Answer on Question #61347-Physics-Electromagnetism

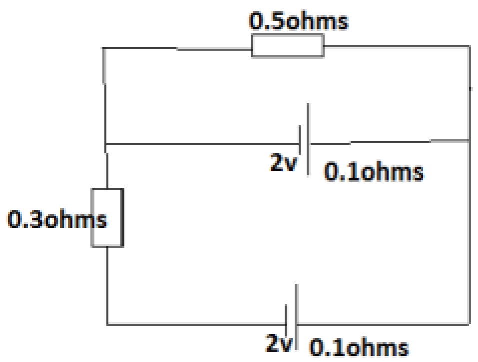
1 In the circuit shown, each of the cells has an emf of 2V and internal resistance of 0.1Ω. Find the current in through the 0.5Ω

a) 0.13A

b) 3.45A

c) 1.27A

d) 2.44A



Solution

We use Kirchhoff's laws:

$$\begin{cases} 2 - 0.1I_2 - 0.5I_3 = 0 \\ 2 - 0.1I_2 - 2 + 0.3I_1 + 0.1I_1 = 0 \rightarrow I_1 = \frac{1}{4}I_2 \\ I_3 = I_2 - I_1 \end{cases}$$

$$I_3 = I_2 - I_1 = \frac{3}{4}I_2$$

$$2 - 0.1\frac{4}{3}I_3 - 0.5I_3 = 0$$

$$I_3 = \frac{2}{0.1\frac{4}{3} + 0.5} = 3.16\ A.$$

2) Calculate the electric field everywhere outside of a very long rod, radius r and charged to a uniform linear charge density λ.

a) E⃗ =λπrϵ0r^

b) E⃗ =λπϵ0ln1rr^

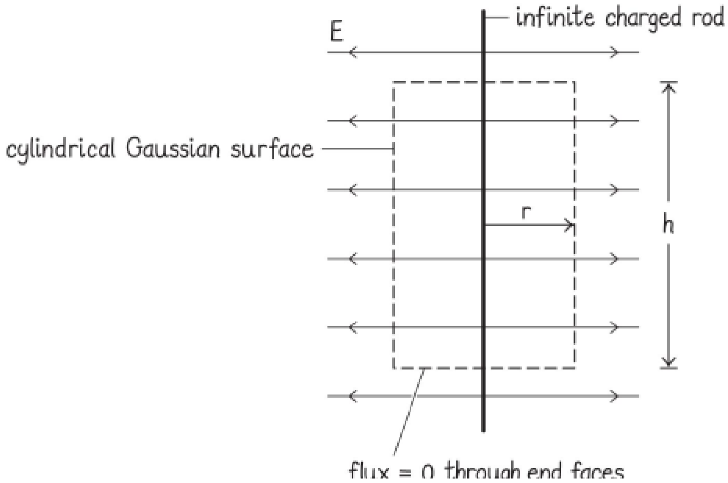
c) E⃗ =λ2πrϵ0r^

d) E⃗ =λ2πϵ0ln1rr^

Solution

An infinitely long rod has cylindrical symmetry. We assume the rod's diameter is vanishingly small. From the symmetry of the problem, we know that the electric field points radially outward. We therefore make a sketch showing the rod and a few representative field lines.

We draw a cylindrical Gaussian surface of radius r and height h around the rod.



The cylinder encloses a length h of the rod, so the enclosed charge is:

$$q_{enc} = \lambda h$$

The electric flux through the top and bottom faces of the Gaussian surface is zero because the electric field is parallel to those faces. We also know that symmetry requires the electric field to have the same magnitude E at each position on the cylindrical part of the surface. We can therefore pull the electric field out of the integral. The electric flux through that part of the surface is E

$$\Phi_E = \oint_{cylinder\ surface} \vec{E} \cdot \overrightarrow{dA} = \int E dA = E \int dA$$

The area of the cylindrical surface is equal to the circumference of the cylinder, $2\pi r$, times its height h, so the electric flux becomes

$$\Phi_E = E(2\pi r h)$$

Substituting our results for q_{enc} and Φ_E into the expression for Gauss' law, we obtain

$$E(2\pi r h) = \frac{\lambda h}{\epsilon_0}$$

$$E = \frac{\lambda}{2\pi r \epsilon_0} = \frac{k\lambda}{r}$$