ELECTRICITY

Task 1

Aim:

To investigate the current – voltage relationship for a resistor and filament lamp. To determine whether each obeys ohms law.

Ohms law states that the current through a conductor is proportional to the potential difference across it provided that there is no change in temperature. It is given by the formula V = IR

Method:

- The circuit is set up as above, the power supply needs to be set at about 4V. The first experiment will be carried out with the filament lamp.
- Electrons in a circuit move from the negative terminal to the positive terminal, during which energy can be lost through components causing a difference in the electrical potential energy between the negative and positive terminals. This is called the potential difference and is measured with a voltmeter. The voltmeter is connected in parallel with the component, to measure the voltage going through it.
- The ammeter measures the electrical current and is measured in amperes, or amps. When the current is 1 amp, the flow of charge is 1 coulomb per second.
  Care should be taken to make sure the voltmeter and ammeter are working correctly.
- The variable resistor is moved along slightly and readings from the ammeter and voltmeter are recorded in an appropriate t able. Readings are continued to be recorded at intervals along the variable resistor until it reaches the end or till sufficient results are taken.
- The current is then directed backwards, for negative results to be taken. This is done to see if there is any change in the results, as sometimes it can make a difference. It will help prove if a component is an ohmic conductor.
- Now the fixed resistor is put in place of the filament lamp.
- Again, readings are taken from the voltmeter and ammeter as the varia ble resistor is moved along.
- Readings are recorded in another table. When the variable resistor has reached the end or there are sufficient results, the current can be directed backwards again for negative readings.

The results should then be presented graphically, as the outcome of the line will show the relationship between the current and voltage. A straight line will show the component does obey ohms law as the current is constant and proportional to the p.d. A gradient can be calculated to determi ne the resistance.
A curved graph will show the alternative, that it is not an ohmic conductor. The p.d and current are not proportional.

Ohms law can be presented mathematically by the equation V = IR which can be compared to the equation of a straight -line graph to calculate the gradient and find the resistance.

V = R I
↓   ↓ ↓
Y =m x + c

The graphs will be set out as follows, showing the negative axis along with positive.

Results:

Filament Lamp

Positive		Negative	
P.d/V	**I/A**	**Pd./V**	**I/A**
0.01	0.01	-0.012	-0/01
0.14	0.09	-0.012	-0.3
0.54	0.13	-0.014	-0.7
1	0.16	-0.016	-1
1.5	0.20	-0.019	-1.5
2	0.23	-0.023	-2
2.5	0.24	-0.023	-2.5
3.1	0.27	-0.027	-3
3.5	0.29	-0.031	-4
4.3	0.32		

Resistor

Positive		Negative	
Pd./V	**I/A**	**Pd./V**	**I/A**
0.05	0.003	-0.0025	-0.02
0.5	0.03	-0.04	-0.5
1	0.06	-0.07	-1
1.5	0.1	-0.1	-1.5
2	0.13	-0.14	-2

2.5	0.16	-0.17	-2.5
3	0.2	-0.2	-3
3.5	0.23	-0.23	-3.5

Analysis of results:

The graph for the filament lamp produced a curved line showing n o proportionality and that the lamp is not an ohmic conductor. A resistance cannot be calculated because it is not constant.
The graph for the fixed resistor produced a straight line. Which means the current – voltage relationship is proportional and it is an ohmic conductor. A resistance can be calculated because it is constant.

Gradient = $\dfrac{\Delta Y}{\Delta X}$ = $\dfrac{3.5}{0.23}$ = $\underline{15.2\Omega}$

Conclusion:

Ohms law is only applicable when the temperature is kept constant. The graph for the filament lamp had a c urved line. The filament got hotter as the current increased and therefore the resistance increased. Because the temperature and current were not constant, the filament lamp is not an ohmic conductor. The gradient of the curve is very small at the begin ning showing that there is little resistance. However as the current increases, the gradient of the curve increases too. The resistance is changing due to this change in current and temperature.
Overall it is possible to determine two main things. Fir stly, the filament lamp is not an ohmic conductor, and secondly, the resistance becomes more constant as the current increases.
The fixed resistor produced a straight -line graph. Instantly from looking at the graph it is clear to see that the current – voltage relationship is constant. The resistor is an ohmic conductor. Because of this it was possible to determine a value for the resistance from the gradient. The value was said to be about 15 Ω and I obtained 15.2Ω, which is a fair value.
This also shows that the experiments were carried out accurately. Sufficient results were obtained to produce graphs and determine if each component were an ohmic conductor. Some of the results in the tables may have been slightly anomalous but overall appeared correct. Any errors that may have occurred in the experiment were probably due to human error rather than systematic error. These could include errors when recording readings off the ammeter or voltmeter or when rounding off numbers, which would give minimal error. There was not much that could go wrong in the experiment once it was set up accurately and everything was checked to be in working order.
The experiment could have been repeated and an average set of results could be made to plot graphs, but I don't think it is necessary and may have just wasted time.

Task 2
An atom has three parts - neutrons, protons and electrons, set out as below

Electrons revolve around the protons and neutrons continuously. When an electron ahs enough energy(this could be from the voltage), it can break free from the outer orbit to become a free electron. When an electron leaves an atom the atom is then more positively charged and is unbalanced. Thus it will always want to get an electron back to the valence orbit to become balanced. As electrons are negative they will always be attracted to a positive atom. This continous movement of electrons, as atoms gain and lose one, is the current.

What happened with the filament lamp is that as the p. d was increased, the filament got hot due to the increase in current. As the current increased the chance of free electrons bumping into atoms was increased and they did, causing vibrations. As the atoms vibrate more they relaese their potential energy i n the form of kinetic energy, and they then take in the heat as energy and vibrate even more causing more heat to be produced. The vibration of the atoms impedes the flow of electrons, therefore changing the resistance, which increases. Because of the ch anges in temperature and resistance the filament is non – ohmic.

The fixed resistor didn't get as hot as the filament lamp when the current was increased. The fixed resistor may be made out of a material with a higher melting point so the atoms are more stable as well. As the atoms are not vibrating as much, the flow of free electrons is not impeded and resisitance stays constant. Hence it is an ohmic conductor.

Task 3

The potential divider is used to supply a variable p.d. Therefore a desired level c an be obtained. The potential divider can allow the voltage across a component to be varied continuously between 0v and the battery voltage by use of a sliding contact. Whereas a rheostat varies the resistance, it is designed to resist current flow. Bec ause it has a maximum resistance it does not allow the voltage across a component, or the current through it, to be reduced to zero. A rheostat is also quite bulky and dissipates the surplus energy in the form of heat so it can get very hot.

Task 4

1a) $V = IR$
$I = V/R$
$I = 8/4$
$\underline{I = 2a}$

b) Current is constant, therefore $\underline{I = 2a}$

   c)   V = IR
            V = 2 x 3
            <u>V = 6V</u>

   d)   V = IR
            R(total) = 3 + 4
            R(total) = 7Ω
            V = 2 x 7
            <u>V = 14V</u>

2a)   R(total) = 2 + 3 = <u>5Ω</u>

   b)   I = V/R
            I = 10/5
            <u>I = 2a</u>

   c)   V = IR
            V =2 x 2
            <u>V = 4V</u>

   d)   V = IR
            V = 2 x 3
            <u>V = 6V</u>

3)   Terminal pd. = E – IR
            E = terminal pd. + IR
            E = 10 + 2 x 1
            <u>E = 12V</u>

4a)   1/R(total) = 1/R(1) + 1/R(2)
            1/R(total) = 1/3 + 1/6
            1/R(total) = 3/6
             R(total) = 6/3 = <u>2Ω</u>

   b)   V = IR
            V = 6 x 2
            <u>V = 12V</u>

   c)   12V

   d)   I = V/R
            I = 12/3
            <u>I = 4a</u>

   e)   I = V/R
            I = 12/3
            <u>I = 4a</u>

5)   Current across parallel resist ors = 0.9a

V(across 5Ω resistor) = IR

Current is constant in series circuit = 0.9a
V = IR
V = 0.9 x 5
V = 4.5V
V(across parallel resistors) = 12 − 4.5
V = 7.5V

I = V/R
I1 = 7.5/30
<u>I1 = 0.25a</u>

Need to find the total resistance of the parallel re sistors

V = IR
R = V/I
R = 7.5/0.9
R = 8.3Ω
Equation for 2 parallel resistors must be rearranged to find r.

1/R(total) = 1/r + 1/r
1/R = 1/30 + 1/r
1/r = 1/R − 1/30
1/r = 8 1/3 − 1/30
1/r = 3/25 − 1/30
1/r = 13/150
<u>r = 11.54Ω</u>