Name: (illegible) Answers

AP E&M Unit 3 – Worksheet 1 - Capacitors

1. The inner and outer cylindrical conductors have radius 0.14 mm and 2.3 mm respectively. What is the capacitance of a 4 cm long piece of this wire? If 3 Volts is applied across the capacitor, how much energy could be stored?

$C = \frac{2\pi\varepsilon L}{\ln(b/a)}$

a) $C = \frac{(2)(\pi)(\varepsilon_0)(4\text{E-}2)}{\ln(2.3\text{E-}3/.14\text{E-}3)}$

$C = 7.9\text{E-}13\ F$

b) $U = \frac{1}{2}CV^2$

$U = 3.6\text{E-}12\ J$

2. What is the capacitance of the moon viewed as an isolated conductor? The moon's radius is approximately 1738 km.

$C = 4\pi\varepsilon_0 R = (4\pi\varepsilon_0)(1738\text{E}3)$

$C = 1.9\text{E-}4\ F$

3. A spherical capacitor has been created so the inner sphere has a radius of 0.5 mm and the outer sphere has a radius of 2mm.
   a. If the insulator that is separating them has a dielectric constant of 2.5, what is the capacitance of the sphere?
   b. With a 12 V potential difference, how much stored energy is in this capacitor when it is fully charged?

a) $C = \frac{K4\pi\varepsilon_0 ab}{b-a} = 1.85\text{E-}13\ F$

b) $U = \frac{1}{2}CV^2 = 1.33\text{E-}11\ J$

4. The plates of a spherical capacitor have radii of 25mm and 28 mm respectively. What must the area of a parallel plate capacitor be to have the same capacitance and separation as the spherical capacitor?

$C = 4\pi\varepsilon_0\left(\frac{ab}{b-a}\right)$

$C = 4\pi\varepsilon_0\left(\frac{(25\text{E-}3)(28\text{E-}3)}{28\text{E-}3 - 25\text{E-}3}\right)$

$C = 2.59\text{E-}11\ F$

$C = \frac{\varepsilon_0 A}{d}$

$2.59\text{E-}11 = \frac{\varepsilon_0 A}{3\text{E-}3}$

$A = 8.8\text{E-}3\ m^2$

5. In an attempt to design a cylindrical capacitor of 4E-6 F, you have two wires, one of radius 6cm, the other of radius 2.6 cm. If you are to separate these two conductors with a dielectric (dielectric constant of 4.5), how long would you need to make the wire?

$4\text{E-}6 = \frac{2\pi(4.5)(\varepsilon_0)L}{\ln(6/2.6)}$

$L = 13367.8\ m$