AP PHYSICS C: ELECTRICITY AND MAGNETISM • EXERCISE SHEET

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, $\omega = \dfrac{1}{\sqrt{LC}}$
- 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: $\frac{1}{2}\dfrac{Q^2}{C} = \frac{1}{2}LI^2$.

2 Practice

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

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

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

3 Exam-style questions

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

A B
C D

A $\dfrac{1}{LC}$
B $\dfrac{1}{\sqrt{LC}}$
C $\sqrt{LC}$
D LC

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

A B
C D

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

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

(a) Find the angular frequency of oscillation. [3]

(b) State the mechanical system this behaves like. [1]