PHYSICS - - MAIN – 2 SOLUTIONS

1. **a) Zero**

   Charge does not flow from one independent loop to another.

2. **d)** $\mathbf{\frac{32}{23}\mu F}$

   12 μ F and 6 μ F are in series of again are in parallel with 4 μ F.

   Therefore, resultant of these three will be $= \frac{12\times6}{12+6}+4=4+4=8\mu F$

   This equivalent capacitance is in series with 1 μ F

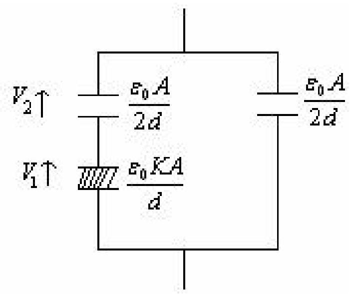
   Its equivalent capacitance $= \frac{8\times1}{8+1}=\frac{8}{9}\mu F$ (i)

   Equivalent of 8 μ F, 2 μ F and 2 μ F $= \frac{4\times8}{4+8}=\frac{32}{12}=\frac{8}{3}\mu F$

   and $C_{eq}=1=\frac{\frac{32}{9}\times C}{\frac{32}{9}+C}$

   $\Rightarrow \quad C=\frac{32}{23}\mu F$

3. **d)** $\mathbf{C_{eq}=\frac{\varepsilon_0 L^2(1+3K)}{d(1+2K)}}$



$$\frac{1}{C}=\frac{d}{\varepsilon_0 KA}+\frac{2d}{\varepsilon_0 A}=\frac{d+2dK}{\varepsilon_0 KA}\Rightarrow C=\frac{\varepsilon_0 KA}{d(1+2K)}$$

$$C_{eq}=\frac{\varepsilon_0 A}{d}+\frac{\varepsilon_0 KA}{d(1+2K)}=\frac{\varepsilon_0 A(1+3K)}{d(1+2K)}=\frac{\varepsilon_0 L^2(1+3K)}{d(1+2K)}$$

4. **a)** $\mathbf{\frac{5Q}{6}}$

5. **b)** **8μC**

$C_{eq.} = \frac{14}{9}\mu F; \; V_{eff} = (16-7) = 9V$.

∴ $Q_{total} = C_{eq.} \times V_{eff} = 14\mu C$, which divides itself between B and C in the ratio of the capacitances.

6. **d)** **800μJ**

Using KCL and KVL we can find the potential difference across capacitor which comes out to be 20 V.
So energy stored in capacitor is,

$U = \frac{4\times10^{-6}\times20^2}{2}$ = 800 μJ

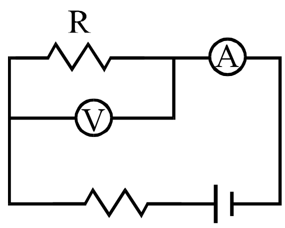
7. **c)** **3**

By taking one more similar uniformly charged semi-spherical shell we can complete the shell. In that case field at a becomes zero, which is possible with direction of field is along 3.

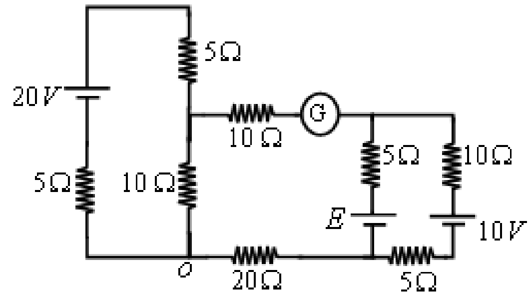
8. **a)** **RC *ln*(2.5)**

$q = Cv_0\left[1-e^{-t/RC}\right]$ and $q = C\left[0.6v_0\right]$

9. **b)**



10. **a) 10V**

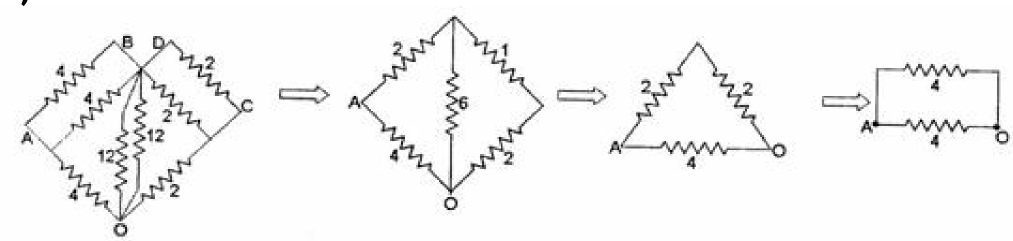


If there will be no current in G. As the potential difference across 10Ω resistance equal to $10V$ then

$$\frac{\frac{10}{15}+\frac{E}{5}}{\frac{1}{15}+\frac{1}{15}}=10$$

$$\Rightarrow E = 10V$$

11. **b) 2Ω**



12. **(b) 2 Ω, 12 V**

When S_2 is open, l= L/2

$$\therefore \quad E = \left(\frac{6V}{L/2}\right)L = 12\,V$$

when S_2 is closed

$$V_{10} = \left(\frac{12}{L}\right)\times\frac{5}{12}L = 5$$

But $\quad V_{10} = 10\times\left(\frac{6}{10+r}\right)$

$$10\times\left(\frac{6}{10+r}\right) = 5 \;\Rightarrow\; r = 2\,\Omega$$

13. **(b)** $\frac{\mu_0 I}{4\pi}\frac{ln4}{\sqrt{3}a}\hat{k}$

14. **a)** $\frac{\mu_0 I}{\sqrt{2}\pi a}\left[-\hat{k}-\hat{j}\right]$

$$\vec{B}_{OA}=\vec{B}_{BC}=\frac{\vec{B}_{AB}}{2}=\frac{\mu_0 I}{4\pi a}(\sin 45°+\sin 0°)=\frac{\mu_0 I}{4\sqrt{2}\pi a}(-\hat{k})$$

So net $\vec{B}_Z=4\vec{B}_{OA}=\frac{\mu_0 I}{\sqrt{2}\pi a}(-\hat{k})$ similarly $\vec{B}_y=\frac{\mu_0 I}{\sqrt{2}\pi a}(-\hat{j})$ or $\vec{B}=\frac{\mu_0 I}{\sqrt{2}\pi a}(-\hat{j}-\hat{k})$

15. **(c)** $\frac{qB}{2}\left(\frac{y^2}{x}+x\right)$

$$r^2=y^2+(r-x)^2$$

$$=y^2+r^2+x^2-2rx$$

$$\therefore \quad r=\frac{x^2+y^2}{2x}=\frac{p}{Bq}$$

$$\therefore \quad p=\frac{qB}{2}\left(x+\frac{y^2}{x}\right)$$

16. **(b)** $\frac{\mu_0 I}{4\pi a}\sqrt{\pi^2+4}$

$B_1=\frac{\mu_0 I}{4a}$ (Due to semi circular part)

$B_2=\frac{\mu_0 I}{4\pi a}$ (Due to two parallel parts)

$B=\sqrt{B_1^2+B_2^2}$

17. **b)** $\frac{25m}{2qE_0}$

By the work energy theorem,

Change in kinetic energy = work done by all the forces.

$\frac{1}{2}m(5)^2 - 0 = xqE_o$

$x = \frac{25m}{2qE_o}$

$\therefore$ (b) is correct.

18. **b)** $\mathbf{\frac{q(b-a)B}{2m}}$

Solution : Width of the magnetic field region $(b-a) \le R$; Where 'R' is its radius of curvature inside magnetic field,

$\therefore R = \frac{mv}{qB} = (b-a) \Rightarrow v_{\min} = \frac{(b-a)qB}{m}$

(b) is the correct option.

19. **d)** $\mathbf{M = \frac{\mu_0 a}{2\pi} \ln\left(1+\frac{b}{c}\right)\vec{B}}$

Conceptual

20. **d)** $\mathbf{\frac{2Br^2\omega}{R}}$

The emf induced across a radius $= e = \frac{1}{2}Br^2\omega =$ potential difference between the centre and
the rim. The rod fixed along a diameter is equivalent to two radii joined in parallel between
the centre and the rim. As each radius has a resistance R/2, the equivalent resistance between
the centre and the rim is R/4.

Current $= \frac{e}{(r/4)} = \frac{4}{R}\cdot\frac{1}{2}Br^2\omega = \frac{2Br^2\omega}{R}.$

21. **a)** $\mathbf{\frac{1}{VR}\left[\frac{\mu_0 IV}{2\pi}\ln\left(\frac{b}{a}\right)\right]^2}$

Induced emf $\int_a^b Bv\,dx = \int_a^b \frac{\mu_0 I}{2\pi x} v\,dx$

$\Rightarrow$Induced emf $= \frac{\mu_0 Iv}{2\pi} \ell n\left(\frac{b}{a}\right)$ $\Rightarrow$Power dissipated $= \frac{E^2}{R}$

Also, power = F.V $\Rightarrow$ $F = \frac{E^2}{VR}$

$\Rightarrow \quad F = \frac{1}{VR}\left[\frac{\mu_0 IV}{2\pi} \ell n\left(\frac{b}{a}\right)\right]^2$

22. **c)** $\mathbf{ML^2T^{-2}A^{-2}}$

$$L = \frac{e}{di/dt} = \frac{[W/q]}{(di/dt)} = \frac{M\,L^2T^{-2}/AT}{A/T^{-1}}$$

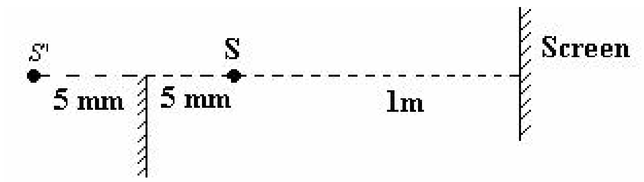
23. **c)** $\sqrt{3}$**A**

$i^2 = 9t^2$

$$<i^2>_{0-1} = \frac{\int_0^1 9t^2 dt}{\int_0^1 dt} = 3$$

$\therefore i_{rms} = \sqrt{3}$ A

24. **a)** $\mathbf{5 \times 10^{-5}}$ **m**



$\frac{\lambda D}{d} = \frac{\lambda(1)}{5\times10^{-7}}$, $S'$is virtual source, d=10 mm

25. **d)** $\mathbf{\sin\phi + \sin\theta = m\frac{\lambda}{d}}$

Path difference $= d\sin\phi + d\sin\theta$

and for maxima, $\Delta x = m\lambda$

$\Rightarrow \quad \sin\phi + \sin\theta = \frac{m\lambda}{d}$

26. **c)** **6 cm**

Ray will retrace their path if image after refraction through slab will be formed at center of curvature of mirror

27. **c)** $\mu = \sqrt{\frac{7}{3}}$

We can find $i = 30^0$

$\sin 30^0 = \mu \sin(60 - C)$

$\sin C = \frac{1}{\mu}$

28. **a)** $\mathbf{2\hat{i} - 4\hat{j} + 2\hat{k}}$

Conceptual

29. **b)** **5.4MeV**

30. **c)** $\mathbf{I_0 / 9}$