A-Level Physics

Capacitance
(Multiple Choice)

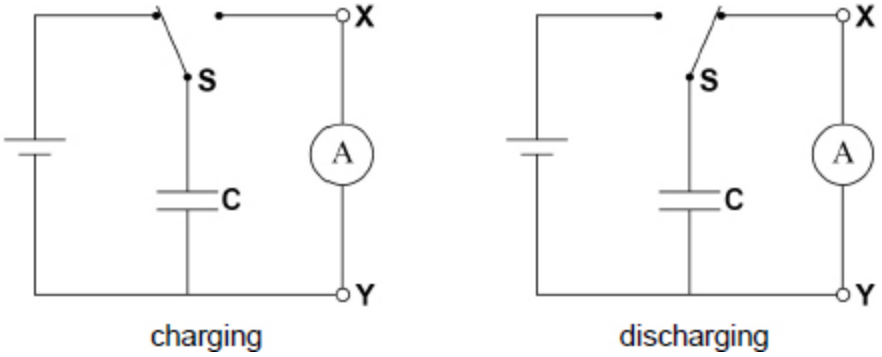
Question Paper

Time available: 22 minutes
Marks available: 20 marks

1. A switch **S** allows capacitor **C** to be completely charged by a cell and then completely discharged through an ammeter.

The emf of the cell is $4.0\ \text{V}$ and it has negligible internal resistance.

The capacitance of **C** is $0.40\ \mu\text{F}$ and there are 8000 charge–discharge cycles every second.



What are the magnitude and direction of the average conventional current in the ammeter?

	Magnitude of current / A	Direction of current	
A	1.3×10^{-2}	**X** to **Y**	⬭
B	1.3×10^{-2}	**Y** to **X**	⬭
C	2.0×10^{-10}	**X** to **Y**	⬭
D	2.0×10^{-10}	**Y** to **X**	⬭

(Total 1 mark)

2. A $30\ \mu\text{F}$ capacitor is charged by connecting it to a battery of emf $4.0\ \text{V}$.

The initial charge on the capacitor is Q_0.

The capacitor is then discharged through a $500\ \text{k}\Omega$ resistor.

The time constant for the circuit is T.

Which is correct?

A T is $15\ \text{ms}$. ⬭

B Q_0 is $12\ \mu\text{C}$. ⬭

C After a time T the pd across the capacitor is $1.5\ \text{V}$. ⬭

D After a time $2T$ the charge on the capacitor is Q_0e^2. ⬭

(Total 1 mark)

3. Capacitor **X** of capacitance C has square plates of side length l and separation d and is made with a dielectric of relative permittivity ε.

Capacitor **Y** has square plates of side length $3l$ and separation $\frac{d}{3}$ and is made with a dielectric of relative permittivity $\frac{\varepsilon}{3}$.

What is the capacitance of **Y**?

A $\frac{C}{27}$ ⬭

B $\frac{C}{9}$ ⬭

C $9C$ ⬭

D $27C$ ⬭

(Total 1 mark)

4. A parallel plate capacitor is connected across a battery and the energy stored in the capacitor is E.
Without disconnecting the battery, the separation of the plates is halved.

What is the energy now stored in the capacitor?

A $0.5E$ ⬭

B E ⬭

C $2E$ ⬭

D $4E$ ⬭

(Total 1 mark)

5. A fully charged capacitor of capacitance $2.0\ \text{mF}$ discharges through a $15\ \text{k}\Omega$ resistor.

What fraction of the stored energy remains after 1.0 minute?

A $\frac{1}{4}$ ⬭

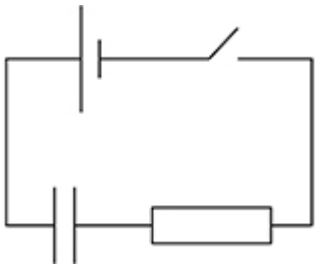
B $\frac{1}{e^2}$ ⬭

C $\frac{1}{16}$ ⬭

D $\frac{1}{e^4}$ ⬭

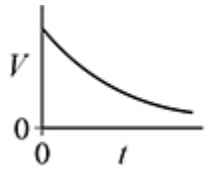
(Total 1 mark)

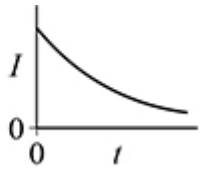
6. The capacitor in the circuit is initially uncharged.
The switch is closed at time $t = 0$



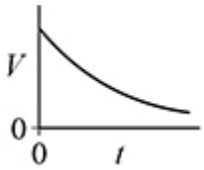
Which pair of graphs shows how the potential difference V across the capacitor and the current I in the circuit change with time t?

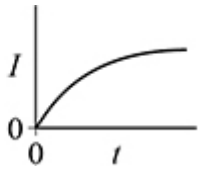
A





B





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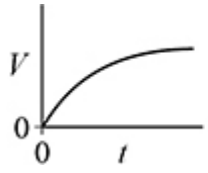
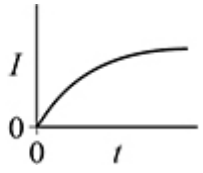
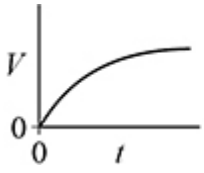
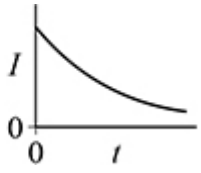




D





A ⬭

B ⬭

C ⬭

D ⬭

(Total 1 mark)

7. An uncharged capacitor is connected to a power supply which supplies a constant current of 10 μA.

After 100 ms, the potential difference across the capacitor is 5.0 kV.

What is the capacitance of the capacitor?

A 2.0×10^{-10} F ⬭

B 4.0×10^{-10} F ⬭

C 2.5×10^{9} F ⬭

D 5.0×10^{9} F ⬭

(Total 1 mark)

8. When a parallel-plate capacitor is connected across a battery, the energy stored in the capacitor is W.

The battery remains connected as the distance between the capacitor plates is halved.

What is the energy now stored in the capacitor?

A $0.5W$ ⬭

B W ⬭

C $2W$ ⬭

D $4W$ ⬭

(Total 1 mark)

9. A parallel-plate capacitor is made using a sheet of dielectric material between, and in contact with, two plates.
The properties of four sheets of dielectric material are shown.

Which sheet will produce the maximum capacitance?

Sheet	Relative permittivity	Thickness / mm
A	2	0.40
B	3	0.90
C	4	1.0
D	6	1.6

(Total 1 mark)

10. A 10 μF capacitor stores 4.5 mJ of energy.
It then discharges through a 25 Ω resistor.

What is the maximum current during the discharge of the capacitor?

A 1.2 A

B 18 A

C 30 A

D 36 A

(Total 1 mark)

11. A parallel-plate capacitor is made by inserting a sheet of dielectric material between two plates. Both plates are in contact with the sheet.

Which relative permittivity and sheet thickness give the greatest capacitance?

	Relative permittivity	Thickness / mm	
A	2	0.40	⬭
B	3	0.90	⬭
C	4	1.0	⬭
D	6	1.6	⬭

(Total 1 mark)

12. A 1.0 μF capacitor is charged for 20 s using a constant current of 10 μA.

What is the energy transferred to the capacitor?

A 5.0×10^{-3} J ⬭

B 1.0×10^{-2} J ⬭

C 2.0×10^{-2} J ⬭

D 4.0×10^{-2} J ⬭

(Total 1 mark)

13. A 1.0 μF capacitor initially stores 15 μC of charge. It then discharges through a 25 Ω resistor.

What is the maximum current during the discharge of the capacitor?

A 0.60 mA ⬭

B 1.2 mA ⬭

C 0.60 A ⬭

D 1.2 A ⬭

(Total 1 mark)

14. An air-filled parallel-plate capacitor is charged from a source of emf. The electric field has a strength E between the plates. The capacitor is disconnected from the source of emf and the separation between the isolated plates is doubled.

What is the final electric field between the plates?

A $2E$ ⬭

B E ⬭

C $\frac{E}{2}$ ⬭

D $\frac{E}{4}$ ⬭

(Total 1 mark)

15. A parallel-plate capacitor has square plates of length l separated by distance d and is filled with a dielectric.

A second capacitor has square plates of length $2l$ separated by distance $2d$ and has air as its dielectric.

Both capacitors have the same capacitance.

What is the relative permittivity of the dielectric in the first capacitor?

A $\frac{1}{2}$ ⬭

B 1 ⬭

C 2 ⬭

D 8 ⬭

(Total 1 mark)

16. A capacitor of capacitance C has a charge of Q stored on the plates. The potential difference between the plates is doubled.

What is the change in the energy stored by the capacitor?

A $\frac{Q^2}{2C}$ ⬭

B $\frac{Q^2}{C}$ ⬭

C $\frac{3Q^2}{2C}$ ⬭

D $\frac{2Q^2}{C}$ ⬭

(Total 1 mark)

17. A parallel-plate capacitor is fully charged and then disconnected from the power supply. A dielectric is then inserted between the plates.

Which row correctly identifies the charge on the plates and the electric field strength between the plates?

	Charge	Electric field strength	
A	Stays the same	Increases	⬭
B	Increases	Decreases	⬭
C	Increases	Increases	⬭
D	Stays the same	Decreases	⬭

(Total 1 mark)

18. A capacitor of capacitance 120 μF is charged and then discharged through a 20 kΩ resistor.

What fraction of the original charge remains on the capacitor 4.8 s after the discharge begins?

A 0.14 ⬭

B 0.37 ⬭

C 0.63 ⬭

D 0.86 ⬭

(Total 1 mark)

19. The separation of the plates of an isolated charged parallel−plate capacitor is increased.

What also increases?

A the capacitance of the capacitor ⬭

B the charge on the plates ⬭

C the strength of the electric field between the plates ⬭

D the pd between the plates ⬭

(Total 1 mark)

20. A 500 μF capacitor is charged to a pd of 10.0 V. It is then discharged through a 100 kΩ resistor.

What is the time taken for the pd to fall from 10.0 V to 5.0 V?

A 35 s ⬭

B 50 s ⬭

C 72 s ⬭

D 100 s ⬭

(Total 1 mark)