Electricity and Magnetism

- Physics 259 – L02
- Lecture 27

UNIVERSITY OF CALGARY

Chapter 24

Last time

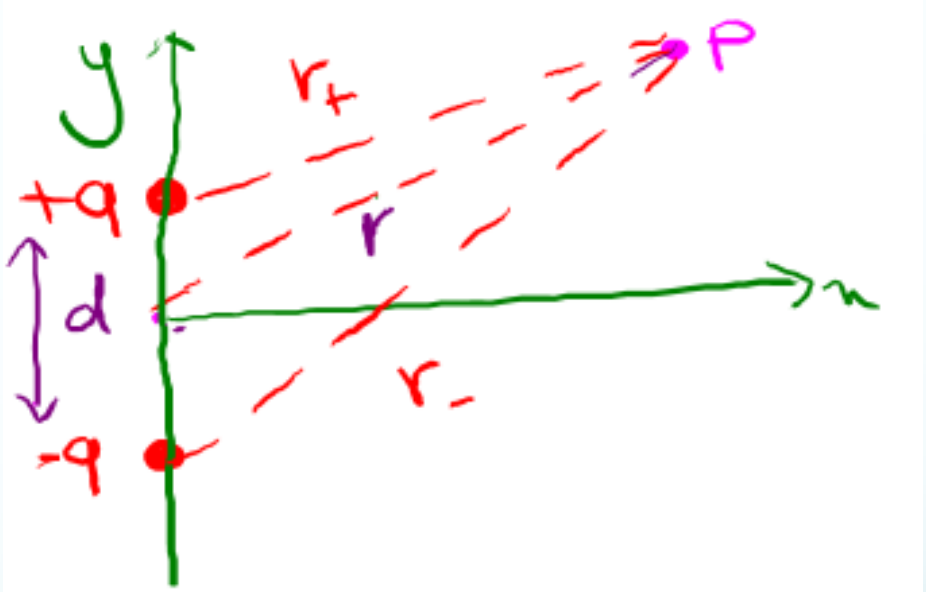
- Equipotential surfaces: visualizing electric potential
- Potential due to an electric dipole
- Potential due to a continuous charge distribution

This time

- Some examples

- **Deriving field from potential of dipole**

$$V = \frac{q}{4\pi\varepsilon_0}\frac{d\cos\theta}{r^2} = \frac{1}{4\pi\varepsilon_0}\frac{p\cos\theta}{r^2}$$



Now we can calculate the electric filed for an arbitrary point P at a distance r from the center of the dipole.

$$\begin{aligned} V(r) &= \frac{p\cos\theta}{4\pi\epsilon_0 r^2} \\ &= \frac{pz/r}{4\pi\epsilon_0 r^2} \\ &= \frac{pz}{4\pi\epsilon_0 r^3} \\ &= \frac{pz}{4\pi\epsilon_0\left(x^2+y^2+z^2\right)^{3/2}} \\ &= \frac{pz}{4\pi\epsilon_0}\left(x^2+y^2+z^2\right)^{-3/2} \end{aligned}$$

Note that $z = r\cos\theta$.

$$\begin{aligned} E_x &= -\frac{\partial V}{\partial x} = -\frac{\partial}{\partial x}\left[\frac{pz}{4\pi\epsilon_0}\left(x^2+y^2+z^2\right)^{-3/2}\right] \\ &= -\frac{pz}{4\pi\epsilon_0}\left(-\frac{3}{2}2x\right)\left(x^2+y^2+z^2\right)^{-5/2} \\ &= \frac{3pzx}{4\pi\epsilon_0 r^5} \end{aligned}$$

TopHat Question

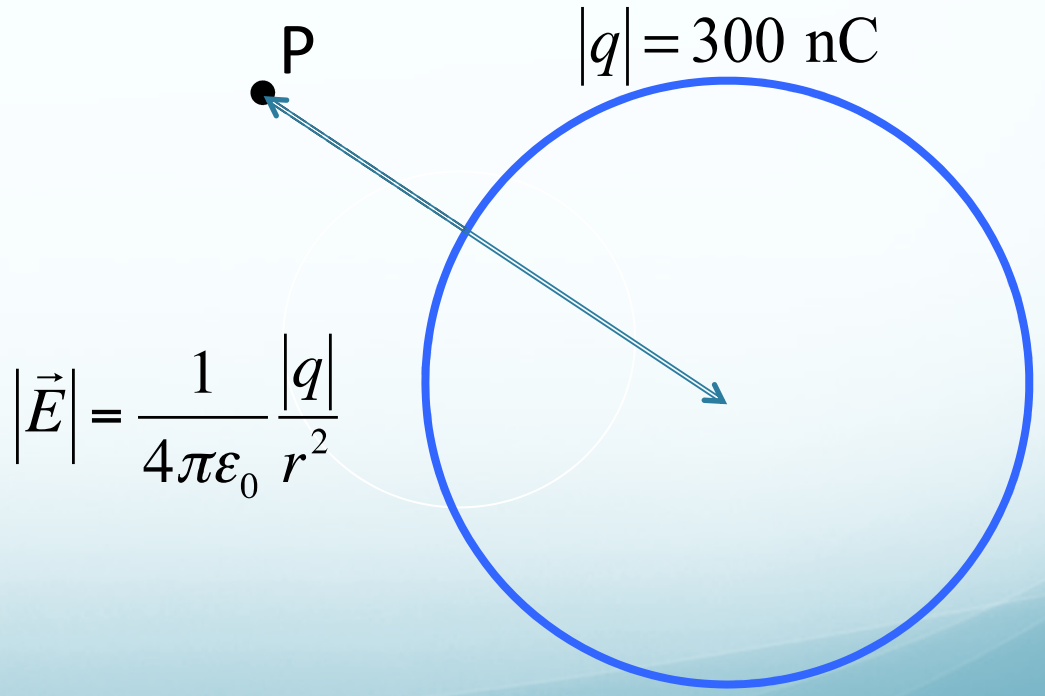
Consider a uniformly charged insulating shell with a diameter of 1.0 m and a total charge of –300 nC. What is the **magnitude** of the **electric field** at point P a distance 30 cm outside the surface?

A. 3400 V/m

B. 4200 V/m

C. 9000 V/m

D. 30000 V/m



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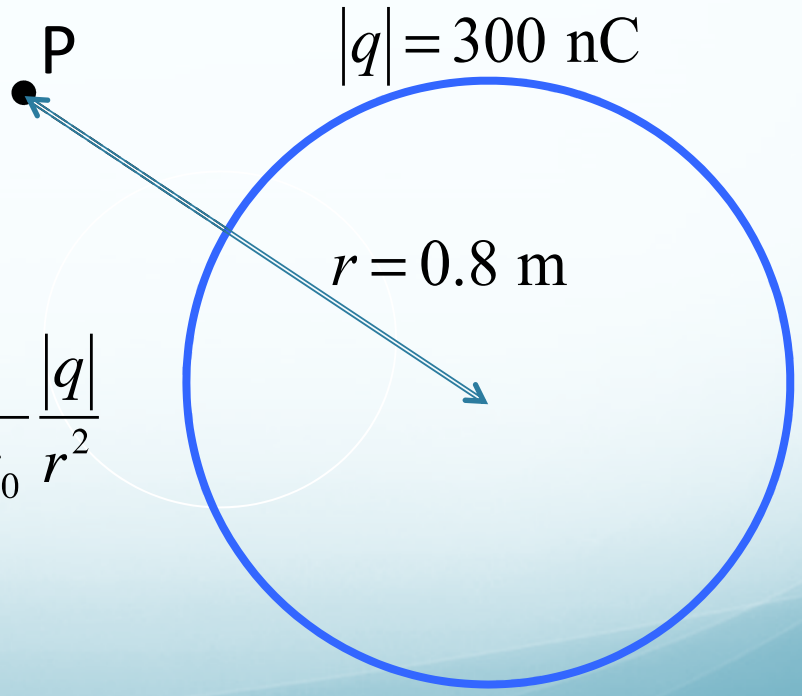

$$|\vec{E}| = \frac{1}{4\pi\varepsilon_0}\frac{|q|}{r^2}$$

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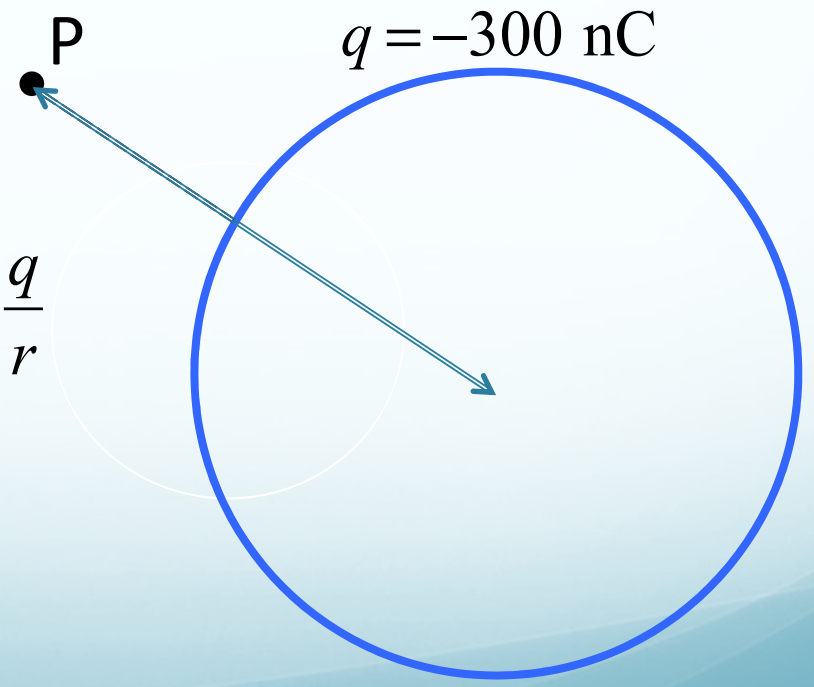

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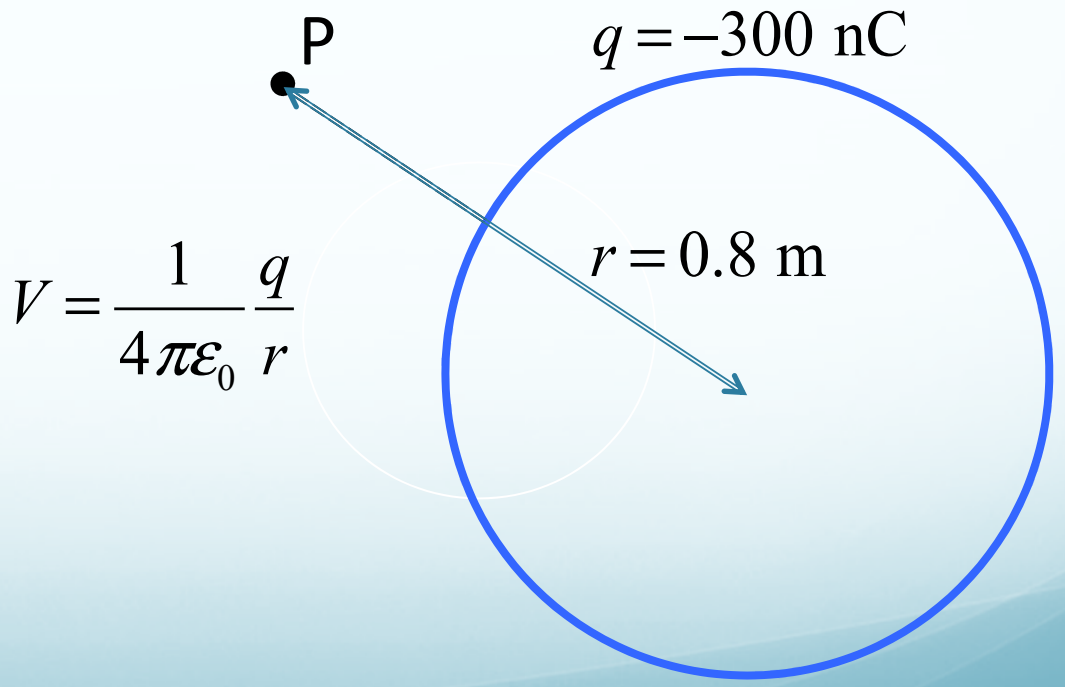

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TopHat Question

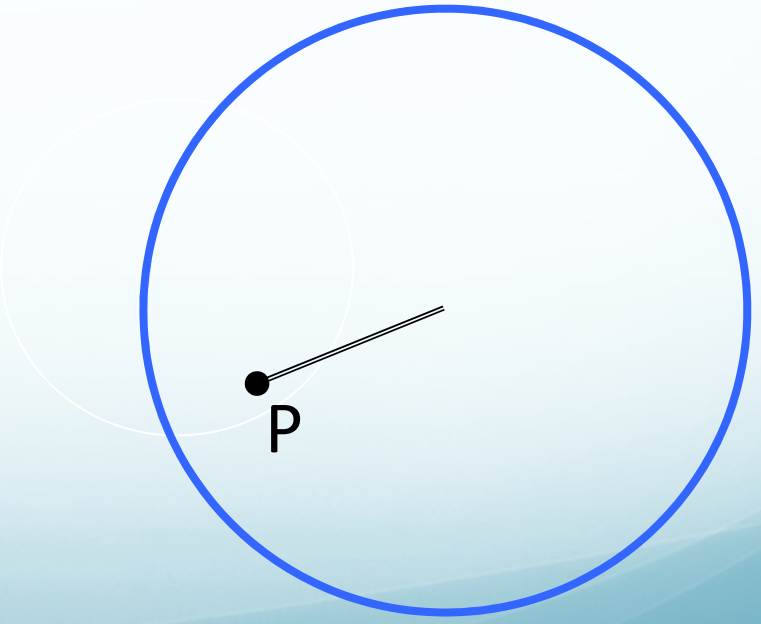
Consider a uniformly charged insulating shell with a diameter of 1.0 m and a total charge of –300 nC. What is the **magnitude** of the **electric field** at point P a distance 30 cm from the centre?

A. 30000 V/m

B. 11000 V/m

C. 9000 V/m

D. 0 V/m



TopHat Question

Consider a uniformly charged insulating shell with a diameter of 1.0 m and a total charge of –300 nC. What is the **electric potential** at point P a distance 30 cm from the centre?

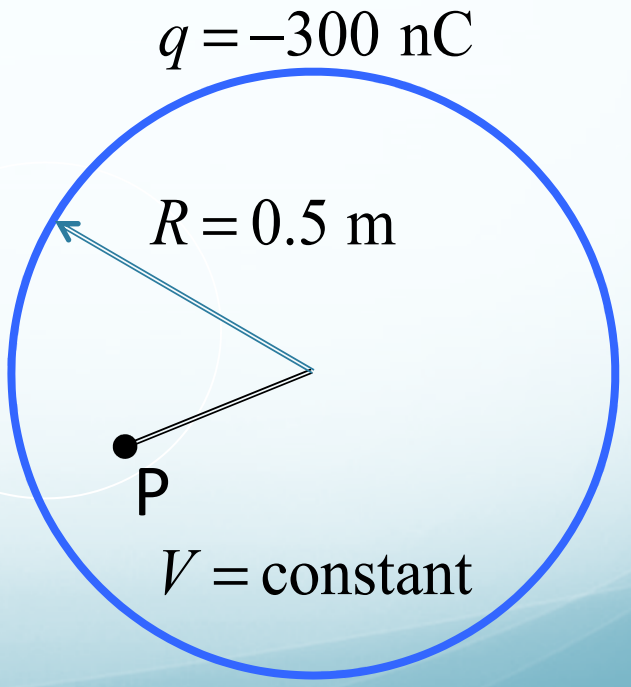
A. –9000 V

B. –5400 V

C. –3400 V

D. 0 V

$$V = \frac{1}{4\pi\varepsilon_0}\frac{q}{R}$$



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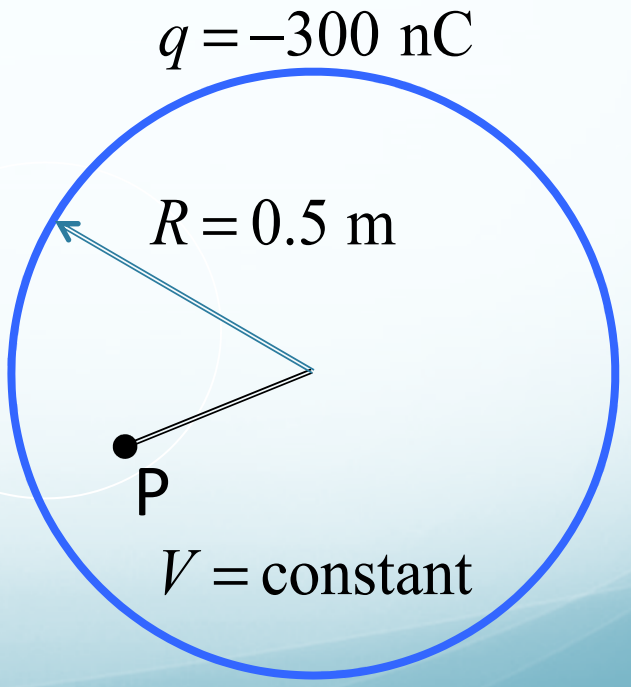

This section we finished:

Chapter 24

See you on next Monday