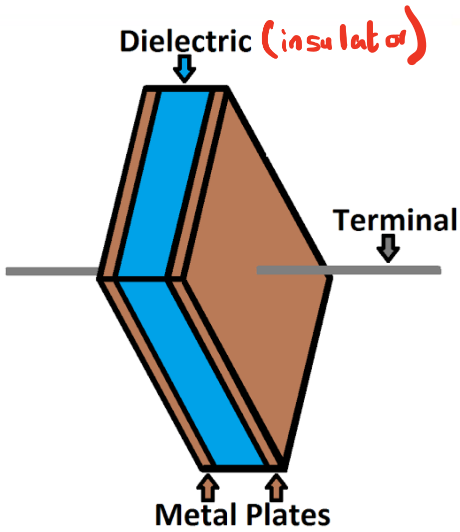
Capacitance = storage capacity.

Topic: Capacitance.

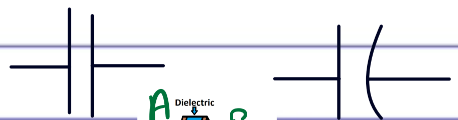
Date:

Capacitor : An electronic device / Component that stores electrical energy inside it.

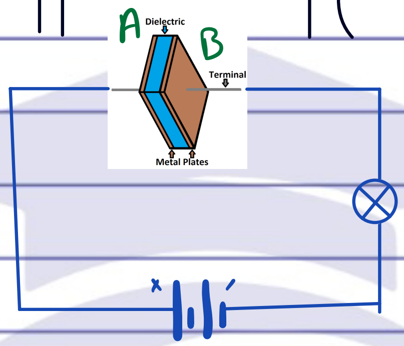
→ It is used to supply extra amount of Energy or charge when circuit demands.



Symbols :



Construction.



Working. (Charging)

1) The capacitor is connected to a DC power supply.

2) The positive terminal of the battery attract electrons from plate A and the -ve terminal deposit them on plate B.

3) This produces a positive charge on plate A and an equal -ve charge on plate B.

4) This deposition of Electrons produces a potential difference across the plates of the capacitor.

5) The greater the charge on plate the higher the voltage induced across them.

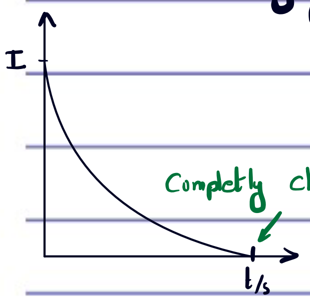
Dielectric

Dielectrics are non-conducting materials. It will not have any free-charge carriers.

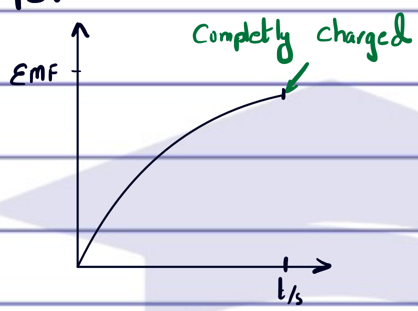
6) A point comes when charge on plates is enough that potential difference across capacitor gets equal to the EMF of that Battery.

→ The strength with which battery tries to take electrons From A to B becomes equal to the opposition from the capacitor it self.

Therefore charging stops.



Current in circuit

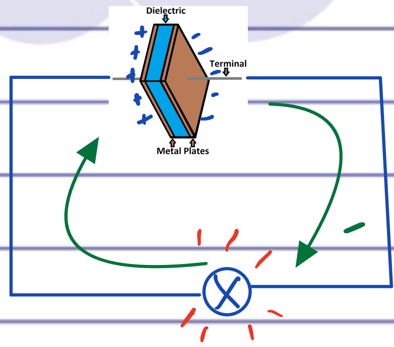


Voltage on capacitor.

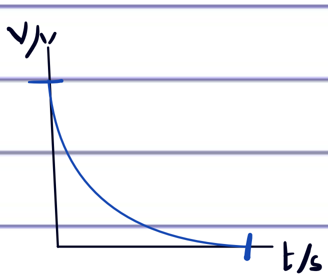
Working (Discharging)

1) When a capacitor discharged Electron move from −ve to +ve terminal.

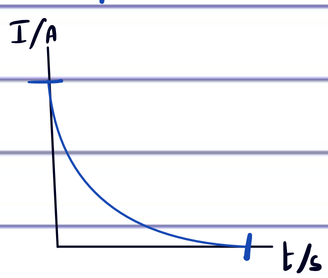
2) The current is high at the slant but decreases gradually as the potential difference across falls.



3) After some time PD across capacitor is zero



Voltage across capacitor



Current across capacitor.

Topic: ______ Date: ______

Capacitor Stores energy but not charge why?

- → After charging both the plates of capacitor achieve equal and opposite charge
- → Hence net charge is zero.
- → However, work is done in seperating those charges ∴ energy is stored in the capacitor.

Capacitance:

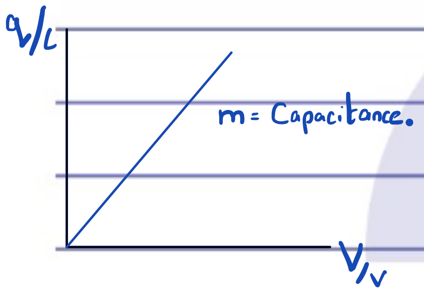
It is the charge stored per unit potential difference on one plate of a capacitor.

$$\boxed{C = \frac{q}{V}}$$

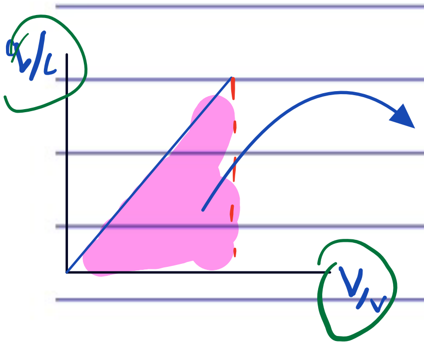
SI unit = F (Farad)

usually we use μF

$$V = \frac{WD}{q}$$



Define Farad: It is the capacitance of the capacitor when 1C of charge is stored on one plate of a capacitor for a potential difference of 1 V.



Area = q.V

Since $V = \frac{WD}{q}$

$q \times V = WD/\text{Energy}$.

$\frac{1}{2} \times V \times q$

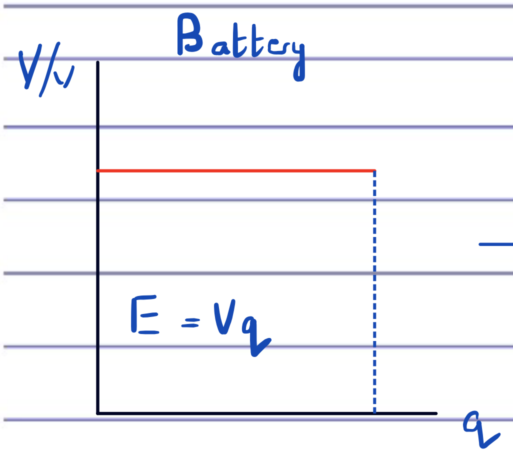
$$E = \frac{1}{2} qV$$

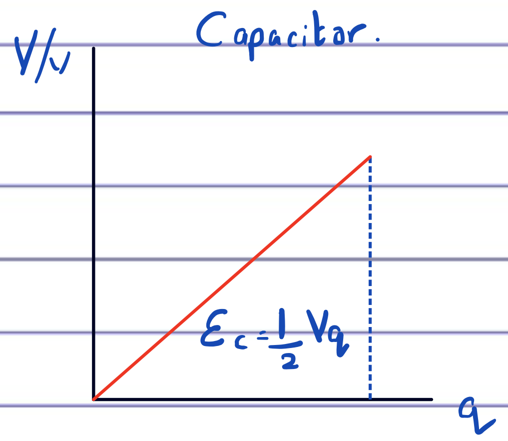
$$E = \frac{1}{2}(CV)(V)$$

$$\boxed{E = \frac{1}{2} qV}$$

$$\boxed{E = \frac{1}{2} CV^2}$$

Topic: ______ Date: ______



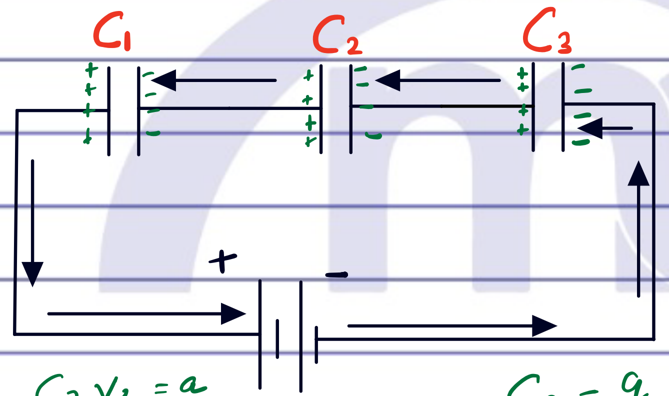


During the charging process, half of the energy supplied is lost as heat

① In the wires

② In the battery due to internal Resistance.

Capacitors in Series:



Charge: The charge on each capacitor is same and equal to the total

$q_T = q_1 = q_2 = q_3$

$C_1 = \frac{q}{V_1}$

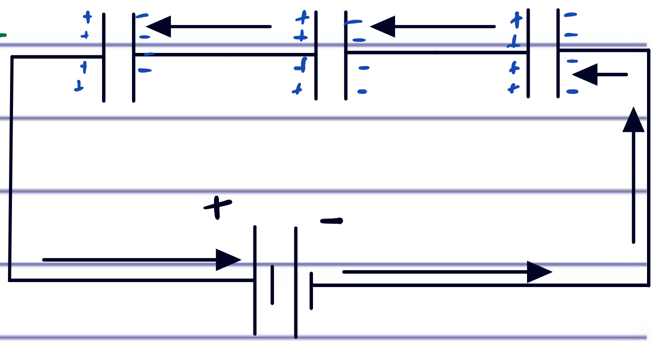
$C_1V_1 = q$

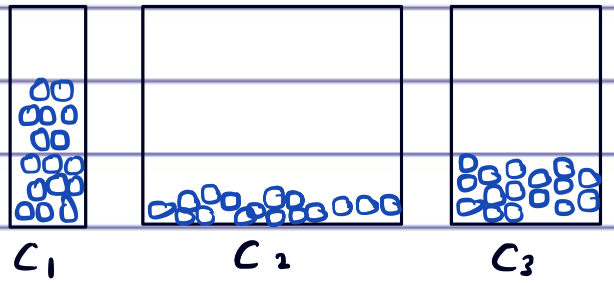
$C_1V_1 = C_2V_2$

$C_2V_2 = q$

$C_2 = \frac{q}{V_2}$

$C_3 = \frac{q}{V_3}$





Size of the box = Capacitance.

Amount of substance = charge

level of substance = Voltage

$C_1V_1 = C_2V_2$

Topic: ______________ Date: ______________

Voltage $V_T = V_1 + V_2 + V_3$

The Voltage on each Capacitor depends upon the capacitance, if charge is same Large capacitor attains small Voltage and small attains large

Capacitance : As $q = CV$ & $V = \frac{q}{C}$

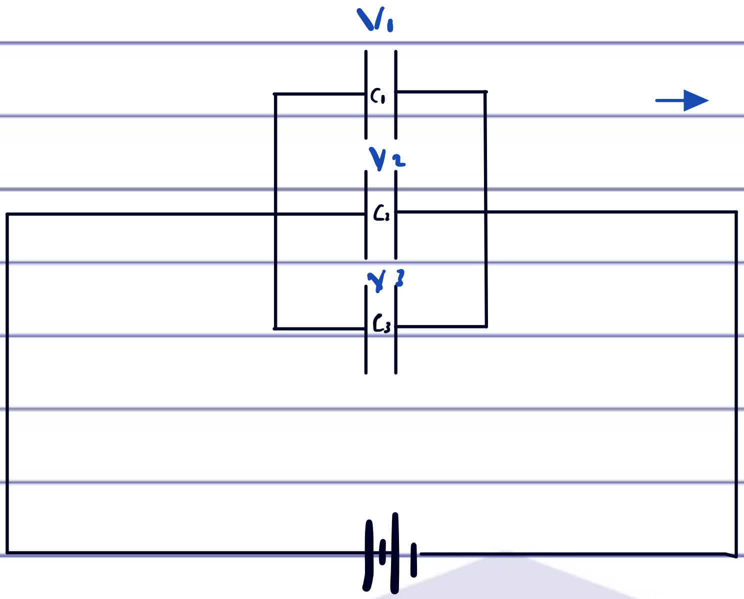
$$\frac{q_T}{C_T} = \frac{q_1}{C_1} + \frac{q_2}{C_2} + \frac{q_3}{C_3}$$

$$\frac{q}{C_T} = q\left(\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}\right)$$

$$\boxed{\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}}$$ Affective capacitance.

Topic: ____________ Date: ____________

⇒ Capacitors in Parallel:



→ $V_1 = V_2 = V_3 = EMF$

The Voltage is equal to EMF because charging stops when P.D across capacitor is equal to the EMF of source.

$q = CV$

$q \propto C$

→ $C_1 = 100\mu F$ $C_2 = 50\mu F$ $C_3 = 150\mu F$

* q_3 is more as C_3 is largest.
* larger capacitor stores more charge on one plate.

→ $q_1 + q_2 + q_3 = q_T$

→ Battery drives all those electrons from one plate of capacitors to the next.

$$q_T = q_1 + q_2 + q_3$$

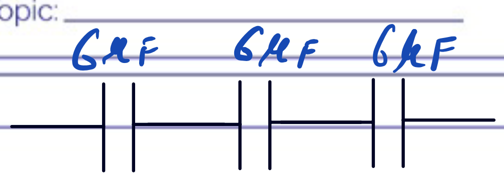
$$C_T V_T = C_1 V_1 + C_2 V_2 + C_3 V_3$$

$$\cancel{V} C_T = \cancel{V}(C_1 + C_2 + C_3)$$

$$\boxed{C_T = C_1 + C_2 + C_3}$$ → Effective capacitance.

Topic: Date:

1

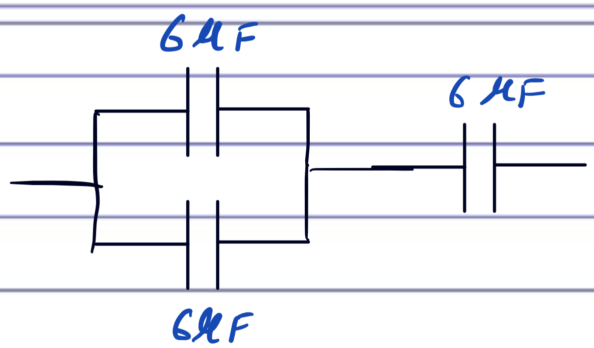


$$\frac{1}{C_T} = \frac{1}{6} + \frac{1}{6} + \frac{1}{6} = \frac{3}{6} = 2\mu F$$

$$\boxed{C_T = \frac{C}{n}}$$

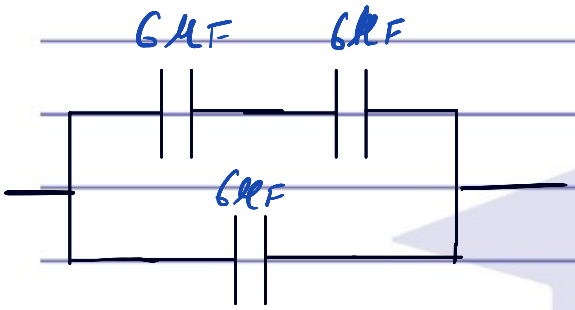
C → Capacitance of Single capacitor

n → no of capacitors



$$\frac{1}{C_T} = \frac{1}{6} + \frac{1}{12}$$

$C_T = 4\mu F$



$3\mu F + 6\mu F = 9\mu F$

Uses of capacitors.

1- Stores energy

2- Stabilizers

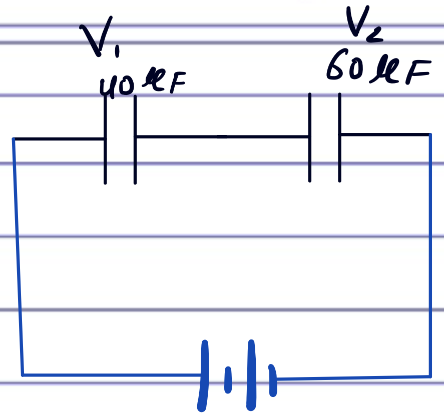
3- Tuning circuits.

4) Rectifiers (Converting AC to DC)

30µF , 6V max.

A max of 6V can be applied across the capacitor and can be charged to a maximum of 6V

A Voltage above 6V would cause insulation of Capacitor to fail which leads to discharging.



$C_1 = 40\mu F$, $6V_{max}$

$C_2 = 60\mu F$, $6V_{max}$

What is the safest Voltage that can be applied across the combination.

$V_T = ?$

$$V_T = V_1 + V_2$$

Since charge is same on $q_1 = q_2$

$$C_1V_1 = C_2V_2$$

$$40V_1 = 60V_2$$

$$\frac{40}{60}V_1 = V_2$$

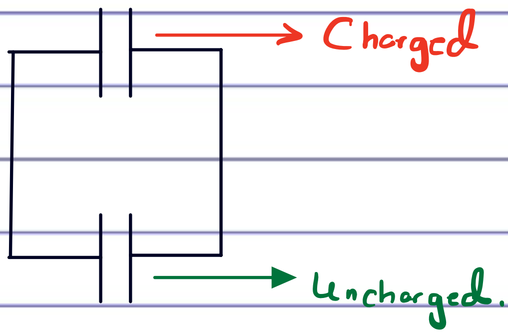
$$V_T = V_1 + \frac{2}{3}V_1$$

$$V_T = 6 + \frac{2}{3}(6)$$

$$\boxed{V_T = 10V}$$

Topic: ________ Date: ________

Charging one capacitor using another capacitor.



* Capacitors are attached in parallel to one another.
* Electrons move from one capacitor to the next.
* The charged capacitor now discharges and uncharged one gets charged.
* The process stops when both the capacitors achive. the same P.D (V of the one capacitor falls as it discharges and other capacitor V rises as it charges.

Initial Energy

$$\mathcal{E} = \frac{1}{2} C_1 V_1^2$$

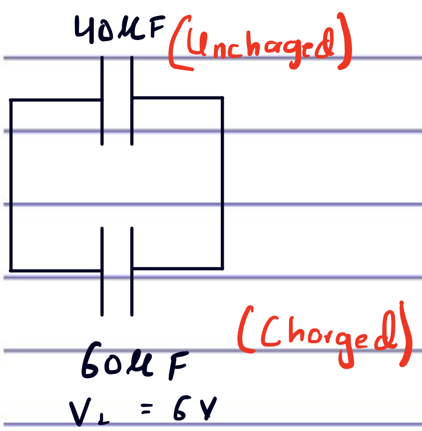
Final Energy

$$\mathcal{E} = \frac{1}{2} C_T V_T^2 \rightarrow \text{Capacitors in parallel}$$

$C_T = C_1 + C_2$

$$q = C_T V_T$$

$$\frac{q}{C_T} = V_T$$



i) q_2

ii) C_T

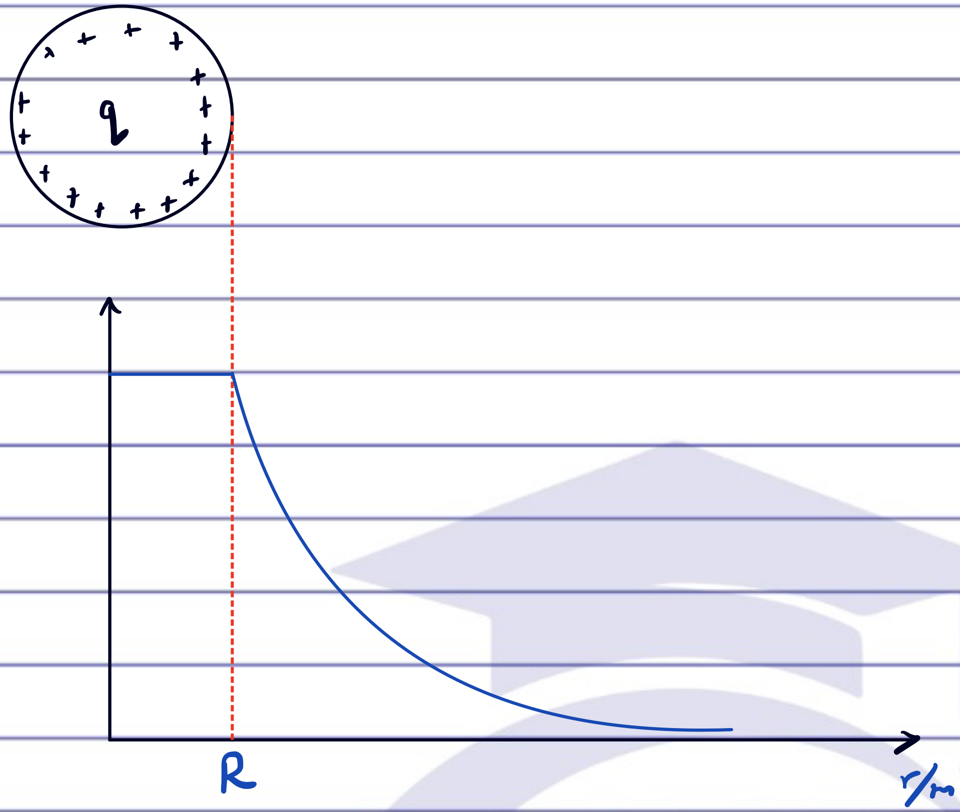
iii) V_T

iv) I.E

v) F.E

Topic: Date:

Capacitance of a charged sphere.



$$C = \frac{q}{V}$$

$$C = \frac{\cancel{q}}{\frac{k\cancel{q}}{R}}$$

$$C = \frac{R}{\frac{1}{4\pi\varepsilon_0}}$$

$$\boxed{C = 4\pi\varepsilon_0 R}$$

$\Rightarrow$ The capacitance of the metal sphere only depend upon the radius of the sphere.

16. **M/J 08/P4/Q5**

A capacitor C is charged using a supply of e.m.f. 8.0V. It is then discharged through a resistor R.

The circuit is shown in Fig. 5.1.

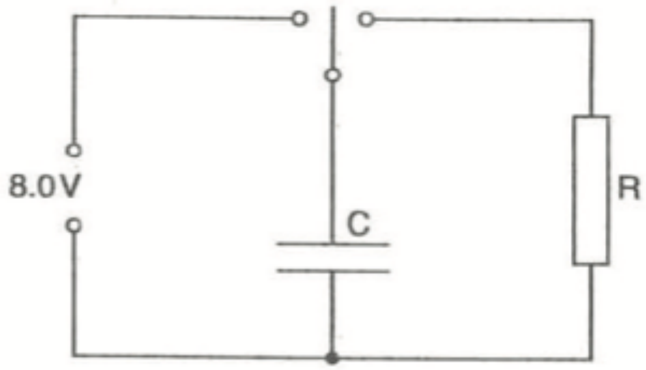


Fig. 5.1

The variation with time t of the potential difference V across the resistor R during the discharge of the capacitor is shown in Fig. 5.2.

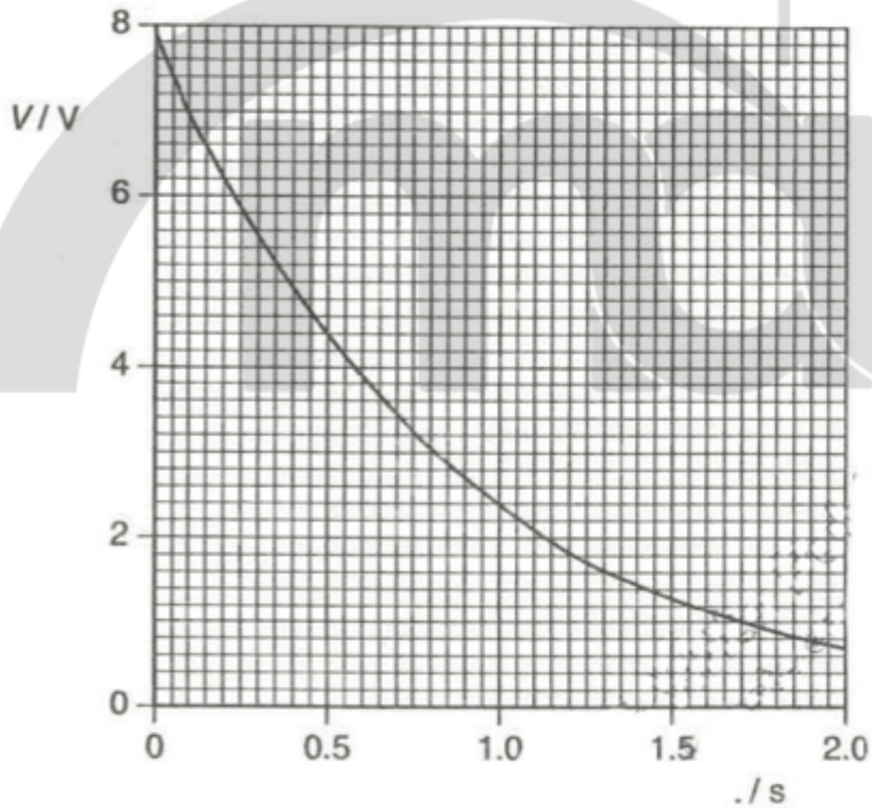


Fig. 5.2

(a) During the first 1.0 s of the discharge of the capacitor, 0.13 J of energy is transferred to the resistor R.

Show that the capacitance of the capacitor C is 4500 μF.

$E = \frac{1}{2} CV^2$

$E = \frac{1}{2} C (V_f^2 - V_i^2)$

$-0.13 = \frac{1}{2} C (2.5^2 - 8^2)$

$C = 4500 \mu F$

[3]

(b) Some capacitors, each of capacitance 4500 μF with a maximum working voltage of 6V, are available.

Draw an arrangement of these capacitors that could provide a total capacitance of 4500 μF for use in the circuit of Fig. 5.1.

[2]

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