This print-out should have 14 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering. The due time is Central time.

Please notice that for your homework to be considered towards your grade, it needs to be submitted one hour before the corresponding recitation starts. Work submitted after this time, but before the DUE DATE on top of this page, will be accepted but not graded.

**PLEASE REMEMBER THAT YOU MUST CARRY OUT YOUR CALCULATIONS TO AT LEAST THREE SIGNIFICANT FIGURES. YOUR ANSWER MUST BE WITHIN ONE PERCENT OF THE CORRECT RESULT TO BE MARKED AS CORRECT BY THE SERVER.**

### Flux Through a Loop 02
30:08, calculus, numeric, > 1 min, normal.

**001**
A rectangular loop located a distance from a long wire carrying a current is shown in the figure. The wire is parallel to the longest side of the loop.

![Diagram of a rectangular loop with a current through a long wire.](diagram)

Find the total magnetic flux through the loop. Answer in units of Wb.

### Square Plate Capacitor
30:10, calculus, numeric, > 1 min, normal.

**002**
A 0.1 A current is charging a capacitor that has square plates, 5 cm on a side.

The permittivity of free space is \(8.85419 \times 10^{-12} \text{ C}^2/\text{N m}^2\).

If the plate separation is 4 mm find the time rate of change of electric flux between the plates. Answer in units of \(\text{V m/s}\).

### Rod Sliding Down Tracks
31:02, calculus, numeric, > 1 min, normal.

**004**
A straight, horizontal rod slides along parallel conducting rails at an angle with the horizontal, as shown below. The rails are connected at the bottom by a horizontal rail so that the rod and rails forms a closed rectangular loop. A uniform vertical field exists throughout the region.

Assume: The rod remains in contact with the rails as it slides down the rails. The rod experiences no friction or air drag. The rails and rod have negligible resistance. The acceleration of gravity is 9.8 m/s².

![Diagram of a rod sliding down tracks.](diagram)

If the velocity of the rod is 2.5 m/s, what is the current through the resistor? Answer in units of mA.
What is the terminal velocity of the rod? Answer in units of \( \text{m/s} \).

**Circular Magnetic Field 02**

31:05, calculus, numeric, > 1 min, normal.

A magnetic field directed into the page changes with time according to

\[
B = a + bt^2,
\]

where \( a = 1.4 \, \text{T} \), \( b = 0.03 \, \text{T/s}^2 \), and \( t \) is in seconds. The magnetic field pole has a circular cross section of radius \( R = 2.5 \, \text{cm} \).

What is the magnitude of the electric field at point \( P_1 \) when \( t = 3 \, \text{s} \) and \( r_1 = 2 \, \text{cm} \)? Answer in units of \( \text{mV/m} \).

**007**

What is the direction of the electric field?

1. The electric field is perpendicular to \( r_1 \) and directed clockwise.
2. The electric field is perpendicular to \( r_1 \) and directed counter-clockwise.
3. The electric field is parallel to \( r_1 \) and directed away from the center of the magnetic field.
4. The electric field is parallel to \( r_1 \) and directed to the center of the magnetic field.
5. Information is not sufficient to make a decision.

**008**

What is the magnitude of the electric field at point \( P_2 \) when \( t = 3 \, \text{s} \) and \( r_2 = 3 \, \text{cm} \)? Answer in units of \( \text{mV/m} \).

**Rectangular Loop and Wire 02**

31:01, calculus, numeric, > 1 min, normal.

A long, straight wire carries a current and lies in the plane of a rectangular loops of wire, as shown in the figure.

Determine the maximum \( \text{emf}, |\mathcal{E}| \), induced in the loop by the magnetic field created by the current in the straight wire. Answer in units of \( \text{mV} \).

**010**

If at \( t = 0 \), \( \delta=0 \), and a positive \( I \) denotes an upward moving current in the figure, then which statement below is correct at \( t = 0 \).

1. There is zero current in the loop.
2. The current in the loop is clockwise.
3. The current in the loop is counter-clockwise.
4. The sense of current is not determined with the information given.

**Fundamental Formulae 01**

31:09, calculus, multiple choice, < 1 min, fixed.

Which equation best represents Gauss’s Law for electrostatics?

1. \( \oint \vec{B} \cdot d\vec{s} = 0 \)
Which equation best represents Gauss’s Law for magnetostatics?

1. $\oint \mathbf{B} \cdot d\mathbf{A} = 0$
2. $\oint \mathbf{B} \cdot d\mathbf{A} = \mu_0 \varepsilon_0 \frac{\partial \Phi_E}{\partial t}$
3. $\oint \mathbf{E} \cdot d\mathbf{s} = -\frac{\partial \Phi_B}{\partial t}$
4. $\oint \mathbf{E} \cdot d\mathbf{s} = \frac{Q}{\varepsilon_0}$
5. $\oint \mathbf{B} \cdot d\mathbf{A} = 0$
6. $\oint \mathbf{E} \cdot d\mathbf{A} = \frac{Q}{\varepsilon_0}$
7. $\oint \mathbf{B} \cdot d\mathbf{A} = \frac{Q}{\varepsilon_0}$
8. $\oint \mathbf{B} \cdot d\mathbf{s} = \mu_0 I + \mu_0 \varepsilon_0 \frac{\partial \Phi_E}{\partial t}$
9. $\oint \mathbf{E} \cdot d\mathbf{A} = -\frac{\partial \Phi_B}{\partial t}$
10. $\oint \mathbf{E} \cdot d\mathbf{A} = \frac{Q}{\varepsilon_0}$

Which equation best represents Faraday’s Law?

1. $\oint \mathbf{B} \cdot d\mathbf{s} = 0$
2. $\oint \mathbf{B} \cdot d\mathbf{A} = \mu_0 \varepsilon_0 \frac{\partial \Phi_E}{\partial t}$
3. $\oint \mathbf{B} \cdot d\mathbf{A} = \mu_0 I$
4. $\oint \mathbf{E} \cdot d\mathbf{s} = \frac{Q}{\varepsilon_0}$
5. $\oint \mathbf{B} \cdot d\mathbf{A} = 0$
6. $\oint \mathbf{E} \cdot d\mathbf{A} = \frac{Q}{\varepsilon_0}$
7. $\oint \mathbf{B} \cdot d\mathbf{A} = \frac{Q}{\varepsilon_0}$
8. $\oint \mathbf{B} \cdot d\mathbf{s} = \mu_0 I + \mu_0 \varepsilon_0 \frac{\partial \Phi_E}{\partial t}$
9. $\oint \mathbf{E} \cdot d\mathbf{A} = -\frac{\partial \Phi_B}{\partial t}$
10. $\oint \mathbf{E} \cdot d\mathbf{s} = -\frac{\partial \Phi_B}{\partial t}$

Which equation best represents Ampere-Maxwell’s Law?

1. $\oint \mathbf{B} \cdot d\mathbf{s} = 0$
2. $\oint \mathbf{B} \cdot d\mathbf{A} = \mu_0 \varepsilon_0 \frac{\partial \Phi_E}{\partial t}$
3. $\oint \mathbf{E} \cdot d\mathbf{s} = -\frac{\partial \Phi_B}{\partial t}$
4. $\oint \mathbf{E} \cdot d\mathbf{s} = \frac{Q}{\varepsilon_0}$
5. $\oint \mathbf{B} \cdot d\mathbf{A} = 0$
6. $\oint \mathbf{B} \cdot d\mathbf{s} = \mu_0 I + \mu_0 \varepsilon_0 \frac{\partial \Phi_E}{\partial t}$
7. $\oint \mathbf{B} \cdot d\mathbf{A} = \frac{Q}{\varepsilon_0}$
8. $\oint \mathbf{E} \cdot d\mathbf{A} = \frac{Q}{\varepsilon_0}$
9. $\oint \mathbf{E} \cdot d\mathbf{A} = -\frac{\partial \Phi_B}{\partial t}$
10. $\oint \vec{B} \cdot d\vec{A} = \mu_0 I$