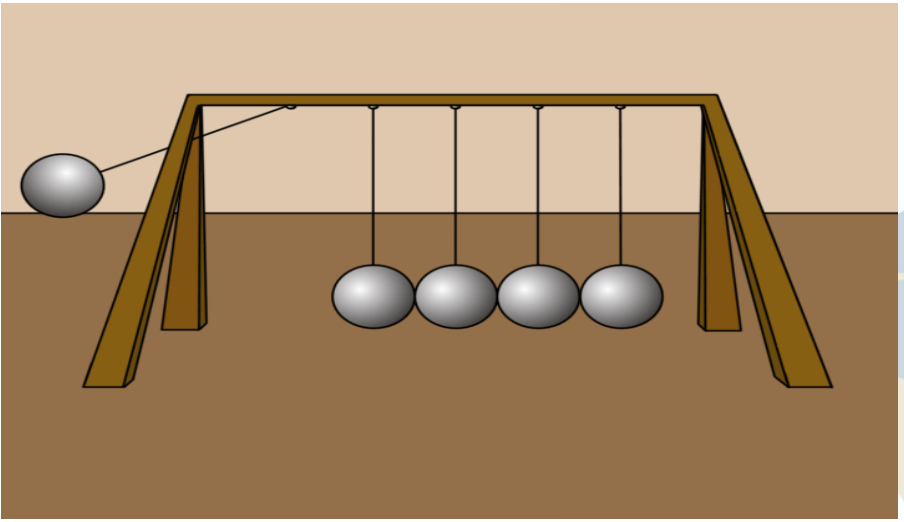

Physics - Grade 11 S

Unit Two: Mechanics

Chapter 8 – Newton's Second Law

Prepared & Presented by: Mr. Mohamad Seif

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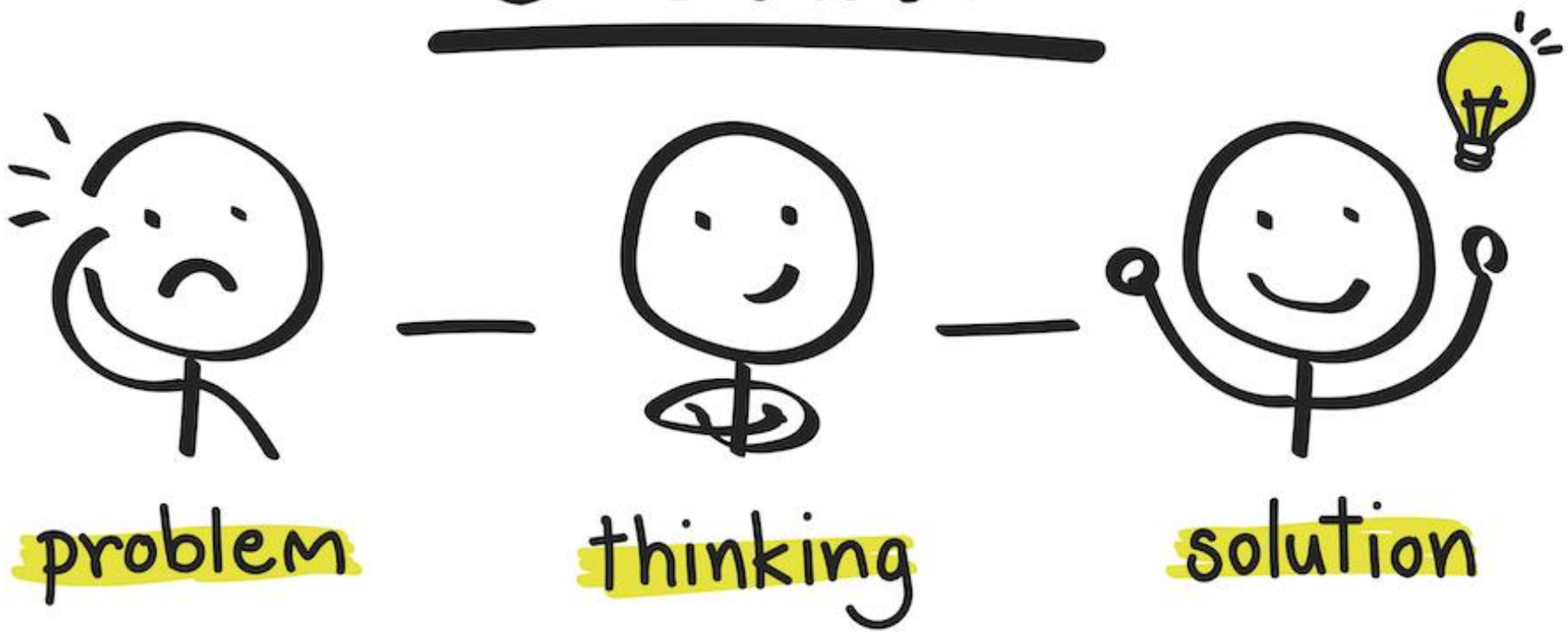
PROBLEM SOLVING



Exercise 1: Rectilinear motion of a car

A car of mass 1000 Kg is moving under the engine force of magnitude F=500N. Neglect friction.

1) **Draw a free body diagram showing all forces.**

2) **Apply newtons second law, calculate the acceleration of the box.**

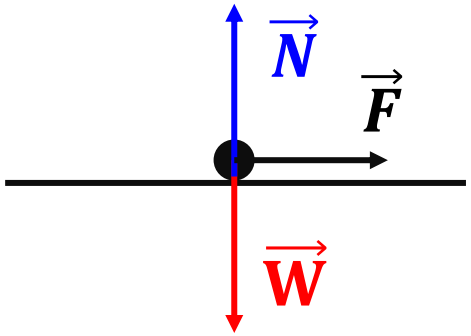
3) **Specify the nature of motion then calculate the distance covered, knowing that the car starts from rest and moves 10 seconds.**

Given: $m = 1000\ Kg$; $F = 500N$; $f = 0N$; $v_0 = 0$.

1) Draw a free body diagram showing all forces.

The forces are:

• Weight: $\vec{W}$. • Normal: $\vec{N}$ • Engine force: $\vec{F}$



2) Apply newton's second law, calculate the acceleration of the box.

$$\sum \vec{F}_{ex} = m\vec{a} \quad \Rightarrow \quad \vec{W} + \vec{N} + \vec{F} = m\vec{a}$$

Project along the direction of motion: $F = ma$

$$a = \frac{F}{m} = \frac{500}{1000} \quad \Rightarrow \quad a = 0.5 m/s^2$$

3) **Specify the nature of motion then calculate the distance covered after 10 seconds, knowing that the car starts from rest.**

$a = 0.5m/s^2 > 0$ **then:**

The motion is U.A.R.M

Using the time equation:

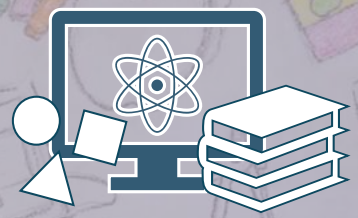
$$x = \frac{1}{2}at^2 + v_0t + x_0.$$

$$x = \frac{1}{2} \times 0.5 \times (10)^2 + 0 \times (10) + 0$$

$$x = \frac{1}{2} \times 0.5 \times (10)^2$$

$$x = 12.5m$$

The End



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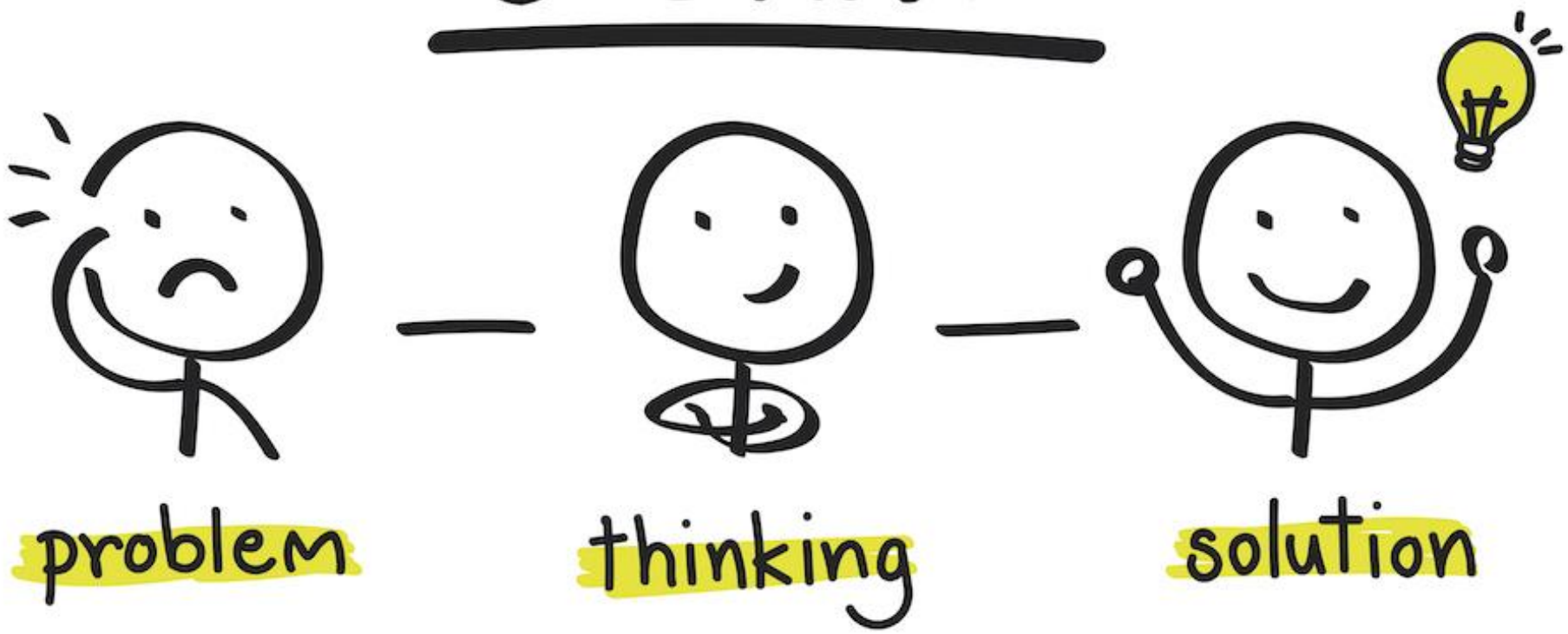
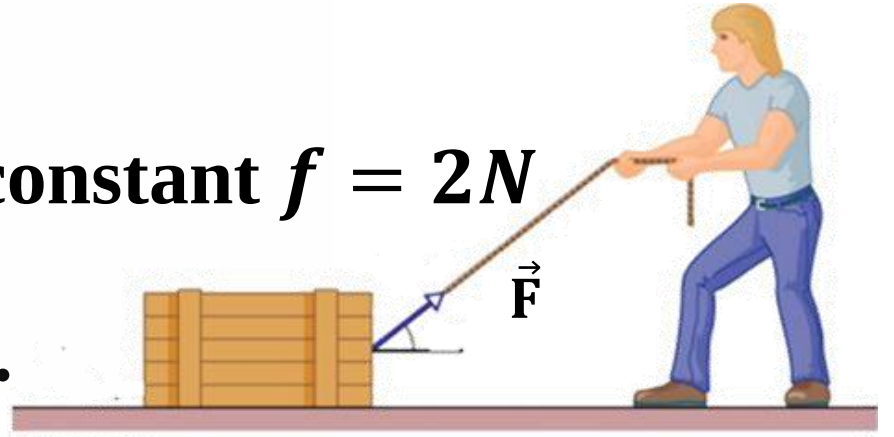


Exercise 2: motion of a box

A box, considered as a particle, of mass 5 Kg starts from rest, is pulled by a rope with a constant force $\vec{F}$ of value $F = 6N$ making an angle of 30° with the horizontal.

The friction between the box and the surface is constant $f = 2N$

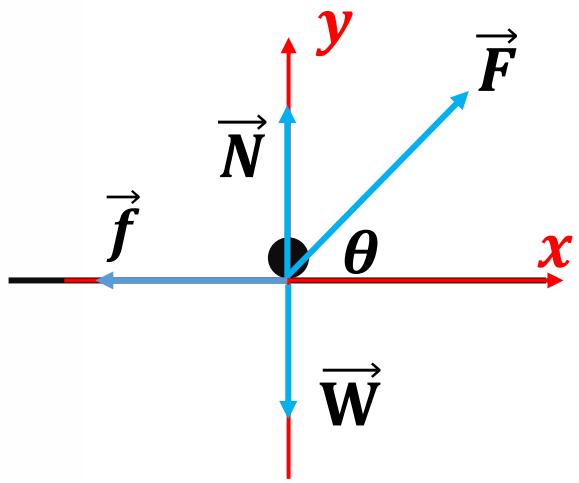


1) **Draw a free body diagram showing all forces.**

2) **Apply newtons second law, calculate the acceleration of the box.**
3) **Specify the nature of motion then calculate the velocity after moving a distance $x = 3m$.**
4) **Calculate the value of the normal reaction.**

$m = 5kg; F = 6N; \theta = 30^{\circ}; f = 2N$ & $g = 10m/s^2; v_0 = 0; x = 3m.$

1) Draw a free body diagram showing all forces.



- $\vec{w}$: weight vertical downward.
- $\vec{N}$: Normal Reaction vertical upward.
- $\vec{F}$: Applied Force upward to the right making an angle 30 with the horizontal.
- $\vec{f}$: friction force horizontal to the left

$m = 5kg$; $F = 6N$; $\theta = 30^{\circ}$; $f = 2N$ & $g = 10m/s^2$; $v_0 = 0$; $x = 3m$.

2) Apply newtons second law, calculate the acceleration of the box.

$$\sum \vec{F}_{ex} = m\vec{a}$$

$$\vec{W} + \vec{N} + \vec{f} + \vec{F} = m\vec{a}$$

Project along direction of motion:

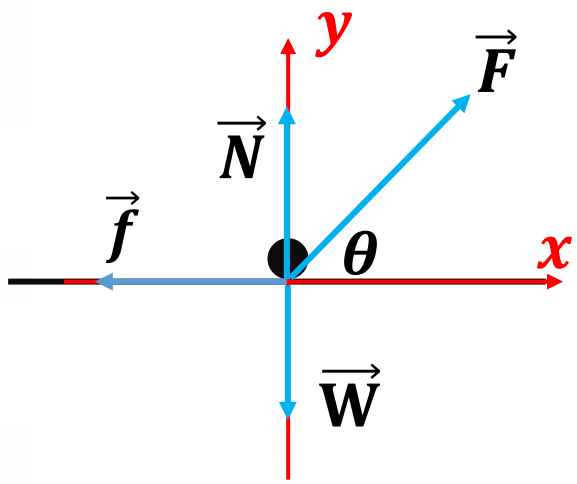
$$-f + F\cos\theta = ma$$

$$-2 + 6\cos 30 = 5 \times a$$

$$-2 + 5.2 = 5 \times a$$

$$a = \frac{3.2}{5}$$

$$a = 0.64m/m^2$$



$m = 5kg$; $F = 6N$; $\theta = 30^{\circ}$; $f = 2N$ & $g = 10m/s^2$; $v_0 = 0$; $x = 3m$.

3) Specify the nature of motion then calculate the velocity after moving a distance $x = 3m$.

$a = 0.64\, m/s^2 > 0$ then:

Then the motion is U.A.R.M

$$v^2 - v_0^2 = 2a(x - x_0)$$

$$v^2 - (0)^2 = 2 \times 0.64(3 - 0)$$

$$v^2 = 2 \times 0.64(3 - 0)$$

$$v^2 = 3.84$$

$$v = 1.95m/s$$

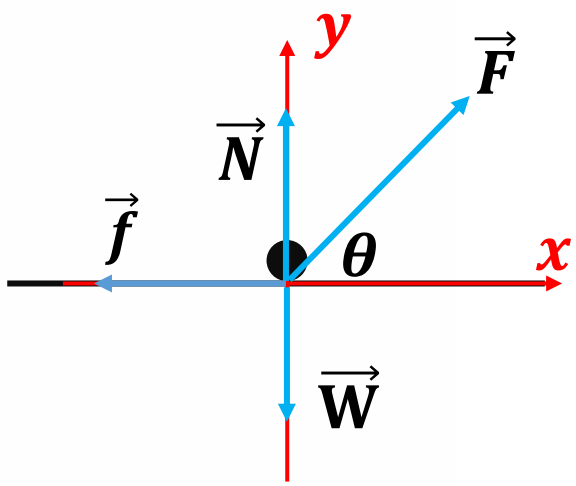
4) Calculate the value of the normal reaction.

$$\sum \vec{F}_{ex} = m\vec{a}$$

$$\vec{w} + \vec{N} + \vec{f} + \vec{F} = m\vec{a}$$

Projection along y- axis

$$-w + N + F\sin\theta = 0$$

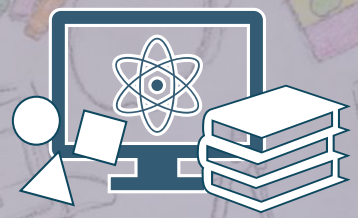


$$-50 + N + 3 = 0$$

$$-47 + N = 0$$

$$N = 47\ N$$

The End



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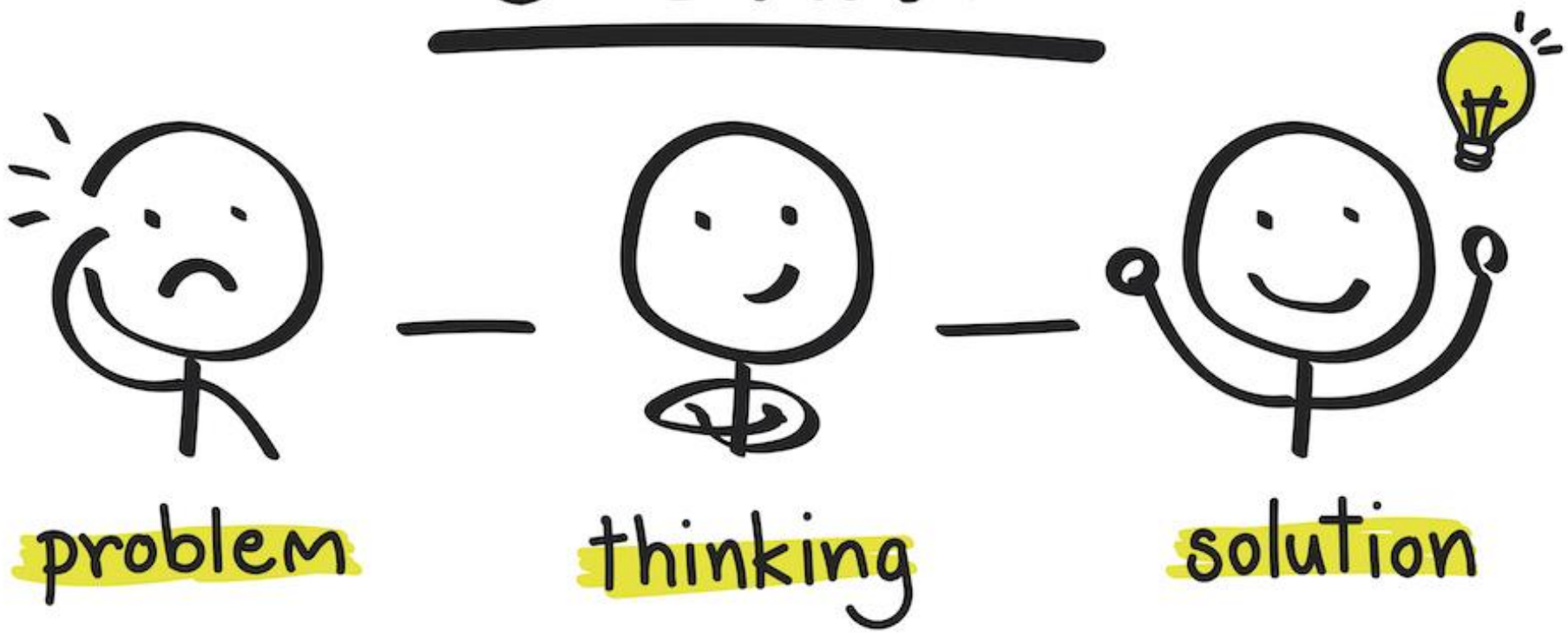
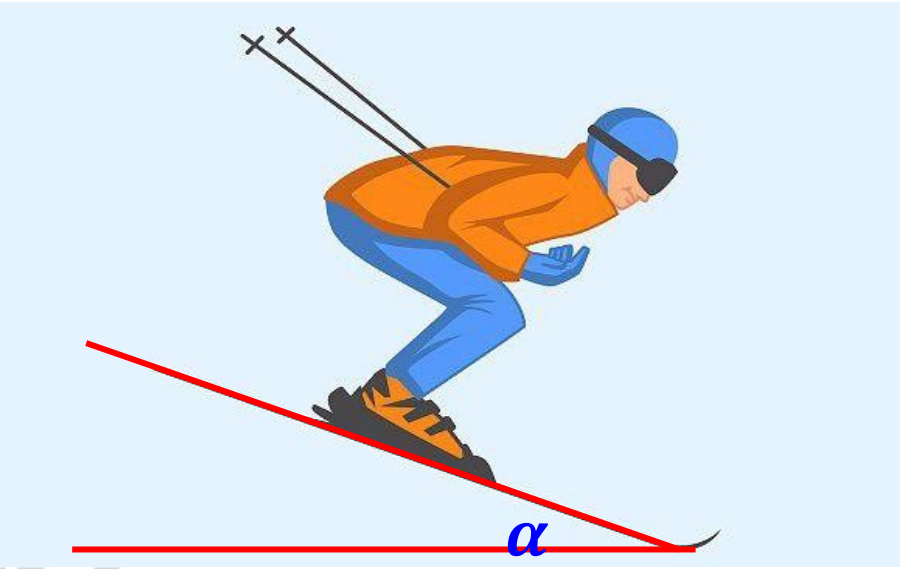


Exercise 3: motion of skier over inclined plane

A skier of mass $m = 60\ Kg$ modeled as a particle, descends an inclined plane making an angle of $\alpha = 30^{o}$ with respect to the horizontal.



The frictions are given by : $f = 30\ N$

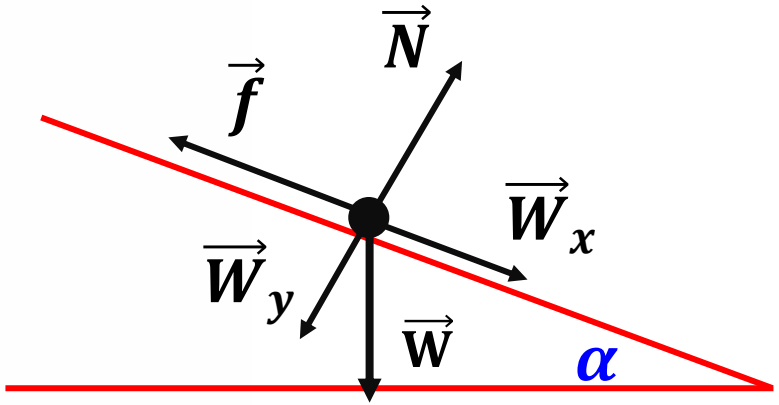
1) Draw free body diagram then represent external forces.
2) Determine the acceleration of the skier and deduce its nature of motion.
3) Calculate the speed of the skier after 2 seconds knowing that its initial speed is $V_0 = 10m/s$.

$m = 60\ Kg$; α = 30º; $f = 30\ N$; $v_0 = 10 m/s$; g=10N/m.

1) Draw free body diagram then represent external forces.

The forces are:

- **Weight: ($\vec{W}$)**
- **Normal ($\vec{N}$)**
- **Friction ($\vec{f}$)**



$m = 60\ Kg$; α = 30°; $f = 30\ N$; $v_0 = 10m/s$; g=10N/m.

2) Determine the acceleration of the skier and deduce its nature of motion.

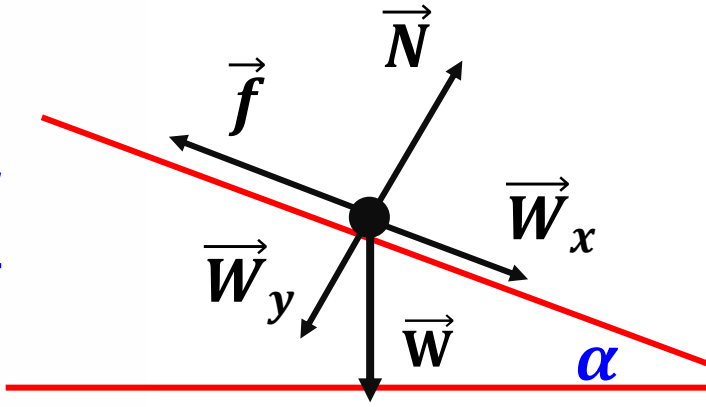
$$\sum \vec{F}_{ex} = m\vec{a}$$

$$\vec{W} + \vec{N} + \vec{F} = m\vec{a}$$

Projection along the direction of motion:

$$mgsin\alpha - f = ma$$

$$a = \frac{mgsin\alpha - f}{m}$$



$$a = \frac{60 \times 10 \times sin30 - 30}{60}$$

$$a = 4.5m/s^2 > 0$$

UARM

$m = 60\ Kg$; α = 30º; $f = 30\ N$; $v_0 = 10m/s$; g=10N/m.

3) Calculate the speed of the skier after 2 seconds knowing that its initial speed is $V_0 = 10m/s$.

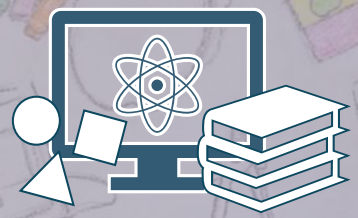
Using the time equation:

$$V = at + v_0$$

$$V = 4.5 \times 2 + 10$$

$$v = 19m/s$$

The End



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