

10.3 Capacitors

Name: _____ Class: _____ Date: _____

Total: 11 marks

KEY WORDS capacitor 电容器 • capacitance 电容 • series 串联
• parallel-plate capacitor 平行板电容器 • series and parallel 串联和并联

Objective

Build the skills to answer exam questions on **capacitors**.**You must be able to:**

- define **capacitance** 电容 as $C = \frac{Q}{V}$
- use the parallel-plate result $C = \frac{\varepsilon_0 A}{d}$
- calculate the **energy stored**, $U = \frac{1}{2} CV^2 = \frac{1}{2} \frac{Q^2}{C}$
- combine capacitors in **series and parallel** 串联和并联

1 Worked examples

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

■ Capacitance

$C = \frac{Q}{V}$ (farads). For parallel plates, $C = \frac{\varepsilon_0 A}{d}$ — larger area or smaller gap gives more capacitance.

■ Energy stored

$U = \frac{1}{2} CV^2 = \frac{1}{2} \frac{Q^2}{C}$, stored in the field (energy density $u = \frac{1}{2} \varepsilon_0 E^2$).

■ Combining capacitors

- Parallel:** $C = C_1 + C_2 + \dots$
- Series:** $\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \dots$ (less than the smallest).

2 Practice

2.1 A parallel-plate capacitor has area 0.020 m^2 and separation 1.0 mm ($\varepsilon_0 = 8.85 \times 10^{-12}$). Find its capacitance. [2]

2.2 Two $4.0 \mu\text{F}$ capacitors are connected in parallel. Find the total capacitance. [1]

2.3 Find the energy stored in a $10 \mu\text{F}$ capacitor at 12 V . [2]

3 Exam-style questions

3.1 The capacitance of a parallel-plate capacitor is [1]

- A** $\frac{\varepsilon_0 d}{A}$
- B** $\frac{\varepsilon_0 A}{d}$
- C** $\varepsilon_0 A d$
- D** $\frac{A}{\varepsilon_0 d}$

3.2 Two capacitors in series have a total capacitance that is [1]

- A** the sum of the two
- B** less than either one
- C** the larger of the two
- D** zero

3.3 A $5.0\ \mu\text{F}$ capacitor is charged to $100\ \text{V}$.

(a) Find the charge stored.

[2]

(b) Find the energy stored.

[2]

Solutions

2.1 $C = \frac{\epsilon_0 A}{d} = \frac{(8.85 \times 10^{-12})(0.020)}{1.0 \times 10^{-3}} = 1.8 \times 10^{-10}\ \text{F}.$

2.2 $C = 4.0 + 4.0 = 8.0\ \mu\text{F}.$

2.3 $U = \frac{1}{2}CV^2 = \frac{1}{2}(10 \times 10^{-6})(12)^2 = 7.2 \times 10^{-4}\ \text{J}.$

3.1 B.

3.2 B.

3.3 (a) $Q = CV = (5.0 \times 10^{-6})(100) = 5.0 \times 10^{-4}\ \text{C}.$ (b) $U = \frac{1}{2}CV^2 = \frac{1}{2}(5.0 \times 10^{-6})(100)^2 = 0.025\ \text{J}.$