Potential Energy

- Total electric potential energy, U, of a system of charges is obtained from the work done by an external F, (W^*) to assemble the system, bringing each charge in from ∞. In terms of work done by the field, $W^* = -W$.

- Bring q_1 from ∞, $W^* = 0$ since no electric F yet

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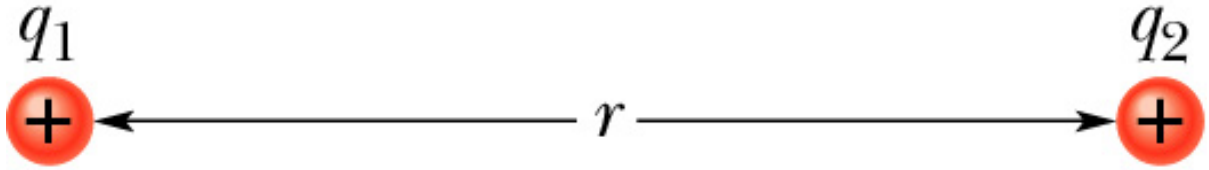
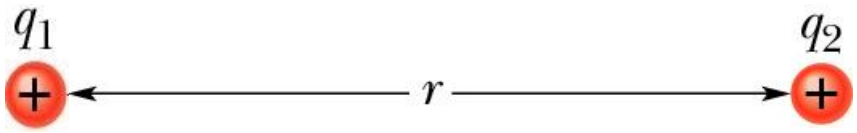


- Bring q_1 from ∞, *W** = 0 since no electric *F* yet

Potential Energy (Fig. 25-16)

- Potential due to q_1 is

$$V = k\frac{q_1}{r}$$



- Bring q_2 in from infinity. From definition of potential energy

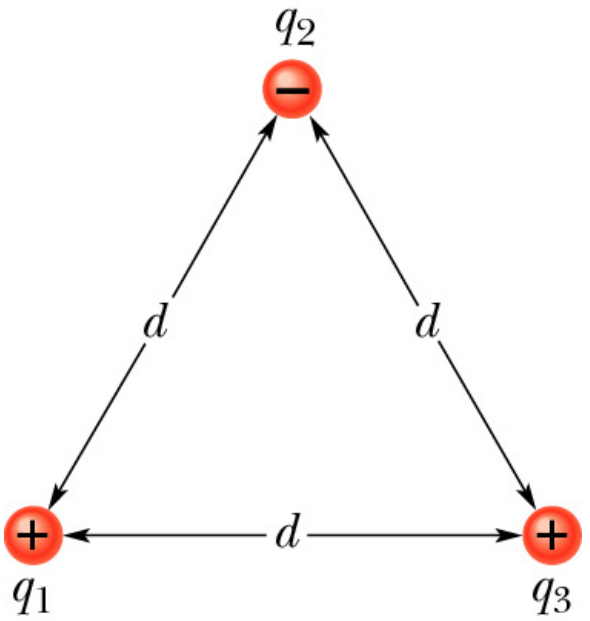
$$U = -W = W^* = q_2 V = k\frac{q_1 q_2}{r} \quad \text{or} \quad U = k\frac{q_1 q_2}{r}$$

- Charges of like sign, W^* and U are +
- Charges of opposite sign, W^* and U are -

Potential Energy

- What is the potential energy when add an additional charge to system?

- Move q_1 from ∞, $W^* = U = 0$
- Move q_2 from ∞



$$W^*_{12} = U_{12} = k\frac{q_1 q_2}{d}$$

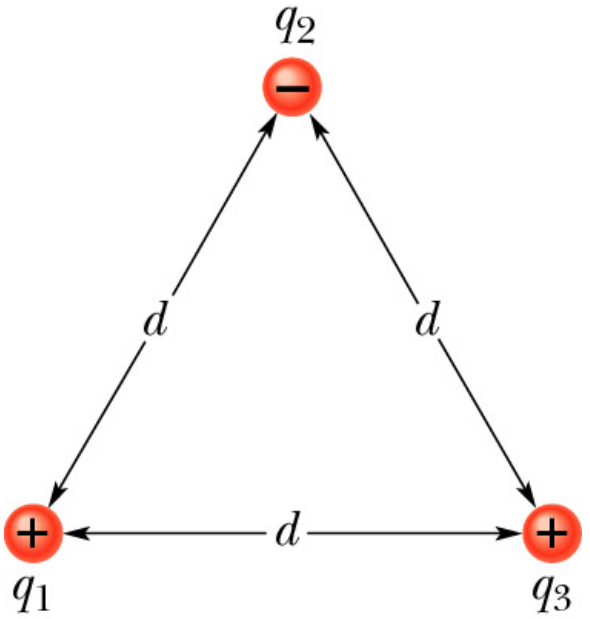
Potential Energy (Fig. 25-17)

- Now bring in q_3

$$W^*_{13} = U_{13} = k\frac{q_1 q_3}{d}$$

- Must also remember q_2

$$W^*_{23} = U_{23} = k\frac{q_2 q_3}{d}$$

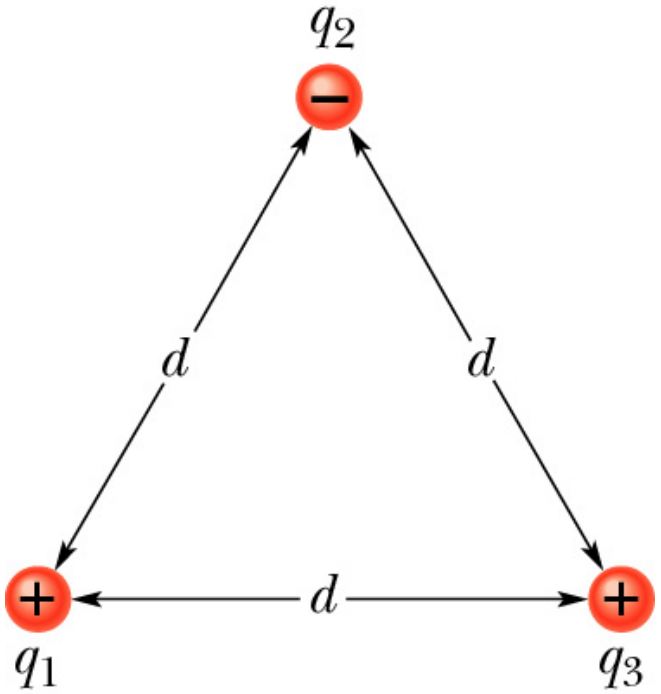


Potential Energy

- Total potential energy is the scalar sum

$$U = U_{12} + U_{13} + U_{23}$$

$$q_1 = +q, \quad q_2 = -4q, \quad q_3 = +2q$$

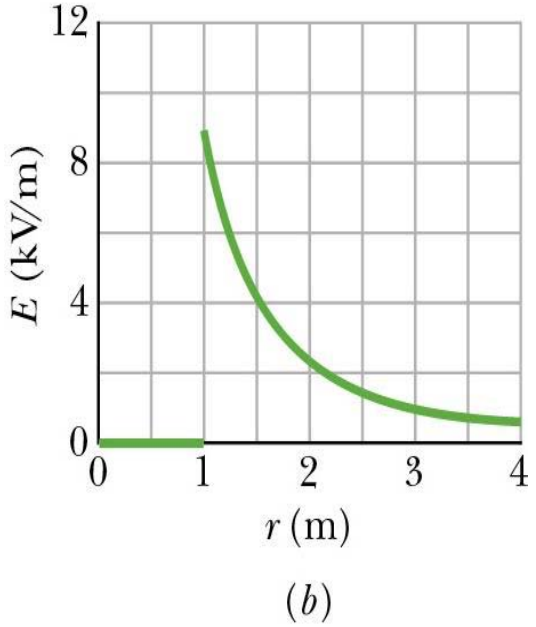


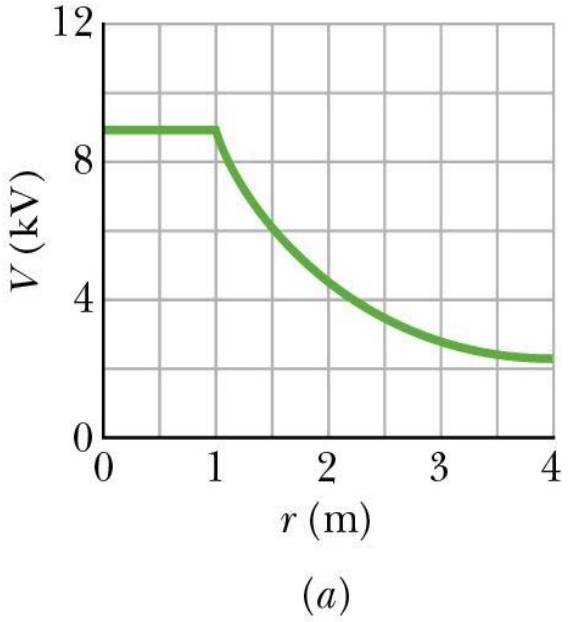
$$U = k\left(\frac{(+q)(-4q)}{d} + \frac{(+q)(+2q)}{d} + \frac{(-4q)(+2q)}{d}\right) = -k\frac{10q^2}{d}$$

Electric Potential for Conductors

- Using what we know about conductors
  - $E = 0$ inside
  - All excess charge is on surface
- All points of a conductor – whether inside or on the surface – are at the same potential
  - A conductor is an equipotential

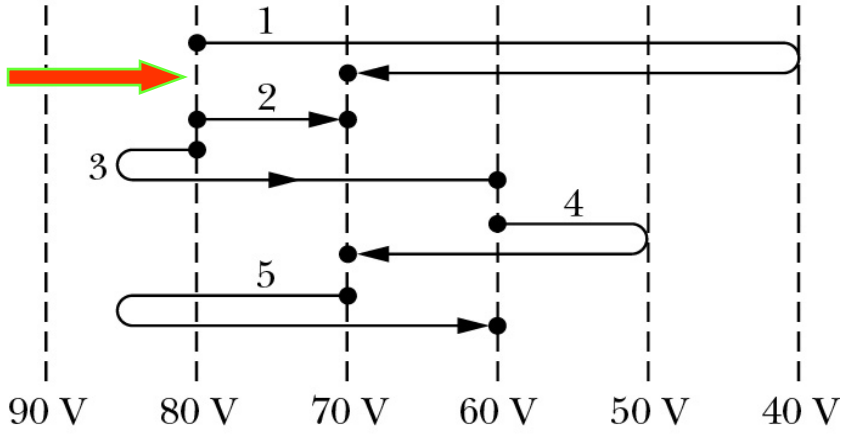
Electric Potential for Conductors (Fig. 25-18)





Electric Potential (Checkpoint #3)

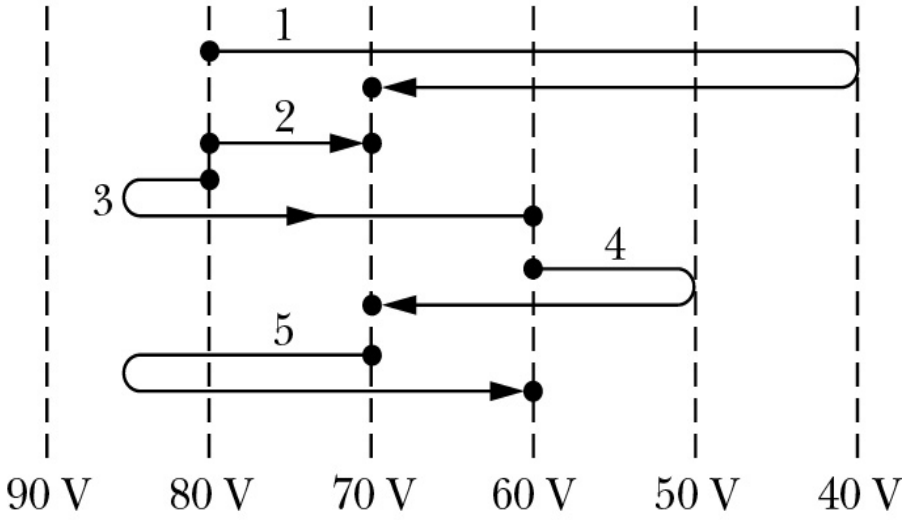
- An electron moves along 5 different paths between parallel equipotential surfaces
- a) What is the direction of the E associated with the surfaces?



- Positive potentials which decrease going to the right.

Electric Potential (Exercise)

- b) Rank the paths by amount of work we do (greatest first).



$$W^* = -W = q\Delta V$$

$$W^* = q\left(V_f - V_i\right)$$

- Electron gives $W^*_{Path-1} = -q(70-80) = +10q$

3, then 1 & 2 & 5, last 4