# Summary for

# The Electric Field & How Radio Works

## PHYSICS

- The electric field $E$ is defined as force per unit charge: $E = F/q$. The unit of $E$: newton per coulomb (N/C).
- It represents the influence of a charge in space, independent of any specific test charge. It always exists around the charge and its effects can be made seen by placing a test charge.
- The test charge is taken to be infinitesimally small so it does not alter the field it measures and is always positive, as a consequence field lines point outward from positive charges and inward toward negative ones.
- Field direction: direction in which a positive charge would feel the force.
- The field of a point charge decreases with distance squared: $E = kQ/r^2$. but never fully vanishes, extending theoretically to infinity. At Large distances, it becomes noise due to super-positioning with everything else.
- Superposition principle: multiple electric fields add vectorially.
- Antennas exploit oscillating electric fields — moving electrons generate time-varying currents. So: A receiver antenna's electrons oscillate in response to the incoming field, producing an electrical signal. The oscillation frequency corresponds to the signal frequency (radio waves).
- Comparison: gravity is always attractive, while electric forces can be attractive or repulsive.
- Most objects are neutral, since massive electrostatic force pushes to equilibrium.
- The electric force between two electrons is roughly $10^{42}$ times stronger than their gravitational attraction.

# TOOLBOX

- Visualizing: A continuous data set (such as field vectors) can be sampled discretely at chosen positions to show overall run and avoid clutter.