

# 13.6 Circuits with Capacitors and Inductors (LC Circuits)

Name: \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_ **Total: 10 marks**

**KEY WORDS** lc circuit LC 电路 • angular frequency 角频率 • oscillation 振荡  
• simple harmonic motion 简谐运动 • inductor 电感器

## Objective

Build the skills to answer exam questions on **circuits with capacitors and inductors (LC circuits)**.

You must be able to:

- describe the **oscillation** 振荡 of charge and current in an LC circuit
- explain the **energy exchange** between the capacitor's electric field and the inductor's magnetic field
- relate the **angular frequency** 角频率 to the elements,  $\omega = \frac{1}{\sqrt{LC}}$
- compare LC oscillations with the **simple harmonic motion** of a mass on a spring

## 1 Worked examples

Study these first. Each one shows the method for a question type used later.

### ■ LC oscillation

With no resistance, the charge and current **oscillate**: energy sloshes back and forth between the capacitor's electric field and the inductor's magnetic field.

### ■ Angular frequency

$$\omega = \frac{1}{\sqrt{LC}}.$$

### ■ Like a mass on a spring

The LC circuit is the electrical analogue of simple harmonic motion ( $L$  plays the role of mass,  $1/C$  the role of stiffness). Conservation of energy links the maximum charge to the maximum current:  $\frac{1}{2} \frac{Q^2}{C} = \frac{1}{2} LI^2$ .

## 2 Practice

**2.1** Find the angular frequency of an LC circuit with  $L = 2.0$  H and  $C = 8.0 \mu\text{F}$ . [2]

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**2.2** State what oscillates in an LC circuit. [1]

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**2.3** State the mechanical system that an LC circuit is analogous to. [1]

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## 3 Exam-style questions

**3.1** The angular frequency of an LC circuit is [1]

- A  $\frac{1}{LC}$
- B  $\frac{1}{\sqrt{LC}}$
- C  $\sqrt{LC}$
- D  $LC$

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**3.2** In an LC circuit, energy is exchanged between the [1]

- A resistor and the battery
- B capacitor and the inductor
- C two resistors
- D two batteries

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**3.3** An LC circuit has  $L = 0.50 \text{ H}$  and  $C = 20 \mu\text{F}$ .

(a) Find the angular frequency of oscillation.

[3]

(b) State the mechanical system this behaves like.

[1]

## Solutions

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**2.1**  $\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{(2.0)(8.0 \times 10^{-6})}} = 250 \text{ rad s}^{-1}.$

**2.2** the charge on the capacitor and the current in the inductor.

**2.3** a mass on a spring (simple harmonic motion).

**3.1 B.**

**3.2 B.**

**3.3** (a)  $\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{(0.50)(20 \times 10^{-6})}} = \frac{1}{\sqrt{1.0 \times 10^{-5}}} = 316 \text{ rad s}^{-1}.$  (b) a mass oscillating on a spring.