تقدم لجنة ElCoM الاكاديمية

تلخيص قوانين لمادة:

فيزياء عامة (2)

جزيل الشكر للطالب:

فيصل العبادي

$$Q = N e$$

Q : charge

N : number of electrons

$e : 1.6 * 10^{-19}$ c

$$\vec{F} = q_\circ \vec{E}$$

Electric Force - القوة الكهربائية : $\vec{F}$

الشحنة المتأثرة : $q_\circ$

Electric Field - المجال الكهربائي : $\vec{E}$

$$\vec{F} = K_e \frac{|q_1||q_2|}{r^2}$$

القوة بين شحنتين نقطيتين : $\vec{F}$

مربع المسافة بين الشحنتين : r^2

$\frac{1}{4\pi\epsilon_\circ} = 9*10^9$: Ke

$8.85*10^{-12}$: $\epsilon_\circ$

$$\vec{E} = K_e \frac{|q|}{r^2}$$

المجال الكهربائي الناشئ عن شحنة نقطية : $\vec{E}$

مربع المسافة بين الشحنة والنقطة المطلوب حساب المجال عندها : r^2

$$a = \frac{q_\circ E_\circ}{m}$$

تسارع جسيم مشحون في مجال كهربائي منتظم : a

وزن الجسيم : m

$\rho = \frac{q}{V}$ "c/m³"

كثافة الشحنة الحجمية : ρ

الحجم : V

$\sigma = \frac{q}{A}$ "c/m²"

كثافة الشحنة السطحية : σ

المساحة : A

$\lambda = \frac{q}{l}$ "c/m"

كثافة الشحنة الطولية : λ

الطول : l

$\frac{4}{3}\pi r^3$ = حجم الكرة "sphere"

$\pi r^2 l$ = حجم الاسطوانة "cylinder"

$4\pi r^2$ = مساحة الكرة

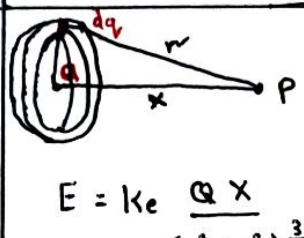
$2\pi r l$ = المساحة الجانبية للاسطوانة

πr^2 = مساحة الدائرة

$2\pi r$ = محيط الدائرة

$$E = \frac{K_e \lambda l}{a(a+l)}$$

مجال ناشئ عن Wire , Rod



$$E = K_e \frac{Q x}{(x^2+a^2)^{\frac{3}{2}}}$$

$$Q = \lambda(2\pi a)$$

مجال ناشئ عن Ring

$$E = \frac{2 K_e \lambda}{R}$$

مجال ناشئ عن semi-circle

$l = R\alpha$ (α : Radian)

$q = \lambda l = \lambda R \alpha$

$$E = \frac{2K_e \lambda \sin(\alpha/2)}{R}$$

$$\Phi = E A \cos\theta$$

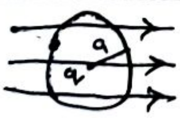
التدفق الكهربائي - flux : Φ

المساحة : A

الزاوية بين العمودي على المساحة والمجال : θ

$$\Phi = \frac{q_{in}}{\epsilon_\circ}$$

الشحنات داخل سطح غاوس : q



charged with external $\vec{E}$

$$\Phi = \Phi_q + \Phi_E = \frac{q}{\epsilon_\circ} + zero$$

$$\Phi_{hemi} = \Phi_q + \Phi_E = \frac{q}{2\epsilon_\circ} + \frac{E\, 4\pi a^2}{2}$$

Conducting Sphere (shell)/(solid)

$r < a$

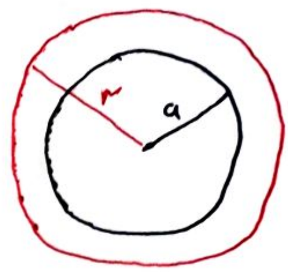
$E_{in} = 0$

$\phi = 0$

$r > a$

$$E_{out} = \frac{K_e Q}{r^2} = \frac{\sigma a^2}{\epsilon_\circ r^2}$$

$$Q = \sigma(4\pi a^2)$$



$r = a$

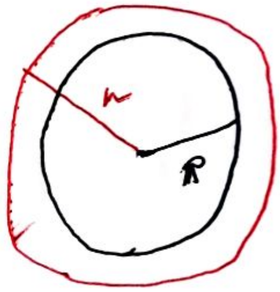
$$E = \frac{\sigma}{\epsilon_\circ}$$

Insulating sphere

$r > R$

$$E_{out} = \frac{K_e Q}{r^2}$$

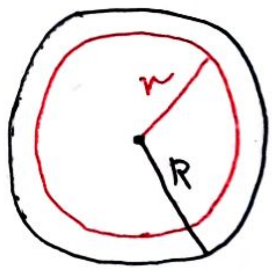
$$Q = \rho(\frac{4}{3}\pi R^2)$$



$r \leq R$

$$E = \frac{K_e Q r}{R^3}$$

$$E = \frac{r\rho}{3\epsilon_\circ}$$



Infinit -Large- sheet "plane"

Insulator ⇝ $E = \frac{\sigma}{2\epsilon_\circ}$

Conducting ⇝ $E = \frac{\sigma}{\epsilon_\circ}$

Infinit conducting cylinder

$r < b$

$E_{in} = 0$

$r > b$ Also for infinit wire

$$E_{out} = 2K_e \frac{\lambda}{r}$$

$r = b$

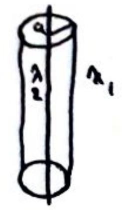
$$E = \frac{\sigma}{\epsilon_\circ}$$

Infinit insulating cylinder

$r > a$ $E_{out} = \frac{\rho a^2}{2\epsilon_\circ r}$

$r < a$ $E_{in} = \frac{\rho r}{2\epsilon_\circ}$

wire inside cylinder



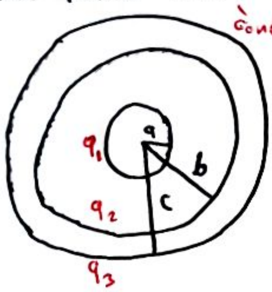
$$E_{in} = \frac{2 K_e \lambda_2}{r}$$

$$E_{out} = \frac{2 K_e (\lambda_1 + \lambda_2)}{r}$$

sphere inside thick shell

Isulator

conduct



$q_1 = - q_2$

$q_{shell} = q_2 + q_3$

$a < r < b$

$$E = K_e \frac{Q_1}{r^2}$$

$r = b$

$E = zero$

$b < r < c$

$E = zero$

$r = c$

$$E = K_e \frac{Q}{c^2}$$

$r > c$

$$E = K_e \frac{Q}{r^2}$$

$W = F_e \cdot d$

$= q \cdot E \cdot d$

work done on charged particle in uniform $\vec{E}$

$\Delta U = - W$

$= - q \int \vec{E} \cdot \vec{ds}$

ΔU: change in electric potential energy

$$\Delta V_{A \to B} = \frac{\Delta U}{q_0}$$

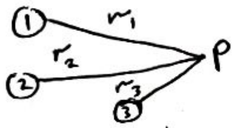
$$= - \int_A^B \vec{E} \cdot \vec{ds}$$

$= - E \cdot d \cos \theta$

ΔV: change in electric potential

$$V = \frac{K_e q}{r}$$

V: electric potential of a point charge



$V_p = V_1 + V_2 + V_3 = \sum V$

$U = \sum U$ * الإشارة تعوض هنا

$W = - q \cdot \Delta V$

$V_\infty = Zero$

Equi-Potential surface

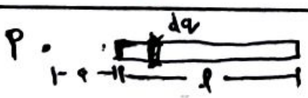
الجهد متساوي عند جميع نقاطه

Conductors

تمثل سطح متساوي الجهد

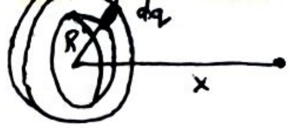
وجهد اي نقطة داخله مساوي

للجهد عند السطح



$$V_p = K_e \lambda \ln \left| \frac{l + a}{a} \right|$$

Electric potential of rod/wire



$$V_p = K_e \frac{Q}{\sqrt{R^2 + x^2}}$$

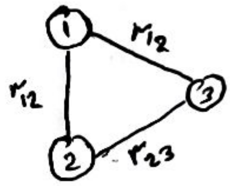
Electric potential of ring

$$V_p = \frac{K_e Q}{r}$$

$L = R \alpha$

$$\lambda = \frac{Q}{R \alpha}$$

$$= K_e \lambda \alpha = \frac{K_e Q \alpha}{L}$$



$$U = \frac{K_e q_A q_B}{r_{AB}}$$

$$U = K_e \left(\frac{q_1 q_2}{r_{12}} + \frac{q_1 q_3}{r_{23}} + \frac{q_2 q_3}{r_{23}} \right)$$

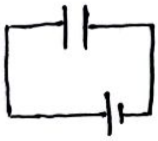
$$E_r = - \frac{dV}{dr}$$

المجال يساوي سالب مشتقة الجهد

$$C = \frac{Q}{\Delta V}$$

C : Capacitance [F]
Q : charge
ΔV : Potential

Parallel Plate Capacitor



$$C = \frac{\epsilon_0 A}{d} \quad E_{in} = \frac{\sigma}{\epsilon_0}$$

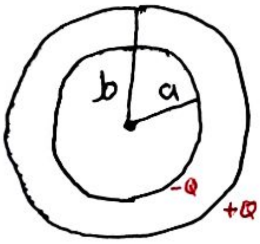
σ : surface charge density
E : electric field

ϵ_0 : السماحية للفراغ
A : مساحة الصفيحة
d : البعد بين الصفيحتين

Cylinderical Capacitor

$$C = \frac{L}{2 K_e \ln\left(\frac{b}{a}\right)}$$

Spherical Capacitor



$$C = \frac{4\pi\epsilon_0 ab}{b-a}$$

if $b \rightsquigarrow \infty$ (Isolated sphere)

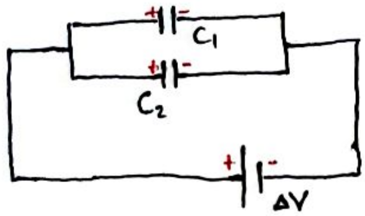
$$C = 4\pi\epsilon_0 a$$

sphere :
$V = \frac{4}{3}\pi r^3$
$a = 4\pi r^2$

$$V = Ed$$

V : voltage
E : electric field
d : distance

Parallel Combination

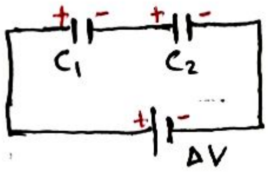


$$Q_1 \neq Q_2$$

$$\Delta V = \Delta V_1 = \Delta V_2$$

$$C_{eq} = C_1 + C_2$$

Series Combination



$$Q_1 = Q_2 = Q_{eq}$$

$$\Delta V = \Delta V_1 + \Delta V_2$$

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$$

The energy stored in a capacitor

$$U = \frac{1}{2} q \Delta V = \frac{1}{2} C \Delta V^2 = \frac{Q^2}{2C}$$

capacitor with dielectric netreal

$$Q = Q_0$$

$$C = C_0 K$$

$$\Delta V = \frac{\Delta V_0}{K}$$

$$U = \frac{U_0}{K}$$

K : dielectric constant

the work done (change in energy)

$$W = U_f - U_i = U_0\left(\frac{1}{K} - 1\right)$$

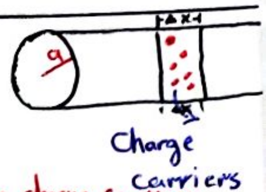
Average current

$$I_{avg} = \frac{\Delta Q}{\Delta t}$$

Instantinous Current

$$I(t) = \frac{\partial Q(t)}{\partial t}$$

$$n = \frac{\text{Number of charge carriers}}{\text{Volume}}$$



n : number density of the charge carriers
N : number of charge carriers

$$N = n A \Delta x$$

A : area $= \pi a^2$
Δx : sectional length

$$I = n A q V_d$$

V_d : drift velocity

The current density

$$\vec{J} = \frac{I}{\text{Area}}$$

$$\vec{J} = \sigma \vec{E} = \frac{\vec{E}}{\rho}$$

σ : conductivity ρ : resistivity

$$V = IR = I\left(\frac{\rho L}{A}\right)$$

R : Resistance

The power deliverd in the resistance
The heat dissipated in the resistance

$$P = IV = I^2 R$$

Temperature - Resistance dependent

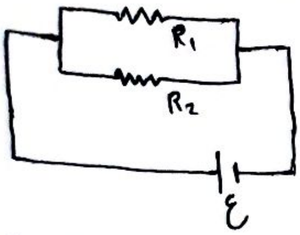
$$R(T) = R_0(1 + \alpha(T - T_0))$$

$$\rho(T) = \rho_0(1 + \alpha(T - T_0))$$

$T_0 = 20\,c°$

R : ~~Resistivity~~ Resistance ρ : Resistivity

Parallel Combination

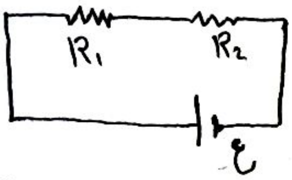


$\mathcal{E}$: EMF : electro motive force

$\mathcal{E} = \Delta V_1 = \Delta V_2$

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$

Series Combination

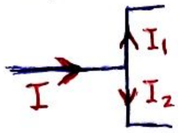


$\mathcal{E} = \Delta V_1 + \Delta V_2$

$R_{eq} = R_1 + R_2$

Kirchoff's Rules

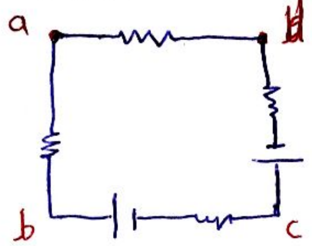
First Rule : conservation of charge



$\sum I_{in} = \sum I_{out}$

$I = I_1 + I_2$

Second Rule : conservation of energy



$\sum \Delta V$ through closed loop $= 0$

$\sum \Delta V_{abcda} = 0$

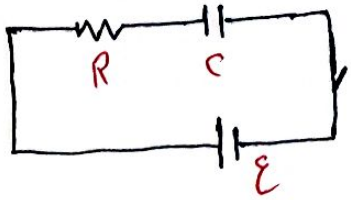
Kirchoff Convenation

نفرض إتجاه للتيار إذا لم يكن معطى
وتعمل إتجاه للحلقة
يفضل الاتجاه لليمين والحلقة

إذا المقاومة نفس الاتجاه
يكون جهدها سالب
وإذا عكس يكون موجب
عند البطاريات لا ننظر للتيار ولكن لاتجاه
الحلقة إذا نفس الاتجاه ← موجب
عكس الاتجاه ← سالب

*تذكر وضع سهم للبطارية من السالب للموجب

Charging RC-Circuit



Initially uncharged capacitor

$\tau = RC$

τ : time constant

$Q_{max} = \mathcal{E} C$

$q(t) = Q_{max}(1 - e^{-\frac{t}{\tau}})$

$I_{max} = \frac{\mathcal{E}}{R}$

$I(t) = \frac{dq}{dt} = I_{max}\, e^{-\frac{t}{\tau}}$

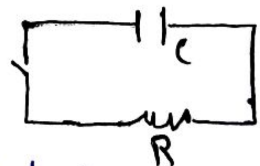
$V_c(t) = \mathcal{E}(1 - e^{-\frac{t}{\tau}})$

$V_R(t) = \mathcal{E}\, e^{-\frac{t}{\tau}}$

$U(t) = \frac{1}{2}\mathcal{E}^2 C(1 - e^{-\frac{t}{\tau}})^2 = U_{max}(1 - e^{-\frac{t}{\tau}})^2$

$P(t) = \frac{\mathcal{E}^2}{R} e^{-\frac{2t}{\tau}} = P_{max}\, e^{-\frac{2t}{\tau}}$

Discharging RC-Circuit



Initially charged capacitor

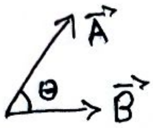
$q(t) = Q_0\, e^{-\frac{t}{\tau}}$

$I_{max} = \frac{Q}{\tau}$

$I(t) = \frac{dq}{dt} = -\frac{Q_0}{RC} e^{-\frac{t}{\tau}} = -I_{max}\, e^{-\frac{t}{\tau}}$

$U(t) = \frac{Q_0^2}{2C} e^{-\frac{2t}{\tau}} = U_{max}\, e^{-\frac{2t}{\tau}}$

Cross Product



$\vec{B} \times \vec{A} = \vec{C}$

$\vec{A} \times \vec{B} = -\vec{C}$

$\vec{B} \times \vec{A} \neq \vec{A} \times \vec{B}$

لتحديد اتجاه المتجه الناتج
استخدم قاعدة اليد اليمنى

ج <-  -> الحد الاول

تحرك من الحد الاول للحد الثاني
فيكون الابهام باتجاه المحصلة

مثال: $\hat{i} \times \hat{j} = \hat{k}$, $\hat{j} \times \hat{i} = -\hat{k}$

$\hat{k} \times \hat{i} = \hat{j}$, $\hat{i} \times \hat{k} = \hat{j}$

اما إذا اعطى المتجهات بدلالة
مركباتها فنقوم بعمل ماتريكس

$\vec{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$

$\vec{B} = B_x\hat{i} + B_y\hat{j} + B_z\hat{k}$

$$\vec{C} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$$

$$\vec{C} = (A_yB_z - B_yA_z)\,\hat{i}$$
$$-$$
$$(A_xB_z - B_xA_z)\,\hat{j}$$
$$+$$
$$(A_xB_y - B_xA_y)\,\hat{k}$$

إذا اعطى الزاوية وطلب
الـ magnitude للفيكتور الناتج

$$|\vec{C}| = |\vec{A}|\,|\vec{B}|\,\sin\theta_{B,A}$$

إذا بدون زاوية

$$|\vec{C}| = \sqrt{(\hat{i})^2 + (\hat{j})^2 + (\hat{k})^2}$$

$\vec{F} = q\,\vec{V} \times \vec{B}$

$|\vec{F}| = q\,|\vec{V}|\,|\vec{B}|\,\sin\theta_{V,B}$

F: Magnetic force القوة المغناطيسية (N)

V: Velocity – السرعة (m/s)

B: Magnetic field المجال المغناطيسي (T)

Right Hand Rule for + Charges

B: باطن اليد , V: رؤوس الاصابع , F: الابهام

⊙: outword – للخارج , ⊗: Inword – للداخل

إذا حكالي إلكترون او شحنة سالبة بطبق القاعدة
و لكن بالاخر بعكس الاتجاه

Magnetic force on a current-carrying Conductor

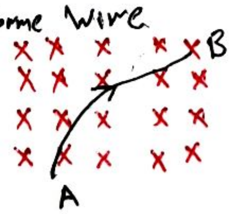
$\vec{F} = I\,\vec{L} \times \vec{B}$

$|\vec{F}| = I\,|\vec{L}|\,|\vec{B}|\,\sin\theta_{L,B}$

I: Current – التيار (A)

L: length – طول السلك (m)

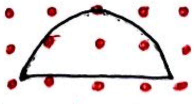
On Non-Uniforme Wire



$$\vec{F} = I\int_A^B \vec{B} \times d\vec{L}$$

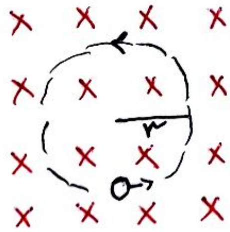
Force on semi-circle conductor

$\vec{F}_{Arc} = -\vec{F}_{wire}$



For closed loop, the net magnetic force is zero

$F_{semi\ circle} = 0$



$$V = \frac{2\pi r}{T}$$

$$T = \frac{2\pi m}{qB}$$

$$r = \frac{mV}{qB}$$

T: perodic time (sec)

m: mass (Kg)

r: radius of the circular path

q: charge (C)

V: velocity (m/s)

$$W = \frac{qB}{m}$$

$$T = \frac{2\pi}{W}$$

W: Angular Velocity "frequancy" (rad/s)

Ampere's Law

$$\oint B\,ds = \mu_0 I$$

s: Circumference - المحيط

$\mu_0 = 4\pi * 10^{-7}$

Magnetic field of semi-infinite wire

$$B = \frac{\mu I}{4\pi r}$$

Magnetic field of an infinite wire

[1] $r > R$

$$B = \frac{\mu_0 I}{2\pi r}$$

r: radius of the amperian loop

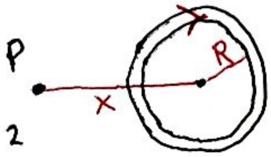
الاتجاه على قاعدة اليد اليمنى

$R > r$

[2] $$B = \frac{\mu_0 I r}{2\pi R^2}$$

R: radius of the wire

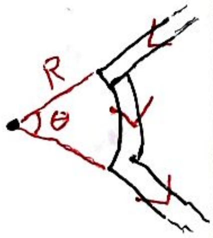
Magnetic field of a circular loop



$$B_p = \frac{\mu_0 I R^2}{2(x^2+R^2)^{\frac{3}{2}}}$$

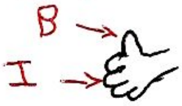
Magnetic field of an Arc (curved wire)

$$B = \frac{\mu I}{4\pi R}\theta$$



θ: in radian

كل من الحلقة والقوس على قاعدة اليد اليمنى



magnetic field of a finite wire

$$B_p = \frac{\mu_0 I}{4\pi r}(\cos\theta_1 - \cos\theta_2)$$

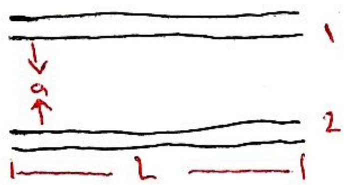
نرسم مستقيمين من النقطة لأطراف السلك ونأخذ الزوايا كما هي في الأعلى

r: distance between the wire and P

أو بنوخذهم للزوايا بعاكس الشكل وبنوخذ ال sin الهم

$$B_P = \frac{\mu_0 I}{4\pi r}(\sin\theta_1 - \sin\theta_2)$$

Magnetic force between two parallel conductors



$$F_{1\to 2} = \frac{\mu_0 I_1 I_2}{2\pi a} L_2$$