

10.3 Capacitors

Name: _____ Class: _____ Date: _____

Total: 11 marks

KEY WORDS capacitor

- parallel-plate capacitor
- capacitance
- series
- series and parallel

Objective

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

You must be able to:

- define **capacitance** as $C = \frac{Q}{V}$
- use the parallel-plate result $C = \frac{\epsilon_0 A}{d}$
- calculate the **energy stored**, $U = \frac{1}{2}CV^2 = \frac{1}{2}\frac{Q^2}{C}$
- combine capacitors in **series and parallel**

1 Key knowledge and 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, $C = \frac{\epsilon_0 A}{d}$ – 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 $u = \frac{1}{2}\epsilon_0 E^2$).

■ 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 ($\epsilon_0 = 8.85 \times 10^{-12}$). 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** $\frac{\epsilon_0 d}{A}$
B $\frac{\epsilon_0 A}{d}$
C $\epsilon_0 A d$
D $\frac{A}{\epsilon_0 d}$

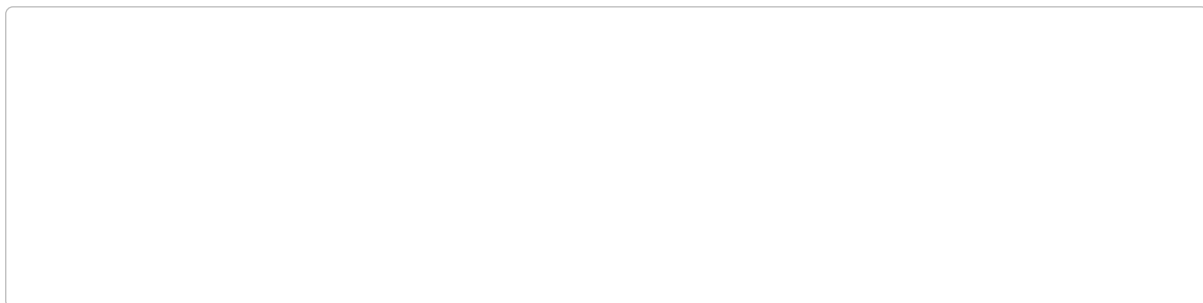
3.2 Two capacitors in series have a total capacitance that is [1]

- ☐ **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

Each answer shows the steps, then the **result**.

2.1

- $C = \frac{\varepsilon_0 A}{d} = \frac{(8.85 \times 10^{-12})(0.020)}{1.0 \times 10^{-3}} = 1.8 \times 10^{-10} \text{ F}$

2.2

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

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

- $\frac{\varepsilon_0 A}{d}$.

3.2 B

- less than either one.

3.3

(a)

- $Q = CV = (5.0 \times 10^{-6})(100) = 5.0 \times 10^{-4} \text{ C}$

(b)

- $U = \frac{1}{2}CV^2 = \frac{1}{2}(5.0 \times 10^{-6})(100)^2 = 0.025 \text{ J}$