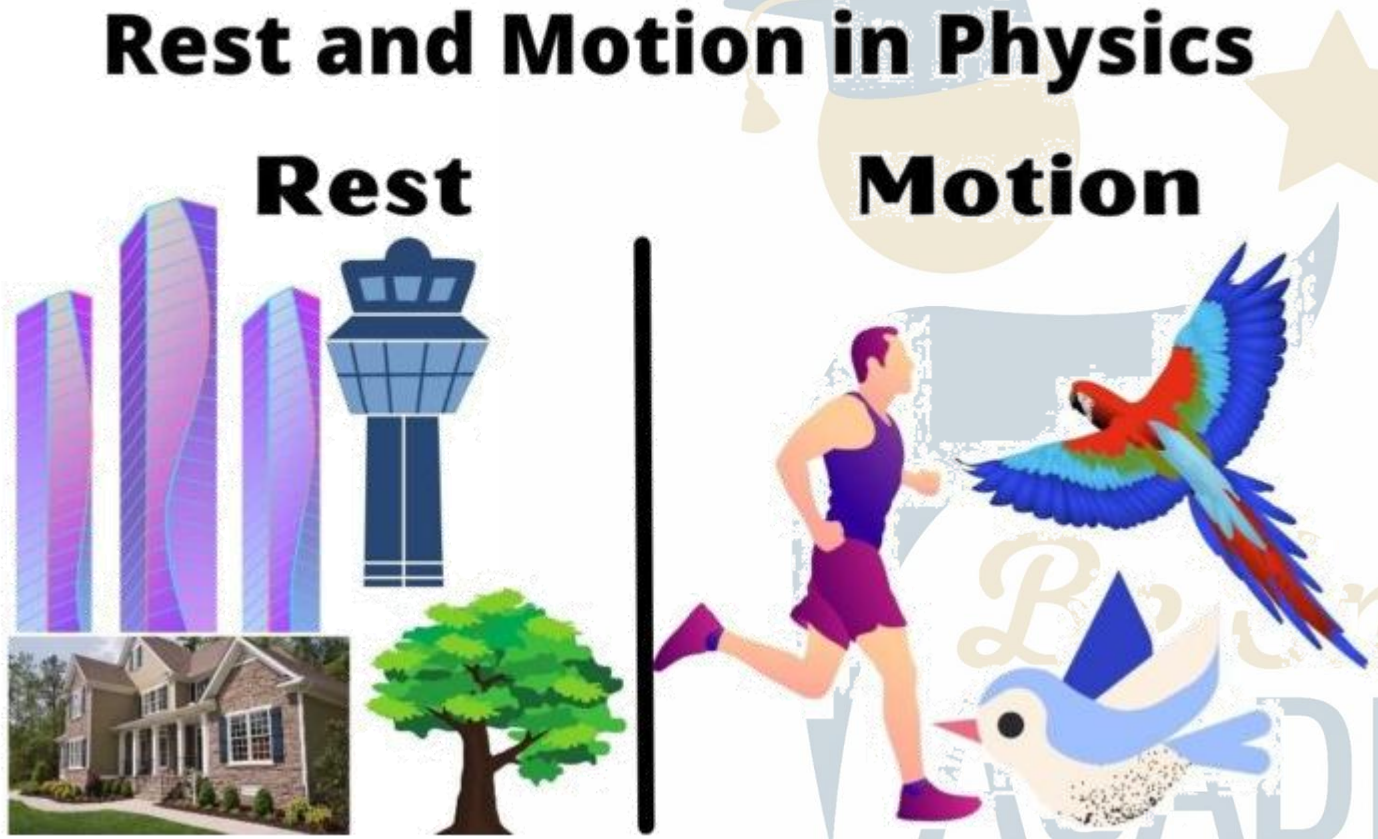
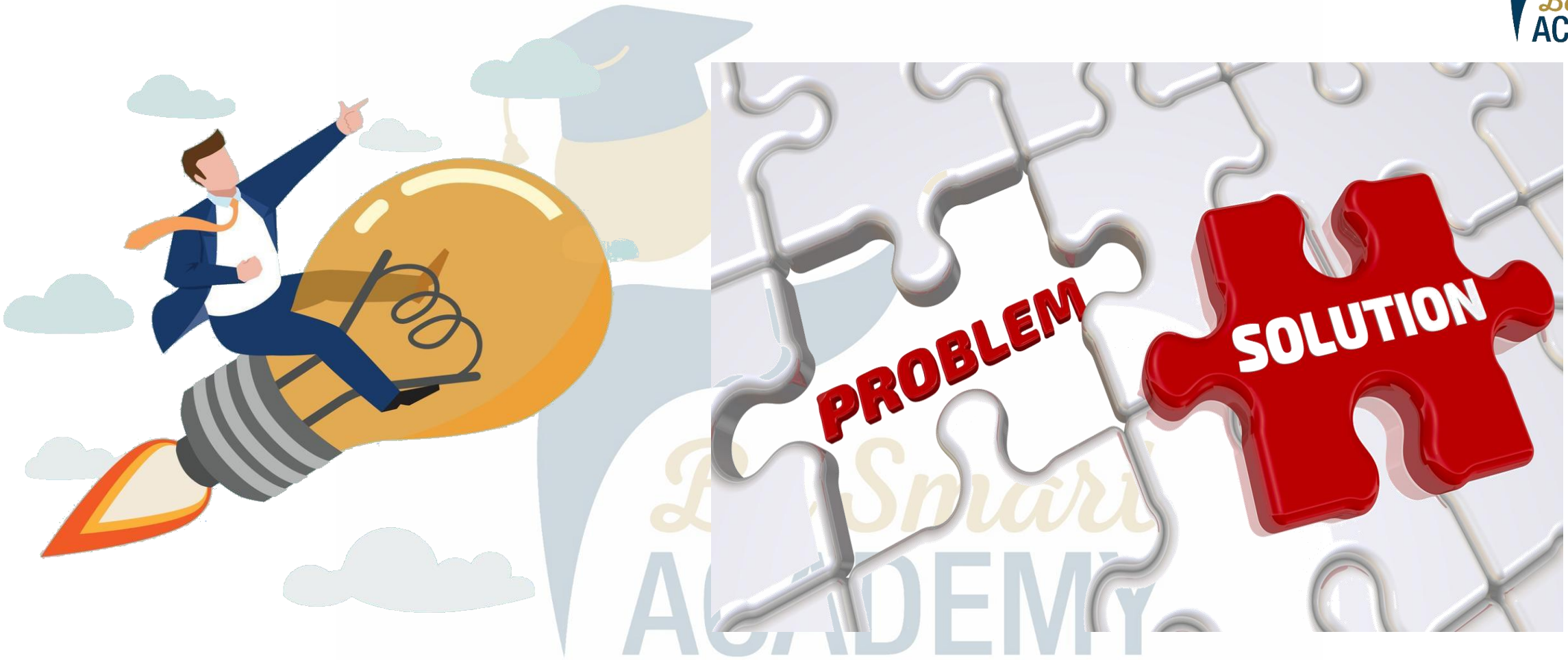
Physics – Grade 10



Unit Four
Mechanics

Chapter 14
Description of motion

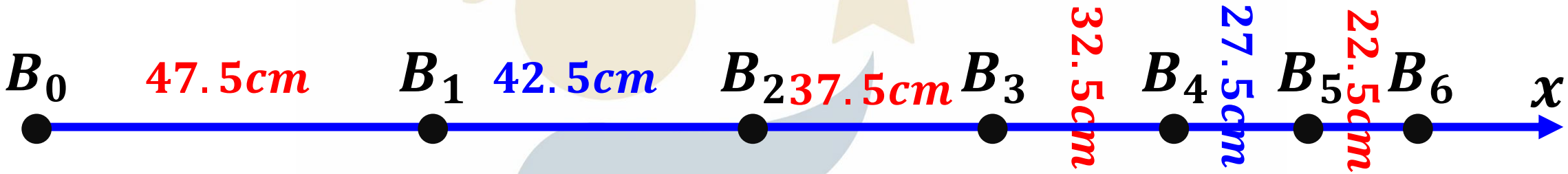
Prepared & Presented by: Mr. Mohamad Seif



Think then Solve

Exercise 1

A puck (B) is launched up air table with initial velocity vector $\vec{V}_0$ of magnitude $V_0 = 5m/s$.



The time constant between two consecutive dots is $\tau = 100ms$.

1. Indicate with justification the trajectory described by the motion of the puck.
2. Determine the average speed between B_1 and B_5.

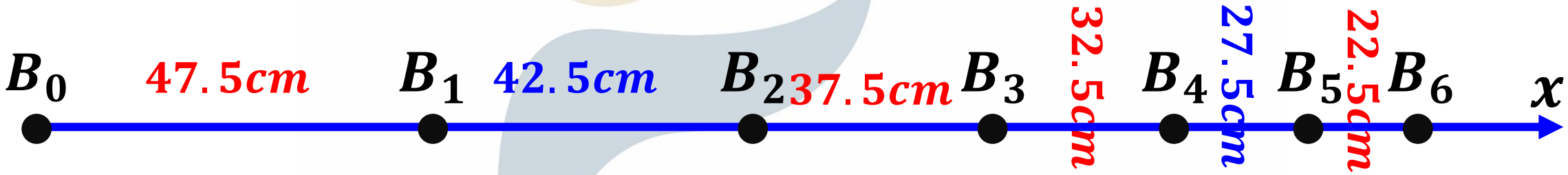
Exercise 1

3. Calculate the instantaneous speeds V_1, V_3 and V_5 at B_1, B_3 and B_5 respectively.
4. Determine the average acceleration between B_1 & B_3; B_3 & B_5;
5. Calculate the instantaneous acceleration a_2, a_4 at B_2 and B_4 respectively.
6. Deduce the nature of motion.
7. Give the characteristics of the acceleration vector at B_2.

Exercise 1

$V_0 = 5m/s$; $\tau = 100ms \div 1000 = 0.1s$.

1.Indicate with justification the trajectory described by the motion of the puck.

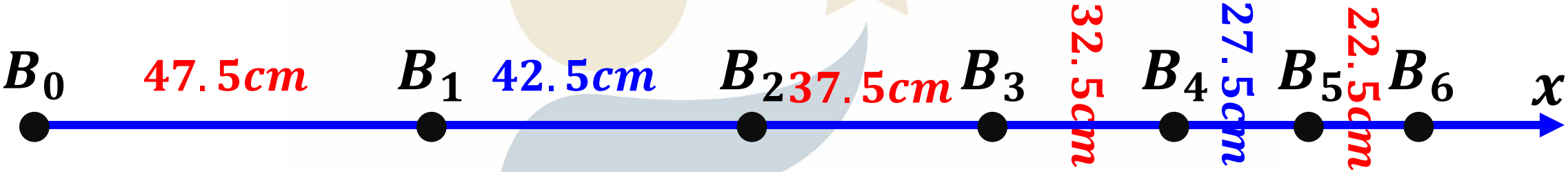


The trajectory of motion is rectilinear (St. line), because the points are collinear.

Exercise 1

$V_0 = 5m/s$; $\tau = 100ms \div 1000 = 0.1s$.

2.Determine the average speed between B_1 and B_5.



$$V_{1,5} = \frac{B_1B_5}{t_5 - t_1} \Rightarrow V_{1,5} = \frac{B_1B_2 + B_2B_3 + B_3B_4 + B_4B_5}{5\tau - \tau}$$

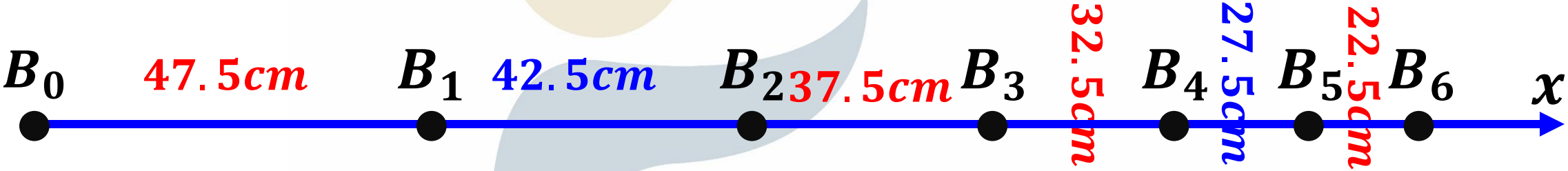
$$V_{1,5} = \frac{(42.5 + 37.5 + 32.5 + 27.5) \times 10^{-2}}{4\tau} \Rightarrow V_{1,5} = \frac{140 \times 10^{-2}}{4 \times 0.1}$$

$$V_{1,5} = 3.5 m/s$$

Exercise 1

$V_0 = 5m/s$; $\tau = 0.1s$.

3.Calculate the instantaneous speeds V_1, V_3 and V_5 at B_1, B_3 and B_5 respectively.



$$V_1 = \frac{B_0B_2}{t_2 - t_0}$$

$$V_1 = \frac{B_0B_2}{2\tau - 0}$$

$$V_1 = \frac{(47.5 + 42.5) \times 10^{-2}}{2\tau}$$

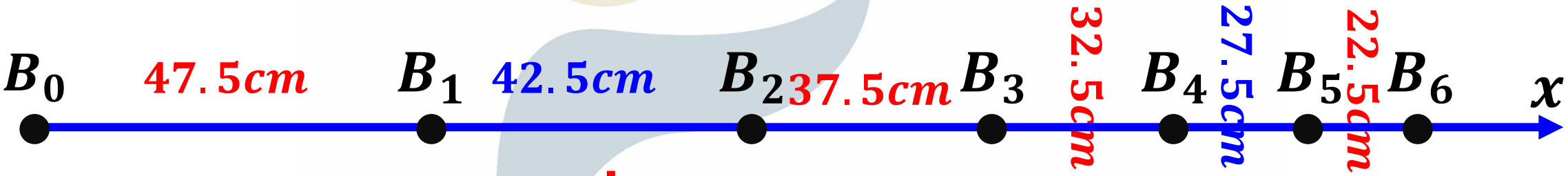
$$V_1 = \frac{90 \times 10^{-2}}{2 \times 0.1}$$

$$V_1 = 4.5m/s$$

Exercise 1

$V_0 = 5m/s$; $\tau = 0.1s$.

3.Calculate the instantaneous speeds V_1, V_3 and V_5 at B_1, B_3 and B_5 respectively.



$$V_3 = \frac{B_2B_4}{t_4 - t_2}$$

$$V_3 = \frac{B_2B_4}{4\tau - 2\tau}$$

$$V_3 = \frac{(37.5 + 32.5) \times 10^{-2}}{2\tau}$$

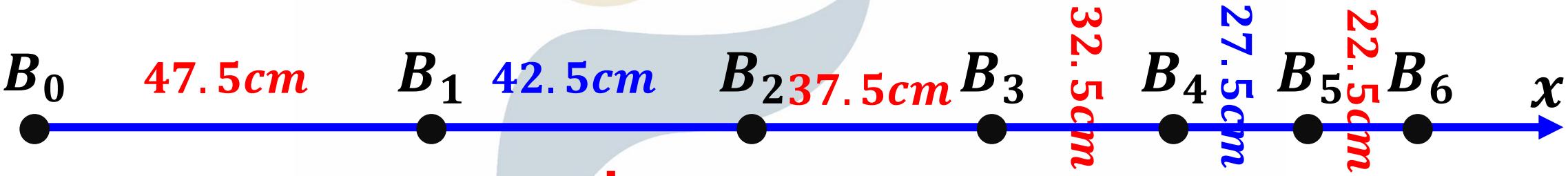
$$V_3 = \frac{70 \times 10^{-2}}{2 \times 0.1}$$

$$V_3 = 3.5m/s$$

Exercise 1

$V_0 = 5m/s$; $\tau = 0.1s$.

3.Calculate the instantaneous speeds V_1, V_3 and V_5 at B_1, B_3 and B_5 respectively.



$$V_5 = \frac{B_4B_6}{t_6 - t_4}$$

$$V_5 = \frac{B_4B_6}{6\tau - 4\tau}$$

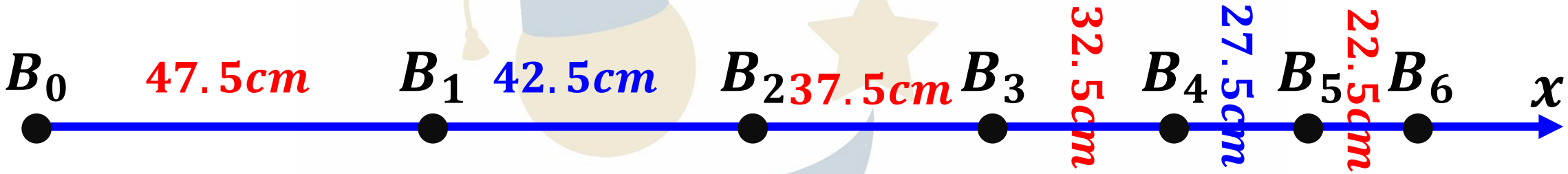
$$V_5 = \frac{(27.5 + 22.5) \times 10^{-2}}{2\tau}$$

$$V_5 = \frac{50 \times 10^{-2}}{2 \times 0.1}$$

$$V_5 = 2.5m/s$$

Exercise 1:

4.Determine the average acceleration between B_1 & B_3; B_3 & B_5



$$a_{1,3} = \frac{V_3 - V_1}{t_3 - t_1}$$

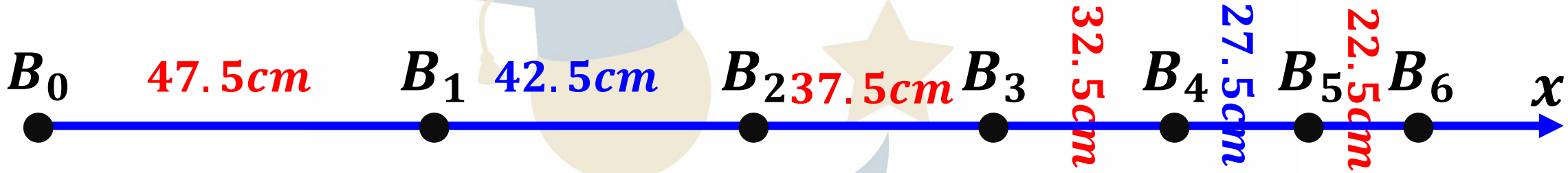
$$a_{1,3} = \frac{3.5 - 4.5}{2\tau}$$

$$a_{1,3} = \frac{-1}{2 \times 0.1}$$

$$a_{1,3} = -5m/s^2$$

Exercise 1:

4.Determine the average acceleration between B_1 & B_3; B_3 & B_5



$$a_{3,5} = \frac{V_5 - V_3}{t_5 - t_3}$$

$$a_{3,5} = \frac{2.5 - 3.5}{2\tau}$$

$$a_{3,5} = \frac{-1}{2 \times 0.1}$$

$$a_{3,5} = -5m/s^2$$

Exercise 1

$V_0 = 5m/s$; $\tau = 0.1s$; $V_1 = 4.5m/s$; $V_3 = 3.5m/s$; $V_5 = 2.5m/s$

5.Calculate the instantaneous acceleration a_2, a_4 at B_2 and B_4 respectively.

$$a_2 = \frac{V_3 - V_1}{t_3 - t_1} \Rightarrow a_2 = \frac{3.5 - 4.5}{3\tau - \tau} \Rightarrow a_2 = \frac{-1}{2 \times 0.1}$$

$$a_2 = -5m/s^2$$

$$a_4 = \frac{V_5 - V_3}{t_5 - t_3} \Rightarrow a_4 = \frac{2.5 - 3.5}{5\tau - 3\tau} \Rightarrow a_4 = \frac{-1}{2 \times 0.1}$$

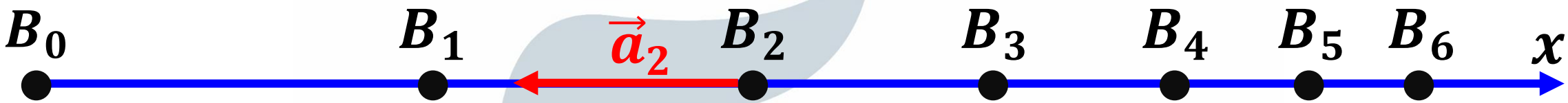
$$a_4 = -5m/s^2$$

Exercise 1

6.Deduce the nature of motion.

Since $a_2 = a_4 = a = -5m/s^2 < 0$ the motion is decelerated motion

7.Give the characteristics of the acceleration vector at B_2.



Origin: B_2

Line of action: Horizontal

Direction: To Left

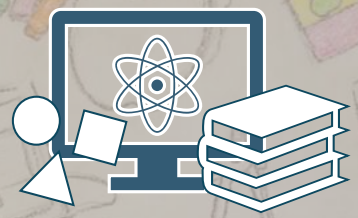
Magnitude: $a_2 = -5\,m/s^2$

$1cm \rightarrow 2.5m/s^2$

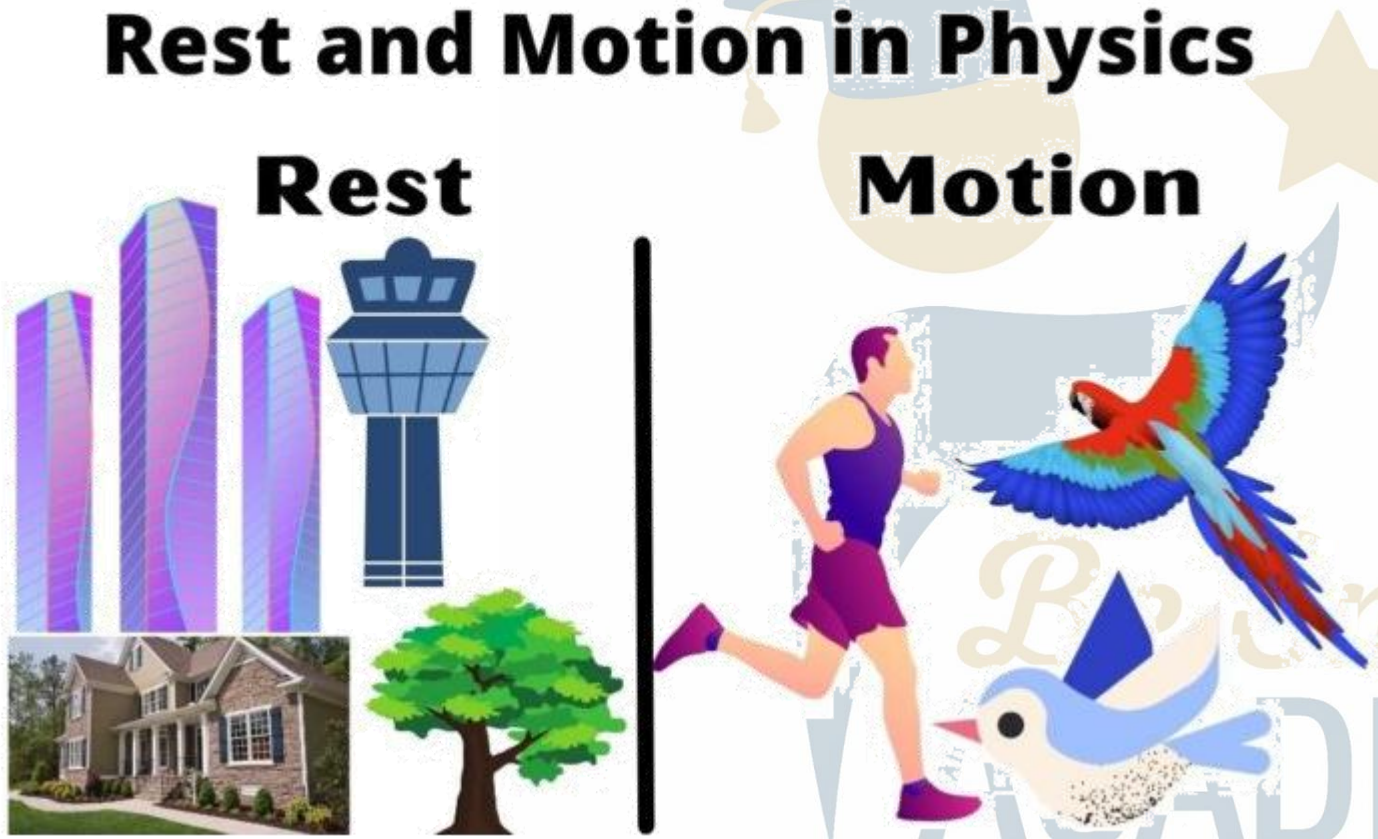
$x = ?? \rightarrow 5m/s^2$

$$x = \frac{1cm \times 5}{2.5} \approx 2cm$$

The End



Physics – Grade 10



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Chapter 14
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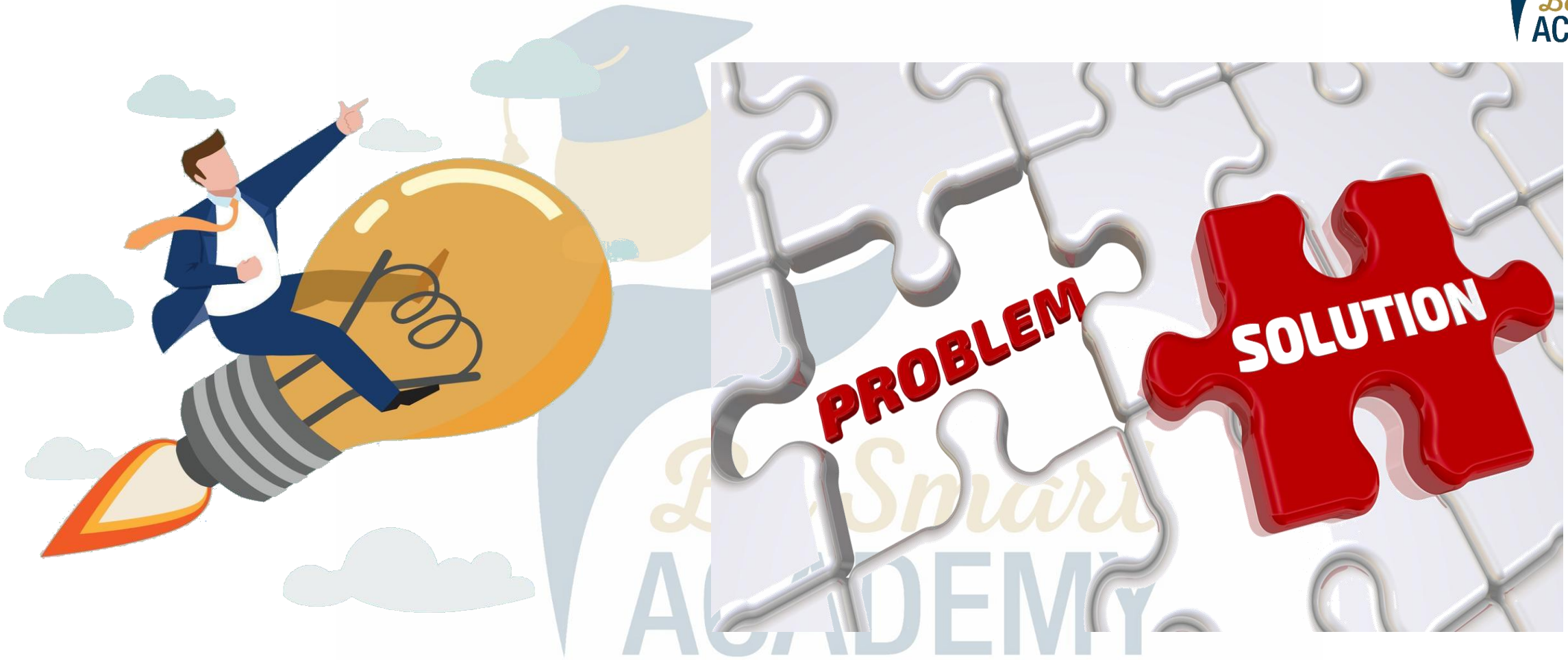


Think then Solve

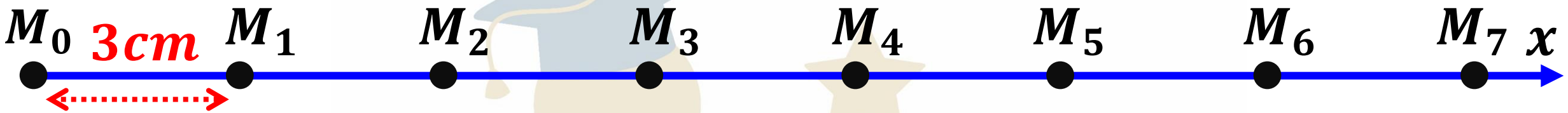
Exercise 2:

The figure shows the recording of the successive positions of a puck M on an inclined air table.

The time interval separating two successive points is τ = 40ms.

1. **Indicate with justification the trajectory described by the motion of the puck.**
2. **Determine the average speeds $V_{1,7}$ and $V_{5,7}$ between: M_1 & M_7, and between M_5 & M_7.**

Exercise 2:



3. Determine the instantaneous speed of the puck V_2, V_4 and V_6 at the points M_2, M_4 and M_6.
4. Determine the characteristics of instantaneous velocity at M_4 Scale: $1cm \rightarrow 0.25 m/s$
5. Determine the average acceleration $a_{1,3}$ and $a_{3,5}$ between M_1 & M_3 and between M_3 & M_5.
6. Calculate the instantaneous acceleration a_3, a_5 at M_3 and M_5 respectively.

Exercise 2:

$\tau = 40ms \div 1000 = 0.04s$; $M_0M_1 = M_1M_2 = \cdots = 3cm$

1.Indicate with justification the trajectory described by the motion of the puck.

The trajectory of the puck M is rectilinear, because the line joining the points from M_0 to M_7 is straight line

Exercise 2:

$\tau = 0.04s$; $M_0M_1 = M_1M_2 = \cdots = 3cm$

2. Determine the average speeds $V_{1,7}$ and $V_{5,7}$ between: M_1 & M_7, and between M_5 & M_7

$$V_{1,7} = \frac{M_1M_7}{t_7 - t_1} \Rightarrow V_{1,7} = \frac{M_1M_7}{7\tau - \tau} \Rightarrow V_{1,7} = \frac{M_1M_7}{6\tau}$$

$$V_{1,7} = \frac{(6 \times 3) \times 10^{-2}}{6 \times 0.04} \Rightarrow V_{1,7} = 0.75 m/s$$

Exercise 2:

$\tau = 0.04s$; $M_0M_1 = M_1M_2 = \cdots = 3cm$

2. Determine the average speeds $V_{1,7}$ and $V_{5,7}$ between: M_1 & M_7, and between M_5 & M_7

$$V_{5,7} = \frac{M_5M_7}{t_7 - t_5} \Rightarrow V_{5,7} = \frac{M_5M_7}{7\tau - 5\tau} \Rightarrow V_{5,7} = \frac{M_5M_7}{2\tau}$$

$$V_{5,7} = \frac{(3+3)\times 10^{-2}}{2\times 0.04} \Rightarrow V_{5,7} = 0.75\,m/s$$

Exercise 2:

$\tau = 0.04s$; $M_0M_1 = M_1M_2 = \cdots = 3cm$

3.Determine the instantaneous speed of the puck V_2, V_4 and V_6 at the points M_2, M_4 and M_6

$$V_2 = \frac{M_1M_3}{t_3 - t_1} \Rightarrow V_2 = \frac{M_1M_3}{3\tau - \tau} \Rightarrow V_2 = \frac{M_1M_3}{2\tau}$$

$$V_2 = \frac{6 \times 10^{-2}}{2 \times 0.04} \Rightarrow V_2 = 0.75m/s$$

Exercise 2:

$\tau = 0.04s$; $M_0M_1 = M_1M_2 = \cdots = 3cm$

3.Determine the instantaneous speed of the puck V_2, V_4 and V_6 at the points M_2, M_4 and M_6.

$$V_4 = \frac{M_3M_5}{t_5 - t_3} \Rightarrow V_4 = \frac{M_3M_5}{5\tau - 3\tau} \Rightarrow V_4 = \frac{M_3M_5}{2\tau}$$

$$V_4 = \frac{6 \times 10^{-2}}{2 \times 0.04} \Rightarrow V_4 = 0.75m/s$$

Exercise 2:

$\tau = 0.04s$; $M_0M_1 = M_1M_2 = \cdots = 3cm$

3.Determine the instantaneous speed of the puck V_2, V_4 and V_6 at the points M_2, M_4 and M_6.

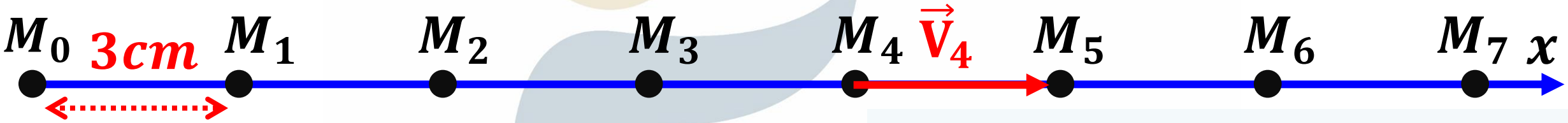
$$V_6 = \frac{M_5M_7}{t_7 - t_5} \Rightarrow V_6 = \frac{M_5M_7}{7\tau - 5\tau} \Rightarrow V_6 = \frac{M_5M_7}{2\tau}$$

$$V_6 = \frac{6 \times 10^{-2}}{2 \times 0.04} \Rightarrow V_6 = 0.75m/s$$

Exercise 2:

$\tau = 0.04s$; $V_2 = V_4 = V_6 = 0.75m/s$

4.Determine the characteristics of instantaneous velocity at M_4. Scale: $1cm \rightarrow 0.25\,m/s$



Origin:	point M_4
Line of action:	Horizontal
Direction:	To the Right
Magnitude:	$V_4 = 0.75m/s$

$$1cm \rightarrow 0.25m/s$$
$$x = ?? \rightarrow 0.75m/s$$

$$x = \frac{1cm \times 0.75m/s}{0.25m/s}$$

$$x = 3cm$$

Exercise 2:

$\tau = 0.04s$; $V_2 = V_4 = V_6 = 0.75m/s$

5.Determine the average acceleration $a_{1,3}$ and $a_{3,5}$ between M_1 & M_3 and between M_3 & M_5

$$a_{1,3} = \frac{V_3 - V_1}{t_3 - t_1}$$

$$a_{1,3} = \frac{0.75 - 0.75}{3\tau - \tau}$$

$$a_{1,3} = 0\ m/s^2$$

$$a_{3,5} = \frac{V_5 - V_3}{t_5 - t_3}$$

$$a_{3,5} = \frac{0.75 - 0.75}{3\tau - \tau}$$

$$a_{3,5} = 0m/s^2$$

Exercise 2:

$\tau = 0.04s$; $V_2 = V_4 = V_6 = 0.75m/s$

6.Calculate the instantaneous acceleration a_3, a_5 at M_3 and M_5 respectively.

$$a_3 = \frac{V_4 - V_2}{t_4 - t_2}$$

$$a_3 = \frac{0.75 - 0.75}{4\tau - 2\tau}$$

$$a_3 = 0\ m/s^2$$

$$a_5 = \frac{V_6 - V_4}{t_6 - t_4}$$

$$a_5 = \frac{0.75 - 0.75}{6\tau - 4\tau}$$

$$a_5 = 0\ m/s^2$$

The End