Determine the nature of motion of A.
4. Determine the speed of A when its ordinate y = 12 m.
5. Determine the resultant of the forces acting on A.

Quiz **System of particles** **20 min**

$m_1 = 3\text{kg}, \vec{r}_A = -3t\vec{i} + 3t^2\vec{j}, m_2 = 2\text{kg}, \vec{r}_B = 2t\vec{i} - 2t^2\vec{j}$

1. Calculate the position of A at t=0, t=1, and at t=2 seconds.

At $t_0 = 0$: $\vec{r}_{0A} = -3(0)\vec{i} + 3(0)^2\vec{j}$ ⇒ $\vec{r}_{0A} = 0$

At $t_1 = 1s$: $\vec{r}_{1A} = -3(1)\vec{i} + 3(1)^2\vec{j}$ ⇒ $\vec{r}_{1A} = -3\vec{i} + 3\vec{j}$

At $t_2 = 2s$: $\vec{r}_{1A} = -3(2)\vec{i} + 3(2)^2\vec{j}$ ⇒ $\vec{r}_{2A} = -6\vec{i} + 12\vec{j}$

Quiz System of particles 20 min

$m_1 = 3kg, \vec{r}_A = -3t\vec{i} + 3t^2\vec{j}, m_2 = 2kg, \vec{r}_B = 2t\vec{i} - 2t^2\vec{j}$

2. Determine the equation of trajectory of A.

$x = -3t$ ➡ $t = -\frac{x}{3}$ ➡ Substitute in y

$y = 3t^2$ ➡ $y = 3\left[-\frac{x}{3}\right]^2$ ➡ $y = \frac{x^2}{3}$

3. Determine the nature of motion of A

$\vec{r}_A = -3t\vec{i} + 3t^2\vec{j}$ ➡ $\vec{V}_A = -3\vec{i} + 6t\vec{j}$ ➡ $\vec{a}_A = 6\vec{j}$

Since a>0, then the motion of A is U.A.R.M

Quiz System of particles 20 min

$m_1 = 3kg, \vec{r}_A = -3t\vec{i} + 3t^2\vec{j}, m_2 = 2kg, \vec{r}_B = 2t\vec{i} - 2t^2\vec{j}$

4. Determine the speed of A when its ordinate y = 12 m.

$y = 3t^2 \Rightarrow 12 = 3t^2 \Rightarrow t^2 = 4 \Rightarrow t = 2sec$

$\vec{V}_A = -3\vec{i} + 6t\vec{j} \Rightarrow \vec{V}_A = -3\vec{i} + 6(2)\vec{j} \Rightarrow \vec{V}_A = -3\vec{i} + 12\vec{j}$

$V_A = \sqrt{V_x^2 + V_y^2} \Rightarrow V_A = \sqrt{(-3)^2+(12)^2}$

$V_A = 12.36 m/s$

Quiz **System of particles** **20 min**

$\mathrm{m_1} = 3\mathrm{kg}$, $\vec{r}_A = -3t\vec{i} + 3t^2\vec{j}$, $\mathrm{m_2} = 2\mathrm{kg}$, $\vec{r}_B = 2t\vec{i} - 2t^2\vec{j}$

5. Determine the resultant of the forces acting on A.

$$\sum \vec{F}_{ex/A} = m_1\vec{a}_A$$

$$\sum \vec{F}_{ex/A} = 3(6\vec{j})$$

$$\sum \vec{F}_{ex/A} = 18\vec{j}$$

Quiz **System of particles** **20 min**

Particle B:

1. **Determine the acceleration vector of B and deduce the resultant of the forces acting on B.**
2. **Determine the radius of curvature of the trajectory of B at t = 1 s.**

Quiz System of particles 20 min

$\mathrm{m_1} = 3\mathrm{kg}, \vec{r}_A = -3t\vec{i} + 3t^2\vec{j}, \mathrm{m_2} = 2\mathrm{kg}, \vec{r}_B = 2t\vec{i} - 2t^2\vec{j}$

1. Determine the acceleration vector of B and deduce the resultant of the forces acting on B.

$$\vec{r}_B = 2t\vec{i} - 2t^2\vec{j} \Rightarrow \vec{V}_B = 2\vec{i} - 4t\vec{j} \Rightarrow \vec{a}_B = -4\vec{j}$$

$$\sum \vec{F}_{ex/B} = m_2\vec{a}_B \Rightarrow \sum \vec{F}_{ex/B} = 2(-4\vec{j}) \Rightarrow \sum \vec{F}_{ex/B} = -8\vec{j}$$

Quiz System of particles 20 min

2. Determine the radius of curvature of the trajectory of B at t = 1 s.

$$\vec{V}_B = 2\vec{i} - 4t\vec{j}$$

$$V_B = \sqrt{(2)^2 + (-4t)^2}$$

$$V_B = \sqrt{4 + 16t^2}\ m/s$$

$$a_t = V'_B = \frac{32t}{2\sqrt{4 + 16t^2}}$$

$$a_t = \frac{8t}{\sqrt{1 + 4t^2}}\ m/s^2$$

$$a_t = \frac{8(1)}{\sqrt{1 + 4(1)^2}} = 3.57 m/s^2$$

$$a_n^2 = a^2 - a_t^2$$

$$a_n^2 = (4)^2 - (3.57)^2$$

$$a_n = 1.80 m/s^2$$

Quiz System of particles 20 min

$$a_n = 1.80 m/s^2$$

$$a_n = \frac{V^2}{R}$$

$$R = \frac{V^2}{a_n} = \frac{\left[\sqrt{4 + 16t^2}\right]^2}{1.80}$$

$$R = \frac{\left[\sqrt{4 + 16(1)^2}\right]^2}{1.80}$$

$$R = 11.11 m$$

Quiz **System of particles** **20 min**

System A + B:

1. **Determine the position vector of the center of mass G of the system [A + B].**
2. **Determine the acceleration vector of the center of mass G of the system [A + B].**
3. **Deduce the resultant of the forces acting on G.**

Quiz **System of particles** **20 min**

$m_1 = 3\text{kg}, \vec{r}_A = -3t\vec{i} + 3t^2\vec{j}, m_2 = 2\text{kg}, \vec{r}_B = 2t\vec{i} - 2t^2\vec{j}$

1. Determine the position vector of the center of mass G of the system [A + B].

$$\vec{r}_G = \frac{m_1\vec{r}_A + m_2\vec{r}_B}{m_1 + m_2} \Rightarrow \vec{r}_G = \frac{3(-3t\vec{i}+3t^2\vec{j})+2(2t\vec{i}-2t^2\vec{j})}{3+2}$$

$$\vec{r}_G = \frac{-9t\vec{i}+9t^2\vec{j}+4t\vec{i}-4t^2\vec{j}}{5} \Rightarrow \vec{r}_G = \frac{-5t\vec{i}+5t^2\vec{j}}{5}$$

$$\vec{r}_G = -t\vec{i} + t^2\vec{j}$$

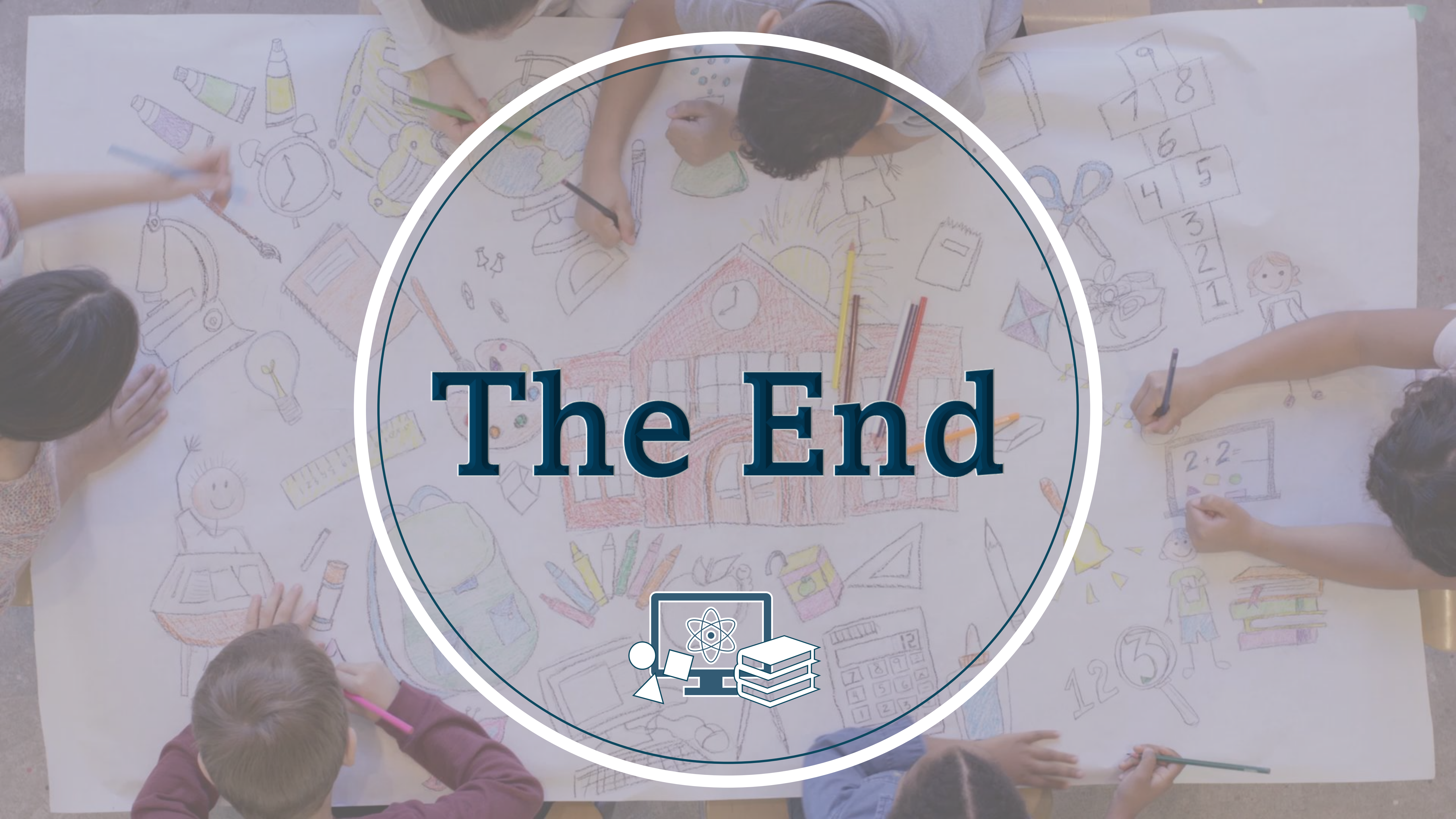
2. Determine the acceleration vector of the center of mass G of the system [A + B].

$$M.\vec{a}_G = \sum \vec{F}_{ex/A} + \sum \vec{F}_{ex/B}$$

$$(3+2)\vec{a}_G = -18\vec{j} + 8\vec{j}$$

$$5\vec{a}_G = -10\vec{j}$$

$$\vec{a}_G = -2\vec{j}$$


The End

Be Smart Academy