

13.4 Inductance

Name: _____ Class: _____ Date: _____

Total: 11 marks

Objective

Build the skills to answer exam questions on **inductance**.

You must be able to:

- define **inductance** 电感 and its unit the **henry** 亨利
- relate the **back emf** 反电动势 to the rate of change of current, $\varepsilon = -L \frac{dI}{dt}$
- calculate the **energy stored** in an inductor, $U = \frac{1}{2}LI^2$
- relate stored energy to the magnetic **energy density** $u = \frac{B^2}{2\mu_0}$

1 Worked examples

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

■ Inductance

$L = \frac{N\Phi_B}{I}$, measured in henries (H). It measures how much flux linkage a current produces.

■ Back emf

$\varepsilon = -L \frac{dI}{dt}$ —an inductor opposes **changes** in current with an induced (back) emf.

■ Energy stored

$U = \frac{1}{2}LI^2$, held in the magnetic field (energy density $u = \frac{B^2}{2\mu_0}$).

2 Practice

2.1 An inductor produces a back emf of 6.0 V when the current changes at 3.0 A s⁻¹. Find its inductance. [2]

2.2 Find the energy stored in a 0.50 H inductor carrying 4.0 A. [2]

2.3 State the SI unit of inductance. [1]

3 Exam-style questions

3.1 The back emf across an inductor is [1]

- A LI
- B $-L\frac{dI}{dt}$
- C $\frac{1}{2}LI^2$
- D I/L

3.2 The energy stored in an inductor is [1]

- A LI
- B $\frac{1}{2}LI^2$
- C $\frac{1}{2}L^2I$
- D LI^2

3.3 A 0.20 H inductor carries a current rising at 5.0 A s^{-1} .

(a) Find the back emf. [2]

(b) Find the energy stored when the current reaches 3.0 A. [2]

4 Go further

- work through the **13.4 Inductance** lesson on the **Learn** page;

- read the **Electromagnetic Induction** section of the AP Physics C: E&M handout on the **Know** page.

Solutions

2.1 $L = \frac{|\varepsilon|}{|dI/dt|} = \frac{6.0}{3.0} = 2.0 \text{ H.}$

2.2 $U = \frac{1}{2}LI^2 = \frac{1}{2}(0.50)(4.0)^2 = 4.0 \text{ J.}$

2.3 the henry (H).

3.1 B.

3.2 B.

3.3 (a) $|\varepsilon| = L \frac{dI}{dt} = 0.20 \times 5.0 = 1.0 \text{ V.}$ (b) $U = \frac{1}{2}(0.20)(3.0)^2 = 0.90 \text{ J.}$