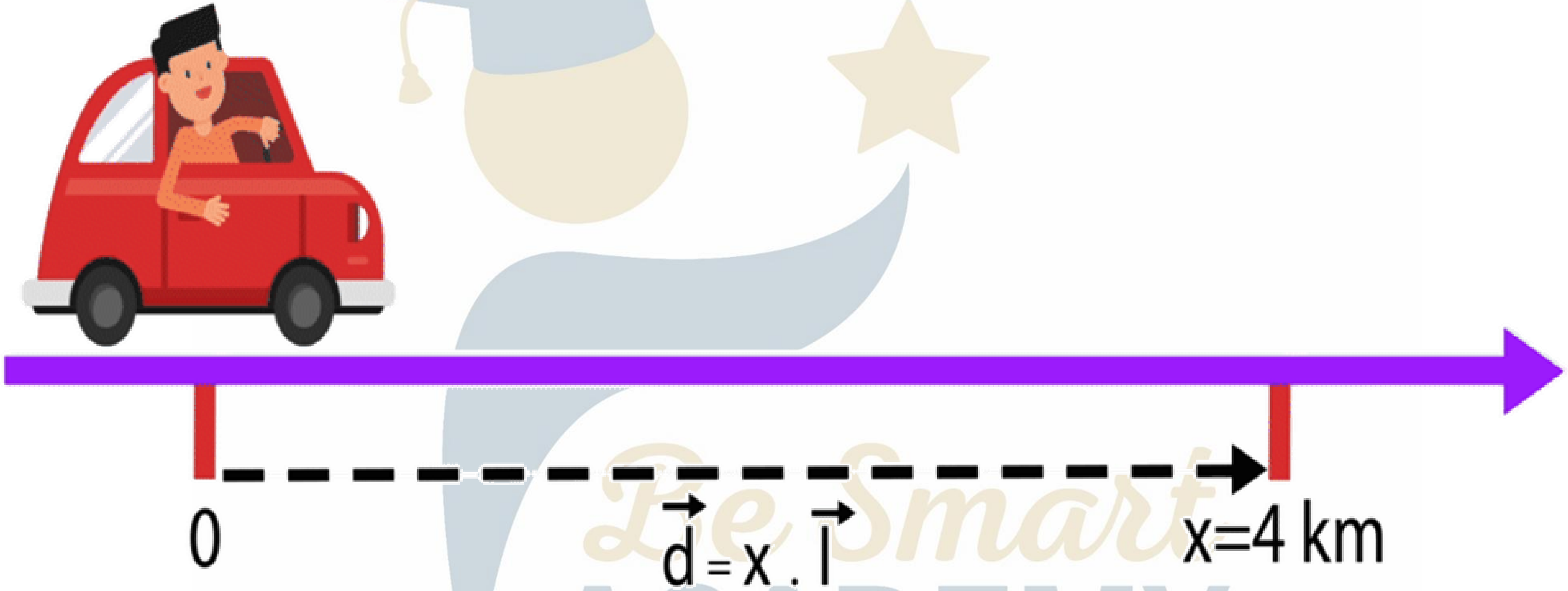
Physics – Grade 10

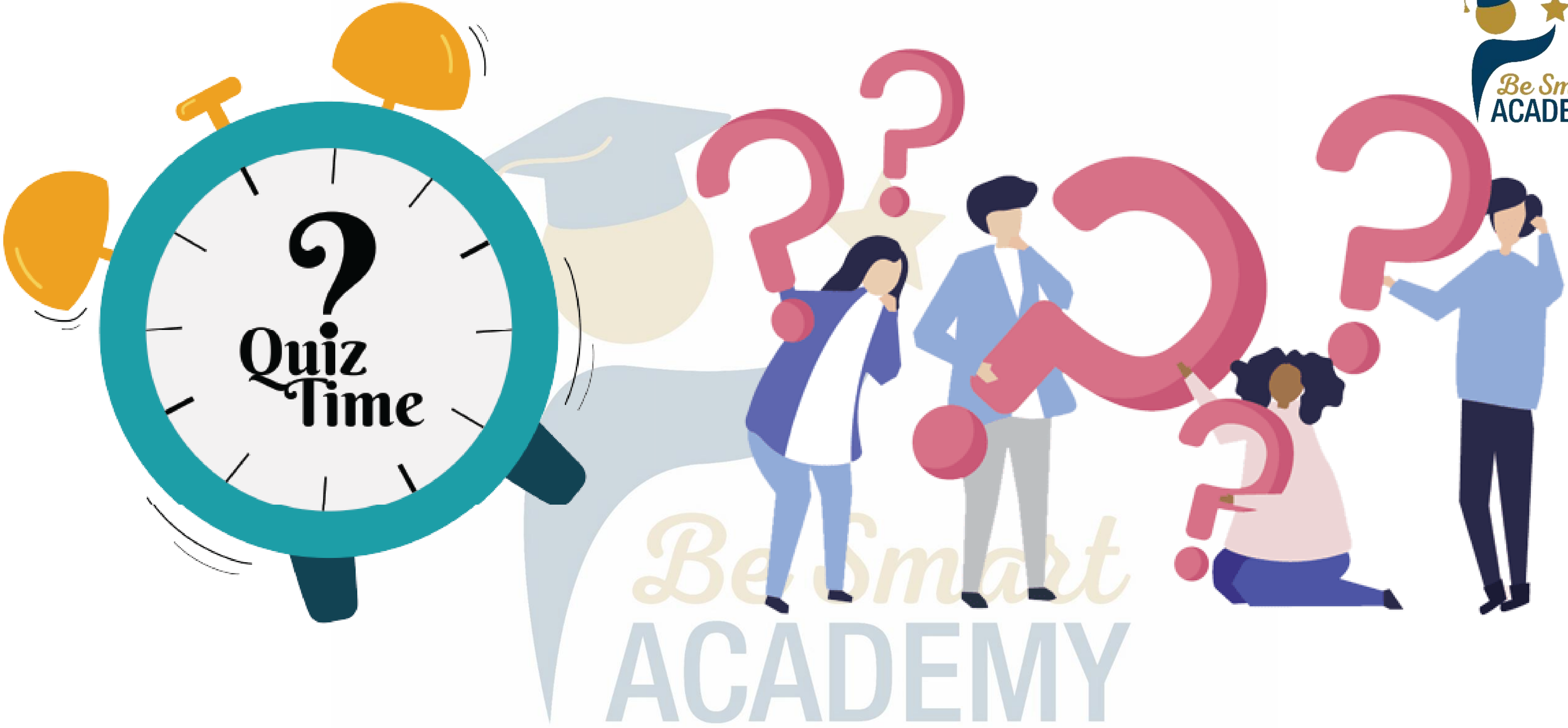
Unit Four – Mechanics



Chapter 15 – Rectilinear motion

Prepared & Presented by: Mr. Mohamad Seif

Be Smart ACADEMY

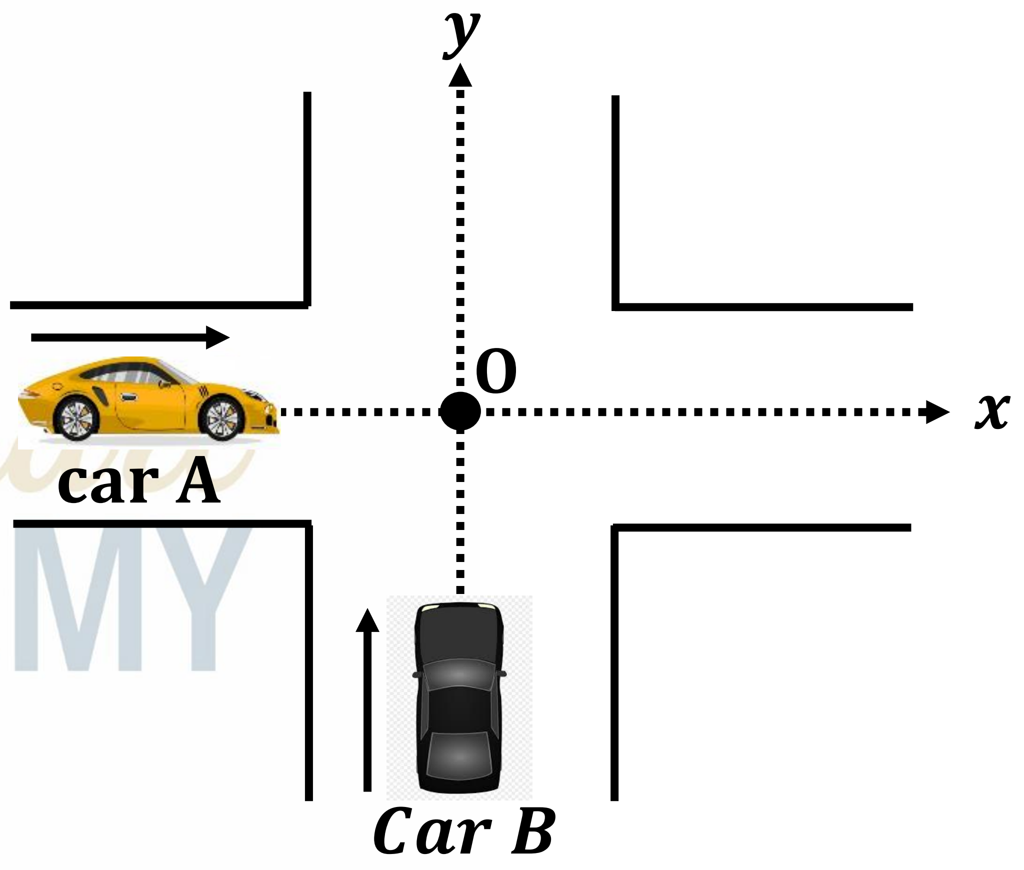


Quiz 1 25 min

Two cars A and B are moving towards a round point in straight paths that are perpendicular to each other and intersect at point O (See the figure).

The motions of A and B are studied respectively on the frames of reference ($X'OX$) and ($y'Oy$).

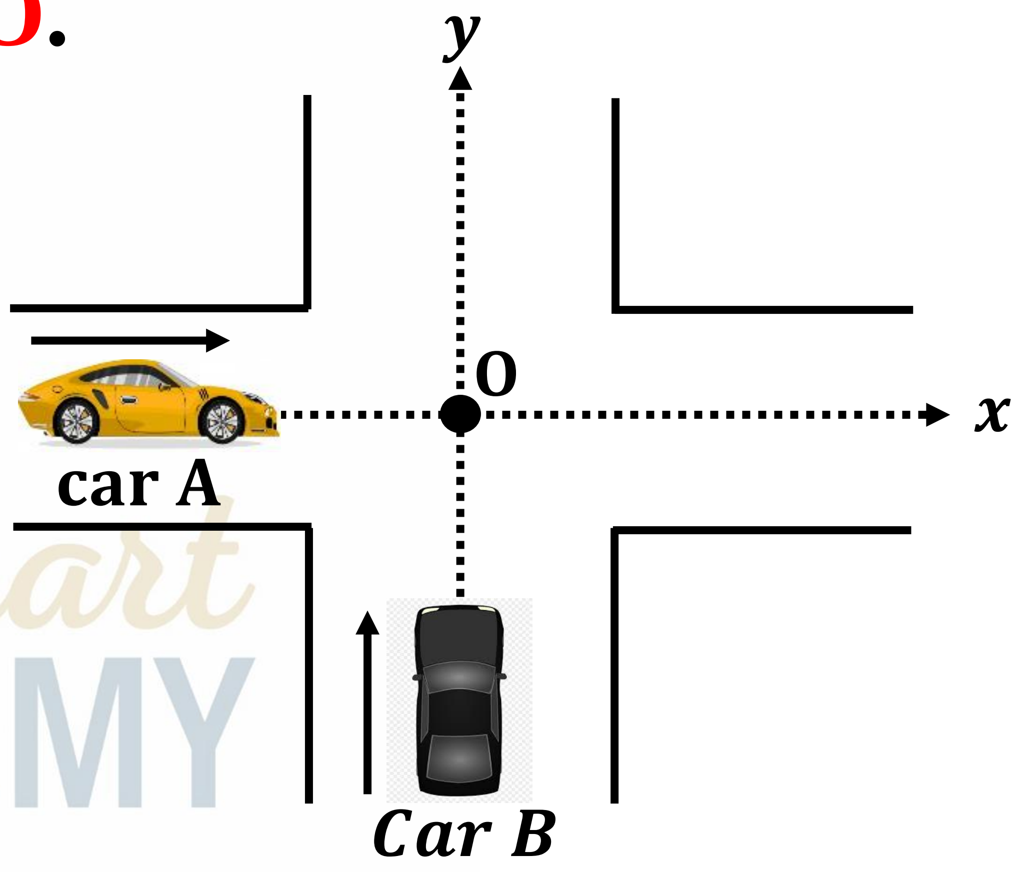
Car (A) moves $20m$ each second. The driver does not see car B and continues its motion at the same speed.



Quiz 1 25 min

At the instant $t_0 = 0$ chosen as the origin of time, car A is at a distance $d = 120m$ before O.

1. Specify the nature of motion of car A.
2. Calculate the speed (V_A) of car A.
3. write the time equation x(t) of car A.
4. Deduce the instant t_1 when car A reaches point O.

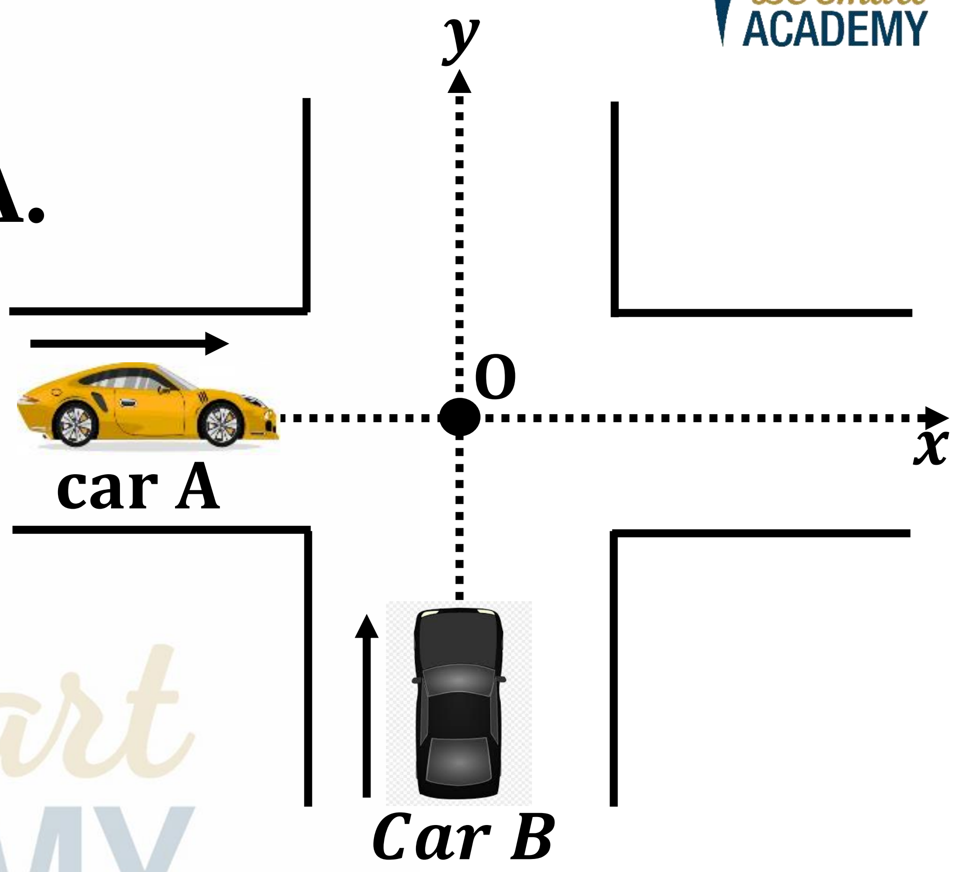


Quiz 1 25 min

$x = 20m$; same speed; $x_0 = -120m$.

1.Specify the nature of motion of car A.

Because car (A) moves with same speed then the motion U.R.M



2.Calculate the speed (V_A) of car A.

$$V = \frac{\Delta d}{\Delta t} \Rightarrow V = \frac{20m}{1s}$$

$$V = 20m/s$$

Quiz 1 — 25 min

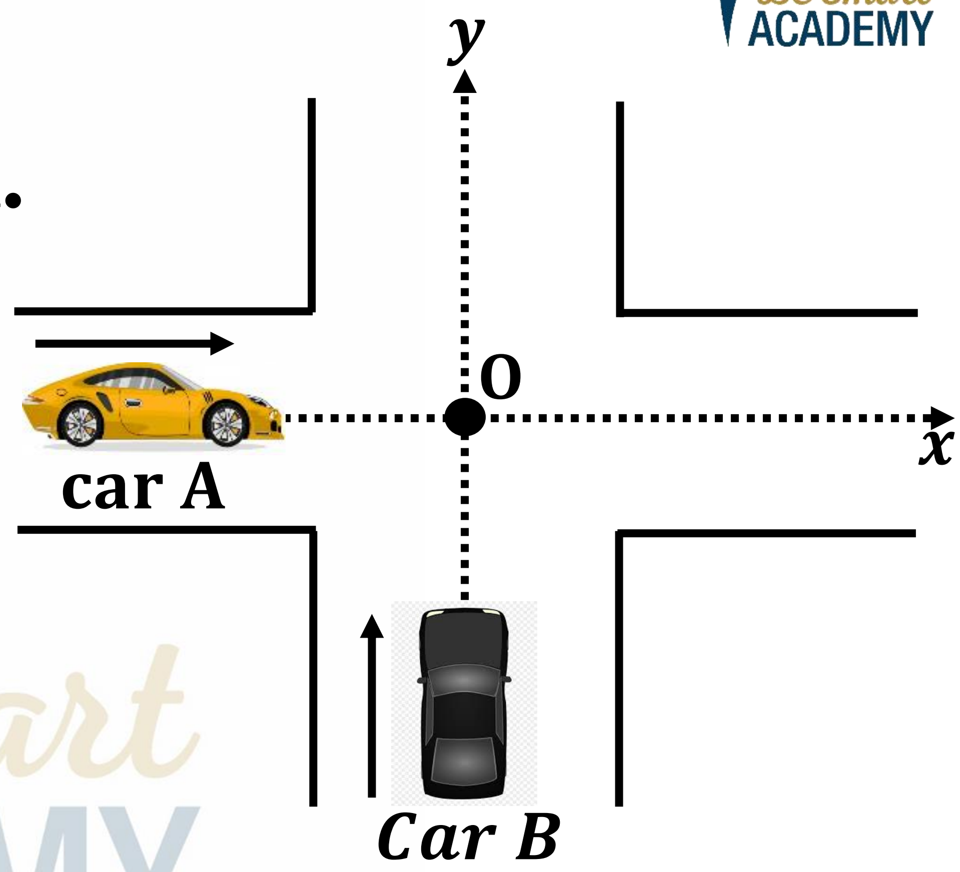
$x = 20m$; same speed; $x_0 = -120m.$

3. write the time equation x(t) of car A.

$$x = Vt + x_0$$

$$x = 20t - 120$$

4. Deduce the instant t_1 when car A reaches point O.



At the origin O; $x = 0$

$x = 20t - 120$ ➡ $0 = 20t_1 - 120$

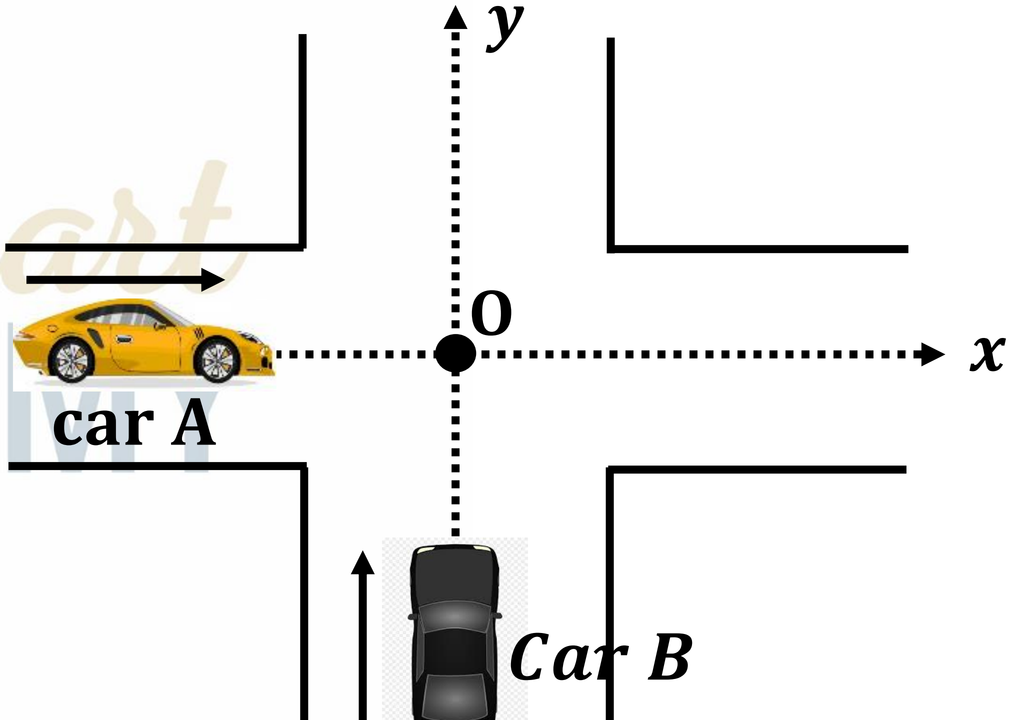
$+120 = 20t_1$ ➡ $t_1 = \frac{120}{20}$ ➡ $t_1 = 6\ s$

Quiz 1 25 min

At $t_0 = 0$, car B is at a distance $d = 100m$ before O and its speed is $V_0 = 12m / s$.

At this instant, the driver of car (B) sees car (A). To avoid it, he speeds up with a constant acceleration $a = 2m / s^2$.

1. Specify the nature of motion of car B.
2. write the time equation y(t) of car B.
3. Determine the position of B at the instant t_1 that calculated before.



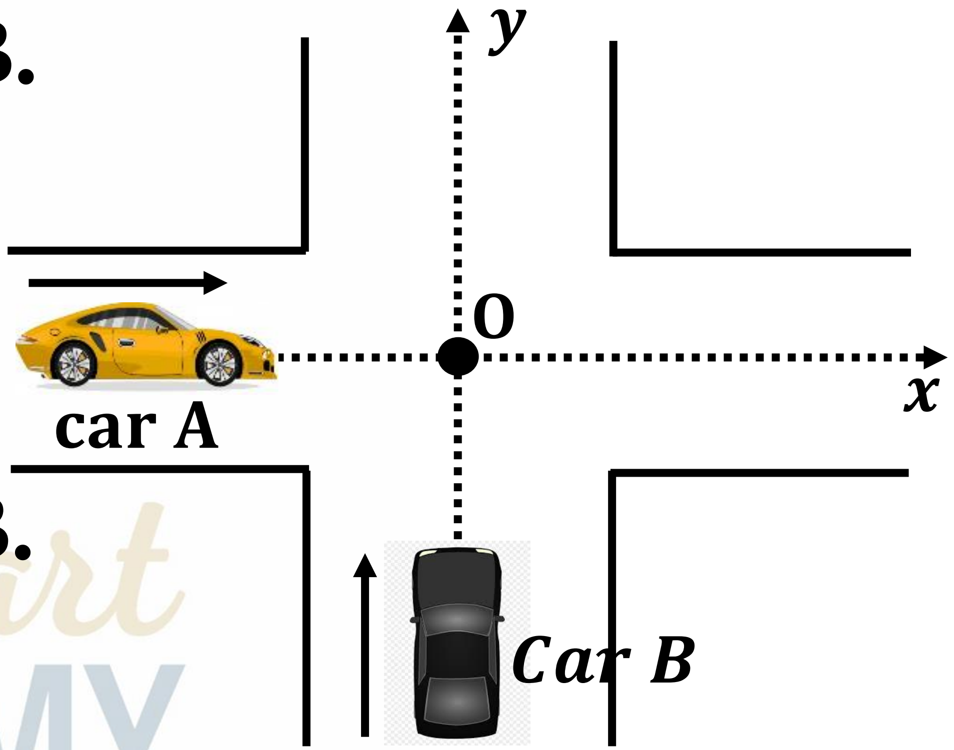
Quiz 1 25 min

$x_0 = -100m; V_0 = 12m / s; a = 2m / s^2.$

1.Specify the nature of motion of car B.

Because the acceleration of car (B) is constant and positive ($a = 2m/s^2 > 0$)

The motion is U.A.R.M



2. Write the time equation y(t) of car B.

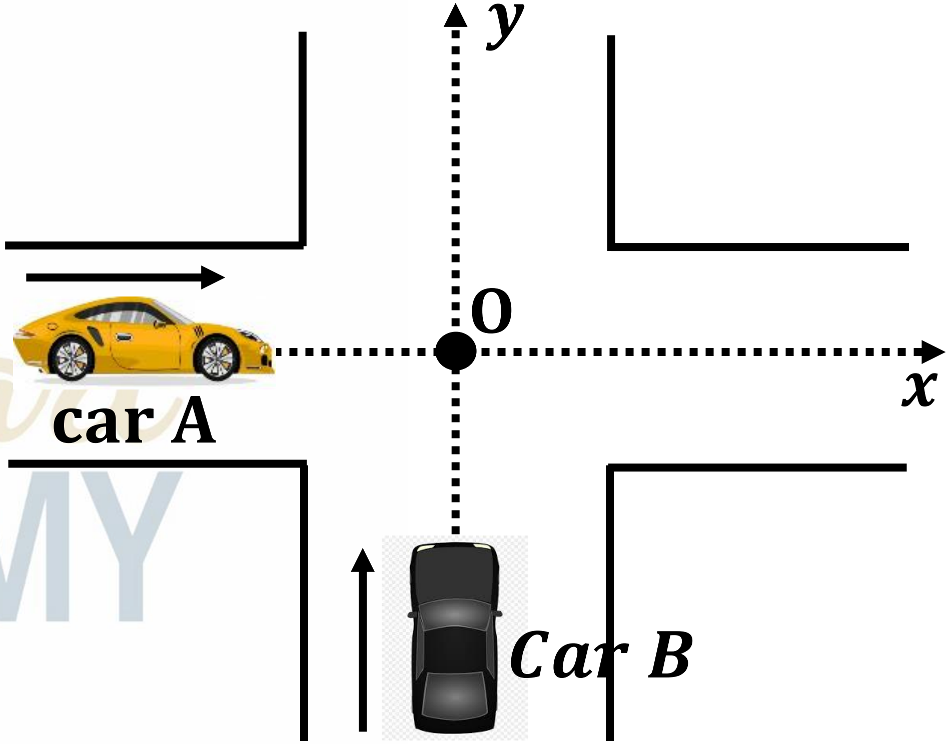
$$y = \frac{1}{2}at^2 + V_0 t + x_0$$

$$y = \frac{1}{2}(2)t^2 + 12t - 100 \Rightarrow y = t^2 + 12t - 100$$

Quiz 1 25 min

$x_0 = -100m; V_0 = 12m / s; a = 2m / s^2.$

3. Determine the position of B at the instant t_1 that calculated before.



$$y = t^2 + 12t - 100$$

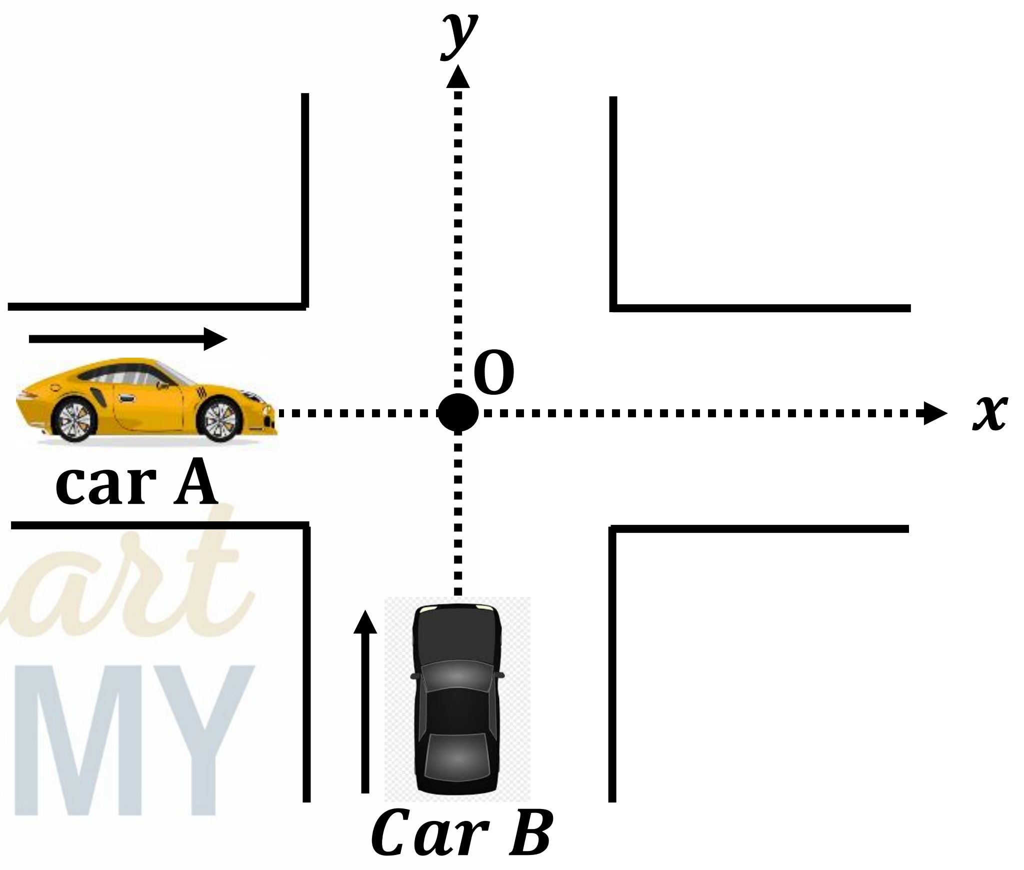
$$y = (6)^2 + 12(6) - 100$$

$$y = 36 + 72 - 100$$

$$y = 8m$$

4. Choose from the list below the scenario that takes place at O. Justify your choice.

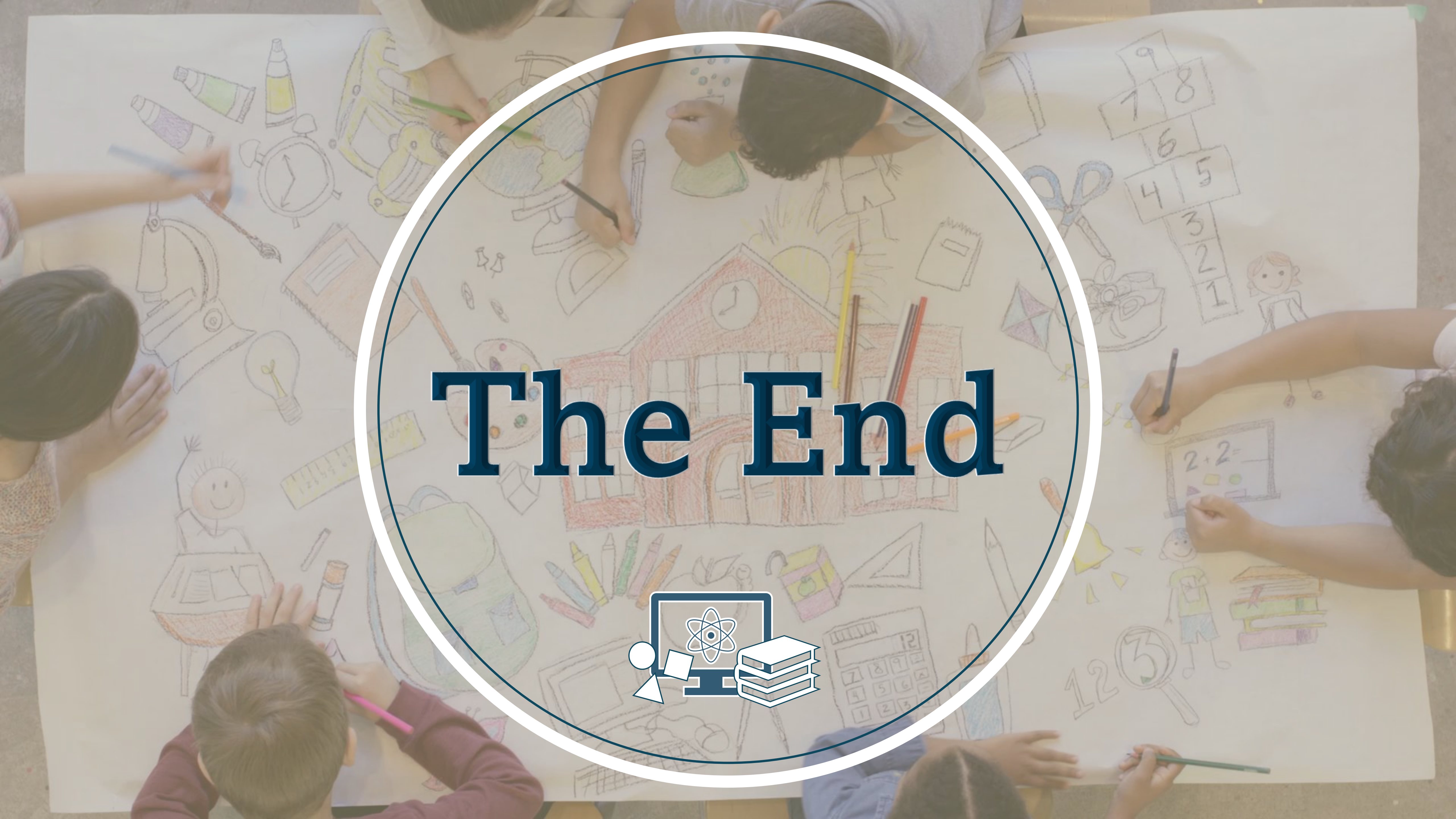
- The two cars crash at point O.
- Car A, reaches O before car B.
- Car B, reaches O before car A



At $t_1 = 6s$ car (A) was at origin O then $x = 0$

At $t_1 = 6s$ car (B) was at y $= 8m$

This means car (B) reaches O before car (A).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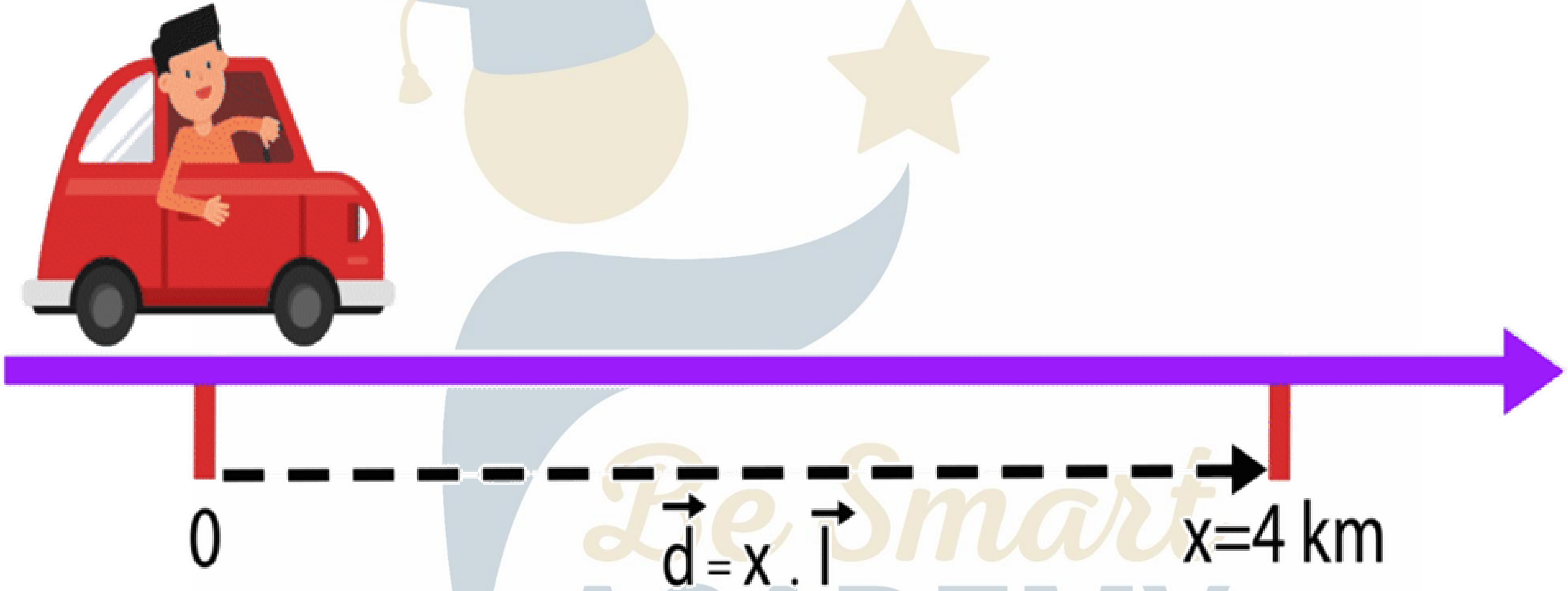
Physics – Grade 10

Unit Four – Mechanics



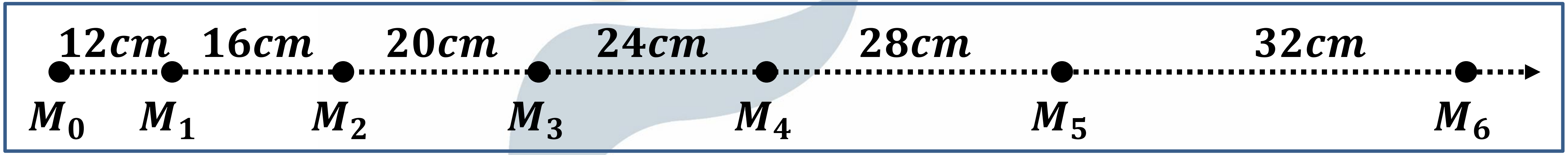
Chapter 15 – Rectilinear motion

Prepared & Presented by: Mr. Mohamad Seif


Quiz
Time

Quiz 2 — 35 min

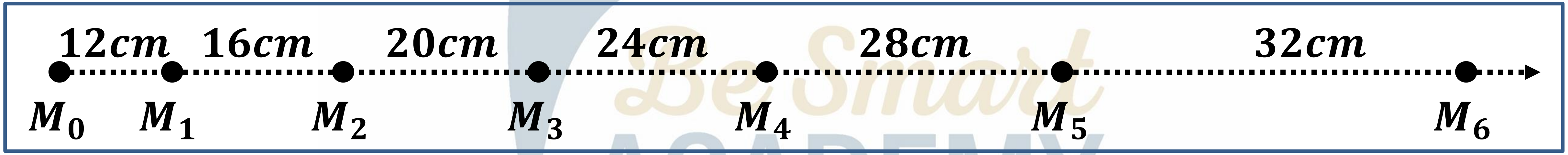
Consider a puck (M) moving on a horizontal air table. The successive positions of the center of the puck (M) is recorded below at a time constant $\tau = 100ms$. M_0 is at $t = 0s$.



1. **Calculate the instantaneous speeds $V_1, V_2, V_3, and\ V_4$ at $M_1, M_2, M_3, and\ M_4$ respectively.**
2. **Calculate the accelerations a_2 and a_3 of the motion at M_1 and M_3 respectively.**

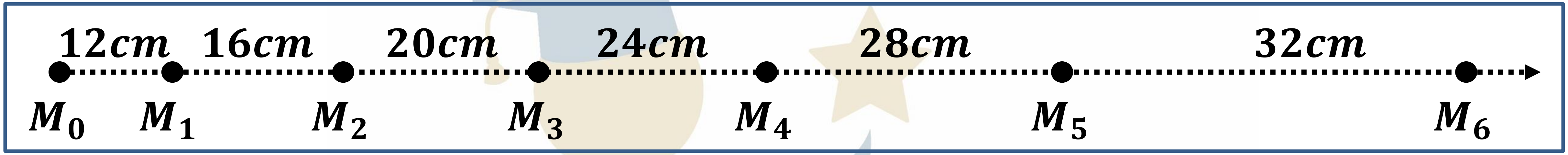
Quiz 2 **35 min**

3. **Specify the nature of motion of the puck (M).**
4. **Deduce the magnitude V_0 of the initial velocity vector $\vec{V}_0$ at M_0.**
5. **Show that the time equation of M is: $X_M = 2t^2 + t$.**



Quiz 2 — 35 min

$\tau = 100ms$



1. Calculate the instantaneous speeds $V_1, V_2, V_3, and\ V_4$ at $M_1, M_2, M_3, and\ M_4$ respectively.

$$V_1 = \frac{M_0M_2}{t_2 - t_0} = \frac{M_0M_2}{2\tau - 0}$$

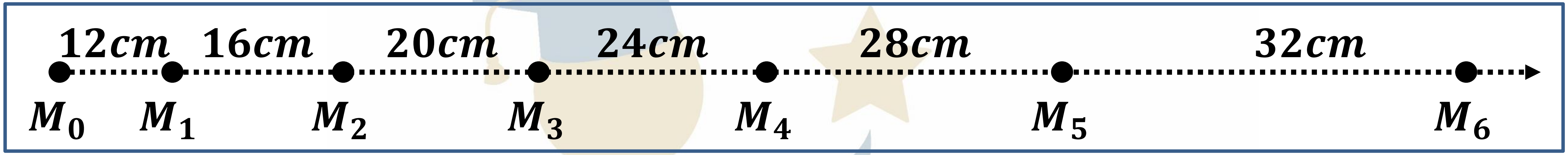
$$V_1 = \frac{(12+16) \div 100}{(2 \times 100) \div 1000}$$

$$V_1 = \frac{0.28}{0.2}$$

$$V_1 = 1.4m/s$$

Quiz 2 — 35 min

$\tau = 100ms$



1. Calculate the instantaneous speeds $V_1, V_2, V_3, and\ V_4$ at $M_1, M_2, M_3, and\ M_4$ respectively.

$$V_2 = \frac{M_1M_3}{t_3 - t_1} = \frac{M_1M_3}{3\tau - \tau}$$

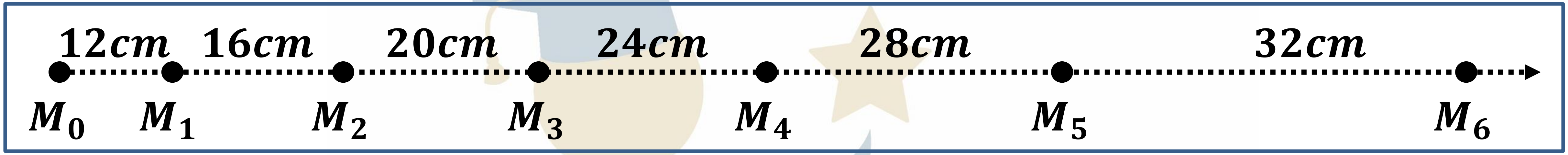
$$V_2 = \frac{(16 + 20) \div 100}{(2 \times 100) \div 1000}$$

$$V_2 = \frac{0.36}{0.2}$$

$$V_2 = 1.8m/s$$

Quiz 2 35 min

$\tau = 100ms$



1. Calculate the instantaneous speeds $V_1, V_2, V_3, and\ V_4$ at $M_1, M_2, M_3, and\ M_4$ respectively.

$$V_3 = \frac{M_2M_4}{t_4 - t_2} = \frac{M_2M_4}{4\tau - 2\tau}$$

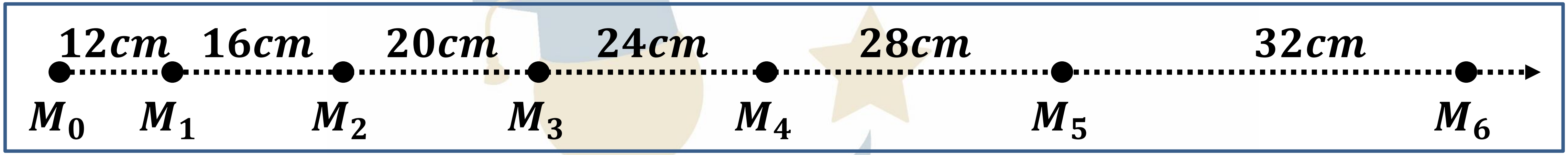
$$V_3 = \frac{(20 + 24) \div 100}{(2 \times 100) \div 1000}$$

$$V_3 = \frac{0.44}{0.2}$$

$$V_3 = 2.2m/s$$

Quiz 2 — 35 min

$\tau = 100ms$



1. Calculate the instantaneous speeds $V_1, V_2, V_3, and\ V_4$ at $M_1, M_2, M_3, and\ M_4$ respectively.

$$V_4 = \frac{M_3M_5}{t_5 - t_3} = \frac{M_3M_5}{5\tau - 3\tau}$$

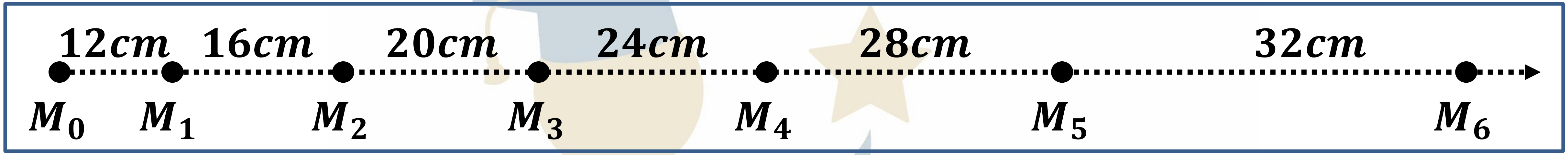
$$V_4 = \frac{(24 + 28) \div 100}{(2 \times 100) \div 1000}$$

$$V_4 = \frac{0.52}{0.2}$$

$$V_4 = 2.6m/s$$

Quiz 2 35 min

$$\tau = 100ms \div 1000 = 0.1s$$



2. Calculate the accelerations a_2 and a_3 of the motion at M_1 and M_3 respectively.

$$a_2 = \frac{V_3 - V_1}{t_3 - t_1}$$

$$a_2 = \frac{2.2 - 1.4}{3\tau - \tau}$$

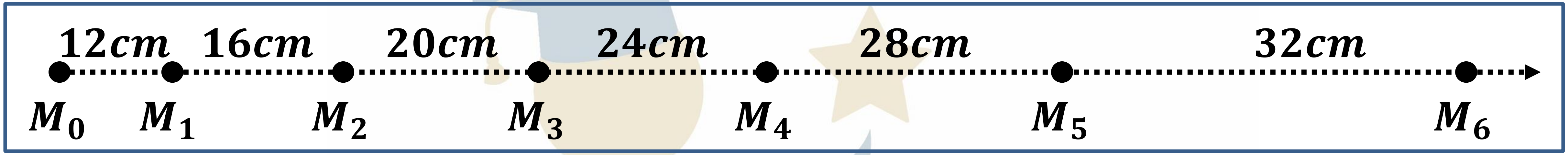
$$a_2 = \frac{0.8}{2\tau}$$

$$a_2 = \frac{0.8}{(2 \times 100) \div 1000} = \frac{0.8}{0.2}$$

$$a_2 = 4m / s^2$$

Quiz 2 35 min

$$\tau = 100ms \div 1000 = 0.1s$$



2. Calculate the accelerations a_2 and a_3 of the motion at M_1 and M_3 respectively.

$$a_3 = \frac{V_4 - V_2}{t_4 - t_2} \Rightarrow a_3 = \frac{2.6 - 1.8}{4\tau - 2\tau} \Rightarrow a_3 = \frac{0.8}{2\tau}$$

$$a_3 = \frac{0.8}{(2 \times 100) \div 1000} = \frac{0.8}{0.2} \Rightarrow a_3 = 4m / s^2$$

Quiz 2 35 min

3. Specify the nature of motion of the puck (M).

Because the speed increases with time and acceleration is constant and positive ($a = 4m/s^2 > 0$) then:

The motion is U.A.R.M

4. Deduce the magnitude V_0 of the initial velocity vector $\vec{V}_0$ at M_0.

$V = at + V_0$ ⇨ $V_1 = a_1 t + V_0$ ⇨ $V_1 = a_1 \times \tau + V_0$

$1.4 = 4 \times (0.1) + V_0$ ⇨ $1.4 = 0.4 + V_0$

$1.4 - 0.4 = V_0$ ⇨ $V_0 = 1m/s$

Quiz 2 — 35 min

5. **Show that the time equation of M is:** $X_M = 2t^2 + t$.

$$X_M = \frac{1}{2}at^2 + V_0 t + x_0$$

$$X_M = \frac{1}{2}(4)t^2 + 1 \times t + 0$$

$$X_M = 2t^2 + t$$

Quiz 2 **35 min**

Another puck (N) is moving along the same x-axis of time equation:

$$X_N = -13t + 16.$$

1. **Specify the nature of motion of (N).**

2. **Show that the two pucks move in opposite directions.**

Quiz 2 35 min

$$X_N = -13t + 16$$

1. Specify the nature of motion of (N).

The given equation ($X_N = -13t + 16$) in the form of $x = Vt + x_0$ then:

The motion is U.R.M

2. Show that the two pucks move in opposite directions.

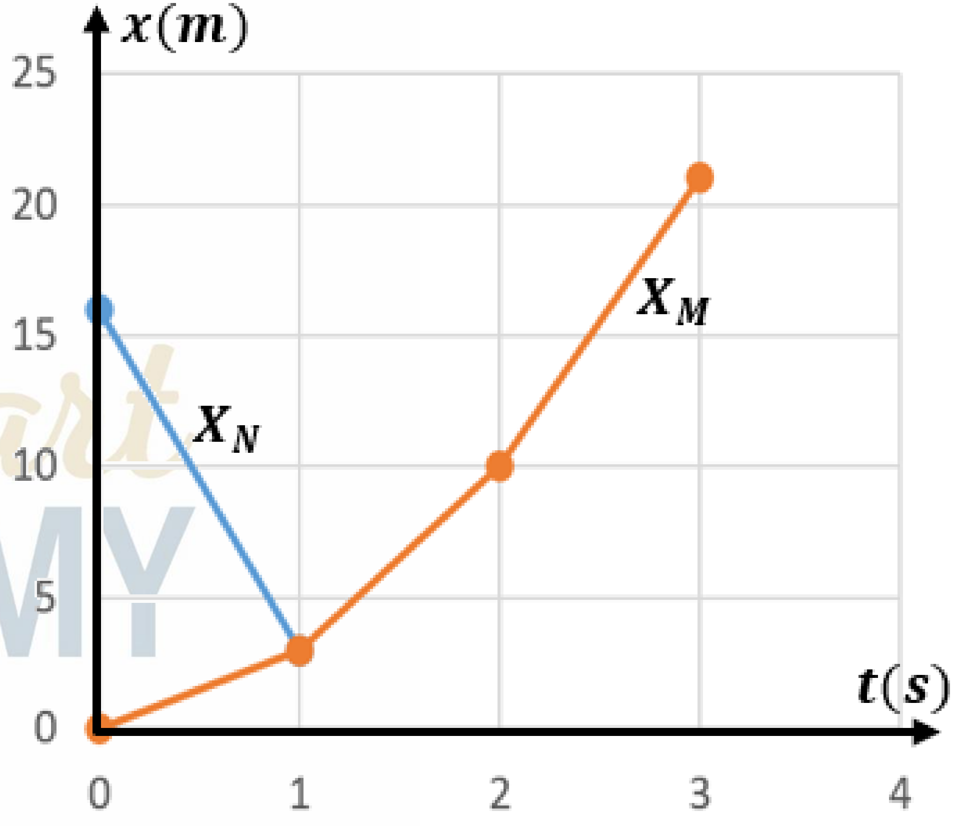
The negative sign in the time equation of the puck N ($X_N = -13t + 16$) means the speed is negative ($V = -13 m/s$) then the two pucks moves in opposite directions.

Quiz 2 35 min

3. The graph below represents the motion of the two pucks.

a. Determine, graphically, the meeting instant and position of the two pucks.

b. Verify your answer by calculation



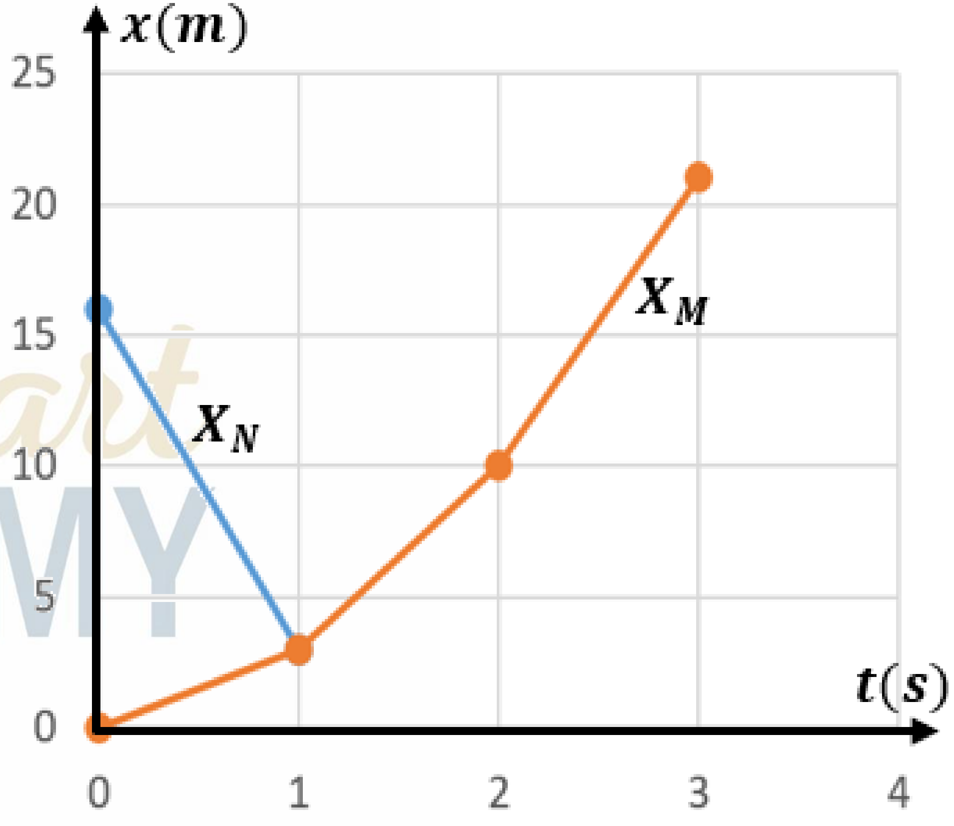
Quiz 2 — 35 min

a. Determine, graphically, the meeting instant and position of the two pucks.

From the graph the two pucks meet when the two curves intersects:

$$t = 1s$$

$$x = 2.5m$$



Quiz 2 35 min

b. Verify your answer by calculation

$$X_M = X_N$$

$$2t^2 + t = -13t + 16$$

$$2t^2 + t + 13t - 16 = 0$$

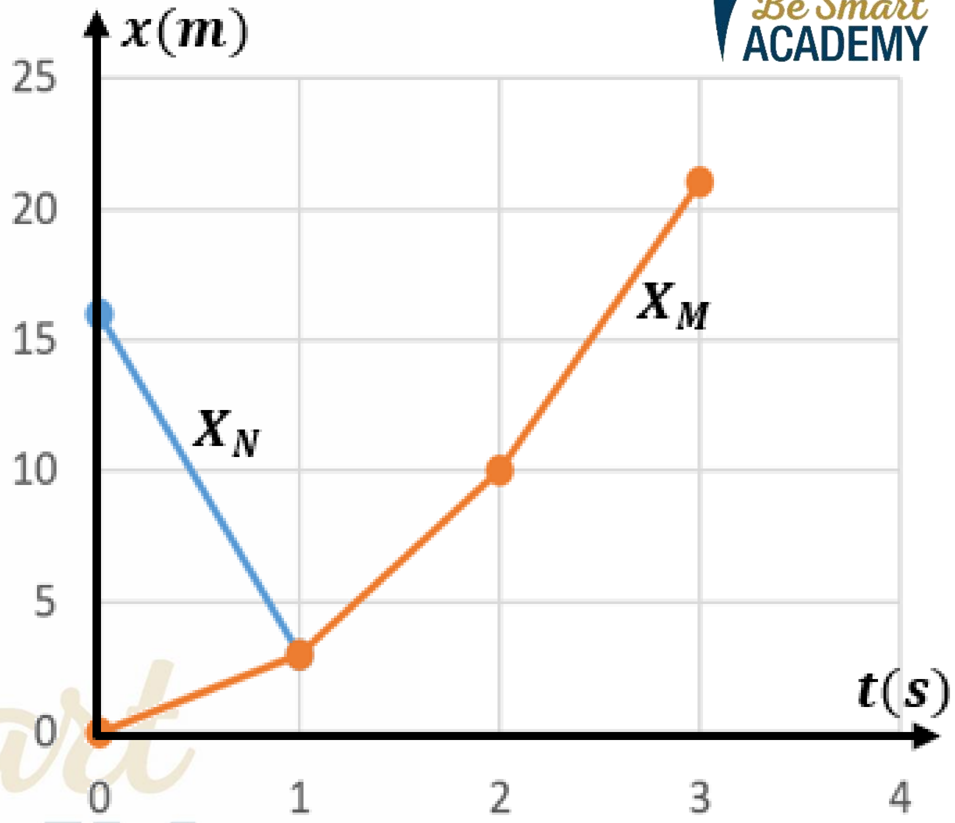
$$(2t^2 + 14t - 16 = 0) \div 2$$

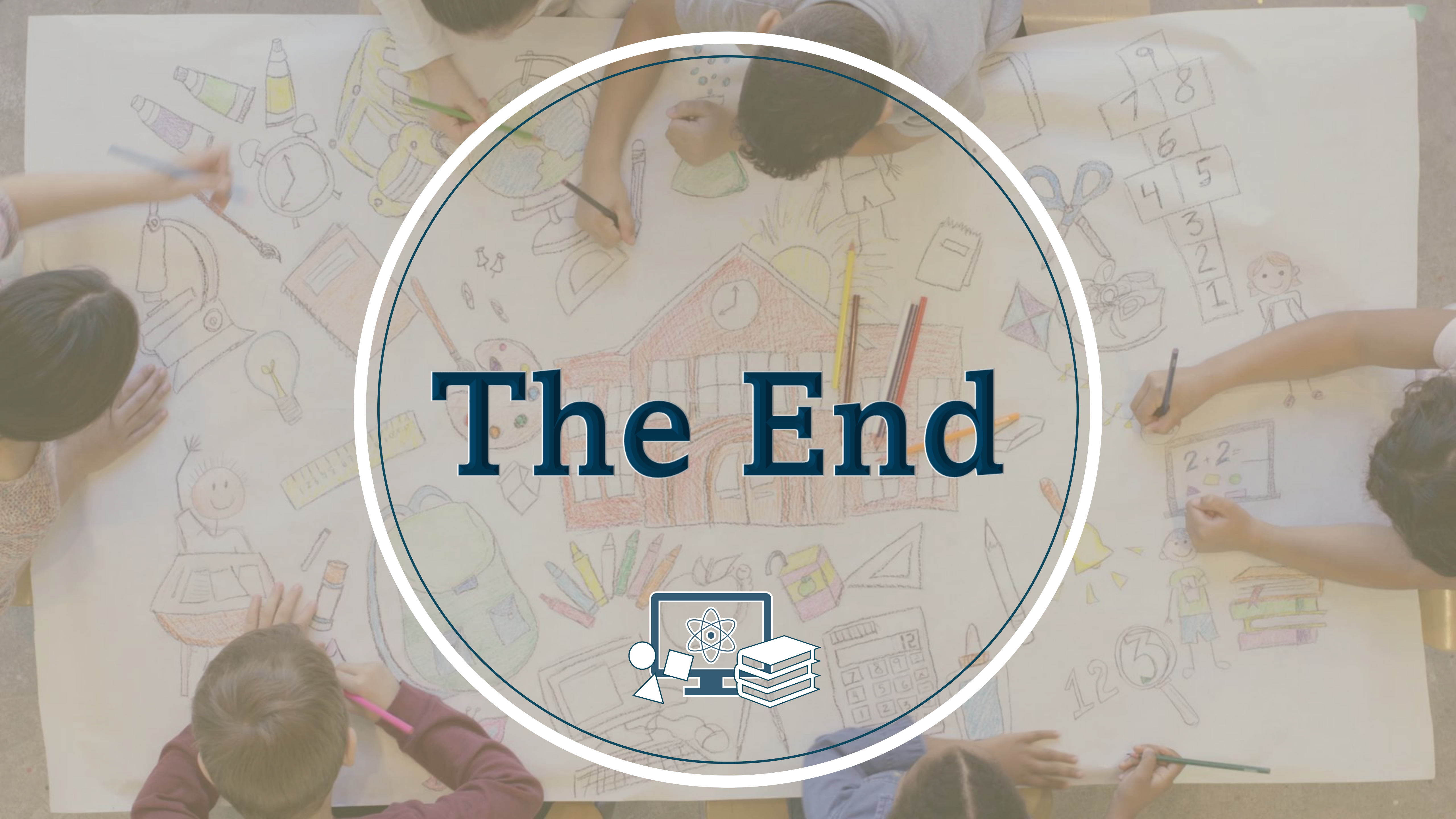
$$t^2 + 7t - 8 = 0$$

$$(t - 1)(t + 8) = 0$$

$t - 1 = 0$ → $t = 1s$ → **Accepted**

$t + 8 = 0$ → $t = -8$ → **rejected**





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