LONDON SCIENCE COLLEGE

Name:

Date:

CAPACITORS
TEST 3

A2-Level

Mark

Grade

PHYSICS

For this paper you must have:

- Ruler
- Pencil and Rubber
- Scientific calculator, which you are expected to use when appropriate

Instructions

- Answer all questions
- Answer questions in the space provided
- All working must be shown

Information

- The marks for the questions are shown in brackets

1 A 680 μF capacitor is charged fully from a 12 V battery. At time t = 0 the capacitor begins to discharge through a resistor. When t = 25 s the energy remaining in the capacitor is one quarter of the energy it stored at 12 V.

(a) Determine the pd across the capacitor when t = 25s.

(2)

(b) (i) Show that the time constant of the discharge circuit is 36 s.

(ii) Calculate the resistance of the resistor.

(4)

(Total 6 marks)

2 (a) As a capacitor was charged from a 12 V supply, a student used a coulomb meter and a voltmeter to record the charge stored by the capacitor at a series of values of potential difference across the capacitor. The student then plotted a graph of pd (on the *y*-axis) against charge (on the *x*-axis).

(i) Sketch the graph obtained.

(ii) State what is represented by the gradient of the line.

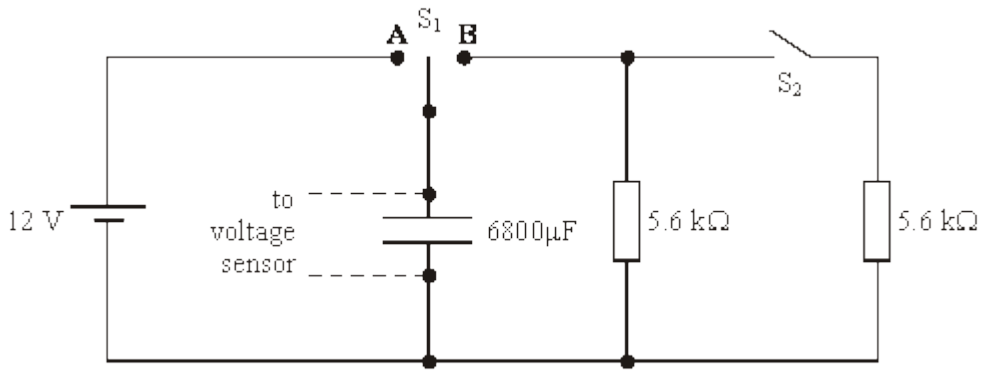
_____

(iii) State what is represented by the area enclosed by the line and the *x*-axis of the graph.

_____

(3)

(b) The student then connected the capacitor as shown in the diagram below to carry out an investigation into the discharge of the capacitor.

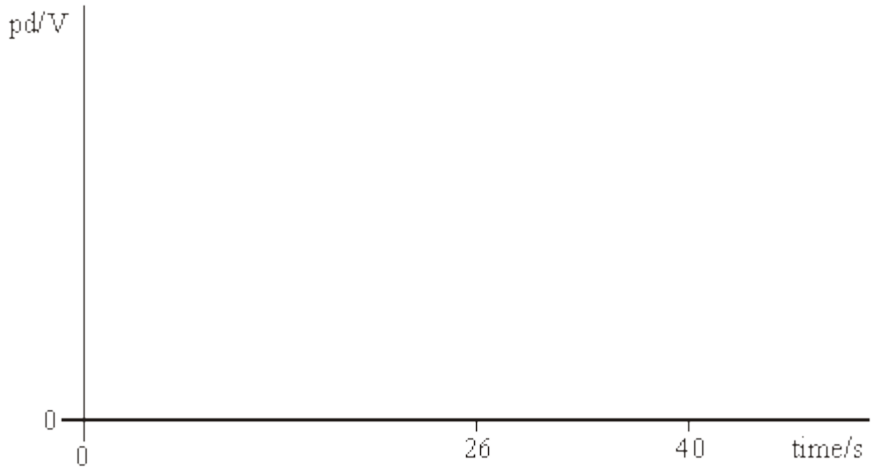


The student used a voltage sensor, datalogger and computer to obtain values for the pd across the capacitor at various times during the discharge.

(i) At time t = 0, with switch S_2 open, switch $S_1$was moved from position **A** to position **B**. Calculate the pd across the capacitor when t = 26 s.

(ii) At time t = 26 s, as the discharge continued, the student closed switch S_2. Calculate the pd across the capacitor 40 s after switch S_1 was moved from position **A** to position **B**.

(iii) Sketch a graph of pd against time for the student's experiment described in parts (b)(i) and (b)(ii).



(7)

(Total 10 marks)

3 A capacitor of capacitance 330 μF is charged to a potential difference of 9.0 V. It is then discharged through a resistor of resistance 470 kΩ.

Calculate

(a) the energy stored by the capacitor when it is fully charged,

_____

_____

_____

_____

(2)

(b) the time constant of the discharging circuit,

_____

_____

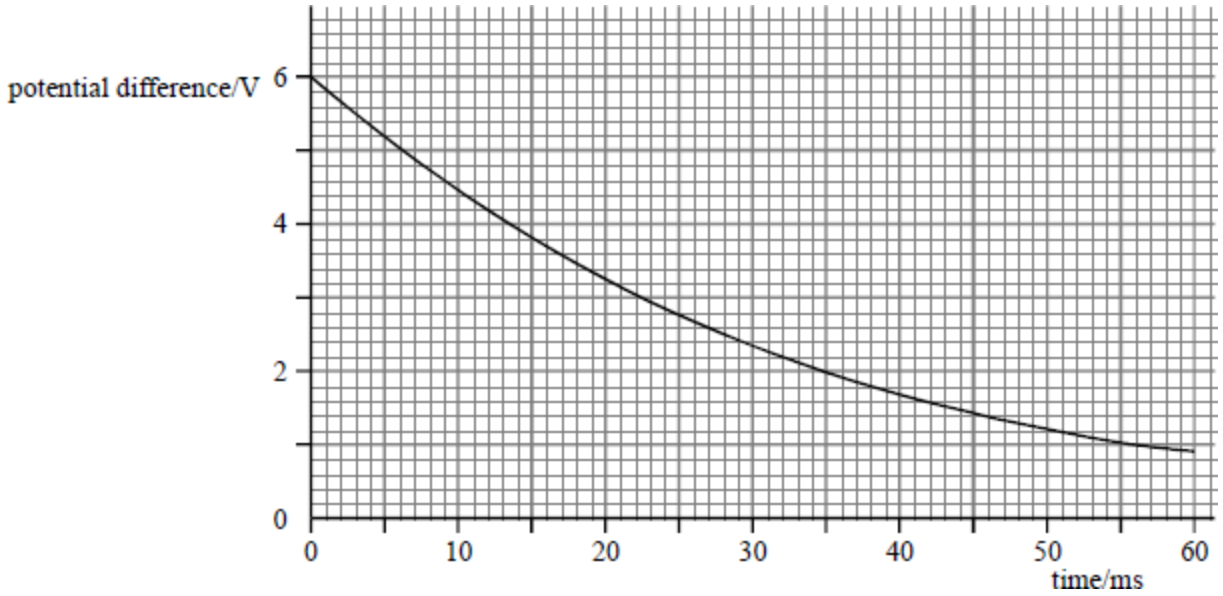
(1)

(c) the p.d. across the capacitor 60 s after the discharge has begun.

(3)

(Total 6 marks)

4 A student used a voltage sensor connected to a datalogger to plot the discharge curve for a 4.7 μF capacitor. She obtained the following graph.



Use data from the graph to calculate

(a) the initial charge stored,

(2)

(b) the energy stored when the capacitor had been discharging for 35 ms,

(3)

(c) the time constant for the circuit,

_____

_____

_____

_____

(3)

(d) the resistance of the circuit through which the capacitor was discharging.

_____

_____

_____

(2)

(Total 10 marks)

5 (a) A 2.0 μF capacitor is charged through a resistor from a battery of emf 4.5 V. Sketch a graph on the axes below to show how the charge stored, Q, varies with the potential difference, V, across the capacitor during the charging process. Mark appropriate values on the axes of the graph.

(2)

(b) (i) Show that the energy stored by a charged capacitor is given by $E = \frac{1}{2}QV$.

(ii) Calculate the energy stored by the capacitor in part (a) when the potential difference across it is 1.5 V.

(5)

(Total 7 marks)

6 (a) For a capacitor of capacitance C, sketch graphs of charge, Q, and energy stored, E, against potential difference, V.

graph A

graph b

What is represented by the slope of graph A?

(3)

(b) A capacitor of capacitance 0.68 F is charged to 6.0 V. Calculate

(i) the charge stored by the capacitor,

_____

_____

(ii) the energy stored by the capacitor.

_____

_____

(2)

(Total 5 marks)

7 An initially uncharged capacitor of capacitance 20 μF is charged by a constant current of 80 μA. Which line, **A** to **D**, in the table gives the potential difference across, and the energy stored in, the capacitor after 50 s?

	potential difference / V	**energy stored / J**
A	4.0×10^{-3}	2.0×10^{-3}
B	4.0×10^{-3}	4.0×10^{-1}
C	2.0×10^{2}	2.0×10^{-3}
D	2.0×10^{2}	4.0×10^{-1}

(Total 1 mark)

8 Which one of the following statements about a parallel plate capacitor is **incorrect**?

A The capacitance of the capacitor is the amount of charge stored by the capacitor when the pd across the plates is 1V.

B A uniform electric field exists between the plates of the capacitor.

C The charge stored on the capacitor is inversely proportional to the pd across the plates.

D The energy stored when the capacitor is fully charged is proportional to the square of the pd across the plates.

(Total 1 mark)

9 A 1000 μF capacitor and a 10 μF capacitor are charged so that they store the same energy. The pd across the 1000 μF capacitor is V_1 and the pd across the other capacitor is V_2.

What is the value of the ratio $\left(\frac{V_1}{V_2}\right)^2$?

A $\frac{1}{1000}$

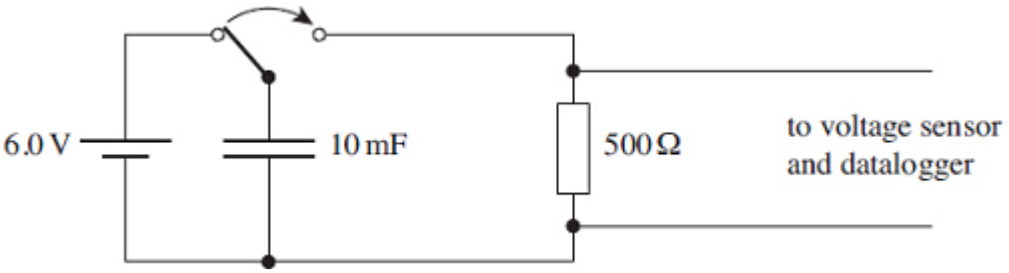
B $\frac{1}{100}$

C $\frac{1}{10}$

D 10

(Total 1 mark)

10 A voltage sensor and a datalogger are used to record the discharge of a 10 mF capacitor in series with a 500 Ω resistor from an initial pd of 6.0 V. The datalogger is capable of recording 1000 readings in 10 s. Which line, **A** to **D**, in the table gives the pd and the number of readings made after a time equal to the time constant of the discharge circuit?



	potential difference/V	number of readings
A	2.2	50
B	3.8	50
C	3.8	500
D	2.2	500

(Total 1 mark)