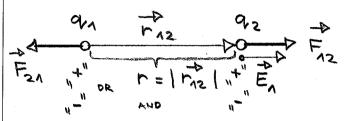
Electric field

The physical quantity describing the properties of the body is **electric charge** q or Q and its unit in the system SI is: **coulomb** (1 C)

The basic law of interaction is the **Coulomb**'s **law** about the point charges: $F_{12} = k \frac{q_1 \ q_2}{r^2}$, where F_{12} is the force exerted by one point charge (1) onto another (2), q_1 and q_2 – values of charges, r – distance between the point charges.



The physical quantity describing the field is the electric field strength $E = \frac{F}{q}$, SI unit newton per coulomb 1 N/C = 1 V/m - volt per meter

Point charge q_1 is generating the electric field E_1 in the location of another point charge q_2 :

$$E_1 = \frac{F_{12}}{q_2} = k \frac{q_1}{r^2} \frac{q_2}{q_2} = k \frac{q_1}{r^2} .$$

The coefficient k in the system SI: $k = 9 \cdot 10^9 \frac{\text{N} \cdot \text{m}^2}{\text{C}^2}$,

 $k = \frac{1}{4\pi \,\varepsilon_0}$ is used in the case of electric field with

spherical symmetry properties.

The permittivity constant (permittivity of free space):

$$\varepsilon_0 = \frac{1}{4\pi \cdot 9 \cdot 10^9} \frac{\text{C}^2}{\text{N} \cdot \text{m}^2} \approx 8,85 \cdot 10^{-12} \frac{\text{C}^2}{\text{N} \cdot \text{m}^2} \text{ or } \frac{\text{F}}{\text{m}}$$

is used in the case of the **uniform** electric field (the field lines are parallel and positioned with constant density)

The physical quantity describing the impact of the substance on the field is **relative permittivity**:

$$\varepsilon_r = \frac{E_0}{E} = \frac{E_{\text{vacuum}}}{E_{\text{substance}}}$$
. The product $\varepsilon = \varepsilon_0 \ \varepsilon_r$ is then called

the absolute permittivity of the substance.

The quantity ε_r shows how many times **weaker** is the electric field in the substance than in the vacuum.

If the body generates in the substance the electric field E, then the same body would generate in vacuum at the same distance the electric field $E_0 = \varepsilon_r E$. The electric field in vacuum E_0 is described by the **electric induction**

$$D=\varepsilon_0\varepsilon_r\,E=\varepsilon\,E$$

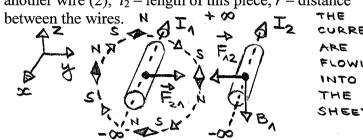
Magnetic field

The physical quantity describing the properties of the body is current-length element I l

Current-length element = $current \times length$ of the wire unit in the system SI is: **ampere times meter** (1 A 'm)

The basic law of interaction is the **Ampere**'s law about the current-carrying wires: $F_{12} = K \frac{I_1 I_2 I_2}{r}$, where I_1 and

 I_2 are currents in the two parallel infinitely long wires, F_{12} – force exerted by one wire (1) onto the piece of another wire (2), I_2 – length of this piece, r – distance



The physical quantity describing the field is the **magnetic** induction or magnetic flux density $B = \frac{F}{I \ l}$, SI unit tesla 1 T = 1 N/(A m) - newton per ampere and meter

Straight wire carrying current I_1 is generating the magnetic inducton B_1 in the location of the current element $I_2 l_2$: $B_1 = \frac{F_{12}}{I_2 l} = K \frac{I_1 \cdot I_2}{r I_2 l_2} l_2 = K \frac{I_1}{r}$

The coefficient K in the system SI: $K = 2 \cdot 10^{-7} \text{ N/A}^2$, $K = \frac{\mu_0}{2\pi}$ is used in the case of magnetic field with **cylindrical** symmetry properties.

The permeability constant (permeability of free space):

$$\mu_0 = 4\pi \cdot 10^{-7} \frac{\text{H}}{\text{m}} = 4\pi \cdot 10^{-7} \frac{\text{N}}{\text{A}^2} \approx 1,26 \frac{\mu \text{N}}{\text{A}^2}$$

is used in the case of the **uniform** magnetic field (the field lines are parallel and positioned with constant density)

The physical quantity describing the impact of the substance on the field is **relative permeability**:

$$\mu_r = \frac{B}{B_0} = \frac{B_{
m substance}}{B_{
m vacuum}}$$
. The product $\mu = \mu_0 \ \mu_r$ is then

called the **absolute permeability** of the substance. The quantity μ_r shows how many times **stronger** is the magnetic field in the substance than in the vacuum.

If the wire generates in the substance the magnetic induction B, then the same wire would generate in vacuum at the same distance the magnetic induction $B_0 = B/\mu_r$. The magnetic field in vacuum B_0 is described by the **magnetic field strength**

$$H = \frac{B}{\mu_0 \mu_r} = \frac{B}{\mu}$$

Point charge q is generating at the distance r from this charge the electric induction: $D = ε_0 ε_r E_{-0} ε_r E0 ε_r E_{-0} ε_r E_{-0} ε_r E_{-0} ε_r E_{-0} ε_r E_{-0} ε_r E0 ε_r E_{-0} ε_r E_{-0} ε_r E_{-0} ε_r E_{-0} ε_r E_{-0} ε_r E0 ε_r E_{-0} ε_r E_{-0} ε_r E_{-0} ε_r E_{-0} ε_r E_{-0} ε_r E0 ε_r E_{-0} ε_r E_{-0} ε_r E_{-0} ε_r E_{-0} ε_r E_{-0} ε_r E_$		
$D = \varepsilon_0 \varepsilon_r \ E = \varepsilon_0 \varepsilon_r \ \frac{E_0}{\varepsilon_r} = \varepsilon_0 \varepsilon_r \frac{1}{4\pi \varepsilon_0 \varepsilon_r} \frac{q}{r^2} = \frac{q}{4\pi r^2}$ $To find the electric induction generated by some charge, we should divide the charge by the area of the surface on which the electric field arises: Electric induction = \frac{\text{charge}}{\text{area}} \to \text{SI unit of } D: \ 1 \frac{C}{\text{m}^2} The flux of the field is the physical quantity describing the field (E, D, B \text{ or } H) is the surface density of the flux. The flux itself is the scalar quantity by definition. The flux of D = \text{electric induction } D \times \text{area } A \Phi_D = DA \cos \beta = D_n A = \mathbf{D} \cdot \mathbf{A} \text{ (scalar product)} Gauss law in the case of the electrostatic field: the flux of electric induction through the closed surface is equal to the algebraic sum of charges enclosed by this surface. The electrostatic field lines start from the positive charges and end at the negative ones. Faraday-Maxwell law: the electromotive force along the closed line (the sum of all voltages along the in the case of electromagnetic induction is equal to the negative speed of change of the magnetic flux penetrating the surface enclosed by this line. Gauss law: All the charges located inside the closed surface in the surface enclosed by this line. Gauss law: \oint D_n dA = \sum_i q_i = \oint_{P} dV H = \frac{1}{\mu_0 \mu_r} \mu_r B_0 = \frac{1}{2\pi r} (and the magnetic field strength generated by some current-carrying wire we should divide the current by the eutrrent earlying wire we should divide the current by the eutrrent-carrying wire we should divide the current by the electrorsity of the file on which the magnetic field arises: Magnetic field strength e magnetic field arises: Magnetic field strength e magnetic field arises: Magnetic field strength e current by the electrorsity of the field lines are closed line in the case of the magnetic field: the flux of magnetic field into through the closed surface is equal to zero. The magnetic field strength elength of t$	Point charge q is generating at the distance r from	Long straight wire carrying current I is generating at the
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electric field and to store the charge is described by field and store the current is described by inductance		
	<u> </u>	· ·
$L = -\frac{\sigma_{self}}{4I} \; ; \; L = \frac{\Delta \Psi}{4I} \; .$	-	$L = -\frac{\sigma_{self}}{4I}$; $L = \frac{\Delta \Phi}{4I}$.
capacitance $L = -\frac{\mathcal{E}_{self}}{\frac{\Delta I}{\Delta t}}$; $L = \frac{\Delta \Phi}{\Delta I}$.	$C = \frac{1}{U}$.	
1C	THE STATE OF THE S	
The SI unit of capacitance is farad $1 = \frac{1 \text{ C}}{1 \text{ V}}$. The SI unit of inductance is henry $1 = \frac{1 \text{ Wb}}{1 \text{ A}}$.	The SI unit of capacitance is farad $1 F = \frac{1}{1} V$.	The SI unit of inductance is henry $1 H = \frac{1 \text{ W O}}{1 \text{ A}}$.
The capacitor is the system of bodies developed for The inductor is the system of wires developed for	The canacitor is the system of hodies developed for	The inductor is the system of wires developed for
obtaining a certain capacitance. The inductor is the system of whes developed for obtaining a certain inductance.		
The strength of the uniform electric field E in the B in the long		· · · · · · · · · · · · · · · · · · ·
capacitor: $E = \frac{q}{\varepsilon A}$ solenoid as an inductor: $B = \mu \frac{N}{l}I$ The capacitance of the plate capacitor: $C = \frac{\varepsilon A}{d}$, The inductance of the long solenoid: $L = \mu \frac{N^2}{l}A$,	capacitor: $E = \frac{1}{\varepsilon A}$	solenoid as an inductor: $B = \mu - \frac{1}{l}$
The conscitonce of the plate conscitor: $C = \mathcal{E}A$	The connections of the plate connection: $C = \mathcal{E}A$	N^2
The inductance of the long solenoid: $L = \mu - \frac{1}{l}A$,	The capacitance of the plate capacitor: $C = \frac{d}{d}$,	I he inductance of the long solenoid: $L = \mu - \frac{1}{l} A$,
where $\varepsilon = \varepsilon_0 \ \varepsilon_r$ is the absolute permittivity of the where $\mu = \mu_0 \ \mu_r$ is the absolute permeability of the		where $\mu = \mu_0 \mu_r$ is the absolute permeability of the
substance between plates, A – area of the one plate substance inside the solenoid, N – number of windings of		
and d – distance between plates. the solenoid, A – area of the one winding and l – length	and d – distance between plates.	
of the solenoid.		
The energy of the electric field in the capacitor The energy of the magnetic field in the inductor	2	
$E_e = \frac{CU^2}{2}$ $E_m = \frac{LI^2}{2}$	$E_{\perp} = \frac{C U^2}{2}$	$E = \frac{L I^2}{I}$
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