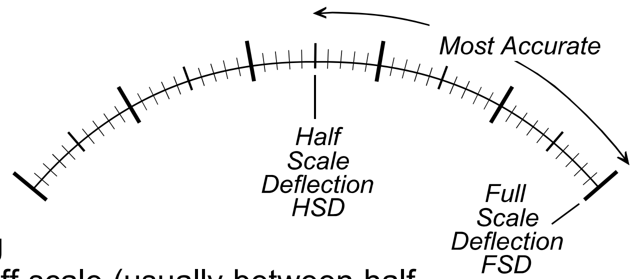
Assignment

ELECTROTECHNOLOGY
ELTK1100
ASSIGNMENT #2
SOLUTIONS

1. **(a)** 2.76 mA.
(b) 13.8 mA.
(c) 0.69 mA.
(d) 27.6 mA.



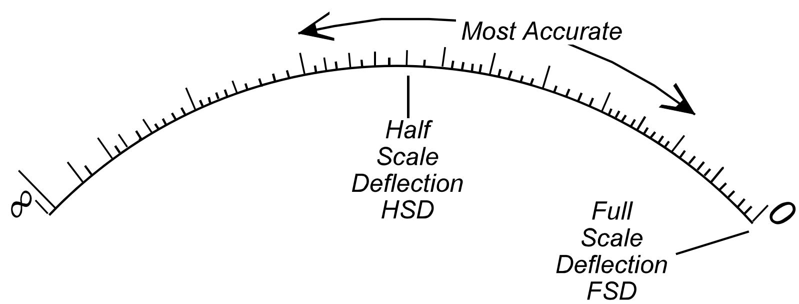
Analog ammeter and voltmeter readings are most accurate when the meter reading has the largest deflection without going off scale (usually between half scale deflection and full scale deflection - i.e. between 5mA and 10mA on the 10mA scale).

Yes, the reading can be more accurate. For part (a), the reading is 2.76mA, but it is very difficult to determine the last digit on a 10mA scale. If the scale is decreased from 10mA to 5mA, the 2.76mA reading will cause a larger deflection and it will be easier to determine the last digit. Accuracy has increased. Simply, 2.76mA can be read on a 5mA scale.

2. **(a)** 2.82 V.
(b) 141 V.
(c) 5.64 V.
(d) 1.41 V.

No, the accuracy is at it's best. For the 2.82V reading of part (a), the needle is to the right of half scale deflection (2.5V on 5V scale), so the meter accuracy cannot be increased. Simply, a reading of 2.82V, cannot be measured on a 2.5V scale. It will go off scale.

3. **(a)** 370Ω.
(b) 37kΩ.
(c) 37Ω.



Each range of an Analog Ohmmeter covers the same scale, 0Ω to infinity. To obtain accurate readings, you must select a range that positions the needle closer to half scale deflection (as shown on the drawing).

When the needle is close to full scale deflection, it is difficult to determine the second digit. The range must be decreased.

No, the reading of 370Ω taken on the Rx100 scale is close to half scale deflection, so the reading is as accurate as it can be.

4. **(a)**

$$R_T = R_1 + R_2 + R_3$$
$$= 2k\Omega + 6k\Omega + 4k\Omega = 12k\Omega \quad {}^{1}$$
$$I_T = \frac{V_T}{R_T} = \frac{120V}{12k\Omega} = \frac{120}{12 * 10^3} = 10\ mA. \quad {}^{2}$$
$$I_T = I_1 = I_2 = I_3 = 10\ mA. \quad {}^{3}$$

$$V_1 = I_1 R_1 = 10mA * 2k\Omega$$
$$= 10 * 10^{-3} * 2 * 10^3 = 20V. \quad {}^{4}$$
$$V_2 = I_2 R_2 = 10mA * 6k\Omega = 60V. \quad {}^{5}$$
$$V_3 = I_3 R_3 = 10mA * 4k\Omega = 40V. \quad {}^{6}$$

	V (V)	I (mA)	R (Ω)
T	***120***	10 [2]	12k [1]
1	20 [4]	10 [3]	***2k***
2	60 [5]	10 [3]	***6k***
3	40 [6]	10 [3]	***4k***

Series circuit

(b)

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$
$$= \frac{1}{2k\Omega} + \frac{1}{6k\Omega} + \frac{1}{4k\Omega}$$
$$\frac{1}{R_T} = 0.917mS$$

$$R_T = \frac{1}{0.000917} = 1090\Omega \quad {}^{1}$$

or

$$2k\Omega \parallel 6k\Omega = \frac{2 * 10^3 * 6 * 10^3}{(2 * 10^3 + 6 * 10^3)}$$
$$= \frac{1.2 * 10^7}{8 * 10^3} = 1.5k\Omega$$
$$1.5k\Omega \parallel 4k\Omega = \frac{6 * 10^6}{5.5 * 10^3} = 1090\Omega$$
$$R_T = 1090\Omega \quad {}^{1}$$

then

$$V_T = V_1 = V_2 = V_3 = 120V. \quad {}^{2}$$
$$I_T = \frac{V_T}{R_T} = \frac{120V}{1090\Omega} = 110mA. \quad {}^{3}$$
$$I_1 = \frac{V_1}{R_1} = \frac{120V}{2k\Omega} = 60mA. \quad {}^{4}$$
$$I_2 = \frac{V_2}{R_2} = \frac{120V}{6k\Omega} = 20mA. \quad {}^{5}$$
$$I_3 = \frac{V_3}{R_3} = \frac{120V}{4k\Omega} = 30mA. \quad {}^{6}$$

	V (V)	I (mA)	R (Ω)
T	***120***	110 [3]	1090 [1]
1	120 [2]	60 [4]	***2k***
2	120 [2]	20 [5]	***6k***
3	120 [2]	30 [6]	***4k***

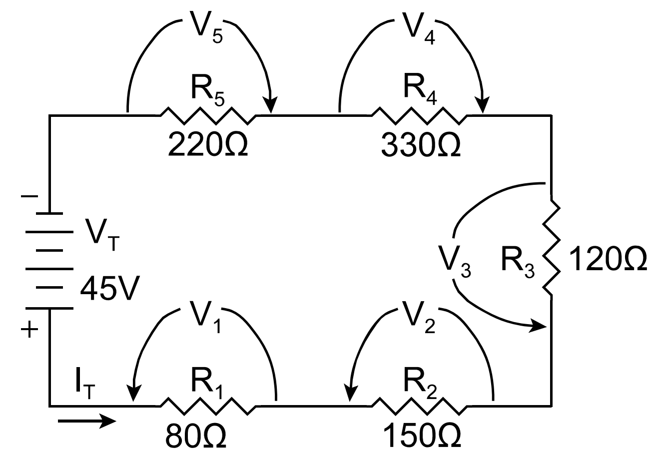
Parallel circuit

5.

$$G_T = G_1 + G_2 + G_3$$
$$= 0.25mS + 0.333mS + 0.5mS$$
$$= 1.083mS$$

$$I_T = V_T\, G_T$$
$$= 120V * 0.001083S = 130mA.$$

6.



	V (V)	I (mA)	R (Ω)
T	***45***	50	900 [1]
1	4 [2]	50	***80***
2	7.5 [3]	50	***150***
3	6 [4]	50	***120***
4	16.5 [5]	50	***330***
5	11 [6]	50	***220***

Series circuit

$$R_T = R_1 + R_2 + R_3 + R_4 + R_5$$
$$= 80\Omega + 150\Omega + 120\Omega + 330\Omega + 220\Omega$$
$$= 900\Omega \quad ^1$$

$$V_1 = \frac{R_1}{R_T} * V_T = \frac{80\Omega}{900\Omega} * 45V = 4V. \quad ^2$$

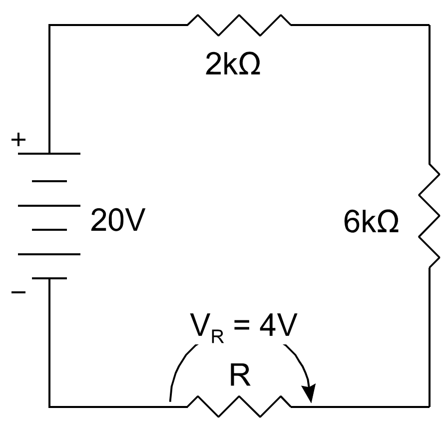
$$V_2 = \frac{R_2}{R_T} * V_T = \frac{150\Omega}{900\Omega} * 45V = 7.5V. \quad ^3$$

$$V_3 = \frac{R_3}{R_T} * V_T = \frac{120\Omega}{900\Omega} * 45V = 6V. \quad ^4$$

$$V_4 = \frac{R_4}{R_T} * V_T = \frac{330\Omega}{900\Omega} * 45V = 16.5V. \quad ^5$$

$$V_5 = \frac{R_5}{R_T} * V_T = \frac{220\Omega}{900\Omega} * 45V = 11V. \quad ^6$$

7.



	V (V)	I (mA)	R (Ω)
T	***20***	2 [1]	10k
2k	4	2 [1]	***2k***
6k	12	2 [1]	***6k***
R	***4***	2 [1]	2k [2]

Series circuit

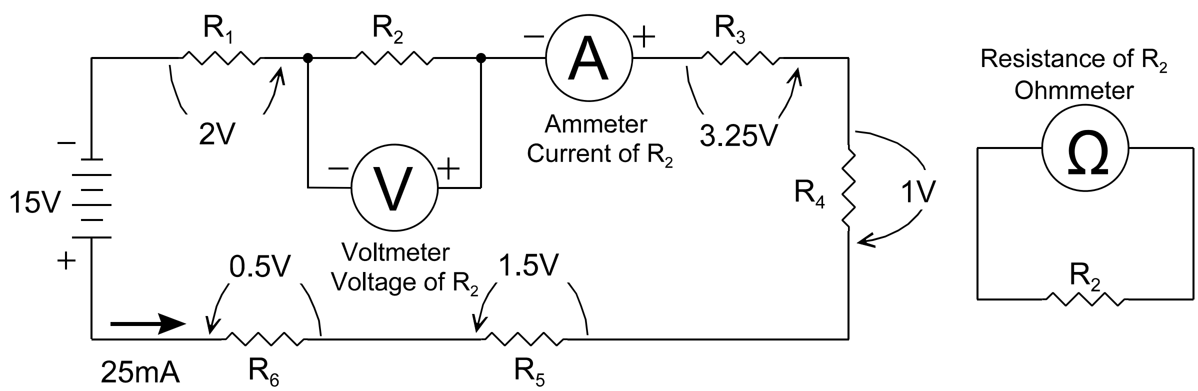
4V of the circuits potential is dropped across R. This is a series circuit so this means 20V - 4V = 16V of potential is available for the two other resistors in the circuit.

$$R_{2ks6k} = R_{2k} + R_{6k} = 2k\Omega + 6k\Omega = 8k\Omega$$

$$I = \frac{V_{2ks6k}}{R_{2ks6k}} = \frac{16V}{8k\Omega} = 2mA.$$ [1]

$$R = \frac{V_R}{I} = \frac{4V}{2mA} = 2k\Omega$$ [2]

8.



From KVL for series circuits

$$V_T = V_1 + V_2 + V_3 + V_4 + V_5 + V_6$$

$$\therefore \; V_2 = V_T - V_1 - V_3 - V_4 - V_5 - V_6$$

$$V_2 = 15V - 2V - 3.25V - 1V - 1.5V - 0.5V = 6.75V$$ [1]

$$R_1 = \frac{V_1}{I} = \frac{2V}{25mA} = 80\Omega$$ [2]

$$R_2 = \frac{V_2}{I} = \frac{6.75V}{25mA} = 270\Omega$$ [3]

$$R_3 = \frac{V_3}{I} = \frac{3.25V}{25mA} = 130\Omega$$ [4]

$$R_4 = \frac{V_4}{I} = \frac{1V}{25mA} = 40\Omega$$ [5]

$$R_5 = \frac{V_5}{I} = \frac{1.5V}{25mA} = 60\Omega$$ [6]

$$R_6 = \frac{V_6}{I} = \frac{0.5V}{25mA} = 20\Omega$$ [7]

	V (V)	I (mA)	R (Ω)
T	***15***	***25***	600 [8]
1	***2***	***25***	80 [2]
2	6.75 [1]	***25***	270 [3]
3	***3.25***	***25***	130 [4]
4	***1***	***25***	40 [5]
5	***1.5***	***25***	60 [6]
6	***0.5***	***25***	20 [7]

Series circuit

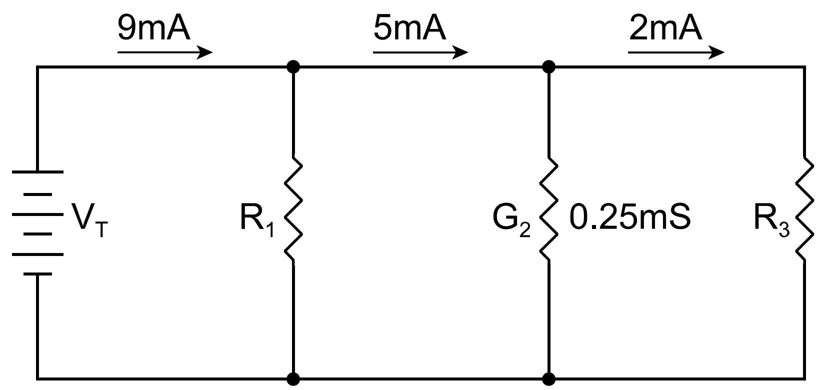
Check:

$$R_T = R_1 + R_2 + R_3 + R_4 + R_5 + R_6$$

$$R_T = 80\Omega + 270\Omega + 130\Omega + 40\Omega + 60\Omega + 20\Omega = 600\Omega \quad ^8$$

$$R_T = \frac{V_T}{I} = \frac{15V}{25mA} = 600\Omega \quad ^8$$

9.



9mA goes into first junction and 5mA goes to rest of circuit, ∴ 4mA goes through R_1.
5mA goes into second junction and 2mA goes to R_3, ∴ 3mA goes through R_2.

$$R_2 = \frac{1}{G_2} = \frac{1}{0.25mS} = 4000\Omega \quad ^1$$

$$V_2 = I_2 R_2 = 3mA * 4000\Omega = 12V \quad ^2$$

$$V_T = V_1 = V_2 = V_3 = 12V \quad ^3$$

$$R_1 = \frac{V_1}{I_1} = \frac{12V}{4mA} = 3000\Omega \quad ^4$$

$$R_3 = \frac{V_3}{I_3} = \frac{12V}{2mA} = 6000\Omega \quad ^5$$

	V (V)	I (mA)	R (Ω)	
T	12 [3]	***9***	1333 [6]	
1	12 [3]	***4***	3000 [4]	
2	12 [2]	***3***	4000 [1]	***0.25mS***
3	12 [3]	***2***	6000 [5]	

Parallel circuit

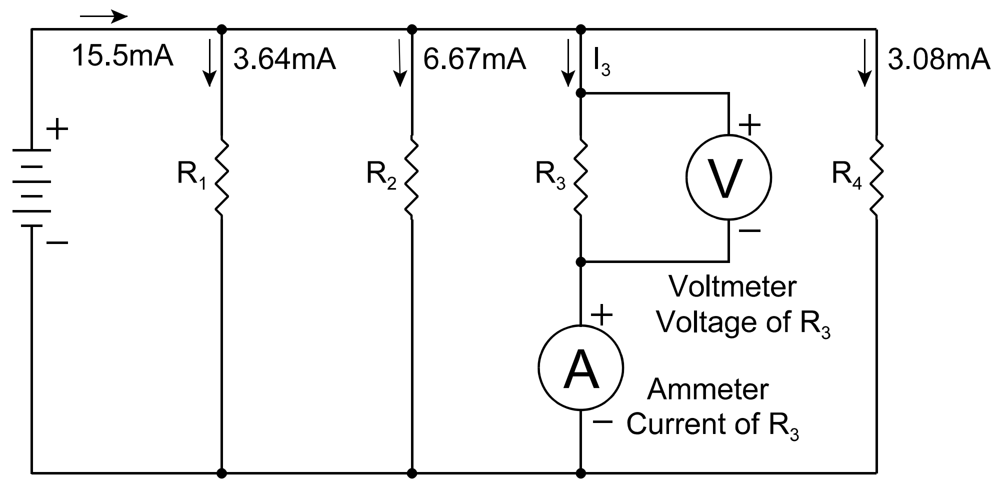
Check:

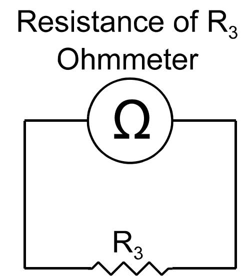
$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{3000\Omega} + \frac{1}{4000\Omega} + \frac{1}{6000\Omega}$$

$$R_T = 1333\Omega \quad ^6$$

$$R_T = \frac{V_T}{I_T} = \frac{12V}{9mA} = 1333\Omega \quad ^6$$

10.





$$V_T = I_T R_T = 15.5A * 773\Omega = 12.0V = V_1 = V_2 = V_3 = V_4 \quad ^{1}$$

From KCL for parallel circuits

$$I_T = I_1 + I_2 + I_3 + I_4$$

$$\therefore \quad I_3 = I_T - I_1 - I_2 - I_4$$

$$I_3 = 15.5mA - 3.64mA - 6.67mA - 3.08mA = 2.11mA \quad ^{2}$$

$$R_1 = \frac{V_1}{I_1} = \frac{12.0V}{3.64mA} = 3300\Omega \quad ^{3}$$

$$R_2 = \frac{V_2}{I_2} = \frac{12.0V}{6.67mA} = 1800\Omega \quad ^{4}$$

$$R_3 = \frac{V_3}{I_3} = \frac{12.0V}{2.11mA} = 5690\Omega \quad ^{5}$$

$$R_4 = \frac{V_4}{I_4} = \frac{12.0V}{3.08mA} = 3900\Omega \quad ^{6}$$

	V (V)	I (mA)	R (Ω)
T	12 [1]	***15.5***	***773***
1	12 [1]	***3.64***	3300 [3]
2	12 [1]	***6.67***	1800 [4]
3	12 [1]	2.11 [2]	5690 [5]
4	12 [1]	***3.08***	3900 [6]

Parallel circuit

Check:

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} = \frac{1}{3300\Omega} + \frac{1}{1800\Omega} + \frac{1}{5690\Omega} + \frac{1}{3900\Omega}$$

$$R_T = 775\Omega \quad ^{7}$$

This compares to R_T = 773Ω. Difference is due to rounding calculations to 3 significant digits.