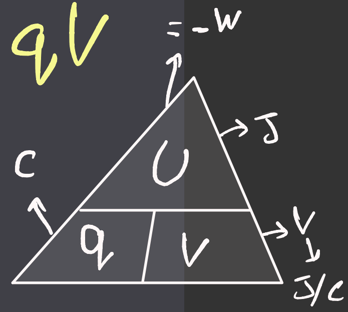
Potential energy $U = -w$ or $U = qV$

electric Potential $V = \frac{-w}{q}$ or $\frac{U}{q}$



Scaler quantity

electric Potential Si unit: $\underset{\text{Volt}}{V} = \frac{\overset{\text{Joule}}{J}}{\underset{\text{Coulomb}}{C}}$

Change in V

$\underset{\text{in eletric field}}{\Delta V} = V_f - V_i$

Change in U

$\Delta U = q\,\Delta V = q(V_f - V_i)$

Work by the E

$$W = -\Delta U$$

$$W = -q\Delta V$$

Conservation Of energy

Kinetic energy

$$\Delta K = -\Delta U$$

$$\Delta K = -q\Delta U$$

Electron Volts

$1.602 \times 10^{-19} C$ Volt

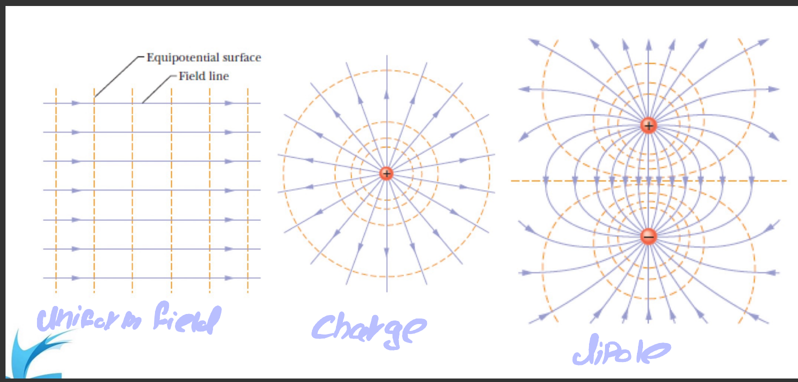
$$1eV = e(1V)$$

$J \rightarrow eV$	$eV \rightarrow J$
قسمة $\rightarrow 1.602 \times 10^{-19}$	ضرب $\rightarrow 1.602 \times 10^{-19} J$

Equipotential surfaces and El. Fi.

+ve q → out Arrow

-ve q → in Arrow



Calculating U from E

- $\Delta V = -\int E \cdot d$ genral formula

Special Cases: distance

- Uniform field → $\Delta V = -E \Delta X$

vector: from Higher V → lower V

Potential due to a Char. Particle

$$V = \frac{kq}{r}$$

Potential Due to a Group of Charged Particles

$= \Sigma V$ or $k \Sigma \frac{q}{r}$

Potential due to a Char. Particle

Example 1:

The electric potential at a distance 5 cm from a point charge 2.5 nC is:

$V = \frac{kq}{r} = \frac{k(2.5\times10^{-9})}{5\times10^{-2}} = 449.5\,V \approx 450\,V$

Solution:

(A) 450 V
(B) 320 V
(C) 280 V
(D) 150 V

$V = \frac{kq}{r} = \frac{k(2.5\times10^{-9})}{5\times10^{-2}} = 449.5\,V \approx 450\,V$

Potential due to a Char. Particle

Example 2:

4cm

E=180 2cm $V=?$

$180 = \frac{kq}{(2\times10^{-2})^2}$ $q = 8\times10^{-12}$

A point charge produces an electric field of 180 N/C at 2 cm. The electric potential at 4 cm from the charge is:

Solution:

$V = \frac{kq}{r_2}$

$E = \frac{kq}{r_1^2}$

$180 = \frac{kq}{(2\times10^{-2})^2}$

$q = 8\times10^{-12}$

q $E = 180\,N/C$ r_1 2cm r_2 V 4cm

$k = 8.99\times10^{9}$

(A) 3.7 V
(B) 2.4 V
(C) 1.8 V
(D) 0.4 V

$V = 1.79$

$V \approx 1.8$

Potential due to a Char. Particle

Example 3:

As shown in the arrangement below, the electric potential at point A is: $V = V_1 + V_2$

$V_1 = \frac{kq_1}{r_1} = \frac{kq_1}{r_1} = 13485$

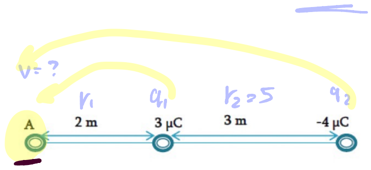
$V_2 = \frac{kq_2}{r_2} = -7192$

$-7192 + 13485 = 6293 \approx 6300\,V$

Solution:

(D)

(A) 1200 V
(B) 2400 V
(C) 5600 V
(D) 6300 V



Potential due to a Char. Particle

Example 4:

Referring to Example 3, the work needed to bring a charge 6 nC from infinity to point A is: 6nC

B ∞ —— A

Solution:

(B)

$W = -\Delta U = -(U_A - U_B)$

$U_A = qV_A = 3.78\times10^{-5}\,J$

$U_B = qV_B = zero$

(A) -1.52×10^{14} eV
(B) -2.36×10^{14} eV
(C) -4.57×10^{14} eV
(D) -6.39×10^{14} eV

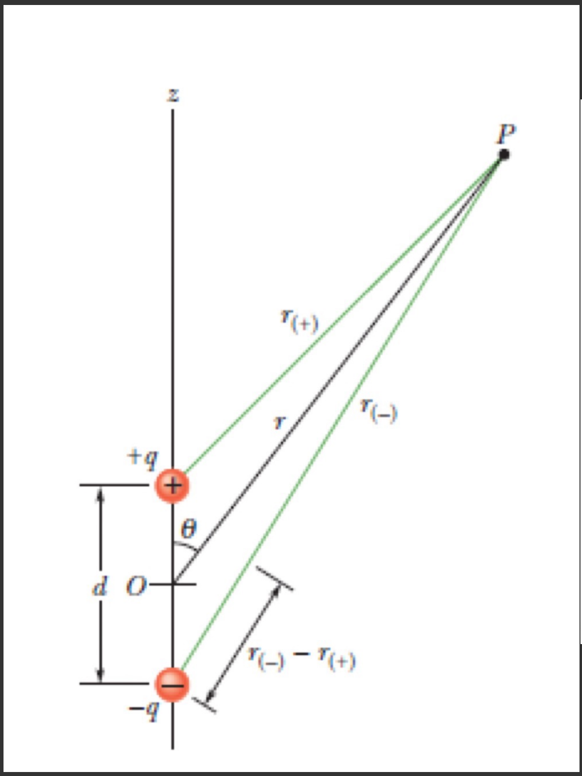
$= \frac{-3.78\times10^{-5}\,J}{1.602\times10^{-19}} = -2.36\times10^{14}\,eV$

Potential Due to an Electric Dipole

$V = \frac{KP\cos\theta}{r^2}$

$P = |q|d$

> dipole momentum



Example 5:

Two equal and opposite charges 6.0 μC and -6.0 μC are separated by a distance of 2 cm. The electric potential at a point 30 cm away from the axis of the dipole is: $P = |q|d = 1.2\times10^{-7}$

$d = 2\times10^{-2}$

$r = 30\times10^{-2}$

$P = 6\times10^{-6} \times 2\times10^{-2}$

Solution:

$\frac{K\times(6\times10^{-6})(2\times10^{-2})\cos(0)}{(30\times10^{-2})^2}$

$= 1.2\times10^{4}\,V$

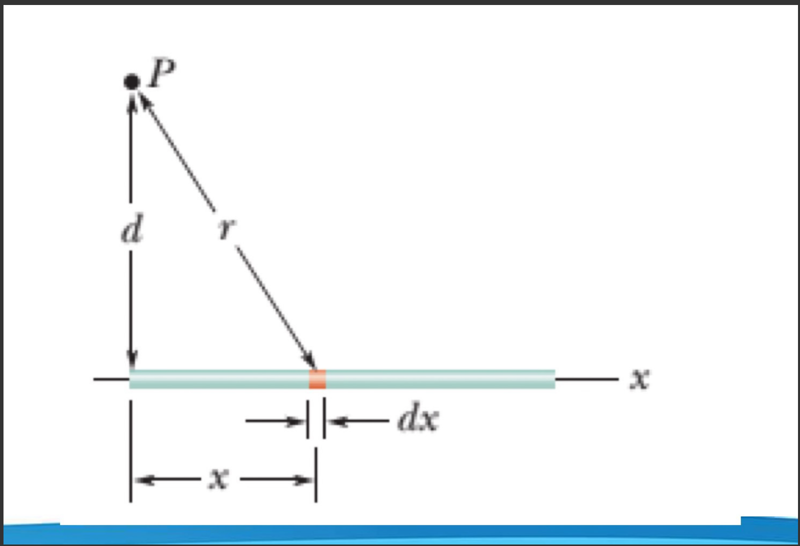
(A) 9.4×10^4 V
(B) 7.6×10^4 V
(C) 5.7×10^4 V
(D) 1.2×10^4 V ✓

Potential Due to a Continuous Charge Distribution

Not Important

$V = k\int \frac{dq}{r}$

$dq = \lambda d$



Charged Disk

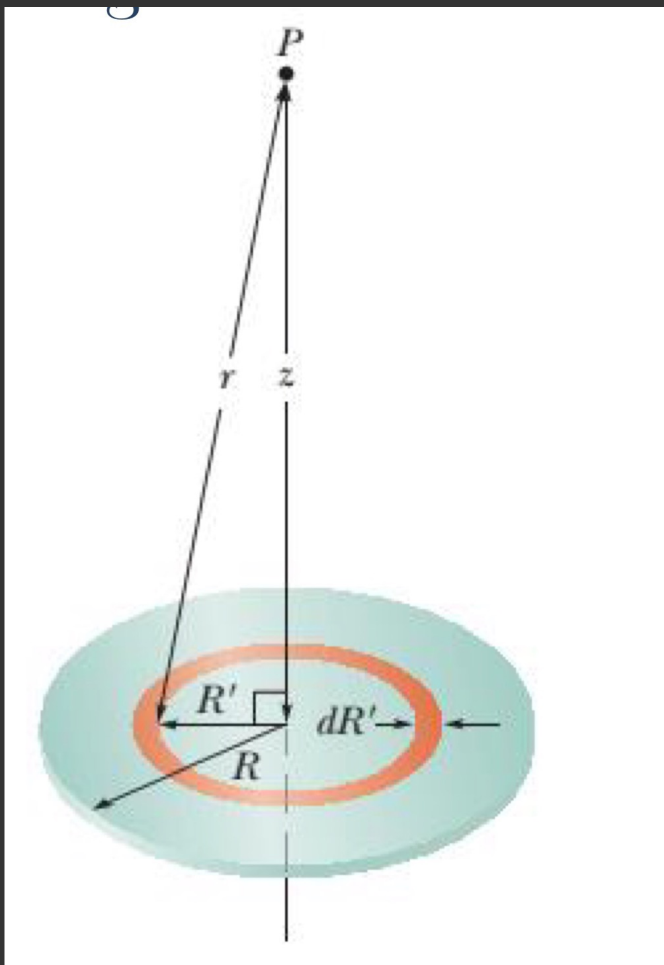
has magnitude

عدد الشحنات الموجودة في ال Disk ←

$$dq = \underbrace{\sigma}_{\text{كثافة الشحنات}}\underbrace{(2\pi R')}_{\text{الطول}}\underbrace{(dR')}_{\text{العرض}},$$

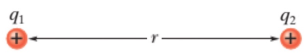
مساحة

$$V = \frac{\sigma}{2\varepsilon_0}\left(\sqrt{z^2 + R^2} - z\right).$$



Electric Potential Energy of a System of Charged Particles

➤ For two particles at separation r,



$$U = W = \frac{k q_1 q_2}{r}$$

لو في اكثر من شحنتين يسير اسوي القانون لكل شحنة مع الثانية واجمع عشان يطلعلي مجموع طاقة الشغل للنظام

$q_1 \& q_2 \xrightarrow[\text{signs}]{\text{Same}} U = +$ " تجمع "

$q_1 \& q_2 \xrightarrow[\text{signs}]{\text{Not same}} U = -$ " تطرح "

Example 6:

Four charges 1, 2, 3 and -4 μC are located at the corners of a square of side 3 m as shown in the figure. The electric potential energy of the system is:

Solution:

$U_1 = \frac{k(1\mu)(2\mu)}{3} = 6\times10^{-3}$

$U_2 = \frac{k(1\mu)(3\mu)}{3} = 9\times10^{-3}$

$U_3 = \frac{k(1\mu)(-4\mu)}{3} = -0.01$

$U_4 = \frac{k(2\mu)(3\mu)}{3} = 0.02$

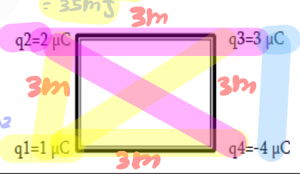
$U_5 = \frac{k(2\mu)(-4\mu)}{3} = -0.02$

$U_6 = \frac{k(-4\mu)(3\mu)}{3} = -0.04$

6 energies to sum

$= -0.035\ J$
$= 35\ mJ$

(A) -15 mJ
(B) -24 mJ
✓ (C) -35 mJ
(D) -46 mJ



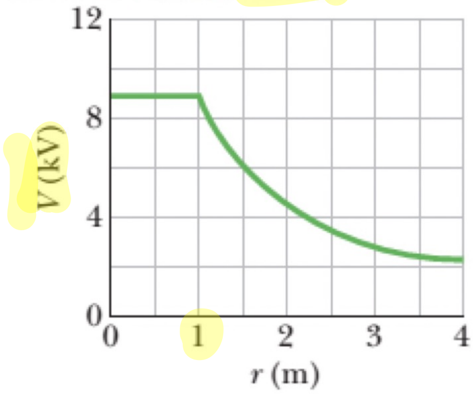
Potential of a Charged Isolated Conductor

Sphere

$$V = \frac{kq}{R} \text{ , Electric Potential of a conducting sphere}$$

مهما تتحرك داخل الكورة التأثير
واحد لأنه الشحنات على سطح
الكورة ف لو بعدت لجهة اليمين
صح تنقص التأثير من الجهة اليسار
لكن الجهة اليمين راح تعوضوا لأنك
قربت من شحنات الجهة اليمين
ف التأثير حيصير اكبر

A plot of $V(r)$ both inside and outside a charged spherical shell of radius $1.0\ m$.



A plot of $E(r)$ for the same shell.

لا يوجد مجال في الداخل لأن الشحنات على السطح فقط ليس في الداخل

المجال الكهربائي