Name: ____ **Date:** ____________________ **Period:** ________

AP Physics C
Electric Potential HO31

1.) A point charge Q = +9.10 μC is held fixed at the origin. A second point charge with a charge of q = -0.420 μC and a mass of 3.20 x 10^{-4} kg is placed on the x-axis, 0.960 m from the origin. (UP 24-1)

a.) What is the electric potential energy of the pair of charges? (Assume potential energy is zero when separation is infinite.)

b.) The second charge is released from rest. What is its speed when it is 0.240 m from the origin?

2.) A point charge q_1 = -5.80 μC is held stationary at the origin. A second point charge q_2 = +4.30 μC moves along the x-axis from x = 0.260 m to x = 0.380 m. How much work is done by the electric force on q_2? (UP 24-3)

3.) Repeat Problem 2 if q_1 = +5.80 μC.

4.) Three equal point charges q = 840 nC are placed at the corners of an equilateral triangle whose side is 1.00 m. What is the potential energy of the system? (Assume potential energy is zero when separation is infinite.) (UP 24-8)

5.) Repeat Problem 4 if two of the charges have q = -840 nC.

6.) A point charge q_1 = 2.00 nC is placed at the origin, and a second point charge q_2 = -3.00 nC is placed on the x-axis at x = +20.0 cm. A third point charge q_3 = 5.00 nC is to be placed on the x-axis between q_1 and q_2. Take as zero the potential energy of the three charges when they are infinitely apart. (UP 24-9)

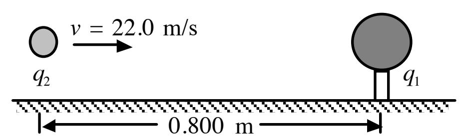
a.) What is the potential energy of the system of the three charges if q_3 is placed at x = +10.0 cm?

b.) Where should q_3 be placed to make the potential energy of the system equal to zero?

7.) A small metal sphere, carrying a net charge of q_1 = +7.50 μC, is held in a stationary position by insulating supports. A second metal sphere, with a net charge of q_2 = +3.00 μC and mass 2.00 g, is projected toward q_1. When the two spheres are 0.800 m apart, q_2 is moving toward q_1 with speed 22.0 m/s. Assume the spheres can be treated as point charges and neglect the force of gravity. (UP 24-5)

a.) What is the speed of q_2 when the spheres are 0.500 m apart?

b.) How close does q_2 get to q_1?



Problem 7

8.) The potential at a distance of 0.750 m from a very small charged sphere is 48.0 V, with the potential taken to be zero at an infinite distance from the sphere. If the sphere is treated as a point charge, what is its charge? (UP 24-10)

9.) A particle with a charge of +4.30 nC is in a uniform electric field directed to the left. It is released from rest and moves to the left; after it has moved 5.00 cm, its kinetic energy is found to be +2.50 x 10^{-6} J. (UP 24-12)

a.) What work was done by the electric force?

b.) What is the potential of the starting point with respect to its endpoint?

c.) What is the magnitude of the electric field?

10.) A charge of 37.0 nC is placed in a uniform electric field that is directed vertically upward and that has a magnitude of 5.00 x 10^4 N/C. What work is done by the electric force when the charge moves (UP 24-15)

a.) 0.450 m to the right; b.) 0.670 m downward; c.) 0.580 m upward

d.) 2.60 m at an angle of 45.0° upward from the horizontal?

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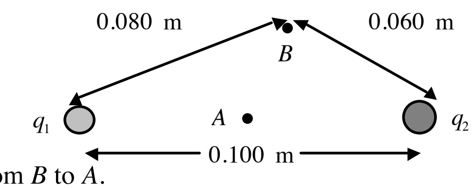
AP Physics C
Electric Potential HO32

1.) Two point charges q_1 = +6.80 nC and q_2 = -5.10 nC are 0.100 apart. Point A is midway between them; point B is 0.080 m from q_1 and 0.060 m from point q_2. Take the potential to be zero at infinity. (UP 24-17)



a.) Find the potential at A.

b.) Find the potential at B.

c.) Find the work done by the electric field on a charge of +2.50 nC that travels from B to A.

d.) Find the work done by the electric field on a charge of +2.50 nC that travels from A to B.

e.) Find the work done by the electric field on a charge of -2.50 nC that travels from B to A.

2.) A positive point charge $+q$ is at the point $x = 0$, $y = -a$, and a negative charge $-q$ is fixed at the point $x = 0$, $y = +a$. Take V to be zero at an infinite distance from the charges. (UP 24-20)

a.) Derive an expression for the potential at points on the y-axis as a function of the coordinate y.

b.) Draw a graph of the potential on the y-axis as a function of y over the range from $y = -4a$ to $y = +4a$.

c.) What is the answer to part (a.) and (b.) if the two charges are interchanged so that $+q$ is at the point $x = 0$, $y = +a$, and $-q$ is at the point $x = 0$, $y = -a$?

3.) A positive point charge $+q$ is at the point $x = 0$, $y = 0$, and a negative charge $-2q$ is fixed at the point $x = a$, $y = 0$. Take V to be zero at an infinite distance from the charges. (UP 24-21)

a.) What is the potential at a point on the x-axis, a distance x from the origin?

b.) Draw a graph of the potential on the x-axis as a function of x over the range from $x = -2a$ to $x = +2a$.

c.) At what positions on the x-axis is the potential equal to zero?

d.) What does the answer to part (a.) become when $x >> a$?

4.) Two large parallel metal sheets carrying equal and opposite charges are separated by a distance of 52.0 mm. The electric field between them is uniform and has magnitude 670 N/C. (UP 24-24)

a.) What is the potential difference between the sheets?

b.) What is the surface charge density σ on the positive sheet?

5.) A charge $+Q$ is uniformly distributed throughout a solid insulating sphere. Find the potential everywhere, both outside and inside the sphere. Take V to be zero at an infinite distance from the sphere. (UP 24-70)

6.) An infinitely long line of charge has linear charge density 4.00×10^{-12} C/m. A proton (mass 1.67×10^{-27} kg, charge $+1.60 \times 10^{-19}$ C) is 18.0 cm from the line and moving directly toward the line at 2.50×10^{3} m/s. How close does the proton get to the line of charge? (UP 24-30)

7.) A long coaxial cable consists of an inner cylindrical conductor with radius a and an outer coaxial cylindrical conductor with inner radius b and outer radius c. The outer cylinder is mounted on insulating supports and has no net charge. The inner cylinder has uniform positive charge per unit length λ. Use the electric field to calculate the potential difference between the two cylindrical conductors. (UP 24-74)

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AP Physics C
Electric Potential HO33

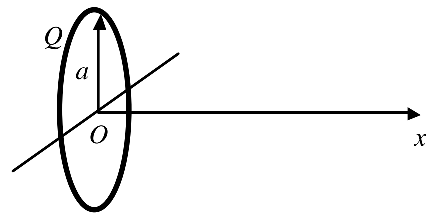
1.) A thin insulating rod is bent into a semicircular arc of radius a, and a total electric charge Q is distributed uniformly along the rod. Calculate the electric potential at the center of curvature of the arc if the potential is assumed to be zero at infinity. (UP 24-68)

2.) Electric charge is distributed uniformly around a thin ring of radius a, with total charge Q. The ring is in the y-z plane centered at the origin. (UP 24-69)

a.) Find the potential at points along the x-axis.

b.) Find the potential by integrating the following expression for E_x.

$$E_x = k\frac{Qx}{\left(x^2 + a^2\right)^{3/2}}$$



3.) A solid conducting sphere carrying charge q has radius a. It is inside a concentric hollow conducting sphere of inner radius b and outer radius c. The hollow sphere has no net charge. Take $V = 0$ as $r \rightarrow \infty$. Use the electric field to calculate the potential V at the following values of r (UP 24-72)

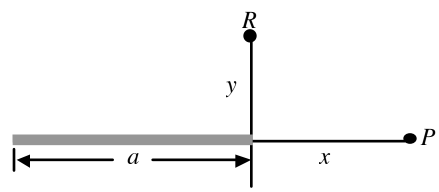
a.) $r = c$ b.) $r = b$ c.) $r = a$ d.) $r = 0$.

4.) A solid conducting sphere of radius R that carries positive charge Q is concentric with a very thin insulating shell of radius $2R$ that also carries charge Q. The charge Q is distributed uniformly over the insulating shell. Use the electric field to calculate the potential difference between the solid conducting sphere and the thin insulating shell. (UP 24-73)

5.) Electric charge Q is uniformly distributed along a thin rod of length a. Take the potential to be zero at infinity. Find the potential at the following points: (UP 24-77)

a.) point P, a distance x to the right of the rod.

b.) point R, a distance y above the right hand end of the rod.



6.) A disk of radius R has a uniform surface charge density σ. (UP 24-65)

a.) By regarding the disk as a series of thin concentric rings, calculate the electric potential V at a point on the disk's axis a distance x from the center of the disk. Assume that $V = 0$ at infinity.

b.) Use the potential found in (a.) to find E_x.

7.) Two metal spheres of different sizes are charged such that the electric potential is the same at the surface of each. Sphere A has a radius three times that of sphere B. Let Q_A and Q_B be the charges on each sphere, and let E_A and E_B be the electric field magnitudes at the surface of each sphere. (UP 24-79)

a.) What it the ratio Q_B/Q_A? b.) What is the ratio E_B/E_A?

8.) A solid, non conducting sphere of radius a has a volume charge density given by the equation $\rho(r) = \rho_0(r/a)^3$, where r is the distance from the sphere's center. Take the potential to be zero as $r \rightarrow \infty$. (AP Book)

a.) Determine the potential V as a function of r.

b.) Sketch the potential for all regions of space.