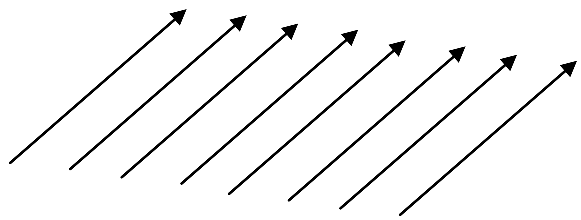
Potential difference and electric potential:

$$\Delta V = -\int_i^f \vec{E} \bullet d\vec{s}; \vec{E} = -\overrightarrow{grad} \cdot V; div\vec{E} = \frac{\rho}{\varepsilon_0}; \vec{\nabla} \times \vec{E} = \vec{0}$$

$$dV = -\vec{E} \cdot d\vec{s}$$

$$q = \pm 1.60 \cdot 10^{-19} C; 1eV = 1.60 \cdot 10^{-19} J; 1MeV = 1.60 \cdot 10^{-13} J$$

A uniform electric field is constant in direction and magnitude. The length, direction, and density of vector arrows representing the electric field does not change over the region of uniformity.



1. (2) How much work is done (by a battery, generator, or some other source of potential difference) in moving Avogadro's number of electrons from an initial point where the electric potential is 9.00V to a point where the electric potential is -5.00V. (1.35MJ=14eV·N_A)
2. (1) a)Calculate the speed of a proton that is accelerated from rest through a potential difference of 120V b) Calculate the speed of an electron that is accelerated through the same potential difference. (a) 1.52E5m/s b) 6.49E6m/s)
3. Calculate $\vec{\nabla} \times \vec{E}; \vec{E} = \frac{k_e q}{\left(\sqrt{x^2 + y^2 + z^2}\right)^3} \langle x, y, z \rangle$
4. Calculate $\int_i^f \vec{E} \bullet d\vec{s}$ for

   $\vec{E} = \langle x^2, xy \rangle$ from (0,0) to (1,1) along the path y=x and along the path y=x^2

5. Calculate: $\vec{\nabla} \cdot \vec{E} \equiv div\vec{E}$ for $\vec{E} = \langle x^2 z, y^3, xyz \ln z \rangle$

Potential differences in a uniform electric field

6. (5) An electron moving parallel to the x-axis has an initial speed of 3.70E6 m/s at the origin. Its speed is reduced to 1.40E5 m/s at the point x=2.00cm. Calculate the potential difference between the origin and that point. Which point is at the higher potential? (-38.9V; origin is at highest potential.)

7. (6) Starting with the definition of work, prove that at every point on an equipotential surface the surface must be perpendicular to the electric field there.

8. (9) An insulating rod having linear charge density λ=40.0E-6C/m and linear mass density μ=0.100kg/m is released from rest in a uniform electric field of 100V/m directed perpendicular to the rod. a)Determine the speed of the rod after it has travelled 2.00m. Does the answer change if the field is not perpendicular to the rod? (0.400m/s, no)

Electric potential and potential energy due to point charges.

9. (15) Three charges are at the vertices of an isosceles triangle of base 2.00cm and sides 4.00cm. The two charges at the corners of the base are negative, the charge at the top is positive. Calculate the electric potential at the midpoint of the base, taking q=7.00E-6C. (-11.0MV)
10. (19) Show that the amount of work required to assemble four identical point charges of magnitude Q at the corners of a square of side s is $5.41 k_e \frac{Q^2}{s}$
11. (23) Two insulating spheres have radii r_1 and r_2 and masses m_1 and m_2 and uniformly distributed charges - q_1 and q_2. They are released from rest when their centers are separated by a distance d. a)How fast is each moving when they collide. (Use conservation of energy and conservation of momentum.) If the spheres were conductors, would their speeds be greater or less than those calculated in a)?

Obtaining the value of the electric field from the electric potential.

$$\vec{E} = -\overrightarrow{grad} \cdot V$$

12. (29) The potential in a region between x=0 and x=6.00m is V=a+bx. a=10V/m and b=-7V/m^2. Determine a) the potential at x=0, 3.00m, 6.00m, and b) the electric field at the same locations.

13. (37 new) Over a certain region of space the electric potential is $V=5x-3x^2y+2yz^2$. Find the electric field over this region. What is its value at the point (1,0,-2)m.

14. Calculate the electric potential at a point x on the perpendicular axis of an annulus of inner radius a, outer radius b, and a charge density σ

$$V(x) = 2\pi k_e \sigma \left[\sqrt{x^2+b^2} - \sqrt{x^2+a^2} \right]$$

15. (38) A wire having a uniform linear charge density λ is bent into a semicircle with two wires sticking out in the horizontal direction parallel to the diameter. The two wires have a length of 2R each, and R is the

radius of the semicircle. Find the electric potential at the center of the semi-circle: $V = k_e \lambda \left(\pi + 2\ln 3 \right)$

Electric potential due to a charged conductor

16. (39) A spherical conductor has a radius of 14.0cm and charge of 26.0E-6C. Calculate the electric field and the electric potential at a) r=10.0cm, b) r=20.0cm, c) r=14.0cm.

a) E=0, V=1.67MV
b) E=5.84MV/m; V=1.17MV
c) E=11.9MV/m; V=1.67MV

17. (61) Electric dipole in polar coordinates at a point r far from the center of the dipole. (See lecture.)