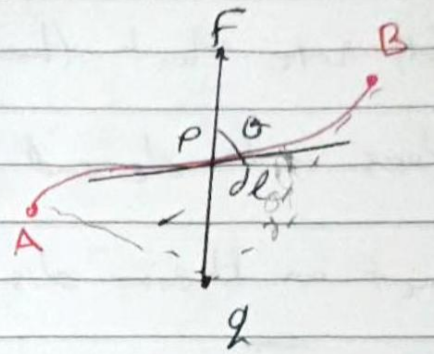
So important

Calculation of electric Potencial Using a linear Integration of electric field



Let the charge (+q) Creat an electric field ($\vec{E}$)

Now take (dl) element of the path A-B tangent with the path.

So $\int_A^B \bar{E} \cdot dl = \int_A^B \underbrace{E \cos\theta \, dl}_{dr}$

where the field strength at the point (P)

$$E = \frac{1}{4\pi\epsilon_0} \frac{q}{r^2}$$

$$\int_A^B E \cdot dl = \int_{r_A}^{r_B} \frac{q}{4\pi\epsilon_0} \frac{dr}{r^2} = \frac{q}{4\pi\epsilon_0} \int_{r_A}^{r_B} \frac{dr}{r^2} = \frac{q}{4\pi\epsilon_0} \cdot \frac{-1}{r} \Big|_{r_A}^{r_B}$$

$$\int_A^B \bar{E} \cdot dl = \frac{q}{4\pi\epsilon_0} \left(\frac{-1}{r_B} + \frac{1}{r_A} \right) = \frac{q}{4\epsilon_0 \pi} \left(\frac{1}{r_A} - \frac{1}{r_B} \right) \quad (1)$$

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نستنتج من المعادلة ① بأن فرق الجهد لا يعتمد على مسار المجال وإنما يعتمد على البعد

from eq(1) note that the electric field between $A \rightarrow B$ does not depend on the path between them, but on their distance from the charge (q).

Now take the charge moving from $B \rightarrow A$

$$\int_B^A E \cdot dl = \frac{q}{4\pi\epsilon_0}\left(\frac{1}{r_B} - \frac{1}{r_A}\right) \text{ --- } ②$$

والآن لو جعلنا $A \leftarrow B \leftarrow A$

$$\therefore \oint E \cdot dl = \int_A^B E \cdot dl + \int_B^A E \cdot dl$$

close integration

تكامل خطي مغلق

أي أن المسار مغلق

The 2^{nd} Charactreristic of the electrostatic filed, (the linear integration of the filed strengh around closed path in

التاريخ / / ٢٠١   الموضوع :

an electric filed equal = ?)

H.w ،
مهم جدا

$$\oint E \cdot dl = \int_A^B E\,dl + \int_B^A E\,dl$$

$$= \int_{r_A}^{r_B} \frac{q}{4\pi\epsilon_0}\frac{dr}{r^2} + \int_{r_B}^{r_A} \frac{q}{4\pi\epsilon_0}\frac{dr}{r^2}$$

$$= \frac{q}{4\pi\epsilon_0}\left(\frac{-1}{r}\Big|_{r_A}^{r_B} + \frac{-1}{r}\Big|_{r_B}^{r_A}\right)$$

$$= \frac{q}{4\pi\epsilon_0}\left(\cancel{\frac{-1}{r_B}} + \cancel{\frac{1}{r_A}} - \cancel{\frac{1}{r_A}} + \cancel{\frac{1}{r_B}}\right)$$

$$= \frac{q}{4\pi\epsilon_0}(0)$$

$= \underline{\text{Zero}}$

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Calculation of Potential Diffrence between two Point in $\vec{E}$

Note:- $V_B - V_A = \frac{W_{AB}}{q}$

$W = F\Delta x = qE\Delta x$

$W_{AB} = \int_A^B qE\,dl$

from $V_B - V_A = -\int_A^B E.\bar{dl}$

where r_A , r_B is the distance between q and A, B

and $\int_A^B E.\bar{dl} = \frac{q}{4\epsilon_0\pi}\left(\frac{1}{r_A} - \frac{1}{r_B}\right)$

the Potantial difference between A and B points.

$\therefore V_B - V_A = \frac{-q}{4\pi\epsilon_0}\left(\frac{1}{r_A} - \frac{1}{r_B}\right) = \frac{q}{4\pi\epsilon_0}\left(\frac{1}{r_B} - \frac{1}{r_A}\right)$

Now let $r_A \to \infty$ $\quad V_A = 0$

$\therefore V_B = \frac{1}{4\pi\epsilon_0}\frac{q}{r_B}$

in general we can write

$\boxed{V = \frac{1}{4\pi\epsilon_0}\frac{q}{r}}$ this in +ve Charge

and

$\boxed{V = \frac{1}{4\pi\epsilon_0}\frac{-q}{r}}$ this, if we have (−ve) charge

Now for many point charges we have to

Sum the all Potencial

total Potencial $V_{tot} = V_1 + V_2 + \dots V_n = \sum_{i=1}^{n} V_i$

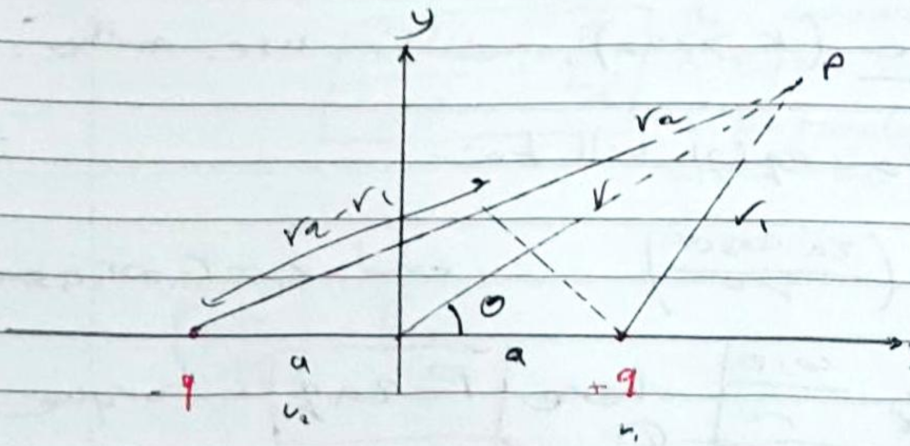
وزعت بشكل مستمر

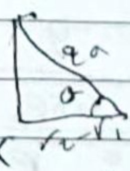
And if the charge in distributed continously

the potencial can be calculated by integration

$$V = \int dv = \frac{1}{4\pi\epsilon_0} \int \frac{dq}{r}$$

سؤال + تطبيق





$\cos\theta = \frac{r_2 - r_1}{2a}$

$r_2 - r_1 = \cos\theta \, 2a$

The Torque exerted on a dipole in an electric field.

we know the $(+q)$

$$V_1 = \frac{1}{4\pi\epsilon_0} \frac{q}{r_1} \quad \text{——— (1)}$$

and also for $(-q)$

$$V_2 = \frac{1}{4\pi\epsilon_0} \frac{-q}{r_2} \quad (2)$$

So the total potencial

$$V = V_1 + V_2 = \frac{q}{4\pi\epsilon_0}\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$$

$$= \frac{q}{4\pi\epsilon_0}\left(\frac{r_2 - r_1}{r_1 r_2}\right) \quad (3)$$

with respect (نسبة إلى)

Now if the (p) in farway w.r.t to dipole length (2a) i.e ($r >> 2a$), one can use another terms θ, r so eq (3) will be:-

$$V = \frac{q}{4\pi\epsilon_0}\left(\frac{2a\cos\theta}{r^2}\right) \qquad \text{and } r_1 \simeq r_2 \Rightarrow r_1 r_2 = r^2$$

$$\boxed{V = \frac{p}{4\pi\epsilon_0} \frac{\cos\theta}{r^2}} \quad (4)$$ where $\boxed{P = 2aq}$ is torque of the dipole

ايجيه بعد لو العزم ثنائي القطب

if $\theta = 90^\circ \Rightarrow V$ in (4) eq. = zero

$V = 0$ جميع النقاط على المحور $y \Leftarrow$

Potential gradiant انحدار الطاقة

we know $V = V_B - V_A = -\int_A^B E \cdot dl$ ①

$$dV = -E \cdot dl$$

مركبة المجال E

$$= -\underbrace{E \cos\theta}_{\text{مركبة } E}\, dl$$

$$\frac{dv}{dl} = -E \cos\theta$$

مشتق الجهد بالنسبة للمسار

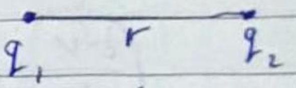
$$\boxed{\frac{-dv}{dl} = E_l}$$

the component of E is equal to the rate (معدل) of potencial change تغير الجهد with the distance in الاتجاه direction with (−ve)

$$\left(\frac{-dv}{dl}\right) = E_{max}$$

The potential of group of point charges is the work to be done to collect these charges by bringing each point charge from infinity.

$$W = q\,V$$



ولتبسيط المسألة نأخذ مجموعة من شحنتين وفي حالة مجموعة من شحنتين فإن

نقل الشحنة الأولى من اللانهاية إلى موضع القياس لا يتطلب إنجاز شغل

$$\text{fro } q_1 \longrightarrow W_1 = 0 \text{ ---- } (1)$$

بالأحرى نقل الشحنة الثانية q_2 من اللانهاية إلى موضع يبعد مسافة r

عن q_1 يتطلب انجاز شغل مقداره W_2

$$\text{for } q_2 \Rightarrow W_2 = q_2 V_1 \text{ ---- } (2)$$

where V_2 is elect. Pot. of q_1 at dis. r

$$\text{and } \quad V_1 = \frac{1}{4\pi\epsilon_0}\frac{q_1}{r_1}$$

$$\therefore W_2 = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r} \text{ ---- } (4)$$

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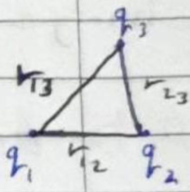
الشغل الكلي للمجموعة

$$W = W_1 + W_2 = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r} \quad \text{--- ⑤}$$

when this is pot. energy of this group

i.e $$\boxed{U = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r_{12}}} \quad \text{--- ⑥}$$

For a group of 3 charges q_1, q_2 and q_3



The potential energy calculate by:

(i) for q_1 at $\infty \Rightarrow W_1 = 0$ --- ①

(ii) for q_2 at $\infty \Rightarrow W_2 = q_2 V_1$ --- ②

$$W_2 = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r_{1,2}} \quad \text{--- ③}$$

(iii) for q_3 at $\infty \Rightarrow W_3 = q_3 V_1 + q_3 V_2$

$$W_3 = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_3}{r_{13}} + \frac{1}{4\pi\epsilon_0}\frac{q_2 q_3}{r_{23}} \quad \text{--- ④}$$

وهكذا لبقية الشحنات

Now the Sum of these equaties

$$U = \underbrace{W_1}_{0} + W_2 + W_3$$

$$U = 0 + \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r_{12}} + \frac{1}{4\pi\epsilon_0}\frac{q_1 q_3}{r_{13}} + \frac{1}{4\pi\epsilon_0}\frac{q_2 q_3}{r_{23}}$$

[ex 11 P.162 + مولد ديفراف P.162
The Van de graff generator] H.W

e.V :- is the energy required to move a charge equal to 1 electron across a potential difference $\Delta V = 1$ volt.

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