Kirchoff's Laws Exercises:

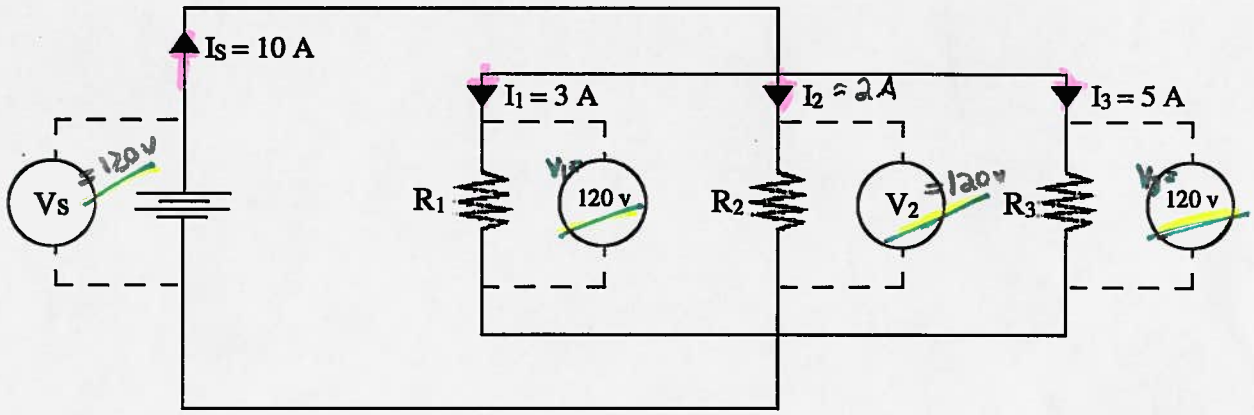
name: SOLUTIONS

Recall:

In **Series** Circuits:	$I_s = I_1 = I_2 = I_3 = I_4 = \ldots$
In **Parallel** Circuits:	$I_s = I_1 + I_2 + I_3 + I_4 + \ldots$
In **Series** Circuits:	$V_s = V_1 + V_2 + V_3 + V_4 + \ldots$
In **Parallel** Circuits:	$V_s = V_1 = V_2 = V_3 = V_4 = \ldots$

SHOW ALL WORK:

1) Study the circuit diagram below and answer the following questions:



a) **What is the value of V_2 ?** $V_S = V_1 = V_2 = V_3$ (Parallel) $V_2 = 120\,V$

b) **What is the value of V_s ?** $V_S = V_1 = V_2 = V_3$ (parallel) $V_S = 120\,V$

c) **What is the value of I_2 ?** $I_S = I_1 + I_2 + I_3$ (parallel)

$10 = 3 + I_2 + 5$ $I_2 = 2A$

d) **What is the Value of R_1 ?**

e) **What is the Value of R_2 ?**

f) **What is the Value of R_3 ?**

$R_1 = \frac{V_1}{I_1}$ $R_2 = \frac{V_2}{I_2}$ $R_3 = \frac{V_3}{I_3}$

$R_1 = \frac{120}{3}$ $R_2 = \frac{120}{2}$ $R_3 = \frac{120}{5}$

$R_1 = 40\Omega$ $R_2 = 60\Omega$ $R_3 = 24\Omega$

g) **Show 2 different ways to calculate the Equivalent Resistance of the entire circuit.**

(1)

$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

$\frac{1}{R_T} = \frac{1}{40} + \frac{1}{60} + \frac{1}{24}$

$\frac{1}{R_T} = \frac{9 + 6 + 15}{360}$

$\frac{1}{R_T} = \frac{30}{360}$

$R_T = 12\Omega$

(2)

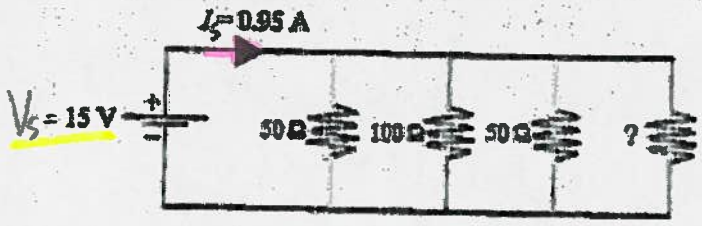
$R_T = \frac{V_S}{I_S}$

$R_T = \frac{120}{10}$

$R_T = 12\Omega$

2) What is the equivalent resistance of the following circuits?

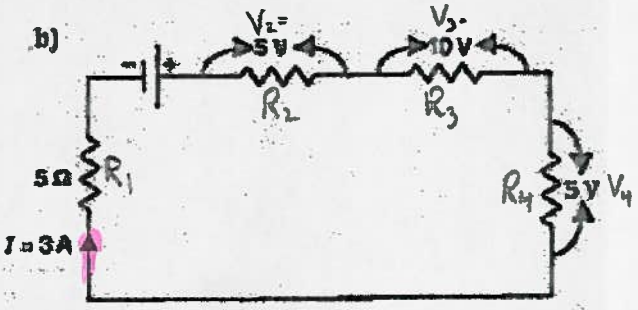
a)



$R_T = \frac{V_s}{I_s}$

$R_T = \frac{15}{0.95} = 15.8\,\Omega$

b)



① $I_s = I_1 = I_2 = I_3 = I_4$ (series)

$= 3\,A$

② $R_2 = \frac{V_2}{I_2}$ $\quad R_2 = \frac{5}{3}$ $\quad R_2 = 1.67\,\Omega$

③ $R_3 = \frac{V_3}{I_3}$ $\quad R_3 = \frac{10}{3}$ $\quad R_3 = 3.33\,\Omega$

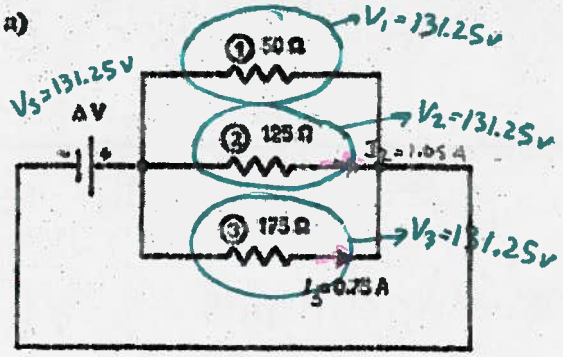
④ $R_4 = \frac{V_4}{I_4}$ $\quad R_4 = \frac{5}{3}$ $\quad R_4 = 1.67\,\Omega$

⑤ $R_T = R_1 + R_2 + R_3 + R_4$ (series)

$R_T = 5 + 1.67 + 3.33 + 1.67 = 11.67\,\Omega$

3) What is the current flowing through the no. 2 resistors in the following circuits? $I_2 = ??$

a)



① $V_3 = I_3 R_3$

$V_3 = 0.75(175)$

$V_3 = 131.25\,V$

② $V_s = V_1 = V_2 = V_3$ (parallel)

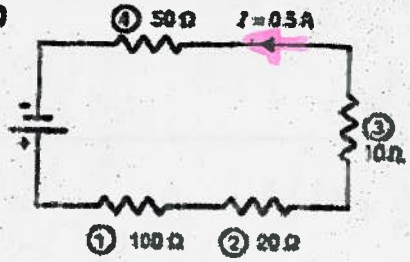
$V_2 = 131.25\,V$

③ $I_2 = \frac{V_2}{R_2}$

$I_2 = \frac{131.25}{125}$

$I_2 = 1.05\,A$

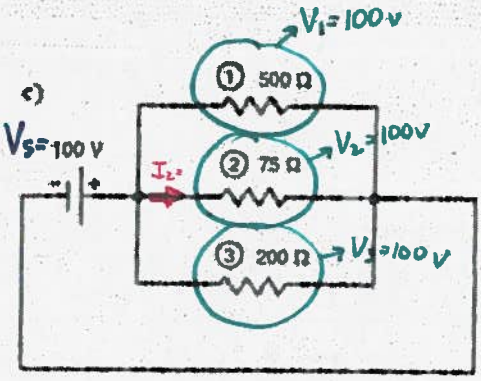
b)



$I_s = I_1 = I_2 = I_3 = I_4$ (series)

$I_2 = 0.5\,A$

c)



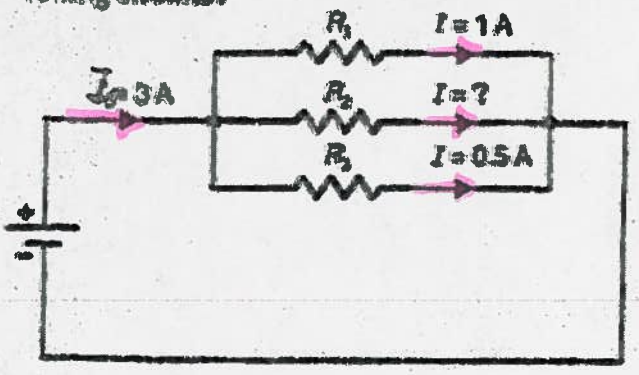
① $V_s = V_1 = V_2 = V_3$

$= 100\,V$

② $I_2 = \frac{V_2}{R_2}$

$I_2 = \frac{100}{75} = 1.33\,A$

4) **Determine the unknown currents in the following circuits:**



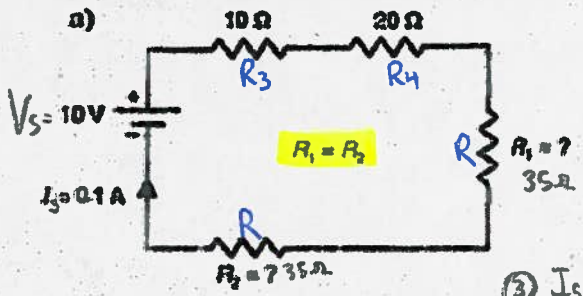
$I_s = I_1 + I_2 + I_3$ (Parallel)

$3 = 1 + I_2 + 0.5$

$I_2 = 1.5A$

5) **Determine the potential difference across the resistors indicated by a question mark.**

a)



① $R_T = \frac{V_s}{I_s}$

$R_T = \frac{10}{0.1}$

$R_T = 100\Omega$

② $R_T = R + R + R_3 + R_4$

$100 = 2R + 10 + 20$

$70 = 2R$

$R = 35\Omega$

$(R_1 \& R_2)$

③ $I_s = I_1 = I_2 = I_3 = I_4$ (Series) $= 0.1A$

④ $V_1 = I_1 R_1$

$V_1 = 0.1(35)$

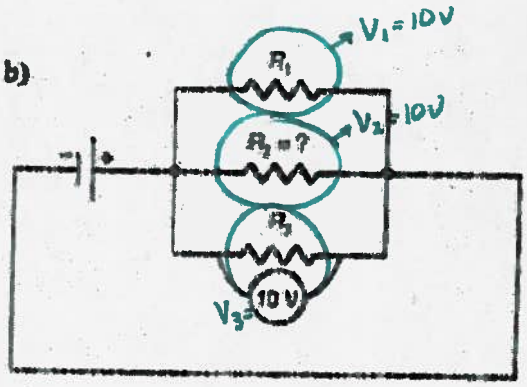
$V_1 = 3.5V$

⑤ $V_2 = I_2 R_2$

$V_2 = 0.1(35)$

$V_2 = 3.5V$

b)



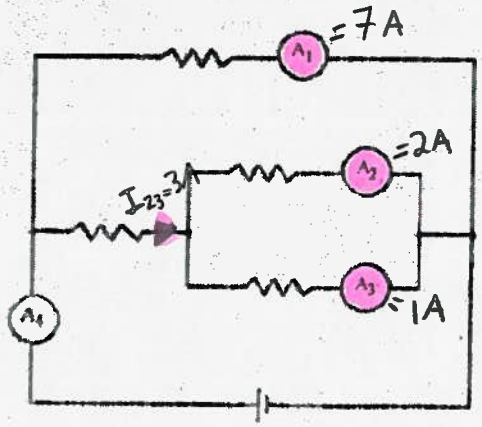
$V_s = V_1 = V_2 = V_3$

(Parallel) $= 10V$

6) **Given the following circuit diagram in which four ammeters have been installed:**

Ammeter A_1 reads 7.0 A.
Ammeter A_2 reads 2.0 A.
Ammeter A_3 reads 1.0 A.

What is the reading on ammeter A_4?



$I_{23} = I_2 + I_3$ (Parallel)

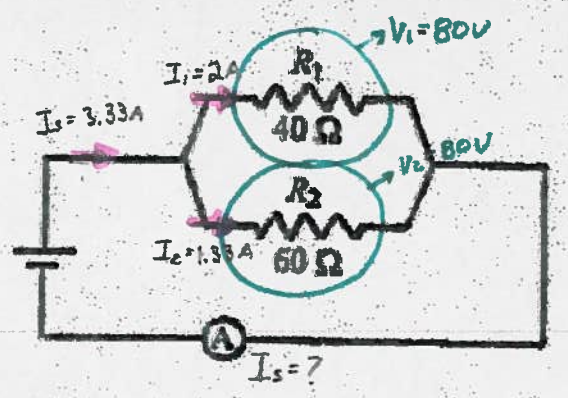
$= 3A$

$I_4 = I_{23} + I_1$

$I_4 = 3 + 7$

$I_4 = 10A$

7) **The following circuit consists of a power supply, two resistors (R_1 and R_2) and an ammeter (A)**



The current through resistor R_1 is 2 A.

What is the current indicated by ammeter (A)? $= I_s$

① $V_1 = I_1 R_1$
$V_1 = 2(40)$
$V_1 = 80V$

② $V_s = V_1 = V_2$
(Parallel) $= 80V$

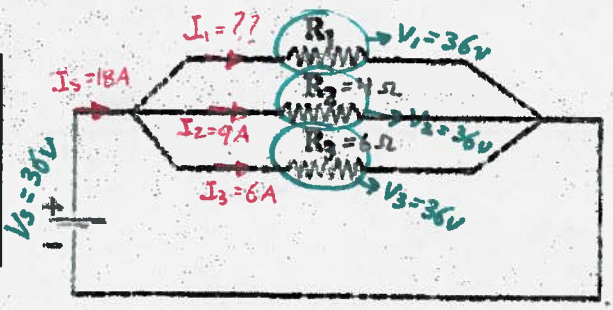
③ $I_2 = \frac{V_2}{R_2}$
$I_2 = \frac{80}{60} = 1.33A$

④ $I_s = I_1 + I_2$
(Parallel)
$I_s = 2 + 1.33$
$I_s = 3.33A$

8) **The following circuit is connected to a source that can provide a current intensity of 18 A when the potential difference (voltage) is 36 V?**

Place on diagram:

$V_s = 36$ V
$I_s = 18$ A
$R_2 = 4\ \Omega$
$R_3 = 6\ \Omega$
$I_3 = 6$ A



① $V_s = V_1 = V_2 = V_3$
(Parallel) $= 36V$

② $I_2 = \frac{V_2}{R_2}$
$I_2 = \frac{36}{4}$
$I_2 = 9A$

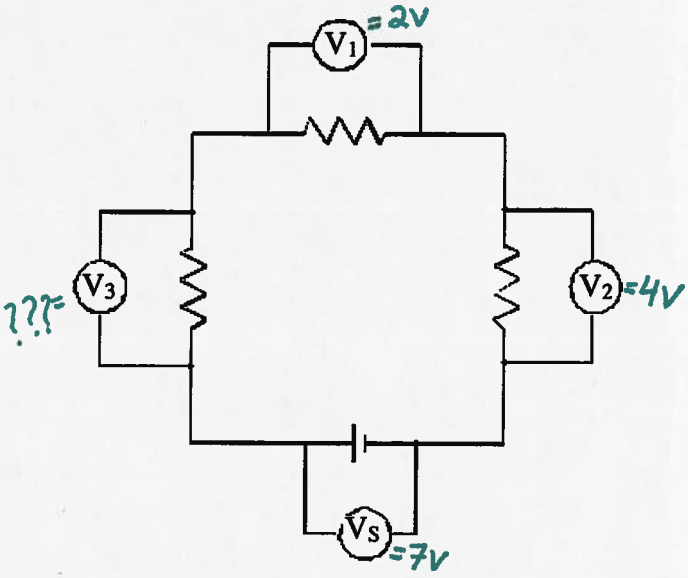
③ $I_s = I_1 + I_2 + I_3$
$18 = 6 + 9 + I_3$
$I_3 = 3A$

What is the current intensity I_1 flowing through resistor R_1?

9) Given the following electric circuit with four voltmeters.

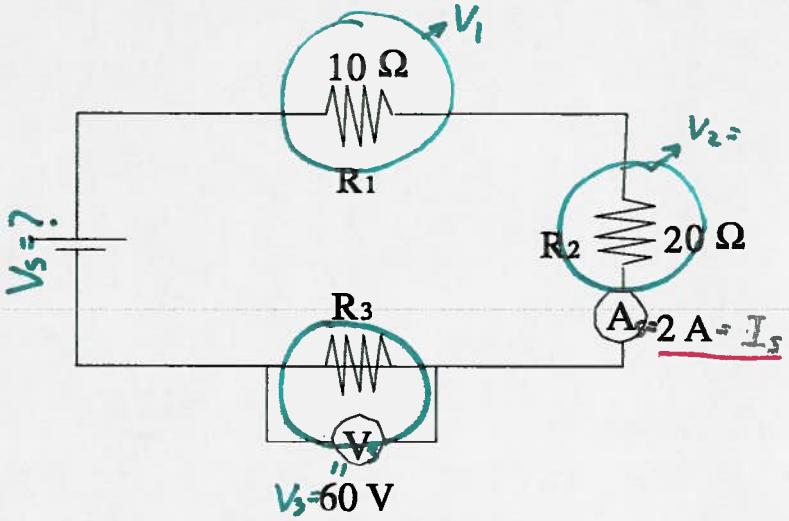
Voltmeter V_1 reads 2.0 V.
Voltmeter V_2 reads 4.0 V.
Voltmeter V_s reads 7.0 V.

What is the reading on voltmeter V_3?



$V_s = V_1 + V_2 + V_3$
(Series)
$7 = 2 + 4 + V_3$
$V_3 = 1V$

10) The circuit illustrated below consists of a power supply, three resistors (R_1, R_2 and R_3), an ammeter (A) and a voltmeter (V).



What is the potential difference (*V*) at the terminals of the power supply? (Vs)

METHOD: 1

① $I_s = I_1 = I_2 = I_3$ (series) $= 2A$

② $V_1 = I_1 R_1$
$V_1 = 2(10)$
$V_1 = 20V$

③ $V_2 = I_2 R_2$
$V_2 = 2(20)$
$V_2 = 40V$

④ $V_s = V_1 + V_2 + V_3$ (series)
$V_s = 20 + 40 + 60$
$V_s = 120V$

METHOD: 2

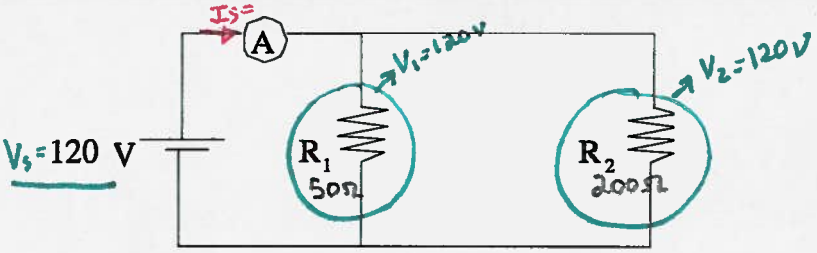
① $I_s = I_1 = I_2 = I_3$ (series) $= 2A$

② $R_3 = \frac{V_3}{I_3} = \frac{60}{2} = 30\Omega$

③ $R_T = R_1 + R_2 + R_3$ (series)
$R_T = 10 + 20 + 30$
$R_T = 60\Omega$

④ $V_s = I_s R_T$
$V_s = 2(60)$
$V_s = 120V$

11) An electric circuit is illustrated below. The value of the resistors are: $R_1 = 50\ \Omega$, $R_2 = 200\ \Omega$



a) What is the value of the equivalent resistance of this circuit?

b) What is the value of the total current read by the ammeter?

c) What is the current flowing through R_1 ?

d) What is the current flowing through R_2 ?

a) $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$
$\frac{1}{R_T} = \frac{1}{50} + \frac{1}{200}$
$\frac{1}{R_T} = \frac{4+1}{200}$
$\frac{1}{R_T} = \frac{5}{200}$
$R_T = 40\Omega$

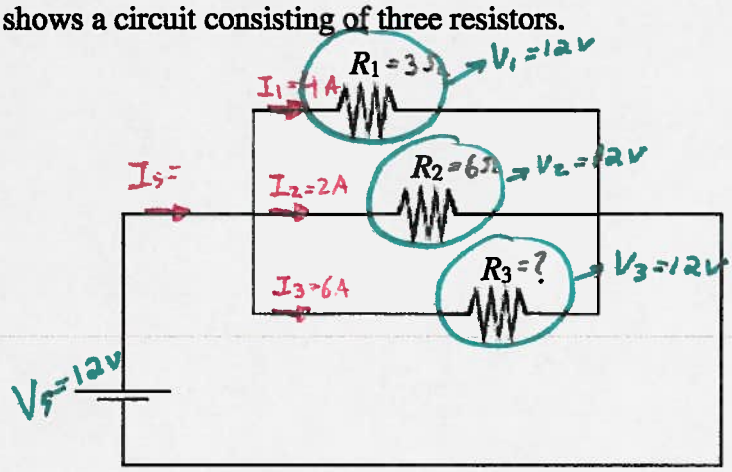
b) $I_s = \frac{V_s}{R_T}$
$I_s = \frac{120}{40} = 3A$

$V_s = V_1 = V_2$ (Parallel)
$= 120V$

c) $I_2 = \frac{V_2}{R_2}$
$I_2 = \frac{120}{50}$
$I_2 = 2.4A$

d) $I_3 = \frac{V_3}{R_3}$
$I_3 = \frac{120}{200}$
$I_3 = 0.6A$

12) The following diagram shows a circuit consisting of three resistors.



a) Place the following information on the above circuit diagram:

$R_1 = 3\ \Omega$ $I_1 = 4\ A$	$R_2 = 6\ \Omega$ $I_2 = 2\ A$	$R_3 = ?$ $I_3 = 6\ A$

b) What is the total current provided by the power source (I_s) ? $I_s = I_1 + I_2 + I_3$ (Parallel)

$I_s = 4 + 2 + 6$

$I_s = 12A$

c) What is the potential difference of the Power Source (V_s) ?

① $V_1 = I_1 R_1$ $\quad V_1 = 4(3)$ $\quad V_1 = 12V$

② $V_s = V_1 = V_2 = V_3$ (Parallel) $\quad V_s = 12V$

d) What is the value of resistor R_3?

$R_3 = \frac{V_3}{I_3}$ $\quad R_3 = \frac{12}{6} = 2\Omega$

Solutions:

1) a) 120 V b) 120 V c) 2 A d) 40 Ω e) 60 Ω f) 24 Ω g) 12 Ω
2) a) Req = 15.79 Ω b) Req = 11.67 Ω
3) a) 1.05 A b) 0.5A c) 1.33A
4) 1.5A
5) a) $V_1 = 3.5V$ $V_2 = 3.5V$ b) 10V
6) 10A
7) 3.33A
8) 3A
9) 1V
10) 120V
11) a) 40Ω b) 3A c) 2.4A d) 0.6A
12) a) - b) 12A c) 12V d) 2Ω