CHAPTER

1.1

BASIC CONCEPTS

1. A solid copper sphere, 10 cm in diameter is deprived of 10^{20} electrons by a charging scheme. The charge on the sphere is

(A) 160.2 C (B) –160.2 C

(C) 16.02 C (D) –16.02 C

2. A lightning bolt carrying 15,000 A lasts for 100 μs. If the lightning strikes an airplane flying at 2 km, the charge deposited on the plane is

(A) 13.33 μC (B) 75 C

(C) 1500 μC (D) 1.5 C

3. If 120 C of charge passes through an electric conductor in 60 sec, the current in the conductor is

(A) 0.5 A (B) 2 A

(C) 3.33 mA (D) 0.3 mA

4. The energy required to move 120 coulomb through 3 V is

(A) 25 mJ (B) 360 J

(C) 40 J (D) 2.78 mJ

5. $i = ?$

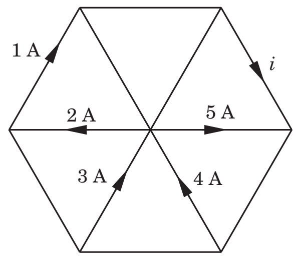


Fig. P.1.1.5

(A) 1 A (B) 2 A

(C) 3 A (D) 4 A

6. In the circuit of fig P1.1.6 a charge of 600 C is delivered to the 100 V source in a 1 minute. The value of v_1 must be

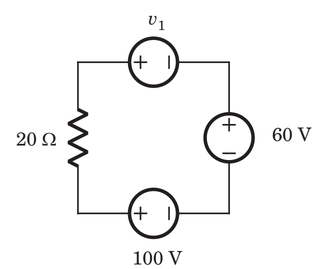


Fig. P.1.1.6

(A) 240 V (B) 120 V

(C) 60 V (D) 30 V

7. In the circuit of the fig P1.1.7, the value of the voltage source E is

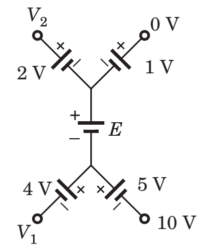


Fig. P.1.1.7

(A) –16 V (b) 4 V

(C) –6 V (D) 16 V

8. Consider the circuit graph shown in fig. P1.1.8. Each branch of circuit graph represent a circuit element. The value of voltage v_1 is

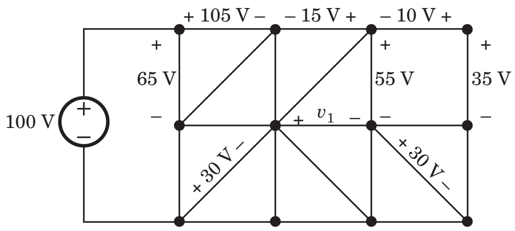


Fig. P.1.1.8

(A) –30 V (B) 25 V

(C) –20 V (D) 15 V

9. For the circuit shown in fig P.1.1.9 the value of voltage v_o is

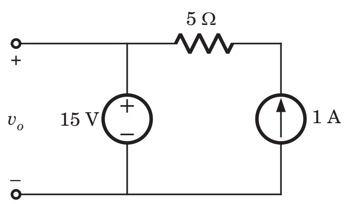


Fig. P.1.1.9

(A) 10 V (B) 15 V

(C) 20 V (D) None of the above

10. R_1 = ?

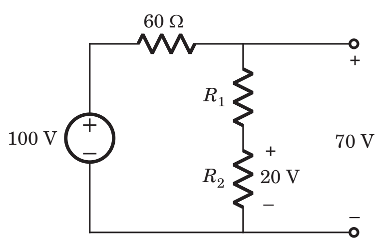


Fig. P.1.1.10

(A) 25 Ω (B) 50 Ω

(C) 100 Ω (D) 2000 Ω

11. Twelve 6 Ω resistor are used as edge to form a cube. The resistance between two diagonally opposite corner of the cube is

(A) $\frac{5}{6}$ Ω (B) $\frac{6}{5}$ Ω

(C) 5 Ω (D) 6 Ω

12. v_1 = ?

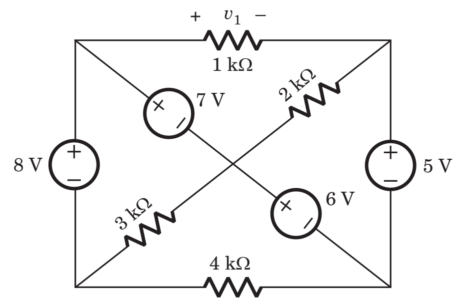


Fig. P1.1.12

(A) –11 V (B) 5 V

(C) 8 V (D) 18 V

13. The voltage v_o in fig. P1.1.11 is always equal to

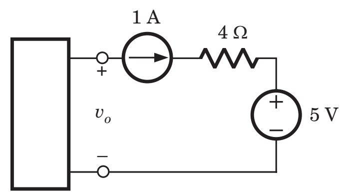


Fig. P1.1.11

(A) 1 V (B) 5 V

(C) 9 V (D) None of the above

14. R_{eq} = ?

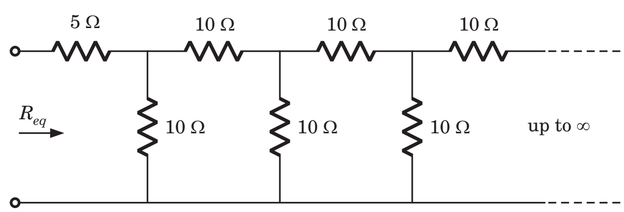


Fig. P1.1.14

(A) 11.86 Ω (B) 10 Ω

(C) 25 Ω (D) 11.18 Ω

15. v_s = ?

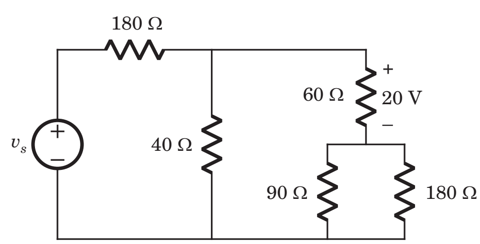


Fig. P.1.1.15

(A) 320 V (B) 280 V

(C) 240 V (D) 200 V

24. Let $i(t) = 3te^{-100t}$ A and $v(t) = 0.6(0.01 - t)e^{-100t}$ V for the network of fig. P.1.1.24. The power being absorbed by the network element at $t = 5$ ms is

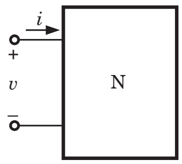


Fig. P.1.1.24

(A) 18.4 μW
(B) 9.2 μW
(C) 16.6 μW
(D) 8.3 μW

25. In the circuit of fig. P.1.1.25 bulb A uses 36 W when lit, bulb B uses 24 W when lit, and bulb C uses 14.4 W when lit. The additional A bulbs in parallel to this circuit, that would be required to blow the fuse is

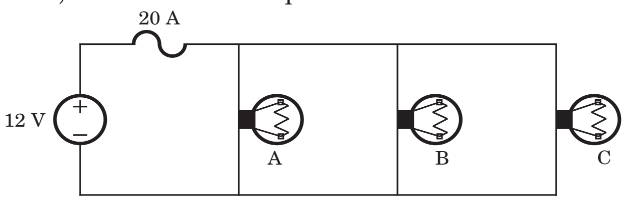


Fig. P.1.1.25

(A) 4
(B) 5
(C) 6
(D) 7

26. In the circuit of fig. P.1.1.26, the power absorbed by the load R_L is

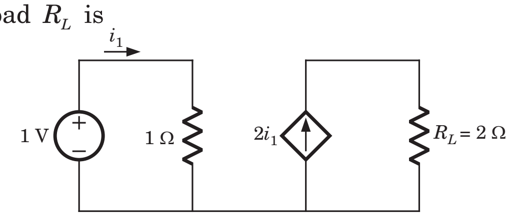


Fig. P.1.1.26

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

27. $v_o = ?$

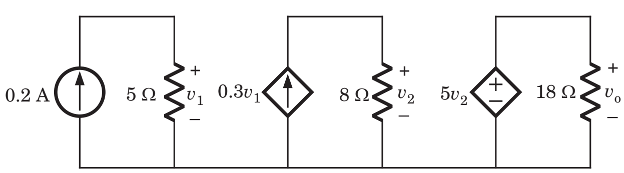


Fig. P.1.1.27

(A) 6 V
(B) –6 V
(C) –12 V
(D) 12 V

28. $v_{ab} = ?$

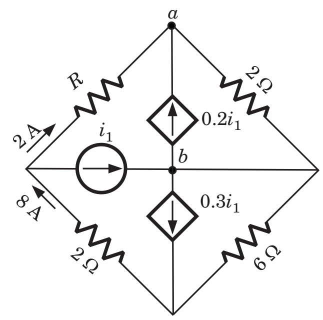


Fig. P.1.1.28

(A) 15.4 V
(B) 2.6 V
(C) –2.6 V
(D) 15.4 V

29. In the circuit of fig. P.1.1.29 power is delivered by

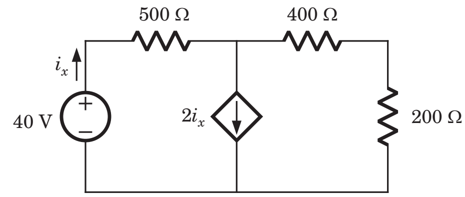


Fig. P.1.1.29

(A) dependent source of 192 W
(B) dependent source of 368 W
(C) independent source of 16 W
(D) independent source of 40 W

30. The dependent source in fig. P.1.1.30

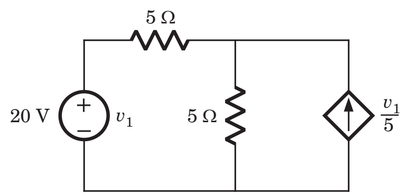


Fig. P.1.1.30

(A) delivers 80 W
(B) delivers 40 W
(C) absorbs 40 W
(D) absorbs 80 W

31. In the circuit of fig. P.1.1.31 dependent source

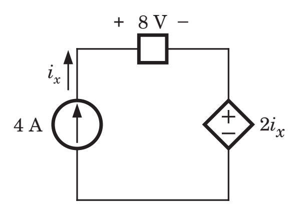


Fig. P.1.1.31

(A) supplies 16 W
(B) absorbs 16 W
(C) supplies 32 W
(D) absorbs 32 W

32. A capacitor is charged by a constant current of 2 mA and results in a voltage increase of 12 V in a 10 sec interval. The value of capacitance is

(A) 0.75 mF (B) 1.33 mF

(C) 0.6 mF (D) 1.67 mF

33. The energy required to charge a 10 μF capacitor to 100 V is

(A) 0.10 J (B) 0.05 J

(C) 5×10^{-9} J (D) 10×10^{-9} J

34. The current in a 100 μF capacitor is shown in fig. P.1.1.34. If capacitor is initially uncharged, then the waveform for the voltage across it is

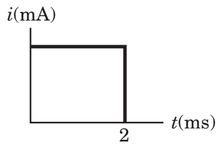
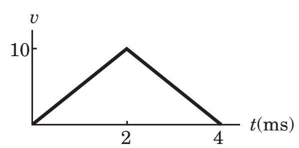
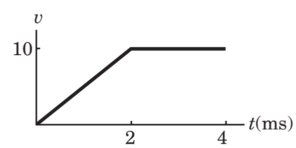


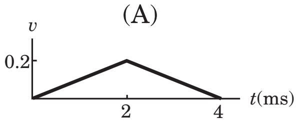
Fig. P. 1.1.34



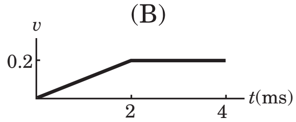
(A)



(B)



(C)



(D)

35. The voltage across a 100 μF capacitor is shown in fig. P.1.1.35. The waveform for the current in the capacitor is

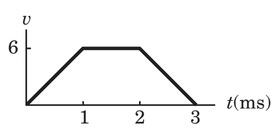
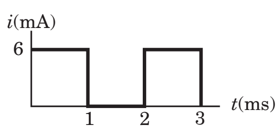
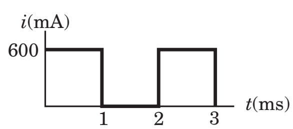


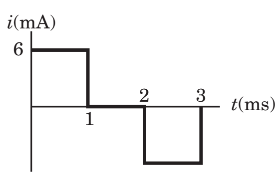
Fig. P.1.1.35



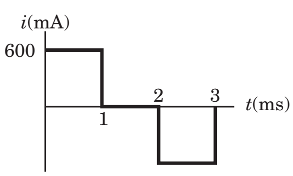
(A)



(B)



(C)



(D)

36. The waveform for the current in a 200 μF capacitor is shown in fig. P.1.1.36 The waveform for the capacitor voltage is

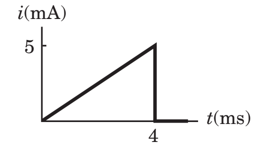
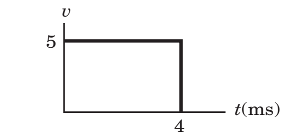
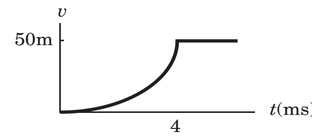


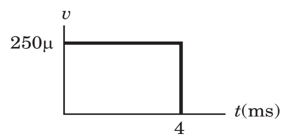
Fig. P. 1.1.36



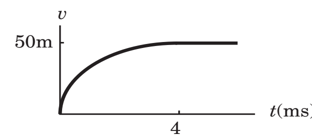
(A)



(B)



(C)



(D)

37. $C_{eq} = ?$

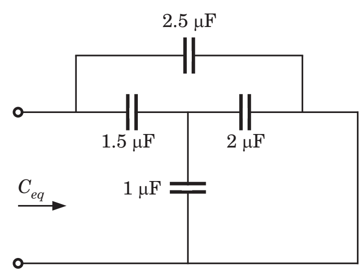


Fig. P.1.1.37

(A) 3.5 μF (B) 1.2 μF

(C) 2.4 μF (D) 2.6 μF

38. In the circuit shown in fig. P.1.1.38

$$i_{in}(t) = 300 \sin 20t \text{ mA, for } t \geq 0.$$

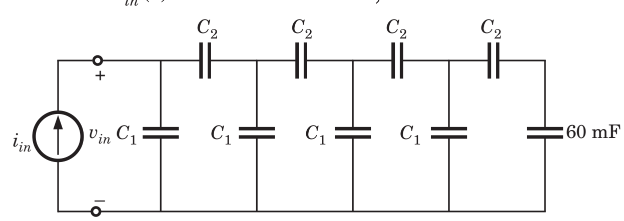


Fig. P. 1.1.38

Let $C_1 = 40$ μF and $C_2 = 30$ μF. All capacitors are initially uncharged. The $v_{in}(t)$ would be

(A) –0.25cos 20t V (B) 0.25cos 20t V

(C) –36cos 20t mV (D) 36cos 20t mV

SOLUTIONS

1. (C) $n = 10^{20}$, $Q = ne = e10^{20} = 16.02$ C

Charge on sphere will be positive.

2. (D) $\Delta Q = i \times \Delta t = 15000 \times 100\mu = 1.5$ C

3. (B) $i = \frac{dQ}{dt} = \frac{120}{60} = 2$ A

4. (B) $W = Qv = 360$ J

6. (A)

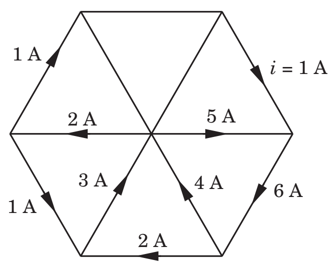


Fig. S 1.1.5

6. (A) In order for 600 C charge to be delivered to the 100 V source, the current must be anticlockwise.

$$i = \frac{dQ}{dt} = \frac{600}{60} = 10 \text{ A}$$

Applying KVL we get

$v_1 + 60 - 100 = 10 \times 20$ or $v_1 = 240$ V

7. (A) Going from 10 V to 0 V

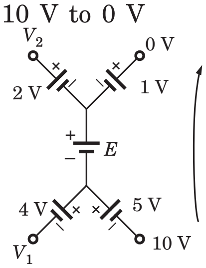


Fig. S 1.1.7

$10 + 5 + E + 1 = 0$ or $E = -16$ V

8. (D) $100 = 65 + v_2 \Rightarrow v_2 = 35$ V

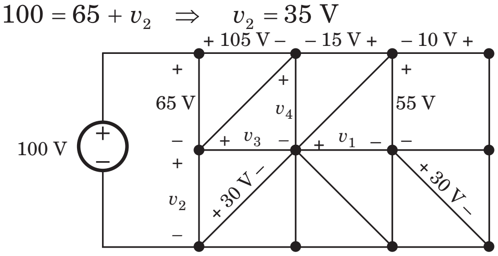


Fig. S 1.1.8

$v_3 - 30 = v_2 \Rightarrow v_3 = 65$ V

$105 + v_4 - v_3 - 65 = 0 \Rightarrow v_4 = 25$ V

$v_4 + 15 - 55 + v_1 = 0 \Rightarrow v_1 = 15$ V

9. (B) Voltage is constant because of 15 V source.

10. (C) Voltage across 60 Ω resistor = 30 V

Current $= \frac{30}{60} = 0.5$ A

Voltage across R_1 is $= 70 - 20 = 50$ V

$R_1 = \frac{50}{0.5} = 100\ \Omega$

11. (C) The current i will be distributed in the cube branches symmetrically

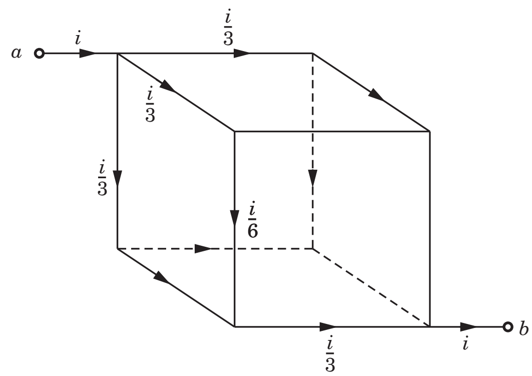


Fig. S. 1.1.11

$$v_{ab} = \frac{6i}{3} + \frac{6i}{6} + \frac{6i}{3} = 5i,$$

$$R_{eq} = \frac{v_{ab}}{i} = 5\ \Omega$$

12. (C) If we go from +side of 1 kΩ through 7 V, 6 V and 5 V, we get $v_1 = 7 + 6 - 5 = 8$ V

13. (D) It is not possible to determine the voltage across 1 A source.

14. (D) $R_{eq} = 5 + \frac{10(R_{eq} + 5)}{10 + 5 + R_{eq}}$

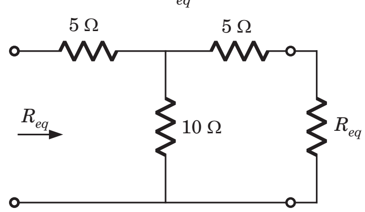


Fig. S 1.1.14

$\Rightarrow R_{eq}^2 + 15R_{eq} = 5R_{eq} + 75 + 10R_{eq} + 50$

$\Rightarrow R_{eq} = \sqrt{125} = 11.18\ \Omega$

$\frac{v_o-20}{5}+\frac{v_o}{5}=\frac{20}{5} \quad \Rightarrow \quad v_o=20$ V

Power is $P=v_o\times\frac{v_1}{5}=20\times\frac{20}{5}=80$ W

31. (D) Power $P=vi=2i_x\times i_x=2i_x^2$

$i_x=4$ A, $P=32$ W (absorb)

32. (D) $v_{t2}-v_{t1}=\frac{1}{C}\int_{t1}^{t2} idt \quad \Rightarrow \quad 12=\frac{1}{C}2\text{m}\,(t_2-t_1)$

$\Rightarrow \quad 12C=2\text{m}\times 10 \quad \Rightarrow \quad C=1.67$ mF

33. (B) $E=\frac{1}{2}Cv^2=5\times10^{-6}\times100^2=0.05$ J

34. (D) $v_c=\frac{1}{c}\int_0^{2\text{m}} idt=\frac{10\times10^{-3}}{100\times10^{-6}}(2\times10^{-3})=0.2$ V

This 0.2 V increases linearly from 0 to 0.2 V. Then current is zero. So capacitor hold this voltage.

35. (D) $i=C\frac{dv}{dt}$

For $0<t<1$, $C\frac{dv}{dt}=100\times10^{-6}\times\frac{6-0}{10^{-3}-0}=600$ mA

For 1 ms $<t<$ 2 ms,

$C\frac{dv}{dt}=100\times10^{-6}\times\frac{0-6}{(3-2)\text{m}}=-600$ mA

36. (B) For $0\le t\le 4$,

$v_C=\frac{1}{C}\int idt=\frac{1}{200\times10^{-6}}\int\frac{5\text{m}}{4\text{m}}tdt=3125t^2$

At $t=4$ ms, $v_c=0.05$ V

It will be parabolic path. at $t=0$ t-axis will be tangent.

37. (A) 2 μF is in parallel with 1 μF and this combination is in series with 1.5 μF.

$C_1=\frac{1.5\,(2+1)}{1.5+2+1}=1\mu\text{F}$, C_1 is in parallel with 2.5 μF

$C_{eq}=1+2.5=3.5\ \mu\text{F}$

38. (A) $C_a=\frac{30\times60}{30+60}=20$ mF, $C_b=\frac{30(20+40)}{30+20+0}=20$ mF

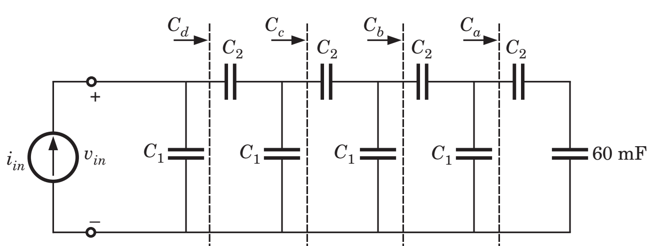


Fig. S 1.1.38

We can say $C_d=20$ mF, $C_{eq}=20+40=60$ mF

$v_C=\frac{1}{C}\int idt=\frac{1}{60\text{m}}\left(-\frac{300}{20}\cos 20t\right)\times10^{-3}=-0.25\cos 20t$ V

39. (C) $i_{C1}=\frac{i_{in}C_1}{C_1+C_2}=0.8\sin 600t$ mA

At $t=2$ ms, $i_{C1}=0.75$ mA

40. (B) $v_{C1}=\frac{v_{in}C_2}{C_1+C_2}=\frac{4v_{in}}{6+4} \quad \Rightarrow \quad \frac{v_{c1}}{v_{in}}=0.4$

41. (D) $V=2+3+5=10$, $Q=1$ C, $C=\frac{Q}{V}=0.1$ F

42. (A) $v_L=L\frac{di}{dt} \Rightarrow \quad 100\text{m}=L\frac{200\text{m}}{4\text{m}} \quad \Rightarrow \quad L=2$ mH

43. (B) $v_L=L\frac{di}{dt}=0.01\times2(377\cos 377t)$ V

$=7.54\cos 377t$ V

44. (A) $i=\frac{1}{L}\int vdt=\frac{1}{0.01}\int 120\cos 3t\,dt=\frac{12000}{377}\sin 377t$

$P=vi=\frac{12000\times120}{377}(\sin 377t)(\cos 377t)$

$=1910\sin 754t$ W

45. (D) $v_L=L\frac{di_L}{dt}$, $i_C=C\frac{dv_C}{dt}$

$v_C=3v_L \Rightarrow \quad i_C=3LC\frac{d^2i_L}{dt}=-9.6\sin 4t$ A

46. (B) $v_L=L\frac{di_L}{dt}$

For $2<t\le4$, $\quad v_L=(0.05)\left(\frac{-100-0}{2}\right)=-2.5$ V

For $4<t\le8$, $\quad v_L=(0.05)\left(\frac{100+100}{4}\right)=2.5$ V

For $8<t\le10$, $\quad v_L=(0.05)\left(\frac{0-100}{2}\right)=-2.5$ V

Thus (B) is correct option.

47. (C) Algebraic sum of the current entering or leaving a cutset is equal to 0.

$i_2+i_4+i_3=0 \quad \Rightarrow \quad \frac{6}{2}+\frac{16}{4}+i_3=0$

$i_3=-7$ A, $\quad v_3=-7\times3=-21$ V

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