1. The silver/light-gray material is metal, the dark-gray material between the metal is oxide, and the material at the very bottom is semiconductor. There are 12 visible layers of metal in the cross section image of the chip.
2. $V = IR$ where V is voltage, I is current, and R is resistance
   $\rightarrow I = V / R$
   $V = E L$ where E is the electric field and L is length
   $j = I / A$ where j is current density, I is current, and A is cross-sectional area
   $= V / (RA)$ substitute I equation in terms of V and R
   $= EL / RA$ substitute V equation in terms of E and L
   $= \sigma E$ where $\sigma = L / RA$ (conductance)
   $= q v n$ substitute $j = qvn$ where q is charge, v is velocity of charge, and n is number of carriers per volume
   $\sigma E = q v n \rightarrow v = (\sigma / q n) E \rightarrow v = \mu E$ where μ is mobility of charged carriers
3. $F = qE - mv / \tau = 0$ where F is the force on a moving charge, q is the charge of the particle, E is the electric field, m is the mass of the charge, v is the velocity of the charge, and τ is the avg time between 2 collisions
   $\rightarrow v = (q \tau / m) E = \mu E \rightarrow \mu = q \tau / m$
   $j = n q v$ where q is charge, v is velocity of charge, and n is number of carriers per volume
   $= n q * (q \tau / m) E$ substitute v equation in terms of q, τ, m, and E
   $= (n q^2 \tau / m) E$ simplify
   $= \sigma E$ substitute $j = \sigma E$
   $(n q^2 \tau / m) E = \sigma E \rightarrow (n q^2 \tau / m) = \sigma$
4. $j = n q \mu E = \sigma E \rightarrow \sigma = n q \mu$
   The material used for interconnects should have a high conductivity and low resistivity. From the equation above, the conductivity is directly related to both the mobility and carrier density. Al has 2.33 times the carrier density of Cu, but Cu has 3.6 times the mobility of Al. Therefore, Cu has a higher conductivity than Al and should be used for interconnects in advanced CMOS nodes.
5. Yes, the piece of Si wager is still neutral because doping the wafer with neutral atoms does not change the charge of the material. If a neutral piece of pure Si is doped with neutral P atoms, the material is still charge neutral. Despite the extra free electrons, there are now more protons in the wafer that cancels out the negative charges from the electrons. The same idea for Al. Doping a pure Si wafer with neutral Al atoms will not change the overall charge of the wafer.