EXERCISE - O

SINGLE CORRECT TYPE QUESTIONS

Microscopic Ohm's Law

1. An insulating pipe of cross-section area *'A'* contains an electrolyte which has two types of ions→ their charges being $-e$ and $+2e$. A potential difference applied between the ends of the pipe result in the drifting of the two types of ions, having drift speed = v ($-ve$ ion) and $v/4$ ($+ve$ ion). Both ions have the same number per unit volume = n. The current flowing through the pipe is

(A) $nevA/2$ (B) $nevA/4$ (C) $5\,nevA/2$ (D) $3\,nevA/2$

PCE047

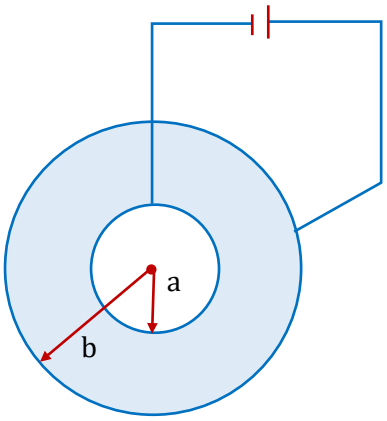
2. A hollow spherical conductor having inner radius '*a*' and outer radius '*b*'. A constant potential difference is applied across inner and outer shell. Due to which current flows radially select the correct statement :-

(A) Drift velocity remains constant

(B) Drift velocity increases radially outward

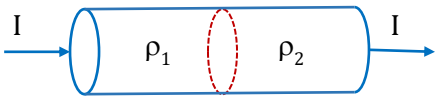
(C) Drift velocity decreases radially outward

(D) Drift velocity first decreases then increases radially outward



PCE050

3. Two long straight cylindrical conductors with resistivities ρ_1 and ρ_2 respectively are joined together as shown in figure. If current I flows through the conductors, the magnitude of the total free charge at the interface of the two conductors is :-



(A) Zero (B) $\dfrac{(\rho_1-\rho_2)I\varepsilon_0}{2}$ (C) $\varepsilon_0 I|\rho_1-\rho_2|$ (D) $\varepsilon_0 I|\rho_1+\rho_2|$

PCE052

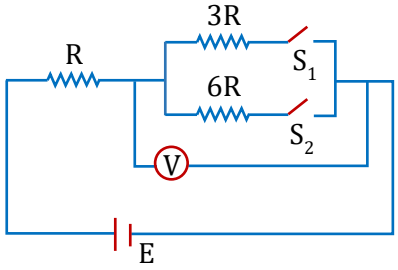
4. Two resistances of equal magnitude R and having temperature coefficient α_1 and α_2 respectively are connected in parallel. The temperature coefficient of the parallel combination is, approximately

(A) $2(\alpha_1+\alpha_2)$ (B) $\dfrac{\alpha_1\alpha_2}{\alpha_1+\alpha_2}$ (C) $\dfrac{\alpha_1-\alpha_2}{2}$ (D) $\dfrac{\alpha_1+\alpha_2}{2}$

PCE056

Kirchoff's Laws

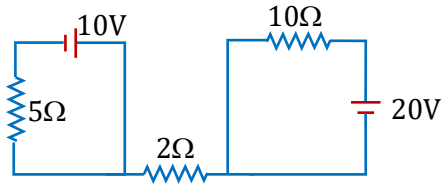
5. In the circuit shown in figure reading of voltmeter is V_1 when only S_1 is closed, reading of voltmeter is V_2 when only S_2 is closed. The reading of voltmeter is V_3 when both S_1 and S_2 are closed then



(A) $V_2 > V_1 > V_3$ (B) $V_3 > V_2 > V_1$ (C) $V_3 > V_1 > V_2$ (D) $V_1 > V_2 > V_3$

PCE060

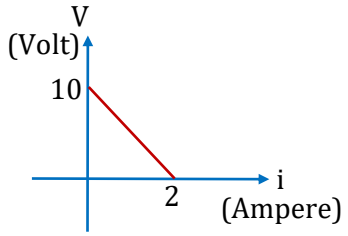
6. In the figure shown the current through 2Ω resistor is



(A) 2 *A* (B) 0 *A* (C) 4 *A* (D) 6 *A*

PCE065

7. A battery of emf E and internal resistance r is connected across a resistance R. Resistance R can be adjusted to any value greater than or equal to zero. A graph is plotted between the current (i) passing through the resistance and potential difference (V) across it. Select the correct alternative.



(A) internal resistance of battery is 5Ω

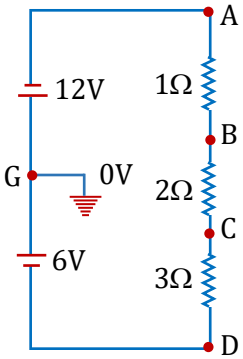
(B) emf of the battery is 20*V*

(C) maximum current which can be taken from the battery is 4*A*

(D) *V-i* graph can never be a straight line as shown in figure

PCE074

8. The potentials of points *A, B, C* and *D* as shown in figure are.

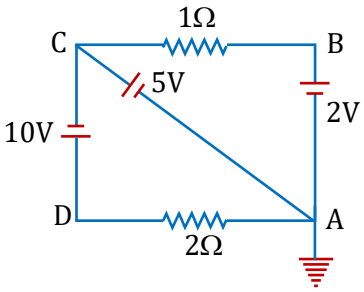


(A) 12*V*, 11*V*, 9*V*, 6*V* (B) –11*V*, –12*V*, –9*V*, –6*V*

(C) –12*V*, –11*V*, –9*V*, –6*V* (D) –12*V*, –11*V*, –6*V*, –9*V*

PCE127

9. In the circuit shown in figure, the potential of B and the current through 2Ω resistance.

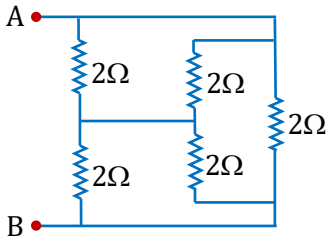


(A) 2 V and 7.5 A (B) 3 V and 7.5 A (C) 2 V and 5 A (D) 3 V and 5 A

PCE132

Equivalent Resistance and Equivalent of Battery

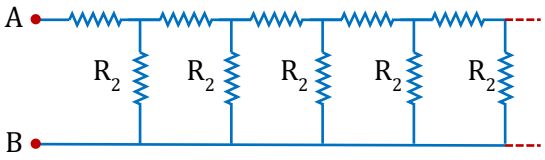
10. Find the equivalent resistance across AB



(A) 1 Ω (B) 2 Ω (C) 3 Ω (D) 4 Ω

PCE059

11. Consider an infinite ladder network shown in figure. A voltage V is applied between the points A and B. This applied value of voltage is halved after each section.



(A) $R_1/R_2 = 1$ (B) $R_1/R_2 = 1/2$ (C) $R_1/R_2 = 2$ (D) $R_1/R_2 = 3$

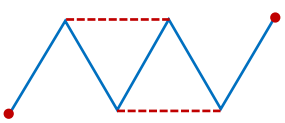
PCE062

12. When a current of 4 A flows within a battery from its positive to negative terminal, the potential difference across the battery is 12 volts. The potential difference across the battery is 9 volts when a current of 2 A flows within it from its negative to its positive terminal. The internal resistance and the e.m.f. of the battery are:-

(A) 0.1 Ω, 4V (B) 0.2 Ω, 5V (C) 0.5 Ω, 10V (D) 0.7 Ω, 10V

PCE067

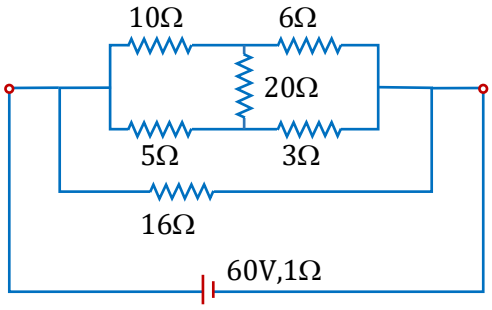
13. Five identical resistors each of resistance 1Ω are initially arranged as shown in the figure by clear lines. If two similar resistances are added as shown by the dashed lines, then change in resistance in final and initial arrangement is



(A) 2 Ω (B) 1 Ω (C) 3 Ω (D) 4 Ω

PCE096

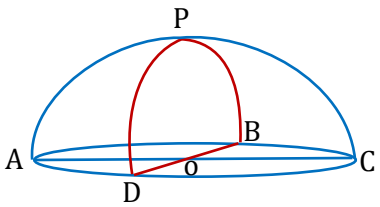
14. Find equivalent resistance of circuit and current in 10Ω resistance?



(A) 5Ω, 3*A* (B) 12Ω, 3*A* (C) 5Ω, 6*A* (D) 5Ω, 12*A*

PCE097

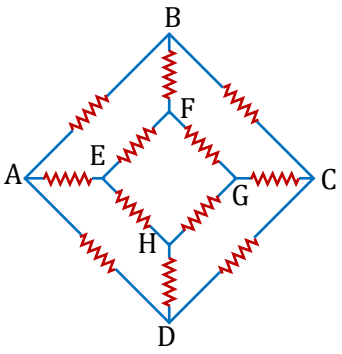
15. A hemispherical network of radius a is made by using a conducting wire of resistance per unit length '*r*'. The equivalent resistance across *OP* will be.



(A) $\left(\frac{2\pi+1}{3}\right)ar$ (B) $\left(\frac{\pi+3}{5}\right)ar$ (C) $\left(\frac{2\pi+3}{8}\right)ar$ (D) $\left(\frac{\pi+2}{8}\right)ar$

PCE123

16. In the network resistors each of value R shown in the fig., calculate the equivalent resistance between the junctions A and C :



(A) 12 R (B) $\frac{9R}{12}$ (C) $\frac{12R}{7}$ (D) $\frac{R}{12}$

PCE125

Heating Effect Due to Current and Electrical Instruments

17. Two bulbs rated (25 W – 220 V) and (100 W – 220 V) are connected in series to a 440 V line. Which one is likely to fuse?

(A) 25 W bulb (B) 100 W bulb (C) Both bulbs (D) None

PCE083

18. Two bulbs one of 200 volts, 60 watts and the other of 200 volts, 100 watts are connected in series to a 200 volt supply. The power consumed will be

(A) 37.5 watt (B) 160 watt (C) 62.5 watt (D) 110 watt

PCE085

19. If the length of the filament of a heater is reduced by 10%, the power of the heater will

(A) increase by about 9% (B) increase by about 11%

(C) increase by about 19% (D) decrease by about 10%

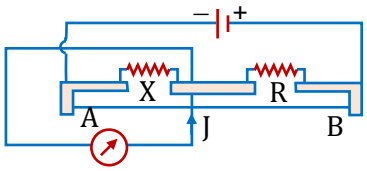
PCE086

20. A wire of length L and 3 identical cells of negligible internal resistances are connected in series. Due to the current, the temperature of the wire is raised by ΔT in time t. N number of similar cells is now connected in series with a wire of the same material and cross section but of length $2L$. The temperature of the wire is raised by the same amount ΔT in the same time t. The value of N is:

(A) 4 (B) 6 (C) 8 (D) 9

PCE092

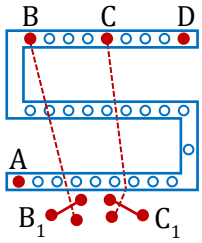
21. The figure shows a metre-bridge circuit, with AB = 100 cm, X = 12Ω and R = 18Ω, and the jockey J in the position of balance. If R is now made 8Ω, through what distance will J have to be moved to obtain balance?



(A) 10 cm (B) 20 cm (C) 30 cm (D) 40 cm

PCE100

22. For the post office box arrangement to determine the value of unknown resistance, the unknown resistance should be connected between



(A) B and C (B) C and D (C) A and D (D) B_1 and C_1

PCE101

23. A galvanometer has a resistance of 20 Ω and reads full-scale when 0.2 V is applied across it. To convert it into a 10 A ammeter, the galvanometer coil should have a

(A) 0.01 Ω resistor connected across it (B) 0.02 Ω resistor connected across it

(C) 200 Ω resistor connected in series with it (D) 2000 Ω resistor connected in series with it

PCE102

24. A galvanometer coil has a resistance 90Ω and full-scale deflection current 10 mA. A 910Ω resistance is connected in series with the galvanometer to make a voltmeter. If the least count of the voltmeter is 0.1V, the number of divisions on its scale is

(A) 90 (B) 91 (C) 100 (D) none

PCE107

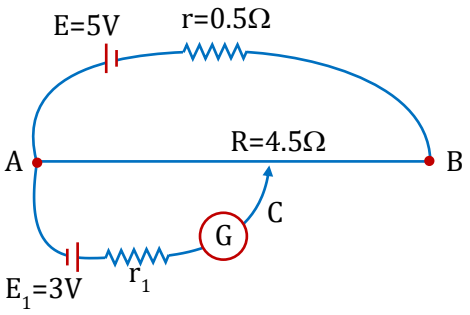
25. In the given potentiometer circuit length of the wire AB is 3 m and resistance is R = 4.5 Ω. The length AC for no deflection in galvanometer is :-

(A) 2 m

(B) 1.8 m

(C) Dependent on r_1

(D) None of these



PCE110

26. The balancing length for a 1.2 volts cell of 5 Ω internal resistance is 900 cm. If a resistance of 10 Ω is connected to the terminals of the cell, the potential difference and balancing length at the ends of resistance will be:

(A) 0.8 volt, 600 cm (B) 0.3 volt, 300 cm (C) 0.24 volt, 130 cm (D) 0.12 volt, 90 cm

PCE118

Capacitance of a System

27. The plate areas and plate separations of parallel plate capacitors are:

Capacitor 1 : Area A_0, separation d_0

Capacitor 2 : Area $2A_0$, separation $2d_0$

Capacitor 3 : Area $2A_0$, separation $d_0/2$

Capacitor 4 : Area $A_0/2$, separation $2d_0$

Capacitor 5 : Area A_0, separation $d_0/2$

Rank these according to their capacitances, least to greatest:

(A) 1, 2, 3, 4, 5 (B) 5, 4, 3, 2, 1

(C) 5, 3 and 4 tie; then 1, 2 (D) 4, 1 and 2 tie; then 5, 3

PCP053

28. A battery is used to charged a parallel-plate capacitor, after which it is disconnected. Then the plates are pulled apart to twice their original separation. This process will double the :

(A) capacitance (B) surface charge density on each plate

(C) stored energy (D) electric field between the two plates

PCP054

29. A capacitor of capacitance C is charged to a potential difference V from a cell and then disconnected from it. A charge $+Q$ is now given to its positive plate. The potential difference across the capacitor is now :-

(A) V (B) $V+\frac{Q}{C}$ (C) $V+\frac{Q}{2C}$ (D) $V-\frac{Q}{C}$, if $V < CV$

PCP057

30. A capacitor is connected to a battery. The force of attraction between the plates when the separation between them is halved

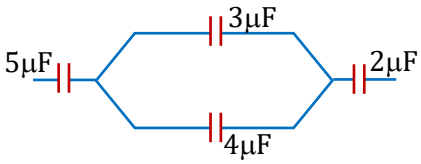
(A) remains the same (B) becomes eight times

(C) becomes four times (D) becomes two times

PCP061

Capacitor Circuits

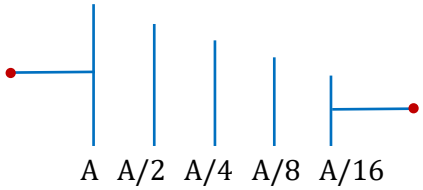
31. If charge on left plate of the 5 μF capacitor in the circuit segment shown in the figure is –20 μC, the charge on the right plate of 3 μF capacitor is :-



(A) +8.57 μC (B) –8.57 μC (C) +11.42 μC (D) –11.42 μC

PCP063

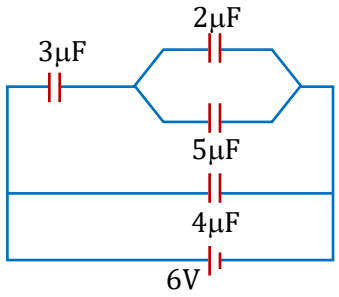
32. 5 Conducting plates each are placed face to face and equi-spaced at distance d. Area of each plate is half the previous plate. If area of first plate is A. Then the equivalent capacitance of the system shown is :-



(A) $\frac{\varepsilon_0 A}{d}$ (B) $\frac{\varepsilon_0 A}{10d}$ (C) $\frac{\varepsilon_0 A}{20d}$ (D) $\frac{\varepsilon_0 A}{30d}$

PCP064

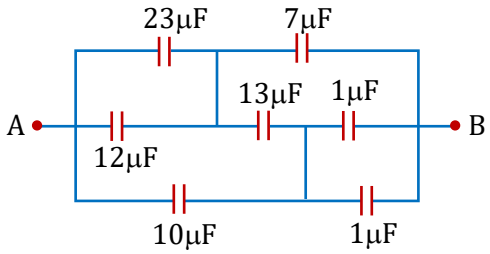
33. In the circuit shown in figure, the ratio of charges on 5 μF and 4 μF capacitor is :-



(A) 4/5 (B) 3/5 (C) 3/8 (D) 1/2

PCP065

34. Find the equivalent capacitance across A and B :-



(A) $\frac{28}{3}\mu f$ (B) $\frac{15}{2}\mu F$ (C) 15 μF (D) None

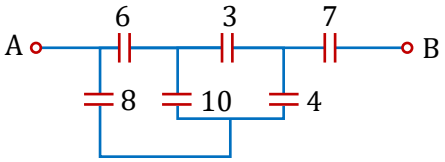
PCP067

35. Three long concentric conducting cylindrical shells have radii R, $2R$ and $2\sqrt{2}R$. Inner and outer shells are connected to each other. The capacitance across middle and inner shell per unit length is:

(A) $\frac{\frac{1}{3}\in_0}{\ln 2}$ (B) $\frac{6\pi\in_0}{\ln 2}$ (C) $\frac{\pi\in_0}{2\ln 2}$ (D) None

PCP068

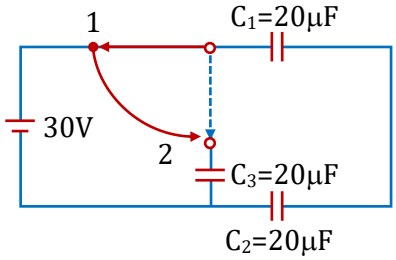
36. In the circuit diagram shown all the capacitors are in μF. The equivalent capacitance between points A and B is (in μF)



(A) 14/5 (B) 7.5 (C) 3/7 (D) None of these

PCP069

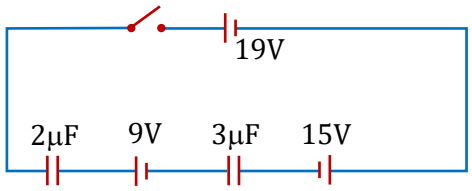
37. In the circuit shown in the figure, the switch can be shifted to positions '1' and '2'. Initially the switch was at position '1' for long time and Now, the switch is shifted to position '2'. The charge appearing on capacitor C_3 is



(A) 225 μC (B) 135 μC (C) 270 μC (D) 75 μC

PCP073

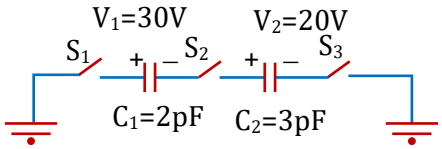
38. Both capacitors are initially uncharged and then connected as shown and switch is closed. What is the potential difference across the 3 μF capacitor ?



(A) 30 V (B) 10 V (C) 25 V (D) None of these

PCP074

39. For the circuit shown, which of the following statements is true?

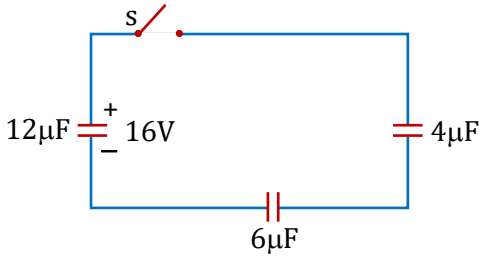


(A) with S_1 closed, $V_1 = 15\ V$, $V_2 = 20\ V$ (B) with S_3 closed, $V_1 = V_2 = 25\ V$

(C) with S_1 and S_2 closed, $V_1 = V_2 = 0$ (D) with S_1 and S_2 closed, $V_1 = 30\ V$, $V_2 = 20\ V$

PCP076

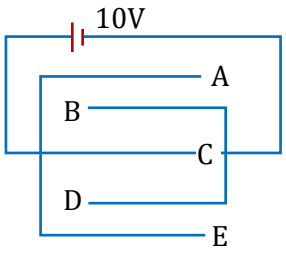
40. For the arrangement shown in Fig. when the switch S is closed, then find the final charge on 6 μF capacitor is:



(A) 12 μC (B) 24 μC (C) 32 μC (D) 48 μC

PCP078

41. Five identical capacitor plates are arranged such that they make capacitors each of 2 μF. The plates are connected to a source of emf 10 V. The charge on plate C is



(A) +20 μC (B) +40 μC (C) +60 μC (D) +80 μC

PCP086

Energy Analysis in Capacitors

42. A capacitor of capacitance C is initially charged to a potential difference of V volt. Now it is connected to a battery of $2V$ with opposite polarity. The ratio of heat generated to the final energy stored in the capacitor will be

(A) 1.75 (B) 2.25 (C) 2.5 (D) 1/2

PCP088

43. Consider a capacitor connected with a battery, capacitor is in steady state. Now plates of capacitor are drawn apart so as to double the separation in two cases.

Case :

(i) Battery remains connected

(ii) Battery is disconnected

Mark the **CORRECT** statement:

(A) In case (i) energy of capacitor increases

(B) In case (i) work done by battery is positive

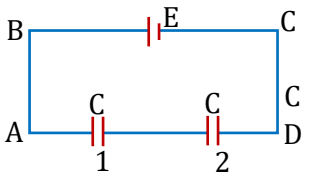
(C) In case (ii) energy of capacitor increases

(D) In case (ii) potential difference across capacitor decreases

PCP095

Dielectrics

44. In the adjoining figure, capacitor (1) and (2) have a capacitance *'C'* each. When the dielectric of dielectric constant K is inserted between the plates of one of the capacitor, the total charge flowing through battery is :-



(A) $\frac{KCE}{K+1}$ from B to C (B) $\frac{KCE}{K+1}$ from C to B

(C) $\frac{(K-1)CE}{2(K+1)}$ from B to C (D) $\frac{(K-1)CE}{2(K+1)}$ from C to B

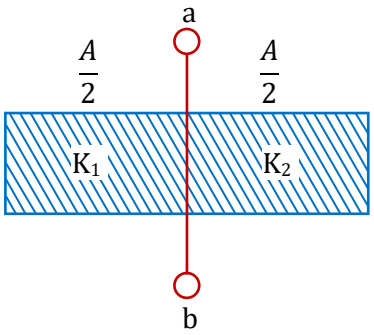
PCP071

45. Condenser A has a capacity of 15 when it is filled with a medium of dielectric constant 15. Another condenser B has a capacity 1 with air between the plates. Both are charged separately by a battery of $100V$. After charging, both are connected in parallel without the battery and the dielectric material being removed. The common potential now is :-

(A) 400 V (B) 800 V (C) 1200 V (D) 1600 V

PCP085

46. The capacity of a parallel plate air capacitor is 10 μF. As shown in the figure this capacitor is divided into two equal parts, these parts are filled by media of dielectric constants $K_1 = 2$ and $K_2 = 4$, capacity of this arrangement will be :–



(A) 20 μF

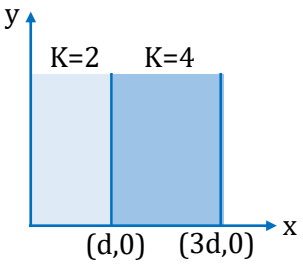
(B) 30 μF

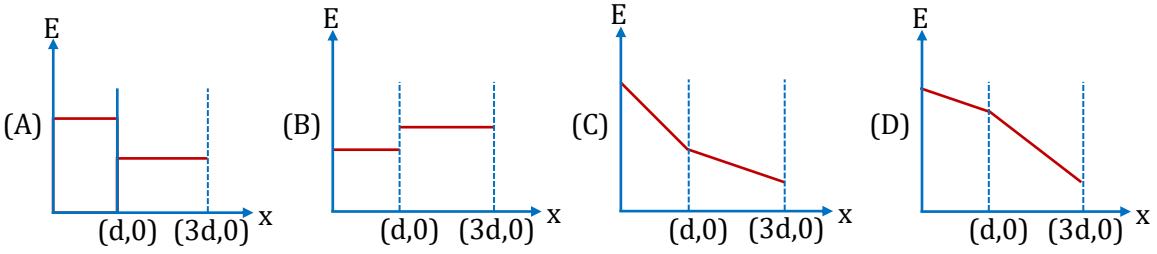
(C) 10 μF

(D) 40 μF

PCP091

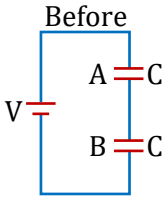
47. A parallel plate capacitor has two layers of dielectric as shown in figure. This capacitor is connected across a battery. The graph which shows the variation of electric field (E) and distance (x) from left plate.





PCP092

48. Two identical capacitors are connected in series as shown in the figure. A dielectric slab ($K > 1$) is placed between the plates of the capacitor B and the battery remains connected. Select correct statement.



(A) The charge supplied by the battery increases.

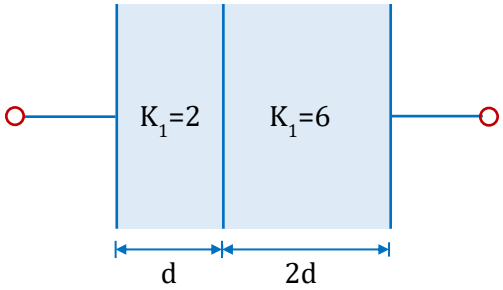
(B) The capacitance of the system decreases.

(C) The electric field in the capacitor B increases.

(D) The electrostatic potential energy decreases.

PCP093

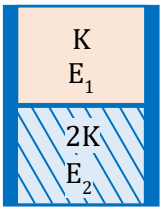
49. A parallel plate capacitor has two layers of dielectric as shown in figure. If this capacitor is connected across a battery, then the ratio of potential difference across the dielectric layer is



(A) $\frac{4}{3}$ (B) $\frac{1}{2}$ (C) $\frac{1}{3}$ (D) $\frac{3}{2}$

PCP094

50. A parallel plate capacitor is connected from a cell and then isolated from it. Two dielectric slabs of dielectric constant K and $2K$ are now introduce in the region between upper half and lower half of the plate (as shown in figure). The electric field intensity in upper half of dielectric is E_1 and lower half is E_2 then



(A) $E_1 = 2\,E_2$

(B) Electrostatic potential energy of upper half is less than that of lower half

(C) Induced charges on both slabs are same

(D) Charge distribution on the plates remains same after insertion of dielectric

PCP096

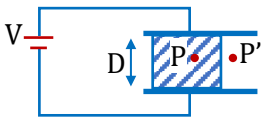
51. A parallel plate capacitor, partially filled with a dielectric slab of dielectric constant K, is connected with a cell of emf V volt, as shown in the figure. Separation between the plates is D. Then

(A) electric field at point P is less than that at point P'.

(B) electric field at point P' is less than that at point P.

(C) electric fields at points P and P' are equal.

(D) electric field at point P is $E = \frac{V}{KD}$.



PCP097

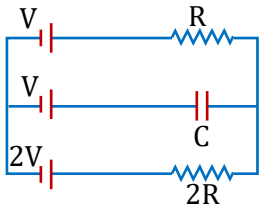
R-C Circuits

52. An uncharged capacitor of capacitance 4 μF, a battery of emf 12 volt and a resistor of 2.5 $M\Omega$ are connected in series. The time after which $v_c = 3v_R$ is (Take $ln2 = 0.693$)

(A) 6.93 sec. (B) 13.86 sec. (C) 20.52 sec. (D) None of these

PCP100

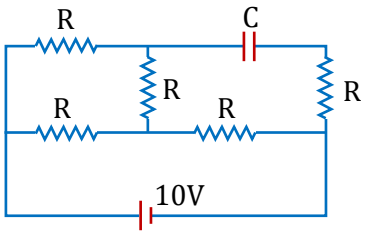
53. In the given circuit, with steady current the potential drop across the capacitor must be :-



(A) V (B) $\frac{V}{2}$ (C) $\frac{V}{3}$ (D) $\frac{2V}{3}$

PCP102

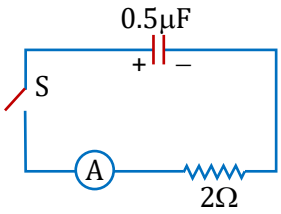
54. Find the potential difference across the capacitor in volts.



(A) $4V$ (B) $2V$ (C) $1V$ (D) $8V$

PCP103

55. A charged capacitor is allowed to discharge through a resistance 2Ω by closing the switch S at the instant $t = 0$. At time $t = ln2$ μs, the reading of the ammeter falls half of its initial value. The resistance of the ammeter equal to

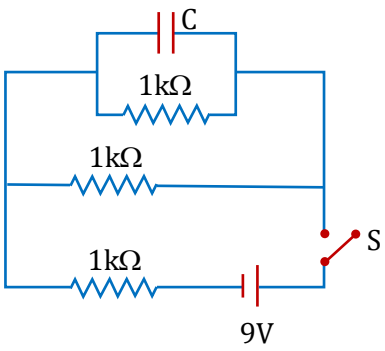


(A) 0 (B) 2 Ω

(C) ∞ (D) 2 $M\Omega$

PCP105

56. A capacitor $C = 100$ μF is connected to three resistor each of resistance 1 $k\Omega$ and a battery of emf $9V$. The switch S has been closed for long time so as to charge the capacitor. When switch S is opened, the capacitor discharges with time constant :-



(A) 33 ms

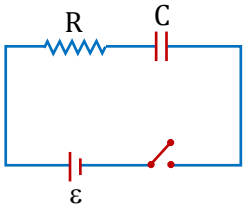
(B) 5 ms

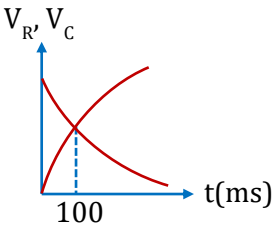
(C) 3.3 ms

(D) 50 ms

PCP107

57. In the *RC* circuit shown, switch is closed at t=0. Graphs showing variation of potential (V_R) across resistor and potential (V_C) across capacitor are given. Time constant of circuit is approximately equal to :-

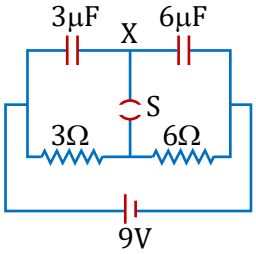




(A) 100 *ms* (B) 145 *ms*
(C) 200 *ms* (D) 300 *ms*

PCP108

58. A circuit is connected as shown in the figure with the switch *S* open. When the switch is closed, the total amount of charge that flows from *Y* to *X* is :-



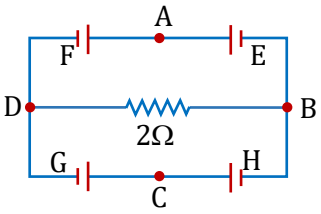
(A) 0 (B) 54 μ*C* (C) 27 μ*C* (D) 81 μ*C*

PCP117

MULTIPLE CORRECT TYPE QUESTIONS

Kirchoff's Laws

59. In the circuit shown *E, F, G* and *H* are cells of e.m.f. 2*V*, 1*V*, 3*V* and 1*V* respectively and their internal resistances are 2Ω, 1Ω, 3Ω and 1Ω respectively.

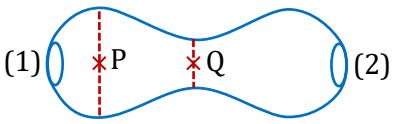


(A) $V_D - V_B = -2/13$ *V*
(B) $V_D - V_B = 2/13$ *V*
(C) $V_G = 21/13$ *V* = Potential difference across *G*
(D) $V_H = 19/13$ *V* = Potential difference across *H*

PCE071

Heating Effect Due to Current and Electrical Instruments

60. A metallic conductor of irregular cross-section is as shown in the figure. A constant potential difference is applied across the ends (1) and (2). Then :



(A) the current at the cross-section *P* equals the current at the cross-section *Q*
(B) the electric field intensity at *P* is less than that at *Q*.
(C) the rate of heat generated per unit time at *Q* is greater than that at *P*
(D) the number of electrons crossing per unit area of cross-section at *P* is less than that at *Q*.

PCE091

61. A micrometer has a resistance of 100 Ω and a full-scale range of 50 μA. It can be used as a voltmeter, or a higher range ammeter provided a resistance is added to it. Pick the correct range and resistance combination(s).

(A) 50 V range with 10 $k\Omega$ resistance in series.

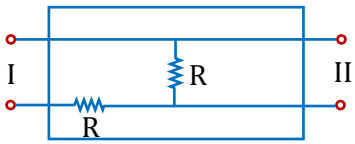
(B) 10 V range with 200 $k\Omega$ resistance in series.

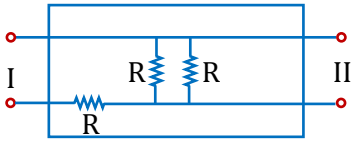
(C) 5 mA range with 1 Ω resistance in parallel.

(D) 10 mA range with 1 $k\Omega$ resistance in parallel.

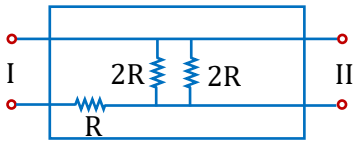
PCE103

62. If a battery of voltage V is connected across terminals I of the black box as shown in figure, an ideal voltmeter connected to terminals II gives a reading of $V/2$. If the same battery is connected to terminals II, an ideal voltmeter across terminals I reads V. Assuming that the black box consists only resistances, which of the following can be the possible combinations?

(A) 

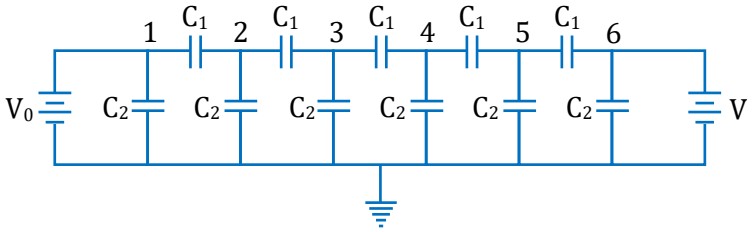
(B) 

(C) 

(D) 

PCE133

63. In the circuit shown, ratio of capacitors is $\frac{C_2}{C_1}=\frac{4}{3}$ and terminal voltage of the battery connected at the left end is V_0. Given that the potentials of nodes 1, 2, 3, 4, 5 and 6 are in geometric progression, when the terminal voltage of the battery connected at the right most end is V. (In steady state condition) Then :-



(A) V may be $\frac{V_0}{3^5}$

(B) V may be $V_0 3^5$

(C) V may be $\frac{V_0}{4}$

(D) V cannot be concluded with this data

PCP126

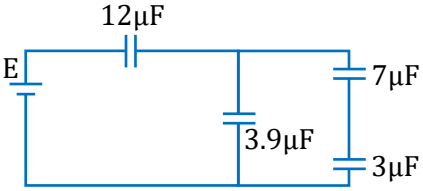
64. Four capacitors and a battery are connected as shown. The potential drop across the 7μF capacitor is 6V. Then the

(A) Potential difference across the 3μF capacitor is 10V

(B) Charge on the 3μF capacitor is 42μC

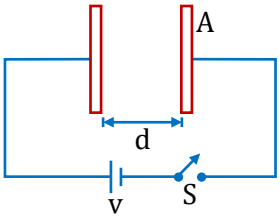
(C) e.m.f of the battery is 30V

(D) Potential difference across the 12μF capacitor is 10V



PCP127

65. A parallel plate air capacitor has plate area A and separation between the plates d. Switch S is closed to connect the capacitor to a cell of emf V.



(A) Amount of heat generated in the circuit as the capacitor gets charged is $\frac{1}{2}CV^2$.

(B) Magnitude of force that one capacitor plate exerts on the other is $\frac{\varepsilon_0 AV^2}{d^2}$.

(C) If the distance between the plates is slowly reduced to $\frac{d}{2}$, the work done by external agent in the process is given by $-\frac{1}{2}CV^2$.

(D) If the distance between the plates is reduced slowly from d to $\frac{d}{2}$, energy dissipated in the circuit is zero.

PCP128

66. A parallel plate air capacitor has initial capacitance C. If plate separation is slowly decreased from d_1 to d_2, then mark the correct statement(s).

[Throughout the process it remains connected to battery]

(A) Work done by electric force = Work done by external agent.

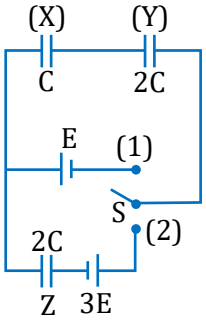
(B) Work done by external force $= -\int \vec{F} \cdot \vec{dx}$, where $\vec{F}$ is the electric force of attraction between the plates at plate separation x.

(C) Work done by electric force ≠ Negative of work done by external agent.

(D) Work done by battery = 2 times the change in electric potential energy stored in capacitor.

PCP129

67. In the given circuit diagram initially all the capacitors are uncharged. Now switch S is closed with position (1) and when steady state reached switch is shifted to position (2) from (1).



(A) Final charge on all three capacitors will be same.

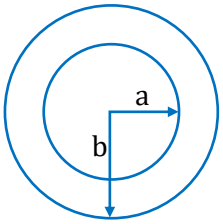
(B) Final charge on capacitor Y is $\frac{4CE}{3}$.

(C) Total heat developed in the circuit after shifting the switch from position (1) to position (2) is $4CE^2$.

(D) Total heat developed in circuit from starting is $\frac{26}{3}CE^2$.

PCP130

68. In the system of concentric conducting spheres, the :-



(A) Capacitance of the system is $\frac{4\pi\varepsilon_0 ab}{b-a}$ when the outer sphere is earthed

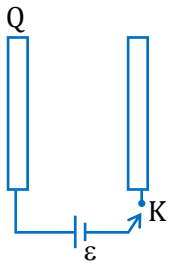
(B) The energy stored in the system if a charge Q is given to the inner sphere is $\frac{Q^2}{8\pi\varepsilon_0}\left(\frac{1}{a}-\frac{1}{b}\right)$ in (a)

(C) If the inner sphere is earthed, equal and opposite charges will be held by the conductors

(D) None of these

PCP131

69. In the given figure the capacitance of capacitor is C. The left plate of the capacitor is given charge Q and right plate is uncharged. Then choose the correct statement(s) :-



(A) The amount of charge that will flow through the battery till the steady state is reached when the switch K is closed will be $C\varepsilon + \frac{Q}{2}$.

(B) The charge appearing on the inner face of the left plate at steady state is $C\varepsilon$

(C) The charge appearing on the interface of the right plate at steady state is $C\varepsilon$

(D) If $\varepsilon = \frac{2Q}{C}$, then work done by cell after closing the switch is $\frac{3Q^2}{C}$.

PCP132

70. The capacitance of a parallel plate capacitor is C when the region between the plate has air. This region is now filled with a dielectric slab of dielectric constant k. The capacitor is connected to a cell of *emf* E, and the slab is taken out:

(A) charge $CE(k-1)$ flows through the cell.

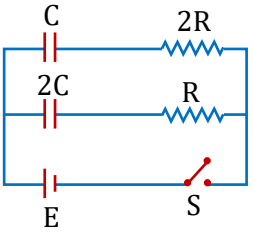
(B) energy $E^2C(k-1)$ is absorbed by the cell.

(C) the energy stored in the capacitor is reduced by $E^2C(k-1)$.

(D) the external agent has to do $\frac{1}{2}E^2C(k-1)$ amount of work to take the slab out.

PCP058

71. In the circuit shown in the figure switch S is closed at time $t = 0$. Select the correct statement :-



(A) Rate of increase of charge is same in both the capacitor.

(B) Ratio of charge stored in capacitance C and $2C$ at any time t would be 1 : 2.

(C) Time constant of both the capacitors are equal.

(D) Steady state charge in capacitors C and $2C$ are in the ratio 1 : 2.

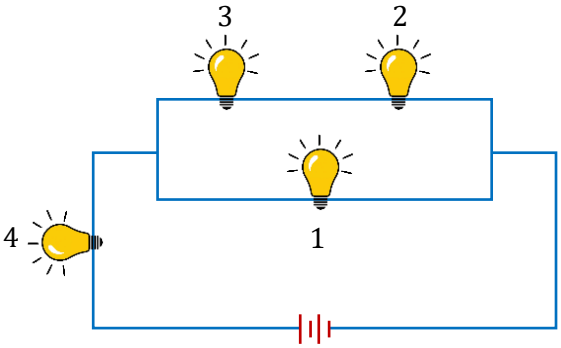
PCP109

COMPREHENSION TYPE QUESTIONS

Heating Effect Due to Current and Electrical Instruments

PARAGRAPH FOR QUESTION NOS. 72 TO 74

All bulbs consume same power. The resistance of bulb 1 is 36Ω.



72. What is the resistance of bulb 3 ?

(A) 4Ω (B) 9Ω (C) 12Ω (D) 18Ω

PCE088

73. What is the resistance of bulb 4 ?

(A) 4Ω (B) 9Ω (C) 12Ω (D) 18Ω

PCE089

74. What is the voltage output of the battery if the power of each bulb is $4W$?

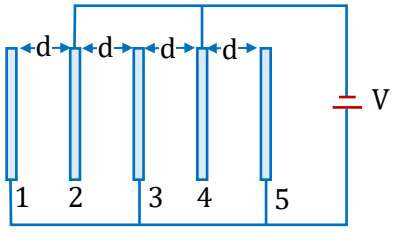
(A) $12V$ (B) $16V$ (C) $24V$ (D) None of these

PCE090

Energy Analysis in Capacitors

PARAGRAPH FOR QUESTION 75 TO 77

Five identical capacitor plates, each of area A, are arranged such that adjacent plates are at d distance apart. Plates are connected to a source of emf V as shown in figure.



75. The charge on plate 1 is

(A) $\frac{\epsilon_0 AV}{d}$ (B) $\frac{2\epsilon_0 AV}{d}$ (C) $-\frac{\epsilon_0 AV}{d}$ (D) $-\frac{2\epsilon_0 AV}{d}$

PCP082

76. The charge on plate 4 is

(A) $\frac{\epsilon_0 AV}{d}$ (B) $\frac{2\epsilon_0 AV}{d}$ (C) $-\frac{\epsilon_0 AV}{d}$ (D) $-\frac{2\epsilon_0 AV}{d}$

PCP083

77. Total electrostatic energy stored in the system is

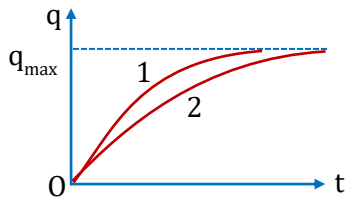
(A) $\frac{A\epsilon_0 V^2}{2d}$ (B) $\frac{2A\epsilon_0 V^2}{d}$ (C) $\frac{A\epsilon_0 V^2}{10d}$ (D) $\frac{3A\epsilon_0 V^2}{2d}$

PCP084

E. R-C Circuits

PARAGRAPH FOR QUESTION NO. 78 AND 79

The charge across the capacitor in two different *RC* circuits 1 and 2 are plotted as shown in figure.



78. Choose the correct statement(*s*) related to the two circuits.

(A) Both the capacitors are charged to the same charge.

(B) The emf's of cells in both the circuit are equal.

(C) The emf's of the cells may be different.

(D) The emf E_1 is more than E_2.

PCP113

79. Identify the correct statement(*s*) related to the R_1, R_2, C_1 and C_2 of the two *RC* circuits.

(A) $R_1 > R_2$ if $E_1 = E_2$

(B) $C_1 < C_2$ if $E_1 = E_2$

(C) $R_1C_1 > R_2C_2$

(D) $\frac{R_1}{R_2}3 < \frac{C_2}{C_1}$

PCP114

EXERCISE - S

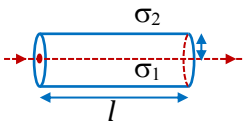
Microscopic Ohm's Law

1. (a) The current density across a cylindrical conductor of radius R varies according to the equation $J = J_0\left(1-\frac{r}{R}\right)$, where r is the distance from the axis. Thus, the current density is a maximum J_0 at the axis $r = 0$ and decreases linearly to zero at the surface $r = R$. Calculate the current in terms of J_0 and the conductor's cross-sectional area is $A = \pi R^2$.

(b) Suppose that instead the current density is a maximum J_0 at the surface and decreases linearly to zero at the axis so that $J = J_0\frac{r}{R}$. Calculate the current.

PCE048

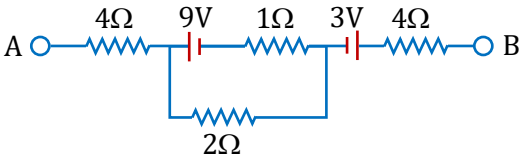
2. A long conductor of circular cross-section has radius r and length l as shown in the figure. The conductivity of the material near the axis is σ_1 and increases linearly with the distance from axis and becomes σ_2 near the surface. Find the resistance of the conductor if the current enters from the one end and leaves from the other end.



PCE064

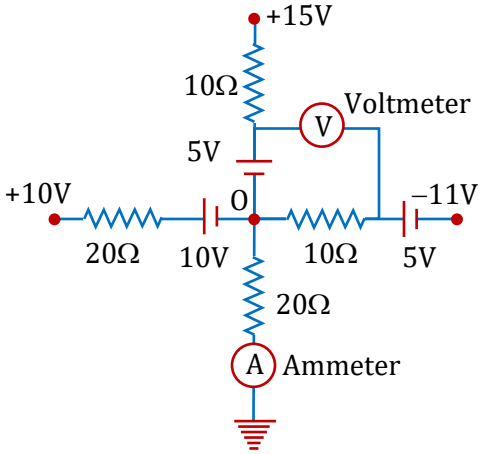
Kirchoff's Laws

3. In the circuit shown in figure potential difference between point A and B is $16V$. Find the current passing through 2Ω resistance.



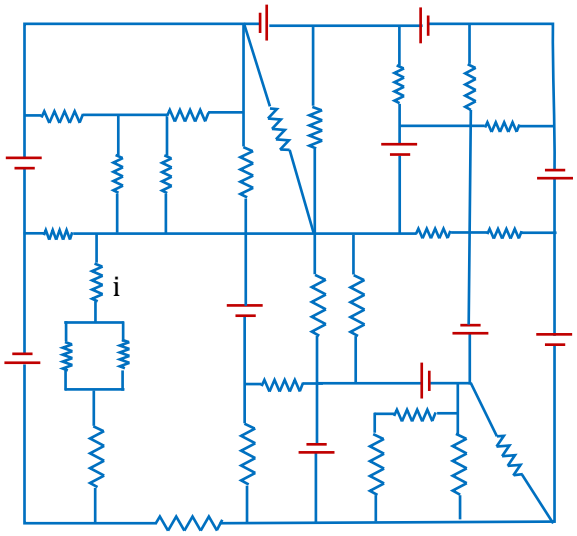
PCE079

4. The potential of certain points in the circuit are maintained at the values indicated. The Voltmeter and Ammeter are ideal. Find the potential of the cross junction point in the circuit (at center O) and the readings of Voltmeter and Ammeter. All cells are ideal.



PCE128

5. What is the magnitude and direction of current i in figure, where all resistance are 4 Ω and all battery have an emf of 10 V? (Hint : This can be answered using only mental calculation)

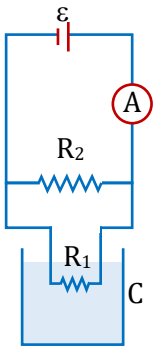


PCE134

Heating Effect Due to Current and Electrical Instruments

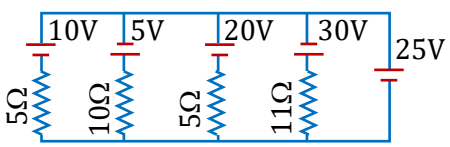
6. The coil of a calorimeter C has a resistance of $R_1 = 60\Omega$. The coil R_1 is connected to the circuit as shown in figure. What is the rise in temperature ($°C$) of 240 grams of water poured into the calorimeter when it is heated for 7 minutes during which a current flow through the coil and the ammeter shows 3A? The resistance $R_2 = 30\Omega$.

[Disregard the resistances of the battery and the ammeter, and the heat losses and heat capacity of the calorimeter and the resistor and specific heat of water = 4200 $J/kg°C$]



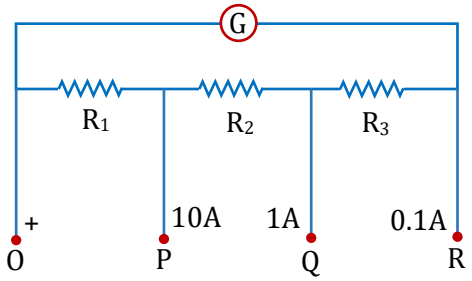
PCE093

7. Find the current through 25 V cell and power supplied by 20 V cell in the figure shown.



PCE095

8. The resistance of the galvanometer G in the circuit is 25Ω. The meter deflects full scale for a current of 10 mA. The meter behaves as an ammeter of three different ranges. The range is 0-10A, if the terminals O and P are taken; range is 0–1 A between O and Q; range is 0–0.1 A between O and R. Calculate the resistance R_1, R_2 and R_3.



PCE105

9. A galvanometer (coil resistance 99 Ω) is converted into a ammeter using a shunt of 1 Ω and connected as shown in the figure (i). The ammeter reads 3A. The same galvanometer is converted into a voltmeter by connected a resistance of 101 Ω in series. This voltmeter is connected as shown in figure (ii). Its reading is found to be 4/5 of the full-scale reading. Find:

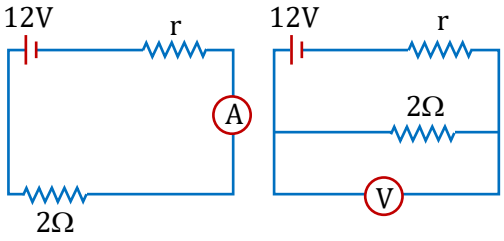


Fig. (i) **Fig. (ii)**

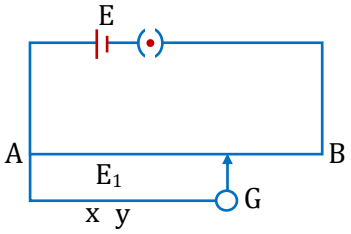
(i) internal resistance r of the cell

(ii) range of the ammeter and voltmeter

(iii) full scale deflection current of the galvanometer

PCE108

10. While doing an experiment with potentiometer it was found that the deflection is one sided and two cases are possible:



(i) the deflection decreased while moving from one end A of the wire to the end B;

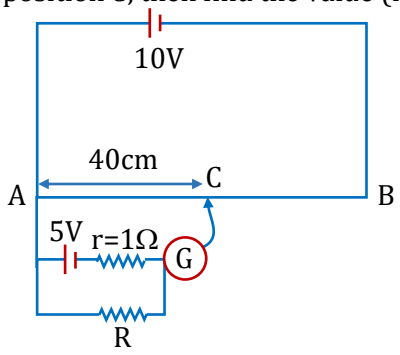
(ii) the deflection increased. while the jockey was moved towards the end B. Then

(a) Which terminal +ve or –ve of the cell E_1, is connected at X in case (i) and how is E_1 related to E?

(b) Which terminal of the cell E_1 is connected at X in case (ii)?

PCE113

11. A potentiometer wire AB is 100 cm long and has a total resistance of 10 ohm. If the galvanometer shows zero deflection at the position C, then find the value (in Ω) of unknown resistance R.



PCE114

Capacitance of a System

12. Eight drops of mercury of equal radii possessing equal charges combine to form a big drop. Then the capacitance of bigger drop compared to each individual small drop is :- (in times)

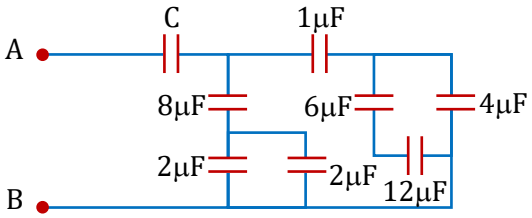
PCP133

13. 2 conducting objects one with charge of $+Q$ and another with $-Q$ are kept on x-axis at $x = 0$ and $x = 1$ respectively. The electric field on the x-axis is given by $3Q\left(x^2+\frac{4}{3}\right)$. If the capacitance of this configuration of objects is C. Value of $\frac{1}{C}$ is

PCP134

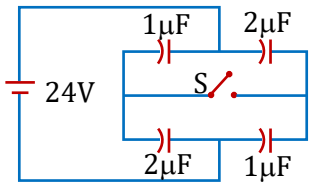
Capacitor Circuits

14. In the following circuit, the resultant capacitance between A and B is 1 μF. Find the value of C.



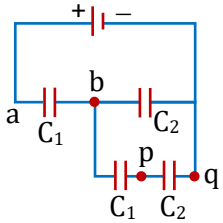
PCP066

15. The connections shown in figure are established with the switch S open. How much charge will flow through the switch if it is closed?



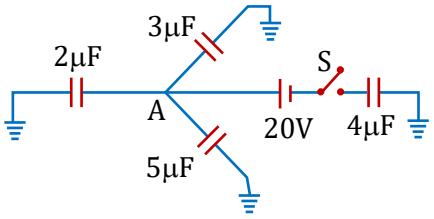
PCP070

16. In the given network if potential difference between p and q is $2V$ and $C_2 = 3C_1$. Then find the potential difference between a and b.



PCP072

17. Three capacitors of 2 μF, 3 μF and 5 μF are independently charged with batteries of emf's $5V$, $20V$ and $10V$ respectively. After disconnecting from the voltage sources. These capacitors are connected as shown in figure with their positive polarity plates are connected to A and negative polarity is earthed. Now a battery of $20V$ and an uncharged capacitor of 4 μF capacitance are connected to the junction A as shown with a switch S. When switch is closed, find :



(a) the potential of the junction A.

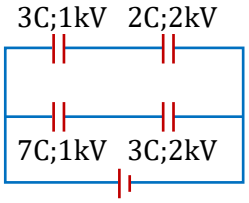
(b) final charges on all four capacitors.

PCP077

18. A 10 μF capacitor is fully charged across a 12-volt battery. The capacitor is then disconnected from the battery and connected across an initially uncharged capacitor, C. The voltage across each capacitor is now 3 volts. What is the unknown capacitance C (in μF)?

PCP079

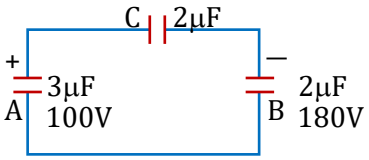
19. The diagram shows four capacitors with capacitances and break down voltages as mentioned. What should be the maximum value of the external emf source such that no capacitor breaks down?



PCP080

Energy Analysis in Capacitors

20. Two capacitors A and B with capacities 3 μF and 2μF are charged to a potential difference of $100V$ and $180V$ respectively. The plates of the capacitors are connected as shown in figure with one wire from each capacitor free. The upper plate of A is positive and that of B is negative. An uncharged 2μF capacitor C with lead wires falls on the free ends to complete the circuit. Calculate:



(i) The final charges on the three capacitors.

(ii) The amount of electrostatic energy stored in the system before and after the completion of the circuit.

PCP081

21. Inside a parallel plate capacitor with an area of 200 cm^2 and the distance between them 0.885 mm is a glass plate, completely filling the space between the plates of the capacitor. What minimum work (in μJ) is required to remove the glass plate? Capacitor is permanently connected to the battery with electromotive force 200 V. The dielectric constant of glass is 5. Force of friction and the mass of the glass plate is neglected.

PCP135

22. A $600pF$ capacitor is charged by $200V$ supply. It is then disconnected from the supply and is connected to another uncharged 600 pF capacitor. Electrostatic energy lost in the process is _____ μJ.

PCP136

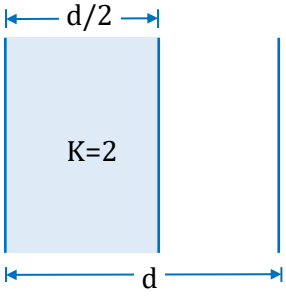
Dielectrics

23. A parallel plate capacitor is to be designed which is to be connected across 1 kV potential difference. The dielectric material which is to be filled between the plates has dielectric constant $K = 6\pi$ and dielectric strength 10^7 V/m. For safety the electric field is never to exceed 10% of the dielectric strength. With such specifications, if we want a capacitor of capacitance $50pF$, what minimum area (in mm^2) of plates is required for safe working?

(Use $\varepsilon_0 = \frac{1}{36\pi} \times 10^{-9}$ in S.I. unit)

PCP056

24. A certain series RC circuit is formed using a resistance R, a capacitor without dielectric having a capacitance $C = 2$ F and a battery of emf $E = 3V$. The circuit is completed and it is allowed to attain the steady state. After this, at $t = 0$, half the thickness of the capacitor is filled with a dielectric of constant $K = 2$ heat generated (in joule) in the circuit between $t = 0$ and $t = \infty$?

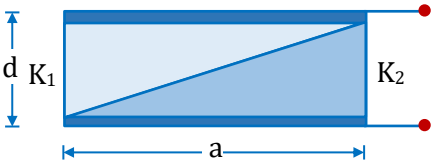


PCP087

25. Two parallel plate air capacitors each of capacitance C were connected in series to a battery with e.m.f ε. Then one of the capacitors was filled up with uniform dielectric with relative permittivity k. What amount of charge flows through the battery ?

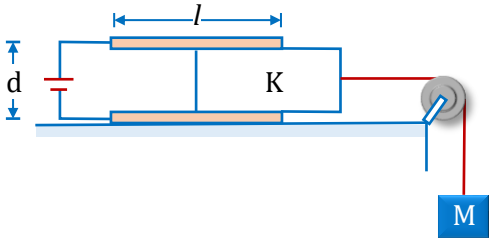
PCP098

26. A capacitor is formed by two square metal-plates of edge a, separated by a distance d. Dielectrics of dielectric constants K_1 and K_2 are filled in the gap as shown in figure. Find the capacitance.



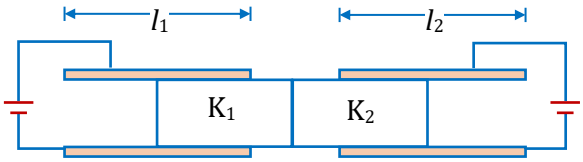
PCP099

27. Consider the situation shown in figure. The width of each plate is b. The capacitor plates are rigidly clamped in the laboratory and connected to a battery of emf E. All surfaces are frictionless. Calculate the value of M for which the dielectric slab will stay in equilibrium.



PCP120

28. Figure shows two parallel plate capacitors with fixed plates and connected to two batteries. The separation between the plates is the same for the two capacitors. The plates are rectangular in shape with width b and lengths l_1 and l_2. The left half of the dielectric slab has a dielectric constant K_1 and the right half K_2. Neglecting any friction, find the ratio of the emf of the left battery to that of the right battery for which the dielectric slab may remain in equilibrium.



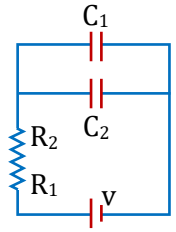
PCP121

E. R-C Circuits

29. A capacitor of capacitance 12.0 μF is connected to a battery of emf 6.00 V and internal resistance 1.00 Ω through resistance less leads. 12.0 μs after the connections are made, what will be (a) the rate at which the energy stored in the capacitor increasing.

PCP101

30. Given $R_1 = 1\ \Omega$, $R_2 = 2\ \Omega$, $C_1 = 2\ \mu F$, $C_2 = 4\ \mu F$. The time constants (in μS) for the circuits is :-

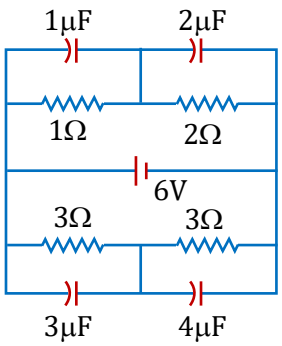


PCP106

31. A parallel-plate capacitor has plate area $20 cm^2$, plate separation 1.0 mm and a dielectric slab of dielectric constant 5.0 filling up the space between the plates. This capacitor is joined to a battery of emf 6.0 V through a $100 k\Omega$ resistor. Find the energy of the capacitor 8.9μs after the connections are made.

PCP110

32. Find the charges on the four capacitors of capacitances 1μF, 2μF, 3μF and 4μF shown in figure.



PCP111

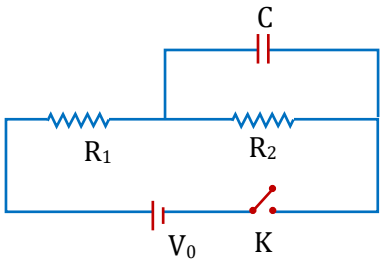
33. In the connection shown in the figure the switch K is open and the capacitor is uncharged. Then we close the switch and let the capacitor charge up to the maximum and open the switch again. Then (Use the following data : $V_0 = 30\ V$, $R_1 = 10\ k\Omega$, $R_2 = 5\ k\Omega$)

(i) the current through R_1 be I_1 immediately after closing the switch.

(ii) the current through R_2 be I_2 a long time after the switch was closed.

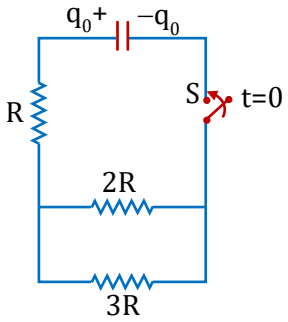
(iii) the current through R_2 be I_3 immediately after reopening the switch.

Find the value of $\frac{I_1}{I_2 I_3}$ (in ampere–1).



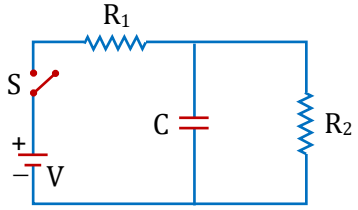
PCP115

34. At $t = 0$ charge on capacitor is q_0. Now switch S is closed. Heat loss in $3R$ is $x \times 10^{-6} J$. Then find the value of x. [Given $q_0 = 15\mu C$, $C = 6/55\ \mu F$]



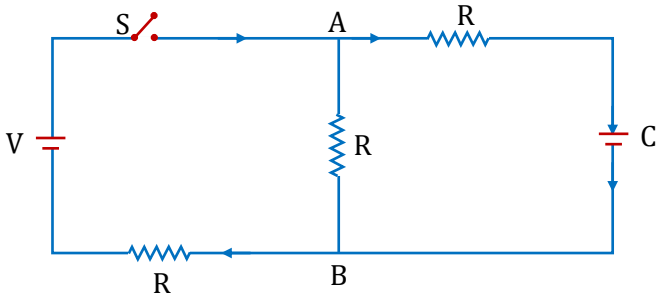
PCP116

35. In the given circuit, the switch S is closed at time $t = 0$. The charge Q on the capacitor at any instant t is given by $Q(t) = Q_0(1 - e^{-\alpha t})$. Find the value of Q_0 and α in terms of given parameters shown in the circuit.



PCP118

36. In the circuit shown in figure, the battery is an ideal one with emf V. The capacitor is initially uncharged. Switch S is closed at time $t = 0$



(a) Find the charge Q on the capacitor at time t.

(b) Find the current in AB at time t. What is its limiting value as $t \to$ infinity?

PCP119

EXERCISE - JEE (Main) PYQ

1. In a large building, there are 15 bulbs of $40W$, 5 bulbs of 100 W, 5 fans of 80 W and 1 heater of 1 kW. The voltage of the electric mains is 220 V. The minimum capacity of the main fuse of the building will be : **[JEE (Main) 2014]**

(1) 8 A (2) 10 A (3) 12 A (4) 14 A

PCE015

2. A parallel plate capacitor is made of two circular plates separated by a distance of 5 mm and with a dielectric of dielectric constant 2.2 between them. When the electric field in the dielectric is 3×10^4 V/m, the charge density of the positive plate will be close to : **[JEE (Main) 2014]**

(1) 6×10^{-7} C/m^2 (2) 3×10^{-7} C/m^2 (3) 3×10^4 C/m^2 (4) 6×10^4 C/m^2

PCP018

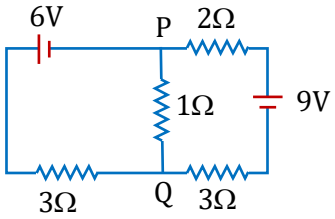
3. In the circuit shown, the current in the 1Ω resistor is :- **[JEE (Main) 2015]**

(1) 0.13 A, from Q to P

(2) 0.13 A, from P to Q

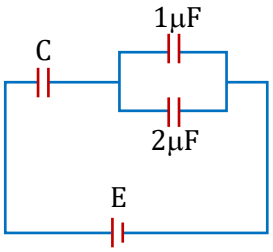
(3) 1.3 A, from P to Q

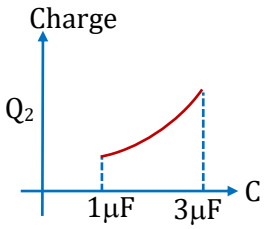
(4) 0A

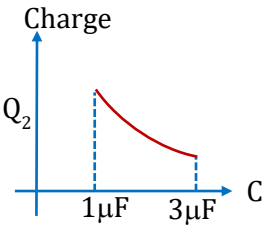


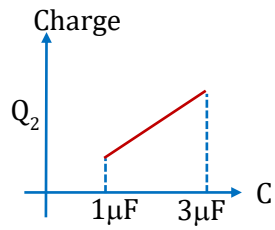
PCE016

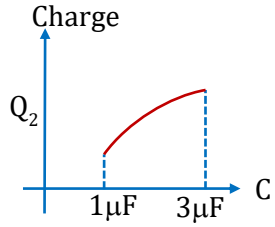
4. In the given circuit, charge Q_2 on the $2\mu F$ capacitor changes as C is varied from $1\mu F$ to $3\mu F$. Q_2 as a function of 'C' is given properly by : (figures are drawn schematically and are not to scale): **[JEE (Main) 2015]**



(1)


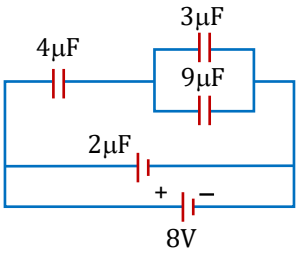
(2)


(3)


(4)


PCP019

5. A combination of capacitors is set up as shown in the figure. The magnitude of the electric field, due to a point charge Q (having a charge equal to the sum of the charges on the 4 μF and 9 μF capacitors), at a point 30 m from it, would equal : **[JEE (Main) 2015]**



(1) 480 N/C (2) 240 N/C (3) 360 N/C (4) 420 N/C

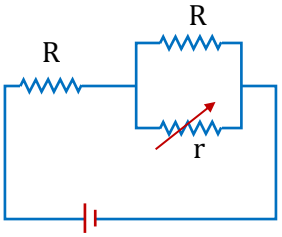
PCP020

6. A galvanometer having a coil resistance of 100Ω gives a full scale deflection, when a current of 1 mA is passed through it. The value of the resistance, which can convert this galvanometer into ammeter giving a full scale deflection for a current of 10A, is :- **[JEE (Main) 2016]**

(1) 3Ω (2) 0.01Ω (3) 2Ω (4) 0.1Ω

PCE017

7. In the circuit shown, the resistance r is a variable resistance. If for $r = f R$, the heat generation in r is maximum then the value of f is : **[JEE (Main) 2016]**



(1) 1 (2) $\frac{1}{4}$ (3) $\frac{1}{2}$ (4) $\frac{3}{4}$

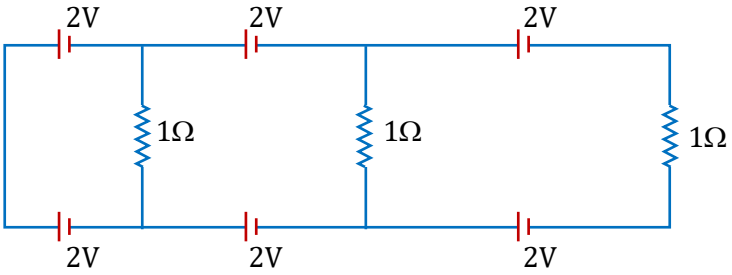
PCP021

8. Three capacitors each of 4 μF are to be connected in such a way that the effective capacitance is 6 μF. This can be done by connecting them : **[JEE (Main) 2016]**

(1) two in parallel and one in series (2) all in parallel
(3) two in series and one in parallel (4) all in series

PCP022

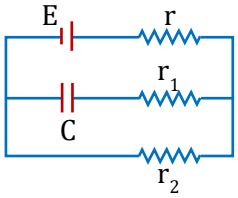
9. In the above circuit the current in each resistance is : **[JEE (Main) 2017]**



(1) 0 A (2) 1 A (3) 0.25 A (4) 0.5 A

PCE018

10. In the given circuit diagram when the current reaches steady state in the circuit, the charge on the capacitor of capacitance C will be : **[JEE (Main) 2017]**



(1) $CE\frac{r_2}{(r+r_2)}$ (2) $CE\frac{r_1}{(r_1+r)}$ (3) CE (4) $CE\frac{r_1}{(r_2+r)}$

PCE019

11. A capacitance of 2 μF is required in an electrical circuit across a potential difference of 1.0 kV. A large number of 1 μF capacitors are available which can withstand a potential difference of not more than 300 V. The minimum number of capacitors required to achieve this is : **[JEE (Main) 2017]**

(1) 24 (2) 32 (3) 2 (4) 16

PCP023

12. In a potentiometer experiment, it is found that no current passes through the galvanometer when the terminals of the cell are connected across 52cm of the potentiometer wire. If the cell is shunted by resistance of 5 Ω, a balance is found when the cell is connected across 40 cm of the wire. Find the internal resistance of the cell. **[JEE (Main) 2018]**

(1) 2 Ω (2) 2.5 Ω (3) 1 Ω (4) 1.5 Ω

PCE020

13. A parallel plate capacitor of capacitance 90 pF is connected to a battery of emf 20V. If a dielectric material of dielectric constant $K = \frac{5}{3}$ is inserted between the plates, the magnitude of the induced charge will be:- **[JEE (Main) 2018]**

(1) 0.3 $n\,C$ (2) 2.4 $n\,C$ (3) 0.9 $n\,C$ (4) 1.2 $n\,C$

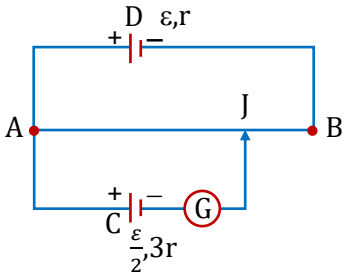
PCP024

14. A carbon resistance has a following colour code. What is the value of the resistance ? **[JEE (Main) 2019]**

(1) 1.64 $M\Omega \pm 5\%$ (2) 530 $k\Omega \pm 5\%$ (3) 64 $k\Omega \pm 10\%$ (4) 5.3 $M\Omega \pm 5\%$

PCE021

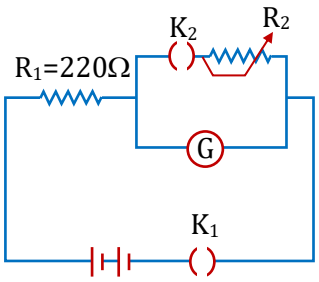
15. A potentiometer wire AB having length L and resistance 12 r is joined to a cell D of emf ε and internal resistance r. A cell C having emf $\varepsilon/2$ and internal resistance $3r$ is connected. The length AJ at which the galvanometer as shown in fig. shows no deflection is : **[JEE (Main) 2019]**



(1) $\frac{5}{12}L$ (2) $\frac{11}{24}L$ (3) $\frac{11}{12}L$ (4) $\frac{13}{24}L$

PCE022

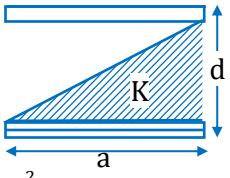
16. The galvanometer deflection, when key K_1 is closed but K_2 is open, equals θ_0 (see figure). On closing K_2 also and adjusting R_2 to 5Ω, the deflection in galvanometer becomes $\frac{\theta_0}{5}$. The resistance of the galvanometer is, then, given by
[Neglect the internal resistance of battery]: **[JEE (Main) 2019]**



(1) 12Ω (2) 25Ω
(3) 5Ω (4) 22Ω

PCE023

17. A parallel plate capacitor is made of two square plates of side 'a', separated by a distance d ($d<<a$). The lower triangular portion is filled with a dielectric of dielectric constant K, as shown in the figure. Capacitance of this capacitor is : **[JEE (Main) 2019]**



(1) $\frac{1}{2}\frac{k\in_0 a^2}{d}3$ (2) $\frac{k\in_0 a^2}{d}\ln K$ (3) $\frac{k\in_0 a^2}{d(K-1)}\ln K$ (4) $\frac{k\in_0 a^2}{2d(K+1)}$

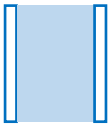
PCP025

18. A galvanometer is used in laboratory for detecting the null point in electrical experiments. If, on passing a current of $6mA$ it produces a deflection of 2°, its figure of merit is close to : **[JEE (Main) 2020]**

(1) $3 \times 10^{-3}\ A/div.$ (2) 333° $A/div.$
(3) $6 \times 10^{-3}\ A/div.$ (4) 666° $A/div.$

PCE024

19. A parallel plate capacitor has plates of area A separated by distance 'd' between them. It is filled with a dielectric which has a dielectric constant that varies as $k(x) = K(1 + \alpha x)$ where 'x' is the distance measured from one of the plates. If $(\alpha d) << 1$, the total capacitance of the system is best given by the expression: **[JEE (Main) 2020]**



(1) $\frac{AK\varepsilon_0}{d}\left(1+\frac{\alpha d}{2}\right)$ (2) $\frac{A\varepsilon_0 K}{d}\left(1+\left(\frac{\alpha d}{2}\right)^2\right)$ (3) $\frac{A\varepsilon_0 K}{d}\left(1+\frac{\alpha^2 d^2}{2}\right)$ (4) $\frac{AK\varepsilon_0}{d}(1+\alpha d)$

PCP026

20. Two identical cells each of emf 1.5 V are connected in parallel across a parallel combination of two resistors each of resistance 20Ω. A voltmeter connected in the circuit measures 1.2V. The internal resistance of each cell is **[JEE (Main) 2022]**

(1) 2.5Ω (2) 4Ω (3) 5Ω (4) 10Ω

PCE025

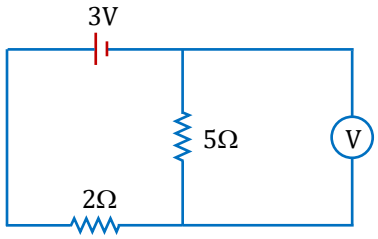
21. A parallel plate capacitor is formed by two plates each of area $30\pi\ cm^2$ separated by 1 mm. A material of dielectric strength $3.6 \times 10^7\ Vm^{-1}$ is filled between the plates. If the maximum charge that can be stored on the capacitor without causing any dielectric breakdown is $7 \times 10^{-6}\ C$, the value of dielectric constant of the material is : **[JEE (Main) 2022]**

$\left\{\text{Use: } \frac{1}{4\pi\varepsilon_0} = 9\times10^9\ Nm^2C^{-2}\right\}$

(1) 1.66 (2) 1.75 (3) 2.25 (4) 2.33

PCP027

22. As shown in the figure, the voltmeter reads $2V$ across 5 Ω resistor. The resistance of the voltmeter is_____Ω. **[JEE (Main) 2023]**

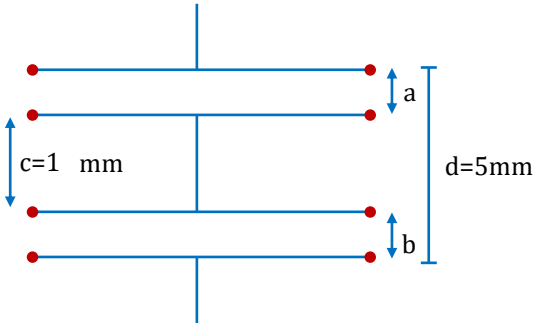


PCE130

23. The length of a metallic wire is increased by 20% and its area of cross section is reduced by 4%. The percentage change in resistance of the metallic wire is _____ . **[JEE (Main) 2023]**

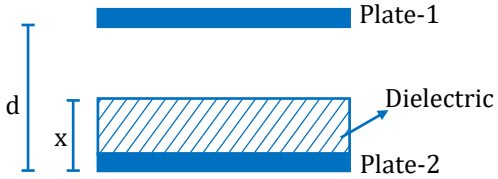
PCE131

24. As shown in the figure, two parallel plate capacitors having equal plate area of 200 cm^2 are joined in such a way that $a \neq b$. The equivalent capacitance of the combination is $x \in_0 F$. The value of x is_____. **[JEE (Main) 2023]**



PCP122

25. A parallel plate capacitor with plate area A and plate separation d is filled with a dielectric material of dielectric constant $K = 4$. The thickness of the dielectric material is x, where $x < d$.

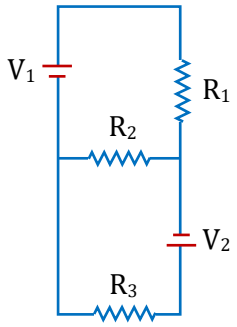


Let C_1 and C_2 be the capacitance of the system for $x = \frac{1}{3}d$ and $x = \frac{2d}{3}$, respectively. If $C_1 = 2\mu F$ the value of C_2 is _____ μF **[JEE (Main) 2023]**

PCP123

EXERCISE - JEE (Advanced) PYQ

1. Two ideal batteries of emf V_1 and V_2 and three resistances R_1, R_2 and R_3 are connected as shown in the figure. The current in resistance R_2 would be zero if **[JEE (Advanced) 2014]**



(A) $V_1 = V_2$ and $R_1 = R_2 = R_3$ (B) $V_1 = V_2$ and $R_1 = 2R_2 = R_3$

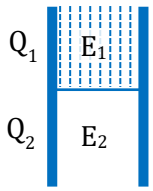
(C) $V_1 = 2V_2$ and $2R_1 = 2R_2 = R_3$ (D) $2V_1 = V_2$ and $2R_1 = R_2 = R_3$

PCE034

2. A galvanometer gives full scale deflection with 0.006 A current. By connecting it to a 4990Ω resistance, it can be converted into a voltmeter of range 0-30 V. If connected to a $\frac{2n}{249}\,\Omega$ resistance, it becomes an ammeter of range 0-1.5 A. The value of n is. **[JEE (Advanced) 2014]**

PCE035

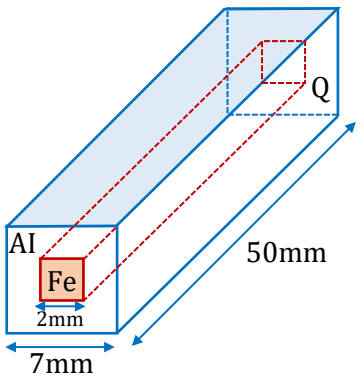
3. A parallel plate capacitor has A dielectric slab of dielectric constant K between its plates that covers 1/3 of the area of its plates, as shown in the figure. The total capacitance of the capacitor is C while that of the portion with dielectric in between is C_1. When the capacitor is charged, the plate area covered by the dielectric gets charge Q_1 and the rest of the area gets charge Q_2. Choose the correct option/options, ignoring edge effects. **[JEE (Advanced) 2014]**



(A) $\frac{E_1}{E_2} = 1$ (B) $\frac{E_1}{E_2} = \frac{1}{K}$ (C) $\frac{Q_1}{Q_2} = \frac{3}{K}$ (D) $\frac{C}{C_1} = \frac{2+K}{K}$

PCP039

4. In an aluminium (Al) bar of square cross section, a square hole is drilled and is filled with iron (Fe) as shown in the figure. The electrical resistivities of Al and Fe are $2.7\times 10^{-8}\Omega m$ and $1.0 \times 10^{-7}\ \Omega m$, respectively. The electrical resistance between the two faces P and Q of the composite bar is **[JEE (Advanced) 2015]**



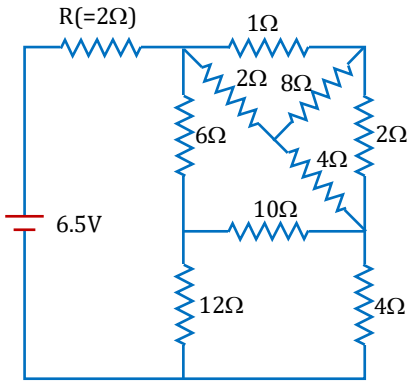
(A) $\frac{2475}{64}\,\mu\Omega$ (B) $\frac{1875}{64}\,\mu\Omega$

(C) $\frac{1875}{49}\,\mu\Omega$ (D) $\frac{2475}{132}\,\mu\Omega$

PCE036

5. In the following circuit, the current through the resistor R (= 2Ω) is I Amperes. The value of I is :

[JEE (Advanced) 2015]

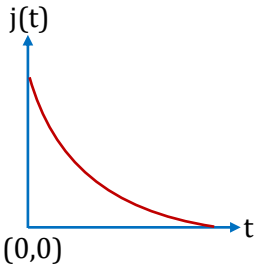


PCE037

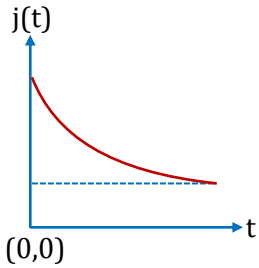
6. An infinite line charge of uniform electric charge density λ lies along the axis of an electrically conducting infinite cylindrical shell of radius R. At time $t = 0$, the space inside the cylinder is filled with a material of permittivity ε and electrical conductivity σ. The electrical conduction in the material follows Ohm's law. Which one of the following graphs best describes the subsequent variation of the magnitude of current density j (t) at any point in the material?

[JEE (Advanced) 2016]

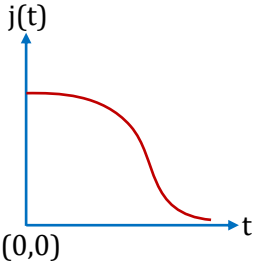
(A)



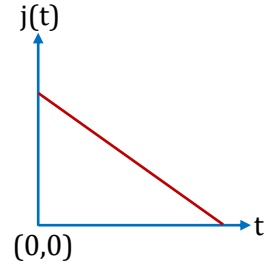
(B)



(C)



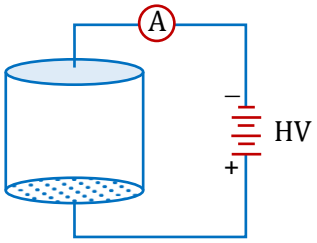
(D)



PCE038

PARAGRAPH FOR QUESTION NO. 7 AND 8

Consider an evacuated cylindrical chamber of height h having rigid conducting plates at the ends and an insulating curved surface as shown in the figure. A number of spherical balls made of a light weight and soft material and coated with a conducting material are placed on the bottom plate. The balls have a radius $r << h$. Now a high voltage source (HV) is connected across the conducting plates such that the bottom plate is at $+V_0$ and the top plate at $-V_0$. Due to their conducting surface the balls will get charged, will become equipotential with the plate and are repelled by it. The balls will eventually collide with the top plate, where the coefficient of restitution can be taken to be zero due to the soft nature of the material of the balls. The electric field in the chamber can be considered to be that of a parallel plate capacitor. Assume that there are no collisions between the balls and the interaction between them is negligible. (Ignore gravity) **[JEE (Advanced) 2016]**



7. Which one of the following statements is correct?

(A) The balls will execute simple harmonic motion between the two plates

(B) The balls will bounce back to the bottom plate carrying the opposite charge they went up with

(C) The balls will bounce back to the bottom plate carrying the same charge they went up with

(D) The balls will stick to the top plate and remain there

PCP040

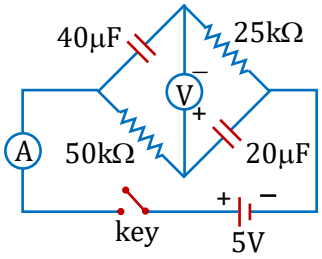
8. The average current in the steady state registered by the ammeter in the circuit will be

(A) proportional to V_0^2 (B) proportional to $V_0^{1/2}$

(C) proportional to the potential V_0 (D) zero

PCP041

9. In the circuit shown below, the key is pressed at time $t = 0$. Which of the following statement(s) is(are) true? **[JEE (Advanced) 2016]**



(A) The voltmeter displays $-5V$ as soon as the key is pressed, and displays $+5V$ after A long time

(B) The voltmeter will display 0 V at time $t = \ln 2$ seconds

(C) The current in the ammeter becomes 1/e of the initial value after 1 second

(D) The current in the ammeter becomes zero after A long time

PCP042

10. Consider two identical galvanometers and two identical resistors with resistance R. If the internal resistance of the galvanometers $R_C < R/2$, which of the following statement(s) about any one of the galvanometers is(are) true? **[JEE (Advanced) 2016]**

(A) The maximum voltage range is obtained when all the components are connected in series.

(B) The maximum voltage range is obtained when the two resistors and one galvanometer are connected in series, and the second galvanometer is connected in parallel to the first galvanometer.

(C) The maximum current range is obtained when all the components are connected in parallel.

(D) The maximum current range is obtained when the two galvanometers are connected in series and the combination is connected in parallel with both the resistors.

PCE039

PARAGRAPH FOR QUESTION NO. 11 AND 12

Consider *A* simple *RC* circuit as shown in figure 1.

Process 1 : In the circuit the switch *S* is closed at $t = 0$ and the capacitor is fully charged to voltage V_0 (i.e., charging continues for time $T >> RC$). In the process some dissipation (E_D) occurs across the resistance *R*. The amount of energy finally stored in the fully charged capacitor is E_C.

Process 2 : In *A* different process the voltage is first set to $\frac{V_0}{3}$ and maintained for *A* charging time $T >> RC$. Then the voltage is raised to $\frac{2V_0}{3}$ without discharging the capacitor and again maintained for *A* time $T >> RC$. The process is repeated one more time by raising the voltage to V_0 and the capacitor is charged to the same final voltage V_0 as in Process 1.

These two processes are depicted in Figure 2. **[JEE (Advanced) 2017]**

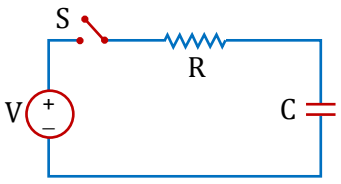


Figure 1

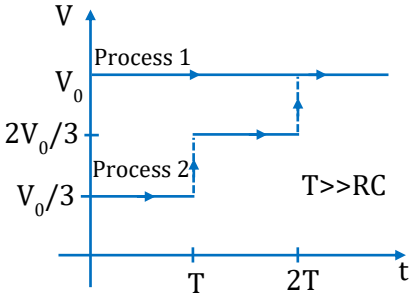


Figure 2

11. In Process 1, the energy stored in the capacitor E_C and heat dissipated across resistance E_D are related by:-

(A) $E_C = E_D$ (B) $E_C = 2E_D$ (C) $E_C = \frac{1}{2}E_D$ (D) $E_C = E_D \ln 2$

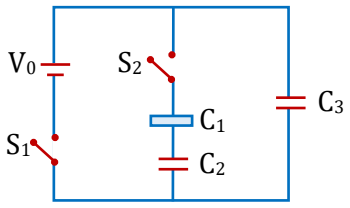
PCP043

12. In Process 2, total energy dissipated across the resistance E_D is :-

(A) $E_D = \frac{1}{3}\left(\frac{1}{2}CV_0^2\right)$ (B) $E_D = 3\left(\frac{1}{2}CV_0^2\right)$ (C) $E_D = \frac{1}{2}CV_0^2$ (D) $E_D = 3CV_0^2$

PCP044

13. Three identical capacitors C_1, C_2 and C_3 have *A* capacitance of 1.0 μF each and they are uncharged initially. They are connected in *A* circuit as shown in the figure and C_1 is then filled completely with *A* dielectric material of relative permittivity $\in_r$. The cell electromotive force (emf) $V_0 = 8V$. First the switch S_1 is closed while the switch S_2 is kept open. When the capacitor C_3 is fully charged, S_1 is opened and S_2 is closed simultaneously. When all the capacitors reach equilibrium, the charge on C_3 is found to be $5\mu C$. The value of $\in_r$. **[JEE (Advanced) 2018]**



PCP045

14. Two identical moving coil galvanometer have 10 Ω resistance and full scale deflection at 2 μ*A* current. One of them is converted into a voltmeter of 100 *mV* full scale reading and the other into an Ammeter of 1 *mA* full scale current using appropriate resistors. These are then used to measure the voltage and current in the Ohm's law experiment with R = 1000 Ω resistor by using an ideal cell. Which of the following statement(s) is/are correct? **[JEE (Advanced) 2019]**

(A) The measured value of R will be $978\Omega < R < 982\Omega$.

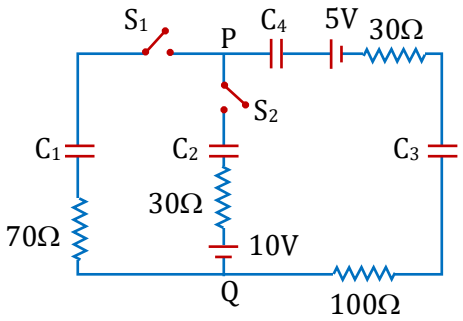
(B) The resistance of the Voltmeter will be 100 kΩ.

(C) The resistance of the Ammeter will be 0.02Ω (round off to 2nd decimal place)

(D) If the ideal cell is replaced by a cell having internal resistance of 5Ω then the measured value of R will be more than 1000 Ω.

PCE040

15. In the circuit shown, initially there is no charge on capacitors and keys S_1 and S_2 are open. The values of the capacitors are C_1 = 10 μ*F*, C_2 = 30 μ*F* and $C_3 = C_4$ = 80 μ*F*. **[JEE (Advanced) 2019]**



Which of the statement(s) is/are correct ?

(A) The keys S_1 is kept closed for long time such that capacitors are fully charged. Now key S_2 is closed, at this time, the instantaneous current across 30 Ω resistor (between points P and Q) will be 0.2 *A* (round off to 1st decimal place).

(B) If key S_1 is kept closed for long time such that capacitors are fully charged, the voltage difference between points P and Q will be 10 *V*.

(C) At time t = 0, the key S_1 is closed, the instantaneous current in the closed circuit will be 25 *mA*.

(D) If key S_1 is kept closed for long time such that capacitors are fully charged, the voltage across the capacitors C_1 will be 4*V*.

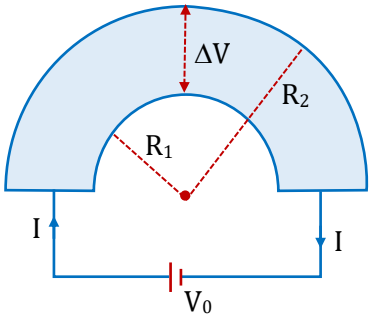
PCP046

16. A parallel plate capacitor of capacitance C has spacing d between two plates having area A. The region between the plates is filled with N dielectric layers, parallel to its plates, each with thickness $\delta = \frac{d}{N}$. The dielectric constant of the m^{th} layer is $K_m = K\left(1+\frac{m}{N}\right)$. For A very large N (> 10^3), the capacitance C is $\alpha\left(\frac{K\in_0 A}{d\ell n2}\right)$. The value of α will be ____. [$\in_0$ is the permittivity of free space]

[JEE (Advanced) 2019]

PCP047

17. Shown in the figure is a semicircular metallic strip that has thickness t and resistivity ρ. Its inner radius is R_1 and outer radius is R_2. If a voltage V_0 is applied between its two ends, a current I flows in it. In addition, it is observed that a transverse voltage ΔV develops between its inner and outer surfaces due to purely kinetic effects of moving electrons (ignore any role of the magnetic field due to the current). Then (figure is schematic and not drawn to scale) **[JEE (Advanced) 2020]**



(A) $I = \frac{v_0 t}{\pi\rho} In\left(\frac{R_2}{R_1}\right)$

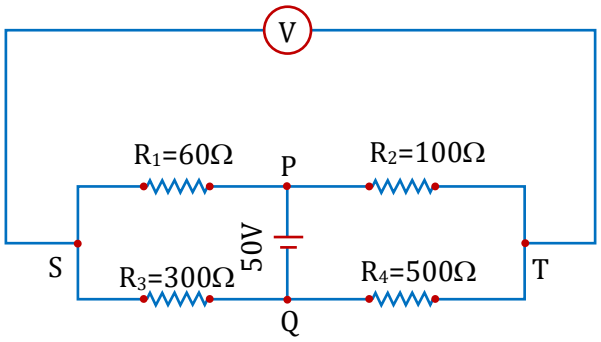
(B) the outer surface is at a higher voltage than the inner surface

(C) the outer surface is at a lower voltage than the inner surface

(D) $\Delta V \propto I^2$

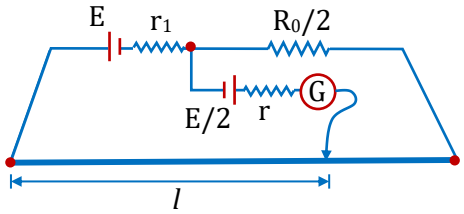
PCE041

18. In the balanced condition, the values of the resistances of the four arms of a Wheatstone bridge are shown in the figure below. The resistance R_3 has temperature coefficient $0.0004°C^{-1}$. If the temperature of R_3 is increased by 100°C, the voltage developed between S and T will be _____ volt. **[JEE (Advanced) 2020]**



PCE042

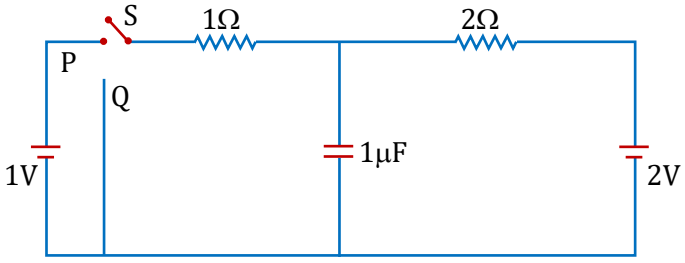
19. In order to measure the internal resistance r_1 of a cell of emf E, a meter bridge of wire resistance R_0 = 50 Ω, a resistance $R_0/2$, another cell of emf $E/2$ (internal resistance r) and a galvanometer G are used in a circuit, as shown in the figure. If the null point is found at ℓ = 72 cm, then the value of r_1 = _____Ω. **[JEE (Advanced) 2021]**



PCE043

QUESTION STEM FOR QUESTION NOS. 20 AND 21

In the circuit shown below, the switch S is connected to position P for a long time so that the charge on the capacitor becomes q_1 μC. Then S is switched to position Q. After a long time, the charge on the capacitor is q_2 μC. **[JEE (Advanced) 2021]**



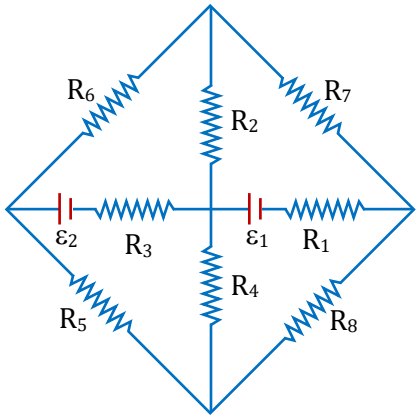
20. The magnitude of q_1 is ___ .

PCP048

21. The magnitude of q_2 is ___ .

PCP049

22. The figure shows a circuit having eight resistances of 1 Ω each, labelled R_1 to R_8, and two ideal batteries with voltages $\varepsilon_1 = 12\ V$ and $\varepsilon_2 = 6\ V$. **[JEE (Advanced) 2022]**



Which of the following statement(s) is(are) correct?

(A) The magnitude of current flowing through R_1 is 7.2 A.

(B) The magnitude of current flowing through R_2 is 1.2 A.

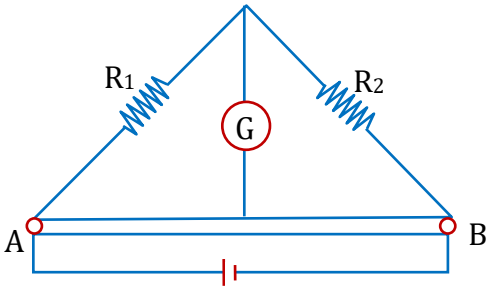
(C) The magnitude of current flowing through R_3 is 4.8 A.

(D) The magnitude of current flowing through R_5 is 2.4 A.

PCE044

23. Two resistances $R_1 = X\ \Omega$ and $R_2 = 1\ \Omega$ are connected to a wire AB of uniform resistivity, as shown in the figure. The radius of the wire varies linearly along its axis from 0.2 mm at A to 1 mm at B. A galvanometer (G) connected to the center of the wire, 50 cm from each end along its axis, shows zero deflection when A and B are connected to a battery. The value of X is _____.

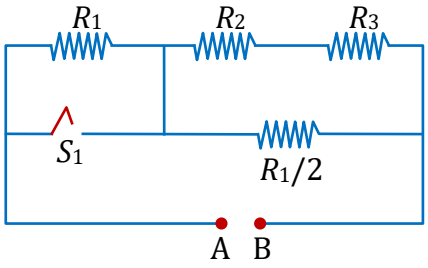
[JEE (Advanced) 2022]



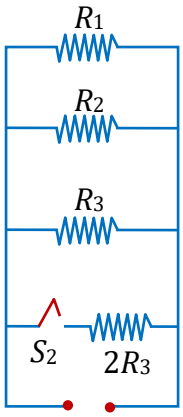
PCE045

24. In Circuit-1 and Circuit-2 shown in the figures, $R_1 = 1\ \Omega$, $R_2 = 2\ \Omega$ and $R_3 = 3\ \Omega$. P_1 and P_2 are the power dissipations in Circuit-1 and Circuit-2 when the switches S_1 and S_2 are in open conditions, respectively.

Q_1 and Q_2 are the power dissipations in Circuit-1 and Circuit-2 when the switches S_1 and S_2 are in closed conditions, respectively.



Circuit-1



Circuit-2

Which of the following statement(s) is(are) correct? **[JEE (Advanced) 2022]**

(A) When a voltage source of 6 V is connected across A and B in both circuits, $P_1 < P_2$.

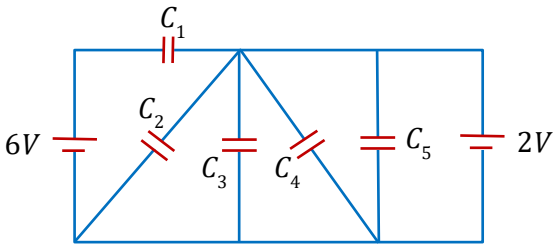
(B) When a constant current source of 2 Amp is connected across A and B in both circuits, $P_1 > P_2$.

(C) When a voltage source of 6 V is connected across A and B in Circuit-1, $Q_1 > P_1$.

(D) When a constant current source of 2 Amp is connected across A and B in both circuits, $Q_2 < Q_1$

PCE046

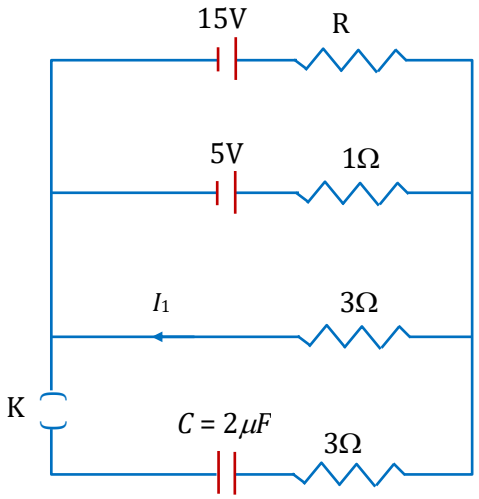
25. In the following circuit $C_1 = 12\ \mu F$, $C_2 = C_3 = 4\ \mu F$ and $C_4 = C_5 = 2\ \mu F$. The Charge stored in C_3 is _____ μC. **[JEE (Advanced) 2022]**



PCP050

26. In a circuit shown in the figure, the capacitor C is initially uncharged and the key K is open. In this condition, a current of 1 A flows through the 1 Ω resistor. The key is closed at time $t = t_0$. Which of the following statement(s) is(are) correct?

[Given: $e^{-1} = 0.36$] **[JEE (Advanced) 2023]**



(A) The value of the resistance R is 3Ω.

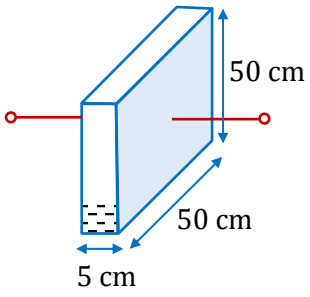
(B) For $t < t_0$, the value of current I_1 is 2A.

(C) At $t = t_0 + 7.2$ μs, the current in the capacitor is 0.6 A.

(D) For $t \to \infty$, the charge on the capacitor is 12 μC.

PCP124

27. A container has a base of 50 cm × 5 cm and height 50 cm, as shown in the figure. It has two parallel electrically conducting walls each of area 50 cm × 50 cm. The remaining walls of the container are thin and non-conducting. The container is being filled with a liquid of dielectric constant 3 at a uniform rate of 250 $cm^3\ s^{-1}$. What is the value of the capacitance of the container after 10 seconds? [Given: Permittivity of free space $\in_0 = 9 \times 10^{-12}\ C^2\ N^{-1}m^{-2}$, the effects of the non-conducting walls on the capacitance are negligible] **[JEE (Advanced) 2023]**



(A) 27 pF (B) 63 pF (C) 81 pF (D) 135 pF

PCP125

JEE (Main) Practice Paper

This paper is for yourself practice and assessment the discussion of this paper is optional though you can see PDF solutions or video solutions or solutions in hardcopy whichever is provided.

SECTION–A

- This section contains **TWENTY** questions.
- Each question has **FOUR** options (1), (2), (3) and (4). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories:

Full Marks : +4, if only the bubble corresponding to the correct option is darkened.
Zero Marks : 0, if none of the bubbles is darkened.
Negative Marks : –1 in all other cases.

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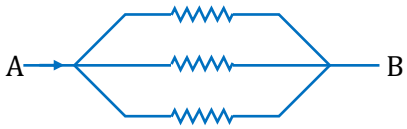
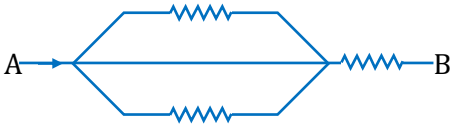
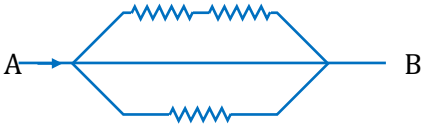
1. Arrange the order of power dissipated in the given circuits, if the same current is passing through all circuits and each resistor is *'r'*

(a) 

(b) 

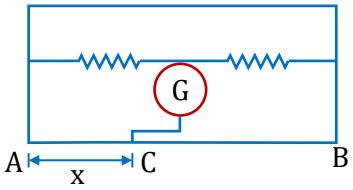
(c) 

(d) 

(1) $P_2 > P_3 > P_4 > P_1$ (2) $P_3 > P_2 > P_4 > P_1$ (3) $P_4 > P_3 > P_2 > P_1$ (4) $P_1 > P_2 > P_3 > P_4$

PCE001

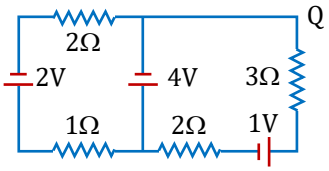
2. In the given circuit, no current is passing through the galvanometer. If the cross-sectional diameter of *AB* is doubled then for null point of galvanometer the value of *AC* would



(1) x (2) $x/2$ (3) $2x$ (4) None

PCE002

3. In the circuit shown, what is the potential difference V_{PQ}?



(1) $+3V$ (2) $+2V$ (3) $-2V$ (4) None

PCE003

4. The variation of current (I) and voltage (V) is parabolic curve shown in figure A. The variation of power P with current I is best shown by which of the following graph

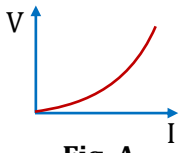
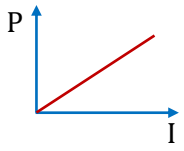
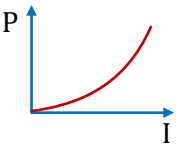
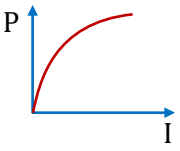
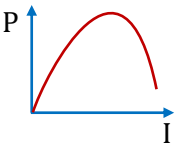


Fig. A

(1) 

(2) 

(3) 

(4) 

PCE004

5. ln a balanced wheat stone bridge, current in the galvanometer is zero. It remains zero when:

(1) battery emf is increased

(2) all resistances are increased by 10 ohms

(3) all resistances are made five times

(4) the battery and the galvanometer are interchanged

(1) Only (1) is correct (2) (1), (2) and (3) are correct

(3) (1), (3) and (4) are correct (4) (1) and (3) are correct

PCE005

6. In a metre bridge experiment, null point is obtained at 20 cm from one end of the wire when resistance X is balanced against another resistance Y. If $X < Y$, then where will be the new position of the null point from the same end, if one decides to balance a resistance of $4X$ against Y?

(1) 50 cm (2) 80 cm (3) 40 cm (4) 70 cm

PCE006

7. A resistance R is to be measured using a meter bridge. Student chooses the standard resistance S to be 100Ω. He finds the null point at $l_1 = 2.9$ cm. He is told to attempt to improve the accuracy. Which of the following is a useful way?

(1) He should measure l_1 more accurately.

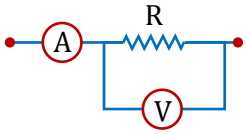
(2) He should change S to 1000Ω and repeat the experiment.

(3) He should change S to 3Ω and repeat the experiment.

(4) He should give up hope of a more accurate measurement with a meter bridge.

PCE007

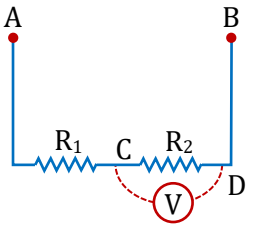
8. In the circuit shown the readings of ammeter and voltmeter are $4A$ and $20V$ respectively. The meters are non ideal, then R is :



(1) 5Ω (2) less than 5Ω (3) greater than 5Ω (4) between 4Ω and 5Ω

PCE008

9. Resistances R_1 and R_2 each 60Ω are connected in series as shown in figure. The Potential difference between A and B is kept 120 volt. Then what will be the reading of voltmeter connected between the point C and D if resistance of voltmeter is 120Ω.

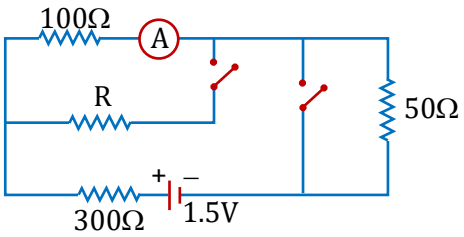


(1) 48 V (2) 24 V

(3) 40V (4) None

PCE009

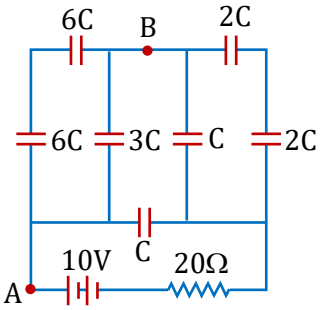
10. In the circuit shown in figure the reading of ammeter is the same with both switches open as with both closed. Then find the resistance R. (Ammeter is ideal)



(1) 300Ω (2) 450Ω (3) 600Ω (4) 650Ω

PCE010

11. For the circuit shown here, the potential difference between points A and B is :-



(1) 2.5 V (2) 7.5 V (3) 10 V (4) Zero

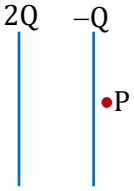
PCP001

12. A parallel-plate capacitor has a plate area of 0.3 m^2 and a plate separation of 0.1 mm. If the charge on each plate has a magnitude of 5×10^{-6} C then the force exerted by one plate on the other has a magnitude of about :

(1) 0 (2) 5 N (3) 1×10^4 N (4) 9×10^5 N

PCP002

13. In the figure shown the plates of a parallel plate capacitor have unequal charges. Its capacitance is 'C'. P is a point outside the capacitor and close to the plate of charge–Q. The distance between the plates is 'd' then which statement is wrong :-



(1) A point charge at point 'P' will experience electric force due to capacitor

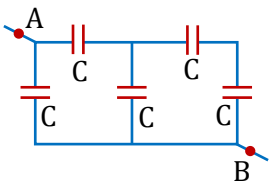
(2) The potential difference between the plates will be $\frac{3Q}{2C}$

(3) The energy stored in the electric field in the region between the plates is $\frac{9Q^2}{8C}$

(4) The force on one plate due to the other plate is $\frac{Q^2}{2\pi \in_0 d^2}$

PCP003

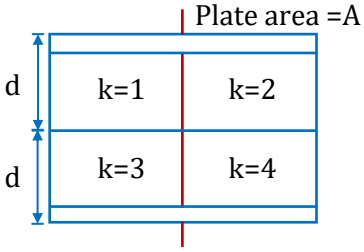
14. What is the equivalent capacitance of the system of capacitors between A and B as shown in the figure.



(1) $\frac{7}{6}C$ (2) 1.6 C (3) C (4) None

PCP004

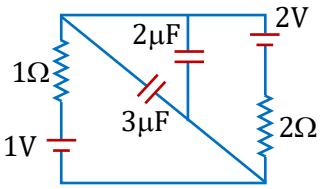
15. Find the capacitance of the system shown in figure.



(1) $\left(\frac{25}{26}\frac{\varepsilon_0 A}{d}\right)$ (2) $\left(\frac{25}{24}\frac{\varepsilon_0 A}{d}\right)$ (3) $\left(\frac{24}{25}\frac{A}{d}\right)$ (4) $\left(\frac{5}{24}\frac{\varepsilon_0 A}{d}\right)$

PCP005

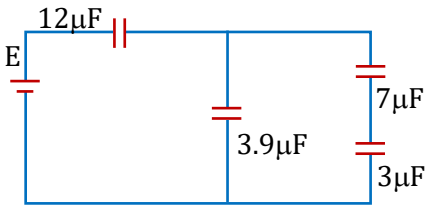
16. In the circuit shown, the charge on the $3\mu F$ capacitor at steady state will be



(1) 6 μC (2) 4 μC (3) $\frac{2}{3}\mu C$ (4) 3 μC

PCP006

17. Four capacitors and a battery are connected as shown. The potential drop across the 7 μF capacitor is 6 V. Then the :



(1) potential difference across the 3 μF capacitor is 10 V

(2) charge on the 3 μF capacitor is 21 μC

(3) e.m.f. of the battery is 30 V

(4) potential difference across the 12 μF capacitor is 12 V.

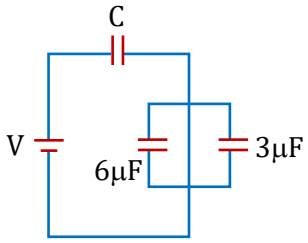
PCP007

18. A 2-μ*F* and a 1-μ*F* capacitor are connected in series and charged by a battery. They store energies *P* and *Q*, respectively. When disconnected and charged separately using the same battery, they store energies *R* and *S*, respectively. Then

(1) $R > P > S > Q$ (2) $P > Q > R > S$ (3) $R > P > Q > S$ (4) $R > S > Q > P$

PCP008

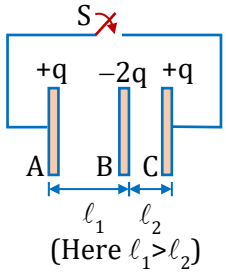
19. If charge on 3μ*F* capacitor is 3μ*C*. Find the charge on capacitor of capacitance *C* in μ*C*.



(1) 3 (2) 6 (3) 9 (4) 12

PCP009

20. Three long conducting plate *A, B* and *C* having charges $+q$, $-2q$ and $+q$ as shown in figure. Here plate *A* and *C* are fixed. If the switch *S* is closed. The middle plate (*B*) will start moving in



(1) Leftward direction (2) Rightward direction

(3) will not move (4) First move leftward & then rightward

PCP010

SECTION–B

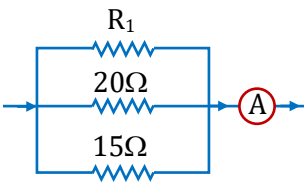
- This section will have **TEN questions**. Candidate can choose to attempt any 5 questions out of these 10 questions. In case if candidate attempts more than 5 questions, first 5 attempted questions will be considered for marking.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value (Answer should be rounded off to the nearest integer).
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+4, if only correct answer is given.
Zero Marks	:	0, if no answer is given.
Negative Marks	:	−1 for incorrect answer.

1. A resistance *R* of thermal coefficient of resistivity = α is connected in parallel with a resistance = 3*R*, having thermal coefficient of resistivity = 2α. Find the value of *k*, if $\alpha_{eff} = \frac{k}{4}\alpha$.

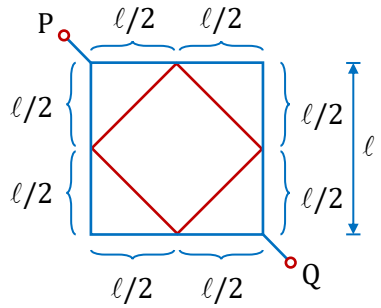
PCE011

2. In the given circuit the current flowing through the resistance 20 ohms is 0.3 ampere while the ammeter reads 0.8 ampere. What is the value (in ohms) of R_1?



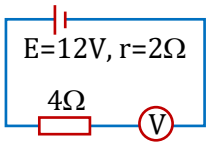
PCE012

3. If the wire has resistivity ρ and cross-sectional area A, the equivalent resistance between P and Q is $\frac{n\rho\ell}{\sqrt{2}A}$, find value of n.



PCE013

4. By error, a student places moving-coil voltmeter V (nearly ideal) in series with the resistance in a circuit in order to read the current, as shown. The voltmeter reading (in V) will be

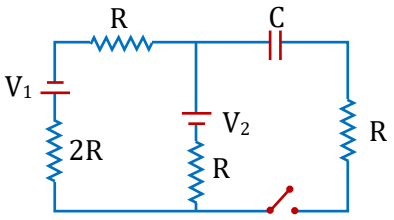


PCE014

5. A capacitor stores $60\mu C$ charge when connected across a battery. When the gap between the plates is filled with a dielectric, a charge of $120\mu C$ flows through the battery. The dielectric constant of the material inserted is :

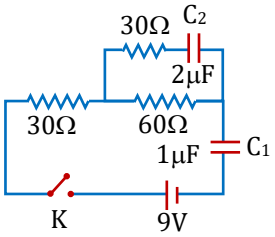
PCP011

6. In the transient circuit shown the time constant of the circuit is $\frac{kRC}{4}$. Find the value of k.



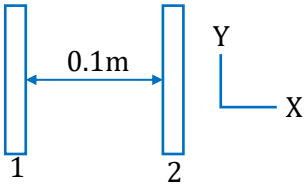
PCP012

7. For the arrangement shown in the figure, the key is closed at $t = 0$. C_2 is initially uncharged while C_1 has a charge of $2\mu C$. The charge on the capacitor C_1 and C_2 is Q_1 and Q_2 respectively in the steady state condition. Find $Q_1 + Q_2$.



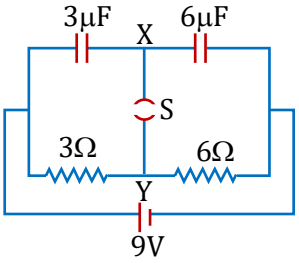
PCP013

8. Two insulating plates are both uniformly charged in such a way that the potential difference between them is $V_2 - V_1 = 20\ V$. (i.e., plate 2 is at a higher potential). The plates are separated by $d = 0.1\ m$ and can be treated as infinitely large. An electron is released from rest on the inner surface of plate 1. What is its speed (in km/s) when it hits plate 2 ? ($e = 1.6 \times 10^{-19}\ C$, $m_0 = 9.11 \times 10^{-31}\ kg$)



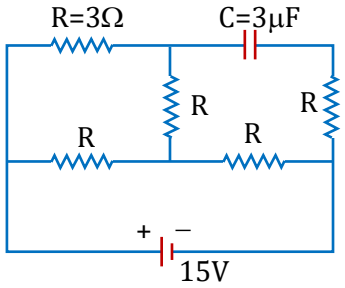
PCP014

9. A circuit is connected as shown in the figure with the switch S open. When the switch is closed, the total amount of charge (in μC) that flows from Y to X is :-



PCP015

10. In the circuit shown, the cell is ideal, with emf = 15 V. Each resistance is of 3Ω. The potential difference (in V) across the capacitor is :-



PCP016

JEE (Advanced) Practice Paper

This paper is for yourself practice and assessment the discussion of this paper is optional though you can see PDF solutions or video solutions or solutions in hardcopy whichever is provided.

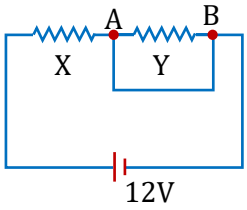
SECTION–I

- This section contains **ELEVEN** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories:

Full Marks : +3 if only the bubble corresponding to the correct option is darkened.
Zero Marks : 0 if none of the bubbles is darkened.
Negative Marks : –1 in all other cases.

---

1. When an ammeter of negligible internal resistance is inserted in series with circuit it reads $1A$. When the voltmeter of very large resistance is connected across X it reads $1V$. When the point A and B are shorted by a conducting wire, the voltmeter measures 10 V across the battery. The internal resistance of the battery is equal to :-



(A) zero (B) 0.5 Ω (C) 0.2 Ω (D) 0.1 Ω

PCE026

2. 2 conducting objects one with charge of $+Q$ and another with $-Q$ are kept on x-axis at $x = 0$ and $x = 1$ respectively. The electric field on the x-axis is given by $3Q\left(x^2+\frac{4}{3}\right)$. If the capacitance of this configuration of objects is C. Then fill $\frac{1}{C}$ (in F^{-1}) in OMR sheet.

(A) 2 (B) 3 (C) 5 (D) 7

PCP028

3. The plates of a parallel plate capacitor are given charges $+4Q$ and $-2Q$. The capacitor is then connected across an uncharged capacitor of same capacitance as first one (= C). Find the final potential difference between the plates of the first capacitor.

(A) $3Q/2C$ (B) $6Q/2C$ (C) $5Q/2C$ (D) $7Q/2C$

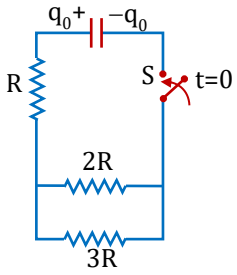
PCP029

4. The plates of a parallel plate capacitor are charged upto 100 volt. A 2 mm thick plate is inserted between the plates, then to maintain the same potential difference, the distance between the capacitor plates is increased by 1.6 mm. Find the dielectric constant of the plate.

(A) 3 (B) 5 (C) 6 (D) 9

PCP030

5. At $t = 0$ charge on capacitor is q_0. Now switch S is closed. Heat loss in $3R$ is $x \times 10^{-6} J$. Then find the value of x. [Given $q_0 = 15\mu C$, $C = 6/55\ \mu F$]



(A) 125 (B) 220 (C) 225 (D) 250

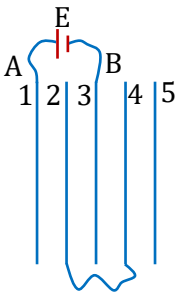
PCP031

6. A parallel plate capacitor is made by stacking n equally spaced plates connected alternatively. If the capacitance between any two adjacent plates is C, then the resultant capacitance is :-

(A) $(n-1)C$ (B) $(n+1)C$ (C) C (D) nC

PCP032

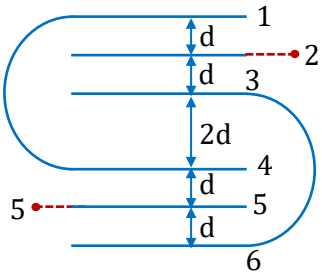
7. Five conducting parallel plates having area A and separation between them d, are placed as shown in the figure. Plate number 2 and 4 are connected by a wire and between points A and B, a cell of emf E is connected. The charge flown through the cell is :-



(A) $\frac{3}{4}\frac{\varepsilon_0 AE}{d}$ (B) $\frac{2}{3}\frac{\varepsilon_0 AE}{d}$ (C) $\frac{4\varepsilon_0 AE}{d}$ (D) $\frac{\varepsilon_0 AE}{2d}$

PCP033

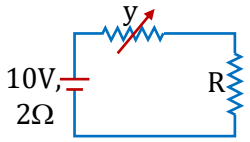
8. There are six plates of equal area A and separation between the plates is d ($d << A$) are arranged as shown in figure. The equivalent capacitance between points 2 and 5, is $\alpha\frac{\in_0 A}{d}$. Then find the value of α.



(A) zero (B) 1 (C) 1.5 (D) 3

PCP034

9. In the figure shown the power generated in y is maximum when $y = 5\Omega$. Then R is :-



(A) 2 Ω (B) 6 Ω (C) 5 Ω (D) 3 Ω

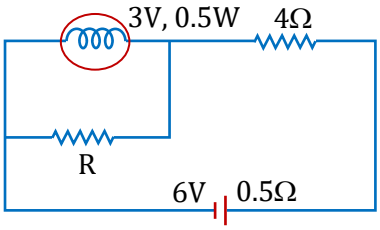
PCP035

10. A rigid container with thermally insulated walls contains a coil of resistance 100 Ω, carrying current 1A. Change in internal energy after 5 min will be

(A) zero (B) 10 kJ (C) 20 kJ (D) 30 kJ

PCE027

11. The value of the resistance R in the circuit shown below so that electric bulb consumes the rated power is :-



(A) 4 ohm (B) 6 ohm (C) 8 ohm (D) 10 ohm

PCP036

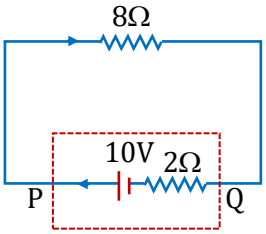
SECTION-II

- This section contains **THREE** questions.
- Each question has **FOUR** options for correct answer(s). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct option(s).
- For each question, choose the correct option(s) to answer the question.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks	: +4	if only (all) the correct option(s) is (are) chosen.
Partial Marks	: +3	if all the four options are correct but ONLY three options are chosen.
Partial Marks	: +2	if three or more options are correct but ONLY two options are chosen, both of which are correct options.
Partial Marks	: +1	if two or more options are correct but ONLY one option is chosen and it is a correct option.
Zero Marks	: 0	if none of the options is chosen (i.e. the question is unanswered).
Negative Marks	: –2	in all other cases.

For Example : If first, third and fourth are the **ONLY** three correct options for a question with second option being an incorrect option; selecting only all the three correct options will result in +4 marks. Selecting only two of the three correct options (e.g. the first and fourth options), without selecting any incorrect option (second option in this case), will result in +2 marks. Selecting only one of the three correct options (either first or third or fourth option), without selecting any incorrect option (second option in this case), will result in +1 marks. Selecting any incorrect option(s) (second option in this case), with or without selection of any correct option(s) will result in –2 marks.

12. A battery of emf 10 volt and internal resistance 2Ω is connected to an external resistance 8Ω as shown in the figure :-



(A) Work done due to conservative electric field while a unit positive charge passes through battery from Q to P (along the arrow) is 8 Joule.

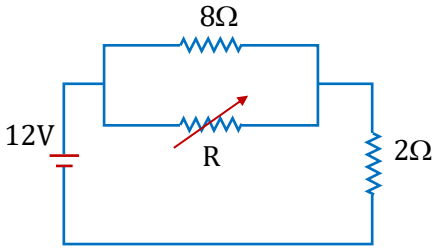
(B) Work done due to conservative electric field while a unit positive charge passes through battery from Q to P (along the arrow) is – 8 Joule.

(C) Work done due to conservative electric field while a unit positive charge passes through 8Ω along the arrow is –8 Joule.

(D) Work done due to non conservative electric field while a unit positive charge moves from Q to P (along the arrow) is 10 Joule.

PCE028

13. The value of the resistance R in figure is adjusted such that power dissipated in the 2Ω resistor is maximum. Under this condition



(A) $R = 0$

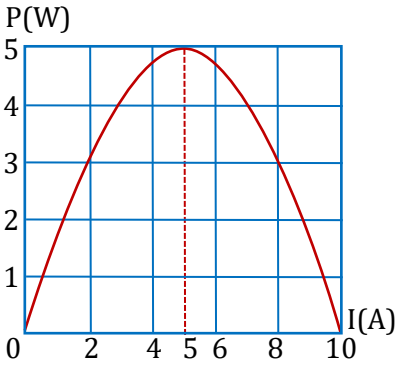
(B) $R = 8\Omega$

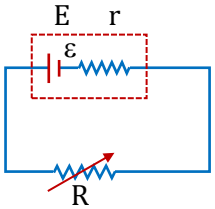
(C) power dissipated in the 2 Ω resistor is 72 W

(D) power dissipated in the 2 Ω resistor is 8 W

PCE029

14. Figure shows the net power dissipated in R versus the current in a simple circuit shown.





(A) The internal resistance of battery is 0.2Ω

(B) The emf of battery is 2V

(C) R at which power is 5W is 2.5 Ω

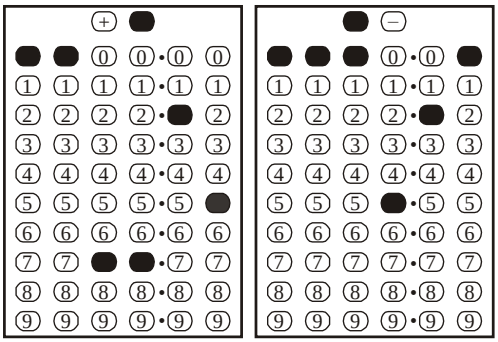
(D) At $i = 2A$, power is 3.2 W

PCE030

SECTION-III

- This section contains **TWO** questions.
- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. 6.25, 7.00, –0.33, –.30, 30.27, –127.30, if answer is 11.36777..... then both 11.36 and 11.37 will be correct) by darken the corresponding bubbles in the ORS.

  For Example : If answer is –77.25, 5.2 then fill the bubbles as follows:



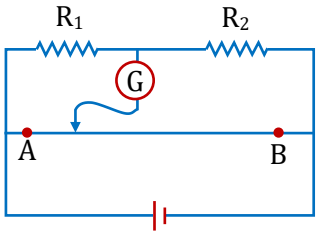
- Answer to each question will be evaluated according to the following marking scheme:

  Full Marks : +3 if ONLY the correct numerical value is entered as answer.

  Zero Marks : 0 in all other cases.

---

15. In the figure shown for which values of R_1 and R_2 the balance point for Jockey is at 40 *cm* from *A*. When R_2 is shunted by a resistance of 10 Ω, balance shifts to 50 *cm*. Find R_2 (in Ω). (AB = 1 *m*):



PCE031

16. If a cell of constant E.M.F. produces the same amount of the heat during the same time in two independent resistors R_1 and R_2, when they are separately connected across the terminals of the cell, one after the another, internal resistance of the cell is $(R_1R_2)^{n/2}$. Find the value of *n*.

PCE032

SECTION–IV

- This section contains **TWO** questions.
- **Each question has matching lists.** The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**.
- For each question, marks will be awarded in one of the following categories:

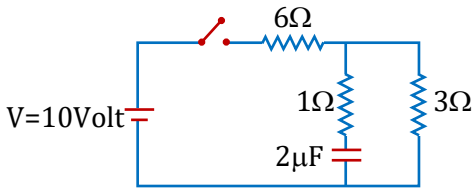
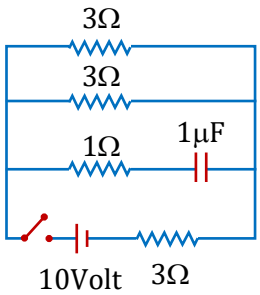
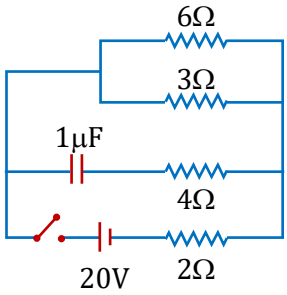
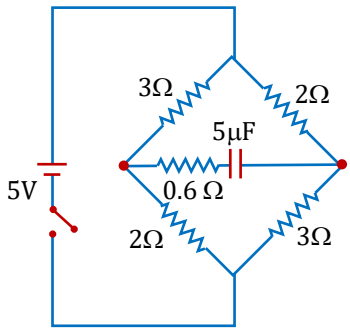
  Full Marks : +3 if only the bubble corresponding to the correct option is darkened.

  Zero Marks : 0 if none of the bubbles is darkened.

  Negative Marks : –1 in all other cases.

---

17. Match the following. In each of the cases shown below, find the time constant of the circuit (in μs) after switch is closed.

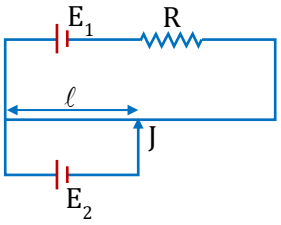
List-I		**List-II**	
(P)		(1)	6
(Q)		(2)	2
(R)		(3)	5
(S)		(4)	15

Codes :

	P	**Q**	**R**	**S**
(A)	1	2	1	4
(B)	3	1	4	2
(C)	1	2	3	4
(D)	2	4	1	3

PCP037

18. In the potentiometer arrangement shown in figure, null point is obtained at length ℓ.



	Column-I		**Column-II**
(A)	If E_1 is increased	(P)	ℓ should increase
(B)	If R is increased	(Q)	ℓ should decrease
(C)	If E_2 is increased	(R)	ℓ should remain the same to again get the null point

(A) (A-P), (B-Q), (C-P)
(B) (A-Q), (B-P), (C-P)
(C) (A-Q), (B-P), (C-R)
(D) (A-P), (B-P), (C-Q)

PCE033

ANSWER KEY

EXERCISE - O

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	D	C	C	D	A	B	A	C	A	A
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	B	C	A	A	D	B	A	A	B	B
Que.	21	22	23	24	25	26	27	28	29	30
Ans.	B	C	B	C	D	A	D	C	C	C
Que.	31	32	33	34	35	36	37	38	39	40
Ans.	A	D	C	B	B	A	A	B	D	C
Que.	41	42	43	44	45	46	47	48	49	50
Ans.	B	B	C	D	B	B	A	A	D	B
Que.	51	52	53	54	55	56	57	58	59	60
Ans.	C	B	C	D	A	D	B	C	ACD	ABCD
Que.	61	62	63	64	65	66	67	68	69	70
Ans.	BC	AD	AB	BCD	ACD	BD	BC	AB	BD	ABD
Que.	71	72	73	74	75	76	77	78	79	
Ans.	BCD	B	A	B	A	D	B	AC	D	

EXERCISE - S

1. (a) $J_0A/3$; (b) $2J_0A/3$

2. $\frac{1}{R}=\frac{\pi r^2}{3l}(2\sigma_2+\sigma_1)$

3. 3.5 A

4. $x=\frac{4}{3}V, 12\frac{1}{3}V, \frac{1}{15}A$

5. $4A$

6. 25

7. $12A, -20W$

8. $R_1 = 0.0278\ \Omega, R_2 = 0.25\ \Omega, R_3 = 2.5\ \Omega$

9. (i) 1.01Ω (ii) 0-5 A, 0-10V, (iii) 0.05 A

10. (a) $+ve, E_1 > E$ (b) $-ve$

11. 4

12. 2

13. 5

14. $\frac{32}{23}\mu F$

15. 12 μC

16. 30 V

17. (a) $\frac{100}{7}$ volts; (b) 28.56 μC, 42.84 μC, 71.4 μC, 22.88 μC

18. 30

19. 2.5 Kv

20. $Q_A = 90\ \mu C, Q_B = 150\ \mu C, Q_C = 210\ \mu C, U_i = 47.4\ mJ, U_f = 18mJ$

21. 16

22. 6

23. 300

24. 3

25. $\Delta q=\frac{1}{2}CE\frac{K-1}{K+1}$

26. $dC_{net}=\frac{\varepsilon_0 a k_1 k_2}{(k_1-k_2)\frac{d}{a}}\log\left(\frac{k_1}{k_2}\right)$

27. $M=\frac{\varepsilon_0 bV^2(k-1)}{2dg}$

28. $\frac{V_1}{V_2}=\frac{\sqrt{k_2-1}}{\sqrt{k_1-1}}$

29. $8.37W$

30. 18

31. $E = 1.59 \times 10^{15}J$

32. $q_1 = 2\times10^{-6}C, q_2 = 8\times10^{-6}C, q_3 = 9\times10^{-6}C, q_4 = 12\times10^{-6}C$

33. 750

34. 225

35. $Q_0 = \frac{CVR_2}{R_1+R_2}$ and $\alpha = \frac{R_1+R_2}{CR_1R_2}$

36. (a) $Q = \frac{CV}{2}\left(1-e^{-2t/3RC}\right)$ (b) $i = \frac{V}{2R} - \frac{V}{6R}e^{-2t/3RC}, \frac{V}{2R}$

EXERCISE - JEE (Main) PYQ

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	3	1	1	4	4	2	3	3	1	1
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	2	4	4	2	4	4	3	1	1	3
Que.	21	22	23	24	25					
Ans.	4	20	25	5	3					

EXERCISE - JEE (Advanced) PYQ

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	ABD	5	AD	B	1	C	B	A	ABCD	BC
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	A	A	1.50	AC	CD	0.99 to 1.01	AC	0.27	3	1.33
Que.	21	22	23	24	25	26	27			
Ans.	0.67	ABCD	5	ABC	8	ABCD	B			

JEE (Main) Practice Paper

	Q.	1	2	3	4	5	6	7	8	9	10
Section-A	A.	1	1	2	2	3	1	3	3	1	3
	Q.	11	12	13	14	15	16	17	18	19	20
	A.	1	2	4	2	2	2	3	4	3	2
Section-B	Q.	1	2	3	4	5	6	7	8	9	10
	A.	5	60	1	12	3	7	9	2650	27	12

JEE (Advanced) Practice Paper

	Q.	1	2	3	4	5	6	7	8
Section-I	A.	C	C	A	B	C	A	B	B
	Q.	9	10	11					
	A.	D	D	B					
Section-II	Q.	12	13	14					
	A.	BD	AC	ABD					
Section-III	Q.	15	16						
	A.	5	1						
Section-IV	Q.	17	18						
	A.	C	B						