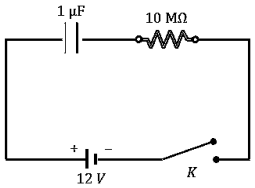
**Q.1** A resistor with resistance of 10 MΩ is connected in series with a capacitor of capacitance 1 μF and a battery withe. m. f. 12 V. Before the switch is closed at timet = 0, the capacitor is uncharged. What fraction of the initial current remains at time, t = 46 s? ($e^{-4.6} = 0.01$)

**(A)**0.09 **(B)**0.01 **(C)**0.02 **(D)**0.57




**Q.2** A capacitor is charged and then discharged through a resistance. The time constant is $\tau$. In what time will the potential difference across the capacitor decrease by 10% ?

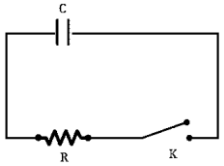
**(A)**$\tau \ln(0.1)$ **(B)**$\tau \ln(0.9)$ **(C)**$\tau \ln\left(\frac{10}{9}\right)$ **(D)**$\tau \ln\left(\frac{11}{10}\right)$

**Q.3** An air capacitor of capacitance 10 μF is connected to a battery of10 V. Now the space between its plates is completely filled with an insulator (K = 2). The magnitude of induced charge on the dielectric is

**(A)**100 μC **(B)**50 μC **(C)**25 μC **(D)**200 μC

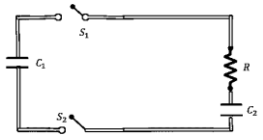
**Q.4** A capacitor discharges through a resistance. The stored energy $U_0$in one capacitive time constant falls to

**(A)**$\frac{U_0}{e^2}$ **(B)**$eU_0$ **(C)**$\frac{U_0}{e}$ **(D)**$e^2U_0$



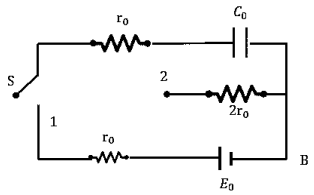

**Q.5** The capacitor $C_1$ in the figure initially carries a charge$q_0$. When the switch $S_1$ and $S_2$are closed, the capacitor $C_1$ is connected to a resistor R and a second capacitor $C_2$ which initially does not carry any charge. The currenti, through resistor R as a function of time *t* is represented as:

**(A)**$i = \frac{q_0}{C_1} e^{\left[\frac{-t(C_1+C_2)}{R}\right]}$ **(B)**$i = \frac{q_0}{C_1 R} e^{\left[\frac{-t(C_1+C_2)}{C_1 C_2 R}\right]}$ **(C)**$i = \frac{2q_0}{C_1 R} e^{\left[\frac{-t}{C_2 R}\right]}$ **(D)**$i = \frac{2q_0}{C_2 R} e^{\left[\frac{-t}{C_1 R}\right]}$



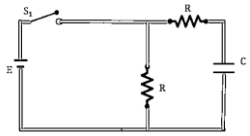

**Q.6** In the given circuit, switch S is at position 1 for a long time. Find the total heat generated in the resistor of resistance$2r_0$, when the switch S is shifted from position 1 to position2.

**(A)**$\frac{C_0E_0^2}{2}$ **(B)**$C_0E_0^2$ **(C)**$\frac{C_0E_0^2}{3}$ **(D)**$2C_0E_0^2$



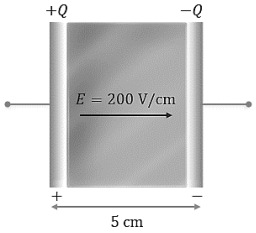
**Q.7** A capacitor $C$ is connected to the two equal resistances as shown in the figure. What is the ratio of time constant during charging and discharging of the capacitance?

**(A)** 1:1 **(B)** 2:1 **(C)** 1:2 **(D)** 4:1




**Q.8** The distance between the plates of a charged parallel plate capacitor is 5 cm and the electric field inside the plates is200 V/cm. An uncharged metal plate of same length and width 2 cm is inserted between the capacitor. The voltage across capacitor after insertion of the plate is

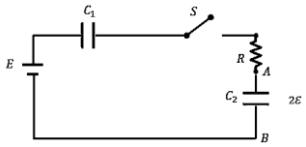
**(A)** 0 **(B)** 400 V **(C)** 600 V **(D)** 100 V




**Q.9** At $\mathbf{t = 0}$ the switch **S** is closed. If initially $\mathbf{C_1}$ is uncharged and $\mathbf{C_2}$ is charged to potential difference $\mathbf{2\mathcal{E}}$ then the current in circuit as a function of time will be:

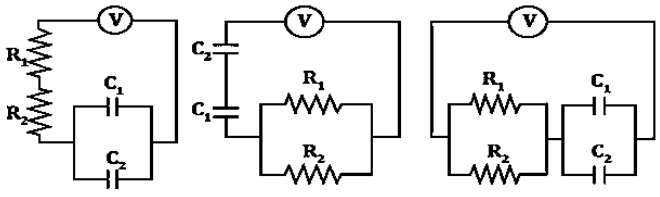
(Given,$\mathbf{C_1 = C_2 = C}$)

**(A)** $\frac{3\mathcal{E}}{R}e^{-2t/RC}$ **(B)** $\frac{\mathcal{E}}{R}e^{-3t/RC}$ **(C)** $\frac{2\mathcal{E}}{R}e^{-2t/RC}$ **(D)** $\frac{\mathcal{E}}{R}e^{-5t/RC}$




**Q.10** In the figure shown below,$\mathbf{R_1 = 1\ \Omega}$ , $\mathbf{R_2 = 2\ \Omega}$ , $\mathbf{C_1 = 4\ \mu F}$ , $\mathbf{C_2 = 2\ \mu F}$, the time constants (in **μs**) for the circuits **I** ,**II** and **III** respectively are

**(A)** 18 , 4, $\frac{8}{9}$ **(B)** 18 , $\frac{8}{9}$ , 2 **(C)** 18 , $\frac{8}{9}$ , 4 **(D)** 4 , $\frac{8}{9}$ , 18

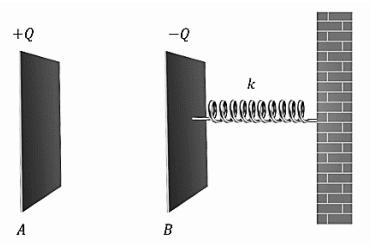


## WORKSHEET

### Charges on Conductors

**Q.1** The plates A and B of a parallel plate capacitor (PPC) as shown in the figure contain charges +Q and -Q respectively. The plate A is fixed and the plate B is connected to one end of a spring of spring constant K. The other end of the spring is connected to a rigid support. If the system is released from rest, what is the maximum elongation produced in the spring? The area of each plate is A and the medium between the plates is air.

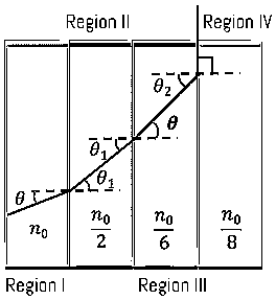
**(A)** $\frac{Q^2}{2KA\varepsilon_0}$ **(B)** $\frac{Q^2}{KA\varepsilon_0}$ **(C)** $\frac{2Q^2}{2KA\varepsilon_0}$ **(D)** $\frac{Q^2}{4KA\varepsilon_0}$




### TIR

**Q.2** A light beam is travelling from Region I to IV (Refer Figure). The refractive index in 4 Regions I, II, III and IV are $n_0, \frac{n_0}{2}, \frac{n_0}{6}$ and $\frac{n_0}{8}$ respectively. The angle of incidence θ for which the beam just misses entering Region IV is

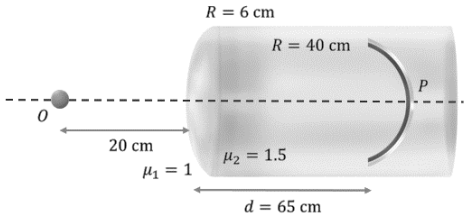
**(A)** $\sin^{-1}\left(\frac{3}{4}\right)$ **(B)** $\sin^{-1}\left(\frac{1}{8}\right)$ **(C)** $\sin^{-1}\left(\frac{1}{4}\right)$ **(D)** $\sin^{-1}\left(\frac{1}{3}\right)$




### Combinations of Lenses & Mirrors

**Q.3** Find the position of the image formed after the first reflection from the concave mirror as shown in the figure.

**(A)** At 20 cm from mirror on the left side **(B)** At 40 cm from mirror on the left side
**(C)** At infinity **(D)** At 10 cm from mirror on the left side




### Series Combination of Cells

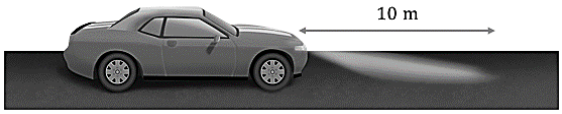
**Q.4** **n** identical cells, each of emf **E** and internal resistance **r**, are joined in series to form a closed circuit. One of the cell **A** is joined with reversed polarity. The potential difference across each cell except **A**, is

**(A)** $\frac{n-1}{n}E$ **(B)** $\frac{2\varepsilon}{n}$ **(C)** $\frac{n-2}{n}c$ **(D)** $\frac{2n}{n-2}€$

**Finding Friction's Magnitude**

**Q.5** A car has a headlight which can illuminate a horizontal straight road in front up to a distance of 10 m. If the coefficient of friction between tire and road is 0.5, the maximum safe speed of the car during a night drive is [Neglect the reaction time of the driver and take g=10 m/s$^2$]

**(A)** 5 m/s **(B)** 8 m/s **(C)** 10 m/s **(D)** 12 m/s

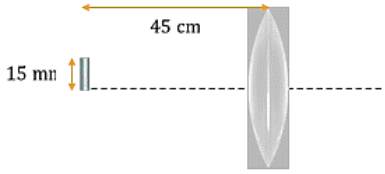



**Lens Formula**

**Q.6** Convex lens of focal length 15 cm has an object kept at distance 45 cm from it. If height of object is 15 mm, determine position and height of image.

**(A)** +22.5 cm; +7.5 mm **(B)** +22.5 cm; −7.5 mm

**(C)** −22.5 cm; +7.5 mm **(D)** −22.5 cm; −7.5 mm




**Electric Bulbs**

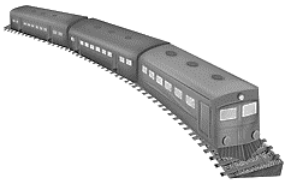
**Q.7** A factory is served by a 220 V supply line. In a circuit protected by a fuse marked 10 A, the maximum number of 100 W lamps in parallel that can be turned on is

**(A)** 11 **(B)** 22 **(C)** 33 **(D)** 66

**Applications of Radius of Curvature**

**Q.8** At certain place on railway track, the radius of curvature of railway track is 200 m. If the distance between the rails is 1.6 m, and the outer rail is raised by 0.08 m above the inner rail, find the speed of train for which there is no side pressure of the rails. (Take g=10 m/s$^2$)

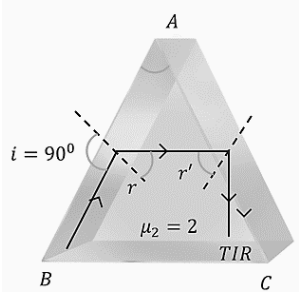
**(A)** 5 m/s **(B)** 10 m/s **(C)** 5 m/s **(D)** 20 m/s



**TIR**

**Q.9** If i=90∘, find minimum value of angle of prism A in degrees for which emergence is not possible:

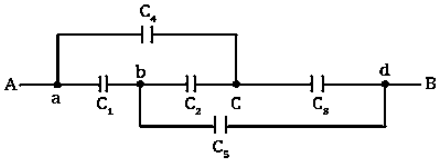
**(A)** 15∘ **(B)** 30∘ **(C)** 45∘ **(D)** 60∘




**Capacitance of Parallel Plate Capacitor**

**Q.10** If the two terminals of a battery of 21 V is connected across A and B, the charge flown through the battery will be

**(A)** $5.4\times10^{-12}$ C **(B)** $5.4\times10^{-13}$ C **(C)** $5.4\times10^{-10}$ C **(D)** $5.4\times10^{-11}$ C

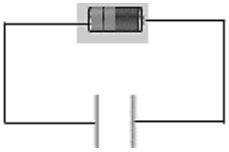



**Energy of a Capacitor**

**Q.11** A parallel plate capacitor is charged by a battery and after charging the battery is removed. Now the distance between the plates is reduced. Choose the correct statement

**(A)** Electric field is not constant **(B)** Potential difference is increased

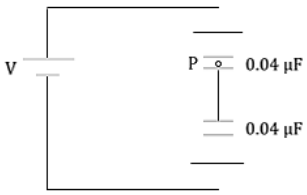
**(C)** Capacitance is decreased **(D)** Electrostatic potential energy is decreased



**Capacitance of Parallel Plate Capacitor**

**Q.12** The particle P shown in figure (31-E11) has a mass of 10 mg and a charge of $-0.01$ μC. Each plate has a surface area 100 $cm^2$ on one side. What potential difference V should be applied to the combination to bold the particle P in equilibrium?

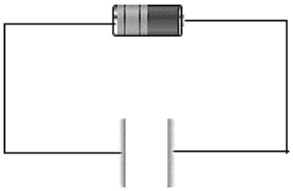
**(A)** 43 V **(B)** 70 V **(C)** 80 V **(D)** 95 V




**New Capacitance in Dielectric**

**Q.13** A capacitor, with air in between the plates, is charged to a potential V0, now the battery is removed and a di-electric medium with di-electric constant k is filled in the space between the plates, due to this the potential difference is dropped to $\frac{V_0}{10}$. Find the value of k?

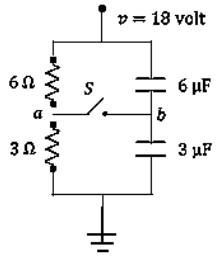
**(A)** 1.6 **(B)** 5 **(C)** 8 **(D)** 10



**Time Constant**

**Q.14** Initially switch S is in open state. How much charge flows through switch S when it is closed? Assume steady state condition to be achieved after S closed.

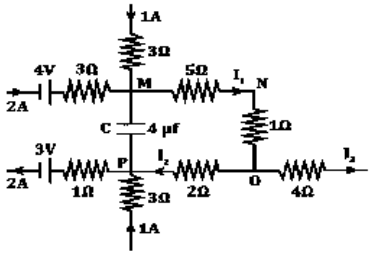
**(A)** 64 μC **(B)** −34 μC **(C)** −68 μC **(D)** −54 μC




**Time Constant**

**Q.15** Capacitor in the circuit is in steady state along with the current flowing in the branches. The value of each resistance is shown in figure. Calculate the energy stored in the capacitor of capacitance 4 μF.

**(A)** $6\times10^{-4}$ J **(B)** $8\times10^{-4}$ J **(C)** $9\times10^{-4}$ J **(D)** $12\times10^{-4}$ J

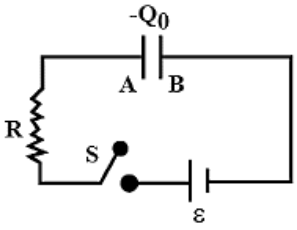



**Time Constant**

**Q.16** The figure shows an RC circuit with a parallel plate capacitor. Before switching on the circuit, plate A of the capacitor has a charge **−Q0** while plate B has no net charge. Now, at **t=0,** the circuit is switched on. How much time (in seconds) will elapse before the net charge on plate A becomes zero?

(Given $C = 1\mu F$, $Q0 = 1mc$, $\varepsilon = 1000V$ and $R = \frac{2\times10^6}{\ln 3}\Omega$)

**(A)**5 sec **(B)**4 sec **(C)**2 sec **(D)**7 sec

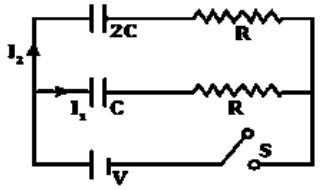



**Time Constant**

**Q.17** In the circuit, switch S is closed at time t=0, Let I1 and I2 be the currents at any finite time t, then the ratio of $\frac{I_1}{I_2}$

**(A)** Is constant **(B)** increases with time

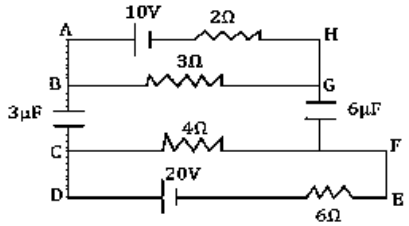
**(C)** Decreases with time **(D)** first increases, then decreases




**Time Constant**

**Q.18** In the circuit shown in figure, the sum of charges on both capacitors at steady state will be

**(A)** 5 μC **(B)** 8 μC **(C)** 12 μC **(D)** 20 μC




**Time Constant**

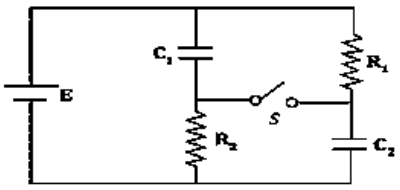
**Q.19** The switch S has been closed for a long time and the electric circuit shown carries a steady current. Let C1=3.0 μF, C2=6.0 μF, R1=4.0 Ω and R2=7.0 Ω. The power dissipated in R2 is 2.8 kW. Then:

**(A)**The power dissipated in the resistor R1 is 1.6 kW.

**(B)**The charge on capacitor C1 is 240 μC.

**(C)**The charge on capacitor C2 is 440 μC.

**(D)**When the switch is opened after long time, the charge on C1 is 660 μC.




**Time Constant**

**Q.20** A wind turbine is rotating with an angular velocity of 180 rev/min. It comes to rest after 5 min. Total number of revolutions made by it before it stops (Assume angular retardation is uniform)

**(A)**450 **(B)**350 **(C)**250 **(D)**150

**ANSWER KEY**

| Q. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Sol. | (B) | (B) | (A) | (A) | (B) | (A) | (A) | (A) | (C) | (C) |
| WORK SHEET | | | | | | | | | | |
| Q. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Sol. | (B) | (B) | (C) | (A) | (C) | (B) | (B) | (B) | (D) | (D) |
| Q. | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Sol. | (D) | (A) | (D) | (D) | (B) | (C) | (C) | (B) | (A,B,D) | (A) |