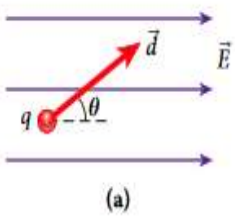
third unit /electric potential

Electric potential energy

The change in electric potential energy is proportional to the work done by the electric field on the charge.

$$\Delta U = U_f - U_i = -W_e$$



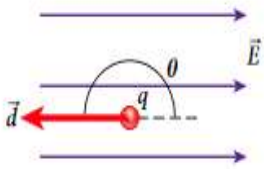
(a)

Charge in a uniform electric field

The work done by the field on the charge is determined by the relationship

$$W = q\vec{E}\bullet\vec{d} = qEd\cos\theta$$

Where the angle (θ) is between the direction of the field and displacement .



(b)

• If the positive charge moves with the field its potential energy decreases and its kineticenergy and the work done by the field positive. And if the charge moves opposite to the field then it's potential energy increases and the kinetic energy decreases were the work done by the fielc

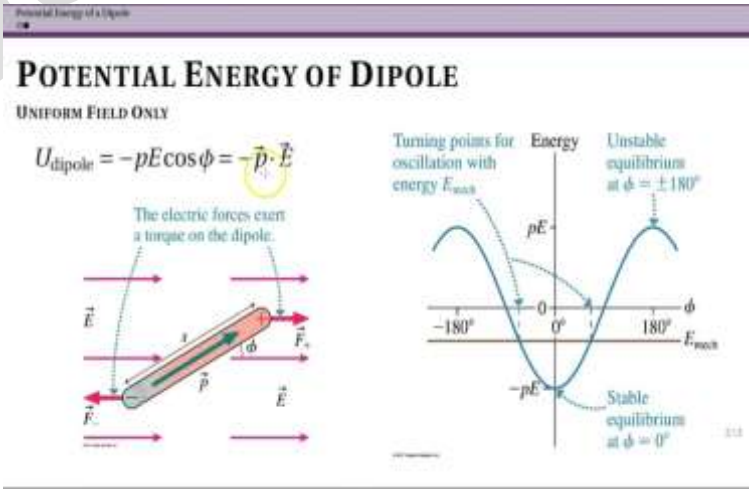
• If the negative charge moves with the field, its potential energy increases and its kinetic energ and the work done by the field is negative. And if the chargemoves opposite to the field then it's potential energy is reduced and its kinetic energy increases were the work done by the field is positive .

• If the charge moves perpendicular to the direction of the field, the potential energy of its electrical position remains constant and the work done on it = zero.

Dipole in the electric field

We get a relationship of electric potential energy
For the dipole in the uniform electric field .

$$U = -\vec{p}\bullet\vec{E} = -pE\cos\theta$$



Definition of electric potential

The amount of work done in moving the positive charge unit from infinity to that point.

$$V = \frac{U}{q}.$$

Difference in electric potential is expressed by:

The amount of change in the electric potential energy of the charge between the two points.

$$\Delta V = V_f - V_i = \frac{U_f}{q} - \frac{U_i}{q} = \frac{\Delta U}{q}$$

The electric potential is measured ir

Very important note: - Do not forget the law of conservation of energy $\Delta K = -\Delta U = -q\Delta V.$

Q 1: What is the kinetic energy needed for the proton to reach the negative plate starting from the positive plate from the rest .note that the electric potential between the plates = 500V?

Q2: An electron accelerates from rest through a potential difference (370V). What is his final speed?

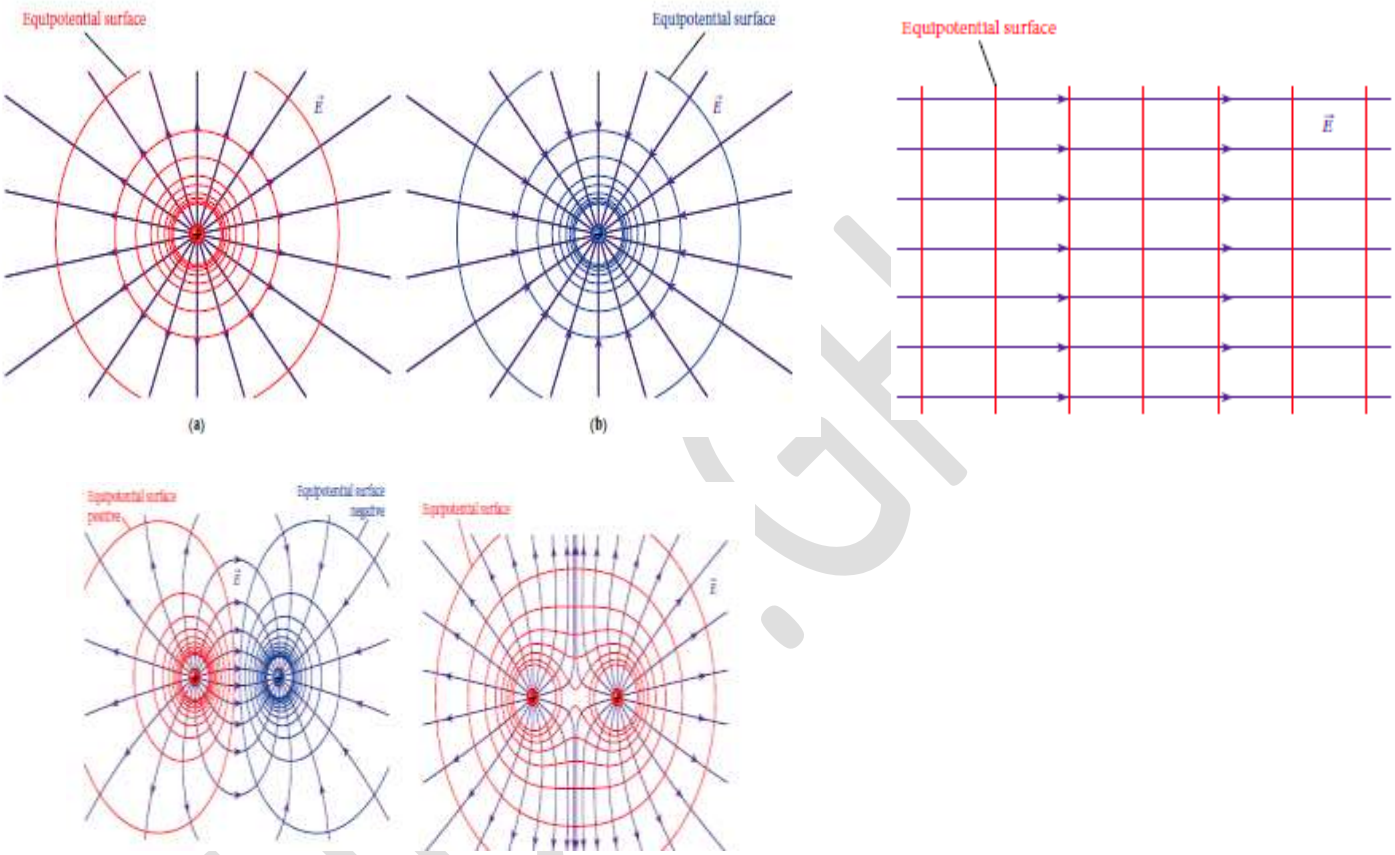
Q3: How much work will an electric field do to move a proton from its electric potential point (+ 180V) to its electric potential point (-60V)?

Q4: What is the electric potential difference required to provide an alpha particle with a kinetic energy (200keV)?

Equal electric potential surfaces

Of its characteristics: -

- Surfaces of conductors form surfaces of equal eclectic potential .
- Equal electric potential surfaces are always perpendicular to the electric field lines at any point in space .



Electric potential of different distributions of charge

When the particle moves in the electric field from a certain starting point to a certain final point we get:

$$W = W_e = \int_i^f q\vec{E}\cdot d\vec{s} = q\int_i^f \vec{E}\cdot d\vec{s}.$$

To connect the work done with the change in electric potential we get: -

$$\Delta V = V_f - V_i = -\frac{W_e}{q} = -\int_i^f \vec{E}\cdot d\vec{s}.$$

The electric potentialcan therefore be expressed at some point:

$$V(\vec{r}) - V(\infty) \equiv V(\vec{r}) = -\int_{-}^{\vec{r}} \vec{E}\cdot d\vec{s}.$$

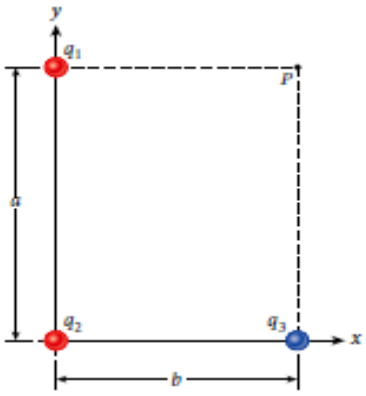
First: - Point charge: -

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

Second: - System of point charges: -

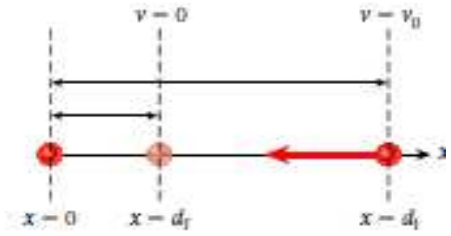
$$V = \sum_{i=1}^{n} V_i = \sum_{i=1}^{n} \frac{kq_i}{r_i}.$$

Question: - If (q1 = + 50µc, q2 = -30µc, q3 = -80µc)
They were (a= 80cm, b = 60cm). Calculate the electric potential at the point (p).



If you put a charge of (-60µc) at point (p), calculate the electric potential energy
Stored therein.

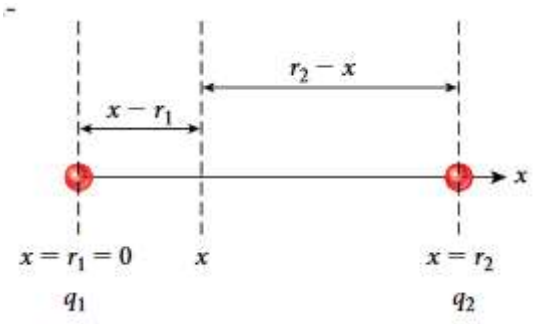
Question: - a positive charge (4.5µc) fixed in place, and launched a particle of mass (6g)
Its charge (3µc) has an initial speed of 66m / s directly towards the fixed charge
From a distance of (4.2cm). To what extent the moving charge approaches the fixed charge
Before it reaches to rest and start to move away from the fixed charge?



Minimum potential

To calculate the minimum electric potential we derive the electric potential function and equal it to zero .

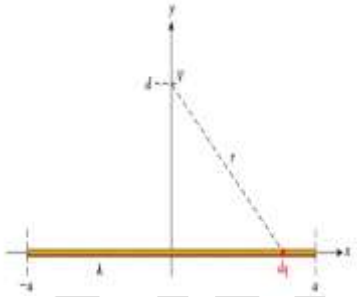
Question: - There is a charge (q_1 = 64nc) at the origin point of the (x) axis, and another charge (q_2 = 4nc) at the site(r_2 = 9cm) on the axis (x). At what point along the x-axis between the two charges does the electric potentialresulting from both of them have a minimum ?



Continuous distribution of the charge

• Thin wire of fixed length:-

$$V = k\lambda \ln\left(\frac{\sqrt{a^2+d^2}+a}{\sqrt{a^2+d^2}-a}\right).$$



• Charged disk**: -**

$V(x) = \frac{2kq}{R^2}\left(\sqrt{x^2+R^2}-x\right)$Where (x) the distance at which the electric potential is calculated along the axis of its symmetry, (R) the radius of the disk .

Find the electric field of electric potential

Question: - If you know that the expression of the voltage of a thin wire of a fixed length at a point located on the vertical half of the line specified for the charge is given by the following relationship :-

$$V = k\lambda \ln\left(\frac{\sqrt{y^2+a^2}+a}{\sqrt{y^2+a^2}-a}\right),$$

Through the equation: - $E_s = -\frac{\partial V}{\partial s}$. ıe electric field is given by: $E_y = \frac{2k\lambda}{y}\frac{a}{\sqrt{y^2+a^2}}.$

Questions on electric potential: -

Q 1: - Hollow ball conductor ofradius (5cm) and surface charge (8nc). Calculate:

• electric potential at a distance (3cm) from the center

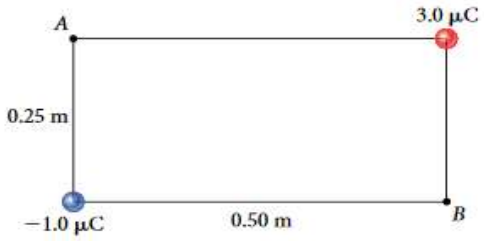
• electric potential on the surface of the conductor

• electric potential at a distance (8cm) from the center

Q 2: - A dust particle as its sink (2.5mg) and its charge (1µc) falls on a point (x = 2m) in an area where the electric potential variesaccording to the equation:$V(x) = (2V / m^2) X^2 - (3V / m^3) X^3$. What is the acceleration that the particle will start moving after it falls?

Q 3: - From the attached figure calculate:

• Amount of electric potential at point (A)



• The amount of electric potential difference between the two points (A, B)

• The amount of electrical work required to transport a charge ($-3.2X10^{-13}C$) from point (A) to point (B) .

Proton gain energy

question: - a proton put between two parallel conductors and the electric potential difference between them (500V) was released nearPositive plate from rest. Calculate

The kinetic energy that a proton gains when it reaches a negative plate

• How fast is the proton?

Batteries

• Means of electric potential generation

•consist of two halves of a cell, and convert chemical energy into electrical energy

Recent examples include: lithium-ion batteries and their characteristics: energy density, the possibility of recharging hundreds of times,

It has no memory (does not need to be modified to retain its charge) and its disadvantages: if it is discharged it can not be recharged again, and if it is quickly discharged it is possible to ignite or burst its components. This problem was dealt withA small integrated circuit that protects the battery pack.

Applications of lithium-ion batteries are electric vehicles but carry less energy than gasoline-powered cars.

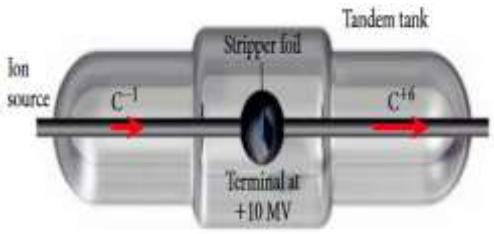
The generator of Van de Graaf

Of means of generating very large electric potential.

Question: - The enclosed figure illustrates the Van de Graff tandem accelerator

Which uses great efforts to study the processes of astrophysical nuclear physics

It has a terminal voltage difference of 10MV. This high voltage is generated at the center
Accelerated so that negative ions accelerate toward the positive terminal.
Depending on the fiqure.
What is the highest kinetic energy that carbon nuclei can gain in this tandem accelerator?



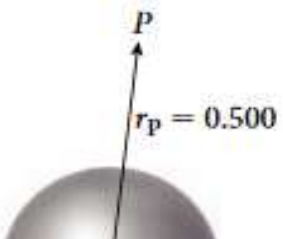
What is the highest speed that carbon nuclei can gain in this tandem accelerator?

Question: - If the electric potential of the generator van de Graaf (10^5V) and diameter (20cm). How many more protons increase than Electrons on its surface?

Question: - Two parallel plates (+ 200V, -100V) are separated by a distance (1cm).
• Find the electric field between the plates

• An electron whose primary location is halfway between the plates. Find its kinetic energy when it hits the positive plate

Question: - The attached figure shows a solid metal ball radius (a = 0.2m)
The distribution of the charge on its surface σ. If the electric potential difference between the ball surface and the point(p) located at a distance (r_p = 0.5m) from the center of the ball is (4π).Calculate amount of σ

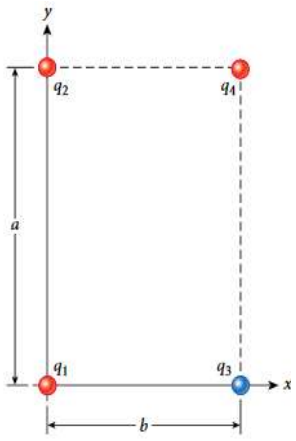


Electric potential energy for a system of point charges

To calculate the electric potential energy of a system of two point charges we apply: -

From the theory of work and energy, if the two charges of the same type, (U>0) must be made positive work to bring them from the infinity and bring them closer and keep them immobile. If the two charges are somewhat different, then U<0 should have a negative work To bring them from the infinity and bring them closer and keep them immobile.

Question: - From the attached figure, calculate the electric potential energy of the system if it is Bring the four charges of infinity and place them in their coordinates shown
In the figure where the charge (q1) is placed at the point of origin, the amount of charge
Is (q_1 = + 1µc, q_2 = + 2µc, q_3 = -3µc, q_4 = + 4µc).



Important exercises on electric potential

Q 1: - Solid conductive sphere radius (R_1 = 1.2m) and its charge (Q = 1.953µC) evenly distributed on its surface .

A conductive and solid sphere of radius (R_2 = 0.6m) is initially charged and 10m from the first sphere. The two sphereswere connected for a moment to a wire and then removed. How much is the charge on the first sphere?

Q 2: - Solid conductive sphere radius (R_1 = 1.435m) and its charge (Q) evenly distributed on its surface Another conductive and solid sphere radius (R_2 = 0.6177m) is initially charged and 10m away from the first sphere. The two spheres were connected for a moment to a wire and then removed. If the amount of charge generated on the second sphere is(0.9356µC). How much is the original charge (Q) on the first sphere?

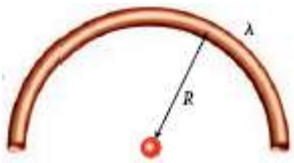
Q3: - Solid conductive sphere of radius (R1) and its charge (Q = 4.263µC) evenly distributed on its surface Another conductive and solid sphere of radius (R2 = 0.6239m) is initially charged and 10m away from the first sphere . The two sphereswere connected for a moment to a wire and then removed. If the amount of charge generated on the second sphere is(1.162µC). What radius of the first sphere?

Q 4: - conductive and solid sphere of radius (R = 1.895m) with charge inside it and the amount of electric field at the surface of it is (3.165x105V / m) .
What is the electric potential value at (29.81m) from the surface of the sphere ?

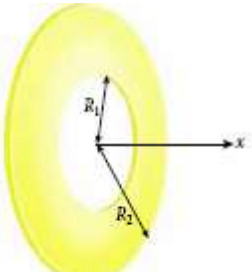
Q 5: - conductive solid sphereof radius (R) with the charge inside it and amount of electric field on the surface of it is (3.269x105V / m) .
If the electric potential value is at a distance (32.37m) of the surface of the sphere is (2.853x105V). So what is the radius of the sphere ?

Q6: - conductive solid sphereof radius (R = 1.351m) and the charge inside it and the amount of electric potential at a distance(34.95cm) of the sphere surface is (3.618x105V).
What is the amount of electric field on the surface of the sphere ?

Q 7: - Find the electric potential value at the center of the curve of the thin wire shown in the figure if the uniformly distributed charge per unit length is ($3x10^{-8}$C / m) and the radius of curvature (R = 8cm).

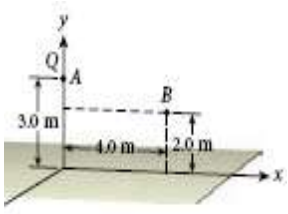


Q 8: - Develop an expression describing the electric potential along the x-axis of a disk in the middle of a gap as shown in the figure where (R1, R2) are the two halves of the inner and outer diameter of the disk. What is the electric potential value when (R1 = 0)?



Q 9: - Plastic leg length (L) as shown in the attached form and has a nonuniform charge distribution (λ= CX), whereC is a positive constant.
Describe an expression ofelectric potential at point (P) on axis (Y) and distance (Y)
From one end of the leg.

Q10: - A dielectric plate in the level (xy) of its uniformly distributed charge ($\sigma = 3.5x10^{-6}C / m^2$). What is the value of the electric potential difference When a charge ($q = 1.25x10^{-6}C$) moving from location (A) to location (B).



Q11: - The electric potential of a space is determined by the relation V (x, y, z) = $x^2 + xy^2 + yz$. Determine the electric field in this area at the coordinate (3,4,5).

Q 12: - Electric field whose value in space varies according to the following charge : -

$$\vec{E} = E_o X e^{-X} \hat{X}$$

• What is the X value at which the electric field reaches its highest value?

• What is the difference in electric potential between X = 0 and X = Xmax?

GOOD LUCK