Course 4

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8. Circular motion

8.8. The measurement units

$[\alpha]_{IS} = Rad$

$[\omega]_{IS} = \frac{Rad}{s}$ | $\omega = \frac{d\alpha}{dt}$

$[\varepsilon]_{IS} = \frac{Rad}{s^2}$ | $\varepsilon = \frac{d\omega}{dt}$

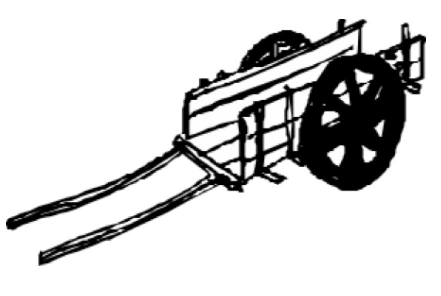
$[T]_{IS} = s$ | $\nu = \frac{1}{T}$; $T = \frac{1}{\nu}$

$[\nu]_{IS} = \frac{1}{s} = s^{-1} = Hz$ | $\omega = 2\pi \cdot \nu = \frac{2\pi}{T}$

II DYNAMICS

1° Introduction

- Aristotel (384 – 322 b.c.)



- Galileo Galilei (1564 – 1642)

2° Newtonian's Principles

2.1. The 1st Principle of dynamics. The principle of inertia

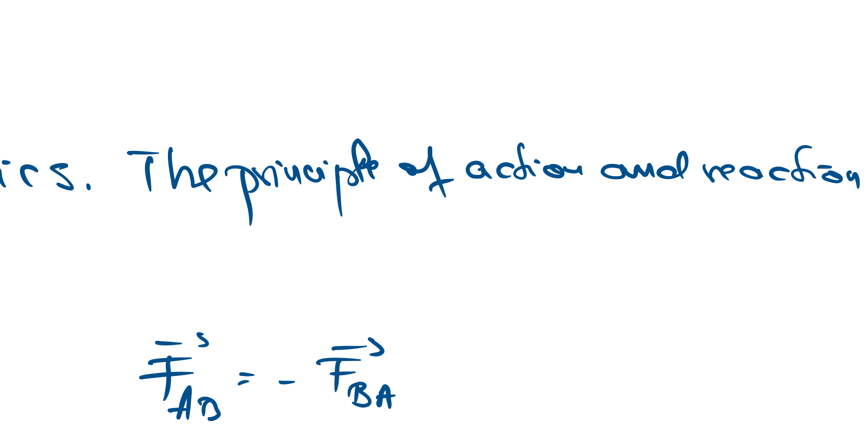
Def A body continuous in its initial state of relative motion or of relative rest unless an unbalanced force is acting on him

$\vec{R} = \sum_i \vec{F}_i$ $\qquad \vec{R} = 0$

m – mass $\qquad [m]_{IS} = kg$

2.2. The 2nd Principle of dynamics. The fundamental principle

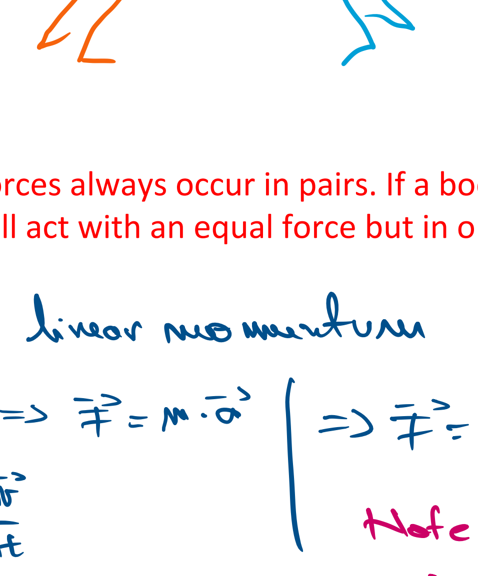
$\boxed{\vec{a} = \frac{\vec{F}}{m}}$



Def The acceleration of a body is directly proportional with the force that act on him and inversely proportional with his mass.

$\vec{F} = m \cdot \vec{a}$

2.3. The 3rd Principle of dynamics. The principle of action and reaction



$\vec{F}_{AB} = -\vec{F}_{BA}$

Def Forces always occur in pairs. If a body A exert a force on a body B called action then the body B will act with an equal force but in opposite direction on body A called reaction.

3. The linear momentum

$\vec{a} = \frac{\vec{F}}{m} \Rightarrow \vec{F} = m \cdot \vec{a}$ | $\Rightarrow \vec{F} = m \cdot \frac{d\vec{v}}{dt} \Rightarrow \vec{F} = \frac{d(m \cdot \vec{v})}{dt}$ | $\Rightarrow$

$\vec{a} = \frac{d\vec{v}}{dt}$

Note

$\vec{p} = m \cdot \vec{v}$ – the linear momentum

$\Rightarrow \boxed{\vec{F} = \frac{d\vec{p}}{dt}} \Rightarrow d\vec{p} = \vec{F}(t) \cdot dt \; \Big| \int \Rightarrow \int_{\vec{p}_1}^{\vec{p}_2} d\vec{p} = \int_{t_1}^{t_2} \vec{F}(t)\,dt \Rightarrow$

$\vec{p}\,\Big|_{\vec{p}_1}^{\vec{p}_2} = \int_{t_1}^{t_2} \vec{F}(t)\,dt \Rightarrow \vec{p}_2 - \vec{p}_1 = \boxed{\Delta\vec{p} = \int_{t_1}^{t_2} \vec{F}(t) \cdot dt}$ – the IMPULSE

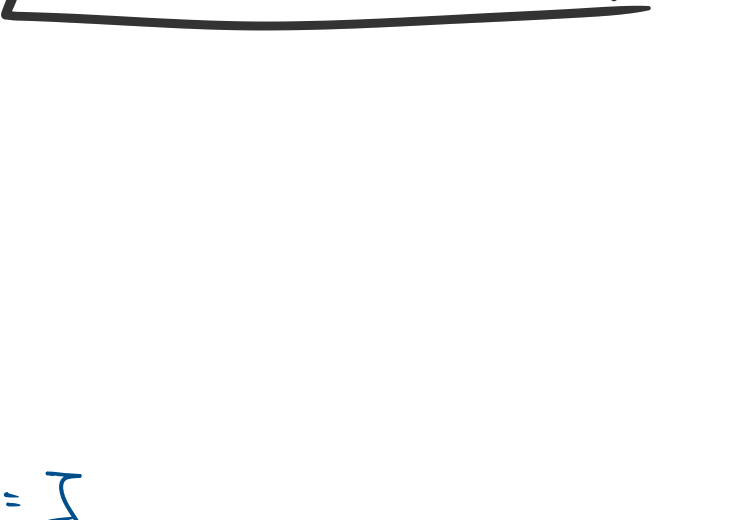
In particular

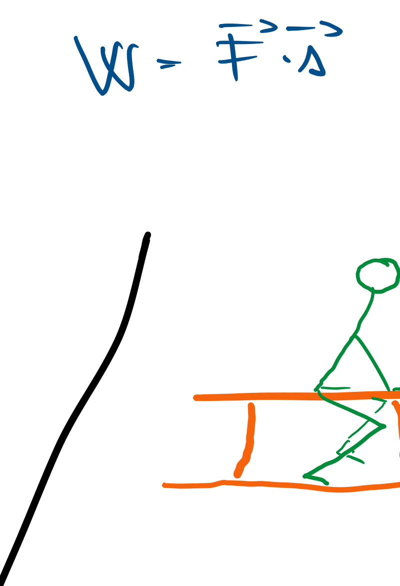
if $v_1 = 0 \Rightarrow \vec{p}_1 = 0$

$\underbrace{\Delta\vec{p}}_{\text{the impulse}} = \underbrace{\vec{p}_2 = m \cdot \vec{v}_2}$

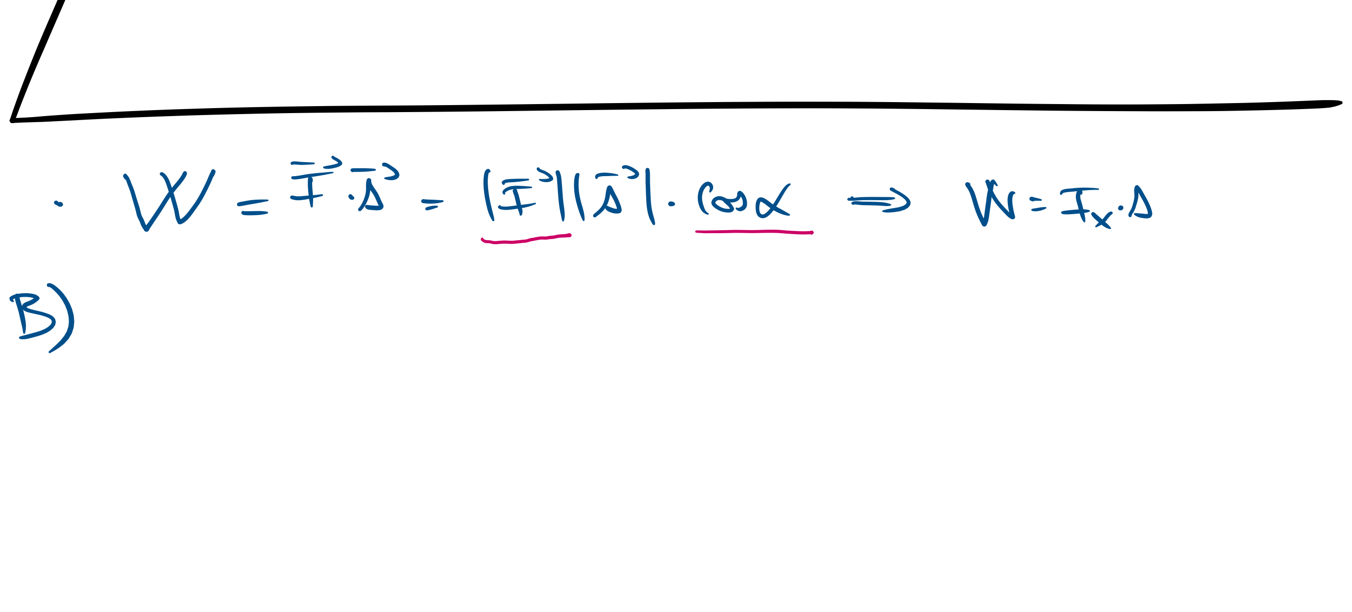
4. The mechanical work

A)



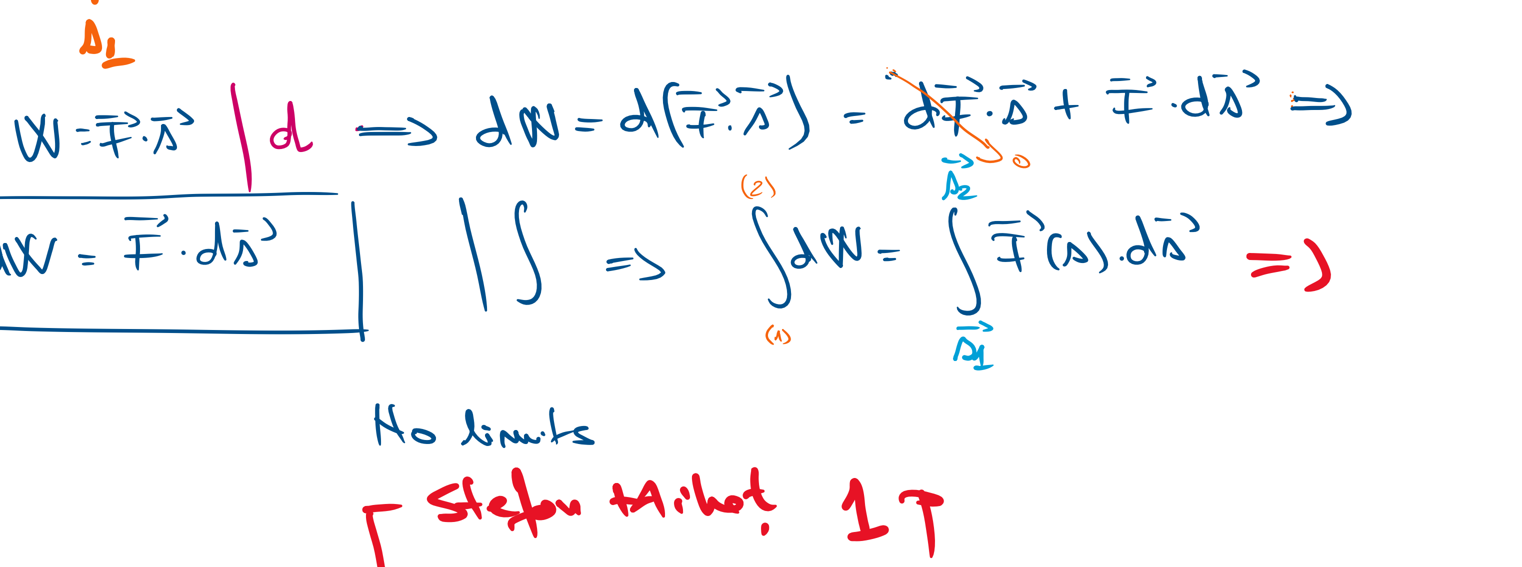


$W = \vec{F} \cdot \vec{s} \qquad [W]_{IS} = J$



- $W = \vec{F} \cdot \vec{s} = |\vec{F}||\vec{s}| \cdot \cos\alpha \Rightarrow W = F_x \cdot s$

B)



$W = \vec{F} \cdot \vec{s} \;\Big|\; d \Rightarrow dW = d(\vec{F} \cdot \vec{s}) = \cancel{d\vec{F}} \cdot \vec{s} + \vec{F} \cdot d\vec{s} \Rightarrow$

$\boxed{dW = \vec{F} \cdot d\vec{s}} \; \Big| \int \Rightarrow \int_{(1)}^{(2)} dW = \int_{\vec{s}_1}^{\vec{s}_2} \vec{F}(s) \cdot d\vec{s} \Rightarrow$

No limits

[Stefan Mihai 1T

$\boxed{W_{(1)\to(2)} = \int_{\vec{s}_1}^{\vec{s}_2} \vec{F}(s)\, d\vec{s}}$

5. The Power

A) $\boxed{P \overset{def}{:=} \frac{dW}{dt}} \Rightarrow dW = P(t) \cdot dt \; \Big| \int \Rightarrow \int dW = \int_{t_1}^{t_2} P(t)\,dt \Rightarrow$

$\boxed{W = \int_{t_1}^{t_2} P(t)\,dt}$

B)

$P = \frac{dW}{dt}$ | $\Rightarrow P = \frac{d(\vec{F} \cdot \vec{s})}{dt} \overset{\vec{F}\,const}{=} \vec{F} \frac{d\vec{s}}{dt} \Rightarrow \boxed{P = \vec{F} \cdot \vec{v}}$

$W = \vec{F} \cdot \vec{s}$

6. The energy