The second midterm will be held on TONIGHT Nov 13, 9:50-11:10 PM.

Allison Road Classroom 103 (Busch)        Aaa-Gzz
Physics Lecture Hall (Busch)               Haa-Lzz
Lucy Stone Hall A102 Aud (Livingston)     Maa-Rnn
Beck Hall 100 Aud (Livingston)             Roa-Zzz

The exam is based on Chapters 25-29 inclusive (this week’s lecture also!).

There will be optional review sessions on Thursday, November 13; 2:00 to 5:00 PM in Room 130W in the Physics and Astronomy building.
All exams will be no calculator, closed book exams with only 1 page of equations. Types of questions include iclickers, only formulae, pure concepts, simple numbers. For details go to [http://www.physics.rutgers.edu/ugrad/227/intro.html#Examinations](http://www.physics.rutgers.edu/ugrad/227/intro.html#Examinations).

If you have a conflict you have to contact Professor Cizewski
[Cizewski@physics.rutgers.edu](mailto:Cizewski@physics.rutgers.edu) to request a conflict exam.
All Right Hand Rules

\[ \vec{B}(r) = \frac{\mu_0}{4\pi} I \frac{d\vec{l} \times \hat{r}}{r^2} = \frac{\mu_0}{4\pi} I \frac{d\vec{l} \times \hat{r}}{r^3} \]

- current segment at the origin \((r' = 0)\)

\[ B = \frac{\mu_0 I}{2\pi r} \]
Faraday’s Law

\[ \oint_{\text{loop}} \vec{E} \cdot d\vec{l} = -\frac{d}{dt} \int_{\text{surface}} \vec{B} \cdot d\vec{A} \]

1. Choose the direction of circulation around the loop \((d\vec{l})\). This also gives the direction \(d\vec{A}\).

2. \(\int_{\text{surface}} \vec{B} \cdot d\vec{A} \equiv \Phi_m < 0\)

3. In order to have negative \(\oint_{\text{loop}} \vec{E} \cdot d\vec{l}\), the electric field (and, thus, the current) must be directed against \(d\vec{l}\). 
Lenz’s Law

\[ \oint_{\text{loop}} \vec{E} \cdot d\vec{l} = - \frac{d}{dt} \int_{\text{surface}} \vec{B} \cdot d\vec{A} \quad \equiv \quad \mathcal{E} = - \frac{d\Phi_m}{dt} \]

An induced current has a direction such that the magnetic field due to the induced current opposes the change in the magnetic flux that induces the current.

The magnitude of \( \Phi_m \) changes (decreases) with time. The induced currents are oriented such as if they try to compensate for this change with their own magnetic field.
Iclicker Question

Which of the following statements is FALSE?

To run DC current, we need

A. mobile charge carriers
B. electric field inside a conductor
C. non-zero net charge density inside a conductor
D. non-equipotential conductors
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To run DC current, we need

A. mobile charge carriers
B. electric field inside a conductor
C. non-zero net charge density inside a conductor
D. non-equipotential conductors
A 60-W light bulb, a 120-W light bulb, and a 240-W light bulb are connected in parallel as shown.

Which bulb glows the brightest?

A. the 60-W light bulb
B. the 120-W light bulb
C. the 240-W light bulb
D. All three light bulbs glow with equal brightness.
A 60-W light bulb, a 120-W light bulb, and a 240-W light bulb are connected in parallel as shown. Which bulb glows the brightest?

A. the 60-W light bulb  
B. the 120-W light bulb  
C. the 240-W light bulb  
D. All three light bulbs glow with equal brightness.
A 60-W light bulb, a 120-W light bulb, and a 240-W light bulb are connected in series as shown.

Across which bulb is there the greatest voltage drop?

A. the 60-W light bulb  
B. the 120-W light bulb  
C. the 240-W light bulb  
D. All three light bulbs have the same voltage drop.
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Magnetic materials

- Paramagnetic materials
- Diamagnetic materials
- Ferromagnetic materials
Problem 29.67

• A slender rod with a length of 0.270m rotates with an angular speed of 9.00rad/s about an axis through one end and perpendicular to the rod. The plane of rotation of the rod is perpendicular to a uniform magnetic field with a magnitude of 0.600T.

• Suppose instead the rod rotates at 9.00rad/s about an axis through its center and perpendicular to the rod. In this case, what is the potential difference between the ends of the rod?

• Suppose instead the rod rotates at 9.00rad/s about an axis through its center and perpendicular to the rod. In this case, what is the potential difference between the center of the rod and one end?
**Magnetic (dipole) moment:**

\[ \mu = abI = AI \]

(A – the loop’s area)

Direction of \( \vec{\mu} \): along \( \vec{B} \).

Torque on a loop with current:

\[ \vec{\tau} = \vec{\mu} \times \vec{B} \]

\[ \tau = \mu B \sin \phi \]

Potential energy of the magnetic moment in the external magnetic field:

\[ U(\phi) = -\mu B \cos(\phi) \]
A rectangular coil of length \(L=0.20\) m and width \(W=0.10\) m on each side carries a current of \(I=1.0\) A in the counter-clockwise direction. It is initially oriented in a plane perpendicular to a magnetic field \(B=0.50\) T going into the paper, as seen in the Figure. What is the change in the potential energy of the coil when it is flipped by \(180^\circ\) around the axis shown?

\[
\Delta U = U(\phi_f) - U(\phi_i)
\]

\[
\Delta U = -\mu B \cos(\phi_f) - (-\mu B \cos(\phi_i))
\]

\[
\Delta U = -\mu B [\cos(0) - \cos(\pi)]
\]

\[
\Delta U = -2\mu B = -2 \cdot 0.02 \cdot 0.5J
\]

\[
\Delta U = -0.02J
\]

- a) \(+0.010\) J
- b) \(+0.020\) J
- c) \(-0.020\) J
- d) \(-0.20\) J
- e) \(-0.010\) J

\( \mu = abI = 0.2m \cdot 0.1m \cdot 1A \)

\( U(\phi) = -\mu B \cos(\phi) \)
A circular coil of radius 40.0 cm with 20 turns lies in the $x$-$y$ plane in a uniform magnetic field of magnitude 0.5 T in the $+x$ direction. The current in the loop is 6.0 A (in the direction shown in the figure). The magnitude and direction of the torque vector acting on the coil is

\[ \vec{\mu} \times \vec{B} \] - in the $-y$ direction.

\[ \mu = \pi r^2 NI \approx 60.3 A \cdot m^2 \quad \mu B \approx 30 A \cdot m^2 \cdot T \]