

Faraday's law, inductors and LR circuits

AP Physics C (Mechanics and E&M, calculus-based) · Test

Name: _____ Date: _____ Class: _____ Mark: ____ / 20

This test covers Faraday's law, inductance, LR circuits and LC oscillations. It has 8 questions worth 20 marks. Calculators are allowed and no hints are given.

Level: AP Physics C (Mechanics and E&M, calculus-based) · **Curriculum:** AP PC:E&M Unit 13

Time: 40 minutes · 8 questions · Total: 20 marks · Calculator allowed

Question 1 Lenz's law (2 marks)

A bar magnet is pushed north pole first towards a flat coil.

- State the polarity of the face of the coil nearest the magnet. (1 mark)
- Explain, using energy, why the polarity must be this way. (1 mark)

Question 2 Flux and emf (3 marks)

A coil of 60 turns and area $8.0 \times 10^{-3} \text{ m}^2$ has B perpendicular to it with $B(t) = 0.20 t^2$ tesla (t in seconds).

- Write an expression for the emf magnitude. (1 mark)
- Calculate it at $t = 1.5 \text{ s}$. (2 marks)

Question 3 Solenoid inductance (2 marks)

A solenoid has $N = 500$, $\ell = 0.25 \text{ m}$ and $A = 3.0 \times 10^{-4} \text{ m}^2$.

- Calculate L. (1 mark)
- Calculate the emf when the current falls at 80 A/s . (1 mark)

Question 4 LR rise (3 marks)

$L = 0.60 \text{ H}$, $R = 30 \Omega$, $\varepsilon = 6.0 \text{ V}$.

- Calculate τ . (1 mark)
- Calculate the current at $t = 40 \text{ ms}$. (2 marks)

Question 5 Energy store (2 marks)

The circuit in Question 4 reaches steady state.

- Calculate the final current. (1 mark)
- Calculate the energy stored in L. (1 mark)

Question 6 Explaining the delay (2 marks)

A student closes a switch in a circuit with a large inductor and a lamp, and the lamp brightens slowly. Explain this delay using the idea of induced emf. (2 marks)

Question 7 LC oscillator (3 marks)

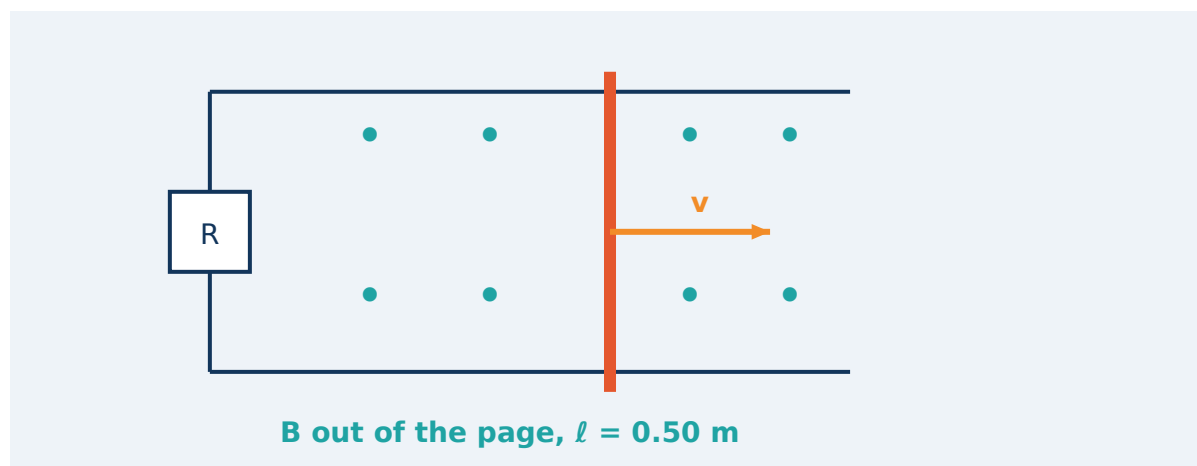
An LC circuit has $L = 10 \text{ mH}$ and $C = 4.0 \text{ }\mu\text{F}$.

- Calculate the angular frequency. (1 mark)
- The capacitor starts with a charge of $20 \text{ }\mu\text{C}$. Calculate the maximum current. (2 marks)

Question 8 Rod on rails (3 marks)

Use the figure: $v = 3.0 \text{ m/s}$, $B = 0.40 \text{ T}$, $R = 2.0 \text{ }\Omega$.

- Calculate the emf and the current. (2 marks)
- Calculate the force needed to keep the rod moving at constant speed. (1 mark)



A rod of length 0.50 m slides on horizontal rails joined by a resistor R .