Announcements

- Exam Thursday, 7pm. **Pick up Exam Info sheet from front of the room.**
- 3" $\times$5" index cards up front as well.
- Optional review session 8:00 pm tonight, here.
- No reading quizzes or drills until after the exam.
- Graded review exercise in problem session tomorrow. Graded post-exam exercise on Friday.
- Last year's exam is available on the Solutions page.
- Toys 'n Tea, Thursday February 13 at 4:00 in Olin 251A

What Will You Be Tested On?

- PHYS 212 exams are not evaluating if you are "good at math" or "good at physics". This exam will test your mastery of the material covered in Unit 1 of PHYS 212.
- This includes:
  - Lectures 1–7
  - Problem Session (assigned problems)
  - Some PHYS 211 content used in this unit (e.g. $\vec{F}_{\text{net}} = m\vec{a}$, $W_{\text{net}} = \Delta K$, circular motion)
- We thoroughly check our exams to eliminate bias with respect to race, gender, or culture.

You’re allowed one 3” $\times$5” index card. Things to put on it:

- Fundamental equations
- Basic derivatives and integrals: x^n, e^x, $\sin x$, $\cos x$
- Surface areas and volumes of spheres, cylinders, & cubes.
- Prefixes: you should know nano, micro, milli, centi, kilo, mega, and giga.
- Examples. Maybe a Gauss’s Law example, Ampere’s Law example, etc.
- Step-by-step methods

Don't take shortcuts!

- Show all work. We grade the process and not the answer, so you need to communicate your approach.
- A generally applicable equation such as $\vec{F} = q\vec{v} \times \vec{B}$ can be used without explanation. Starting with $F = qvB$ is not valid.
- If using a specialized equation that is valid only for a particular situation, you must state the assumptions.

$$\text{long straight wire } \Rightarrow B_{\text{wire}} = \frac{\mu_0 I}{2\pi r}$$

- For Gauss's Law and Ampere's Law problems, you cannot just use the "equation" for a particular geometry.

  (1) Sketch $\vec{E}$ or $\vec{B}$ fields. (2) Draw Gaussian surface or Amperian loop.

  (3) $\oint \vec{B} \cdot d\vec{\ell} = B(2\pi r)$ since $\vec{B} \parallel d\vec{\ell}$ and B is constant

Wolfson Ch 20 #32: In his famous 1909 experiment that demonstrated quantization of electric charge, R. A. Millikan suspended small oil drops in an electric field. With field strength 20 MN/C, what mass drop can be suspended when the drop carries 10 elementary charges?

Ch 20 #32

$$\vec{F} = m\vec{a} \qquad \vec{F} = q\vec{E} \qquad \vec{a} = \vec{g} = 9.8\ m/s^2$$

$$m = \frac{q\vec{E}}{\vec{a}} \qquad m = \frac{10(1.6\times10^{-19})(20\times10^{6}\ N/C)}{9.8}$$

$$\boxed{m = 3.26\times10^{-12}\ kg}$$

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Bad solution ↑ Better solution ↓

Ch 20 #32

$\uparrow F_e = qE$

$\downarrow mg$

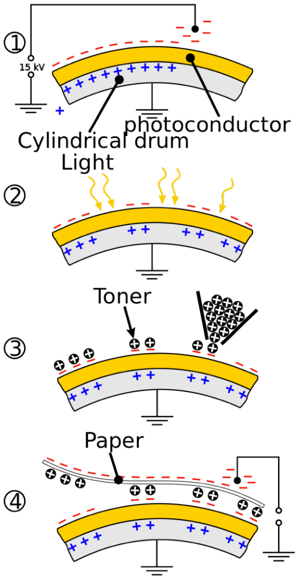
$\Sigma F_y = ma_y = 0$ (since motionless)

$qE - mg = 0 \Rightarrow qE = mg$

$m = \frac{qE}{g} = \frac{(1.6\times10^{-19}C)(20\times10^{6}\ N/C)}{9.8\ m/s^2} = \boxed{3.26\times10^{-12}\ kg}$

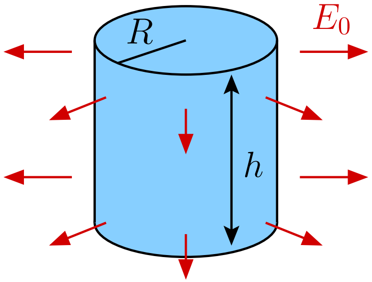
Application: Xerox Machines

- Photo-conducting material (becomes a conductor if light hits it).
- Project an image of the thing you want to copy onto the drum. These regions become conductive and charge leaves.
- Apply powered ink (positively charged). It sticks to the regions that still have charge.
- Transfer ink to paper. Heat it up so that the ink sets.



Lecture 7 — Concept Test 1

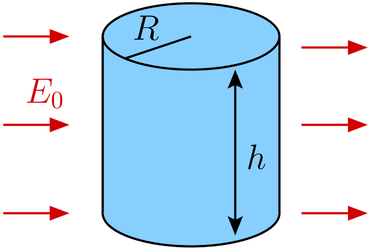
An electric field of magnitude E_0 points radially outward as shown. What is the electric flux Φ_E through the cylinder?



1. 0
2. $2\pi R E_0$
3. $\pi R^2 E_0$
4. $2\pi R^2 E_0$
5. $2\pi R h E_0$
6. $2\pi R^2 h E_0$

Lecture 7 — Concept Test 2

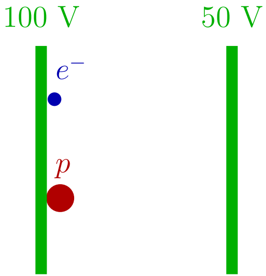
A uniform electric field of magnitude E_0 points to the right as shown. What is the electric flux Φ_E through the wraparound part of the cylinder?



1. 0
2. $2\pi R E_0$
3. $\pi R^2 E_0$
4. $2\pi R h E_0$
5. $2\pi R^2 h E_0$
6. Not enough information to answer this.

Lecture 7 — Concept Test 3

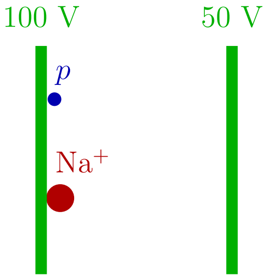
An electron and a proton are released near the left plate of a parallel plate arrangement. The left plate is held at a potential of 100 V, while the right plate is held at a potential of 50 V. The mass of the proton is much larger than the mass of the electron.



What can you say about the speeds of the two particles when they reach the right plate?

1. The electron moves faster
2. The proton moves faster
3. They move at the same speed
4. None of the above

Lecture 7 — Concept Test 4



A proton and a sodium ion, both with charge $+e$, are released near the left plate of a parallel plate arrangement. The left plate is held at a potential of 100 V, while the right plate is held at a potential of 50 V. The mass of the sodium ion is much larger than the mass of the proton.

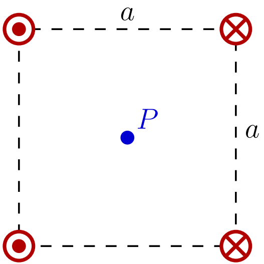
What can you say about the speeds of the two particles when they reach the right plate?

1. The sodium ion moves faster
2. The proton moves faster
3. They move at the same speed
4. None of the above

Lecture 7 — Concept Test 5

Four wires are oriented as shown with current I going out of the page for the two left wires and into the page for the two right wires.

What is the direction of the total magnetic field at the point P at the center of the square?



1. $\uparrow$

2. $\longrightarrow$

3. $\downarrow$

4. $\longleftarrow$

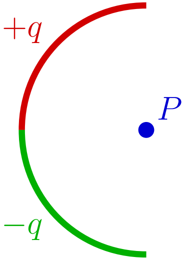
5. $\nwarrow$

6. $\nearrow$

Back. $B = 0$ at P

Lecture 7 — Concept Test 6

Two quarter-circle arcs are arranged as shown in the diagram. The top arc has a charge $+q$ distributed uniformly along the arc, while the bottom arc has a charge $-q$ distributed uniformly along the arc.



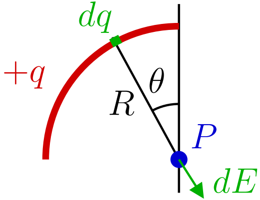
What is the direction of the total electric field at point P due to both of these arcs?

1. $\uparrow$
2. $\longrightarrow$
3. $\downarrow$
4. $\longleftarrow$
5. $E = 0$ at point P
6. None of the other answers

Lecture 7 — Concept Test 7

Looking at the electric field from the top of the two arcs . . .

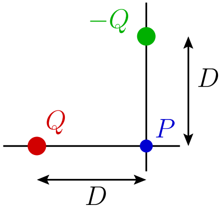
What is dq for that little piece?



1. $dq = q\, d\theta$
2. $dq = \frac{2q}{\pi R}\, d\theta$
3. $dq = \frac{4q}{\pi R}\, d\theta$
4. $dq = \frac{2q}{\pi}\, d\theta$
5. $dq = \frac{4q}{\pi}\, d\theta$
6. None of the other answers

Lecture 7 — Concept Test 8

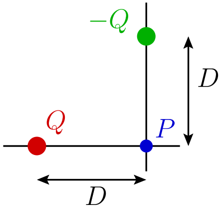
What is the total electric potential at the point P?



1. 0
2. kQ/D
3. $2kQ/D$
4. $-2kQ/D$
5. $\sqrt{2}\,kQ/D$
6. $-\sqrt{2}\,kQ/D$

Lecture 7 — Concept Test 9

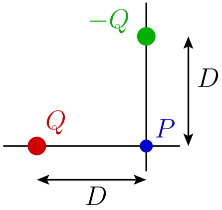
What is the direction of the electric field at the point P?



1. $\nearrow$
2. $\nwarrow$
3. $\swarrow$
4. $\searrow$
5. $E = 0$ at P
6. none of these are correct

Lecture 7 — Concept Test 10

What is the magnitude of the electric field at the point P?



1. 0
2. kQ/D^2
3. $2kQ/D^2$
4. $-2kQ/D^2$
5. $\sqrt{2}\,kQ/D^2$
6. $-\sqrt{2}\,kQ/D^2$