Announcements

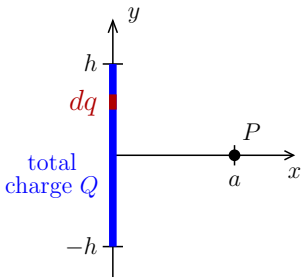
- Exams will given in the evenings from 7:00-9:00 PM, on the following dates (all Thursdays): February 13, March 20, and April 17.
- There will be no lecture on exam dates.
- Online drill due before problem session tomorrow.
- Quiz at the end of problem session tomorrow.
- Hand-In homework due Monday, 4:30 PM. HW box outside of lab room.
- Help sessions Wednesdays and Sundays from 8-10 pm in Olin 264.

Approach for E-field Integrals

1. Draw a sketch, choose integration variable (x, y, or θ)
2. Pick a tiny piece of charge and label it dq
   a. label the size of this tiny piece using dx, dy, or $R\,d\theta$
   b. Draw r (distance between dq and P) on the sketch
   c. Draw an arrow for $d\vec{E}$ at P due to dq
3. Find dE magnitude in terms of integration variable:
   a. Find dq. Line: $dq = \lambda\,dx$ or $dq = \lambda\,dy$. Arc: $dq = \lambda\,R d\theta$
   b. Find r (use Pythagoras)
   c. Plug dq and r into $dE = k\,dq/r^2$
4. Determine the components $dE_x = dE\,\cos\theta$ and $dE_y = dE\,\sin\theta$. You may need to use similar triangles.
5. Determine the limits of integration (where is the charge?)
6. Put it together and solve for $E_x = \int dE_x$ and $E_y = \int dE_y$.

Lecture 2 — Concept Test 1

Which of the following is the correct expression for dq for this rod?

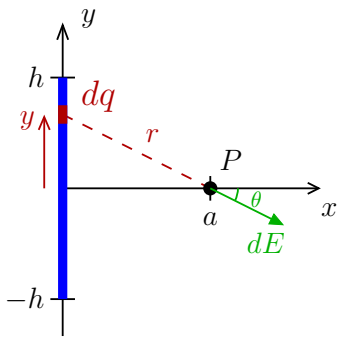


1. $dq = Q\,dx$
2. $dq = Q\,dy$
3. $dq = \dfrac{Q}{a}\,dx$
4. $dq = \dfrac{Q}{a}\,dy$
5. $dq = \dfrac{Q}{2h}\,dx$
6. $dq = \dfrac{Q}{2h}\,dy$

Lecture 2 — Concept Test 2

Which of the following is the correct expression for $\cos\theta$ for this rod?

1. $\dfrac{a}{\sqrt{a^2+y^2}}$
2. $\dfrac{h}{\sqrt{a^2+y^2}}$
3. $\dfrac{y}{\sqrt{a^2+y^2}}$
4. $\dfrac{a}{\sqrt{a^2+h^2}}$
5. $\dfrac{h}{\sqrt{a^2+h^2}}$
6. $\dfrac{y}{\sqrt{a^2+h^2}}$



Useful Integrals

$$\int \frac{x\,dx}{(a^2+x^2)^{3/2}} = \frac{-1}{\sqrt{a^2+x^2}}$$

$$\int \frac{dx}{(a^2+x^2)^{3/2}} = \frac{x}{a^2\sqrt{a^2+x^2}}$$

$$\int \sin^2(ax)\,dx = \frac{x}{2} - \frac{1}{4a}\sin(2ax)$$

$$\int x\sin^2(ax)\,dx = \frac{x^2}{4} - \frac{x}{4a}\sin(2ax) - \frac{1}{8a^2}\cos(2ax)$$

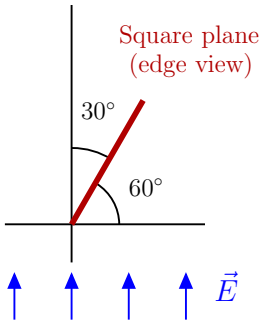
$$\int e^{-bx}\,dx = -\frac{1}{b}e^{-bx}$$

$$\int xe^{-bx}\,dx = -\left(\frac{x}{b} + \frac{1}{b^2}\right)e^{-bx}$$

$$\int x^2e^{-bx}\,dx = -\left(\frac{x^2}{b} + \frac{2x}{b^2} + \frac{2}{b^3}\right)e^{-bx}$$

Lecture 2 — Concept Test 3

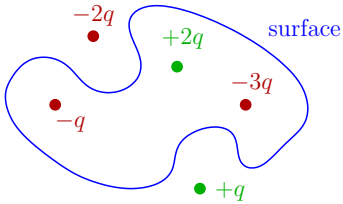
A square with side a is in an electric field with magnitude E, as shown in the diagram. What is the electric flux through the square?



1. 0
2. $a^2 E \cos 30°$
3. $a^2 E \cos 60°$
4. None of these

Lecture 2 — Concept Test 4

What is the electric flux through the surface?



1. 0
2. $-q/\epsilon_0$
3. $-2q/\epsilon_0$
4. $-3q/\epsilon_0$
5. $+q/\epsilon_0$
6. $+2q/\epsilon_0$