PC212 Tutorial Problem
Wilfrid Laurier University

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Definition

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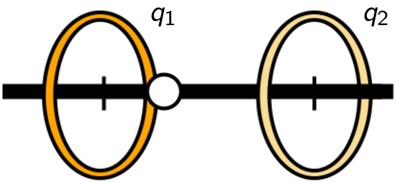

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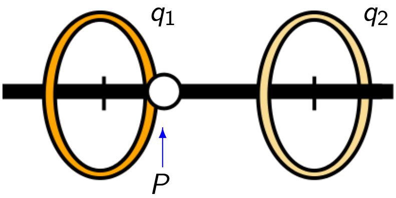

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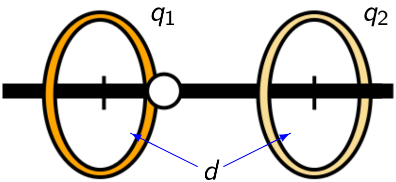

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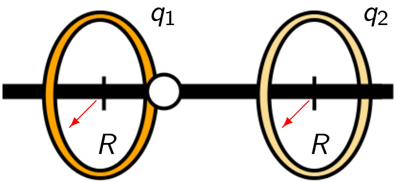

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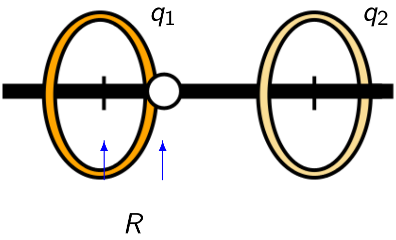

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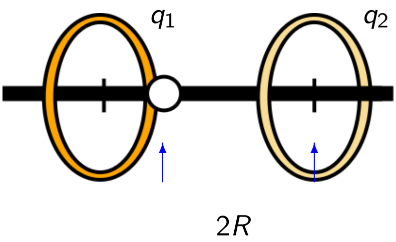

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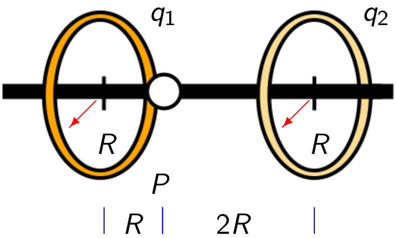

$$\left|\vec{E}\right|_{P,net} \equiv 0$$

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What is the ratio q_1/q_2?

Before Math

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$$\left|\vec{E}\right|_{P,net} \equiv |E_x|_{P,net}$$

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since the x-axis passes through the centre of each ring.

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Also, since q_2 is farther away, it has to be bigger to match the field of q_1, so the *magnitude* of q_1/q_2 is **less than one**.

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($q_2 = q_1 \equiv 0$ is trivial)

Calculations

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Since all points on each ring are at the same distance and angle from P, then each ring can be treated as a **point charge** at a distance R from the x-axis.

Ring 1

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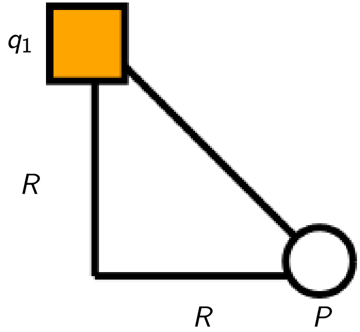
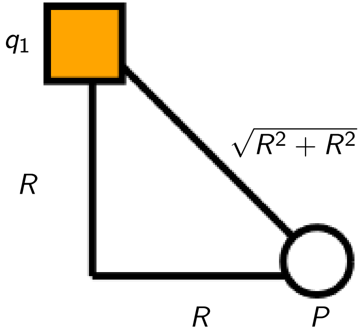
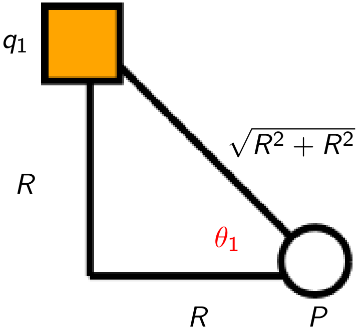


Ring 1



Ring 1



$$\left|\vec{E}_{P1}\right| = \frac{1}{4\pi\epsilon_0}\frac{q_1}{(R^2 + R^2)}$$

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$$= \vec{E}_{P1}\frac{R}{\sqrt{2R^2}}$$

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$$= \vec{E}_{P1}\frac{1}{\sqrt{2}}$$

Ring 2

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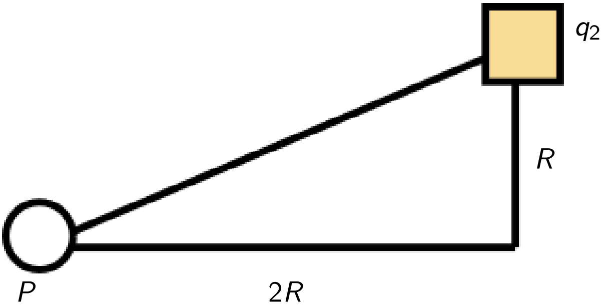
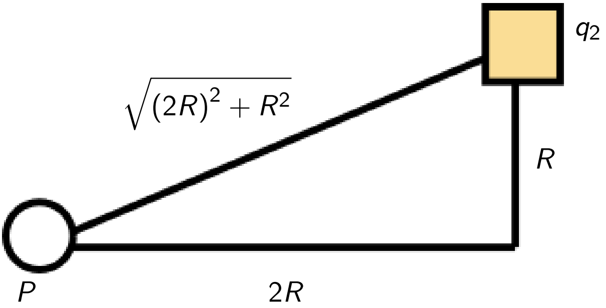


Ring 2



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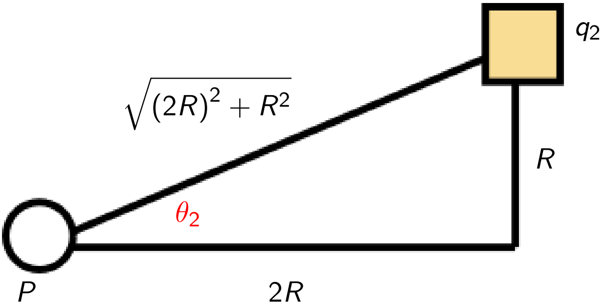

$$\left|\vec{E}_{P2}\right| = \frac{1}{4\pi\epsilon_0}\frac{q_2}{\left(R^2 + (2R)^2\right)}$$

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$$= \vec{E}_{P2}\frac{2}{\sqrt{5}}$$

$$\left|E_{xP1}\right| = \left|E_{xP2}\right|$$

means that

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$$\vec{E}_{P1}\frac{1}{\sqrt{2}} = \vec{E}_{P2}\frac{2}{\sqrt{5}}$$

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so

$$\frac{1}{4\pi\epsilon_0}\frac{q_1}{(2R^2)}\frac{1}{\sqrt{2}} = \frac{1}{4\pi\epsilon_0}\frac{q_2}{(5R^2)}\frac{2}{\sqrt{5}}$$

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which reduces to

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which reduces to

$$\frac{q_1}{(2)}\frac{1}{\sqrt{2}} = \frac{q_2}{(5)}\frac{2}{\sqrt{5}}$$

$$\therefore \frac{q_1}{q_2} = \frac{4\sqrt{2}}{5\sqrt{5}} \approx 0.51$$

Check

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Since we determined that

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$$0 < q_1/q_2 < 1$$

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we see that our answer fulfils that requirement.