Practical-5

Ohm's Law

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Unit- engineering physics

Unit code -SEB101

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Reports

Aim

The aim of this experiment is to verify Ohm's Law, which states that the potential difference across a wire is directly proportional to the current supplied in it.

Introduction

Ohm's law is the most basic law in the field of electricity. Its mathematical relation is given by

$V \propto I$

This symbol of proportionality is broken down with the help of a resistance.

$V=IR$

The R here stands for the resistance and the resistance is dependent on the resistivity, length and area of cross section.

Ohm's law is not universally valid. It is valid only good conductors such as aluminium and copper.

Different relations for the ohm's law are given below

V=IR ...(i)

I=V/R ...(ii)

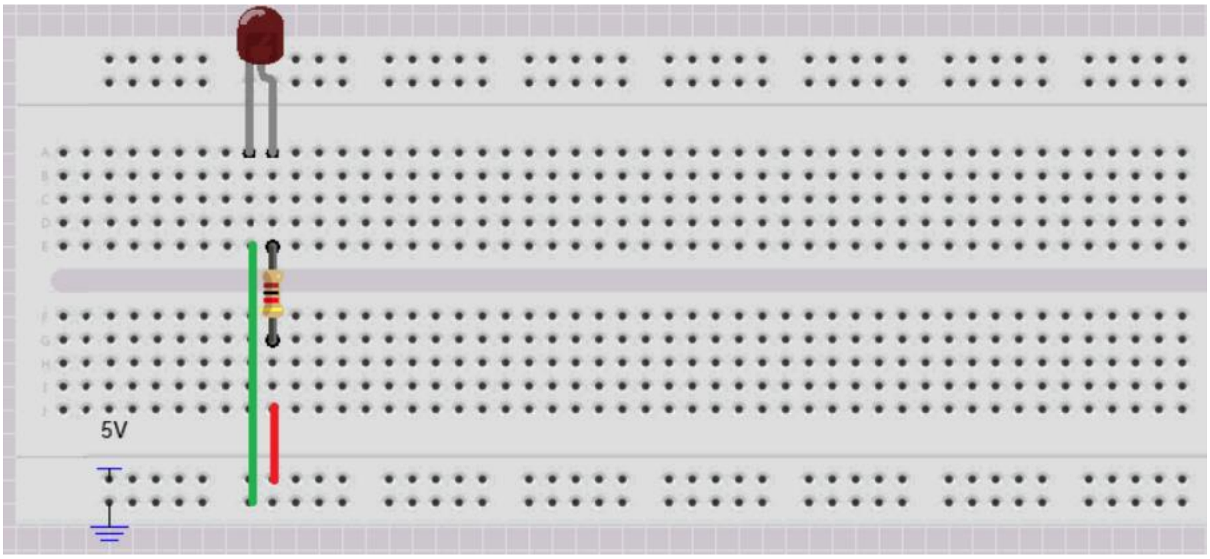
R=V/I ...(iii)

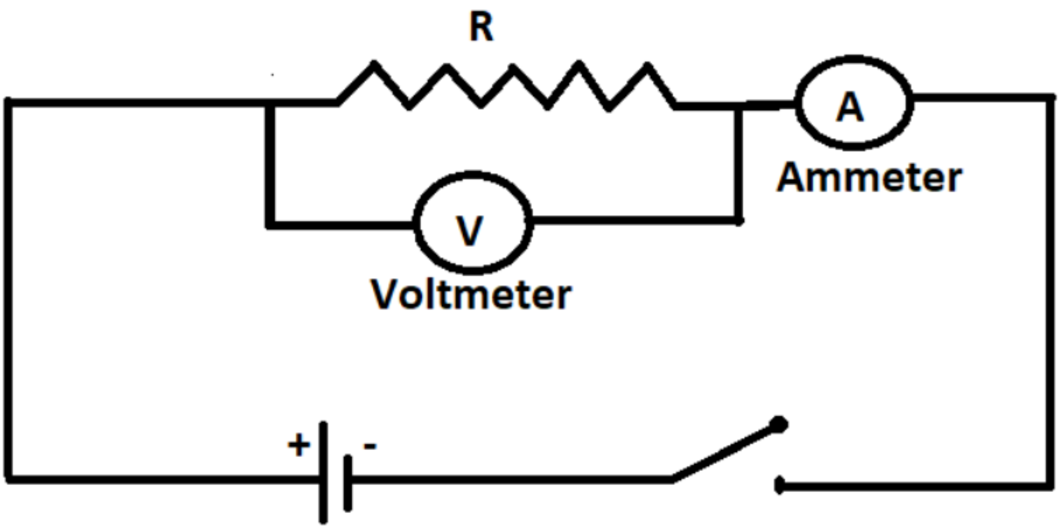
These relations are used differently for different results.

Experiment method

Part A: A known Resistance

1. Set up a power supply up to 5 volts.
2. Set up the circuit as given below.

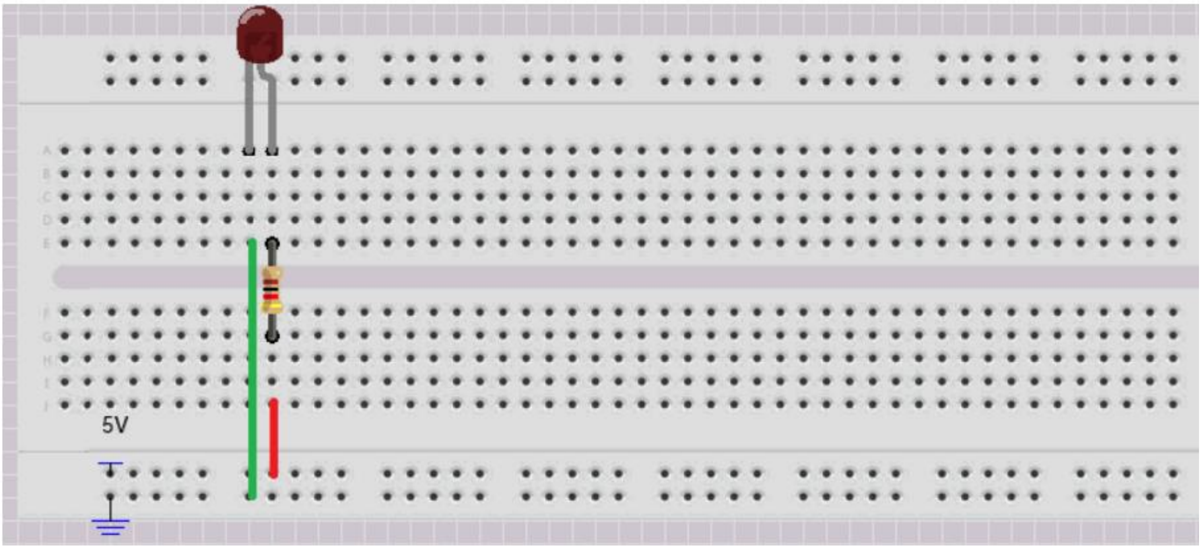


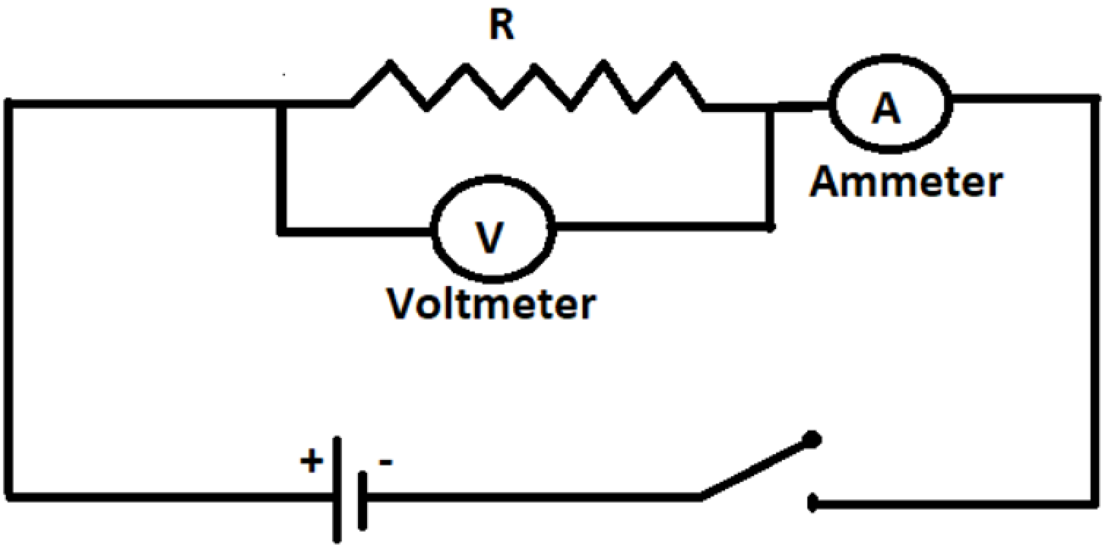


3. If the circuit is correct, LED will turn 'on'.
4. The multimeter should read DC and not AC.
5. Set the voltage at 0.5 volts
6. Increase the voltage up to 6 volts and measure the current in each case.

Part B: An unknown Resistance

1. Set up the power supply.
2. Set up the circuit as given below.

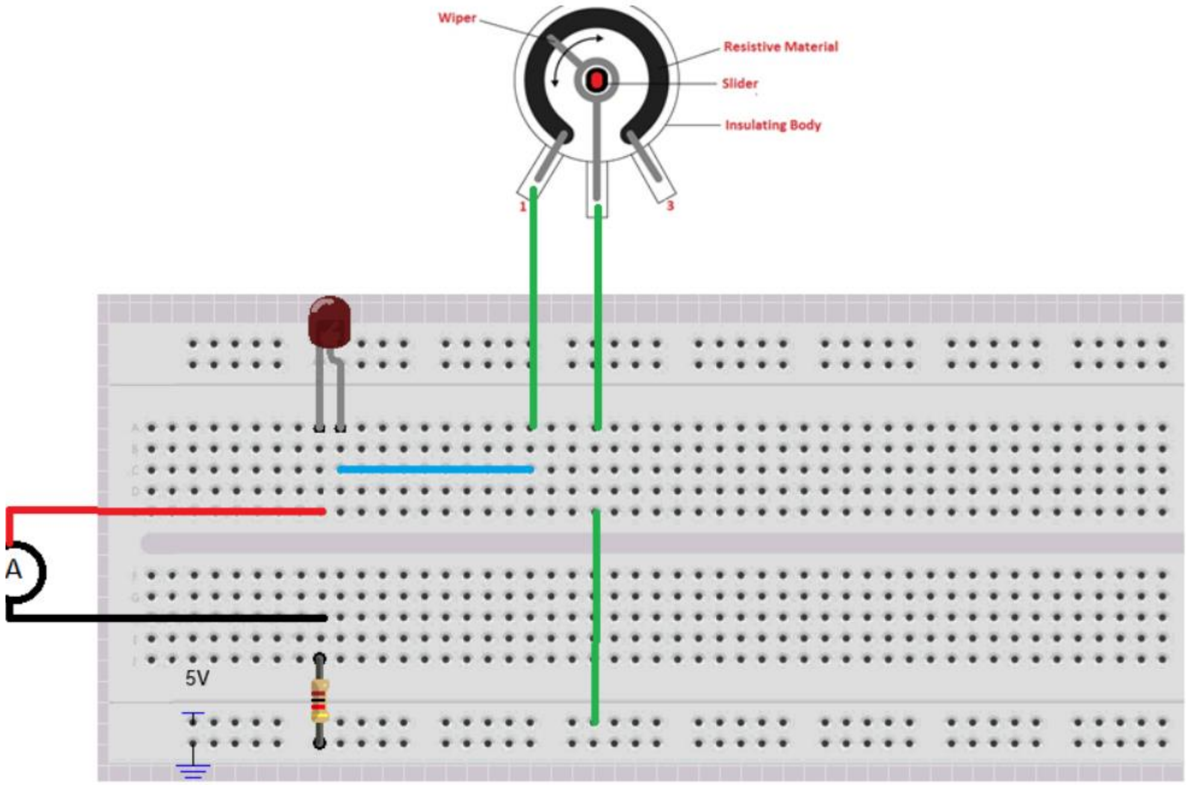




3. Connect the red and black leads of multimeter.
4. The correct circuit will turn on the LED.
5. Increase the voltage and write the current along-side.

Part C: Constant Voltage and variable resistance

1. Measure the resistance of variable resistor also called trim pot.
2. Set multimeter leads in correct positions.
3. Rotate the dial until the resistance is 500 ohm.
4. Make a circuit as shown below.

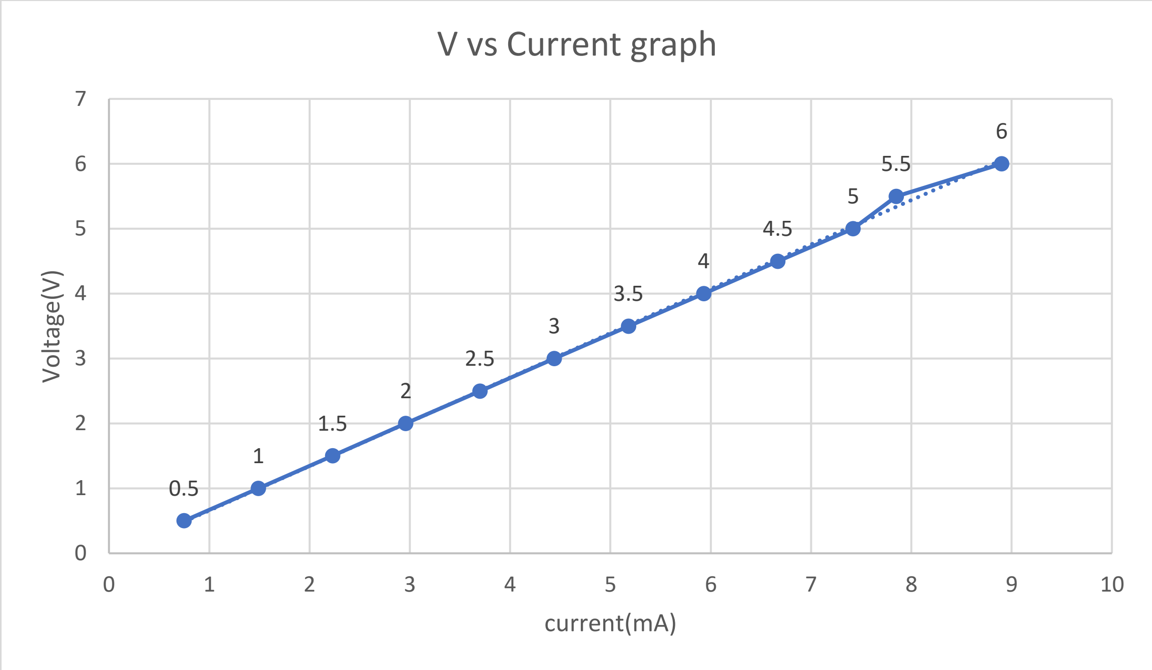


5. Set the voltage as 6 volts.
6. Increase the resistor gradually.

Results and calculations

Part A:

Run	Voltage(V)	Current(mA)	Resistance(kilo-ohm)
1	0.5	0.75	0.67
2	1	1.49	0.67
3	1.5	2.23	0.67
4	2	2.96	0.68
5	2.5	3.7	0.67
6	3	4.44	0.67
7	3.5	5.18	0.67
8	4	5.93	0.67
9	4.5	6.67	0.67
10	5	7.42	0.67
11	5.5	7.85	0.70
12	6	8.90	0.67



The gradient of the graph is calculated below:

Gradient=y_2-y_1/x_2-x_1

= (3-2.5)/ (4.44-3.7)

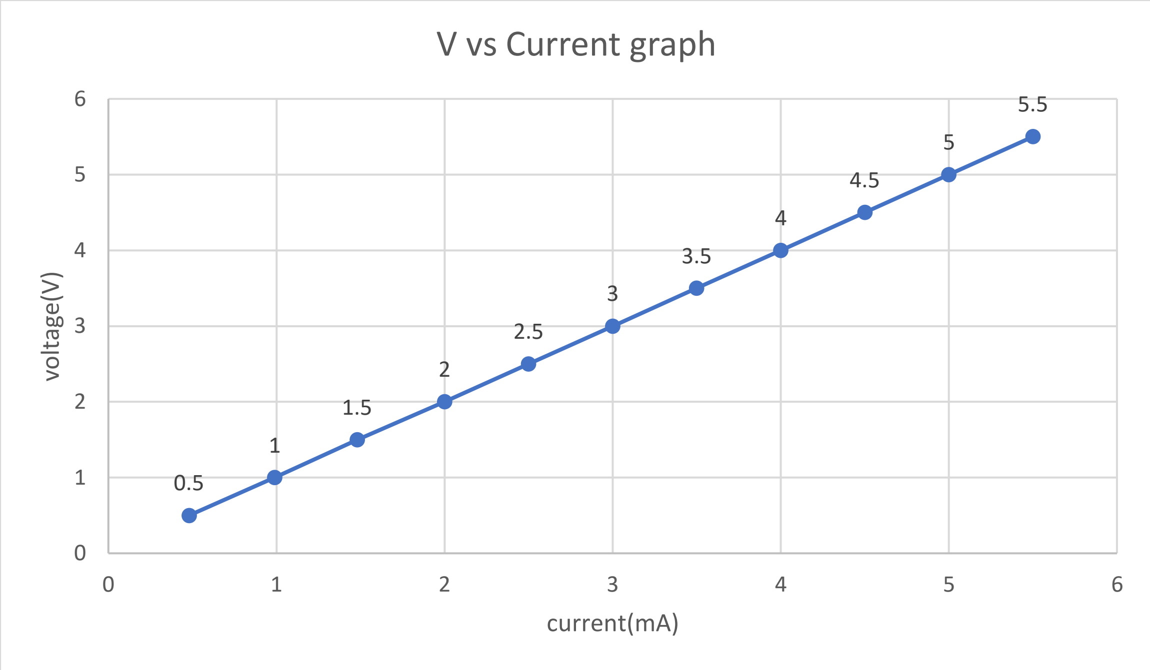
=0.5/0.74

=0.67

The units of gradient are volt/milli ampere or kilo-ohm.

Part B:

Run	Voltage(V)	Current(mA)	Resistance(kilo-ohm)
1	0.5	0.48	1.04
2	1	0.99	1.01
3	1.5	1.48	1.01
4	2	2	1
5	2.5	2.5	1
6	3	3	1
7	3.5	3.5	1
8	4	4	1
9	4.5	4.5	1
10	5	5	1
11	5.5	5.5	1



The unknown resistance from the graph is the gradient

Gradient=y_2-y_1/x_2-x_1

=3.5-3/3.5-3

= 1/1

=1 kilo-ohm

According to the graph the current increases as the voltage increases, which means that current is directly proportional to the voltage following the relation

$V \propto I$

However, the resistance remains constant with the increase in voltage

This means that in the relation V=IR the resistance is acting as a constant.

Part C:

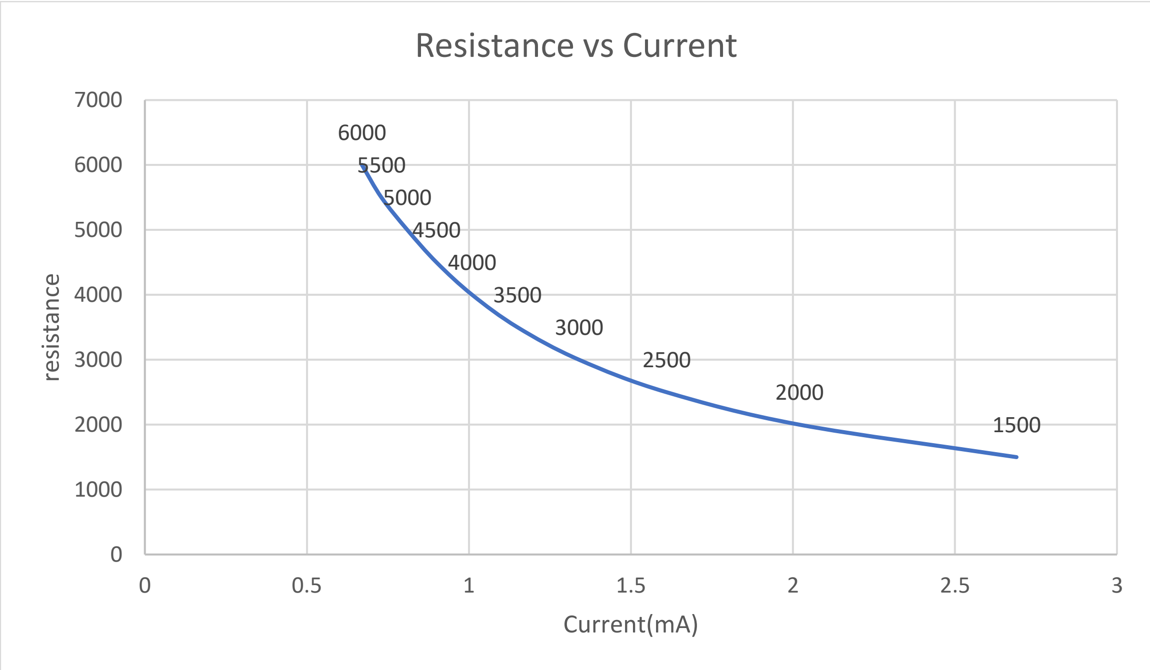
<table>
<tr><th>Run</th><th>Resistance(ohm)</th><th>Current(mA)</th><th>Voltage(V)</th><th>Average value of voltage</th><th>Uncertainty in voltage</th></tr>
<tr><td>1</td><td>1500</td><td>2.69</td><td>4.035</td><td rowspan="7">4.0325</td><td rowspan="7">0.0175</td></tr>
<tr><td>2</td><td>2000</td><td>2.02</td><td>4.04</td></tr>
<tr><td>3</td><td>2500</td><td>1.61</td><td>4.025</td></tr>
<tr><td>4</td><td>3000</td><td>1.34</td><td>4.025</td></tr>
<tr><td>5</td><td>3500</td><td>1.15</td><td>4.025</td></tr>
<tr><td>6</td><td>4000</td><td>1.01</td><td>4.04</td></tr>
<tr><td>7</td><td>4500</td><td>0.90</td><td>4.05</td></tr>
</table>

8	5000	0.81	4.05		
9	5500	0.73	4.015		
10	6000	0.67	4.02		

As the resistance is increase, the current decreases. This is because, in the ohm's law V=IR. Which on further simplifying shows that current I is inversely proportional to resistance.

$R \propto 1/I$

This means as the resistance increases, the current will decrease.



$V=I(1000+R)$

$=1.34 \times 3000 \times 10^{-3}$

$=4.02$

Since the values of the voltage are different in each and every case, the graph formed between v vs I will be non-linear.

Discussions

For the Part A, the resistance was known. The voltage was increased gradually, thus increasing the current. During this experiment the resistance was consistence and almost equal to the calculated value. The minor deflection that it showed could be neglected.

For the Part B, the resistance was unknown. During its procedure, the graph formed is straight line and gives the resistance as 1 kilo-ohm.

For part C the resistance was gradually increased, which decreased the current. Moreover, the graph formed was rectangular parabola and, in this case, the voltage applied was 6 volts and the calculated one was 4.02 volts which means there was a certain voltage drop.

Conclusions

Part A:

1. The value of resistor from the graph is found using the gradient, and its value is 0.67 kilo-ohm.
2. The conductance from the graph is determined as 1/R
   The value of R is 0.67 kilo-ohm
   Conductance=1/R
   =1/0.67
   =1.49 mili-mho
3. The calculated value of resistor = 0.67×10^3 ohm
   The colour given of the resistor are Blue, Grey, Red and Gold.
   Which gives the value as 0.68×10^3kilo-ohm
   The difference between the measure value and the calculated value is because of parameters such as internal resistance and impedance of the instruments are not taken for calculations. Furthermore, there might be a minor mistake in the circuit.

Part B:

1. The results say that as the voltage is increase, the current also increases and as mentioned above follows the relation
   $V \propto I$
2. There are many devices that do not follow ohm's law and show non-ohmic variation in the graph. some of the examples are thermistors, varistors, light dependent resistors, temperature dependent resistors, varicaps et cetera.

Part C:

1. The voltage that was actually applied was 6 volts and the average value from the practical is 4.02.
2. The measured value of voltage is 4.02v and the average calculated value is4.0325+/-0.0175 v.
3. The applied value of voltage was 6 volts. The measured value of the voltage was 4.02v. The voltage drop was 1.8v.

References

- Deakin university, SEB101 lab manual 2019.
- Fundamentals of physics by Resnik, Halliday and Walker, (10th edition)