FINAL EXAM, PART A (100 Points, Show All Work)

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Phy 7B
8-14-02

8 Points Each

1. The molar mass of hydrogen is 1.008 g/mole. Calculate the mass of one hydrogen atom.

12 Points Each

2. Figure 1 shows a uniform ring charge of radius a, and total charge +Q. Calculate the electric field, magnitude & direction, at a point P on the axis of the ring at a distance x from the center of the ring.

3. Find the currents I_1, I_2, and I_3 as labeled in Figure 2.

16 Points Each

4. An infinite plane of surface charge density $\sigma = +8$ nC/m^2 lies in the yz plane at the origin ($x = 0$), and a second infinite plane of surface charge density $\sigma = -8$ nC/m^2 lies in a plane parallel to the yz plane at $x = 3$ m. Find the electric field at:
   a) $x = 1.5$ m.
   b) $x = 6$ m.

5. A parallel plate capacitor has square plates of side 10 cm and a separation of 4 mm. A dielectric slab of constant $k = 2$ has the same area as the plates, but has a thickness of 3 mm.
   a) What is the capacitance without the dielectric?
   b) What is the capacitance with the dielectric?

6. A 4 μF capacitor is charged to 24 V and then connected across a 200 Ω resistor.
   a) Find the initial charge on the capacitor (at the time of connection to the 200 Ω resistor).
   b) Find the initial current through the 200 Ω resistor.
   c) Find the time constant.
   d) Find the charge on the capacitor 4 ms after the capacitor is connected to the 200 Ω resistor.

20 Points

7. Figure 3 shows a curved path in which a gas is taken from state a to state c and 80 J of heat leave the system and 55 J of work are done <u>on</u> the system.
   a) Determine the change in internal energy, $U_c - U_a$.
   b) When the gas is taken along the path cda, the work done <u>by</u> the gas is 38 J. How much heat Q is added to the gas in the process cda?
   c) If $P_a = 2.5\ P_d$, how much work is done by the gas in the process abc?
   d) What is Q for the path abc?
   e) If $U_a - U_b = 10$ J, what is Q for the process bc?

<u>Possibly Useful Constants</u>
$k = 9 \times 10^9$ N-m^2/C^2
$\mu_o = 4\pi \times 10^{-7}$ T-m/A
$\varepsilon_o = 8.85 \times 10^{-12}$ C^2/N-m^2
$R = 8.31$ J/mole-K
$N_A = 6.02 \times 10^{23}$ atoms/mole

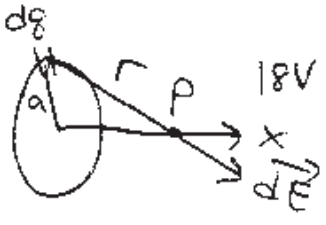

Figure 1

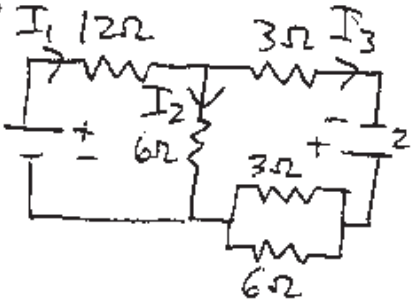

Figure 2

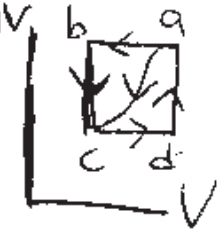

Figure 3