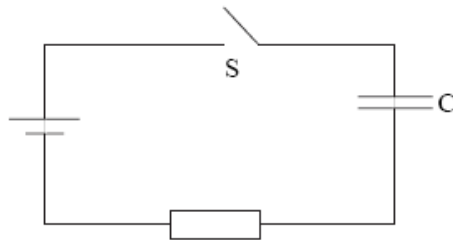


## Test on Capacitors

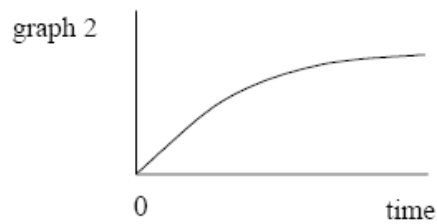
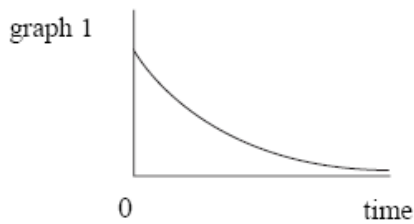
Examination Time - 45 minutes

1.

In the circuit shown, the capacitor  $C$  is charged to a potential difference  $V$  when the switch  $S$  is closed.



Which line, **A** to **D**, in the table gives a correct pair of graphs showing how the charge and current change with time after  $S$  is closed?



	charge	current
<b>A</b>	graph 1	graph 1
<b>B</b>	graph 1	graph 2
<b>C</b>	graph 2	graph 2
<b>D</b>	graph 2	graph 1

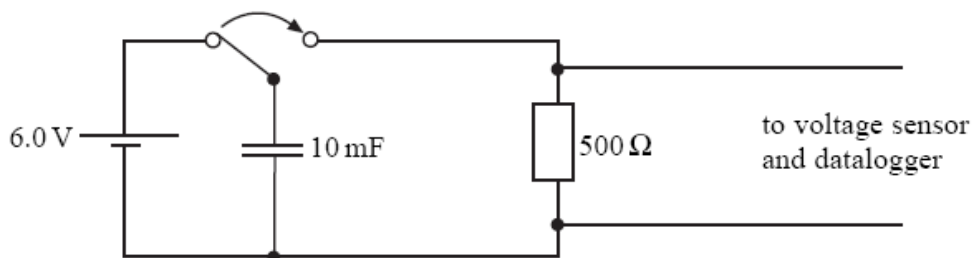
2.

A  $400\ \mu\text{F}$  capacitor is charged so that the voltage across its plates rises at a constant rate from  $0\ \text{V}$  to  $4.0\ \text{V}$  in  $20\ \text{s}$ . What current is being used to charge the capacitor?

- A**  $5\ \mu\text{A}$
- B**  $20\ \mu\text{A}$
- C**  $40\ \mu\text{A}$
- D**  $80\ \mu\text{A}$

3.

A voltage sensor and a datalogger are used to record the discharge of a 10 mF capacitor in series with a 500  $\Omega$  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
<b>A</b>	2.2	50
<b>B</b>	3.8	50
<b>C</b>	2.2	500
<b>D</b>	3.8	500

4.

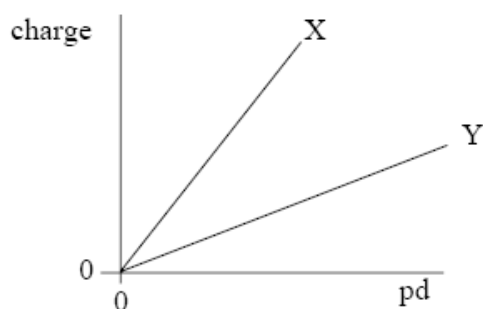
The relationship between two physical quantities may be inverse, inverse square or exponential. Which line, **A** to **D**, in the table shows correct relationships for

- (i) pd and time in capacitor discharge,
- (ii) electric field strength and distance in a radial field, and
- (iii) gravitational potential and distance in a radial field?

	(i) capacitor discharge	(ii) electric field strength	(iii) gravitational potential
<b>A</b>	exponential	inverse	inverse square
<b>B</b>	inverse	inverse square	exponential
<b>C</b>	inverse square	exponential	inverse
<b>D</b>	exponential	inverse square	inverse

5.

The graph shows how the charge stored by each of two capacitors, X and Y, increases as the pd across them increases.



Which one of the following statements is correct?

- A The capacitance of X is equal to that of Y.
- B The capacitance of Y is greater than that of X.
- C The capacitance of Y is less than that of X.
- D The capacitances of both X and Y are increasing.

6.

A  $1000\ \mu\text{F}$  capacitor and a  $10\ \mu\text{F}$  capacitor are charged so that the potential difference across each of them is the same. The charge stored in the  $1000\ \mu\text{F}$  capacitor is  $Q_1$  and the charge stored in the  $10\ \mu\text{F}$  capacitor is  $Q_2$ .

What is the ratio  $\frac{Q_1}{Q_2}$  ?

- A 100
- B 10
- C 1
- D  $\frac{1}{100}$

7.

A  $1000\ \mu\text{F}$  capacitor, initially uncharged, is charged by a steady current of  $50\ \mu\text{A}$ . How long will it take for the potential difference across the capacitor to reach  $2.5\ \text{V}$ ?

- A 20 s
- B 50 s
- C 100 s
- D 400 s

8.

In experiments to pass a very high current through a gas, a bank of capacitors of total capacitance  $50 \mu\text{F}$  is charged to  $30 \text{ kV}$ . If the bank of capacitors could be discharged completely in  $5.0 \text{ ms}$  what would be the mean power delivered?

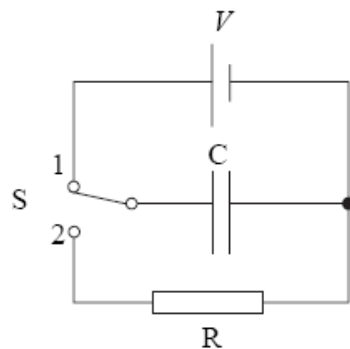
- A 22 kW
- B 110 kW
- C 4.5 MW
- D 9.0 MW

9.

A capacitor of capacitance  $2500 \mu\text{F}$  is charged by a **constant** current of  $200 \mu\text{A}$ . What is the pd across the capacitor  $25 \text{ s}$  after starting to charge?

- A 0.50 V
- B 1.0 V
- C 2.0 V
- D 4.0 V

10.



Switch S in the circuit is held in position 1, so that the capacitor C becomes fully charged to a pd  $V$  and stores energy  $E$ . The switch is then moved quickly to position 2, allowing C to discharge through the fixed resistor R. It takes  $36 \text{ ms}$  for the pd across C to fall to  $\frac{V}{2}$ . After the switch has been moved to position 2, how long does it take before the energy stored by C has fallen to  $\frac{E}{16}$  ?

- A 51 ms
- B 72 ms
- C 432 ms
- D 576 ms

11.

A  $680\ \mu\text{F}$  capacitor is charged fully from a  $12\ \text{V}$  battery. At time  $t=0$  the capacitor begins to discharge through a resistor. When  $t=25\ \text{s}$  the energy remaining in the capacitor is one quarter of the energy it stored at  $12\ \text{V}$ .

(a) Determine the pd across the capacitor when  $t=25\ \text{s}$ .

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.....

*(2 marks)*

(b) (i) Show that the time constant of the discharge circuit is  $36\ \text{s}$ .

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(ii) Calculate the resistance of the resistor.

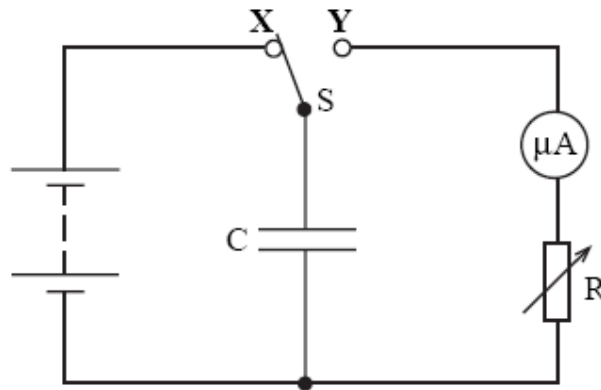
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*(4 marks)*

12.

**Figure 2** shows a circuit used to determine the capacitance of a capacitor  $C$ . Switch  $S$  is held in position **X** until  $C$  is fully charged. It is then switched to position **Y**, so that  $C$  discharges through the microammeter and the variable resistor  $R$ . While discharging,  $R$  is adjusted continuously to keep the current constant until  $C$  has been fully discharged. Measurements taken during the discharge allow the initial charge stored by  $C$  to be determined.

**Figure 2**



**Figure 3** shows a graph of current,  $I$ , against time,  $t$ , obtained in such an experiment.

**Figure 3**



(a) Calculate

(i) the initial charge stored by the capacitor,

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(ii) the capacitance of the capacitor, if the emf of the battery used was 6.0 V.

.....  
.....

(2 marks)

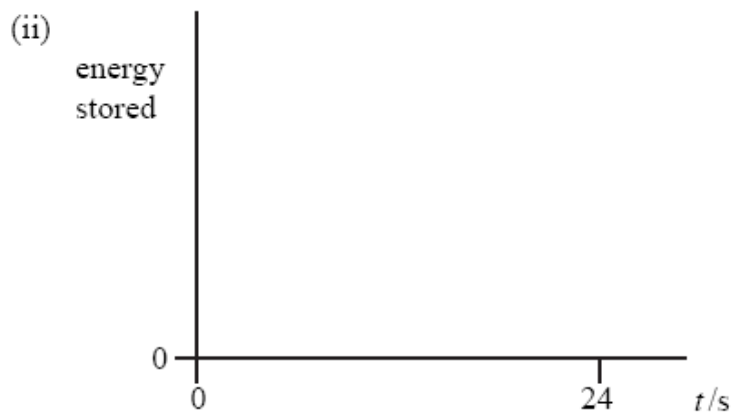
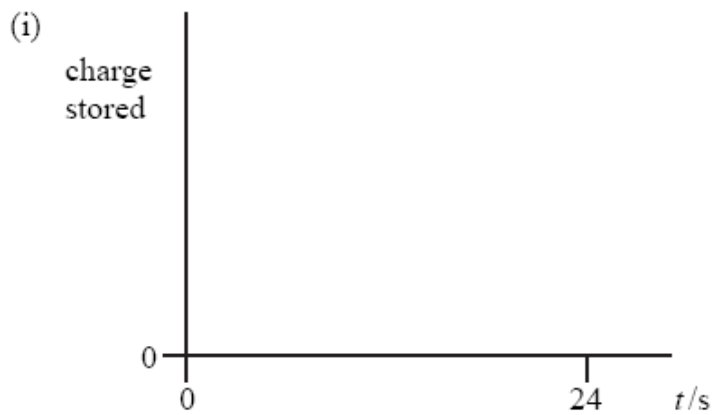
(b) Sketch graphs on the axes below to show, for the capacitor, how

(i) the charge stored

(ii) the energy stored

varied with time during the experiment.

You do not need to show any values on the vertical axes.



(4 marks)

13 (3 marks)

- (a) An experiment is to be carried out to determine the capacitance of a capacitor by measuring the potential difference  $V$  across it at various times  $t$  as it discharges through a resistor. The timing is to be carried out using a stopwatch. If the capacitance is known to be about  $30\ \mu\text{F}$ , suggest a suitable value for the resistance of the resistor, and explain why you have chosen this value.

You may be awarded additional marks to those shown in brackets for the quality of written communication in your answer.

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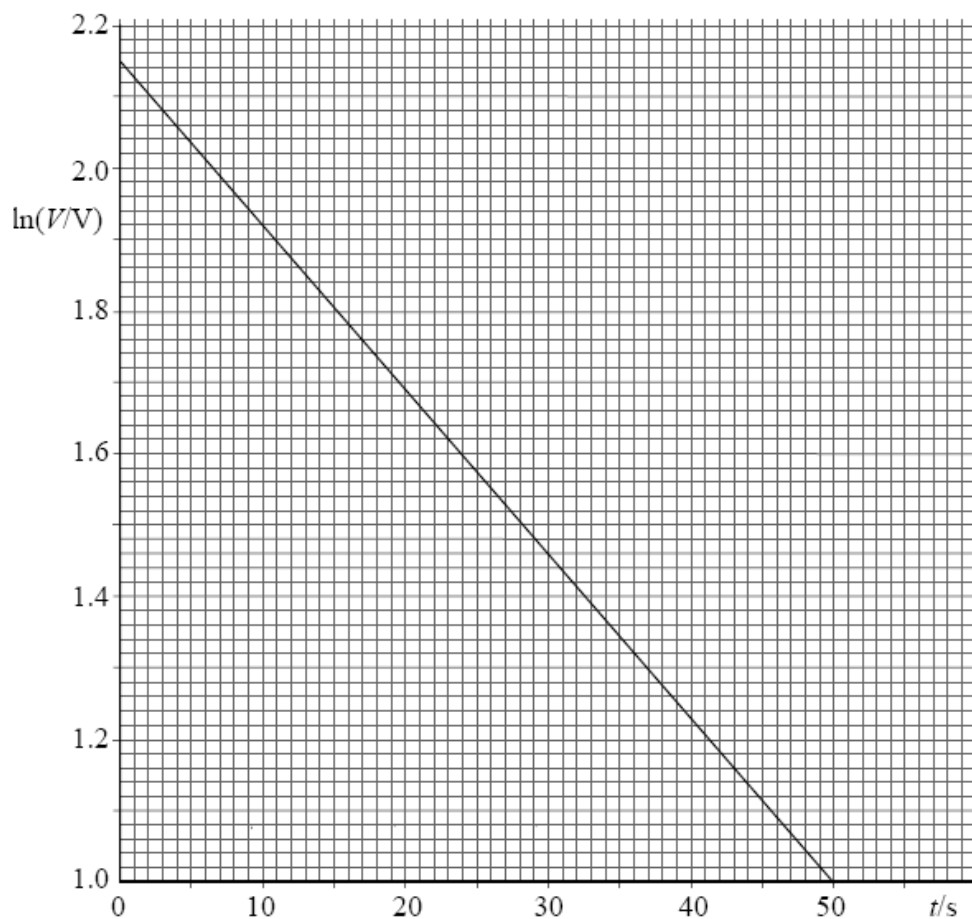
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- (b) A similar experiment, in which the resistor had a resistance of  $91\ \text{k}\Omega$ , gave the graph of  $\ln V$  against  $t$  shown on the opposite page.





Use this graph to calculate

- (i) the pd across the capacitor when  $t = 0$ ,

.....  
 .....

- (ii) the time constant for the discharging circuit,

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 .....

- (iii) the capacitance of the capacitor used in this experiment.

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 .....

(5 marks)

Total = 30 marks