

# Charge storage, energy and RC time constants

Physics grades 11-12 (A Level · IB · Class 11-12) · Test

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Class: \_\_\_\_\_ Mark: \_\_\_\_ / 20

This test covers capacitance, energy, combinations of capacitors and the RC time constant. Use  $\epsilon_0 = 8.85 \times 10^{-12} \text{ F/m}$  where needed. Give every numerical answer with its unit and show the formula and the substitution.

**Level:** Physics grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** A Level 3.7.4

Time: 45 minutes · 8 questions · Total: 20 marks · Calculator allowed

## Question 1 Defining capacitance (2 marks)

Define capacitance and state the unit of capacitance in terms of other SI quantities.

## Question 2 Charge and energy (3 marks)

A 220  $\mu\text{F}$  capacitor is charged to 15 V.

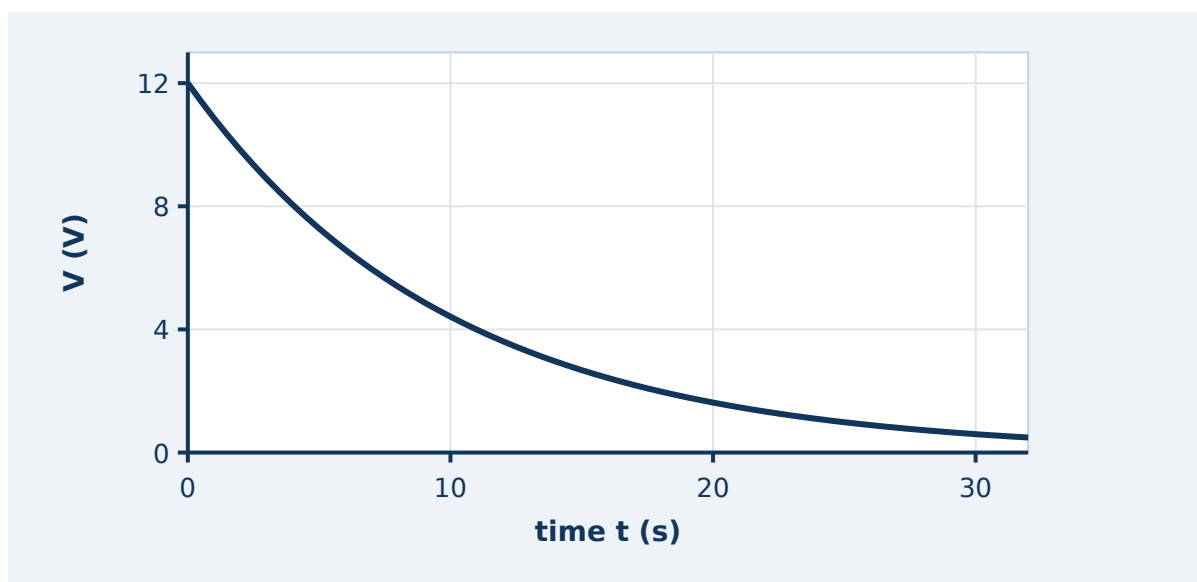
- Calculate the charge stored. (1 mark)
- Calculate the energy stored. (2 marks)

## Question 3 Combining two capacitors (2 marks)

Two 8.0  $\mu\text{F}$  capacitors are available. Calculate the total capacitance when they are connected (a) in series and (b) in parallel.

## Question 4 Reading a discharge graph (4 marks)

The graph shows the voltage across a capacitor discharging through a 20 k $\Omega$  resistor.



Discharge of a capacitor through a 20 k $\Omega$  resistor.

- State the initial voltage. (1 mark)
- Use the graph to determine the time constant. (2 marks)
- Calculate the capacitance. (1 mark)

### Question 5 Charging current (2 marks)

Explain why the current in a charging RC circuit is largest at the start and falls to zero.

### Question 6 Voltage after a delay (3 marks)

A 4.7  $\mu\text{F}$  capacitor charged to 5.0 V discharges through a 330 k $\Omega$  resistor. Calculate the voltage after 2.0 s.

### Question 7 Energy after one time constant (2 marks)

Show that the energy stored in a discharging capacitor falls to about 14 % of its initial value after one time constant.

### Question 8 Unit of the time constant (2 marks)

Show that the unit of RC is the second.