Part - A

1. Two point charges (Q, $4Q$) are separated by a distance of 1m. The force of repulsion between the charges is equal to 3.24×10^{-5} N.
Compute the value of each charge.

2. A body has a shape consisting of a semi-sphere and a cylinder as shown. The body is placed in an electric field of $\boldsymbol{E} = 100\,\boldsymbol{i}$.
Find the electric flux that enters the body.

3. Two parallel plates are separated by a distance $d = 4 \times 10^{-3}$ m. The potential difference between the plates is 120V, and the charge on each is 15×10^{-9} C.
What is the area of each plate?

4. Two very long parallel wires carrying currents I_1 and I_2 as shown.
Find the resultant magnetic field at point P.

5. A 10μF capacitor is placed across a voltage source of 100V.
Find the energy stored in the capacitor.

6. A wire has a length of 1.5 m, a radius of 0.02m, and a resistance of 25 Ω.
What is the resistivity of the wire's material?

7. A beam of ions passes undeflected through crossed electric and magnetic field of 4 x 10^6 N/C and 0.5T respectively.
Find the velocity of the ions.

8. Two concentric conductors carrying currents I_1 and I_2 of 5A and 10A respectively.
Find the magnetic field at point p, at a distance r = 3m from the center.

9. A rod of length 0.5m and negligible mass slides on parallel rails as shown. The resistance of the circuit R = 8Ω. A uniform magnetic field B = 2T is applied perpendicular to the system.
Find the applied force necessary to move the bar at a constant speed of 0.8 m/s.

10. A long 40 turns/m solenoid has a radius of 5 cm and carries 6A. **Calculate the flux** Φ through the shaded area of a ring of inner radius of 2 cm and outer radius 4 cm, positioned perpendicular to the magnetic field and centered on the axis of the solenoid as shown.

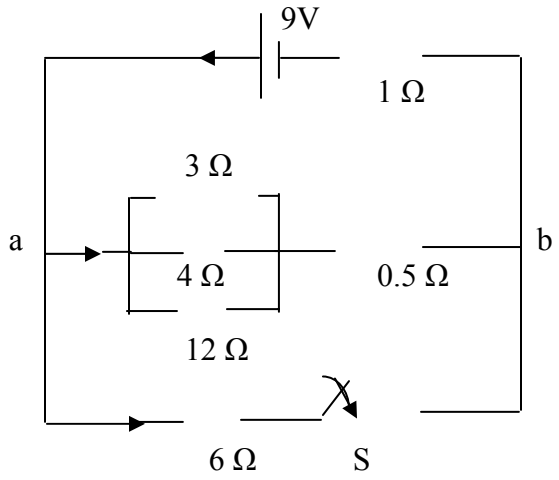
Part - B

1. For the circuit shown below compute the following:

a. The current passing through (1Ω) and (12 Ω) when the key (S) is opened.

b. The current passing through (1 Ω) and (6 Ω) when the key (k) is closed.

c. The potential difference V_{ab} when the key (k) is closed.



2. A uniformly charged thin insulating rod is bent, in the shape shown in the figure. It has a linear charge density(λ) and radius R .

a. Show that the electric field at the center (O) is given by:

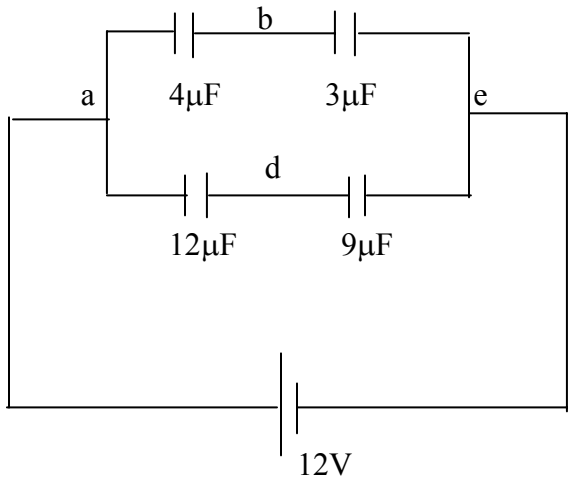
$$\boldsymbol{E} = \frac{K\lambda\sqrt{2}}{R}\,\boldsymbol{i}$$

b. If the rod has a total charge of –8 nC and a length of 15.7 cm; find the net force on a charge of +2 nC placed at the center "O".

3. A circuit consisting of a battery and a capacitors is connected as shown in the figure below. After a long time of connection, calculate the following:-

a. The charge on the 12 μF capacitor .

b. The potential difference $V_{bd.}$



4. A rod of mass *m* is dragged by a **constant** force *P* on a frictionless rail as shown.

a. Use Newton's second law ($\sum F = ma = mdv/dt$) to show that:

$$\upsilon = \frac{P}{\alpha}\left(1 - e^{-\alpha\, t/m}\right)$$

where $\alpha = \dfrac{B^2\ell^2}{R}$

Hint: $\displaystyle\int \frac{dx}{a-bx} = -\frac{1}{b}\ell n(a-bx)$

b. Find the speed υ after 5s, assuming: $(B = 1T,\ \ell = 1m,\ R = 1\Omega,\ P = 2N,\ m = 2kg)$

c. Find the charges on the capacitor after 5 sec. assuming $C = 1\mu F$.