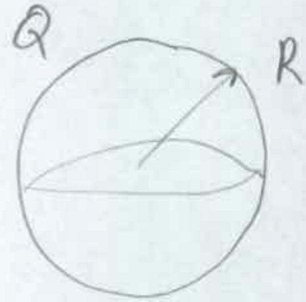
Homework 2, more problems

1) 

$$\boxed{\sigma = \frac{Q}{4\pi R^2}}$$

The electric field inside is 0, outside we use Gauss' theorem with a sphere of radius $r > R$:

$$\phi = AE = 4\pi r^2 E = \frac{Q}{\varepsilon_0}$$

$$E_{out} = \frac{Q}{4\pi \varepsilon_0 r^2}$$

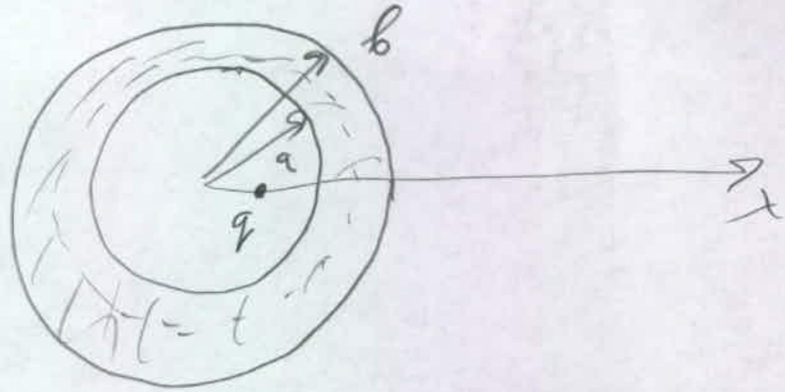
At the surface we can use the expression above with $r = R$:

$$E_{surface} = \frac{Q}{4\pi \varepsilon_0 R^2}$$

or we can use $E_{surface} = \frac{\sigma}{\varepsilon_0}$ for conductors which gives the same answer:

$$E_{surface} = \frac{\sigma}{\varepsilon_0} = \frac{Q}{4\pi \varepsilon_0 R^2} \quad \checkmark$$

2)



Imagine a Gaussian surface that runs inside the conductor, i.e. with radius $a<r<b$. The electric field inside the conductor is 0, so the flux is 0, which means the total charge inside is 0. This implies that the inner surface has charge $-q$, so the outer surface has to have charge $Q+q$. Anywhere outside the sphere the electric field will be that of a sphere with total charge $q+Q$, so at points

(i) $(2b, 0, 0)$ and (ii) $(-2b, 0, 0)$

the electric field will be in magnitude

$$E = \frac{Q+q}{4\pi\varepsilon_0 (2B)^2}$$

If we include the direction too, then

(i) $\underline{\vec{E} = \frac{Q+q}{4\pi\varepsilon_0 (2B)^2}\,\hat{i}}$ (ii) $\underline{\vec{E} = -\frac{Q+q}{4\pi\varepsilon_0 (2B)^2}\,\hat{i}}$

Point (iii) $((a+B)/2, 0, 0)$ is <u>inside</u> the conductor so

(iii) $\underline{\vec{E} = 0}$