Physics · Electric Current and Electromagnetism · Electric Current, Ohm's Law and Kirchhoff's Laws

Kirchhoff's Laws

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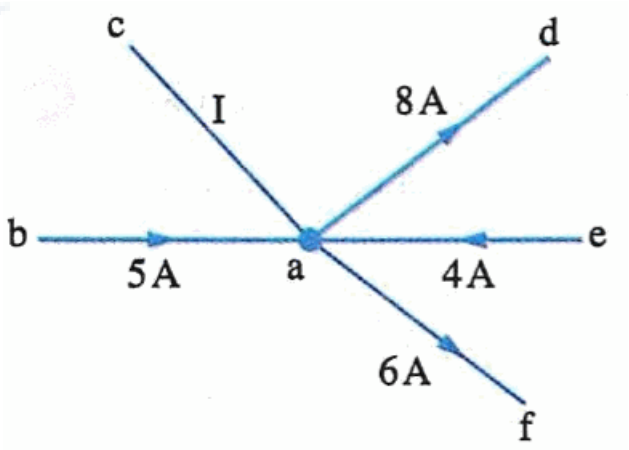
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Multiple choice questions — 81 questions

1 In the electric network shown, ...



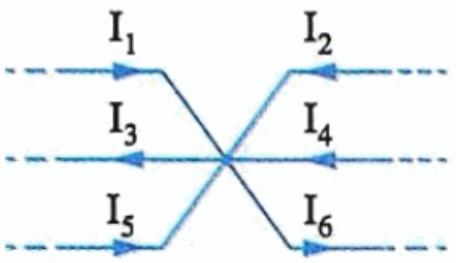
(A) the current (I) = 3 A, and its direction is from a to c

(B) the current (I) = 3 A, and its direction is from c to a

(C) the current (I) = 5 A, and its direction is from a to c

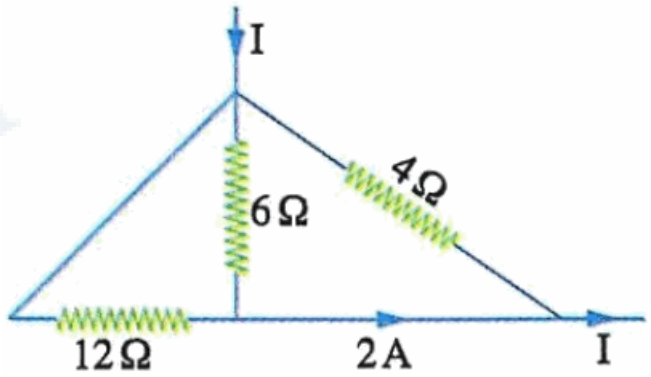
(D) the current (I) = 5 A, and its direction is from c to a

2 In the opposite figure, if $I_1 = I_2 = I_3 = I_4 = I_5$, then I_6 equals .....



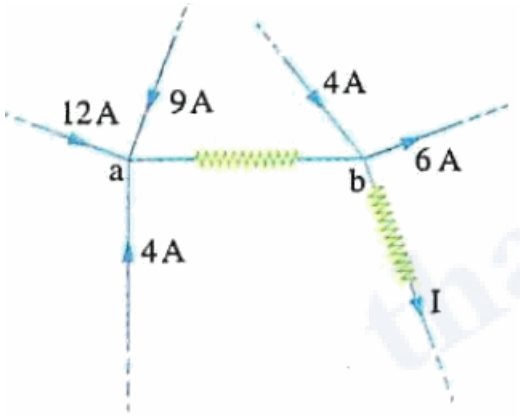
(A) I_1 (B) $2\,I_1$ (C) $3\,I_1$ (D) $4\,I_1$

3 In the figure shown, the value of I is .....



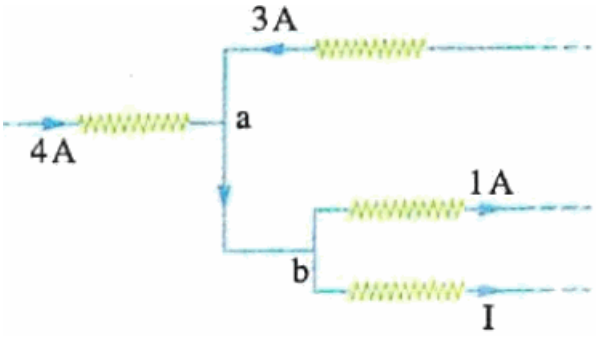
(A) 2 A (B) 4 A (C) 6 A (D) 12 A

4 The opposite figure represents part of an electric circuit, so the value of I is .....



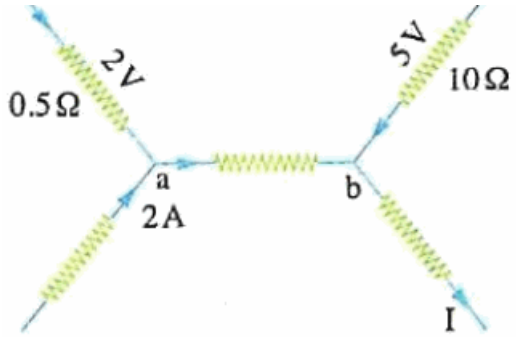
(A) 19 A (B) 23 A (C) 27 A (D) 31 A

5 The opposite figure represents part of an electric circuit, so the value of I is .....



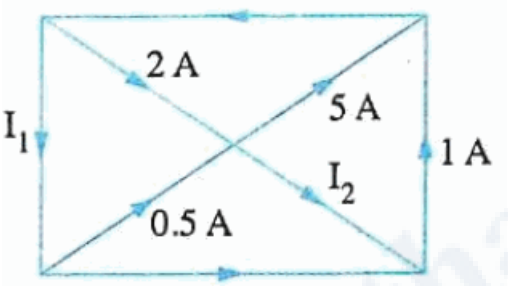
(A) 2 A (B) 4 A (C) 6 A (D) 8 A

6 The opposite figure represents part of an electric circuit, so the value of I is .....



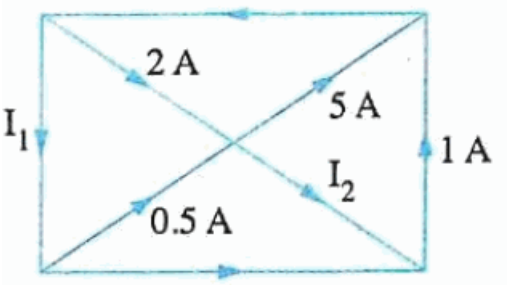
(A) 2.5 A (B) 3.5 A (C) 6.5 A (D) 7.5 A

7 In the opposite figure:
the current I_1 is .....



(A) -2.5 A (B) 3.5 A (C) 4 A (D) 6 A

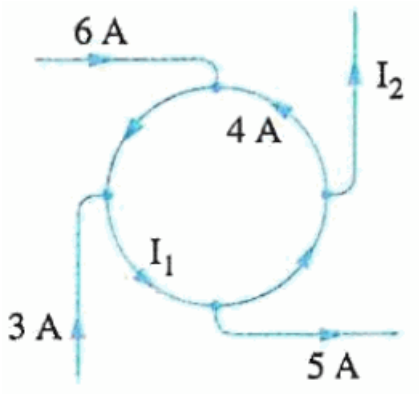
8 In the opposite figure:
the current I_2 is .....



(A) -2.5 A (B) 3.5 A (C) 4 A (D) 6 A

9 A metal ring is connected in an electric circuit and currents flow through it as in the opposite figure, so:

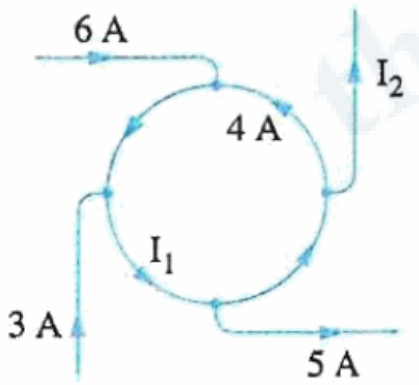
the current I_1 is .....



(A) 0 (B) 4 A (C) 9 A (D) 13 A

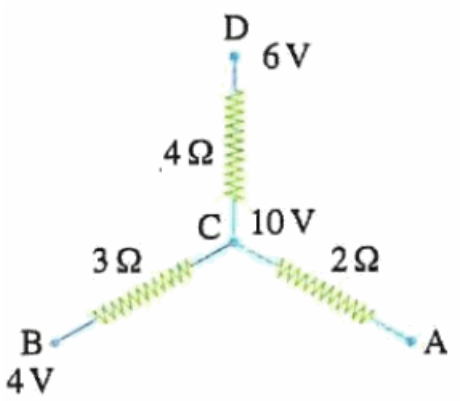
10 A metal ring is connected in an electric circuit and currents flow through it as in the opposite figure, so:

the current I_2 is .....



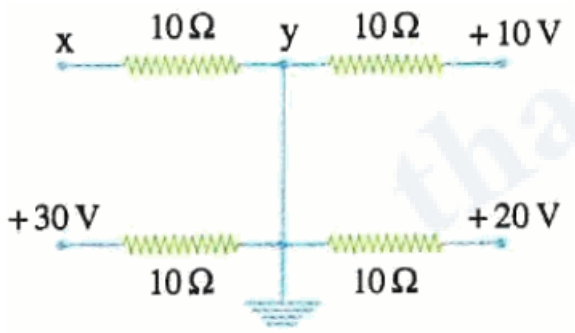
(A) 2 A (B) 4 A (C) 9 A (D) 12 A

11 In the opposite figure, if the potentials of points B, C, D are: potential of B = 4 V, potential of C = 10 V and potential of D = 6 V, then the potential of point A equals .....



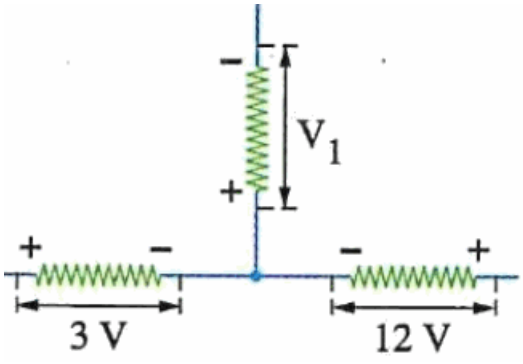
(A) 4 V (B) 8 V (C) 12 V (D) 16 V

12 The opposite figure is part of an electric circuit showing the potential of some points, so the current flowing between the two points (x), (y) shown on the figure equals .....



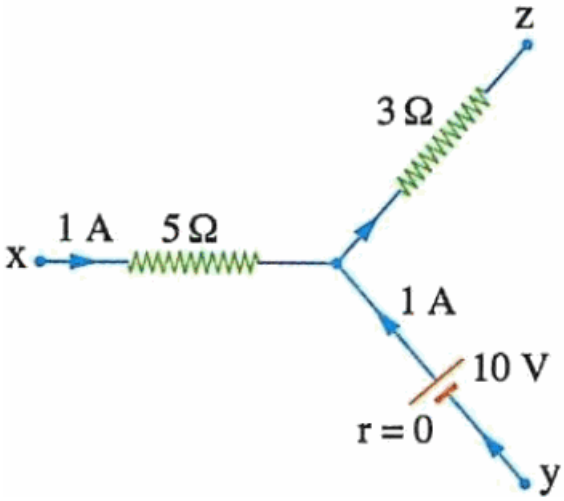
(A) 1 A (B) 4 A (C) 5 A (D) 6 A

13 The opposite figure represents part of a closed electric circuit. If each resistance is 3 Ω, the value of V_1 is .....



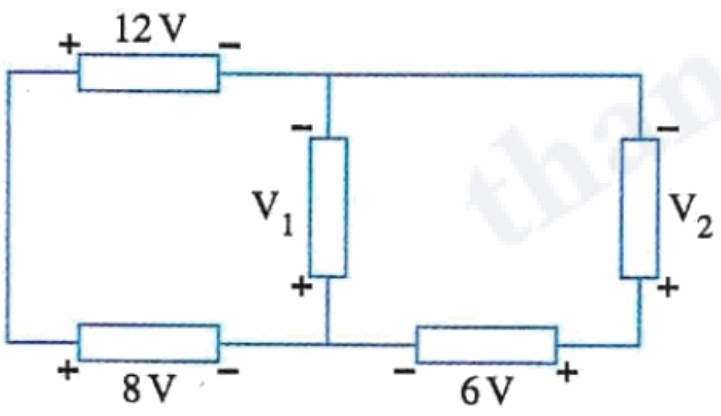
(A) 10 V (B) 20 V (C) 15 V (D) 12 V

14 In the opposite figure, the correct order of the potentials at points x, y, z is .....



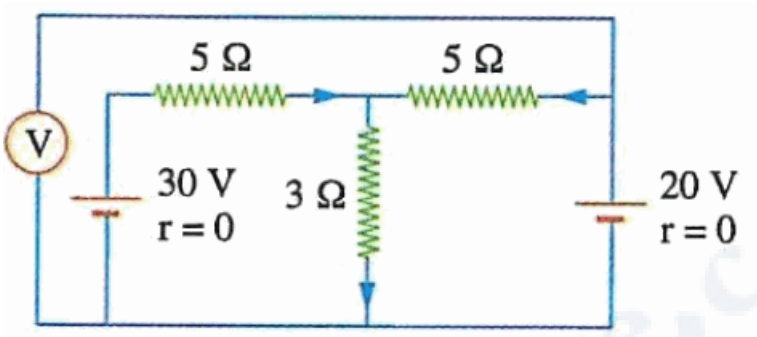
(A) $V_x > V_y > V_z$ (B) $V_y > V_x > V_z$ (C) $V_z > V_x > V_y$ (D) $V_x > V_z > V_y$

15 In the circuit shown, the values are .....



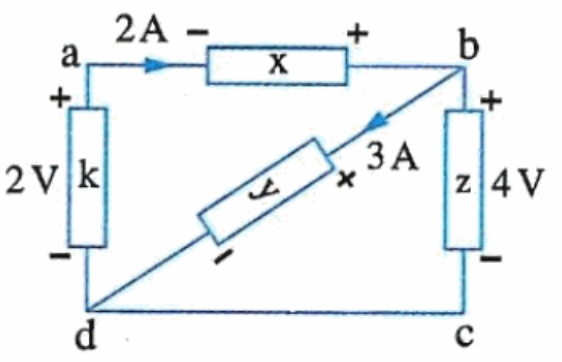
(A) $V_1 = 4$ V, $V_2 = 10$ V (B) $V_1 = 4$ V, $V_2 = 7$ V
(C) $V_1 = 10$ V, $V_2 = 10$ V (D) $V_1 = 10$ V, $V_2 = 7$ V

16 In the electric circuit shown, the voltmeter reading is .....



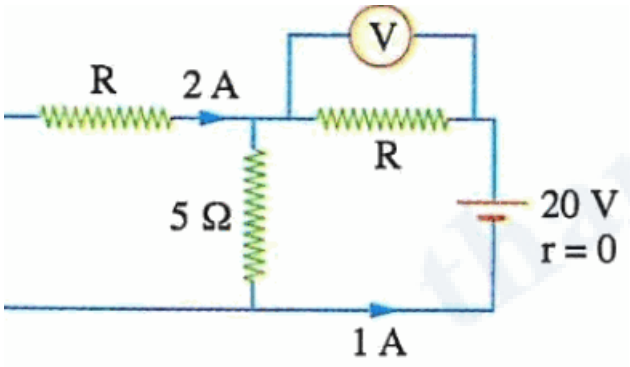
(A) 20 V (B) 15 V (C) 5 V (D) 0

17 In the circuit shown, the values of the power $(P_w)_x$, $(P_w)_y$ are .....



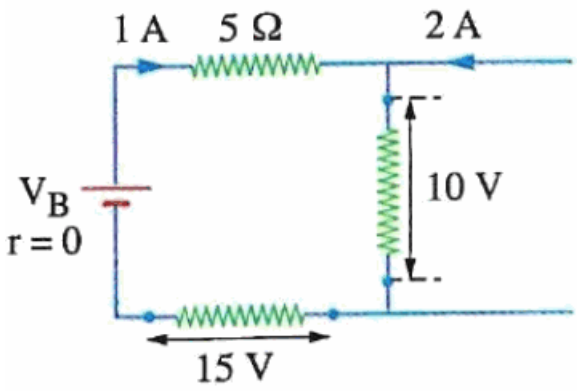
(A) $(P_w)_x$ = 4 W, $(P_w)_y$ = 12 W
(B) $(P_w)_x$ = 12 W, $(P_w)_y$ = 4 W
(C) $(P_w)_x$ = 16 W, $(P_w)_y$ = 12 W
(D) $(P_w)_x$ = 4 W, $(P_w)_y$ = 14 W

18 The opposite figure represents part of an electric circuit, so the voltmeter reading is .....



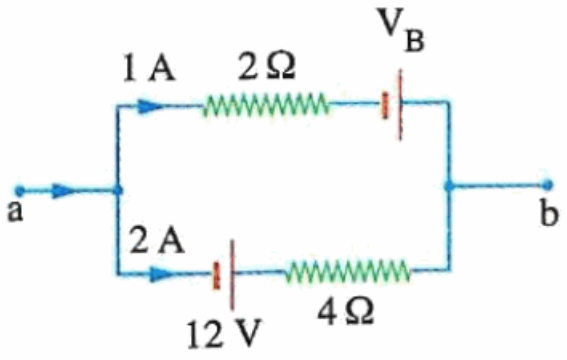
(A) 20 V
(B) 15 V
(C) 5 V
(D) 1 V

19 The opposite figure represents part of an electric circuit carrying an electric current, so the value of V_B is .....



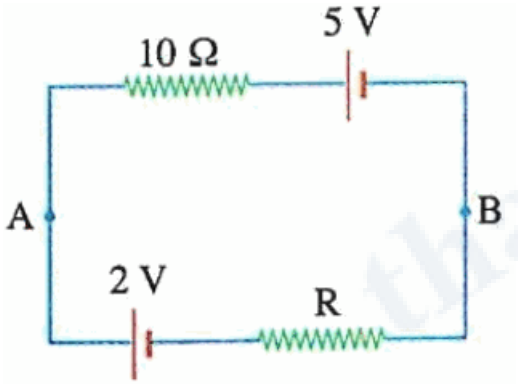
(A) 20 V
(B) 30 V
(C) 40 V
(D) 50 V

20 The opposite figure represents part of an electric circuit, so the emf V_B equals .....



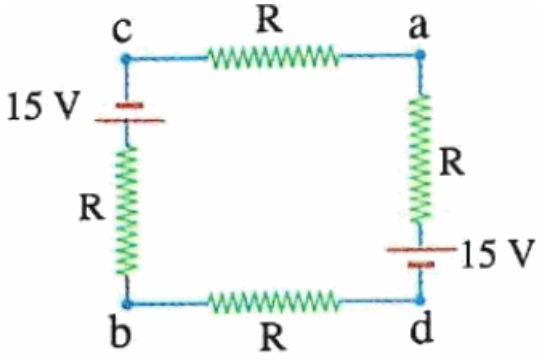
(A) 3 V (B) 4 V (C) 6 V (D) 8 V

21 In the electric circuit shown in the figure, if the potential difference between points A, B is 4 V, then the resistance R equals .....



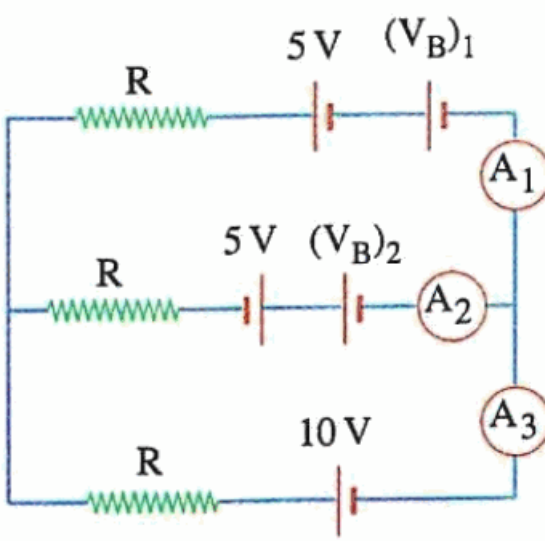
(A) 5 Ω (B) 10 Ω (C) 15 Ω (D) 20 Ω

22 In the circuit shown in the figure, if R = 7.5 Ω, then the potential difference between points a, b equals .....



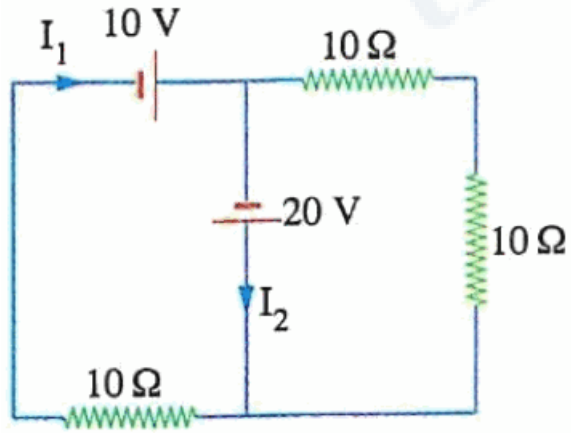
(A) 0 (B) 5 V (C) 10 V (D) 15 V

23 In the opposite electric circuit, if the reading of each of the three ammeters is zero and all batteries have negligible internal resistance, then the two emfs $(V_B)_1$, $(V_B)_2$ are .....



(A) $(V_B)_1$ = 5 V, $(V_B)_2$ = 10 V
(B) $(V_B)_1$ = 10 V, $(V_B)_2$ = 5 V
(C) $(V_B)_1$ = 5 V, $(V_B)_2$ = 15 V
(D) $(V_B)_1$ = 15 V, $(V_B)_2$ = 5 V

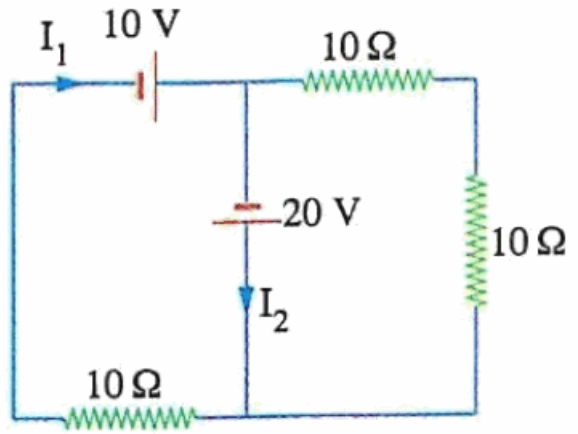
24 In the opposite electric circuit:
the current I_1 equals .....



(A) 1 A
(B) 2 A
(C) 3 A
(D) 4 A

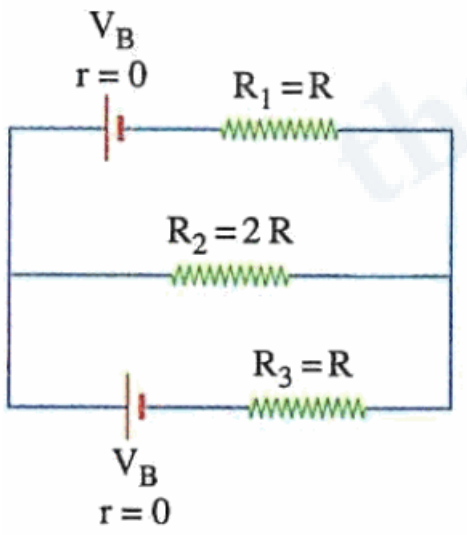
25 In the opposite electric circuit:

the current I_2 equals .....



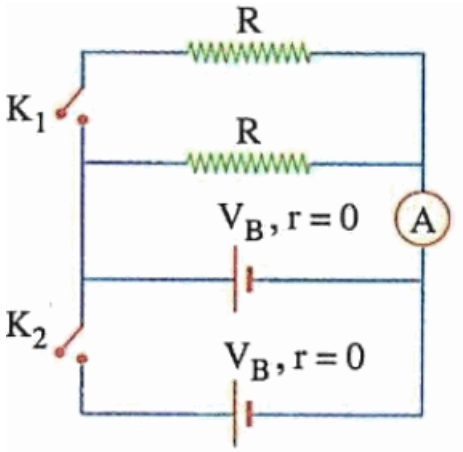
(A) 1 A (B) 2 A (C) 3 A (D) 4 A

26 The opposite figure shows a closed electric circuit. The resistance carrying the largest current is .....



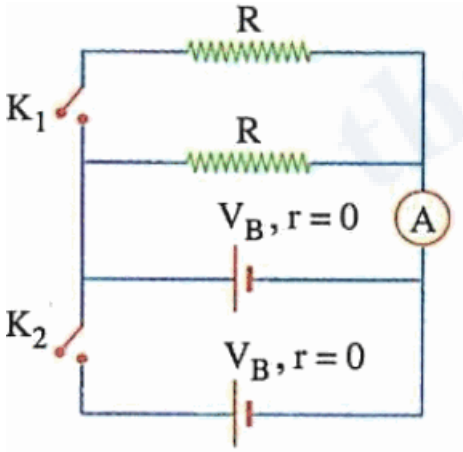
(A) R_1 (B) R_2 (C) R_3 (D) R_1, R_2

27 In the opposite electric circuit, if the ammeter reading is (I), then its reading when: only switch (K_1) is closed is .....



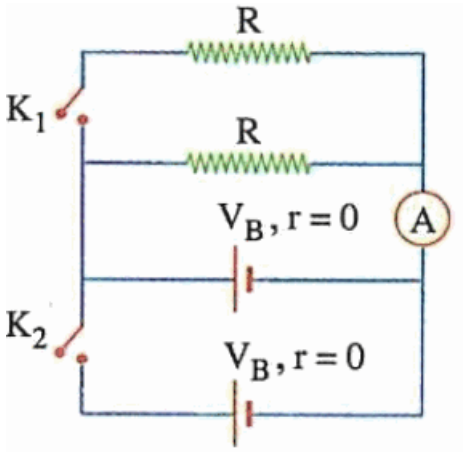
(A) I (B) $I/2$ (C) 2I (D) 4I

28 In the opposite electric circuit, if the ammeter reading is (I), then its reading when: only switch (K_2) is closed is .....



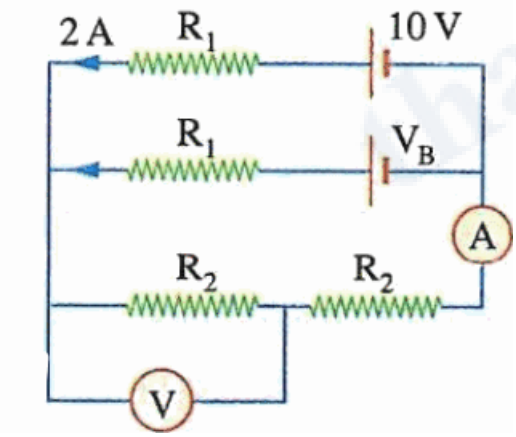
(A) I (B) $I/2$ (C) 2I (D) 4I

29 In the opposite electric circuit, if the ammeter reading is (I), then its reading when: both switches (K_1), (K_2) are closed is .....



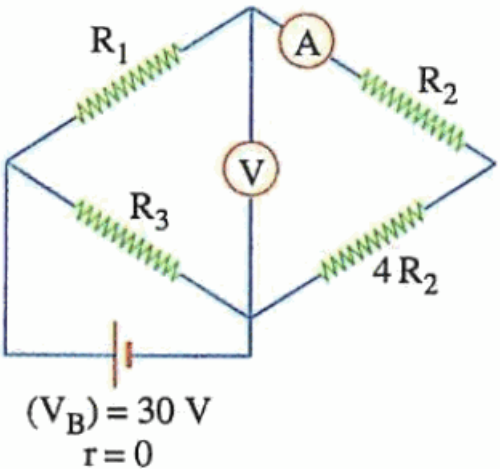
(A) I (B) $I/2$ (C) 2I (D) 4I

30 In the circuit shown, if the ammeter reading is 4 A and the voltmeter reading is 3 V, then the emf (V_B) equals .....



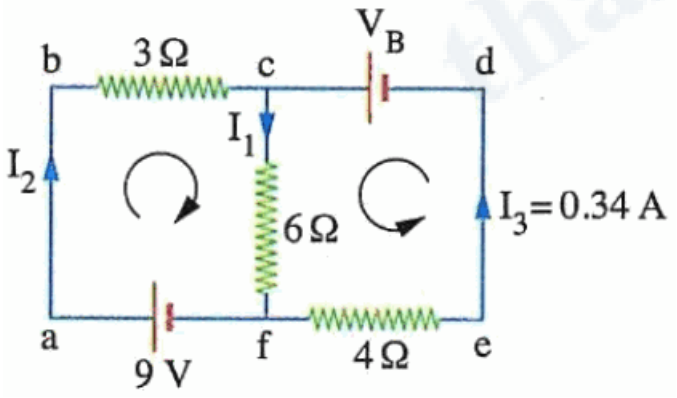
(A) 4 V (B) 6 V (C) 10 V (D) 14 V

31 In the opposite electric circuit, if the ammeter reading is 1 A and the voltmeter reading is 10 V, then the two resistances (R_1), (R_2) are .....



(A) $R_1 = 10\ \Omega, R_2 = 5\ \Omega$
(B) $R_1 = 30\ \Omega, R_2 = 2\ \Omega$
(C) $R_1 = 20\ \Omega, R_2 = 10\ \Omega$
(D) $R_1 = 20\ \Omega, R_2 = 2\ \Omega$

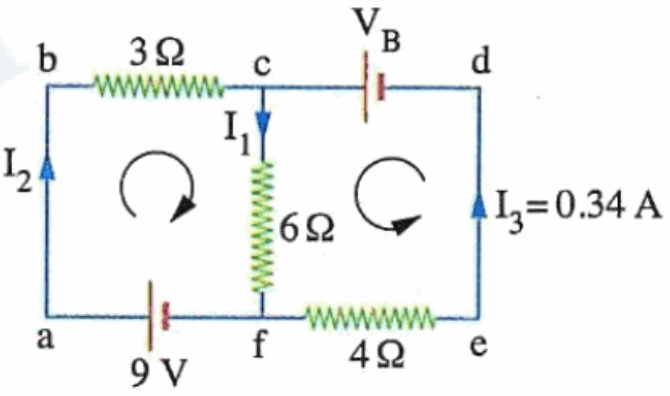
32 From the opposite circuit:
the current I_1 equals .....



(A) 4.01 A
(B) 8.02 A
(C) 0.77 A
(D) 1.11 A

33 From the opposite circuit:

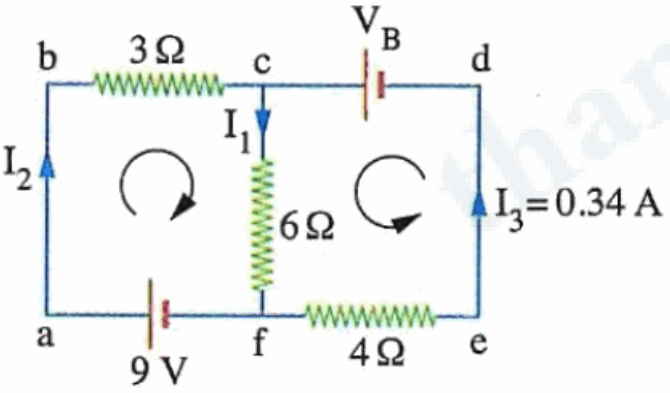
the current I_2 equals .....



(A) 0.77 A (B) 4.01 A (C) 8.02 A (D) 1.11 A

34 From the opposite circuit:

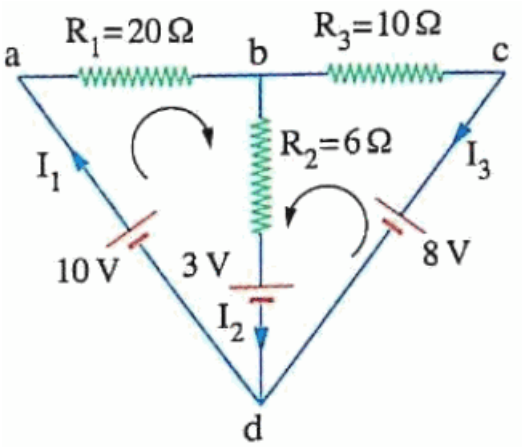
the emf V_B equals .....



(A) 2.01 V (B) 4.03 V (C) 6.01 V (D) 8.02 V

35 From the electric circuit shown:

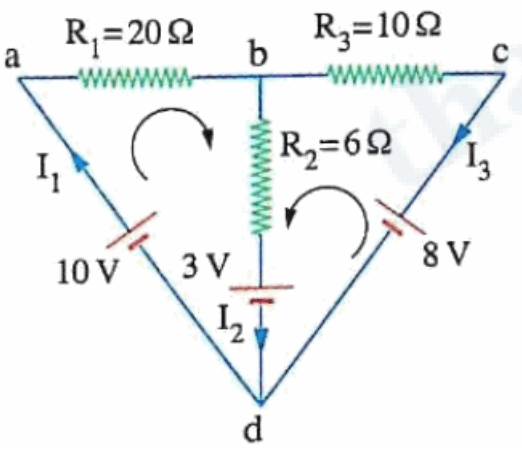
the current through resistor R_1 is .....



(A) 0.22 A (B) -0.23 A (C) 0.45 A (D) 0.53 A

36 From the electric circuit shown:

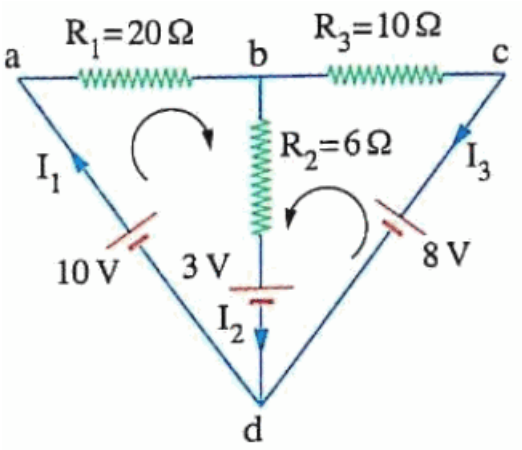
the current through resistor R_2 is .....



(A) 0.22 A (B) -0.23 A (C) 0.45 A (D) 0.53 A

37 From the electric circuit shown:

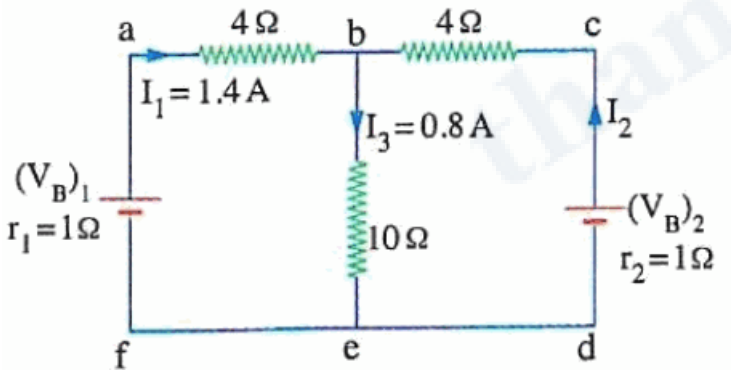
the current through resistor R_3 is .....



(A) 0.22 A (B) -0.23 A (C) 0.45 A (D) 0.53 A

38 From the circuit shown in the figure:

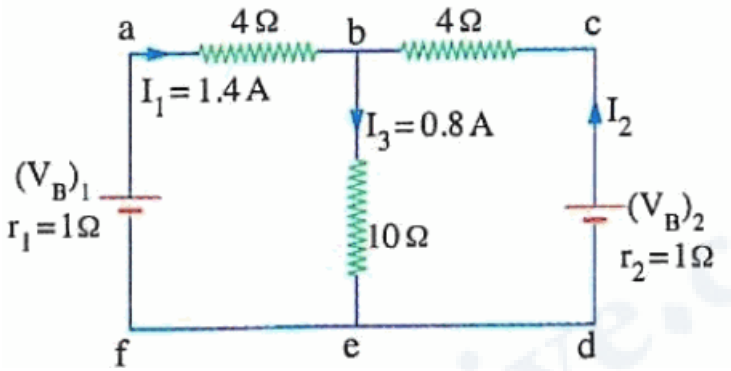
the emf $(V_B)_1$ is .....



(A) 5 V (B) 8 V (C) 15 V (D) 20 V

39 From the circuit shown in the figure:

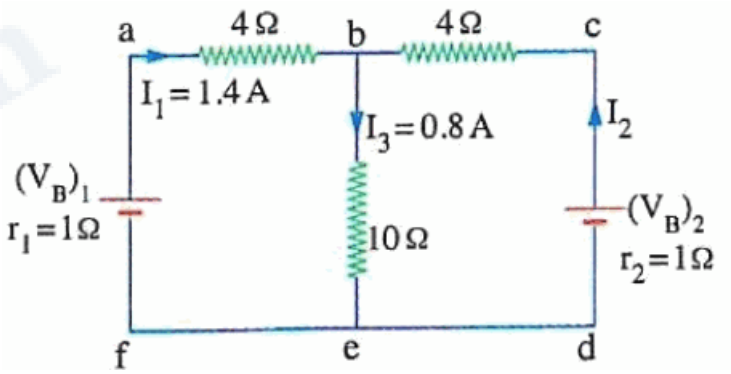
the emf $(V_B)_2$ is .....



(A) 5 V (B) 8 V (C) 10 V (D) 12 V

40 From the circuit shown in the figure:

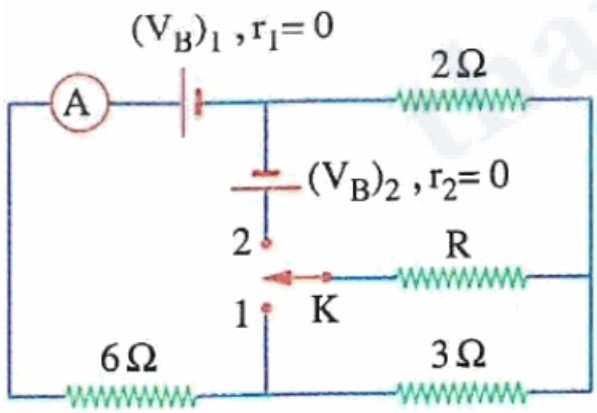
the potential difference between points b, e is .....



(A) 5 V (B) 6 V (C) 7 V (D) 8 V

41 In the opposite electric circuit, the ammeter reads 2 A. When switch K is closed at position (1), the ammeter reads 2.2 A, and when switch K is closed at position (2), the ammeter reads 1.81 A, so:

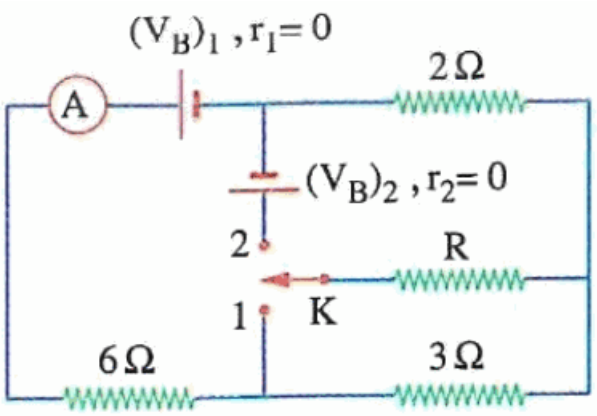
the emf of the battery $(V_B)_1$ is .....



(A) 20 V (B) 22 V (C) 18 V (D) 16 V

42 In the opposite electric circuit, the ammeter reads 2 A. When switch K is closed at position (1), the ammeter reads 2.2 A, and when switch K is closed at position (2), the ammeter reads 1.81 A, so:

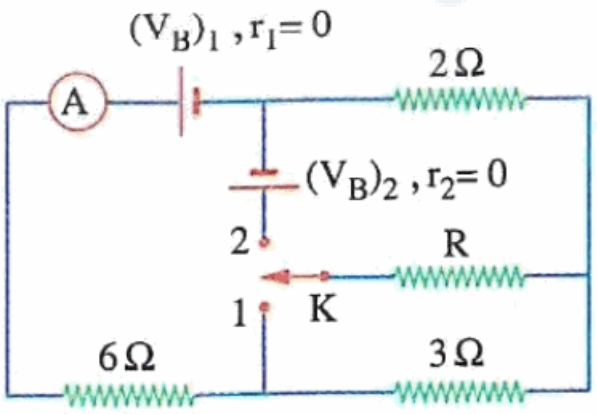
the resistance (R) equals .....



(A) 3 Ω (B) 6 Ω (C) 2 Ω (D) 12 Ω

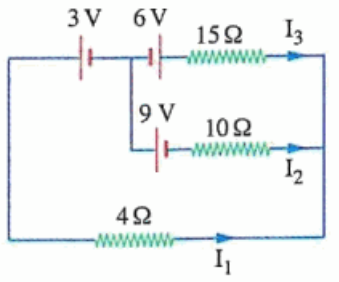
43 In the opposite electric circuit, the ammeter reads 2 A. When switch K is closed at position (1), the ammeter reads 2.2 A, and when switch K is closed at position (2), the ammeter reads 1.81 A, so:

the emf of the battery $(V_B)_2$ is approximately .....



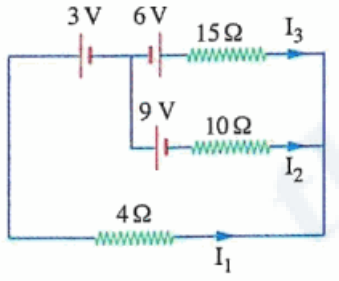
(A) 12 V (B) 14 V (C) 16 V (D) 18 V

44 Using Kirchhoff's two laws in the circuit shown: (note that the directions marked on the figure are assumed directions and not necessarily the true current directions)
the current I_1 is .....



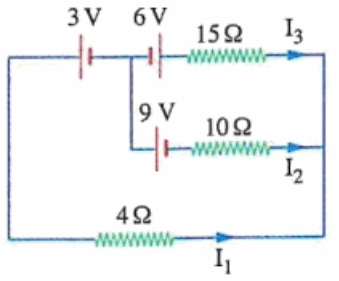
(A) 0.36 A (B) 0.6 A (C) -0.36 A (D) -0.6 A

45 Using Kirchhoff's two laws in the circuit shown: (note that the directions marked on the figure are assumed directions and not necessarily the true current directions)
the current I_2 is .....



(A) 0.96 A (B) 0.6 A (C) -0.96 A (D) -0.6 A

46 Using Kirchhoff's two laws in the circuit shown: (note that the directions marked on the figure are assumed directions and not necessarily the true current directions)
the current I_3 is .....



(A) 0.36 A (B) 0.96 A (C) -0.36 A (D) -0.96 A

47 A student connected two batteries of 6 V and 12 V with negligible internal resistance, two identical ohmic resistors, two ammeters and a switch to form an electric circuit as in figure (1). Then he reversed the polarity of the 6 V battery so that the circuit became as in figure (2).

When switch (K) is closed, what happens to the readings of the ammeters A_1, A_2 respectively: in the circuit of figure (1)?

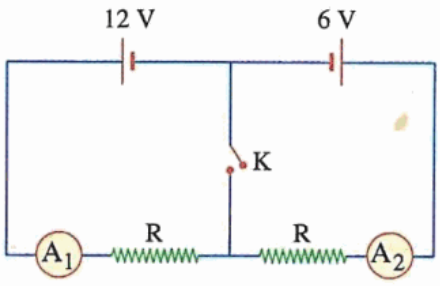


Figure (2)

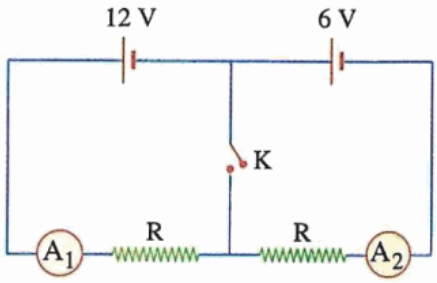


Figure (1)

(A) decreases, increases
(B) decreases, does not change
(C) does not change, decreases
(D) increases, decreases

48 A student connected two batteries of 6 V and 12 V with negligible internal resistance, two identical ohmic resistors, two ammeters and a switch to form an electric circuit as in figure (1). Then he reversed the polarity of the 6 V battery so that the circuit became as in figure (2).

When switch (K) is closed, what happens to the readings of the ammeters A_1, A_2 respectively: in the circuit of figure (2)?

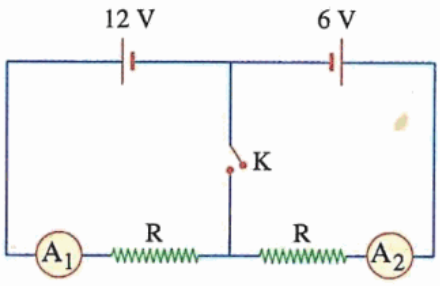


Figure (2)

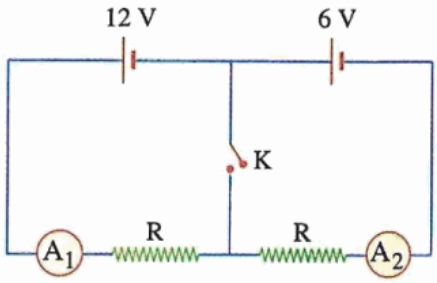
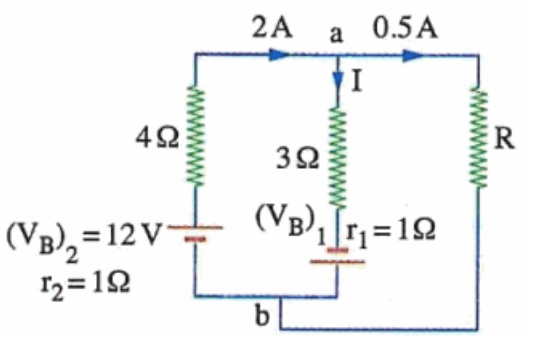


Figure (1)

(A) increases, does not change
(B) increases, increases
(C) decreases, decreases
(D) does not change, does not change

49 From the opposite electric circuit:

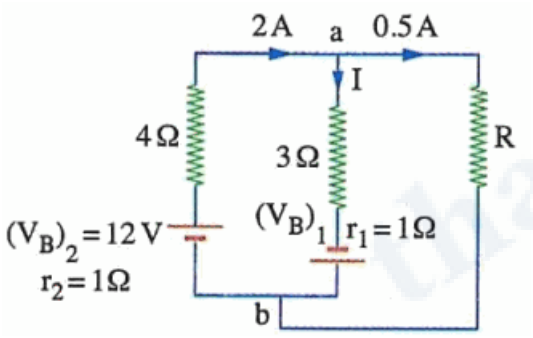
the potential difference between points a, b is .....



(A) 1 V (B) 2 V (C) 4 V (D) 6 V

50 From the opposite electric circuit:

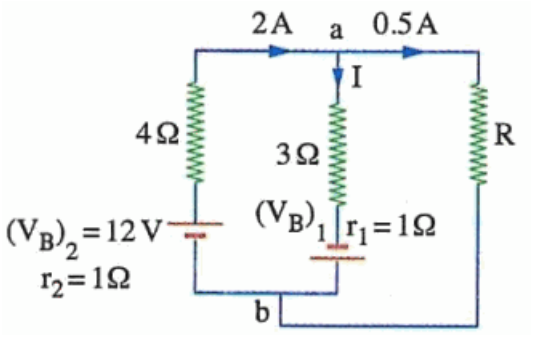
the emf $(V_B)_1$ is .....



(A) 9 V (B) 6 V (C) 4 V (D) 2 V

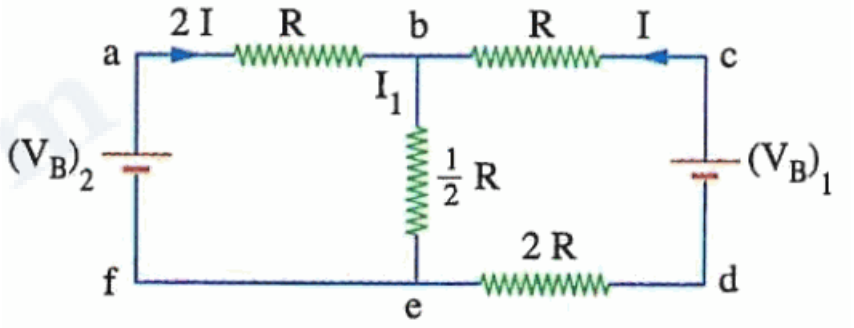
51 From the opposite electric circuit:

the resistance R is .....



(A) 2.5 Ω (B) 2 Ω (C) 4 Ω (D) 7.5 Ω

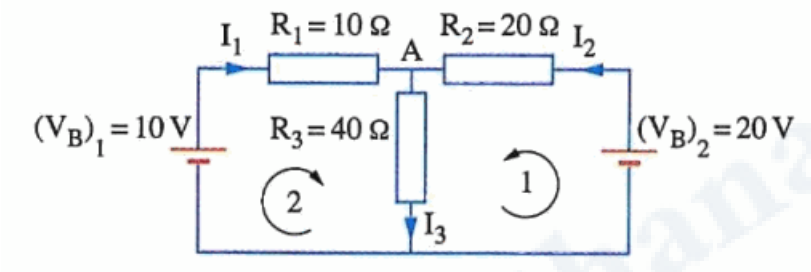
52 From the circuit shown, the ratio $((V_B)_1)/((V_B)_2)$ is .....



(A) *4/5* (B) *5/4* (C) *9/7* (D) *7/9*

53 From the opposite circuit:

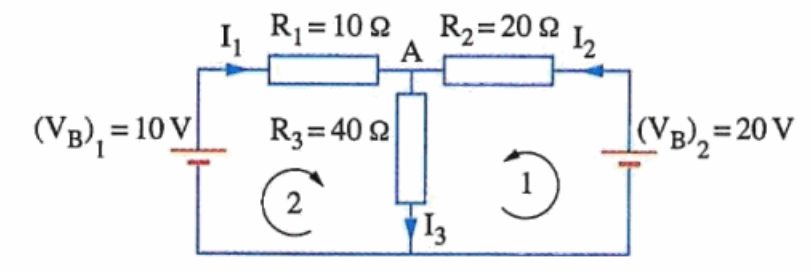
the current through resistor R_3 is .....



(A) *5/3* A (B) *4/7* A (C) *2/7* A (D) *4/9* A

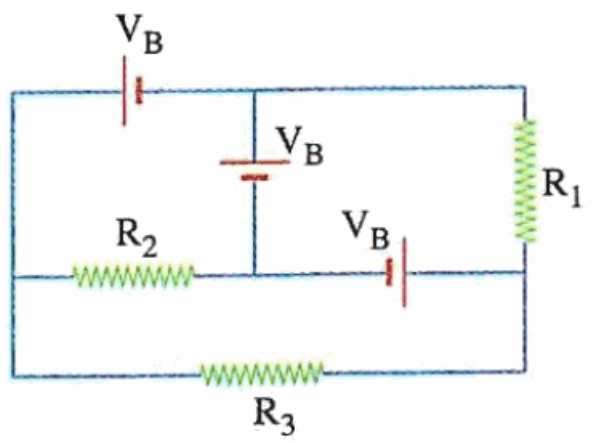
54 From the opposite circuit:

the power consumed in the electric circuit is .....



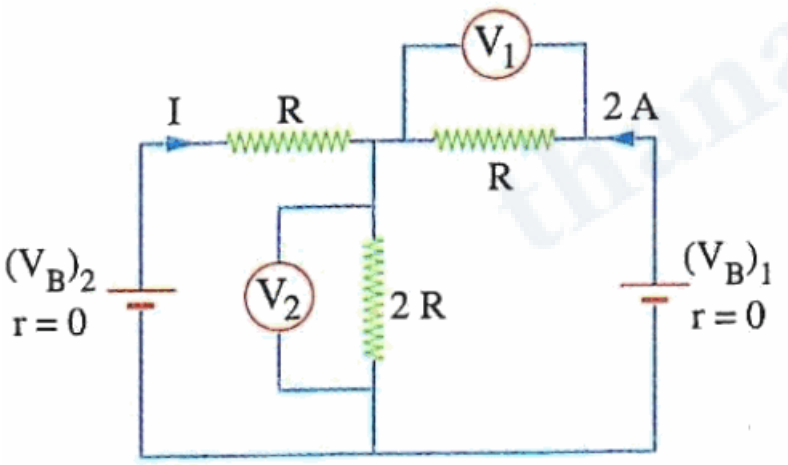
(A) 8.57 W (B) 4.42 W (C) 3.51 W (D) 2.31 W

55 The opposite circuit contains identical cells with negligible internal resistance. Which resistance carries no electric current?



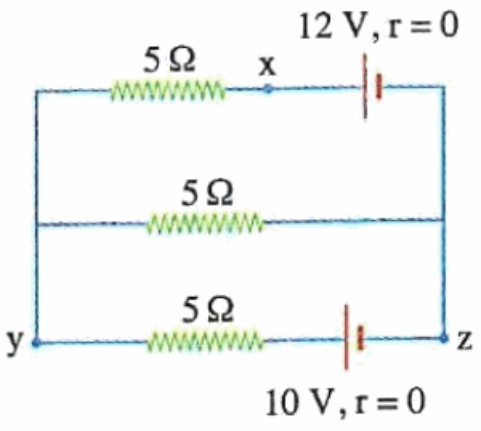
(A) R_1 (B) R_2 (C) R_3 (D) R_1, R_2

56 The opposite figure represents an electric circuit. If $V_2 = 4\ V_1$, then I equals .....



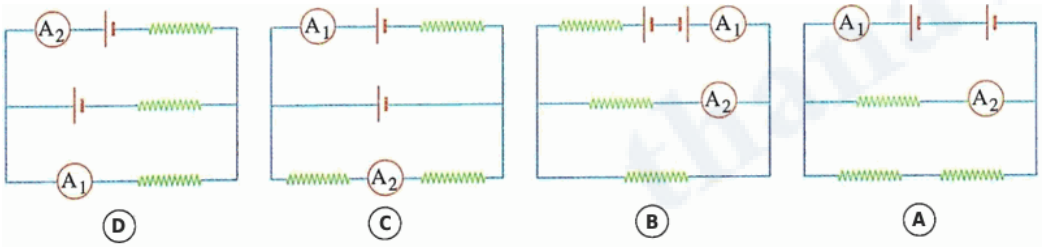
(A) 2 A (B) 4 A (C) 6 A (D) 8 A

57 The opposite figure represents a closed electric circuit, so .....

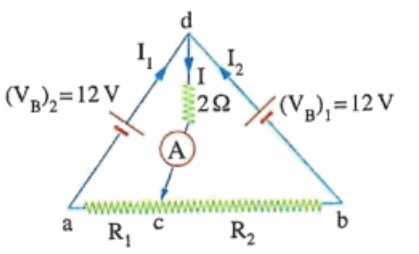


(A) $V_{xy} > V_{xz}$ (B) $V_{xy} = V_{xz}$ (C) $V_{xy} < V_{xz}$ (D) $V_{xy} = V_{yz}$

58 In the following electric circuits, all resistors are identical and all batteries are identical with negligible internal resistance. In which circuit is the reading of ammeter A_1 twice the reading of ammeter A_2?

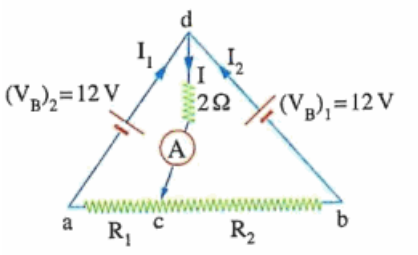


59 In the electric circuit shown, the wire ab is a uniform resistance of 10 Ω and point c, where the slider touches wire ab, divides it into two resistances R_1, R_2 such that $R_2 = 1.5\,R_1$, so: the current I_1 equals .....



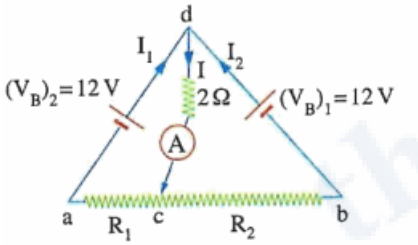
(A) 0.93 A (B) 1.09 A (C) 1.64 A (D) 2.73 A

60 In the electric circuit shown, the wire ab is a uniform resistance of 10 Ω and point c, where the slider touches wire ab, divides it into two resistances R_1, R_2 such that $R_2 = 1.5\,R_1$, so: the current I_2 equals .....



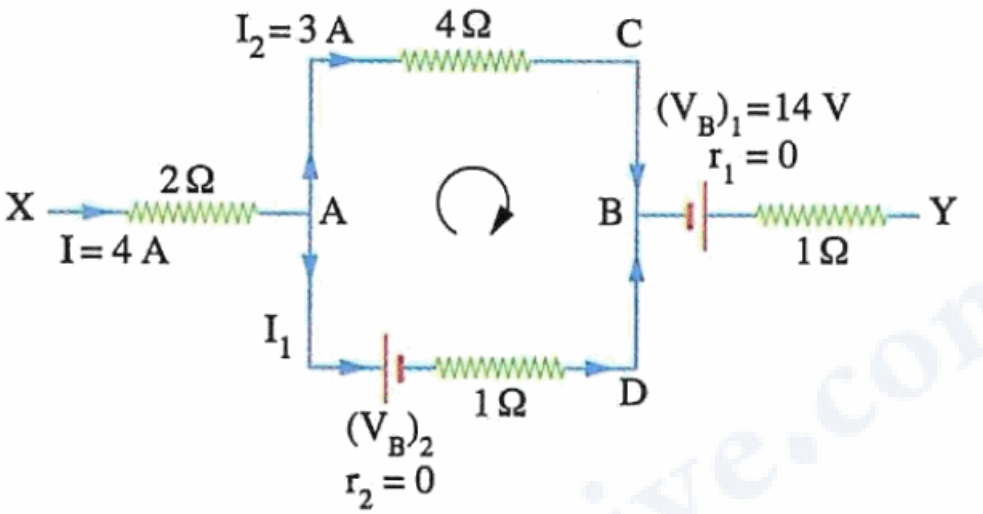
(A) 0.93 A (B) 1.09 A (C) 1.64 A (D) 2.73 A

61 In the electric circuit shown, the wire ab is a uniform resistance of 10 Ω and point c, where the slider touches wire ab, divides it into two resistances R_1, R_2 such that $R_2 = 1.5\,R_1$, so: the current I equals .....



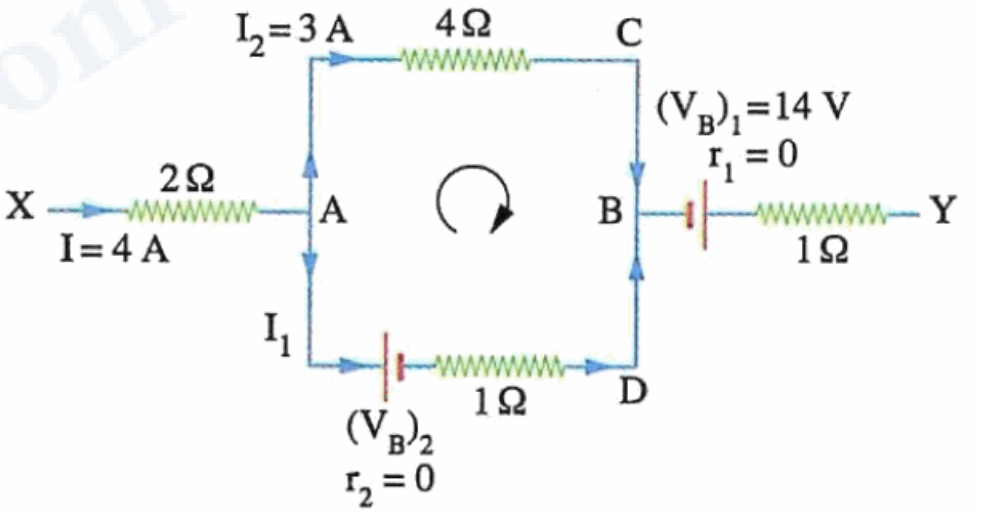
(A) 0.93 A (B) 1.09 A (C) 1.64 A (D) 2.73 A

62 The opposite figure represents part of an electric circuit. Using Kirchhoff's two laws and keeping to the current directions, the path and the data shown, the value of:
the potential difference between points X, Y equals .....



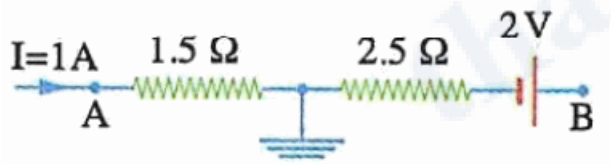
(A) 5 V (B) 7 V (C) 10 V (D) 11 V

63 The opposite figure represents part of an electric circuit. Using Kirchhoff's two laws and keeping to the current directions, the path and the data shown, the value of:
the emf of the battery $(V_B)_2$ equals .....



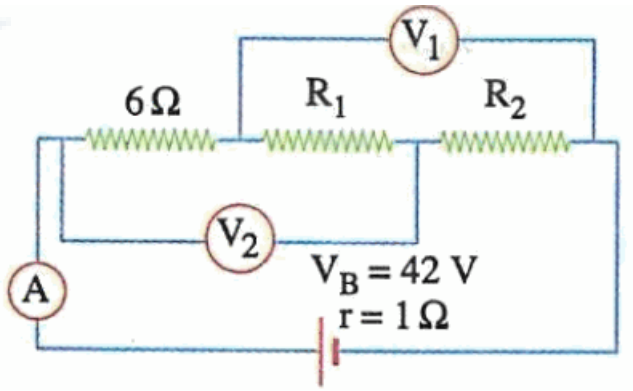
(A) 4 V (B) 8 V (C) 9.5 V (D) 11 V

64 The opposite figure represents part of an electric circuit carrying a current of 1 A, so .....



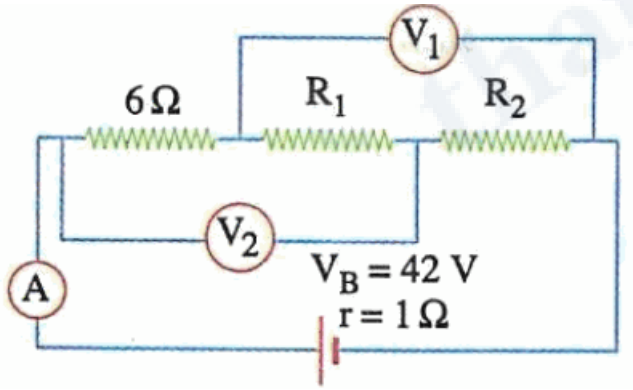
(A) potential of point A (V_A) = -1.5 V, potential of point B (V_B) = 2 V
(B) potential of point A (V_A) = 1.5 V, potential of point B (V_B) = 2 V
(C) potential of point A (V_A) = -1.5 V, potential of point B (V_B) = 0.5 V
(D) potential of point A (V_A) = 1.5 V, potential of point B (V_B) = -0.5 V

65 In the opposite electric circuit, if the reading of voltmeter V_1 is 21 V and the reading of voltmeter V_2 is 24 V, then:
the ammeter reading is .....



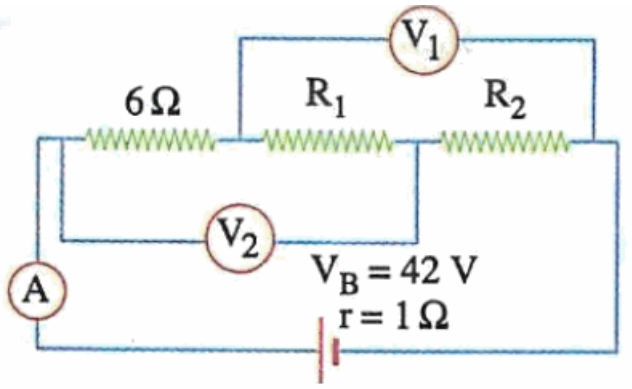
(A) 1 A (B) 2 A (C) 3 A (D) 4 A

66 In the opposite electric circuit, if the reading of voltmeter V_1 is 21 V and the reading of voltmeter V_2 is 24 V, then:
the resistance (R_1) equals .....



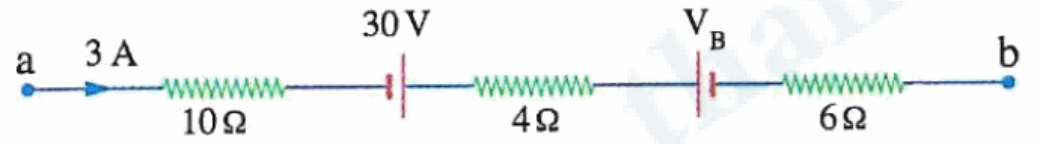
(A) 2 Ω (B) 4 Ω (C) 5 Ω (D) 6 Ω

67 In the opposite electric circuit, if the reading of voltmeter V_1 is 21 V and the reading of voltmeter V_2 is 24 V, then:
the resistance (R_2) equals .....



(A) 2 Ω (B) 4 Ω (C) 5 Ω (D) 6 Ω

68 The following figure shows part of a circuit. If the power consumed between points a, b is 210 W and the internal resistance of the cells is negligible, then:
the unknown emf (V_B) equals .....



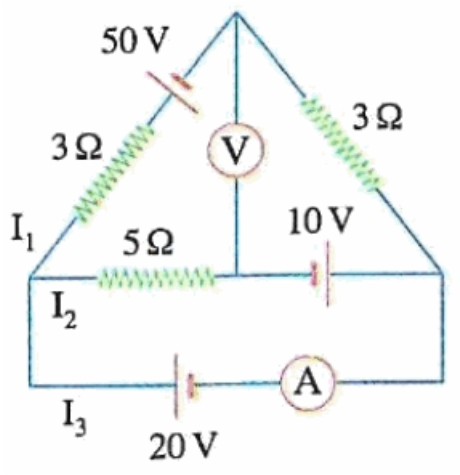
(A) 30 V (B) 20 V (C) 10 V (D) 5 V

69 The following figure shows part of a circuit. If the power consumed between points a, b is 210 W and the internal resistance of the cells is negligible, then:
the potential difference between points a, b equals .....



(A) 20 V (B) 30 V (C) 40 V (D) 50 V

70 From the electric circuit shown in the figure, the readings of the ammeter and the voltmeter are .....



(A) ammeter reading 2 A, voltmeter reading 5 V

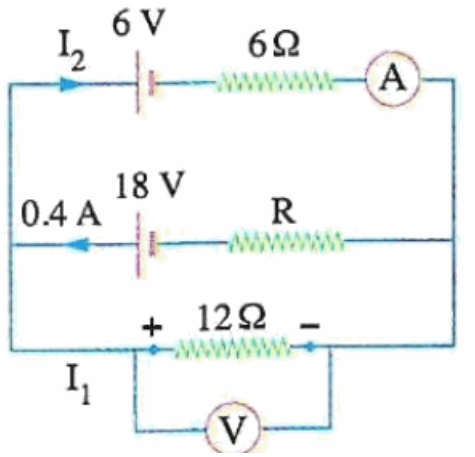
(B) ammeter reading 1 A, voltmeter reading 5 V

(C) ammeter reading 2 A, voltmeter reading 3 V

(D) ammeter reading 1 A, voltmeter reading 3 V

---

71 In the electric circuit shown in the figure:
the readings of the ammeter (A) and the voltmeter (V) are .....



(A) ammeter reading 0.067 A, voltmeter reading 5.6 V

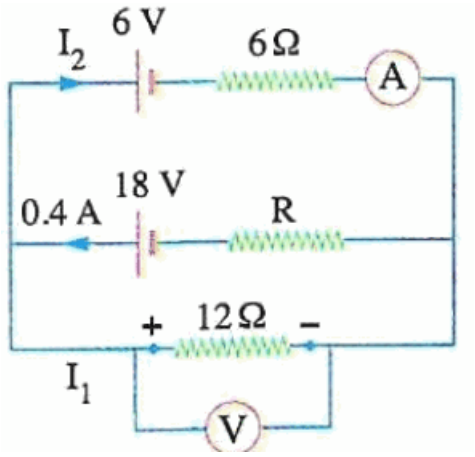
(B) ammeter reading 0.067 A, voltmeter reading 3.7 V

(C) ammeter reading 4.067 A, voltmeter reading 5.6 V

(D) ammeter reading 4.067 A, voltmeter reading 3.7 V

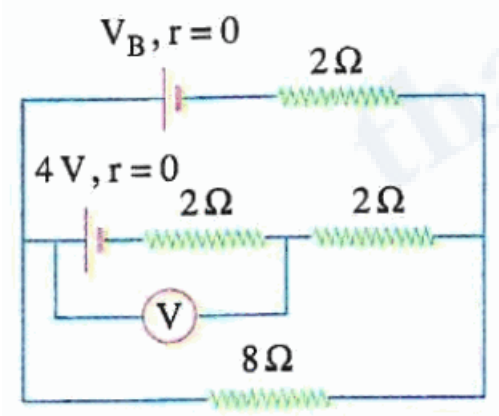
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72 In the electric circuit shown in the figure:
the resistance R is .....



(A) 11 Ω (B) 12 Ω (C) 31 Ω (D) 36 Ω

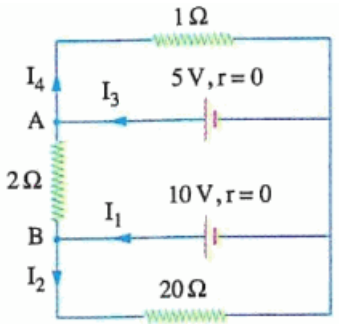
73 In the opposite electric circuit, if the voltmeter reading is 6 V, then the emf (V_B) equals .....



(A) 4 V (B) 8 V (C) 10 V (D) 12 V

74 In the opposite electric circuit:

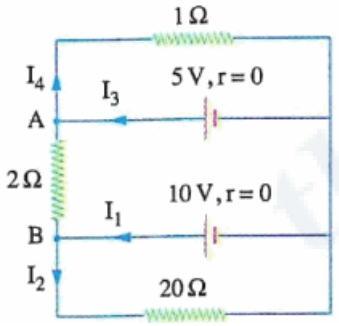
the magnitude and direction of the current through the 2 Ω resistor are .....



(A) 1.5 A from A to B
(B) 1.5 A from B to A
(C) 2.5 A from A to B
(D) 2.5 A from B to A

75 In the opposite electric circuit:

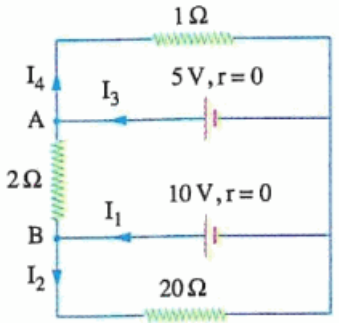
the current I_1 is .....



(A) 1 A
(B) 2 A
(C) 3 A
(D) 4 A

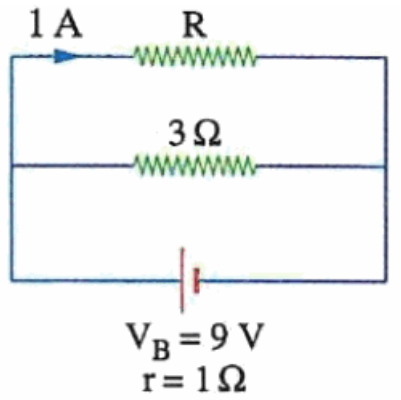
76 In the opposite electric circuit:

the current I_3 is .....



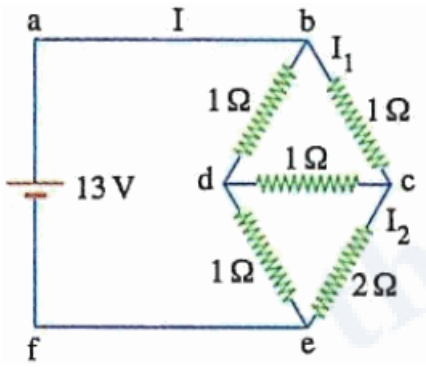
(A) 1.5 A
(B) 2.5 A
(C) 3.5 A
(D) 4.5 A

77 In the opposite electric circuit, if the current through resistor (R) is 1 A, then R equals .....



(A) 1.5 Ω (B) 3 Ω (C) 6 Ω (D) 12 Ω

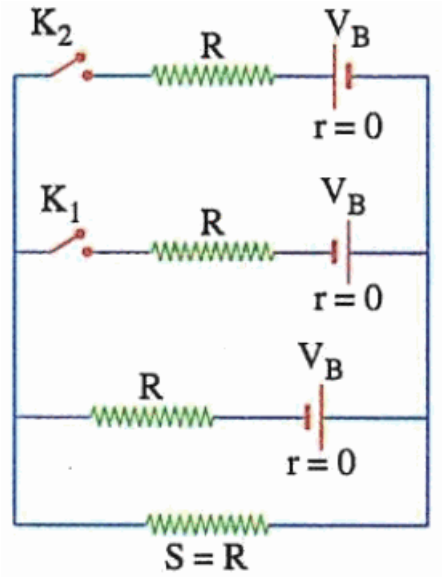
78 From the circuit shown in the drawing, the total resistance of the circuit is .....



(A) 0.5 Ω (B) 1 Ω (C) 1.18 Ω (D) 1.25 Ω

79 In the opposite electric circuit, what happens to the power consumed in resistor S when closing:

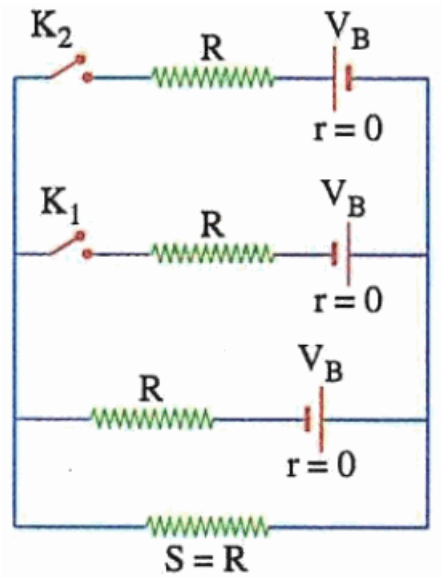
only switch K_1?



(A) increases (B) decreases (C) does not change (D) becomes zero

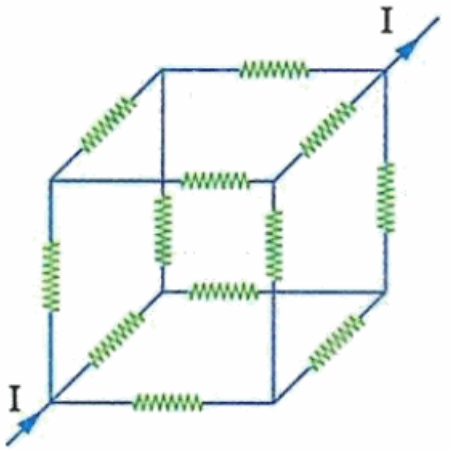
80 In the opposite electric circuit, what happens to the power consumed in resistor S when closing:

only switch K_2?



(A) increases (B) decreases (C) does not change (D) becomes zero

81 In the figure shown, 12 resistors, each R, are connected together in the form of a cube, so the equivalent resistance in terms of R is .....



(A) *1/2* R (B) *5/6* R (C) *3/2* R (D) R

Essay questions — 14 questions

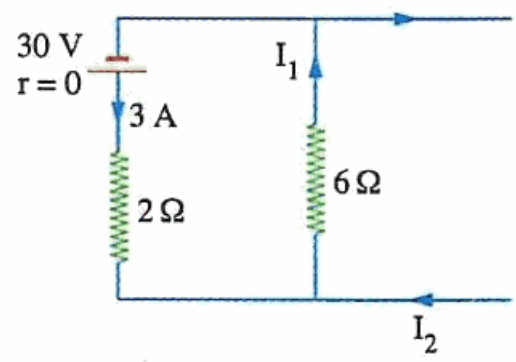
1 State the scientific principle on which each of the following is based:

(1) Kirchhoff's first law.

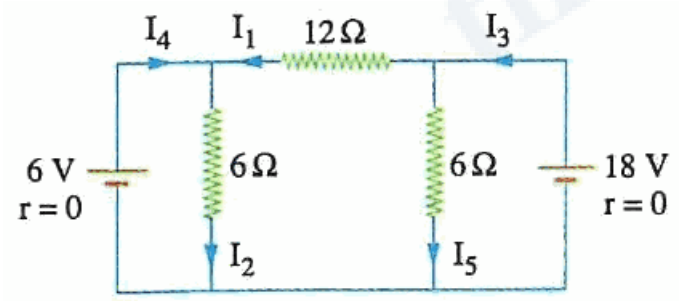
(2) Kirchhoff's second law.

2 The opposite figure represents part of a closed electric circuit.

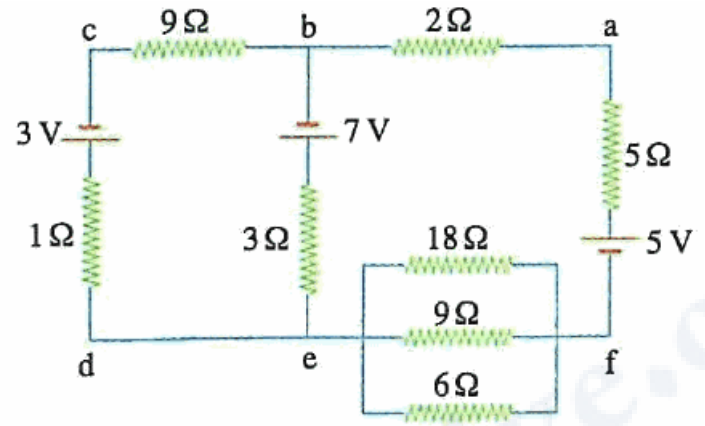
Calculate the current I_2



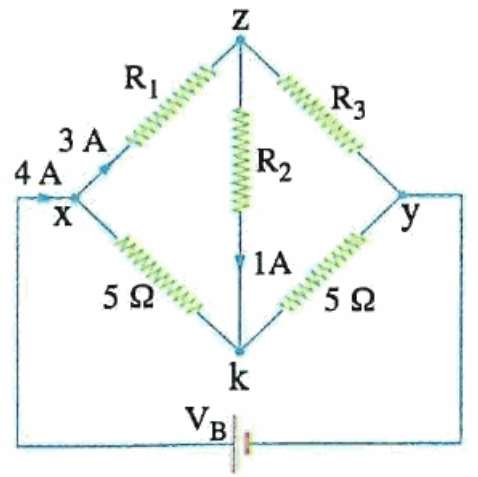
3 Calculate the currents I_3, I_4 in the opposite electric circuit.



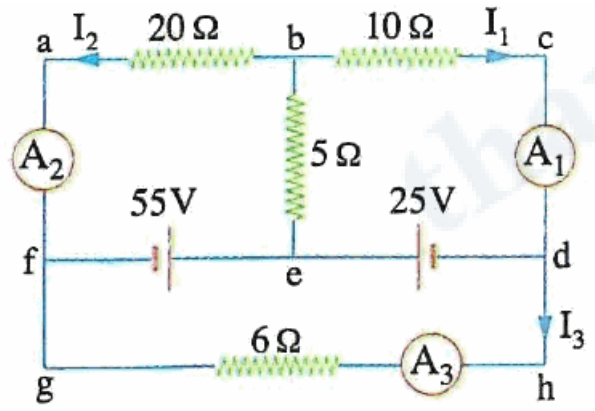
4 From the circuit shown, calculate the current through the 3 Ω resistor



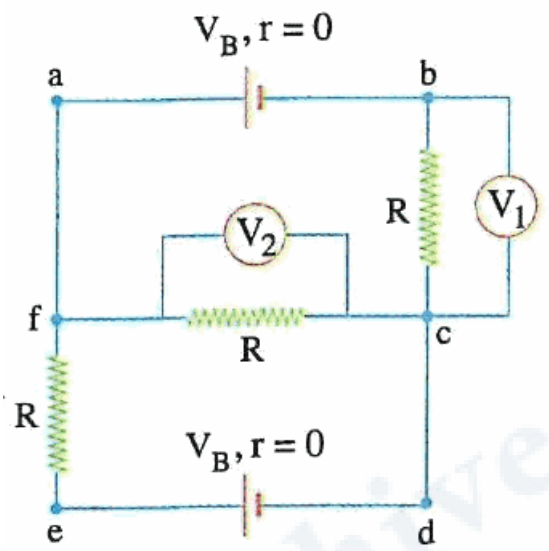
5 The opposite figure represents an electric circuit. Calculate the emf of the battery (V_B), neglecting its internal resistance.



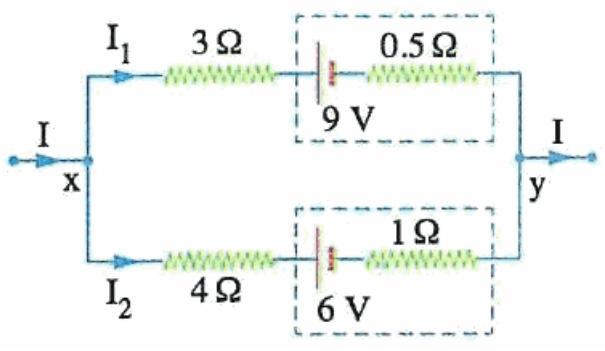
6 In the opposite electric circuit, the reading of ammeter A_1 is $1\ A$ and the internal resistance of the batteries is negligible. Calculate the ratio between the readings of the two ammeters A_2/A_3



7 In the opposite electric circuit, prove that: $V_1/V_2 = 1/2$



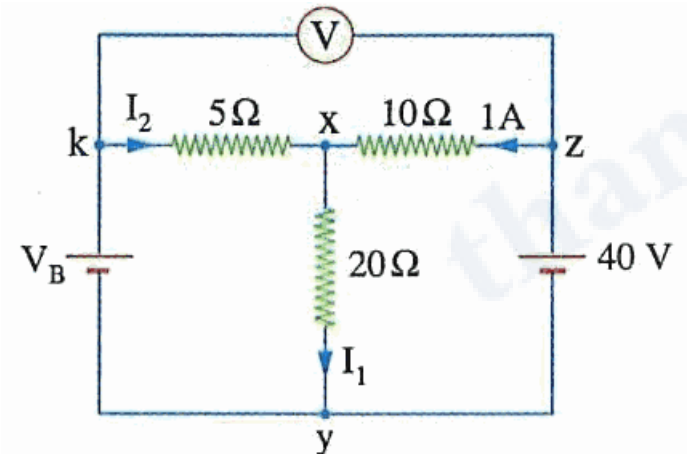
8 The opposite figure shows part of an electric circuit. If the potential difference between points x, y is *16 V*, calculate the current I



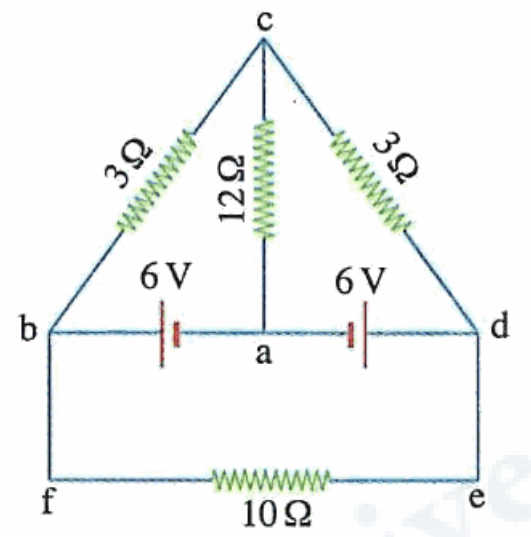
9 In the opposite electric circuit, if the internal resistance of the batteries is negligible, calculate:

(1) the voltmeter reading (V).

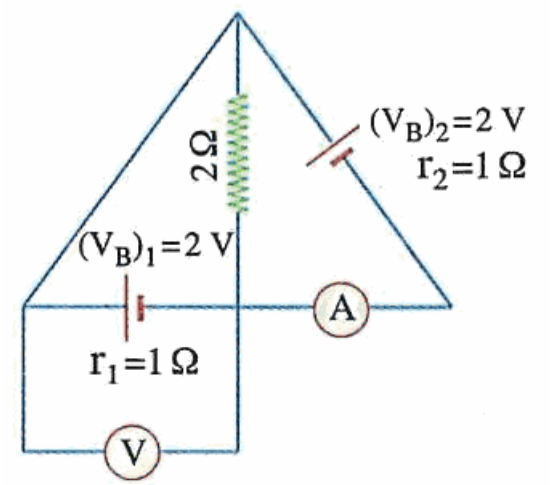
(2) the emf (V_B).



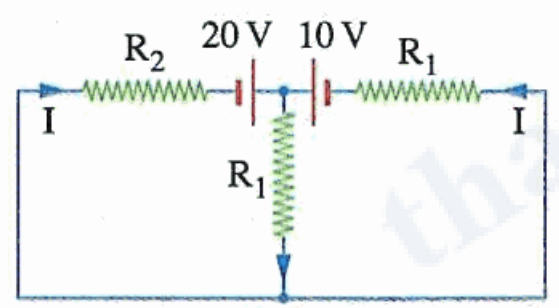
10 From the opposite circuit, calculate the current through the *12* Ω resistor



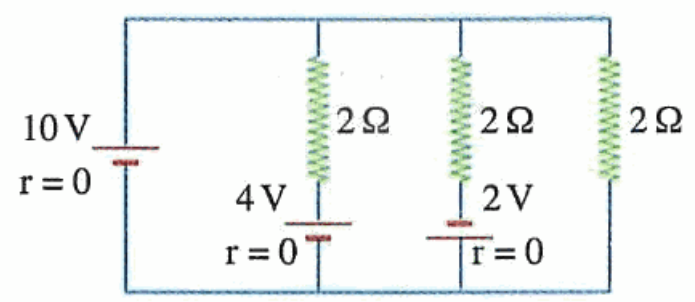
11 In the opposite electric circuit, find the readings of the ammeter and the voltmeter.



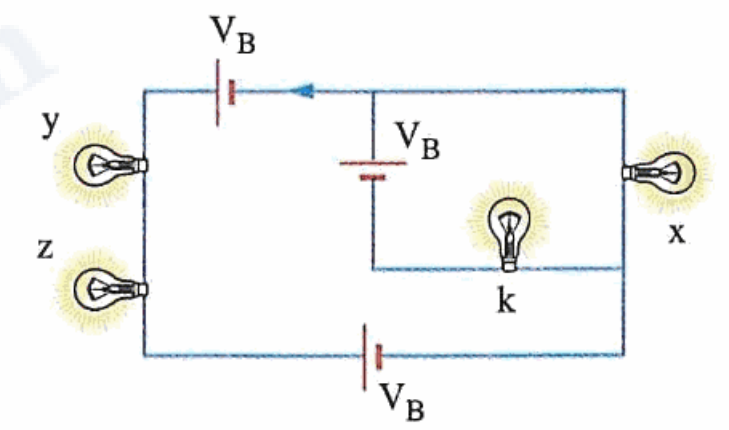
12 In the opposite electric circuit, if the current (I) is the same through each of the two batteries and equals (I), find the ratio between the two resistances R_1/R_2



13 In the opposite circuit, calculate the current through the *10 V* battery

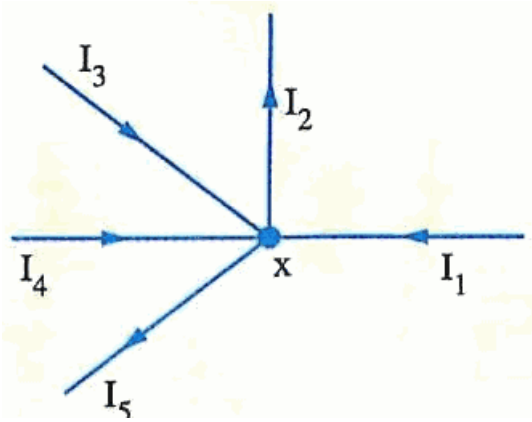


14 The opposite figure shows an electric circuit containing identical cells with negligible internal resistance and identical lamps. Which lamp's filament glows more brightly?



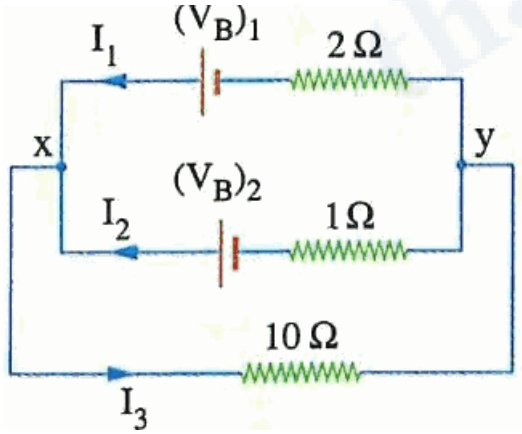
Past exam questions — 23 questions

1 In the opposite figure, applying Kirchhoff's first law at point (x) gives ..... (Trial exam / June 2021)



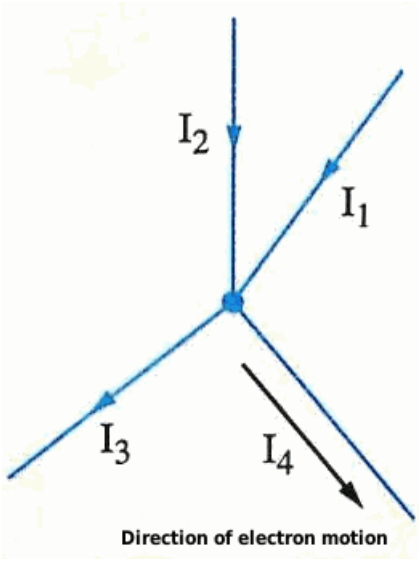
(A) $I_1+I_3+I_4+I_2+I_5=0$
(B) $-I_1-I_3-I_4+I_2+I_5=0$
(C) $-I_1-I_3+I_4+I_2+I_5=0$
(D) $I_1+I_3+I_4-I_2+I_5=0$

2 From the circuit shown in the figure, ... (2nd session 2021)



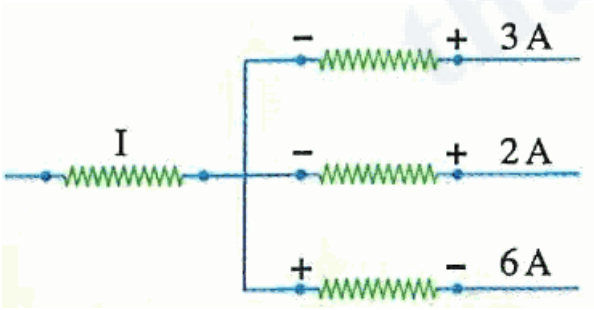
(A) $-I_1-I_2+I_3=0$
(B) $I_1-I_2-I_3=0$
(C) $-I_1+I_2+I_3=0$
(D) $I_1+I_2+I_3=0$

3 The figure represents part of a closed electric circuit. The directions of I_1, I_2, I_3 are conventional current directions, while the direction of I_4 is the direction of motion of the free electrons, so I_3 = ... (2nd session 2022)



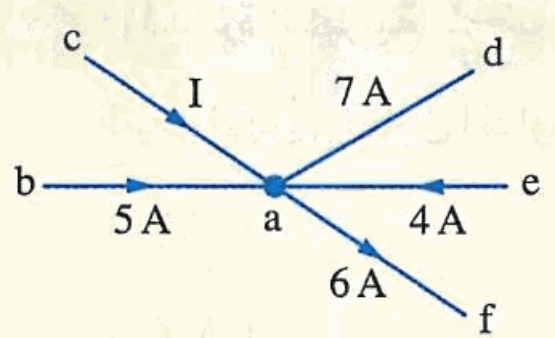
(A) $I_1 + I_2 - I_4$ (B) $I_1 + I_2 + I_4$ (C) $I_4 + I_1 - I_2$ (D) $I_4 + I_2 - I_1$

4 The figure shows part of an electric circuit, so I equals ..... (2nd session 2023)



(A) *11 A* (B) *2 A* (C) *1 A* (D) *4 A*

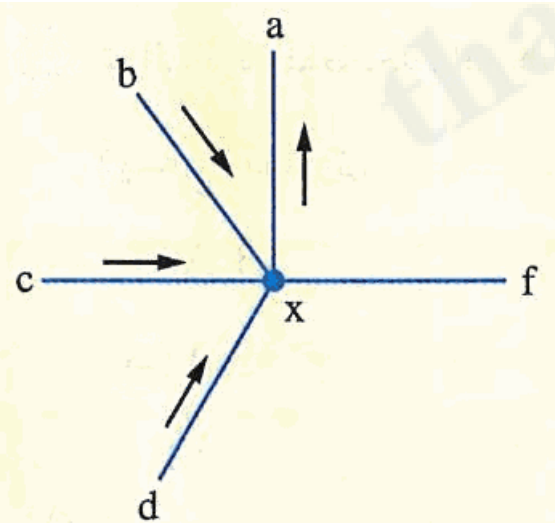
5 The opposite figure represents electric currents flowing in several branches. The value of the current (I) and the direction of the current *(7 A)* respectively are ..... (Sample exam 2025)



(A) *4 A*, from a to d (B) *4 A*, from d to a (C) *13 A*, from a to d (D) *13 A*, from d to a

---

6 In the figure, the directions shown represent the direction of electron motion. The currents in branches xa, xc, xd are *6 A*, *3 A*, *15 A* respectively, and 2.5×10^{19} electrons / second pass in branch xb. The number of electrons passing through branch xf and their direction of motion are ..... (Sample exam 2025)



(A) 1×10^{20} electrons / second, from x to f

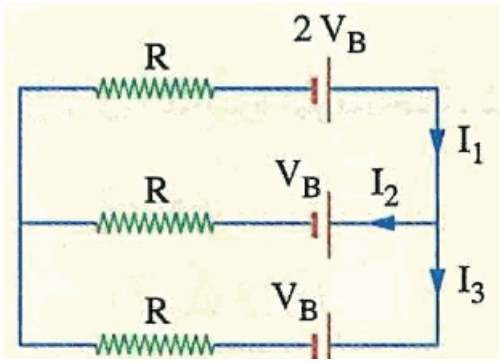
(B) 1×10^{20} electrons / second, from f to x

(C) 1.6×10^{19} electrons / second, from x to f

(D) 1.6×10^{19} electrons / second, from f to x

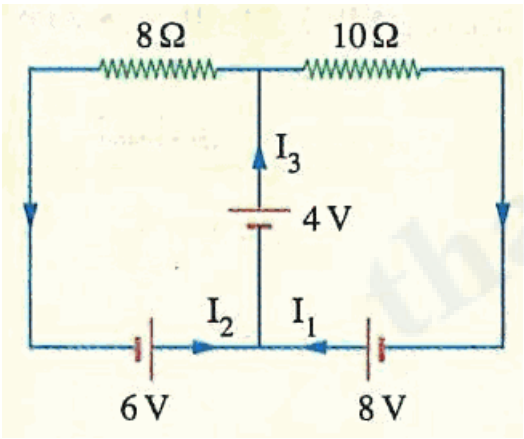
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7 Using the data written on the circuit in front of you, the ratio I_2/I_1 equals ..... (Trial exam / May 2021)



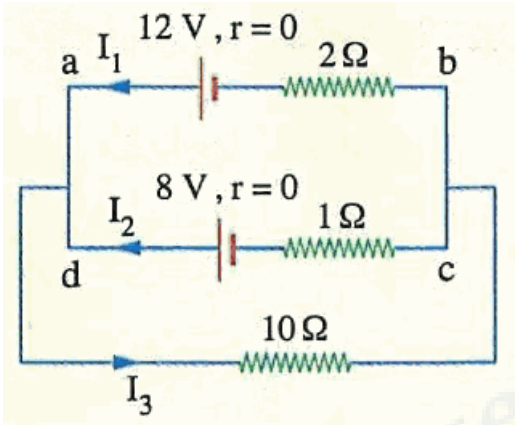
(A) *2/1* (B) *3/1* (C) *1/2* (D) *1/3*

8 In the electric circuit shown, the current I_3 equals ..... (Trial exam / June 2021)



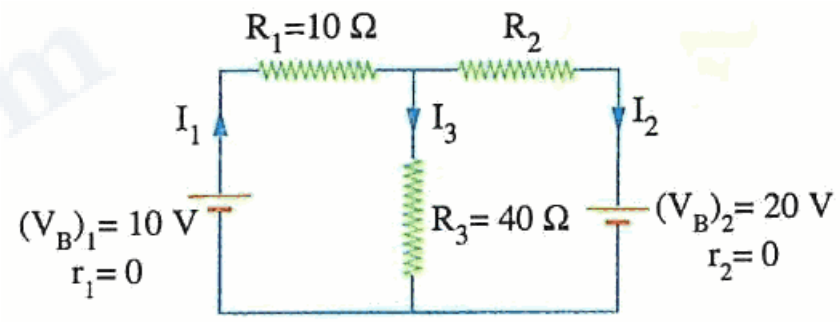
(A) *1.2 A* (B) *1.25 A* (C) *2 A* (D) *2.45 A*

9 In the circuit shown in the figure, Kirchhoff's laws can be applied to the closed path (adcba) as follows ..... (1st session 2021)



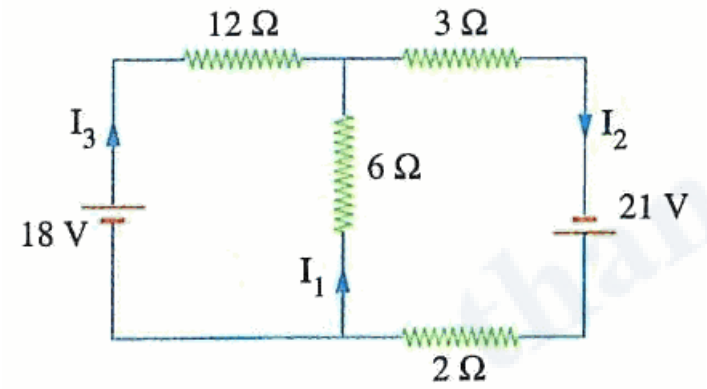
(A) $2I_1 + I_2 + 4 = 0$ (B) $2I_1 - I_2 - 20 = 0$ (C) $2I_1 - I_2 + 4 = 0$ (D) $3I_1 - I_3 - 4 = 0$

10 In the electric circuit shown, if $(I_3 = -2I_1)$, then the current through resistor R_3 equals ..... (1st session 2021)



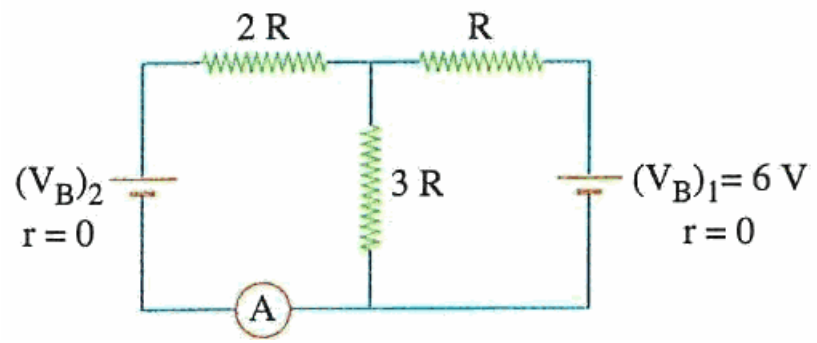
(A) *3/7 A* (B) *4/7 A* (C) *1 A* (D) *2/7 A*

11 In the circuit shown, if I_3 equals *2 A*, then I_2 equals ..... (2nd session 2021)



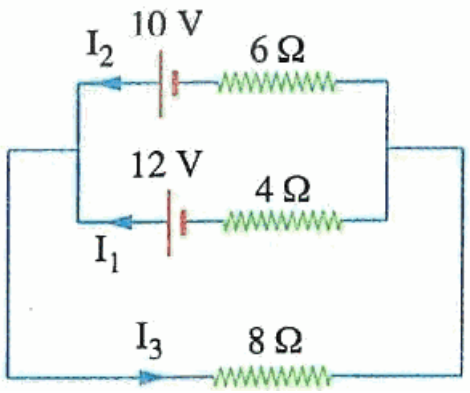
(A) *1 A* (B) *2 A* (C) *3 A* (D) *4 A*

12 In the electric circuit shown in the figure, if the ammeter reading is zero, then $(V_B)_2$ equals ..... (1st session 2022)



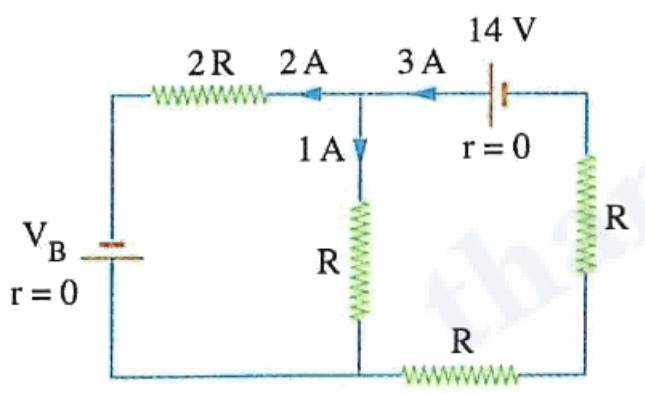
(A) *6 V* (B) *4.5 V* (C) *8 V* (D) *12 V*

13 In the circuit shown, the current through the $8\ \Omega$ resistor equals ..... (1st session 2022)



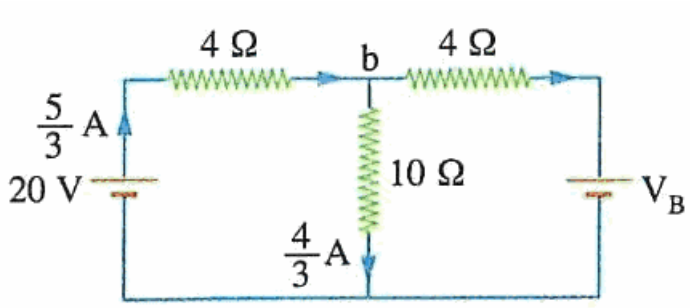
(A) *0.23 A* (B) *0.846 A* (C) *1.077 A* (D) *1.306 A*

14 In the electric circuit shown, the value of V_B equals ..... (2nd session 2022)



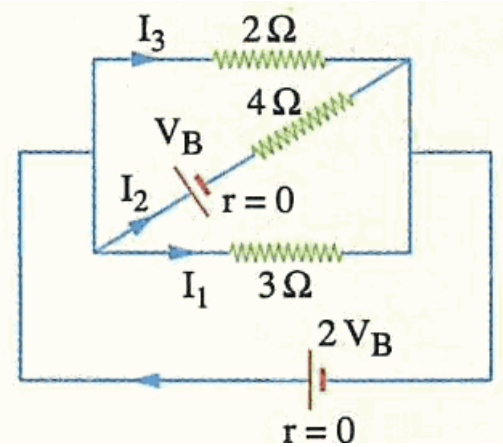
(A) *10 V* (B) *4 V* (C) *15 V* (D) *6 V*

15 In the circuit shown in the figure, the emf (V_B) is ..... (Trial exam 2023)



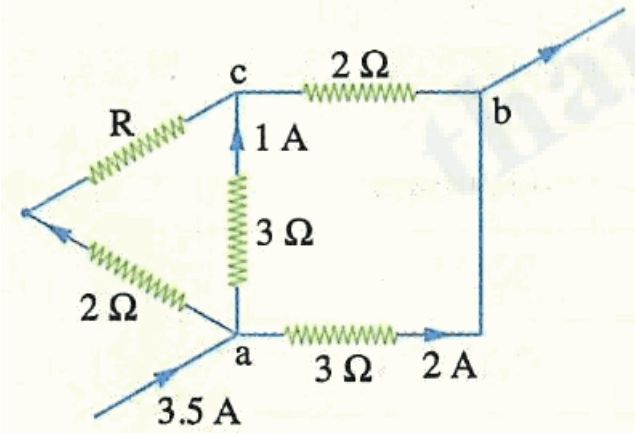
(A) *12 V* (B) *4/3 V* (C) *40/3 V* (D) *44/3 V*

16 You have an electric circuit as in the figure, so the ratio I_3/I_2 equals ..... (1st session 2023)



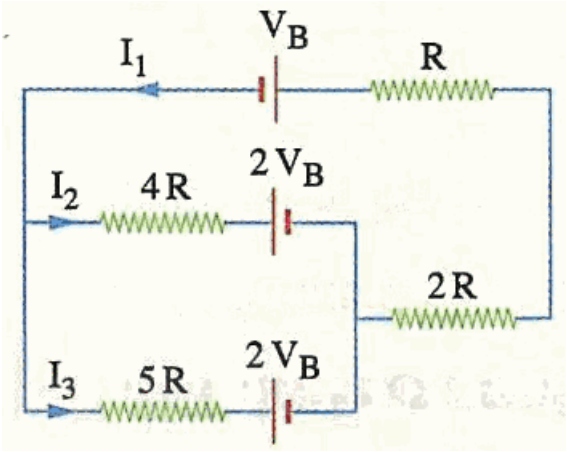
(A) *2/1* (B) *1/4* (C) *1/2* (D) *4/1*

17 The figure in front of you represents part of a closed electric circuit, so the resistance R equals ..... (2nd session 2023)



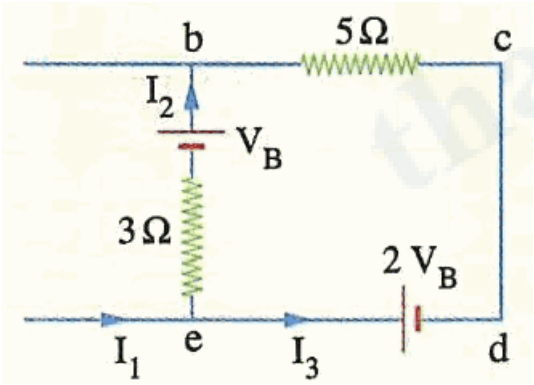
(A) *4 Ω* (B) *2 Ω* (C) *6 Ω* (D) *3 Ω*

18 You have an electric circuit as in the figure, so the relation between the two currents I_1, I_3 is ..... (1st session 2024)



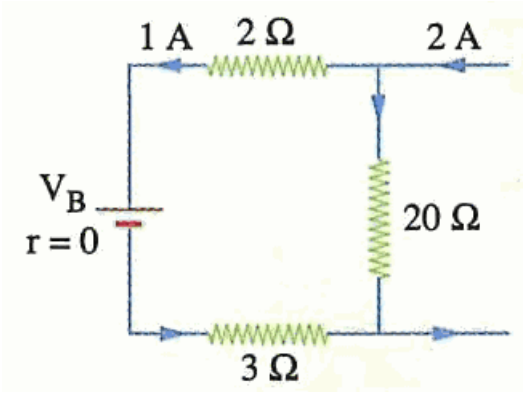
(A) $I_1 = 2.25I_3$ (B) $I_1 = 1.25I_3$ (C) $I_1 = 0.8I_3$ (D) $I_1 = 1.8I_3$

19 The opposite figure shows part of an electric circuit. Using Kirchhoff's two laws, which of the following equations is correct? (2nd session 2024)



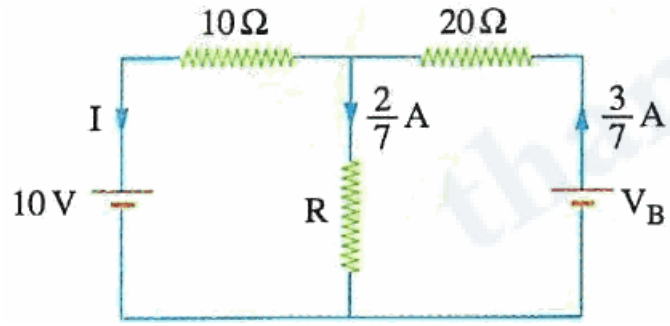
(A) $3I_1 + 7I_2 = -3V_B$ (B) $3I_2 - 5I_3 = -3V_B$ (C) $3I_2 - 5I_3 = 3V_B$ (D) $3I_1 - 8I_2 = 3V_B$

20 The opposite figure represents part of an electric circuit carrying an electric current, so the value of V_B is ..... (Sample exam 2025)



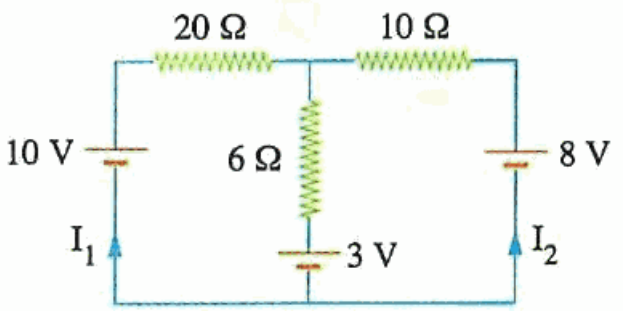
(A) *30 V* (B) *25 V* (C) *20 V* (D) *15 V*

21 In the electric circuit shown in the figure, what are the values of (V_B) and (R)? (1st session 2025)



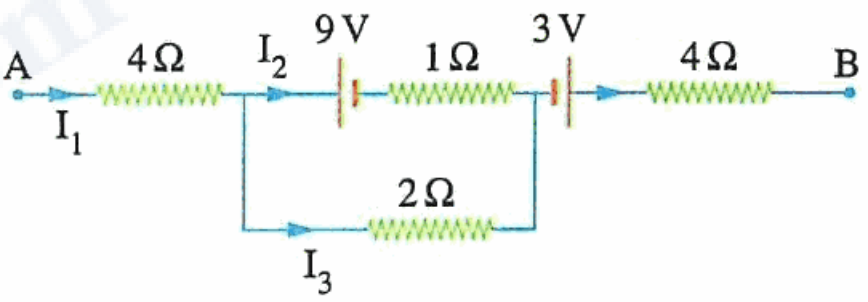
(A) $V_B = 30\ V, R = 40\ \Omega$ (B) $V_B = 20\ V, R = 30\ \Omega$
(C) $V_B = 30\ V, R = 20\ \Omega$ (D) $V_B = 20\ V, R = 40\ \Omega$

22 In the electric circuit shown in the figure, what are the values of (I_1) and (I_2)? (2nd session 2025)



(A) $I_1 = 0.215\ A, I_2 = 0.447\ A$ (B) $I_1 = 0.215\ A, I_2 = 0.232\ A$
(C) $I_1 = 0.232\ A, I_2 = 0.132\ A$ (D) $I_1 = 0.232\ A, I_2 = 0.215\ A$

23 The opposite figure represents part of an electric circuit. If the potential difference between points A, B is *16 V*, then the current through the *2* Ω resistor equals ..... (Sample exam 2026)



(A) *2.5 A* (B) *3.5 A* (C) *4 A* (D) zero

Answer key and solutions

Multiple choice questions

1 D	2 C	3 B	4 B	5 C	6 C	7 C	8 A	9 D	10 B
11 D	12 D	13 C	14 D	15 A	16 A	17 A	18 C	19 B	20 C
21 D	22 A	23 C	24 C	25 D	26 B	27 C	28 A	29 C	30 C
31 D	32 D	33 A	34 D	35 A	36 C	37 B	38 C	39 A	40 D
41 B	42 B	43 A	44 B	45 C	46 A	47 D	48 B	49 B	50 C
51 C	52 C	53 C	54 A	55 A	56 A	57 C	58 D	59 C	60 B
61 D	62 C	63 D	64 D	65 C	66 A	67 C	68 C	69 C	70 B
71 A	72 C	73 D	74 D	75 C	76 B	77 C	78 C	79 A	80 D
81 B									

1 **Answer (D)**

The sum of the currents entering point a equals the sum of the currents leaving it

$5+4+I=8+6$

$I=5\ A$

The direction is from c to a

2 **Answer (C)**

The sum of the entering currents equals the sum of the leaving currents

$I_1+I_2+I_3+I_4=I_5+I_6$

$I_6=4I_1\text{-}I_1=3I_1$

3 **Answer (B)**

The 12Ω and 6Ω resistors are in parallel

$R_p = (12 \times 6)/18 = 4\ \Omega$

$V = 2 \times 4 = 8\ V$

The 4Ω resistor has the same potential difference

$I_{4\Omega} = 8/4 = 2\ A$

$I = 2 + 2 = 4\ A$

4 **Answer (B)**

At a, 12A, 9A and 4A meet

$12 + 9 + 4 = 25\ A$

At b

$25 + 4 = 6 + I$

$I = 23\ A$

5 **Answer (C)**

$4 + 3 = 1 + I$

$I = 6\ A$

6 **Answer (C)**

$I_{0.5\Omega} = 2/0.5 = 4\ A$

$I_{10\Omega} = 5/10 = 0.5\ A$

$I_{ab} = 4 + 2 = 6\ A$

$I = 6 + 0.5 = 6.5\ A$

7 **Answer (C)**

At the top right corner

$I_{top} = 1 + 5 = 6\ A$

At the top left corner

$I_1 = 6\text{-}2 = 4\ A$

8 **Answer (A)**

At the point where the two diagonals cross

$2 + 0.5 = 5 + I_2$

$I_2 = \text{-}2.5\ A$

The negative sign means the actual direction is opposite to the drawn one

9 **Answer (D)**

At the top junction

$I_{\text{top left}} = 6 + 4 = 10\ A$

At the left junction

$I_1 = 10 + 3 = 13\ A$

10 **Answer (B)**

The sum entering equals the sum leaving

$6 + 3 = 5 + I_2$

$I_2 = 4\ A$

11 **Answer (D)**

The sum of the currents entering C equals zero

$(6\text{-}10)/4 + (4\text{-}10)/3$

$+ (V_A\text{-}10)/2 = 0$

$\text{-}1\text{-}2 + (V_A\text{-}10)/2 = 0$

$V_A = 16\ V$

12 **Answer (D)**

$I_{30} = 30/10 = 3\ A$

$I_{20} = 20/10 = 2\ A$

$I_{10} = 10/10 = 1\ A$

$I = 3 + 2 + 1 = 6\ A$

13 **Answer (C)**

$I_{\text{left}} = 3/3 = 1\ A$

$I_{\text{right}} = 12/3 = 4\ A$

$I_{\text{top}} = 1 + 4 = 5\ A$

$V_1 = 5 \times 3 = 15\ V$

14 **Answer (D)**

$V_x = V_j + 5$

$V_z = V_j\text{-}6$

$V_y = V_j\text{-}10$

$V_x > V_z > V_y$

15 **Answer (A)**

Kirchhoff's second law for the left loop

$-12+V_1+8=0$

$V_1=4\ V$

then for the outer loop

$-12+V_2-6+8=0$

$V_2=10\ V$

16 **Answer (A)**

The voltmeter is in parallel with the 20V battery, whose internal resistance is zero

$V=20\ V$

17 **Answer (A)**

y is in parallel with battery z

$V_y=4\ V$

$P_y=4\times3=12\ W$

$V_x=4-2=2\ V$

$P_x=2\times2=4\ W$

18 **Answer (C)**

The current in 5Ω is the entering current plus the current of resistor R

$I_5=2+1=3\ A$

Kirchhoff's second law for the loop

$20-V_R-3\times5=0$

$V_R=5\ V$

19 **Answer (B)**

The battery loop

$V_B=5+10+15=30\ V$

20 **Answer (C)**

The two branches between a and b have the same potential difference

$V_{ab}=2\times4-12=-4\ V$

$V_{ab}=1\times2-V_B$

$-4=2-V_B$

$V_B=6\ V$

21 **Answer (D)**

The two batteries oppose each other

$I=(5-2)/(10+R)$

$V_{AB}=5-10I=4$

$I=0.1\ A$

$10+R=3/0.1=30$

$R=20\ \Omega$

22 **Answer (A)**

The two batteries are in the same direction around the loop

$I=(15+15)/(4\times7.5)=1\ A$

From a to b through d

$V_{ab}=7.5-15+7.5=0$

23 **Answer (C)**

The ammeters read zero: no current in any branch

The resultant emf of each branch equals 10V

$5+(V_B)_1=10$

$(V_B)_1=5\ V$

$(V_B)_2-5=10$

$(V_B)_2=15\ V$

24 **Answer (C)**

The potential difference between the top and bottom junctions equals the 20V battery voltage

$10-10I_1=-20$

$I_1=3\ A$

25 **Answer (D)**

The potential difference between the two junctions is constant

$I_3=(-20)/(10+10)=-1\ A$

$I_2=I_1-I_3=3+1=4\ A$

26 **Answer (B)**

Two equal batteries in the first and third branches, in the same direction

$I_1 = I_3 = (V_B\text{-}u)/R$, $I_2 = u/2R$

$2(V_B\text{-}u)/R = u/2R$

$u = 0.8V_B$

$I_1 = 0.2V_B/R$, $I_2 = 0.4V_B/R$

27 **Answer (C)**

A battery with no internal resistance keeps the voltage across the branches fixed

$I = V_B/R$

Closing K1 adds another branch R with the same voltage

$I' = V_B/R + V_B/R = 2I$

28 **Answer (A)**

Closing K2 adds a battery in parallel with an identical battery

The voltage does not change, so the current does not change

29 **Answer (C)**

Only branch R is added; the two parallel batteries supply more current but do not change the voltage

$I' = 2I$

30 **Answer (C)**

The two upper branches carry the same current 2A and have the same resistance R1 between common ends

so their emfs are equal

$V_B = 10\ V$

31 **Answer (D)**

The voltmeter is across R2 and 4R2, which carry 1A

$10 = 1 \times (R_2 + 4R_2)$

$R_2 = 2\ \Omega$

$30\text{-}10 = 1 \times\ R_1$

$R_1 = 20\ \Omega$

32 **Answer (D)**

Kirchhoff's first law at c

$I_1 = I_2 + 0.34$

Kirchhoff's second law for the left loop

$9\text{-}3I_2 = 6I_1$

$9\text{-}3I_2 = 6I_2 + 2.04$

$I_2 = 0.77\ A$

$I_1 = 1.11\ A$

33 **Answer (A)**

$I_1 = I_2 + 0.34$

$9\text{-}3I_2 = 6I_1$

$I_2 = (9\text{-}2.04)/9 = 0.77\ A$

34 **Answer (D)**

The right loop

$V_B\text{-}4I_3 = 6I_1$

$V_B = 6 \times 1.11 + 4 \times 0.34$

$V_B = 8.02\ V$

35 **Answer (A)**

Assume the drawn directions and write three equations

$I_1 = I_2 + I_3$

$20I_1 + 6I_2 = 10\text{-}3$

$10I_3\text{-}6I_2 = \text{-}8 + 3$

Solve them with the calculator

$I_1 = 0.22\ A$

36 **Answer (C)**

$I_1 = I_2 + I_3$

$20I_1 + 6I_2 = 7$

$10I_3\text{-}6I_2 = \text{-}5$

Solve them with the calculator

$I_2 = 0.45\ A$

37 **Answer (B)**

$I_1 = I_2 + I_3$

$20I_1 + 6I_2 = 7$

$10I_3 - 6I_2 = -5$

Solve them with the calculator

$I_3 = -0.23\ A$

The negative sign means the direction is opposite to the drawn one

38 **Answer (C)**

The first loop

$(V_B)_1 = I_1(1+4) + I_3 \times 10$

$(V_B)_1 = 7 + 8 = 15\ V$

39 **Answer (A)**

At junction b

$I_2 = I_3 - I_1$

$I_2 = 0.8 - 1.4 = -0.6\ A$

The second loop

$(V_B)_2 = I_2(1+4) + I_3 \times 10$

$(V_B)_2 = -3 + 8 = 5\ V$

40 **Answer (D)**

$V_{be} = I_3 R = 0.8 \times 10 = 8\ V$

41 **Answer (B)**

Switch open: all resistors are in series with the first battery

$R_t = 2 + 3 + 6 = 11\ \Omega$

$(V_B)_1 = 2 \times 11 = 22\ V$

42 **Answer (B)**

Position 1: R is in parallel with 3Ω

$R_t = 22/2.2 = 10\ \Omega$

$2 + 6 + 3R/(3+R) = 10$

$R = 6\ \Omega$

43 **Answer (A)**

Position 2: the second branch has R and the second battery

$V = 22\text{-}1.81 \times 8 = 7.52\ V$

$I_{3\Omega} = 7.52/3 = 2.51\ A$

$I_{branch} = 1.81\text{-}2.51$

$I_{branch} = -0.70\ A$

$7.52\text{-}(V_B)_2 = -0.70 \times 6$

$(V_B)_2 \approx 12\ V$

44 **Answer (B)**

Assume the drawn directions and write three equations

$I_1 + I_2 + I_3 = 0$

$4I_1\text{-}15I_3 = -3$

$4I_1\text{-}10I_2 = 12$

Solve them with the calculator

$I_1 = 0.6\ A$

45 **Answer (C)**

$I_1 + I_2 + I_3 = 0$

$4I_1\text{-}15I_3 = -3$

$4I_1\text{-}10I_2 = 12$

Solve them with the calculator

$I_2 = -0.96\ A$

The negative sign means the direction is opposite to the drawn one

46 **Answer (A)**

$I_1 + I_2 + I_3 = 0$

$4I_1\text{-}15I_3 = -3$

$4I_1\text{-}10I_2 = 12$

Solve them with the calculator

$I_3 = 0.36\ A$

47 **Answer (D)**

Closing K puts each battery in a separate loop with its resistor

Before closing

$I = (12 + 6)/2R = 9/R$

After closing

$I_1 = 12/R$, $I_2 = 6/R$

A1 increases and A2 decreases

48 **Answer (B)**

Before closing: the two batteries oppose each other

$I = (12\text{-}6)/2R = 3/R$

After closing

$I_1 = 12/R$, $I_2 = 6/R$

Both readings increase

49 **Answer (B)**

Kirchhoff's first law at a

$I = 2\text{-}0.5 = 1.5\ A$

The left branch

$V_{ab} = 12\text{-}2 \times 5 = 2\ V$

50 **Answer (C)**

$I = 2\text{-}0.5 = 1.5\ A$

$V_{ab} = 2\ V$

The middle branch

$2 = 1.5 \times (3 + 1)\text{-}(V_B)_1$

$(V_B)_1 = 4\ V$

51 **Answer (C)**

$V_{ab} = 2\ V$

$R = 2/0.5 = 4\ \Omega$

52 **Answer (C)**

Kirchhoff's first law at b

$I_1 = 2I + I = 3I$

$(V_B)_2 = 2IR + 3ItimesR/2$

$(V_B)_2 = 3.5IR$

$(V_B)_1 = IR + 3ItimesR/2 + 2IR$

$(V_B)_1 = 4.5IR$

$((V_B)_1)/((V_B)_2) = 9/7$

53 **Answer (C)**

Apply Kirchhoff's two laws

$I_3 = I_1 + I_2$

$10 = 10I_1 + 40I_3$

$20 = 20I_2 + 40I_3$

Solve them with the calculator

$I_3 = 2/7\ A$

54 **Answer (A)**

$I_2 = (20\text{-}40 \times 2/7)/20 = 3/7\ A$

The power consumed is the power given by the 20V battery

$P = 20 \times 3/7 = 8.57\ W$

55 **Answer (A)**

No current flows in R1 because the potential difference across it is zero

so the two batteries oppose each other across it

56 **Answer (A)**

$V_1 = 2 \times\ R = 2R$

$V_2 = 4V_1 = 8R$

$I_{2R} = 8R/2R = 4\ A$

$I = 4\text{-}2 = 2\ A$

57 **Answer (C)**

The 12V battery has no internal resistance, so the voltage across it is constant

$V_{xz} = 12\ V$

The voltage across the upper 5Ω resistor is less than that

$V_{xy} < V_{xz}$

58 **Answer (D)**

Let the junction potential be u; the batteries have no internal resistance

$I_R = u/R$, $I_{bat} = (V_B - u)/R$

$2(V_B - u)/R = u/R$

$u = 2V_B/3$

$I_{A_1} = 2V_B/3R = 2 times V_B/3R = 2I_{A_2}$

59 **Answer (C)**

$R_1 + R_2 = 10$, $R_2 = 1.5R_1$

$R_1 = 4\ \Omega$, $R_2 = 6\ \Omega$

$I = I_1 + I_2$

$12 = 4I_1 + 2(I_1 + I_2)$

$12 = 6I_2 + 2(I_1 + I_2)$

Solve them with the calculator

$I_1 = 1.64\ A$

60 **Answer (B)**

$12 = 6I_1 + 2I_2$

$12 = 2I_1 + 8I_2$

Solve them with the calculator

$I_2 = 1.09\ A$

61 **Answer (D)**

$I = I_1 + I_2$

$I = 1.64 + 1.09 = 2.73\ A$

62 **Answer (C)**

Move from X to Y

The drop across 2Ω

$4 \times 2 = 8\ V$

The drop across the upper branch

$3 \times 4 = 12\ V$

From B to Y the battery helps the current

$4 \times 1 - 14 = -10\ V$

$V_{XY} = 8 + 12 - 10 = 10\ V$

63 **Answer (D)**

The difference between A and B through the upper branch

$V_{AB} = 3 \times 4 = 12\ V$

$I_1 = 4\text{-}3 = 1\ A$

The lower branch

$12 = 1 \times 1 + (V_B)_2$

$(V_B)_2 = 11\ V$

64 **Answer (D)**

The earth between the two resistors: its potential is zero

$V_A = 1 \times 1.5 = 1.5\ V$

$V = -1 \times 2.5 = -2.5\ V$

The battery raises the potential by 2V

$V_B = -2.5 + 2 = -0.5\ V$

65 **Answer (C)**

The terminal voltage of the battery equals the voltage across 6Ω plus the voltages across R1 and R2

$42 - I \times 1 = 6I + 21$

$I = 3\ A$

66 **Answer (A)**

$V_{6\Omega} = 3 \times 6 = 18\ V$

$V_{R_1} = 24\text{-}18 = 6\ V$

$R_1 = 6/3 = 2\ \Omega$

67 **Answer (C)**

$V_{R_2} = 21\text{-}6 = 15\ V$

$R_2 = 15/3 = 5\ \Omega$

68 **Answer (C)**

Power consumed = power of the resistors + power of the battery being charged

$I^2R = 9 \times 20 = 180\ W$

$210 = 180 + 3V_B$

$V_B = 10\ V$

69 **Answer (C)**

$V_{ab} = 60 + 10\text{-}30 = 40\ V$

70 **Answer (B)**

The 20V battery has no internal resistance, so it fixes the voltage between the two ends

$I_{6\Omega} = (20\text{-}50)/6 = \text{-}5\ A$

$I_{5\Omega} = (20 + 10)/5 = 6\ A$

$I_A = 6\text{-}5 = 1\ A$

$V_{top} = \text{-}3 \times (\text{-}5)\text{-}50$

$V_{top} = \text{-}35\ V$

$V_{mid} = \text{-}5 \times 6 = \text{-}30\ V$

$V = |\text{-}35 + 30| = 5\ V$

71 **Answer (A)**

The voltmeter is across 12Ω, which carries I1

$I_1 + I_2 = 0.4$

$12I_1 = 6I_2 + 6$

$I_2 = \text{-}0.067\ A$

$I_1 = 0.467\ A$

$V = 12 \times 0.467 = 5.6\ V$

72 **Answer (C)**

The potential difference between the two junctions, from the previous question

$5.6 = 18\text{-}0.4R$

$R = 31\ \Omega$

73 **Answer (D)**

The middle branch

$6 = 4 + 2I \Rightarrow I = 1\ A$

$V = 4 + 1 \times 4 = 8\ V$

The lower branch

$I = 8/8 = 1\ A$

The upper branch carries their sum

$I = 2\ A$

$8 = V_B\text{-}2 \times 2$

$V_B = 12\ V$

74 **Answer (D)**

Take the potential of the right connection as zero, so the potential of A comes from the 5V battery and that of B from the 10V battery

$I_{2\Omega} = (5-10)/2 = -2.5\ A$

The negative sign means from B to A

75 **Answer (C)**

$I_2 = 10/20 = 0.5\ A$

$I_1 + (-2.5) = I_2$

$I_1 = 3\ A$

76 **Answer (B)**

$I_4 = 5/1 = 5\ A$

$I_3 = I_4 + (-2.5)$

$I_3 = 2.5\ A$

77 **Answer (C)**

The voltage across R equals the voltage across 3Ω

$I_{3\Omega} = R/3$

$9 = R + (1 + R/3) \times 1$

$R = 6\ \Omega$

78 **Answer (C)**

Take the potential of e as zero and the potential of b as 1V

$1 + V_c = 3V_d$

$1 + V_d = 2.5V_c$

$I = (1-V_d) + (1-V_c)$

$I = 0.846\ A$

$R = 1/0.846 = 1.18\ \Omega$

79 **Answer (A)**

The voltage across S with one branch

$V_S = V_B/2$

Closing K1 adds an identical branch in parallel

$V_S = V_B/1.5 = 2/3V_B$

The voltage across S increases, so its power increases

80 **Answer (D)**

The battery of the upper branch opposes the battery of the third branch

The two branches cancel each other

$V_S = 0$

so the power of S becomes zero

81 **Answer (B)**

By symmetry, the end points have equal potentials

$R_{eq} = R/3 + R/6 + R/3 = 5R/6$

Essay questions

1 **Model answer**

(1) The law of conservation of charge.

(2) The law of conservation of energy.

2 **Model answer**

Applying Kirchhoff's second law to the closed path:

$\Sigma V_B = \Sigma IR$

$30 = (3 \times 2) + 6I_1$, so $I_1 = 4\ A$

Applying Kirchhoff's first law at point a:

$I_1 = I_2 + 3$

$I_2 = 1\ A$

3 **Model answer**

Applying Kirchhoff's second law to the path (ahgfedcba):

$18\text{-}6 = 12I_1$, so $I_1 = 1\ A$

For the path (abgha): $6 = 6I_2$, so $I_2 = 1\ A$

At point b: $I_1 + I_4 = I_2$, so $I_4 = 0$

For the path (dcfed): $18 = 6I_5$, so $I_5 = 3\ A$

At point c: $I_3 = I_1 + I_5 = 4\ A$

4 **Model answer**

The resistors $18\ \Omega$, $9\ \Omega$, $6\ \Omega$ are connected in parallel:

$1/(R') = 1/18 + 1/9 + 1/6$, so $R' = 3\ \Omega$

At point b: $I_2 = I_1 + I_3$

Path (abefa): $12 = 10I_2 + 3I_3$

Path (bcdeb): $-4 = 10I_1 - 3I_3$

Solving the equations: $I_1 = -0.1\ A$, $I_2 = 0.9\ A$, $I_3 = 1\ A$

The current through the $3\ \Omega$ resistor equals $1\ A$

5 **Model answer**

At point x: $4 = 3 + I_1$, so $I_1 = 1\ A$

At point k: $I_2 = I_1 + 1 = 2\ A$

Path (xkyx): $V_B = 5I_1 + 5I_2$

$V_B = (5 \times 1) + (5 \times 2) = 15\ V$

6 **Model answer**

Path (afedcba): $55 - 25 = (-1 \times 10) + 20I_2$, so $I_2 = 2\ A$

Path (fedhgf): $55 - 25 = 6I_3$, so $I_3 = 5\ A$

$A_2/A_3 = 2/5$

7 **Model answer**

At point f: $I_1 + I_2 = I_3$

Path (afcba): $V_B = I_1R + I_3R$

Path (cdefc): $V_B = I_2R + I_3R$

So $I_1 = I_2$ and $I_3 = 2I_1$

$V_1/V_2 = I_1R/I_3R = I_1/2I_1 = 1/2$

8 **Model answer**

Path (xlmyx): $16 - 6 - (4 + 1)I_2 = 0$, so $I_2 = 2\ A$

Path (xzkyx): $16 - 9 - (3 + 0.5)I_1 = 0$, so $I_1 = 2\ A$

At point x: $I = I_1 + I_2 = 4\ A$

9 **Model answer**

(1) Path (yzxy): $40 = (1 \times 10) + 20I_1$, so $I_1 = 1.5\ A$

At point x: $I_1 = I_2 + 1$, so $I_2 = 0.5\ A$

$V = V_{xz} - V_{xk} = (1 \times 10) - (5 \times 0.5) = 7.5\ V$

(2) Path (kxyk): $V_B = 20I_1 + 5I_2 = (20 \times 1.5) + (5 \times 0.5) = 32.5\ V$

10 **Model answer**

Path (bfedb): $-6+6=10I_4$, so $I_4=0$

At point c: $I_1+I_2=I_3$

Path (abca): $6=3I_1+12I_3$

Path (dcad): $6=12I_3+3I_2$

Solving the equations: $I_1=I_2=0.22\ A$, $I_3=0.44\ A$

The current in the $12\ \Omega$ resistor equals $0.44\ A$

11 **Model answer**

Redrawing the circuit:

Path (abda): $2=2I_2+I_3$

Path (bdcb): $2=I_1+2I_2$

At point b: $I_1+I_3=I_2$

Solving the equations: $I_1=0.4\ A$, $I_2=0.8\ A$, $I_3=0.4\ A$

Ammeter reading $=I_1=0.4\ A$

Voltmeter reading $=(V_B)_1-I_3r_1=2-(0.4\times1)=1.6\ V$

12 **Model answer**

At point a: $I+I=I_1$, so $I_1=2I$

Path (1): $10=IR_1+I_1R_1=3IR_1$, so $IR_1=10/3$

Path (2): $20=I_1R_1+IR_2=20/3+IR_2$, so $IR_2=40/3$

$R_1/R_2=1/4$

13 **Model answer**

Path (abgha): $10-4=2I_1$, so $I_1=3\ A$

Path (abcfgha): $10+2=2I_2$, so $I_2=6\ A$

Path (abcdefgha): $10=2I_3$, so $I_3=5\ A$

$I_4=I_2+I_3=11\ A$

$I_5=I_1+I_4=3+11=14\ A$

The current through the $10\ V$ battery is $14\ A$

14 **Model answer**

Let the resistance of each lamp be R:

At point a: $I_2=I_1+I_3$

Path (1): $V_B=2I_1R+I_2R$

Path (2): $V_B=I_2R+I_3R$

So $I_3=2I_1$ and $I_2=3I_1$

$P_w = I^2R$ and $I_2 > I_3 > I_1$

The filament of lamp k glows more brightly.

Past exam questions

1	2	3	4	5	6	7	8	9	10
B	A	B	C	A	A	C	D	D	D
11	12	13	14	15	16	17	18	19	20
C	B	C	D	A	D	A	A	C	D
21	22	23							
D	B	B							

1 **Answer (B)**

Sum of entering currents = sum of leaving currents:

$I_1 + I_3 + I_4 = I_2 + I_5$

$-I_1 - I_3 - I_4 + I_2 + I_5 = 0$

2 **Answer (A)**

At point x: the currents I_1, I_2 enter and I_3 leaves:

$I_1 + I_2 = I_3$

$-I_1 - I_2 + I_3 = 0$

3 **Answer (B)**

The conventional current direction is opposite to the direction of electron motion, so the current I_4 enters the point.

$I_3 = I_1 + I_2 + I_4$

4 **Answer (C)**

The current in the resistor flows from the positive end to the negative end.

Entering currents: I, $3\ A$, $2\ A$ and leaving: $6\ A$

$I + 3 + 2 = 6$, so $I = 1\ A$

5 **Answer (A)**

$I + 5 + 4 = 6 + 7$, so $I = 4\ A$

and the $7\ A$ current leaves from a to d

6 **Answer (A)**

The current direction is opposite to the direction of electron motion.

$I_{xb} = Ne = 2.5 \times 10^{19} \times 1.6 \times 10^{-19} = 4\ A$

The current entering in terms of electrons: $4 + 3 + 15 = 22\ A$ and leaving $6\ A$

$I_{xf} = 22\text{-}6 = 16\ A$

$N = 16/(1.6 \times 10^{-19}) = 1 \times 10^{20}$ electrons / second, from x to f

7 **Answer (C)**

Applying Kirchhoff's two laws to the closed paths and solving the equations:

$I_1 = 2I_2$

$I_2/I_1 = 1/2$

8 **Answer (D)**

Applying Kirchhoff's two laws to the closed paths and solving the equations:

$I_3 = 2.45\ A$

9 **Answer (D)**

Applying Kirchhoff's second law to the path (adcba) with the directions shown:

$3I_1\text{-}I_3\text{-}4 = 0$

10 **Answer (D)**

Left path: $10 = 10I_1 + 40I_3$

$I_3 = -2I_1$: $10 = 10I_1\text{-}80I_1$

$I_1 = -1/7\ A$

$I_3 = 2/7\ A$

11 **Answer (C)**

Left path: $18 = (12 \times 2)\text{-}6I_1$, so $I_1 = 1\ A$

$I_2 = I_1 + I_3 = 1 + 2 = 3\ A$

12 **Answer (B)**

No current flows in the ammeter branch.

$I = 6/(R + 3R) = 1.5/R$

$(V_B)_2 = I \times 3R = 4.5\ V$

13 **Answer (C)**

Applying Kirchhoff's two laws to the closed paths and solving the equations:

$I_3 = 1.077\ A$

14 **Answer (D)**

Applying Kirchhoff's two laws to the closed paths and solving the equations:

$V_B = 6\ V$

15 **Answer (A)**

Current in the right $4\ \Omega$ resistor: $5/3\text{-}4/3 = 1/3\ A$

Right path: $V_B = (10 \times 4/3)\text{-}(4 \times 1/3) = 12\ V$

16 **Answer (D)**

Applying Kirchhoff's two laws to the closed paths and solving the equations:

$I_3 = 4I_2$

$I_3/I_2 = 4/1$

17 **Answer (A)**

At point a: $3.5 = 2 + 1 + I$, so the current in $2\ \Omega$ and R equals $0.5\ A$

For the closed path: $(2 \times 0.5) + 0.5R = 3 \times 1$

$R = 4\ \Omega$

18 **Answer (A)**

Applying Kirchhoff's two laws to the closed paths and solving the equations:

$I_1 = 2.25I_3$

19 **Answer (C)**

Applying Kirchhoff's second law to the path (ebcde):

$3I_2\text{-}5I_3 = 3V_B$

20 **Answer (D)**

Current in $20\ \Omega$: $2\text{-}1 = 1\ A$

For the closed path: $V_B = (20 \times 1)\text{-}(2 \times 1)\text{-}(3 \times 1) = 15\ V$

21 **Answer (D)**

At the junction: the current in $10\ \Omega$ equals $3/7\text{-}2/7 = 1/7\ A$

Left path: $2/7R\text{-}10/7 = 10$, so $R = 40\ \Omega$

Right path: $V_B = (20 \times 3/7) + (40 \times 2/7) = 20\ V$

22 **Answer (B)**

Applying Kirchhoff's two laws to the closed paths and solving the equations:

$I_1 = 0.215\ A, I_2 = 0.232\ A$

23 **Answer (B)**

Applying Kirchhoff's two laws to the closed paths and solving the equations:

$I_3 = 3.5\ A$