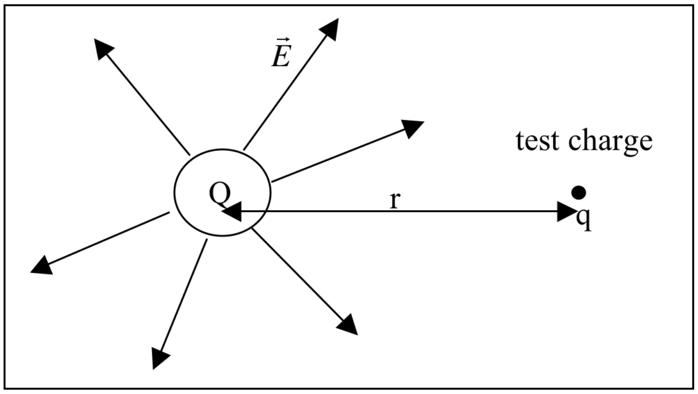


Move the test charge in from infinity.

Energy stored in this system = $U = \frac{kQq}{r}$

If you move the test charge closer to Q (if you decrease r) ➔ more potential energy is stored in the system.

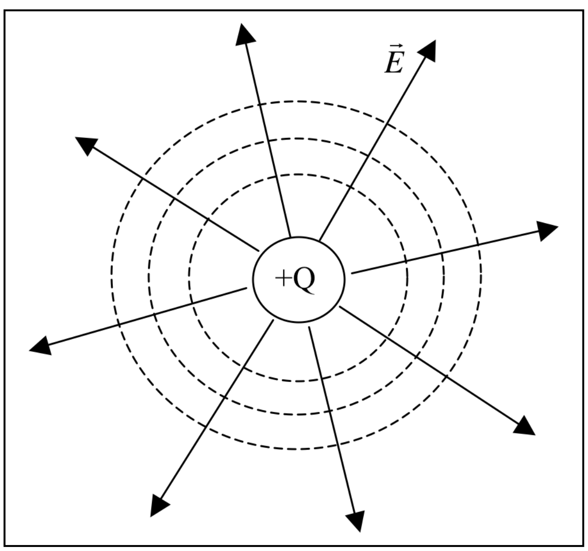
The changes in U depend on where you put your test charge.

➔ A convenient way to express the relationship between the electric potential energy and where you put your test charge is called: **Electric Potential = V**

$$V \equiv \frac{U}{q} = \frac{-W_{elec}}{q}$$

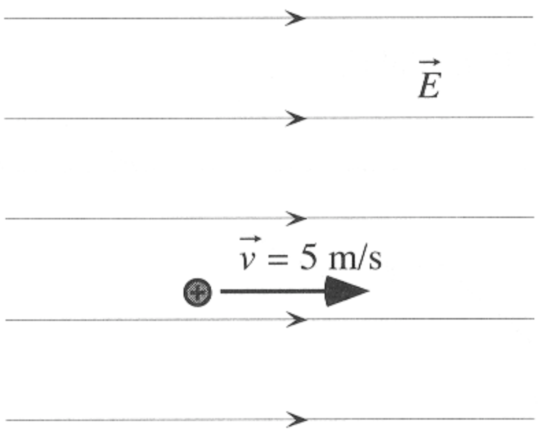
$V = \frac{kQ}{r}$ for a point charge of charge +Q

V increases in a direction opposite to the E-field vector



Dashed Circles = **<u>Equipotential Surfaces</u>**

- Always $\perp$ to E-field lines
- V = constant on an equipotential surface



At the instant shown, a positively charged particle is moving at 5 m/s in the direction of a uniform electric field. Someone makes the following statement:

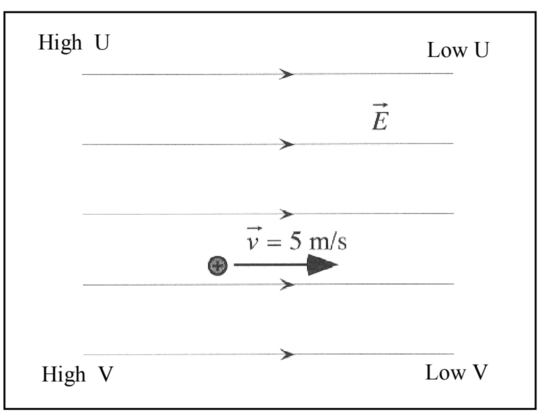
"As the particle continues to move in the direction of the electric field, the particle will gain potential energy since it is moving in the direction of increasing electric potential energy."

What, if anything, is wrong with the above statement? If something is wrong, explain the error and how to correct it. If the statement is valid, explain.

➔ By definition: V increases in a direction opposite to the E-field.

➔ So, since E is directed to the right, V decreases in the direction that the charge is moving.

➔ Since V = U/q, then U also decreases in the direction that the charge is moving.



➔ Use a voltmeter to measure V

➔ If V increases in the +y direction, then you know the E-field points in the –y direction.

If the potential increases as you move from point P in the +x-direction, but the potential does not change as you move from P in the y- or z-directions, what is the direction of the electric field at P?

If we know the potential at a single point, what (if anything) can we say about the magnitude of the electric field at that same point?

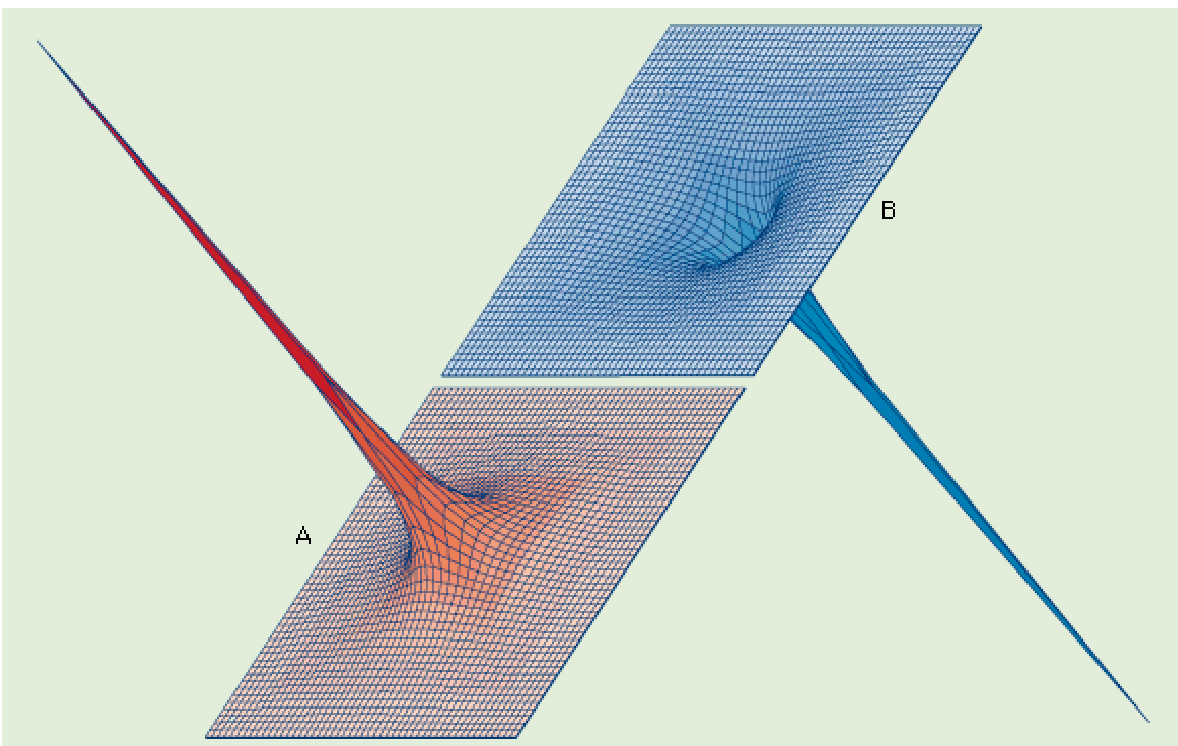
To know anything about the E-field, you need more than one potential measurement (voltage). You need to know how the potential is changing to be able to understand the nature of the E-field.

$$\text{Potential difference} = \Delta V = V_2 - V_1 = -\frac{W_{elec}}{q}$$

➔ ΔV between two points tells you how much work it takes to move a test charge, q, from point 1 to point 2.

- Sometimes it is "difficult" to move the charge from 1 to 2, this will take +W
- If it is "easy" to move the charge from 1 to 2, it will take –W
- W ~ F•d so the work tells you something about the force on the charge
- F = qE so the force tells you something about the E-field.

Electric Potential due to a point charge as a function of position:



A: V due to a +Q; B: V due to a –Q

What if we had more than one point charge? How does that affect the potential?

➔ Just like we did with the electric potential energy, U_e, we can add up the potentials.

http://phet.colorado.edu/simulations/sims.php?sim=Charges_and_Fields

Simulation: Three point charges: q_1, q_2, q_3

➔ calculate the potential, V, at some point A.

➔ calculate the potential, V, at some point B.

➔ calculate the potential difference, ΔV

Conservation of Energy: $\Delta K + \Delta U_e = 0 \quad \Rightarrow \quad \Delta K + q\Delta V = 0$

A Battery has a "voltage" = potential difference (such as a 9-V battery).

➔ Battery does work to keep the + and – charges separated ➔ chemical energy

➔ chemical energy is converted into electric potential energy, U_e

➔ The amount of electric potential energy stored per charge is ΔV (= 9 V)