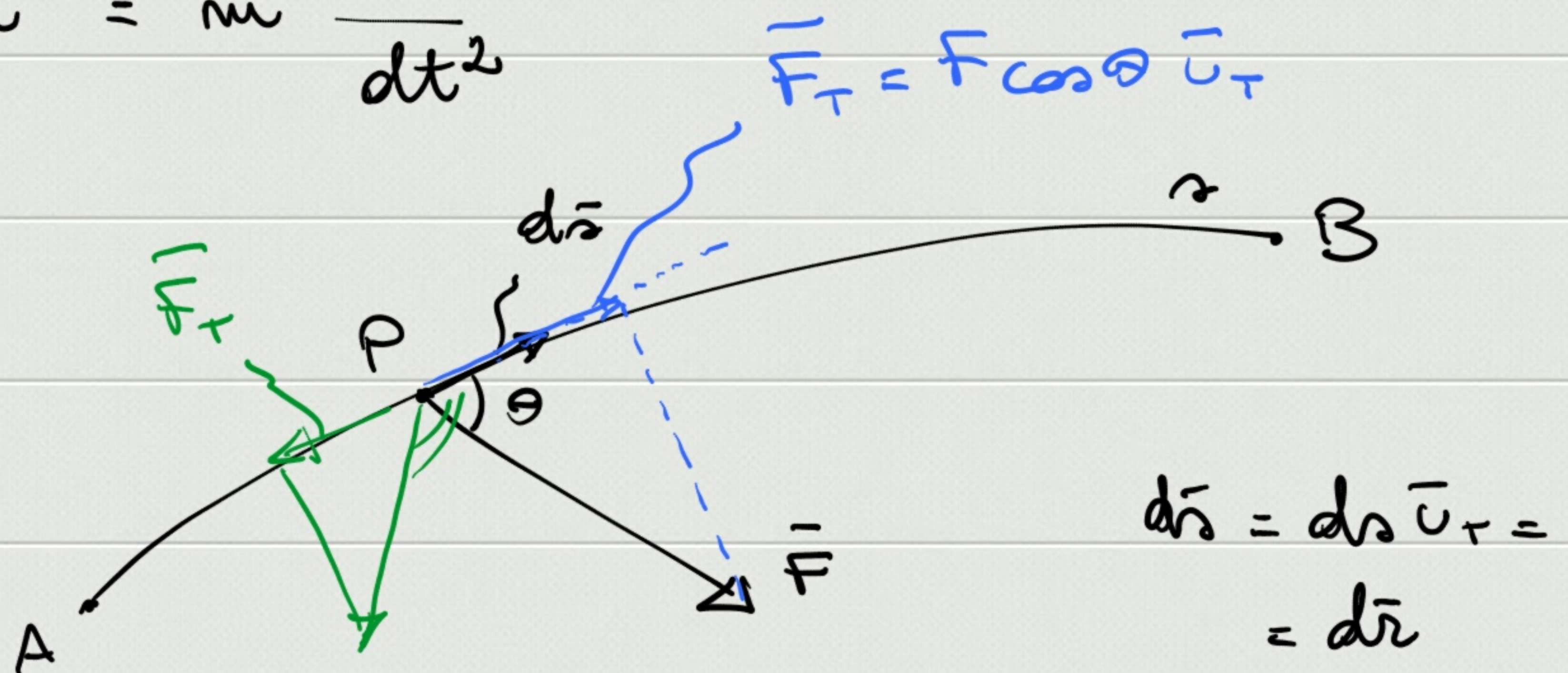


$$\vec{F} = m \vec{a} = m \frac{d^2 \vec{r}}{dt^2}$$



Lavoro (infinitesimo)

$$\boxed{dW = \vec{F} \cdot d\vec{s}}$$

$$dW = \vec{F} d\vec{s} = F ds \cos \theta = F_T ds$$

↑

↖ $m \frac{dv}{dt}$

$$0 \leq \theta < \frac{\pi}{2} \Rightarrow \cos \theta > 0 \Rightarrow dW > 0 \quad \text{lavoro motore}$$

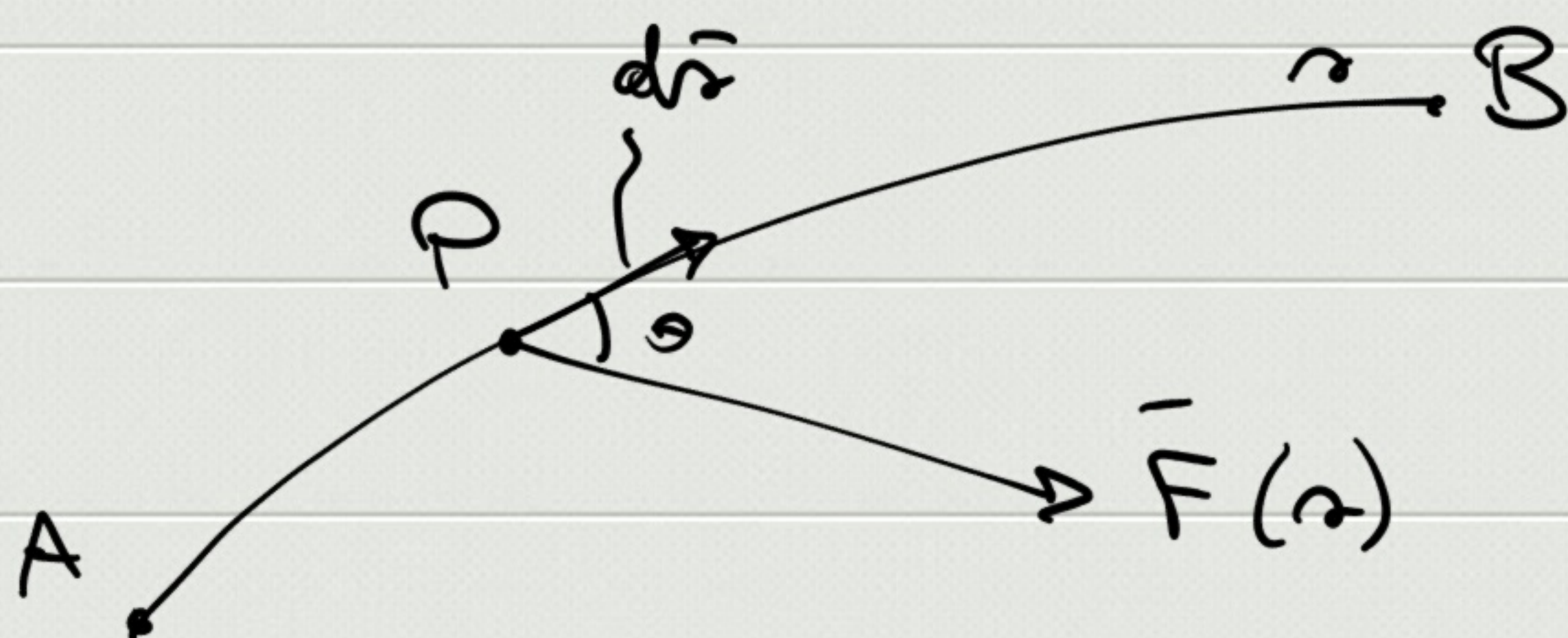
↑

$$\frac{\pi}{2} < \theta \leq \pi \Rightarrow \cos \theta < 0 \Rightarrow dW < 0 \quad \text{lavoro resistente}$$

↓

$$\theta = \frac{\pi}{2} (\vec{F} \perp d\vec{s}) \Rightarrow \vec{F} = \vec{F}_N \quad (F_T = 0)$$

$$\cos \theta = 0 \Rightarrow dW = 0 \quad (\text{lavoro nullo})$$



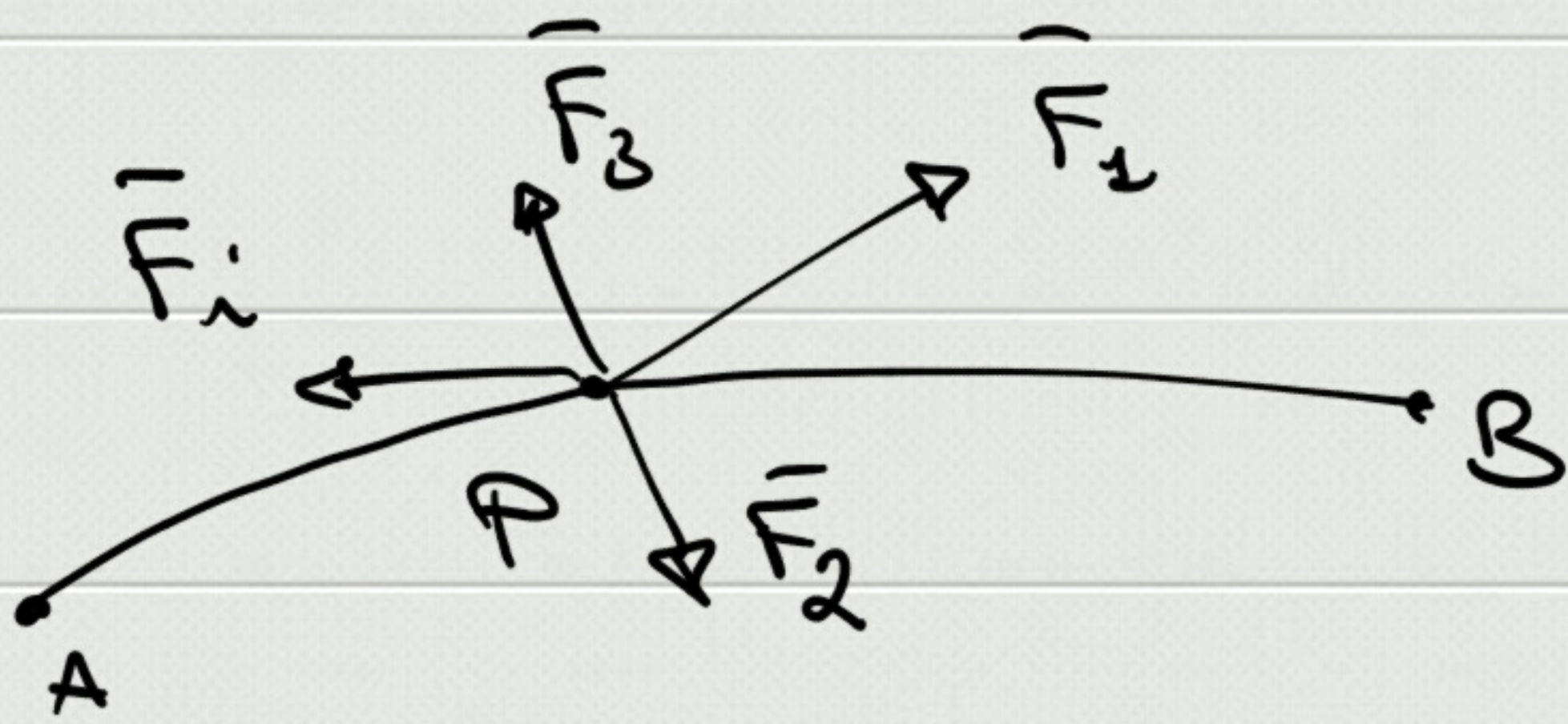
$$W_{A \rightarrow B} = \int_A^B dW = \int_A^B \vec{F} d\vec{s} = \int_A^B F_T ds$$

$$d\vec{s} = dx \vec{u}_x + dy \vec{u}_y + dz \vec{u}_z$$

$$\vec{F} = F_x \vec{u}_x + F_y \vec{u}_y + F_z \vec{u}_z$$

$$\begin{aligned} \Rightarrow W_{A \rightarrow B} &= \int_A^B \vec{F} d\vec{s} = \int_A^B (F_x dx + F_y dy + F_z dz) = \\ &= \int_{x_A}^{x_B} F_x dx + \int_{y_A}^{y_B} F_y dy + \int_{z_A}^{z_B} F_z dz \end{aligned}$$

$$W_{A \rightarrow B} = \int_A^B dW = \cancel{W_B - W_A}$$

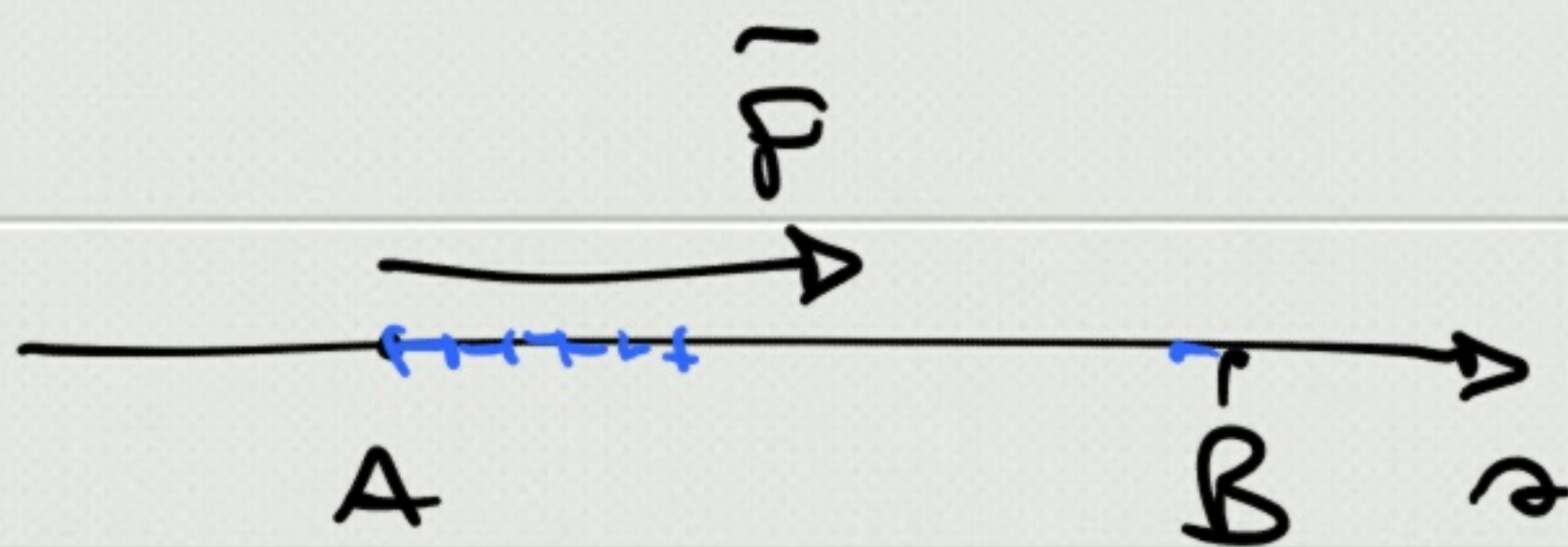


$$\vec{R} = \sum_i \vec{F}_i$$

$$W_{A \rightarrow B} = \int_A^B dW = \int_A^B \vec{R} \cdot d\vec{s} = \int_A^B \sum_i \vec{F}_i \cdot d\vec{s} =$$

$$= \sum_i \underbrace{\int_A^B \vec{F}_i \cdot d\vec{s}}_{(W_{A \rightarrow B})_i} = \sum_i (W_{A \rightarrow B})_i$$

$$\boxed{\vec{F} = \text{const} \parallel d\vec{s}}$$



$$W_{A \rightarrow B} = \int_A^B \vec{F} \cdot d\vec{s} = \int_A^B F ds = F \int_A^B ds = F |\vec{AB}|$$

Potenza : lavoro per unità di tempo

$$dW = \vec{F} d\vec{s}$$

$$\boxed{P = \frac{dW}{dt}}$$

$$\begin{aligned} P &= \frac{dW}{dt} = \vec{F} \frac{d\vec{s}}{dt} = \vec{F} \cdot \frac{d\vec{r}}{dt} = \\ &= \underline{\underline{\vec{F} \cdot \vec{v}}} \end{aligned}$$

$$\langle P \rangle_{\Delta t} = \frac{W_{\Delta t}}{\Delta t}$$

$$[W] = [F \cdot s] = Nm = kg m^2 s^{-2} = J$$

(Joule)

$$[P] = \left[\frac{W}{t} \right] = \frac{J}{s} = kg m^2 s^{-3} = W \text{ (Watt)}$$