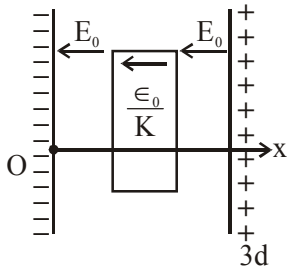
# SCORE JEE (Advanced)

## HOME ASSIGNMENT # 02

## CAPACITOR

## EXERCISE # O-1

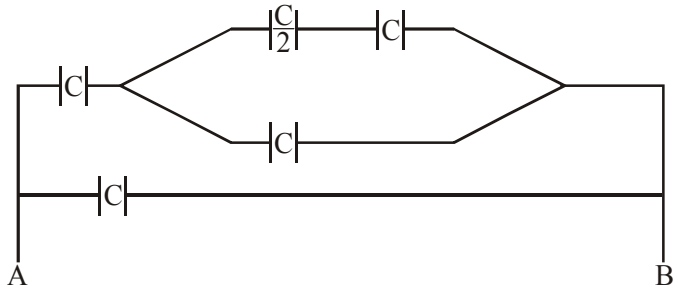
**1. Ans. (B)**




(1) Direction remain same

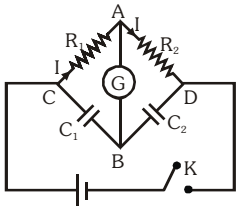
(2) Potential continuously increase

**2. Ans. (D)**




$$C_{eq} = \frac{11C}{7}$$

**3. Ans. (B)**




as $V_A - V_B = 0$, $V_C - V_A = IR_1$, $V_A - V_D = IR_2$, $V_C - V_B = \frac{Q}{C_1}$, $V_B - V_A = \frac{Q}{C_2}$

$$\therefore IR_1 = \frac{Q}{C_1} \text{ ....(i)} \qquad IR_2 = \frac{Q}{C_2} \text{ ...(ii)} \qquad \Rightarrow \frac{R_1}{R_2} = \frac{C_2}{C_1}$$

**4. Ans. (B)**

During time '$t_2$' capacitor is discharging with the help of resistor 'R'

$\therefore\ q = q_0 e^{-t/RC}$

$V = V_0\ e^{-t/RC}$ [$\because Q=CV$]

As $V_0 = \frac{2V}{3}$; $V = \frac{V}{3}$

$t_2 = RC\ \ell n2$

During time '$t_1$' capacitor is charging with the help of battery.

$\therefore\ q = q_0\ (1-e^{-t/RC})$ or $V = V_0\ (1-e^{-t/RC})$

as $V_0 = \frac{2V}{3}$; $V = \frac{V}{3}$

$t_1 = RC\ \ell n2$

$T = t_1 + t_2 = 2RC\ \ell n2$

**5. Ans. (A)**

$$i = \frac{V}{R} = \frac{V}{\left(\frac{\rho \times d}{S}\right)} = \frac{VS}{\rho d}$$

**6. Ans. (C)**

$q = 2 \times 5 = 10\ \mu C$

$C_{eq} = 1$


$C_{eq} = \frac{10}{7}$

$V_{of5}$ may be more than 2.

# EXERCISE # O-2

**1.** **Ans. (B, C, D)**
(B) First C increases

(C) $\frac{1}{2}$ $CV^2$ & $\frac{1}{2}\frac{Q^2}{KC}$

(D) $E = \frac{V}{d}$ in both case potential difference across plate is same.

**2.** **Ans. (A, B, C, D)**
Q – Remain same
Capacitance become KC

**3.** **Ans. (A, B, C)**
Potential across A & B should same.

$$\frac{V_0}{2} = V_0(1 - e^{-\frac{t}{RC}})$$

**4.** **Ans. (ABD)**
At t= 0, capacitor act a short circuit & current in resistor branch = 0.
At t= ∞, $i_R$ =2 mA; $i_C$ = 0.

**Paragraph for question nos. 5 to 7**

**5.** **Ans. (A)**
Electric field will be from A to B

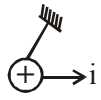
**6.** **Ans. (D)**
Electric field can be either from A to B or from B to A depending on which is plate is positively charged.

**7.** **Ans. (C)**

$\int E \cdot d\ell$ is negative of potential difference and it depend on initial and final point.

**8.** **Ans. (A)**
Current flow is defined with the flow of charge.

$\boxed{L \to R}$





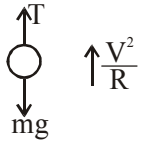
$L \to R$

**9. Ans. (C)**

$t = \dfrac{r}{\in_0}$

$f = qE$

Work energy $\Rightarrow \dfrac{1}{2}mV^2 = F.\ \dfrac{d}{2}$




$$T = mg + \frac{mV^2}{R} = mg + \frac{Fd}{R}$$

**10. Ans. (B)**

$U_q + U_R = U_0 = \dfrac{1}{2}\dfrac{Q^2}{C}$

$U_C = U_R$

$U_L = \dfrac{U_0}{2} = \dfrac{1}{2}\dfrac{Q^2}{C}$

**11. Ans. (A) P, R, S; (B) P, R, S; (C) R; (D) Q, R]**

(A) $C \to \dfrac{C_0}{2}$, $\quad q = \dfrac{C_0V_0}{2}$

$$C = \frac{AC_0}{2d - d + d/K} = \frac{KC_0}{(K+1)},\ V = \frac{Q}{C} = \frac{V_0}{2K}(K+1)$$

(B) Same as A

(C) $C' = KC_0$

$Q = = KC_0V_0$

$$C_{new} = \frac{KC_0}{(K+1)}$$

$$V = \frac{KC_0V_0}{KC_0}(K+1) = V_0(K+1)$$

(D) $C' = KC_0$

$$C_{new} = \frac{KC_0}{(K+1)}$$

$$Q = C_{new} \times V_0 = \frac{KC_0V_0}{(K+1)}$$

# EXERCISE # S

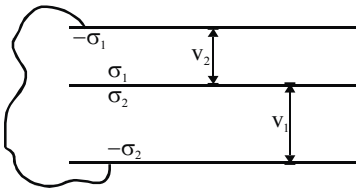
**1.** **Ans. 9**

Charge on 3μF = 3μC

Charge on 6μF = 6μC

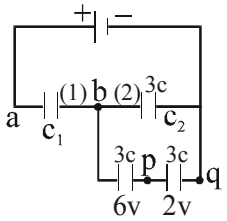
by charge conservation = 9μC

**2.** **Ans. 8**




$$V_1 = V_2 \Rightarrow \frac{\sigma_1}{\varepsilon_0} 5\times10^{-2} = \frac{\sigma_2}{\varepsilon_0} \times 8\times10^{-2} \Rightarrow \frac{\sigma_1}{\sigma_2} = \frac{8}{5}$$

**3.** **Ans. 30 V**




Charge conservation on plates 1, 2 & 3

$CV = 3C \times 8 + C \times 6$

$V = 30$

**4.** **Ans. 2 μA**

$$\frac{Q}{A\in_0}(d - 2\times10^{-3}\, t) = \frac{200 - Q}{A\in_0}(d + 2\times10^{-3}\, t)$$

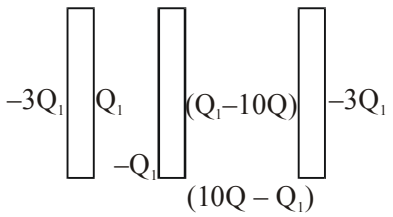
diff.

$i(d - 2Vt) + Q(-2V) = -i(d + 2V + t) + (200 - Q)(2V)$

$\Rightarrow 2id = 200 \times 2V \times 10^{-6}$

$i = 2000\ \mu A$

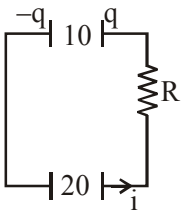
**5.** **Ans. –3Q,** $\frac{+20Q}{3} - \frac{20Q}{3}$, $\frac{-10Q}{3} + \frac{10Q}{3} - 3Q$




$$V_A - V_C = 0 = \left(\frac{2Q_1}{2A\in_0}\right)L + \frac{2(Q_1 - 10Q)}{2A\in_0} = 2L$$

$$\boxed{Q_1 = \frac{20Q}{3}}$$

**6.** **Ans.**




$$-iR - \frac{q}{10} + \frac{100-q}{20} = 0$$

$$iR = 5 + \frac{3q}{20}$$

$$R\frac{dq}{dt} = \frac{3}{20}\left(\frac{100}{3} + q\right)$$

$$q = 200\,(1 - e^{-\frac{3t}{20R}})$$

**7.** **Ans.** $V_1 = \frac{C_0 V_0}{C_0 + C_1}$ = common potential

$$V_2 = \frac{C_0 V_1}{(C_0 + C_1)} = \frac{C_0^2 V_1}{(C_0 + C_1)^2}$$

$$V_n = \frac{C_0^n}{(C_0 + C_1)^n} V_0 = V$$

$$\Rightarrow \frac{C_0 + C_1}{C_0} = \left(\frac{V_0}{V}\right)^{1/n}$$

# CURRENT ELECTRICITY

## EXERCISE # O-1

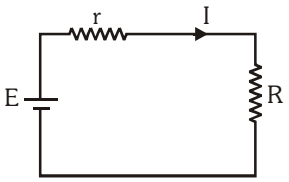
**1. Ans. (D)**

$C \rightarrow$ Average velocity remain same.

Increase in temperature causes increase in velocity of electrons thus increasing the collision frequency.

**2. Ans. (A)**

Any such black box can be replaced by an effective emf and an effective resistor connected in series.(see fig.)

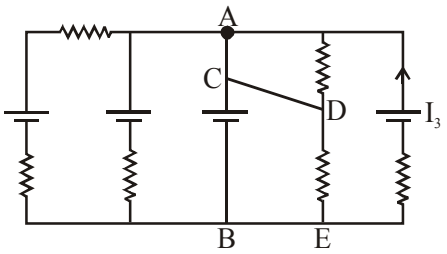



$\therefore$ $E = I(R + r)$ where E is the effective emf and r is the effective resistance.

Using the given data we find E = 12 volts and r = 2 ohms.

Therefore R should equal 118 ohms in order to get a current of 0.1 amp.

**3. Ans. (A)**




$V_A - V_B = 2$

$I_3 R_3 = 1$

BCDE, KVL $\Rightarrow R_2 I_2 = 2$

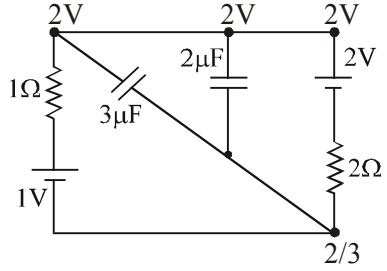
**4. Ans. (D)**

$$P_1 = P_2 = P_3 = \left(\frac{I}{3}\right)^2 R$$

$$P_4 = \left(\frac{2I}{3}\right)^2 R$$

$$P_5 = \left(\frac{I}{3}\right)^2 R$$

**5. Ans. (B)**




$V_{across\ 3\ \mu F} = 2 - \frac{2}{3} = \frac{4}{3}$

Charge $\Rightarrow q = CV = 4\mu C$

**6.** **Ans. (D)**

We have to take two readings one with resistance R and other without R.

A & B $\rightarrow$ connection of E is wrong In C $\rightarrow$ Key should be with R.

**7.** **Ans. (A)**

$R_x = \frac{(R_0)(x)}{1-x}$ ; $l\text{n}\, R_x = l\text{n}\, R_0 + l\text{n}\, x - l\text{n}\,(1-x)$; $\frac{dR_x}{R_x} = 0 + \frac{dx}{x} + \frac{dx}{1-x}$

Systematic error is reduced as effect of cosmelting wire is..... $\frac{dR_x}{R_x}$ is minimum has $x = \frac{1}{2}$

So random error is minimum

# EXERCISE # O-2

**1.** **Ans. (A,B)**

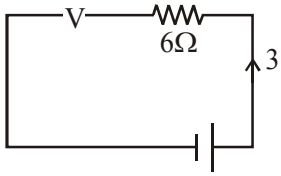
$$R = \int_0^{\ell} \rho x \frac{dx}{\pi\left(r + \frac{rx}{\ell}\right)^2} = \frac{\rho}{\pi r^2}$$

$$\text{Now } R_1 = \int_0^{\ell_1} \rho x \frac{dx}{\pi\left(r + \frac{rx}{\ell}\right)^2} = \frac{\rho}{\pi r^2}\left[\frac{1}{\left(1 + \frac{\ell_1}{\ell}\right)} - 1\right]$$

$$\frac{1}{1 + \frac{\ell_1}{\ell}} = \frac{3}{4}$$

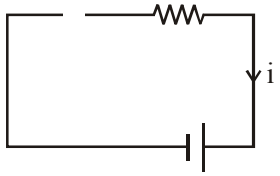
**2.** **Ans. (B,D)**

Direction of current from right of left




18 + 12 + V

V = 6




18 + 12 + V = 0

V = –30

**3.** **Ans. (B,C,D)**

i $\rightarrow$ will same

i = neA Vd

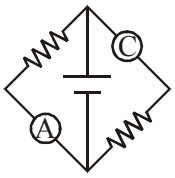
$J = \frac{i}{A}$ , $j^2\ \sigma E$

Current through the wire is same $i_A = i_B = i_C$ $\because$ i=neAV$_d$ and $J = \frac{i}{A}$

**4. Ans. (A)**

**Sol.** Reading of C = V {i in that branch = 0}

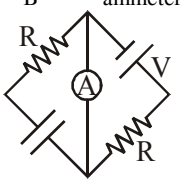
Reading of A = $\frac{V}{R}$ $\Rightarrow$ R




$\frac{V}{V/R} = R$

**5. Ans. (D)**

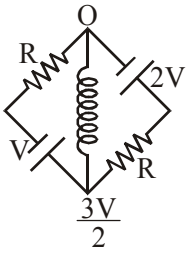
**Sol.** $V_B = iR_{ammeter} = 0 \Rightarrow V_{cap.} = 0$



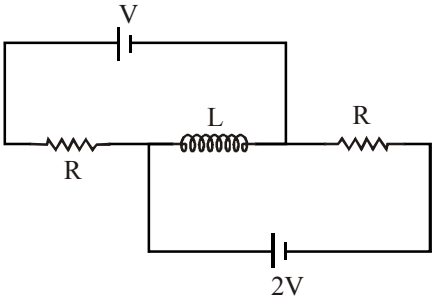

All current will pass through ammeter

**6. Ans. (C)**

**Sol.**

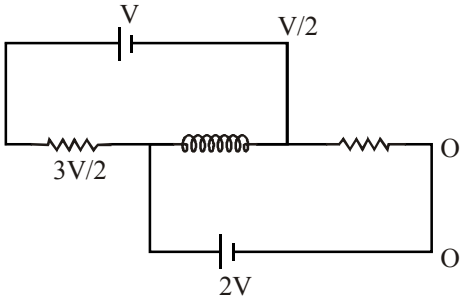



$i = \frac{V}{2R}$



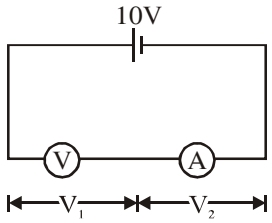

at t = 0 inductor is open circuit $i = \frac{V}{2R}$

$\Rightarrow$

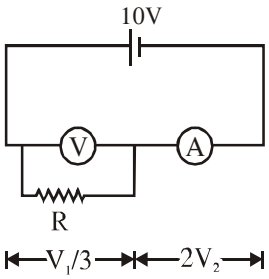


p.d. $V - \frac{V}{2} = \frac{3V}{2}$

**7. Ans. (B)**




Initially $V_1 + V_2 = 10V$ ...(i)




Finally $\frac{V_1}{3} + 2V_2 = 10V$ ...(ii)

From equation (i) & (ii)

We get $V_1 = 6$ volt, $V_2 = 4$ volt

$\therefore$ Final reading $= \frac{V_1}{3} = 2$ volt

**8. Ans. (C)**

$\frac{V_1}{V_2} = \frac{R_A}{R_V} = \frac{4}{6}$ & $R_A = 2\Omega \Rightarrow R_V = 3\Omega$

**9. Ans. (A)**

$$\frac{\frac{R_V R}{R_V + R}}{R_A} = \frac{\frac{V_1}{3}}{2V_2} = \frac{1}{4} \Rightarrow R = \frac{3}{5}\Omega$$

**10. Ans. (A)**

**11. Ans. (B)**

**12. Ans. (C)**

$$\frac{dR}{R} = \frac{d\ell_1}{\ell_1} + \frac{d\ell_2}{\ell_2}$$

**13. Ans. (B)**

**Sol.** $\frac{dQ}{dt} = k(T - T_0)$

$100 = k(40 - 20)$

$k = 5 W/°C$

$400 = 5(T - 20)$

$T = 100°C$

So water comes to Bioling point but entire energy is radiated. So it won't boil.

**14. Ans. (B)**

**Sol.** $\frac{dQ}{dt} = k(T - T_0) = 100\ k\ (40 - 20)$

$k = 5\ W/°C$

$$\frac{dQ_2}{dt} = k(45-20) = 25 \times 5 = 125 \text{ W}$$

**15. Ans. (D)**

**Sol.** For 1st 60 sec, we can use approx method

$$\frac{dT}{dt} = \frac{k}{ms + C_0}(Ta_v - T_0)$$

$$\frac{5}{60} = \frac{5}{ms + 100}[75.5 - 20$$

$$\Rightarrow \quad ms + 100 = 3450$$

$$m \times 4200 = 3350$$

**16. Ans. (A) →(P); (B) →(P,R,S,T); (C) →(Q,R,S,T); (D) →(R,T)**

# EXERCISE # S

**1. Ans. 5**

All the elements of circuit are in parallel arrangement

$\frac{1}{R_{eq}} = \frac{1}{40} + \frac{1}{40} + \frac{1}{40} + \frac{1}{40} + \frac{1}{20} + \frac{1}{20} = \frac{4}{40} + \frac{2}{20}$; $R_{eq} = 5\Omega$; Power = $V^2/R$ = 5 W

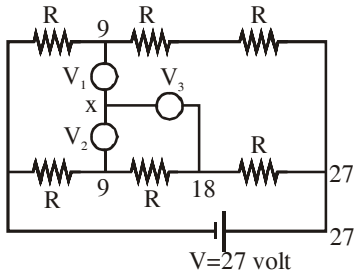
$$m = \frac{3360}{4200} = 0.8\,\text{kg}$$

$$\text{vol.} = \frac{m}{p} = \frac{0.8}{1000}\text{m}^3 = 0.8\ l$$

**2. Ans. 2**

If $I_G$=0 then it becomes a balanced whetstone bridge $\ell_1 = \frac{2}{3} \times 1m = \frac{2}{3} \times 100 = \frac{200}{3} cm$

**3. Ans. 6**




$\frac{x-9}{R} + \frac{x-9}{R} + \frac{x-18}{R} = 0 \Rightarrow x = 12 \ \therefore V_3 = 6$ volt

**4. Ans. 3**

$E_1 = \frac{E \times 40}{100}$ and $E_2 = \frac{E \times 40}{100} \Rightarrow \frac{E_1}{E_2} = 1 \Rightarrow \frac{3E_1}{E_2} = 3$

**5. Ans. 35**

From the given circuit diagram $\frac{R_1}{R_2} = \frac{x^2}{(100)^2 - x^2} \Rightarrow x = 85$

Also $\frac{R_2}{R_1} = \frac{y^2}{(100)^2 - y^2} \Rightarrow y = 50$

$\Delta$ = (85 – 50) cm = 35 cm

# GEOMETRICAL OPTICS

## EXERCISE # O-1

**1.** **Ans. (A)**

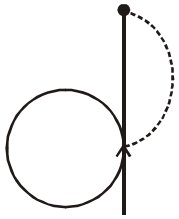
$\therefore$ Incident angle = reflected angle.

**2.** **Ans. (D)**

as $u \to f$ $\quad m \to \infty$

as $u \to \infty$ $\quad m \to 0$

**3.** **Ans. (D)**



**4.** **Ans. (A)**

Optical path = $\int \mu dz = \int_0^A (Az^2 + 1)dz$

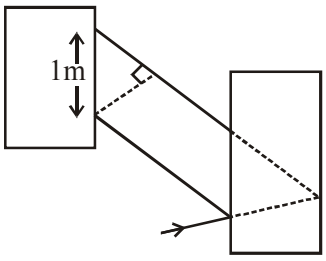
Geometrical path = C

Extra = $\left(\frac{AC^4}{4} + C\right) - C$

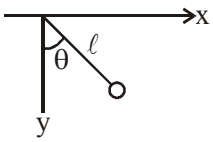
**5.** **Ans. (A)**

Due to refraction.

**6.** **Ans. (C)**




**7.** **Ans. (C)**

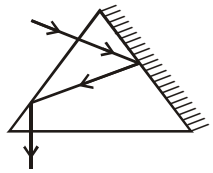



$\frac{\ell \cos\theta}{\mu} = y$

$\ell \sin\theta = x$

$\cos^2\theta + \sin^2\theta = 1$

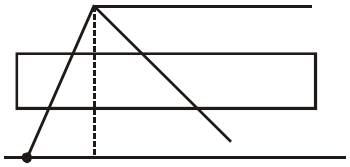
**8. Ans. (C)**



**9. Ans. (A)**

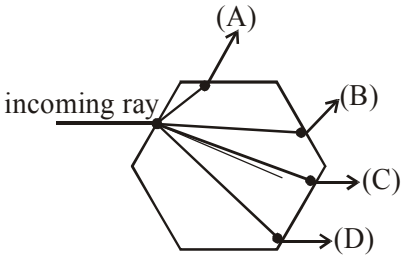
**CORRECTION**

Area will be less



**10. Ans. (B)**

**11.** A light ray strikes a hexagonal ice crystal ice crystal floating in the air as shown in the figure. The correct path of ray may be ?




**Ans. (A)**

**CORRECTION ANS (C)**

**12. Ans. (A)**

**13. Ans. (A)**

**14. Ans. (C)**

**15. Ans. (A)**

**16. Ans. (B)**

**17. Ans. (A)**

**18. Ans. (B)**

**19. Ans. (C)**

# EXERCISE # O-2

**1. Ans. (A,D)**

**2. Ans. (B,C)**

**3. Ans. (D)**

**4. Ans. (C)**

**5. Ans. (BD)**

**6.** **Ans. (ABC)**

**7.** **Ans. (C)**

**8.** **Ans. (B)**

**9.** **Ans. (D)**

**10.** **Ans. (A)**

$\mu_1 \sin r_1 = \sin i_1 \Rightarrow r_1 = \sin^{-1}\left(\frac{\sin i_1}{\mu_1}\right)$

**11.** **Ans. (A)**

$\frac{\mu_1}{\mu_2} \sin i_2 = \sin r_2;\ \frac{\mu_1}{\mu_2}\frac{R_1}{R_2}\frac{\sin i_1}{\mu_1} = \sin r_2;\quad r_2 = \sin^{-1}\left(\frac{R_1}{\mu_2 R_2}\sin i_1\right)$

**12.** **Ans. (BD)**

**13.** **Ans. (A,C,D)**

**14.** **Ans. (A) PQR (B) Q (C) S (D) ST**

**15.** **Ans. (A) PRST (B) Q (C) PQST (D) PRST**

**16.** **Ans. (A,B,C)**

# EXERCISE # S

**1.** **Ans.** $\theta < \sin^{-1}(2\sin 15°)$

**2.** **Ans.** $\left(\frac{16}{25}\text{mm}\right)$

**3.** **Ans.** $y = -\frac{x}{1200} + 0.1$

**4.** **Ans :** Real, below principal axis, anywhere b/w P & $F_1$]

**5.** **Ans.** $\delta_1 = \tan^{-1}\left(\frac{h}{f} - \tan\frac{\theta}{2}\right) + \frac{\theta}{2}$

$\delta_2 = \tan^{-1}\left(\frac{h}{f} + \tan\frac{\theta}{2}\right) - \frac{\theta}{2}$

& Angle between rays = $\tan^{-1}\left(\frac{h}{f} + \tan\frac{\theta}{2}\right) - \tan^{-1}\left(\frac{h}{f} - \tan\frac{\theta}{2}\right)$

**6.** **Ans.** d = 6 cm

**7.** **Ans.** (i) 2°, (ii) $\frac{4\pi}{9}$mm

**8.** **Ans.** (i) $\lambda_0$ = 600 nm, n = 1.5 (ii) $i = \sin^{-1}(0.75) = 48.59°$

**9.** **Ans.** $r_1 = \frac{a}{3}$, $r_2 = \frac{a}{11}$, $r_3 = \frac{a}{50}$

**10.** **Ans.** $\frac{4GM}{Rc^2}$

**11.** **Ans. (i) f = – 10 cm, (ii) (10, 2)**