AQA, Edexcel

A Level

A Level Physics

Capacitors

Name:

M M E

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Total Marks: /30

1. George wishes to explore the rules for multiple capacitors. To do this, he constructs a circuit using three: C_1 is connected in series with C_2; these are both connected in parallel with C_3. All are connected to a 6 V power supply. $C_1 = 10\ \mu F, C_2 = 20\ \mu F$ and $C_3 = 50\ \mu F$.

Total for Question 1: 13

(a) Explain in terms of the flow of electrons how a potential difference is built up across a capacitor. [3]

(b) Which of the following is correct? For two capacitors in series, irrespective of their capacitances, the charge stored by the first will be... [1]

i. Half of that stored by the second.

ii. The same as that stored by the second.

iii. Twice that stored by the second.

(c) In any circuit, charge is conserved. Use this, in combination with Kirchoff's laws, to show that the total capacitance of two capacitors in series is given by $\frac{1}{C_{total}} = \frac{1}{C_1} + \frac{1}{C_2}$. [3]

(d) Using similar techniques, it can be shown that $C_{total} = C_1 + C_2$. For George's circuit, calculate the following:

i. The total capacitance of the circuit. [3]

ii. The reading on a voltmeter placed across capacitor 1. [3]

2. Total for Question 2: 6

(a) What is represented by the area underneath a graph of the potential difference across a resistor against the charge stored by it? [1]

(b) From the equation $W = \frac{1}{2}QV$, derive two other equations for the energy stored in capacitor. One should not include the term V and one should not include the term Q. [3]

(c) State the effect of each of the following on the energy stored by a capacitor. [2]

i. Doubling the potential difference across it.

ii. Halving the capacitance.

3. Ella charges a 50 μF capacitor using a 6 V power supply. She then discharges it through a resistor of resistance R (connected in parallel).

Total for Question 3: 11

(a) Outline an experiment that Ella could perform to demonstrate the discharge characteristics of a capacitor when it is discharging through a resistor. Include a circuit diagram. [3]

(b) After 10 s, the charge has reduced by 99 μC from its initial value of 300 μC. Calculate R. [2]

(c) Calculate the current in the circuit 2τ after the switch has been turned on. [2]

(d) Once it has completely discharged, Ella recharges the capacitor using the same 6 V power supply. Calculate the potential difference across the capacitor after 5 s. [2]

(e) Sketch, on a single set of axes, the variation of V_c, V_R and V_0 with time during charging. V_C, V_R and V_0 are the potential differences across the capacitor, the resistor and the power supply respectively. [2]