PHY 114 A General Physics II
11 AM-12:15 PM TR Olin 101

Plan for Lecture 7 (Chapter 27):

1. **Electrical currents**
2. **Voltage and resistance**
3. **Electrical power**

2	01/24/2012	Electric field	23.4-23.7	23.22,23.20,23.61a	01/26/2012
3	01/26/2012	Gauss's Law	24.1-24.3	24.22a,24.23,24.40	01/31/2012
4	01/31/2012	Electric potential	25.1-25.4	25.12,25.23,25.34,25.01	02/02/2012
5	02/02/2012	Electric potential	25.5-25.8	(Review for exam)	
	02/07/2012	Exam			
6	02/09/2012	Capacitance and dielectrics	26.1-26.7	26.4,26.13,26.30	02/14/2012
7	02/14/2012	Current and resistance	27.1-27.6	27.3,27.12,27.29	02/16/2012
8	02/16/2012	Direct current circuits	28.1-28.2	28.3,28.7,28.19	02/21/2012
9	02/21/2012	Direct current circuits	28.3-28.5	28.23,28.25,28.34	02/23/2012
10	02/23/2012	Review	26.1-28.5	(Review for exam)	
	02/28/2012	Exam			
11	03/01/2012	Magnetic fields	29.1-29.6	29.5,29.12,29.47	03/06/2012
12	03/06/2012	Magnetic field sources	30.1-30.6		
13	03/08/2012	Faraday's law	31.1-31.5		
	03/13/2012	*No class (Spring Break)*			

Remember to send in your chapter reading questions…

	03/15/2012	*No class (Spring Break)*	
14	03/20/2012	Induction and AC circuits	32.1-32.6
15	03/22/2012	AC circuits	33.1-33.9
16	03/27/2012	Electromagnetic waves	34.1-34.3
17	03/29/2012	Electromagnetic waves	34.4-34.7
18	04/03/2012	Ray optics	35.1-35.8
19	04/05/2012	Image formation	36.1-36.4
20	04/10/2012	Image formation	36.5-36.10
21	04/12/2012	Wave interference	37.1-37.6
22	04/17/2012	Diffraction	38.1-38.6
23	04/19/2012	Quantum Physics	40.1-42.10
24	04/24/2012	Molecules and solids	43.1-43.8
25	04/26/2012	Nuclear reactions	45.1-45.4
26	05/01/2012	Nuclear radiation	45.5-45.7
	05/08/2012	Final exam 9 AM	

Evening exams #3 and #4 (lectures 16–25)

Grading:

It is likely that your grade for the course will be determined by the following factors:

4 exams*	45%
Final exam	25%
Problems sets**	15%
Laboratory work***	10%
Quiz****	5%

*All students must take 3 exams. In order to relieve exam stress, the lowest exam score will be weighted 5% while the other two exams will be weighted 20%. If a student elects to take all 4 exams, the lowest of the 4 exams will be dropped.

PHY 114 General Physics II -- Section A

TR 11 AM-12:15 PM	OPL 101	http://www.wfu.edu/~natalie/s12phy114/

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- General information
- Syllabus and homework assignments
- Lecture Notes
- For registered students

Tutorial sessions in Olin 103

- Sundays 5:30-7:30 PM -- Jie Liu
- Mondays 6:00-8:00 PM -- Jie Liu
- Tuesdays 6:00-8:00 PM -- Loah Stevens
- Wednesdays 5:30-7:30 PM -- Jie Liu
- Thursdays 5:30-7:30 PM -- Loah Stevens

i-clicker:

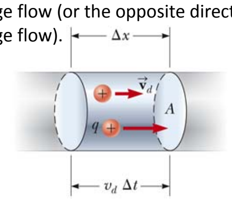
A. Would attend a review of Exam 1 at 5 PM today (Tuesday)
B. Would attend a review of Exam 1 at 5:15 PM Wednesday.

Up to now, we have been considering equilibrium configurations of charges -- electrostatics. Now we will consider steady-state motions of charges.

Electrical current

$$I = \frac{dQ}{dt} \quad \text{units}: \frac{\text{Coulomb}}{\text{second}} \equiv \text{Ampere (A)}$$

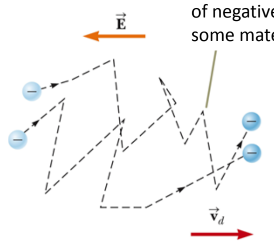
➔By convention $+I$ denotes the direction of positive charge flow (or the opposite direction of negative charge flow).



$$I = nqv_dA$$

drift velocity

charges/volume



Representation of drift velocity of negative charge carrier in some material.

Why would this be a suitable model of the motion of a charge within an electric field?

Suppose you have an electron – charge q=-e and mass m_e initially at rest in the presence of electric field E. What is the velocity at time t:

A. v_d
B. $-eEt/m_e$

Model to describe drift velocity

$$\text{Newton's law: } m_e \frac{dv}{dt} = -eE - \frac{m_e v}{\tau}$$

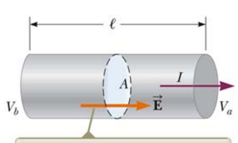
term representing collisions on a time scale of τ

$$\text{Under steady-state conditions: } \left\langle m_e \frac{dv}{dt} \right\rangle = 0 = -eE - \left\langle \frac{m_e v}{\tau} \right\rangle$$

$$\Rightarrow \langle v(t \to \infty) \rangle \equiv v_d = \frac{-eE\tau}{m_e}$$

$$\text{Corresponding current: } I = n(-e)v_d A$$

$$I = \frac{ne^2\tau}{m_e} AE$$



A potential difference $\Delta V = V_b - V_a$ maintained across the conductor sets up an electric field $\vec{\mathbf{E}}$, and this field produces a current I that is proportional to the potential difference.

ΔV=E ℓ

$$I = \frac{ne^2\tau}{m_e} AE = \frac{ne^2\tau}{m_e} \frac{A}{\ell} \Delta V$$

$$\sigma \equiv \frac{1}{\rho}$$

$$I = \frac{1}{R} \Delta V$$

$$R = \rho \frac{\ell}{A}$$

TABLE 27.2 *Resistivities and Temperature Coefficients of Resistivity for Various Materials*

Material	ρ Resistivity[a] ($\Omega \cdot m$)	Temperature Coefficient[b] $\alpha[(°C)^{-1}]$
Silver	1.59×10^{-8}	3.8×10^{-3}
Copper	1.7×10^{-8}	3.9×10^{-3}
Gold	2.44×10^{-8}	3.4×10^{-3}
Aluminum	2.82×10^{-8}	3.9×10^{-3}
Tungsten	5.6×10^{-8}	4.5×10^{-3}
Iron	10×10^{-8}	5.0×10^{-3}
Platinum	11×10^{-8}	3.92×10^{-3}
Lead	22×10^{-8}	3.9×10^{-3}
Nichrome[c]	1.00×10^{-6}	0.4×10^{-3}
Carbon	3.5×10^{-5}	-0.5×10^{-3}
Germanium	0.46	-48×10^{-3}
Silicon[d]	2.3×10^{3}	-75×10^{-3}
Glass	10^{10} to 10^{14}	
Hard rubber	$\sim 10^{13}$	
Sulfur	10^{15}	
Quartz (fused)	75×10^{16}	

[a] All values at 20°C. All elements in this table are assumed to be free of impurities.
[b] See Section 27.4.
[c] A nickel–chromium alloy commonly used in heating elements. The resistivity of Nichrome varies with composition and ranges between 1.00×10^{-6} and $1.50 \times 10^{-6}\ \Omega \cdot m$.
[d] The resistivity of silicon is very sensitive to purity. The value can be changed by several orders of magnitude when it is doped with other atoms.

Example:
What is the resistance of a Al wire of diameter 1mm and length 1m?

$$\text{From table: } \rho = 2.82 \times 10^{-8}\,\Omega m$$
$$A = \pi (d/2)^2 = 7.85 \times 10^{-7}\, m^2$$
$$\ell = 1m$$
$$R = \frac{\rho \ell}{A} = 0.036\Omega$$

Practical resistors:

The colored bands on these resistors are orange, white, brown, and gold.

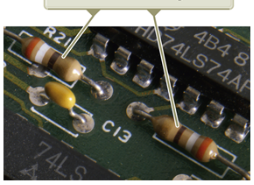


TABLE 27.1 *Color Coding for Resistors*

Color	Number	Multiplier	Tolerance
Black	0	1	
Brown	1	10^1	
Red	2	10^2	
Orange	3	10^3	
Yellow	4	10^4	
Green	5	10^5	
Blue	6	10^6	
Violet	7	10^7	
Gray	8	10^8	
White	9	10^9	
Gold		10^{-1}	5%
Silver		10^{-2}	10%
Colorless			20%

For superconducting materials:

$$\text{Newton's law}: \; m_e \frac{dv}{dt} = -eE - \frac{m_e v}{\tau}$$

term representing collisions on a time scale of τ ➔ ∞

For superconducting materials ρ ➔ 0

Currents confined to surfaces; induced by magnetic fields

TABLE 27.3 *Critical Temperatures for Various Superconductors*

Material	T_c (K)
$HgBa_2Ca_2Cu_3O_8$	134
Tl—Ba—Ca—Cu—O	125
Bi—Sr—Ca—Cu—O	105
$YBa_2Cu_3O_7$	92
Nb_3Ge	23.2
Nb_3Sn	18.05
Nb	9.46
Pb	7.18
Hg	4.15
Sn	3.72
Al	1.19
Zn	0.88

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Energy associated with currents and voltage

Electric potential energy for charge Q in voltage ΔV

$$U = Q\Delta V$$

Rate of change of electric potential energy:

$$\frac{dU}{dt} \equiv P = \frac{dQ}{dt}\Delta V = I\Delta V$$

$$P = I\Delta V = I^2 R = \frac{(\Delta V)^2}{R}$$

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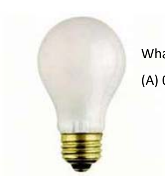
Consider a 60 W light bulb, connected to a 120 V voltage source.



What is the current passing through the wire in the bulb?

(A) 0.5 A (B) 1.0 A (C) 2.0 A (D) 240 A

What is the resistance of the wire in the bulb?

(A) 0.5 Ω (B) 1.0 Ω (C) 2.0 Ω (D) 240 Ω

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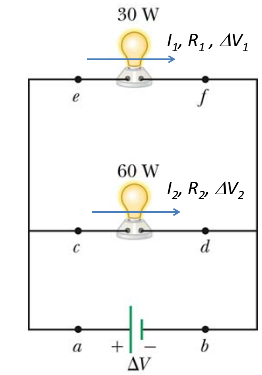


Which is true:

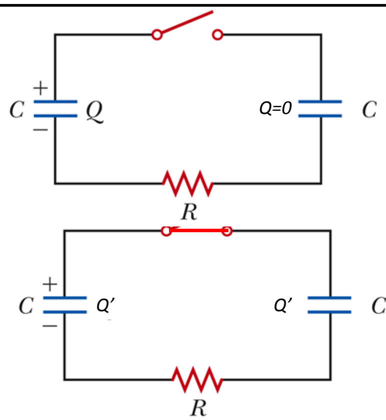
A. $I_1 > I_2$
B. $I_1 < I_2$
C. $I_1 = I_2$

Which is true:

A. $R_1 > R_2$
B. $R_1 < R_2$
C. $R_1 = R_2$

Which is true:

A. $\Delta V_1 > \Delta V_2$
B. $\Delta V_1 < \Delta V_2$
C. $\Delta V_1 = \Delta V_2$



Initially, the switch is open and the left capacitor is charged.

Now the switch is closed.

A. R has no effect.
B. R has an effect on the initial Q'.
C. R has an effect on the final Q'.