

Conceptual Questions

19.1 Electric Potential Energy: Potential Difference

1.

Voltage is the common word for potential difference. Which term is more descriptive, voltage or potential difference?

2.

If the voltage between two points is zero, can a test charge be moved between them with zero net work being done? Can this necessarily be done without exerting a force? Explain.

3.

What is the relationship between voltage and energy? More precisely, what is the relationship between potential difference and electric potential energy?

4.

Voltages are always measured between two points. Why?

5.

How are units of volts and electron volts related? How do they differ?

19.2 Electric Potential in a Uniform Electric Field

6.

Discuss how potential difference and electric field strength are related. Give an example.

7.

What is the strength of the electric field in a region where the electric potential is constant?

8.

Will a negative charge, initially at rest, move toward higher or lower potential? Explain why.

19.3 Electrical Potential Due to a Point Charge

9.

In what region of space is the potential due to a uniformly charged sphere the same as that of a point charge? In what region does it differ from that of a point charge?

10.

Can the potential of a non-uniformly charged sphere be the same as that of a point charge? Explain.

19.4 Equipotential Lines

11.

What is an equipotential line? What is an equipotential surface?

12.

Explain in your own words why equipotential lines and surfaces must be perpendicular to electric field lines.

13.

Can different equipotential lines cross? Explain.

19.5 Capacitors and Dielectrics

14.

Does the capacitance of a device depend on the applied voltage? What about the charge stored in it?

15.

Use the characteristics of the Coulomb force to explain why capacitance should be proportional to the plate area of a capacitor. Similarly, explain why capacitance should be inversely proportional to the separation between plates.

16.

Give the reason why a dielectric material increases capacitance compared with what it would be with air between the plates of a capacitor. What is the independent reason that a dielectric material also allows a greater voltage to be applied to a capacitor? (The dielectric thus increases C and permits a greater V .)

17.

How does the polar character of water molecules help to explain water's relatively large dielectric constant? (Figure 19.18)

18.

Sparks will occur between the plates of an air-filled capacitor at lower voltage when the air is humid than when dry. Explain why, considering the polar character of water molecules.

19.

Water has a large dielectric constant, but it is rarely used in capacitors. Explain why.

20.

Membranes in living cells, including those in humans, are characterized by a separation of charge across the membrane. Effectively, the membranes are thus charged capacitors with important functions related to the potential difference across the membrane. Is energy required to separate these charges in living membranes and, if so, is its source the metabolism of food energy or some other source?

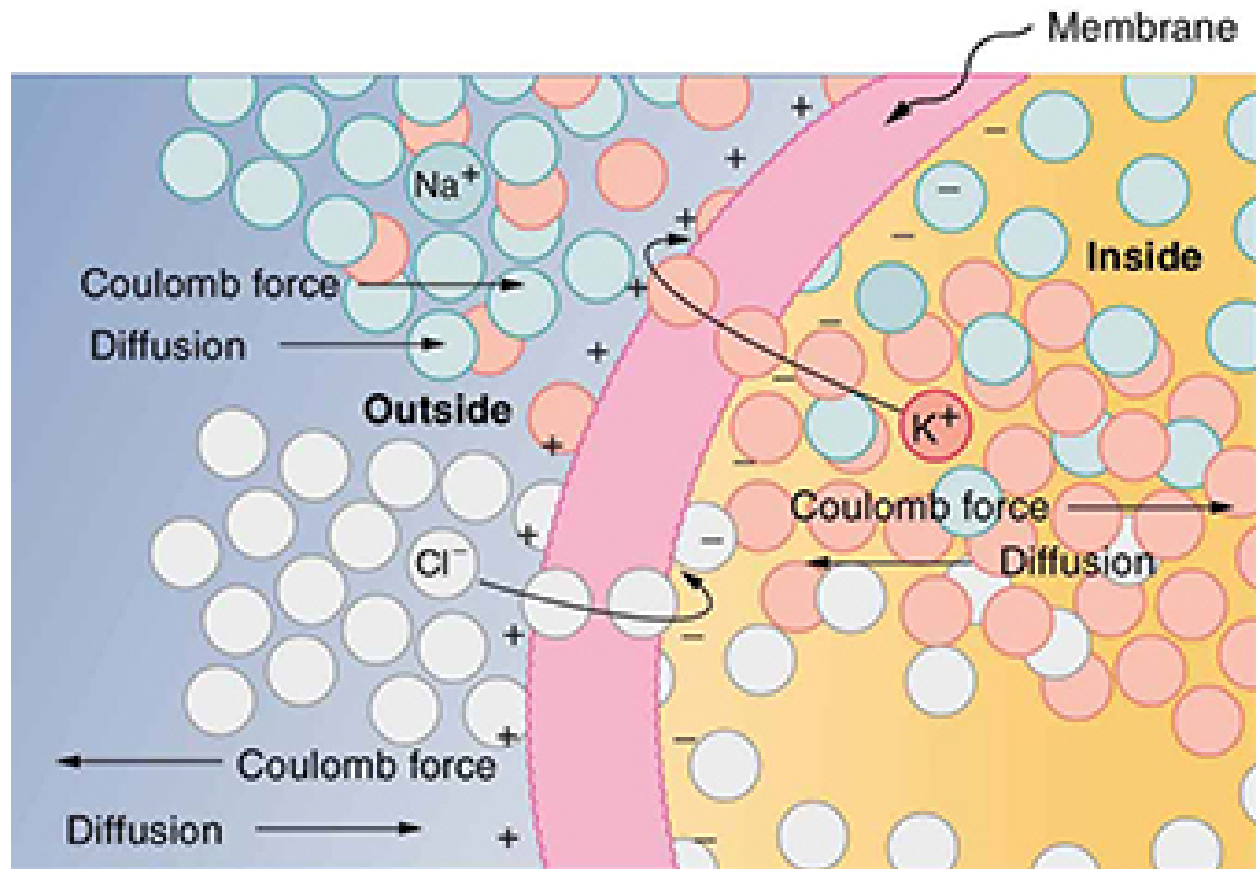


Figure 19.24 The semipermeable membrane of a cell has different concentrations of ions inside and out. Diffusion moves the K^+ (potassium) and Cl^- (chloride) ions in the directions shown, until the Coulomb force halts further transfer. This results in a layer of positive charge on the outside, a layer of negative charge on the inside, and thus a voltage across the cell membrane. The membrane is normally impermeable to Na^+ (sodium ions).

19.6 Capacitors in Series and Parallel

21.

If you wish to store a large amount of energy in a capacitor bank, would you connect capacitors in series or parallel? Explain.

19.7 Energy Stored in Capacitors

22.

How does the energy contained in a charged capacitor change when a dielectric is inserted, assuming the capacitor is isolated and its charge is constant? Does this imply that work was done?

23.

What happens to the energy stored in a capacitor connected to a battery when a dielectric is inserted? Was work done in the process?