Chapter-26

1. A Van de Graaff generator (see Problem 24) produces a beam of 2.00-MeV deuterons, which are heavy hydrogen nuclei containing a proton and a neutron. (a) If the beam current is 10.0 *µ*A, what is the average separation of the deuterons? (b) Is the electrical force of repulsion among them a significant factor in beam stability? Explain.

Ans: (a) We obtain the speed of each deuteron from:

 

 The time between deuterons passing a stationary point is *t* in , so

 

 So the distance between individual deuterons is

 *vt* = (1.38 × 107 m/s)(1.60 × 10–14 s) = 

 (b) One nucleus will put its nearest neighbour at potential

 

 This is very small compared to the 2 MV accelerating potential, so repulsion within the beam is a small effect.

1. Suppose you wish to fabricate a uniform wire from 1.00 g of copper. If the wire is to have a resistance of *R =* 0.500 Ω and all the copper is to be used, what must be (a) the length and (b) the diameter of this wire?

 (a) Given total mass  where
 mass density.

 Taking  resistivity, 

 Thus,

 

 (b) , or 

 Thus,

 

 The diameter is twice this distance: diameter 

1. An aluminum wire with a diameter of 0.100 mm has a uniform electric field of 0.200 V/m imposed along its entire length. The temperature of the wire is 50.0°C. Assume one free electron per atom. (a) Use the information in Table 26.2 to determine the resistivity of aluminum at this temperature. (b) What is the current density in the wire? (c) What is the total current in the wire? (d) What is the drift speed of the conduction electrons? (e) What potential difference must exist between the ends of a 2.00-m length of the wire to produce the stated electric field?

(a) The resistivity is computed from 

 

 (b) The current density is

 

 (c) The current density is related to the current by 

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 (d) The mass density gives the number-density of free electrons; we assume that each atom donates one conduction electron:

 

 Now *J* = *nqvd* gives the drift speed as

 

 The sign indicates that the electrons drift opposite to the field and current.

 (e) The applied voltage is 

1. The cost of energy delivered to residences by electrical transmission varies from $0.070/kWh to $0.258/kWh throughout the United States; $0.110/kWh is the average value. At this average price, calculate the cost of (a) leaving a 40.0-W porch light on for two weeks while you are on vacation, (b) making a piece of dark toast in 3.00 min with a 970-W toaster, and (c) drying a load of clothes in 40.0 min in a 5.20 X 103-W dryer.

 You pay the electric company for energy transferred in the amount
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 (a) 

 (b) 

 (c) 