

PEASE'S 1993 QUALS QUESTION

1. Define the Ampere.

2. How do you measure current (absolutely)?

3. Given that charge is quantized (in integral multiples of q) should not a low current have appreciable fluctuations? How big would these fluctuations be if we measured a current of 0.1 pA (1 electron / μs) with a bandwidth of 10 KHz (i.e. integration times of about $100 \mu\text{s}$)?

4. If we measured current by observing (say, with a scanning tunneling microscope) the deposition of silver atoms at the cathode in an electrolytic cell would we see fluctuations corresponding to the Poisson distribution i.e. a mean deposition rate of 100 electrons/ $100 \mu\text{s}$ (corresponding to the 10 KHz bandwidth) and a standard deviation of $\sqrt{100}$ or 10% of the mean? Do not understand. for Poisson $E(x) = \text{Var}(x)$?

5. If we measured current by measuring the force between two wires carrying the current (fig. 1) would the force fluctuations be averaged out over the huge number of electrons in the wires (note the small dimensions to allow a bandwidth of 10 KHz)? How many electrons are there?

6. If we introduced a pn junction diode into the circuit (fig. 2) would this change the fluctuations observed? Give reasons.

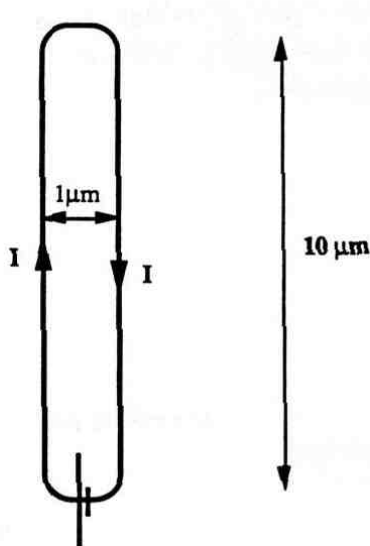


fig. 1

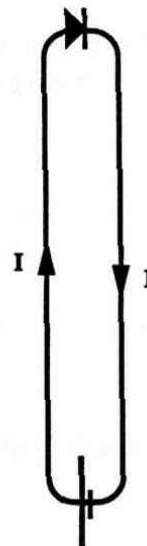


fig. 2

In each case the wire diameter is $0.1 \mu\text{m}$ and the current is measured by measuring the force between the long arms of the wire with a very sensitive sensor (e.g. AFM).