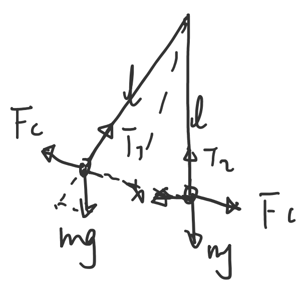
补充题

2022年3月3日 星期四 上午9:51

电磁学干题 y.

库仑定律.

6.

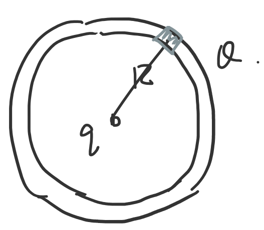


$\frac{F_c}{x} = \frac{T_1}{l} = \frac{mg}{l}$, $\frac{\frac{q_1 q_2}{4\pi\varepsilon_0 x^2}}{x} = \frac{mg}{l}$,

$\frac{q_1 q_2}{4\pi\varepsilon_0 x^3} = \frac{mg}{l}$. $x^3 = \frac{q^2 l}{4\pi\varepsilon_0 mg}$.

$x' = \frac{x}{2}$, $m' = 8m$.

19.



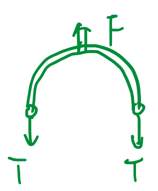
$dQ = \lambda dl = \frac{Q}{2\pi R} \cdot R d\theta = \lambda R d\theta$

$F_c = 2T \sin\frac{d\theta}{2} = T d\theta$.

$\frac{q dQ}{4\pi\varepsilon_0 R^2} = T d\theta$.

$\therefore \frac{\frac{qQ}{2\pi R} \times R d\theta}{4\pi\varepsilon_0 R^2} = T d\theta$, $T = \frac{qQ}{8\pi^2 \varepsilon_0 R^2}$. $dF = \frac{qQ}{8\pi^2\varepsilon_0 R^2} d\theta$

半圆环.

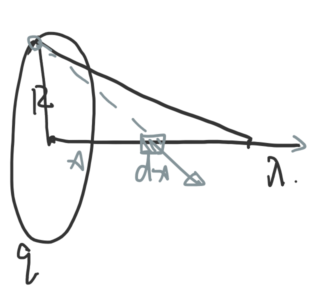


$F = \int_0^\pi dF \cos(\frac{\pi}{2} - \theta)$

$= \frac{qQ}{8\pi^2\varepsilon_0 R^2} \int_0^\pi \sin(\frac{\pi}{2} - \theta) d\theta = \frac{qQ}{4\pi^2\varepsilon_0 R^2}$.

$\therefore T = \frac{F}{2} = \frac{qQ}{8\pi^2\varepsilon_0 R^2}$

21.



$\lambda_0 = \frac{q}{2\pi R}$. $dq = \lambda_0 dl = \frac{q}{2\pi R} \times R d\theta = \frac{q}{2\pi} d\theta$

对 dx. $dF = \int_0^{2\pi} \frac{dq \cdot dQ}{4\pi\varepsilon_0 (R^2 + x^2)} \frac{x}{\sqrt{R^2+x^2}}$

$= \frac{\frac{q}{2\pi}}{4\pi\varepsilon_0} \int_0^{2\pi} d\theta \frac{x}{\sqrt{R^2+x^2}} d\theta$

$= \frac{q}{4\pi\varepsilon_0} \frac{x}{\sqrt{R^2+x^2}} d\theta$. $\hat{x}$

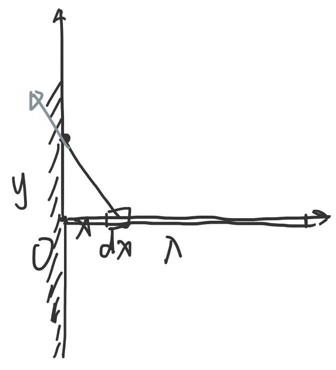
$F = \int_0^{+\infty} \frac{q}{4\pi\varepsilon_0} \frac{x}{(R^2+x^2)^{\frac{3}{2}}} \lambda dx$

$= \frac{\lambda q}{2\pi\varepsilon_0} \int_0^{+\infty} \frac{dx^2}{(R^2+x^2)^{\frac{3}{2}}}$ $(x^2+R^2)^{-\frac{1}{2}} = (x^2+R^2)^{\frac{3}{2}}$

$= -\frac{\lambda q}{2\pi\varepsilon_0} \times 2 \frac{1}{\sqrt{x^2+R^2}} \Big|_0^{+\infty} = \frac{\lambda q}{4\pi\varepsilon_0 R}$

电场强度.

14.



$dq = \lambda dx$

$d\vec{E} = \frac{1}{4\pi\varepsilon_0} \frac{\lambda dx}{x^2+y^2} \vec{e}_x$.

$dE_x = \frac{\lambda}{4\pi\varepsilon_0} \frac{dx}{x^2+y^2} \times \frac{y}{\sqrt{x^2+y^2}}$.

$d\vec{E}_y = \frac{\lambda}{4\pi\varepsilon_0} \frac{dx}{x^2+y^2} \cdot \frac{x}{\sqrt{x^2+y^2}}$.

$E_x = \frac{\lambda y}{4\pi\varepsilon_0} \int_0^\infty \frac{1}{(x^2+y^2)^{\frac{3}{2}}} dx = \frac{\lambda}{4\pi\varepsilon_0 y} \times \frac{x}{(x^2+y^2)^{\frac{1}{2}}} \Big|_0^\infty$

$\frac{x}{(x^2+y^2)^{\frac{1}{2}}} = \frac{(x^2+y^2)^{\frac{1}{2}} - x \frac{x}{(x^2+y^2)^{\frac{1}{2}}}}{(x^2+y^2)} = \frac{y^2}{(x^2+y^2)^{\frac{3}{2}}}$

$= \frac{\lambda}{4\pi\varepsilon_0 y} \lim_{x\to+\infty} \frac{x}{\sqrt{x^2+y^2}} = \frac{\lambda}{4\pi\varepsilon_0 y}$.

$E_y = \frac{\lambda y}{4\pi\varepsilon_0} \frac{1}{y^2\sqrt{x^2+y^2}} \Big|_0^\infty = -\frac{\lambda}{4\pi\varepsilon_0 y}$