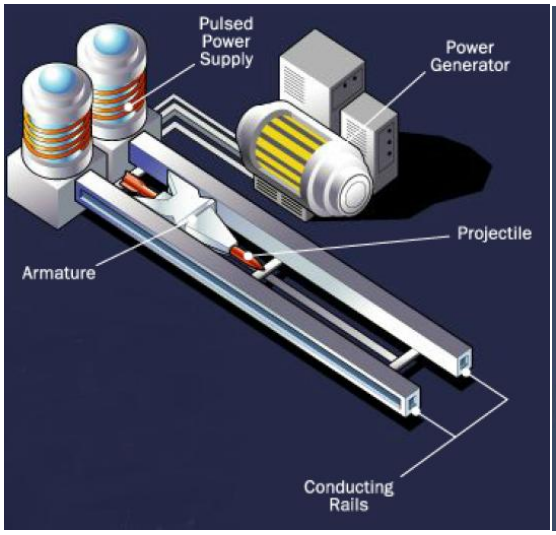
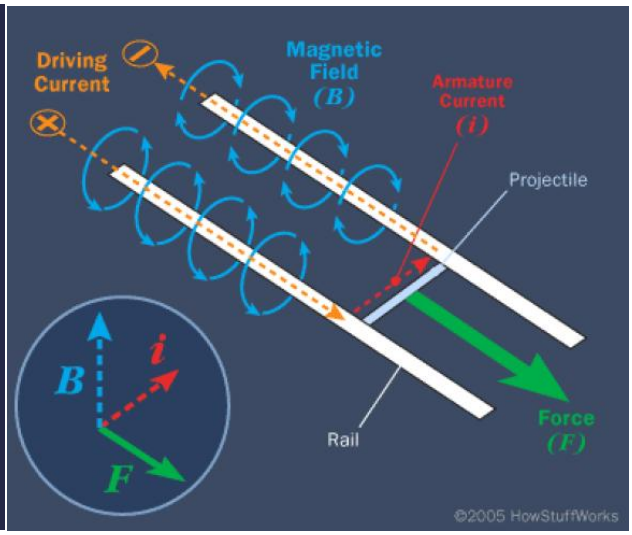
HW7_2

1. Read the following paper:
   http://physics.niser.ac.in/labmanuals/sem6/four_point_resi_ajp2k3.pdf
   a. Explain why one would use the four point probe technique rather than a 2 point probe technique to determine the resistivity of a silicon wafer.
   b. Explain why the current density has no component that is perpendicular to the water tray near the edge of the water tray.
   c. Explain in your own words why the measured resistance will be twice as large if we would place the electrodes at the edge of the water tray.
   d. Derive equation (1) of the paper from the continuity equation and the E-V relation we introduced in chapter 2.





2. A. We are testing the rail gun sketched in the left figure above. A projectile is positioned on top of two conducting rails and can slide over it. A current source that can provide a large current pulse is connected to the end of the rails. The housing of the projectile completes the circuit, i.e. current source, rail 1, projectile, rail 2, current source. When the current source is switched on a large force is exerted on the projectile parallel to the rails which propels the projectile along the rails away from the current source. Use the figure on the top right to explain the force that propel s the projectile along the rails.

B. Derive an equation for the magnetic field between the rails at the position of the projectile. Use the field of an infinite current carrying conductor and superposition.

C. The advantage of a rail gun is that it can make muzzle velocities twice larger than what is currently possible with explosive. This results in a larger firing range. Assume that the projectile has a mass of 20 kg. How much current is required to accelerate the projectile to 2000 m/s assuming the total length of the rail gun is 10 meters, and the rails are 1 meter apart?

D. How much time will it take for the projectile to accelerate from 0 to 2000 m/s?

3. A square loop of wire (side a) lies on a table, a distance s from a very long straight wire which carries a current I, as shown.

a) Find the flux of B through the loop.

b) If someone pulls the loop directly away from the wire at speed v, what emf is generated? In what direction does current flow?

c) What if the loop is pulled to the right instead?