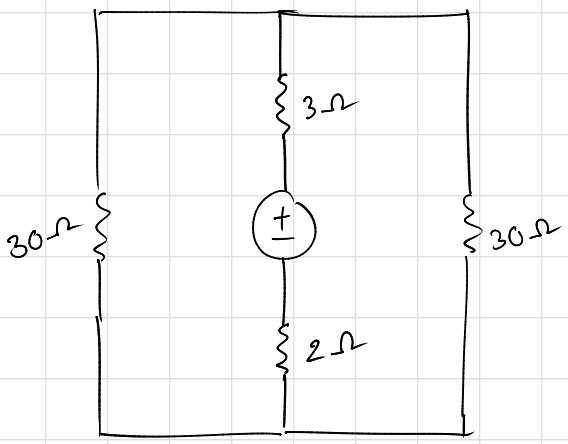
1. a)

$14 + 20 \| (50+30)$

$= 30$

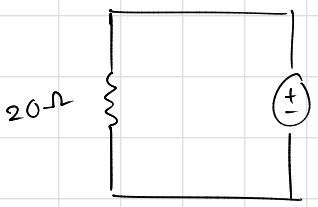


$12 + 27 \| (30+24)$

$= 30\Omega$

$2+3+30\|30$

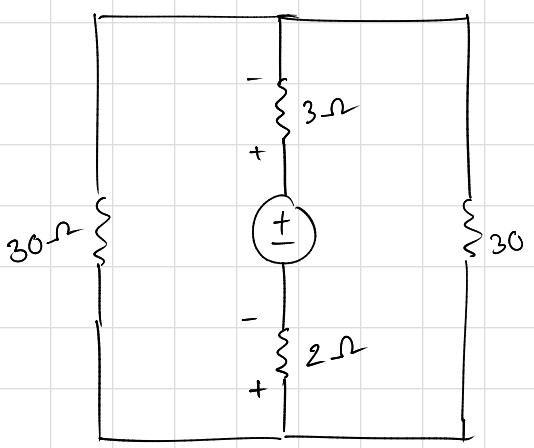
$= 20$



$R_{eq} = 20\Omega$

b) voltage across $3\Omega = 10 \times \dfrac{3}{2+3+30\|30} = 1.5\ V$

" " $2\Omega = 10 \times \dfrac{2}{2+3+30\|30} = 1\ V$

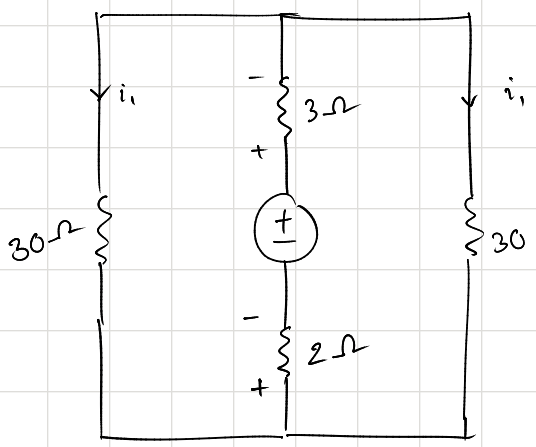


c) current through the whole circuit

$i = \dfrac{10}{20} = 0.5\ A$

$i_1 = 0.5 \times \dfrac{30}{30+30} = 0.25\ A$

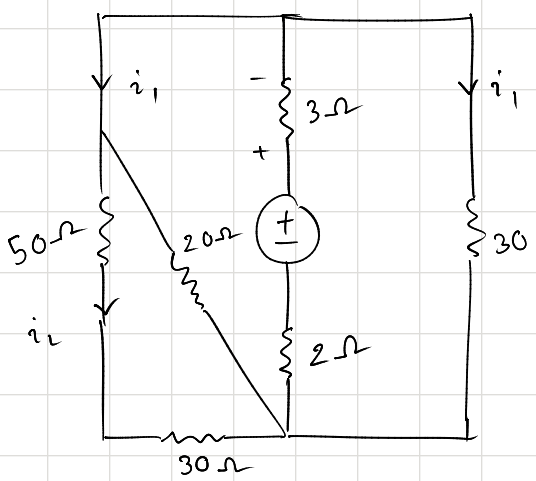
∴ current through $12\Omega = 0.25\ A$



$i_2 = i_1 \times \dfrac{20}{20+(50+30)}$

$= 0.25 \times 0.2$

$= 0.05\ A$



∴ current through $50\Omega = 0.05A$

2. a)

$q_1 = 20t \quad \{0 \le t \le 1\}$

$q_2 = 20 \quad \{1 \le t < 3\}$

$q_3 = -\frac{40}{2}t + c = -20t + c = -20t + 80 \quad \{3 \le t \le 5\}$

$q_3(3) = q_2(3)$

$\Rightarrow -60 + c = 20$

$\Rightarrow c = 80$

$q_4 = \frac{40}{2}t + c = 20t + c = 20t - 120 \quad \{5 \le t \le 7\}$

$q_4(5) = q_3(5)$

$\Rightarrow 100 + c = -20$

$\Rightarrow c = -120$

$q_5 = 20 \quad \{7 \le t\}$

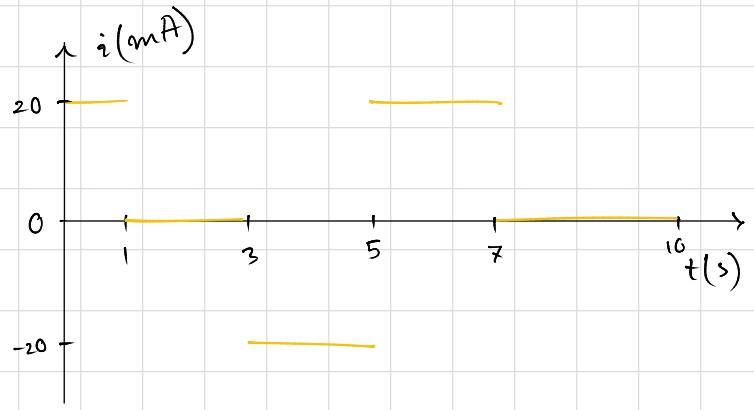
$i_1 = 20$

$i_2 = 0$

$i_3 = -20$

$i_4 = 20$

$i_5 = 0$



b)

$p = i^2R$

for $0 \le t \le 1$

$p = 20^2 \times 10 = 4$ mW

for $1 \le t \le 3$

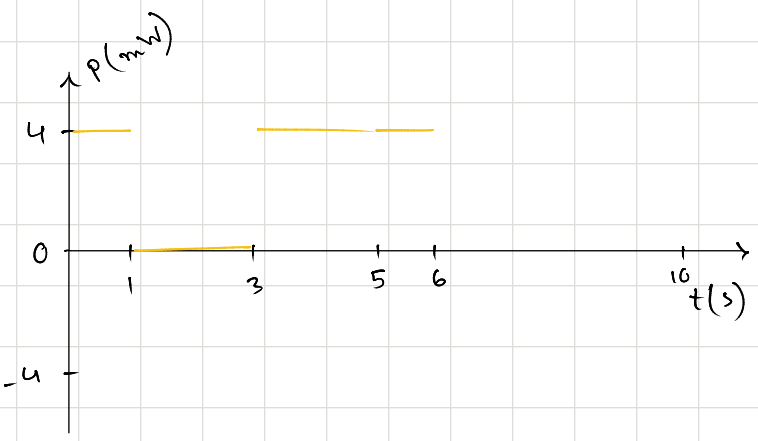
$p = 0^2 \times 10 = 0$

for $3 \le t \le 5$

$p = (-20)^2 \times 10 = 4$ mW

for $5 \le t \le 6$

$p = 20^2 \times 10 = 4$ mW

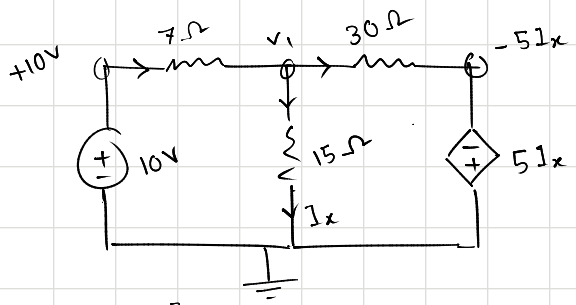


total energy delivered from 0 to 6 sec

$E = 4 \times 1 + 0 + 4 \times 3$

$= 16$ mJ

3. a)



node v_1:

$\frac{10 - v_1}{7} = \frac{v_1 + 5I_x}{30} + \frac{v_1}{15}$

$\Rightarrow \frac{10 - v_1}{7} = \frac{v_1 + \frac{v_1}{3}}{30} + \frac{v_1}{15} \quad \left[I_x = \frac{v_1}{15}\right]$

$\Rightarrow v_1 = 5.625$ V $\quad \therefore I_x = 0.375$ A

current through $7\Omega = \frac{10 - v_1}{7} = 0.625$ A

current through $30\Omega = \frac{v_1 + 5I_x}{30} = 0.25$A

" " $15\Omega = I_x = 0.375$ A

current through 10V = 0.625 A

" " $5I_x = 0.25$ A

b) power supplied by 10V = $10 \times 0.625 = 6.25$ W

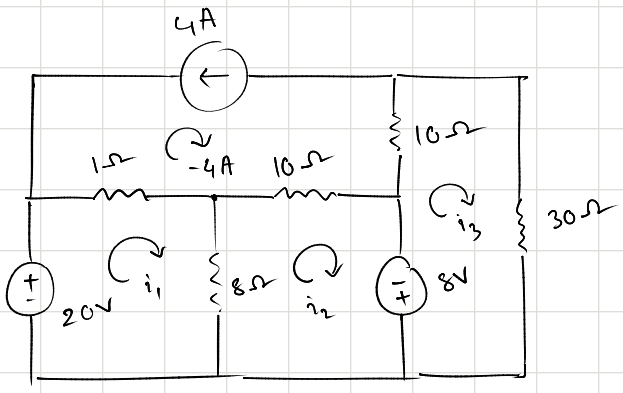
power absorbed by 7Ω = $7 \times 0.625^2 = 2.734$ W

power absorbed by 15Ω = $0.375^2 \times 15 = 2.109$ W

power absorbed by 30Ω = $0.25^2 \times 30 = 1.875$ W

power supplied by 51_x = $5 \times 0.375 \times 0.25 = 0.469$ W

4. a)



loop 1:

$1(i_1 + 4) + 8(i_1 - i_2) - 20 = 0$

$\Rightarrow i_1 + 4 + 8i_1 - 8i_2 - 20 = 0$

$\Rightarrow 9i_1 - 8i_2 = 16$

loop 2:

$8(i_2 - i_1) + 10(i_2 + 4) - 8 = 0$

$\Rightarrow 8i_2 - 8i_1 + 10i_2 + 40 - 8 = 0$

$\Rightarrow -8i_1 + 18i_2 = -32$

loop 3:

$10(i_3 + 4) + 30i_3 + 8 = 0$

$\Rightarrow 10i_3 + 40 + 30i_3 + 8 = 0$

$\Rightarrow 40i_3 = -48$

$\Rightarrow i_3 = -1.2$

$i_1 = 0.326$ A

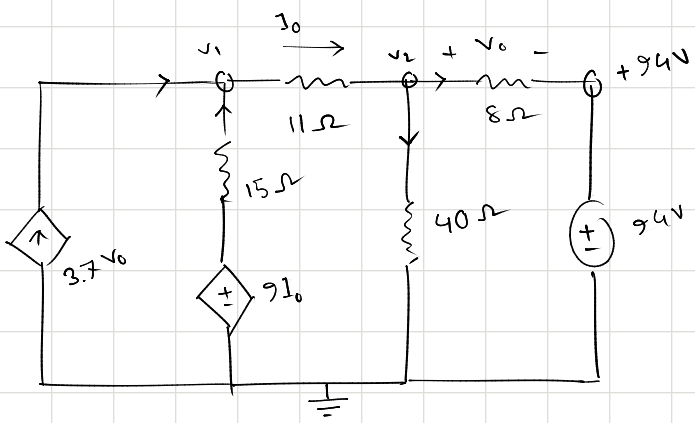
$i_2 = -1.63$ A

$i_3 = -1.2$ A

b) $p = i^2R = (i_1 + 4)^2 \times 1$

$= 18.714$ W

5. a)



node v_1

$3.7v_o + \frac{91_o - v_1}{15} = 1_o$

$\Rightarrow 3.7(v_2 - 94) + \frac{1}{15}\left(9\frac{v_1 - v_2}{11} - v_1\right) = \frac{v_1 - v_2}{11}$

$\Rightarrow 3.7v_2 - 347.8 + \frac{1}{15}\left(\frac{9}{11}v_1 - \frac{9}{11}v_2 - v_1\right)$

$= \frac{1}{11}v_1 - \frac{1}{11}v_2$

$\Rightarrow 3.7v_2 - 347.8 + \frac{3}{55}v_1 - \frac{3}{55}v_2 - \frac{1}{15}v_1 = \frac{1}{11}v_1 - \frac{1}{11}v_2$

$\Rightarrow \left(\frac{3}{55} - \frac{1}{15} - \frac{1}{11}\right)v_1 + \left(3.7 - \frac{3}{55} + \frac{1}{11}\right)v_2 = 347.8$

$\Rightarrow -\frac{17}{165}v_1 + \frac{411}{110}v_2 = 347.8$ —— (1)

node v_2:

$$\frac{v_1 - v_2}{11} = \frac{v_2 - 94}{8} + \frac{v_2}{40}$$

$$\Rightarrow \frac{1}{11}v_1 - \frac{1}{11}v_2 = \frac{1}{11}v_2 - \frac{94}{8} + \frac{v_2}{40}$$

$$\Rightarrow \frac{1}{11}v_1 + \left(-\frac{1}{11} - \frac{1}{8} - \frac{1}{40}\right)v_2 = -\frac{94}{8} \quad \text{—— (11)}$$

$$\Rightarrow \frac{1}{11}v_1 - \frac{53}{220}v_2 = -\frac{94}{8}$$

solve (1) and (11)

$v_1 = 126.68$

$v_2 = 96.578$

b) $v_0 = v_2 - 94 = 2.578$

$I_0 = \frac{v_1 - v_2}{11} = 2.74$