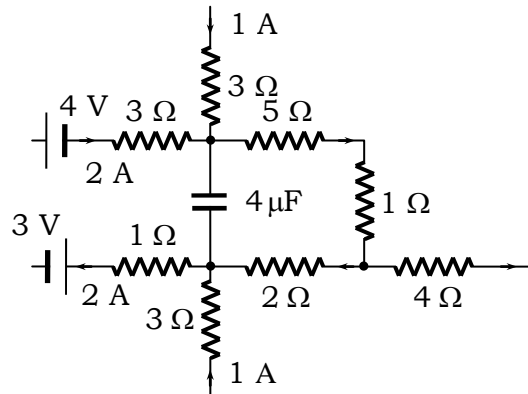


ASSIGNMENT ON ELECTRIC CIRCUITS

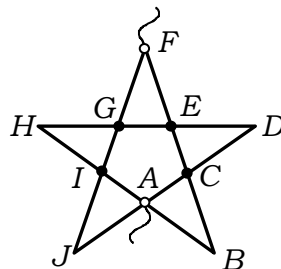
1. A part of a circuit in the steady state with the currents flowing in the branches, the value of resistance are shown in the figure. Calculate the energy stored in the capacitor.



Answer : 800 μJ

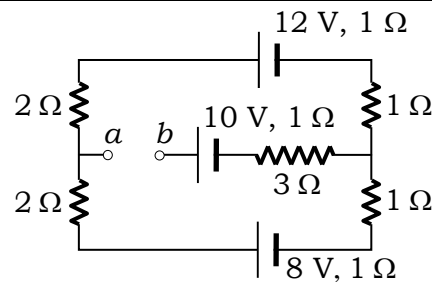
2. A battery of N cells is such that when they are arranged in m rows each of n cells in series the current is maximum for a given external circuit. Instead if the cells are arranged in n parallel sets containing m cells in series, show that the current through the same external circuit is given $I' = \frac{I}{\frac{(m+n)^2}{2N} - 1}$ where I is the maximum current in the first case.

3. A five-pointed regular star figure has been soldered together from uniform wire. The resistance of the section AB is r . Find the resistance of the circuit between the terminals A and F .



Answer : $r \left(\frac{1}{2} + \frac{2 \cos 72}{1 + \cos 72} \right) = 0.972r$

4. Six equal wires each of resistance R are joined so as to form the regular tetrahedron. Find the equivalent resistance between any two vertices.
- Answer :** $\frac{R}{2}$
5. Find the potential difference between the points a and b . If the points a and b are joined by a resistance of 5Ω , calculate the current through this resistance.

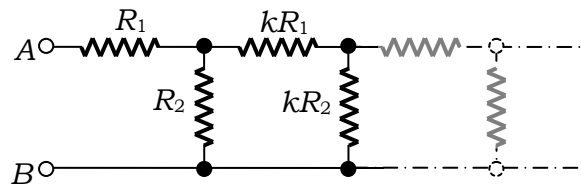


Answer : $V_a - V_b = 2 \text{ V}$, 0 amp

6. An electric kettle has two heating-coils. When one of the coils is switched on, the water in the kettle boils in 6 minutes, and when the other is switched on, the water boils in 8 minutes. In what time will the water boil if both coils are switched on simultaneously (i) in series, (ii) in parallel?

Answer : a) 14 min, b) $\frac{24}{7}$ min

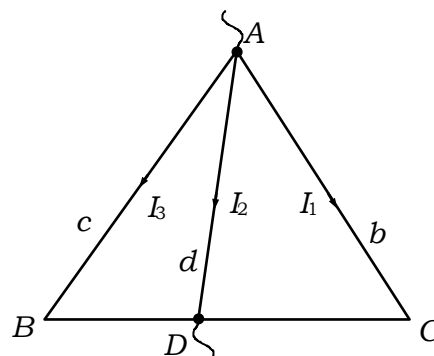
7. The circuit diagram shown in figure consists of a very large (almost infinite) number of elements. The resistance of the resistors in each subsequent element differ by a factor of k from the resistance of the resistors in the previous elements. Determine the resistance R_{AB} if the resistance of the first element are R_1 and R_2 .



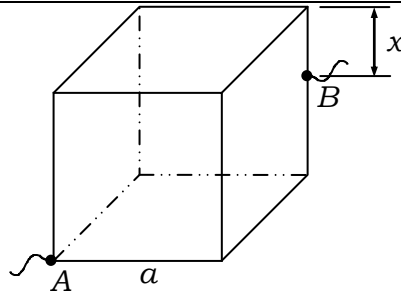
Answer : $R_{eq} = \frac{\{(k-1)R_2 + R_1\} + \sqrt{\{(k-1)R_2 + R_1\}^2 + 4kR_1R_2}}{2k}$

8. The resistance of three wires BC , CA , and AB of same material and uniform cross section are a , b and c respectively. Another wire from A of constant resistance d can make a sliding contact with BC . If a current enters at A and leaves at the point of contact with BC , show that the maximum resistance of network is

$$\frac{(a+b+c)d}{a+b+c+4d}$$



9. A cubical wire frame of side a is made of a uniform resistance wire of resistance per unit length λ . calculate its resistance between one of its vertices and at point on the opposite side at a distance x from one end of that side as shown in the adjacent diagram.

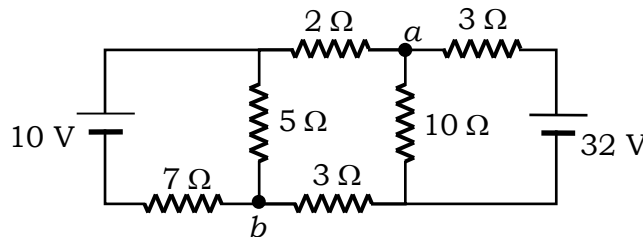


Answer : $R_{eq} = \frac{(10a^2 + 4ax - 5x^2)\lambda}{12a}$

10. A resistor is in the shape of a truncated right circular cone. The end radii are a and b , the length of the frustum is l . If the taper is small so that we can assume uniform current density at any cross-section. Calculate the potential difference applied across the conductor that can maintain a current i through the conductor. The specific resistance of material of the conductor is ρ .

Answer : $V = \frac{\rho li}{\pi ab}$

11. Six resistors and two sources of e.m.f. of negligible internal resistance are connected as shown in the figure. Find the potential difference between the points a and b .

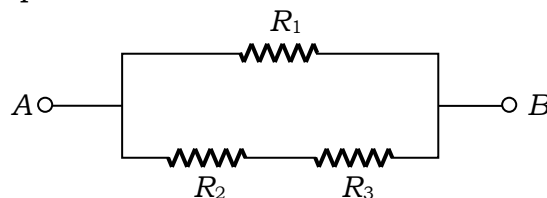


Answer : $V_a - V_b = 14 \text{ V}$

12. A long round conductor of cross-sectional area S is made of material whose resistivity depends only on a distance r from the axis of the conductor as $\rho = \frac{\alpha}{r^2}$, where α is a constant. Find
 a) the resistance per unit length of such a conductor;
 b) the electric field strength in the conductor due to which a current I flows through it.

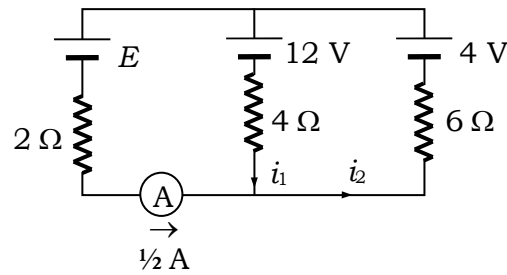
Answer :

13. Three resistors R_1 , R_2 and R_3 with their respective temperature coefficients α_1 , α_2 and α_3 are connected as shown in the adjoining diagram. What will be the equivalent temperature coefficient of the circuit between the terminals A and B for small variation of temperature.



Answer : $\alpha_{eq} = \frac{R_1(R_2 + R_3)}{R_1 + R_2 + R_3} \left\{ \frac{\alpha_1}{R_1} + \frac{\alpha_2 R_2 + \alpha_3 R_3}{(R_2 + R_3)^2} \right\}$

14. For the circuit shown in figure, find the voltage of the unknown battery E and currents i_1 and i_2 . The ammeter, represented by the symbol $\text{---}(\text{A})\text{---}$ can be considered perfect and it reads the current in the wire to be $\frac{1}{2}$ amp in the direction shown.



Answer : $i_1 = -1.1$ amp, $i_2 = -0.6$ amp, $E = 6.6$ V

15. A battery of emf 1.4 V and internal resistance 2Ω is connected to a resistor of 100Ω resistance through an ammeter. The resistance of the ammeter is $\frac{4}{3}\Omega$. A voltmeter has also been connected to find the potential difference across the resistor.

- a) The ammeter reads 0.02 A, what is the resistance of the voltmeter?
 b) The voltmeter reads 1.10 V, what is the error in the readings?

Answer :

16. A fuse made of lead wire has an area of cross-section 0.2 mm^2 . Current in the fuse wire reaches 30 A on short-circuiting. How long after the short-circuiting, will the fuse begin to melt? For lead, the specific heat = $0.032 \text{ cal g}^{-1} \text{ }^\circ\text{C}^{-1}$, melting point = $327 \text{ }^\circ\text{C}$, density = 11.34 g cm^{-3} and the resistivity = $22 \times 10^{-6} \Omega \text{ cm}$. The initial temperature of the wire is 20°C . Neglect heat losses.

Answer :

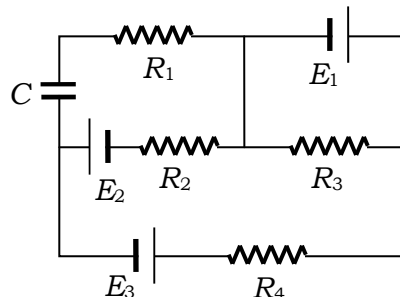
17. In the given circuit

$$E_1 = 3E_2 = 2E_3 = 6 \text{ Volt}$$

$$R_1 = 2R_4 = 6\Omega$$

$$R_3 = 2R_2 = 4\Omega$$

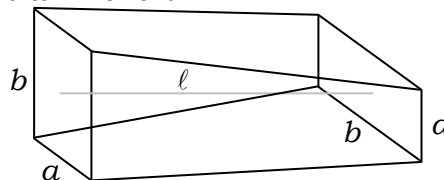
$$C = 5 \mu\text{F}$$



Find the current in R_3 and the energy stored in the capacitor.

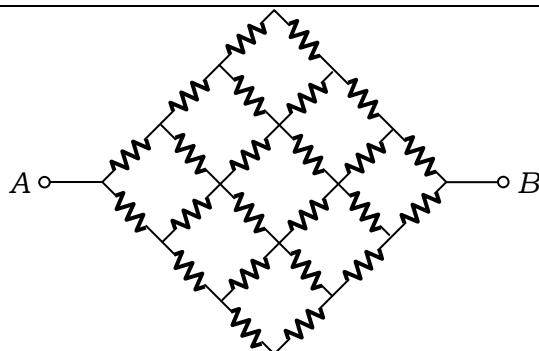
Answer : 1.5 amp, $14.4 \mu\text{J}$

18. Find the resistance of the conductor shown in the following figure. Length of the conductor along the central line is ℓ



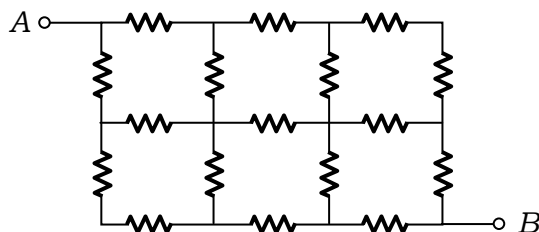
Answer : $R = \frac{2\rho\ell}{(b^2 - a^2)} \ln\left(\frac{b}{a}\right)$

19. Find the equivalent resistance of the resistive network in the following diagram. Given resistance in each branch is r .



Answer : $\frac{13}{7}r$

20. Find the equivalent resistance of the resistive network in the following diagram. Given resistance in each branch is r .



Answer : $\frac{121}{69}r$