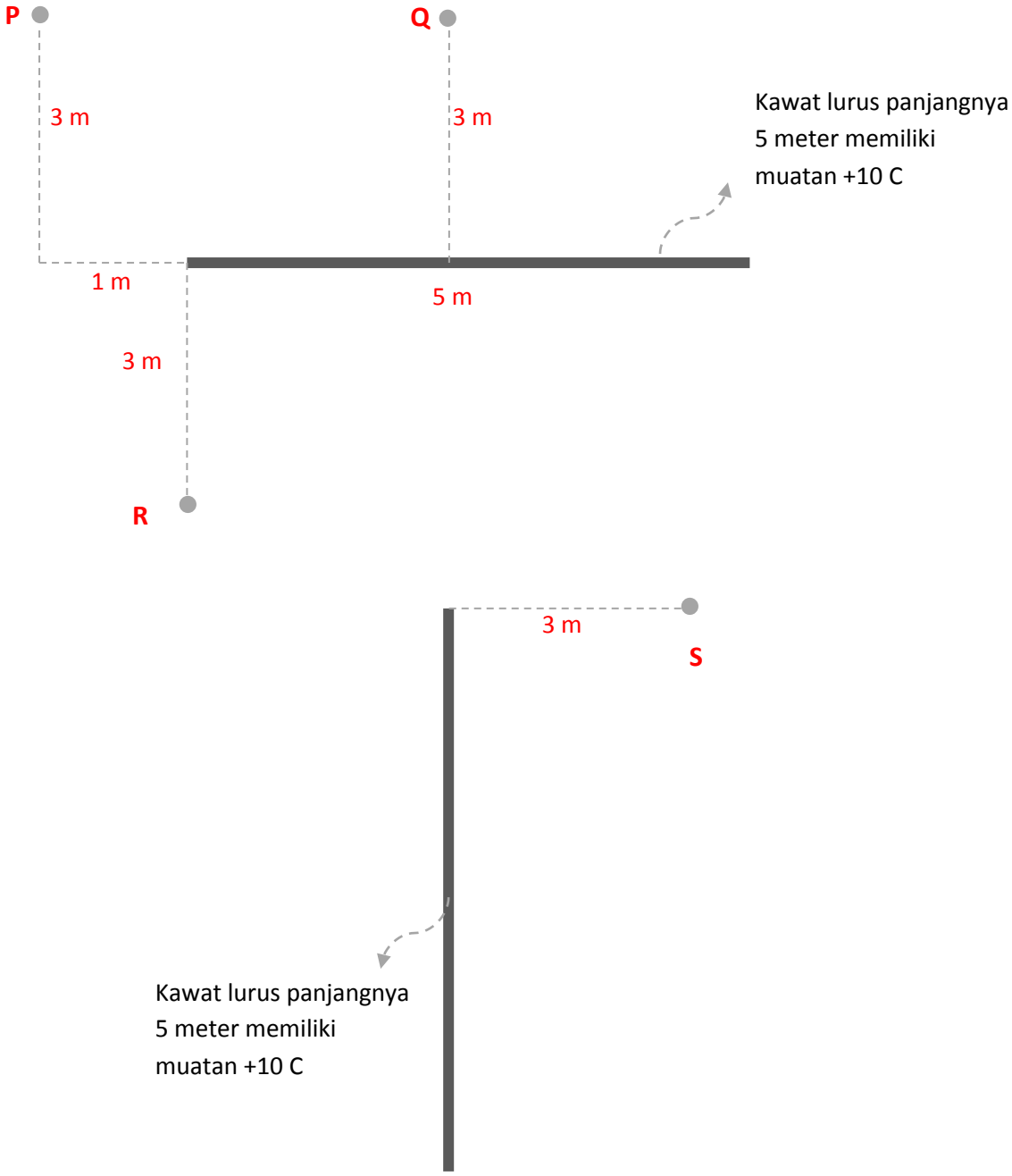
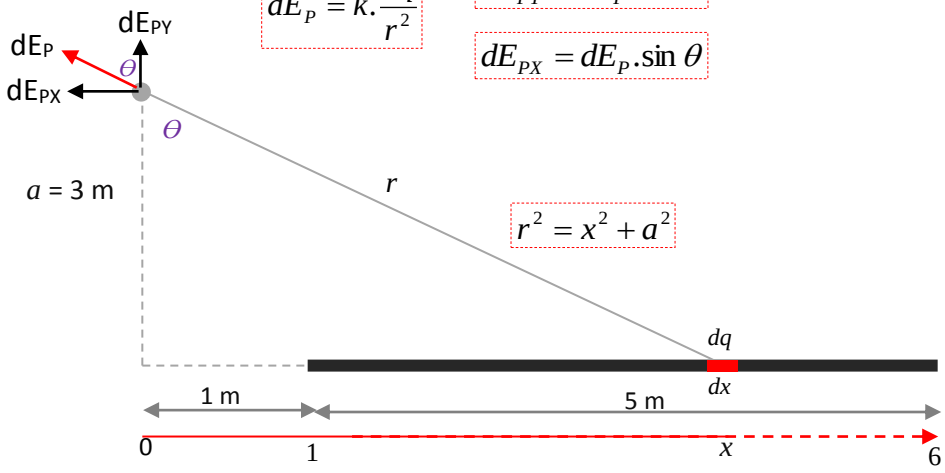
SOAL LATIHAN MEDAN LISTRIK MUATAN GARIS

Tentukan medan listrik pada titik **P**, **Q**, **R**, dan **S**



Jawaban:

P



$$dE_P = k.\frac{dq}{r^2}$$

$$dE_{PY} = dE_P.\cos\theta$$

$$dE_{PX} = dE_P.\sin\theta$$

$$r^2 = x^2 + a^2$$

Kawat lurus panjangnya 5 meter memiliki muatan +10 C, sehingga kerapatan muatannya adalah

$$\lambda = \frac{Q}{L} = \frac{10}{5} = 2 \quad C/m$$

$$dE_{PY} = dE_P.\cos\theta$$

$$dE_{PY} = k.\frac{dq}{r^2}.\cos\theta$$

$$x = a.\tan\theta$$

$$dx = a.\sec^2\theta.d\theta$$

$$E_{PY} = \int dE_{PY}$$

$$= \int k.\frac{dq}{r^2}.\cos\theta$$

$$= \int k.\frac{\lambda.dx}{\left(x^2+a^2\right)}.\cos\theta$$

$$= k\lambda\int \frac{dx}{\left(x^2+a^2\right)}.\cos\theta$$

$$= k\lambda\int \frac{a.\sec^2\theta.d\theta}{\left(a^2.\tan^2\theta+a^2\right)}.\cos\theta$$

$$= k\lambda\int \frac{a.\sec^2\theta.d\theta}{a^2.\left(\tan^2\theta+1\right)}.\cos\theta$$

$$= \frac{k\lambda}{a}\int \frac{\sec^2\theta.d\theta}{\left(\sec^2\theta\right)}.\cos\theta$$

$$= \frac{k\lambda}{a}\int \cos\theta.d\theta$$

$$= \frac{k\lambda}{a}.[\sin\theta]$$

$$= \frac{k\lambda}{a}.\left[\frac{x}{\sqrt{x^2+a^2}}\right]_1^6$$

$$= \frac{9.10^9.2}{3}.\left[\frac{x}{\sqrt{x^2+3^2}}\right]_1^6$$

$$= 6.10^9.\left[\left(\frac{6}{\sqrt{6^2+3^2}}\right)-\left(\frac{1}{\sqrt{1^2+3^2}}\right)\right]$$

$$= 6.10^9.\left[\frac{6}{\sqrt{45}}-\frac{1}{\sqrt{10}}\right]$$

$$= 6.10^9.0{,}5781$$

$$= 3{,}4686.10^9 \quad N/C$$

$$= 3{,}5.10^9 \quad N/C$$

$$dE_{PX} = dE_P.\sin\theta$$

$$dE_{PX} = k.\frac{dq}{r^2}.\sin\theta$$

$$E_{PX} = \int dE_{PX}$$

$$= \int k.\frac{dq}{r^2}.\sin\theta$$

$$= \int k.\frac{\lambda.dx}{\left(x^2+a^2\right)}.\sin\theta$$

$$= k\lambda\int \frac{dx}{\left(x^2+a^2\right)}.\sin\theta$$

$$= \frac{k\lambda}{a}\int \sin\theta.d\theta$$

$$= \frac{k\lambda}{a}.-\cos\theta$$

$$= \frac{k\lambda}{a}.\left[-\frac{a}{\sqrt{x^2+a^2}}\right]_1^6$$

$$= \frac{9.10^9.2}{3}.\left[-\frac{3}{\sqrt{x^2+3^2}}\right]_1^6$$

$$= 6.10^9.\left[\left(-\frac{3}{\sqrt{6^2+3^2}}\right)-\left(-\frac{3}{\sqrt{1^2+3^2}}\right)\right]$$

$$= 6.10^9.\left[-\frac{3}{\sqrt{45}}+\frac{3}{\sqrt{10}}\right]$$

$$= 6.10^9.(0{,}501)$$

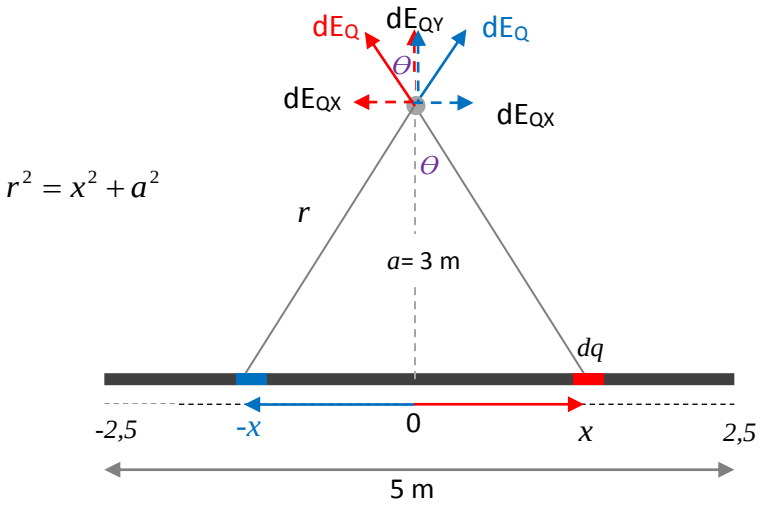
$$= \underline{3.10^9 \quad N/C}$$

$$\vec{E}_P = E_{PX}.(-i)+E_{PY}.(j)$$

$$\vec{E}_P = 3.10^9(-i)+3{,}5.10^9(j) \quad N/C$$

Jawaban:

Q



$r^2 = x^2 + a^2$

Kawat lurus panjangnya 5 meter memiliki muatan +10 C, sehingga kerapatan muatannya adalah

$$\lambda = \frac{Q}{L} = \frac{10}{5} = 2 \quad C/m$$

- Komponen medan listrik arah sumbu x saling meniadakan ⟶ **E_{QX}=0**
- Hanya komponen medan listrik arah sumbu y saja yang dihitung ⟶ **E_{QY}**

$$dE_{QY} = dE_Q.\cos\theta$$

$$dE_{QY} = k.\frac{dq}{r^2}.\cos\theta$$

$$E_{QY} = \int dE_{QY}$$

$$= \int k.\frac{dq}{r^2}.\cos\theta$$

$$= \int k.\frac{\lambda.dx}{\left(x^2 + a^2\right)}.\cos\theta$$

$$= \frac{k\lambda}{a}\int \cos\theta.d\theta$$

$$= \frac{k\lambda}{a}.[\sin\theta]$$

$$= \frac{k\lambda}{a}.\left[\frac{x}{\sqrt{x^2 + a^2}}\right]_{-2,5}^{2,5}$$

$$= \frac{9.10^9.2}{3}.\left[\frac{x}{\sqrt{x^2 + 3^2}}\right]_{-2,5}^{2,5}$$

$$= 6.10^9.\left[\left(\frac{2,5}{\sqrt{2,5^2 + 3^2}}\right) - \left(\frac{-2,5}{\sqrt{(-2,5)^2 + 3^2}}\right)\right]$$

$$= 6.10^9.\left[\frac{2,5}{\sqrt{15,25}} + \frac{2,5}{\sqrt{15,25}}\right]$$

$$= 6.10^9.\frac{5}{\sqrt{15,25}}$$

$$= 7,68.10^9 \quad N/C$$

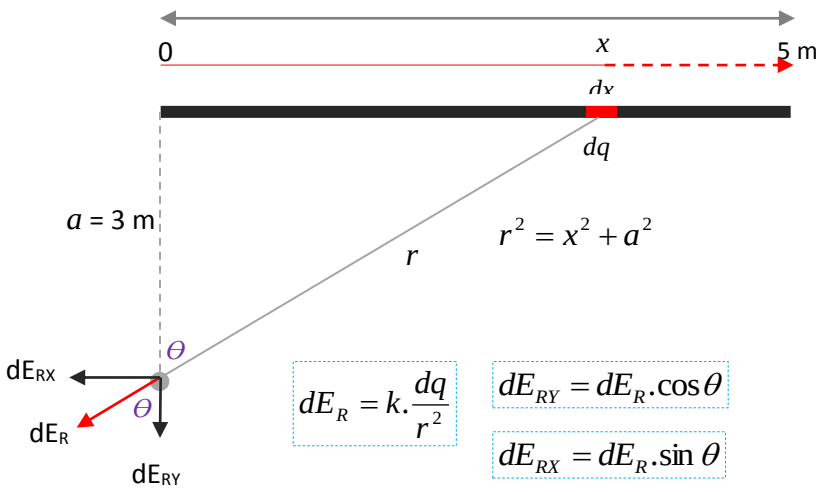
$$\vec{E}_Q = E_{QX}.(i) + E_{QY}.(j)$$

$$\vec{E}_Q = 0 + 7,68.10^9\,(j) \quad N/C$$

$$\vec{E}_Q = 7,68.10^9\,(j) \quad N/C$$

Jawaban:

R



$$dE_R = k.\frac{dq}{r^2} \qquad dE_{RY} = dE_R.\cos\theta \qquad dE_{RX} = dE_R.\sin\theta$$

Kawat lurus panjangnya 5 meter memiliki muatan +10 C, sehingga kerapatan muatannya adalah

$$\lambda = \frac{Q}{L} = \frac{10}{5} = 2 \quad C/m$$

$$E_{RY} = \int dE_{RY}$$
$$= \int k.\frac{dq}{r^2}.\cos\theta$$
$$= \int k.\frac{\lambda.dx}{(x^2+a^2)}.\cos\theta$$
$$= k\lambda\int \frac{dx}{(x^2+a^2)}.\cos\theta$$
$$= \frac{k\lambda}{a}\int \cos\theta.d\theta$$
$$= \frac{k\lambda}{a}.[\sin\theta]$$
$$= \frac{k\lambda}{a}.\left[\frac{x}{\sqrt{x^2+a^2}}\right]_0^5$$
$$= \frac{9.10^9.2}{3}.\left[\frac{x}{\sqrt{x^2+3^2}}\right]_0^5$$
$$= 6.10^9.\left[\left(\frac{5}{\sqrt{5^2+3^2}}\right)-\left(\frac{0}{\sqrt{0^2+3^2}}\right)\right]$$
$$= 6.10^9.\left[\frac{5}{\sqrt{34}}+0\right]$$
$$= 6.10^9.\frac{5}{\sqrt{34}}$$
$$= 5{,}14.10^9 \quad N/C$$

$$E_{RX} = \int dE_{RX}$$
$$= \int k.\frac{dq}{r^2}.\sin\theta$$
$$= \int k.\frac{\lambda.dx}{(x^2+a^2)}.\sin\theta$$
$$= k\lambda\int \frac{dx}{(x^2+a^2)}.\sin\theta$$
$$= \frac{k\lambda}{a}\int \sin\theta.d\theta$$
$$= \frac{k\lambda}{a}.-\cos\theta$$
$$= \frac{k\lambda}{a}.\left[-\frac{a}{\sqrt{x^2+a^2}}\right]_0^5$$
$$= \frac{9.10^9.2}{3}.\left[-\frac{3}{\sqrt{x^2+3^2}}\right]_0^5$$
$$= 6.10^9.\left[\left(-\frac{3}{\sqrt{5^2+3^2}}\right)-\left(-\frac{3}{\sqrt{0^2+3^2}}\right)\right]$$
$$= 6.10^9.\left[-\frac{3}{\sqrt{34}}+\frac{3}{\sqrt{9}}\right]$$
$$= 6.10^9.0{,}48$$
$$= 2{,}91.10^9 \quad N/C$$

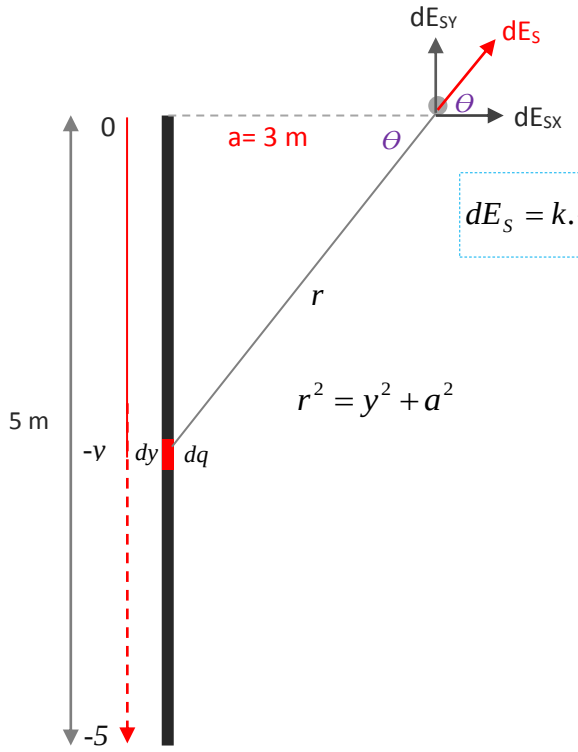
$$\vec{E}_R = E_{RX}.(-i)+E_{RY}.(-j)$$
$$\vec{E}_R = 2{,}19.10^9(-i)+5{,}14.10^9(-j)$$

Jawaban:

S

Kawat lurus panjangnya 5 m memiliki muatan +10 C, sehingga kerapatan muatannya adalah

$$\lambda = \frac{Q}{L} = \frac{10}{5} = 2 \quad C/m$$



$$dE_S = k.\frac{dq}{r^2}$$

$$dE_{SY} = dE_S.\sin\theta$$

$$dE_{SX} = dE_S.\cos\theta$$

$$r^2 = y^2 + a^2$$

$$E_{SY} = \int dE_{SY}$$

$$= \int k.\frac{dq}{r^2}.\sin\theta$$

$$= \int k.\frac{\lambda.dy}{(y^2+a^2)}.\sin\theta$$

$$= k\lambda\int \frac{dy}{(y^2+a^2)}.\sin\theta$$

$$= \frac{k\lambda}{a}\int \sin\theta.d\theta$$

$$= \frac{k\lambda}{a}.-\cos\theta$$

$$= \frac{k\lambda}{a}.\left[-\frac{a}{\sqrt{y^2+a^2}}\right]_{-5}^{0}$$

$$= \frac{9.10^9.2}{3}.\left[-\frac{3}{\sqrt{y^2+3^2}}\right]_{-5}^{0}$$

$$= 6.10^9.\left[\left(-\frac{3}{\sqrt{0^2+3^2}}\right)-\left(-\frac{3}{\sqrt{(-5)^2+3^2}}\right)\right]$$

$$= 6.10^9.\left[-\frac{3}{\sqrt{9}}+\frac{3}{\sqrt{34}}\right]$$

$$= 6.10^9.-0{,}48$$

$$= \left|-2{,}91.10^9\right|$$

$$= 2{,}91.10^9 \quad N/C$$

$$E_{SX} = \int dE_{SX}$$

$$= \int k.\frac{dq}{r^2}.\cos\theta$$

$$= \int k.\frac{\lambda.dx}{\left(y^2+a^2\right)}.\cos\theta$$

$$= k\lambda\int \frac{dx}{\left(y^2+a^2\right)}.\cos\theta$$

$$= \frac{k\lambda}{a}\int \cos\theta.d\theta$$

$$= \frac{k\lambda}{a}.[\sin\theta]$$

$$= \frac{k\lambda}{a}.\left[\frac{y}{\sqrt{y^2+a^2}}\right]_{-5}^{0}$$

$$= \frac{9.10^9.2}{3}.\left[\frac{y}{\sqrt{y^2+3^2}}\right]_{-5}^{0}$$

$$= 6.10^9.\left[\left(\frac{0}{\sqrt{0^2+3^2}}\right)-\left(\frac{-5}{\sqrt{(-5)^2+3^2}}\right)\right]$$

$$= 6.10^9.\left[0+\frac{5}{\sqrt{34}}\right]$$

$$= 6.10^9.+\frac{5}{\sqrt{34}}$$

$$= 5{,}14.10^9 \quad N/C$$

$$\vec{E}_R = E_{RX}.(i)+E_{RY}.(j)$$

$$\vec{E}_R = 5{,}14.10^9(i)+2{,}91.10^9(j)$$