☺*Solution*: The potential of each sphere will be constant and we assume that the potential on the surface of the each sphere can be approximately found by taking the charged spheres as point charges.

An exact solution cannot be given by any of the methods covered in the class. Let $\vec{r_1}, \vec{r_2}$ denote the position vectors of the centers of the two spheres. We shall assume that the potential on the surface of each of the two spheres can be computed by assuming second seond sphere to be a point charge. Also the total potential is a superposition of potentials in this approximation.

(a) Before the two spheres are connected the potential of the first sphere is

$$\phi_1 \approx \frac{1}{4\pi\varepsilon_0}\left(\frac{q_1}{r_1} + \frac{q_2}{|\vec{r_1} - \vec{r_2}|}\right)$$

and the potential of the second sphere is

$$\phi_2 \approx \frac{1}{4\pi\varepsilon_0}\left(\frac{q_1}{|\vec{r_1} - \vec{r_2}|} + \frac{q_2}{r_2}\right)$$

Taking the values $r_1 = 1/10$, $r_2 = 1/100$, $|\vec{r} - 1 - \vec{r_2}| = 10$m and initial values of the charges are $q_1 = 100, \quad q_2 = 1$,

$$\therefore \phi_1 = (9 \times 10^9)\left(\frac{100}{1/100} + \frac{1}{10}\right) \approx 9 \times 10^{13} V$$

$$\phi_2 = (9 \times 10^9)\left(\frac{100}{10} + \frac{1}{1/10}\right) \approx 18 \times 10^{10}\,\text{V}$$

(b) When the two spheres are connected, the charge will flow from one to the other sphere till their potentials become equal. So if q_1 and q_2 are the charges after connecting the two spheres, $\phi_1 = \phi_2$ and we get

$$\frac{q_1}{r_1} + \frac{q_2}{d} = \frac{q_1}{d} + \frac{q_2}{r_2}$$

Also we have the total charge

$$q_1 + q_2 = 101 \times 10^{-8}$$

Thus we get

$$q_1 \approx \frac{101}{122} \times 11 \approx 9.107 \text{ coul} \qquad (1)$$

$$q_2 \approx \frac{101}{122} \times 111 \approx 91.893 \text{ coul} \qquad (2)$$