ELECTROMAGNETISM ASSIGNMENT FOR THE FIRST TIME

HAIXUAN LIN - 23307110267

Abstract. Here is the electromagnetism assignment for the first time which is for the corse given by professor Weichao Liu. In order to practise the expertise in scientific film of physics, students need to practise using LaTeXto composing their own work, even if this is only a ordinary homework.

Main Text

1-1.

(1). Consider the classical model, according to Coulomb's law, and use the radius given in the problem as the Bohr radius as the distance between the electron and the hydrogen atom, we have

$$\boldsymbol{F}_{\mathrm{E}} = -\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^2}\hat{\boldsymbol{r}}$$

The $\hat{\boldsymbol{r}}$ is defined as $\vec{r}/r$ and $\vec{r}$ is the position vetor of electron with the hydrogen nuclei to be refrence point. After calculation we get

$$F_{\mathrm{E}} = 8.24 \times 10^{-8}\,\mathrm{N}$$

(2). Consider the classical model, according to law of universal gravitation, and use the radius given in the problem as the Bohr radius as the distance between the electron and the hydrogen atom, we have

$$\boldsymbol{F}_{\mathrm{G}} = -G\frac{m_{\mathrm{p}}m_{\mathrm{e}}}{r^2}\hat{\boldsymbol{r}}$$

Put in the data to get

$$F_{\mathrm{G}} = 3.63 \times 10^{-47}\,\mathrm{N}$$

The division of two forces is obtained

$$\frac{F_{\mathrm{E}}}{F_{\mathrm{G}}} = \frac{1}{4\pi\varepsilon_0 G}\frac{e^2}{m_{\mathrm{e}}m_{\mathrm{p}}}$$

Put in the data to get

$$\frac{F_{\mathrm{E}}}{F_{\mathrm{G}}} = 2.27 \times 10^{39}$$

(3). Considering the classical model, the Coulomb force provides the centripetal force of the electron moving in a circle around the nucleus of a hydrogen atom

$$-\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^2}\hat{\boldsymbol{r}} = -m_{\mathrm{e}}\frac{v_{\mathrm{e}}^2}{r}\hat{\boldsymbol{r}}$$

We conclude

$$v_{\mathrm{e}} = \sqrt{\frac{1}{4\pi\varepsilon_0}\frac{e^2}{mr}}$$

Put in the data to get

$$v_{\mathrm{e}} = 2.19 \times 10^6\,\mathrm{m/s}$$

1-6. Let the amount of charge carried by the oil drop be small enough that the amount of charge can be estimated discretely, look at the difference between two numerically similar numbers.

$$\begin{aligned} 8.204 \times 10^{-19} - 6.563 \times 10^{-19} &= 1.641 \times 10^{-19} \\ 13.13 \times 10^{-19} - 11.50 \times 10^{-19} &= 1.63 \times 10^{-19} \\ 18.08 \times 10^{-19} - 16.48 \times 10^{-19} &= 1.60 \times 10^{-19} \\ &\cdots \end{aligned}$$

So may as well guess

$$e = 1.63 \times 10^{-19}\,\mathrm{C}$$

1-9. Taking O point at the left end of the rod as the origin, the x-axis is established in the direction of the rod, and the Coulomb force on a point charge on the rod is investigated

$$\mathrm{d}\boldsymbol{F}_{\mathrm{c}} = \frac{1}{4\pi\varepsilon_0}\frac{\eta\mathrm{d}xq}{(l+a-x)^2}\hat{\boldsymbol{x}} = \frac{1}{4\pi\varepsilon_0}\frac{\eta_0\,(1-2x/l)\,\mathrm{d}xq}{(l+a-x)^2}\hat{\boldsymbol{x}}$$

And we do calculus

$$\boldsymbol{F}_{\mathrm{c}} = \int_0^l \frac{1}{4\pi\varepsilon_0}\frac{\eta_0\left(1-\frac{2x}{l}\right)q}{(l+a-x)^2}\mathrm{d}x\hat{\boldsymbol{x}} = \frac{1}{4\pi\varepsilon_0}\left[2\ln\left(1+\frac{l}{a}\right) - \frac{(2a+l)\,l}{a\,(a+l)}\right]\hat{\boldsymbol{x}}$$

References

Email address: 23307110267@m.fudan.edu.cn

Fudan University, Physics Department, China