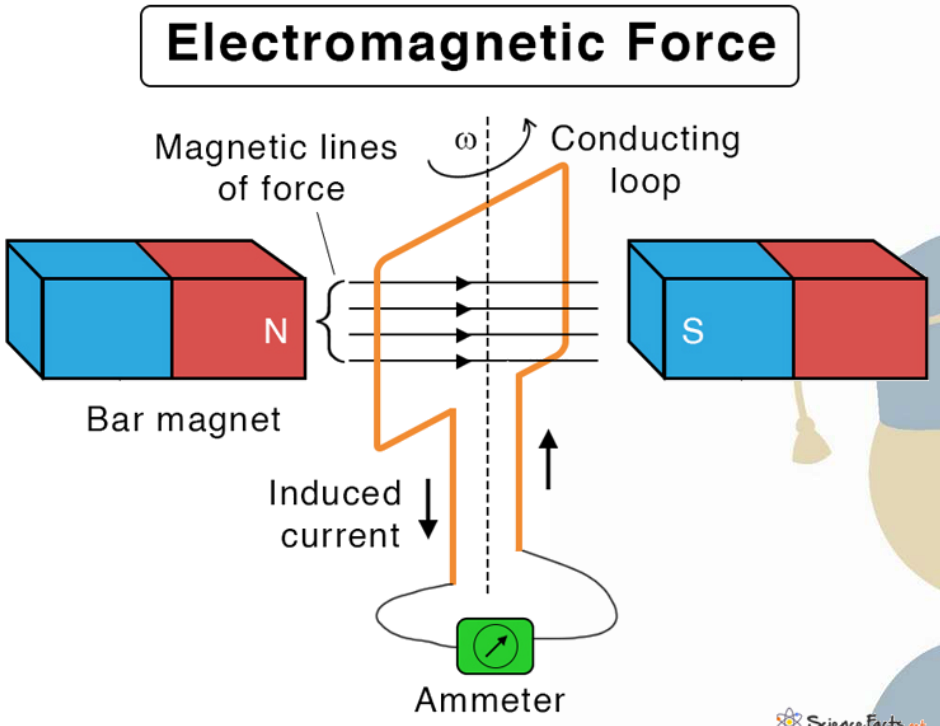
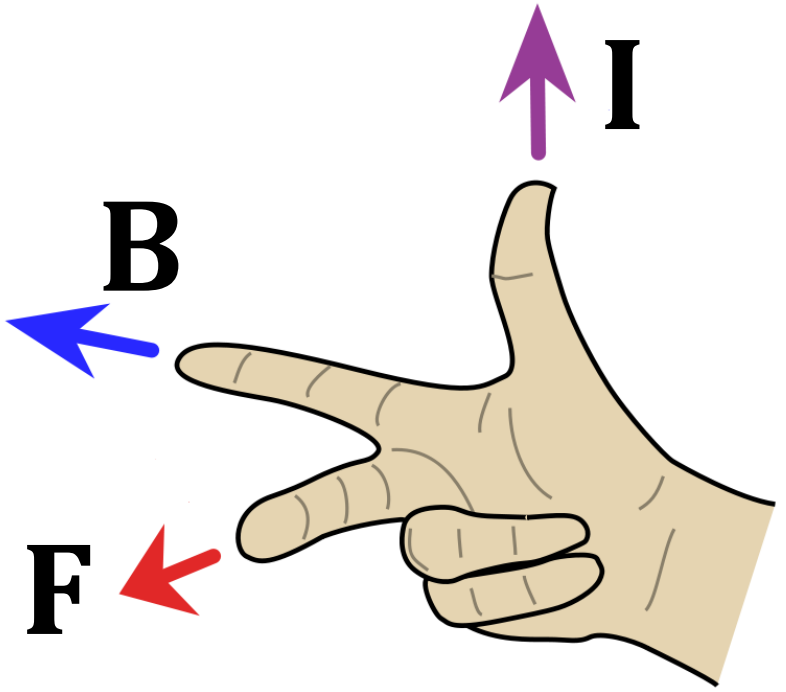
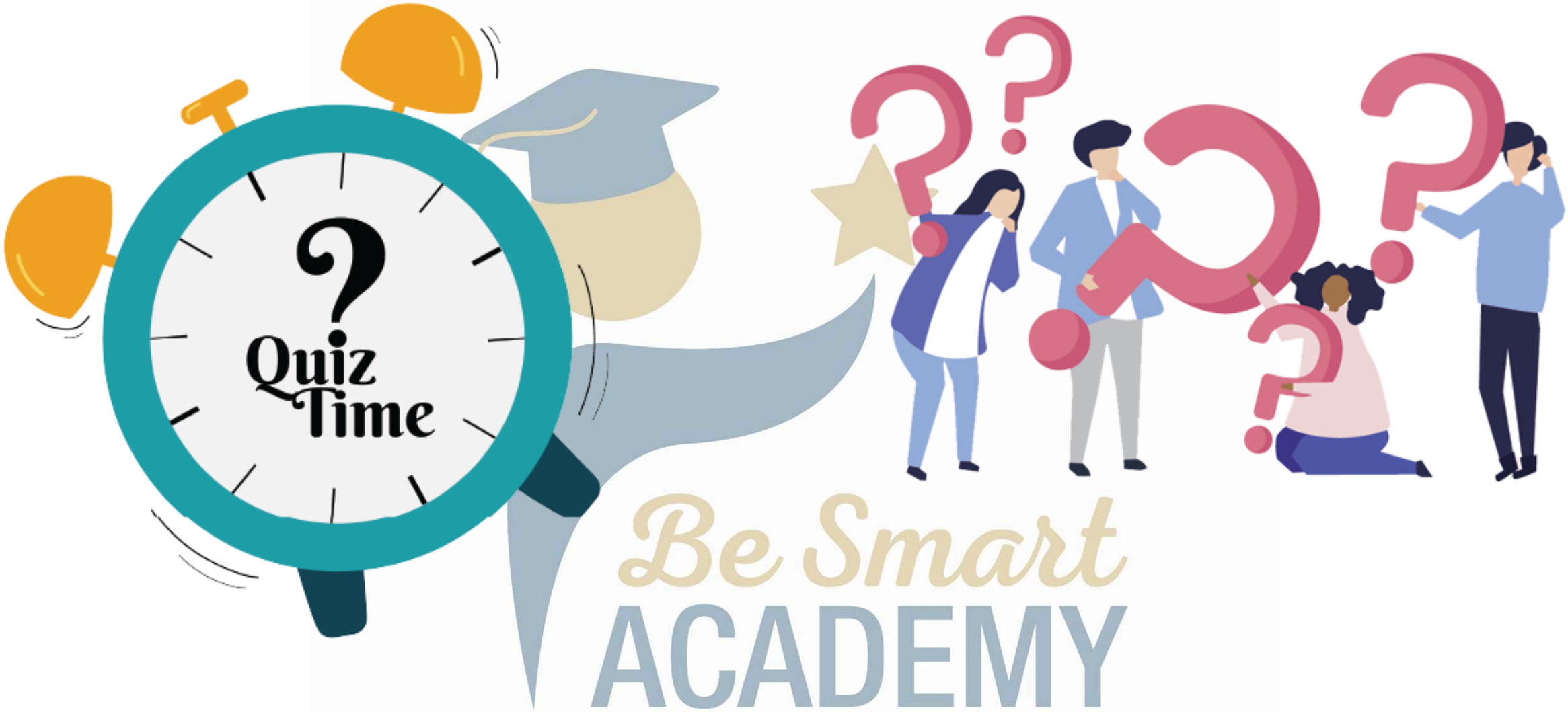




Chapter 19

Electromagnetic force

Prepared & Presented by: Mr. Mohamad Seif



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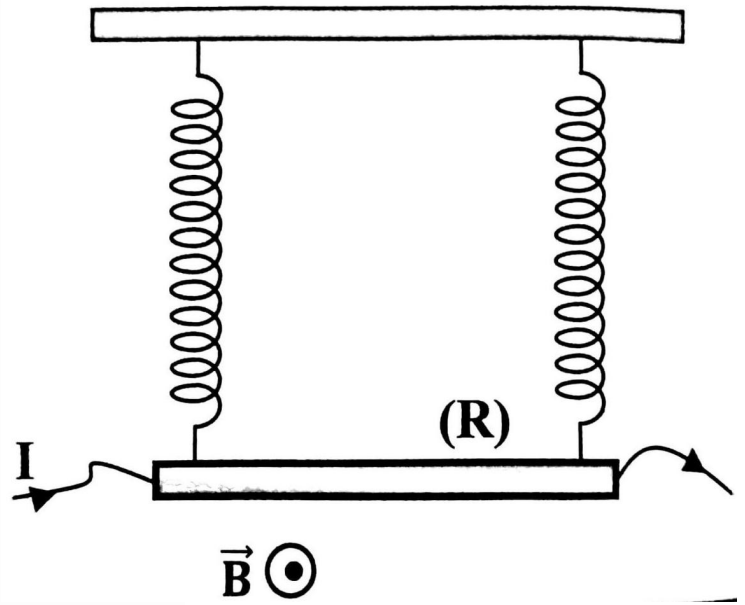
Quiz **graphical study** **Duration: 20min**

The adjacent diagram shows a 20g uniform conducting rod (R) suspended from its ends by means of two identical light springs of stiffness K.



A uniform magnetic field $\vec{B}$ of intensity $B = 0.2T$ exists pointing out of the page.

The rod is connected to an adjustable generator that delivers an electrical current of intensity I which runs through the rod. The two springs are elongated by distance x with respect to their equilibrium position.

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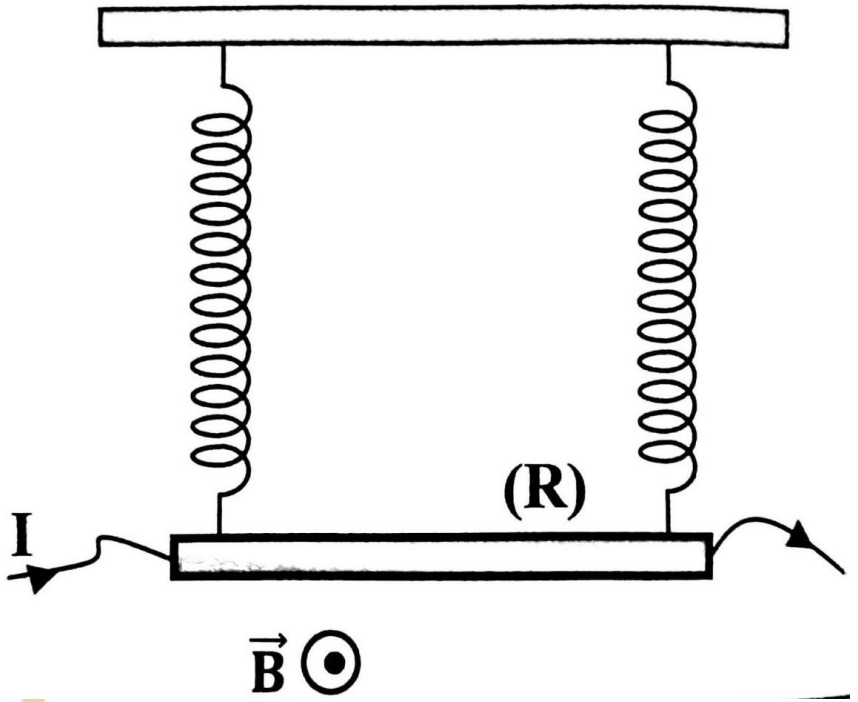
Quiz graphical study Duration: 20min

Graphical study:

In the table below, the values of x and I are given.

I(A)	0	1	2	3	4
x(cm)	10	20	30	40	50



1)Plot the graph of x as a function of I.

2)Indicate the shape of the obtained graph.

3)Determine the equation of the obtained graph.

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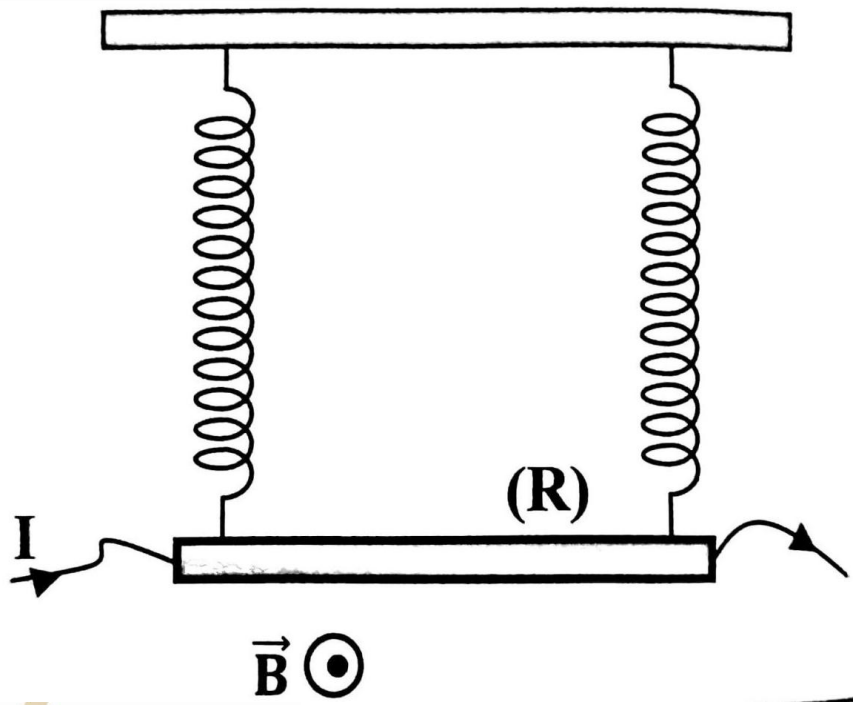
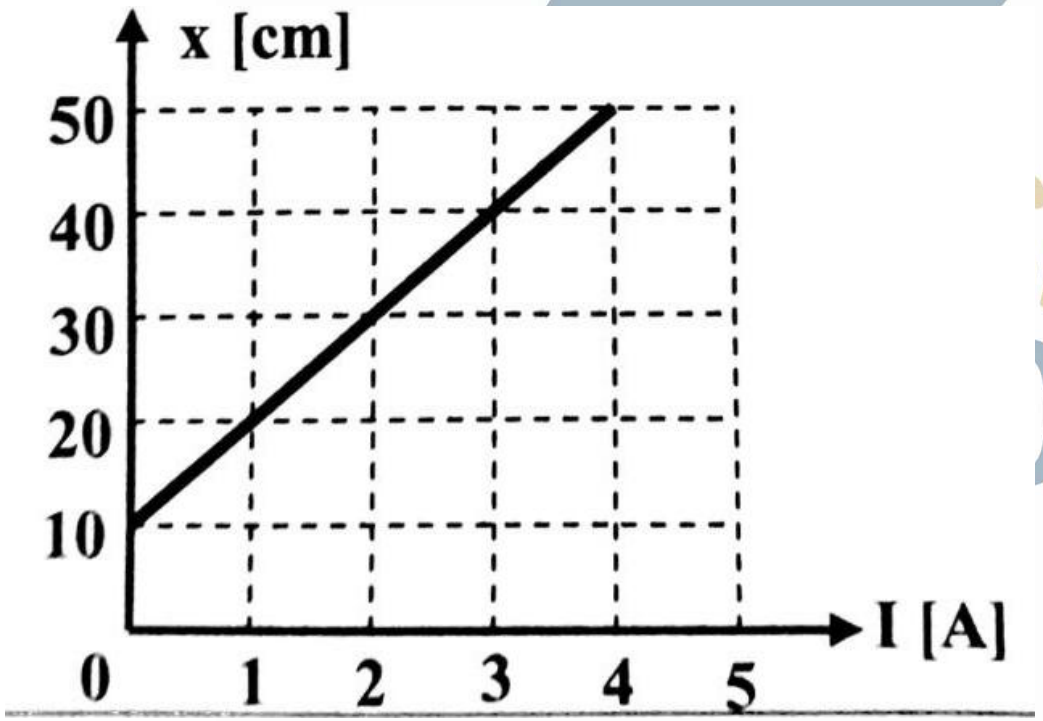
Quiz graphical study Duration: 20min

$m = 20g; B = 0.2T; g = 10N/kg$

I(A)	0	1	2	3	4
x(cm)	10	20	30	40	50

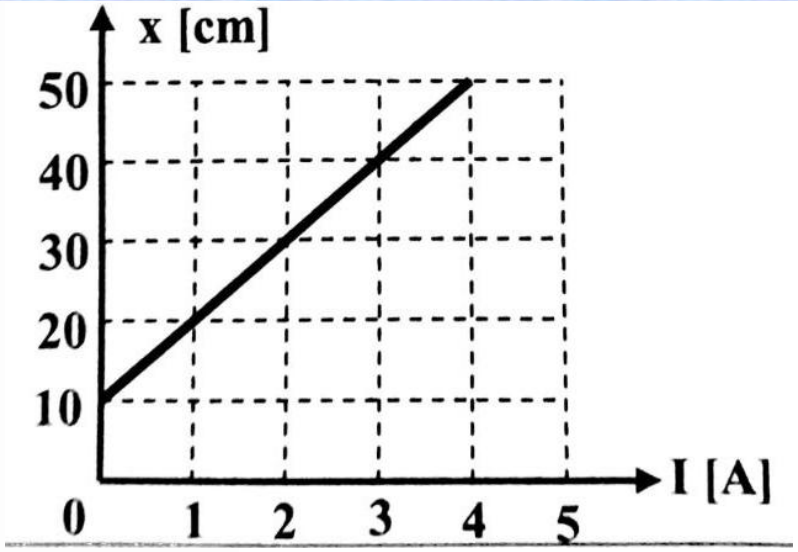


1)Plot the graph of x as a function of I.



Quiz **graphical study** **Duration: 20min**

$m = 20g; B = 0.2T; g = 10N/kg$



2)Indicate the shape of the obtained graph.

Increasing St. line not passing through origin.

3)Determine the equation of the obtained graph.

The general equation of the St. Line is $x = aI + b$, where a is slope

$$a = \frac{x_2 - x_1}{I_2 - I_1} = \frac{0.2 - 0.1}{1 - 0} = 0.1m/A$$

$$x = 0.1I + b$$

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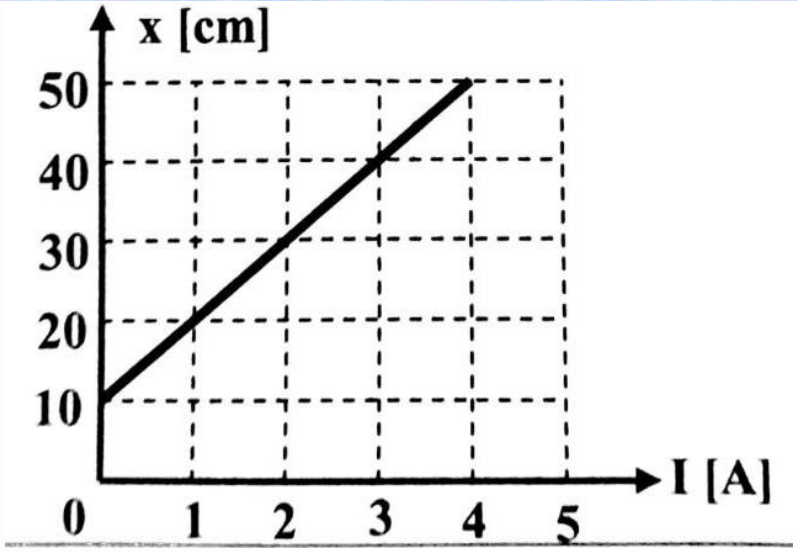
Quiz graphical study Duration: 20min

$m = 20g; B = 0.2T; g = 10N/kg$



$$x = 0.1I + b$$

Substitute (0A; 10cm) in the above equation

$0.1 = 0.1 \times (0) + b$ ⇒ $b = 0.1$

The equation of the obtained graph is:

$$x = 0.1I + 0.1$$

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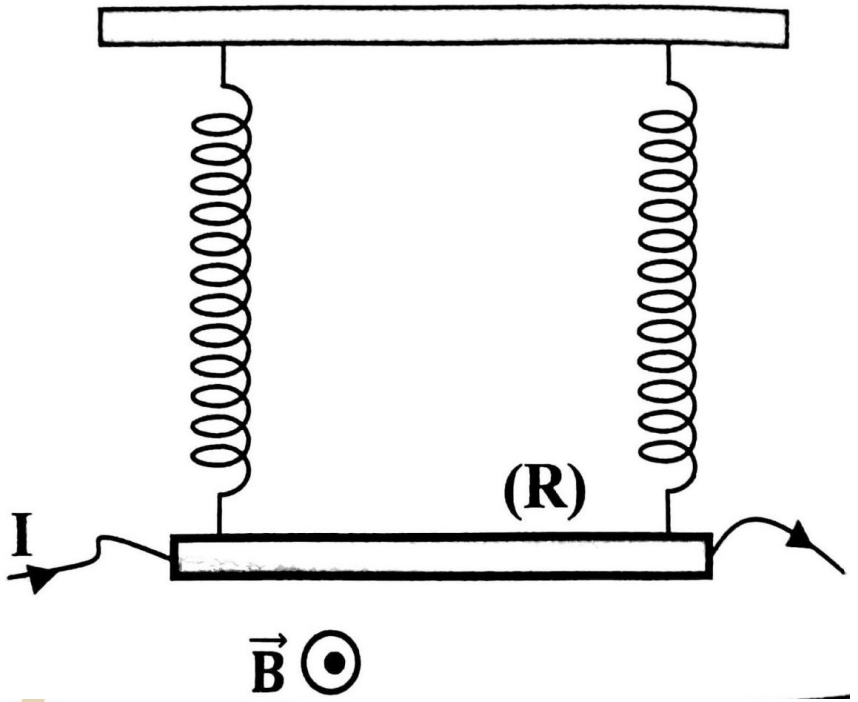
Quiz **graphical study** **Duration: 20min**

Determination of the intensity of the magnetic field:



1) Name and represent all external forces exerted on the rod.
2) Determine the expression of x as function of m, g, I, B, L, and K.
3) Determine the value of the stiffness of the spring and the intensity of the magnetic field, knowing that L=1m.

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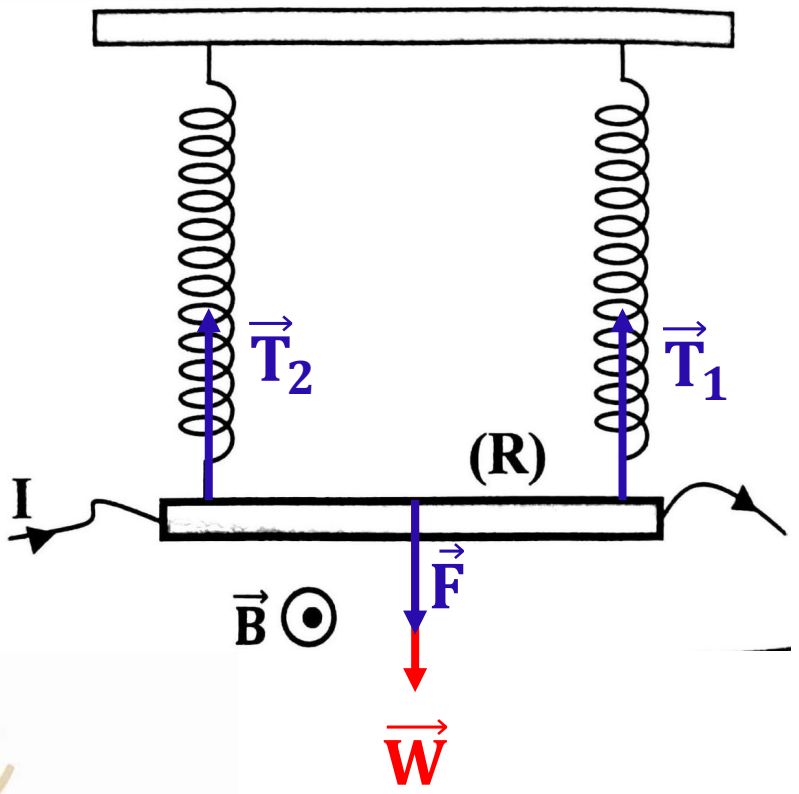
Quiz **graphical study** **Duration: 20min**

$m = 20g; B = 0.2T; g = 10N/kg$

1)Name and represent all external forces exerted on the rod.



The forces are:

- **Weight $\vec{W}$**
- **Electromagnetic force $\vec{F}$**
- **Tension in the two springs $\vec{T}_1$ and $\vec{T}_2$**

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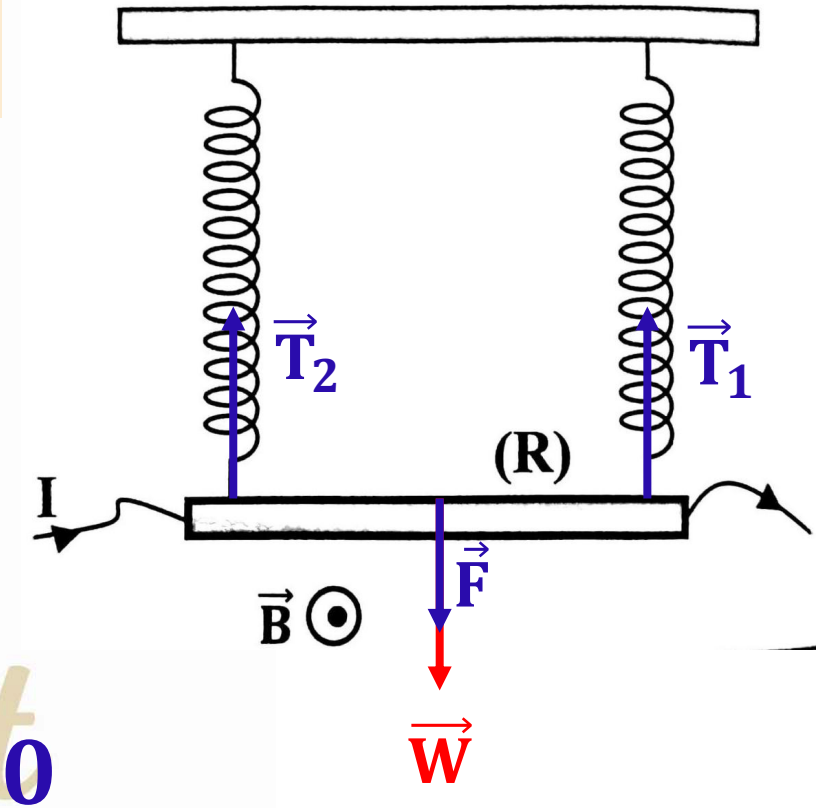
Quiz **graphical study** **Duration: 20min**

$m = 20g; B = 0.2T; g = 10N/kg$

2)Determine the expression of x as function of m, g, I, B, L, and K.



$$\sum \vec{F}_{ex} = \vec{0} \Rightarrow \vec{T}_1 + \vec{T}_2 + \vec{W} + \vec{F} = \vec{0}$$

Project along y-axis: $T_1 + T_2 - W - F = 0$

$$Kx + Kx - mg - ILBsin\alpha = 0 \Rightarrow 2Kx = mg + ILBsin90$$

$$\Rightarrow 2Kx = mg + ILB \Rightarrow x = \frac{mg}{2K} + \frac{LB}{2K}.I$$

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Quiz **graphical study** **Duration: 20min**

$m = 20g; B = 0.2T; g = 10N/kg$

3)Determine the value of the stiffness of the spring and the intensity of the magnetic field, knowing that L=1m.

$$x = \frac{LB}{2K}.I + \frac{mg}{2K}$$

$$x = 0.1I + 0.1$$

By compare we deduce:

$$\frac{mg}{2K} = 0.1 \Rightarrow \frac{0.02 \times 10}{2K} = 0.1 \Rightarrow \frac{0.2}{2K} = 0.1$$

$$\Rightarrow 0.2 = 2K \times 0.1 \Rightarrow K = 1N/m$$

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Quiz **graphical study** **Duration: 20min**

$m = 20g; B = 0.2T; g = 10N/kg; K = 1N/m$

$$x = \frac{LB}{2K}.I + \frac{mg}{2K}$$

$$x = 0.1I + 0.1$$

$$\frac{LB}{2K} = 0.1 \Rightarrow B = \frac{2K \times 0.1}{L} \Rightarrow B = \frac{2 \times 1 \times 0.1}{1}$$

$$B = 0.2T$$

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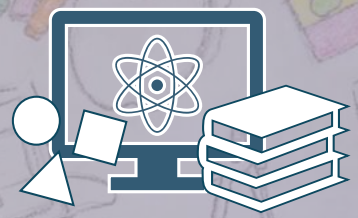
The End



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