ve consider line integrals

$$\int_C \mathbf{F}(\mathbf{r}) \cdot d\mathbf{r} = \int_C (F_1\,dx + F_2\,dy + F_3\,dz) \qquad (d\mathbf{r} = [dx, \quad dy, \quad dz])$$

$$\int_A^B (F_1\,dx + F_2\,dy + F_3\,dz) = f(B) - f(A) \qquad [\mathbf{F} = \operatorname{grad} f]$$

$$\mathbf{F} \cdot d\mathbf{r} = F_1\,dx + F_2\,dy + F_3\,dz$$

*in components* (see Sec. 9.9)

$$(6') \qquad \frac{\partial F_3}{\partial y} = \frac{\partial F_2}{\partial z}, \qquad \frac{\partial F_1}{\partial z} = \frac{\partial F_3}{\partial x}, \qquad \frac{\partial F_2}{\partial x} = \frac{\partial F_1}{\partial y}.$$

$$\iint_S \mathbf{F} \cdot \mathbf{n}\,dA = \iint_S (F_1 \cos\alpha + F_2 \cos\beta + F_3 \cos\gamma)\,dA$$
$$= \iint_R (F_1 N_1 + F_2 N_2 + F_3 N_3)\,du\,dv.$$

$$\iint_S \mathbf{F} \cdot \mathbf{n}\,dA = \iint_S (F_1\,dy\,dz + F_2\,dz\,dx + F_3\,dx\,dy).$$

$\cos\alpha\,dA = dy\,dz$, $\cos\beta\,dA = dz\,dx$, $\cos\gamma\,dA = dx\,dy$.

$$\iint_S G(\mathbf{r})\,dA = \iint_R G(\mathbf{r}(u, v))\,|\mathbf{N}(u, v)|\,du\,dv.$$

$dA = |\mathbf{N}|\,du\,dv = |\mathbf{r}_u \times \mathbf{r}_v|\,du\,dv$

$$A(S) = \iint_S dA = \iint_R |\mathbf{r}_u \times \mathbf{r}_v|\,du\,dv.$$

$$\iint_S G(\mathbf{r})\,dA = \iint_{R^*} G(x, y, f(x, y)) \sqrt{1 + \left(\frac{\partial f}{\partial x}\right)^2 + \left(\frac{\partial f}{\partial y}\right)^2}\,dx\,dy.$$

$$\Delta m = \rho \Delta V = \rho v a \Delta t. \qquad \frac{\Delta m}{\Delta t} = \rho v a.$$

flux

$W = \vec{\nabla} \times \vec{f} \quad \vec{ds}$ $\longrightarrow$ Stocks

$\Phi = \int \vec{f} \cdot \vec{ds}$

$\Phi = \oint f \vec{n} \, ds$

$= \int \nabla \vec{f} \, dv \longrightarrow \iiint_{g} \nabla \vec{f} \, dv$

$\Phi$ = flux

$\oint$ = quand forme fermer