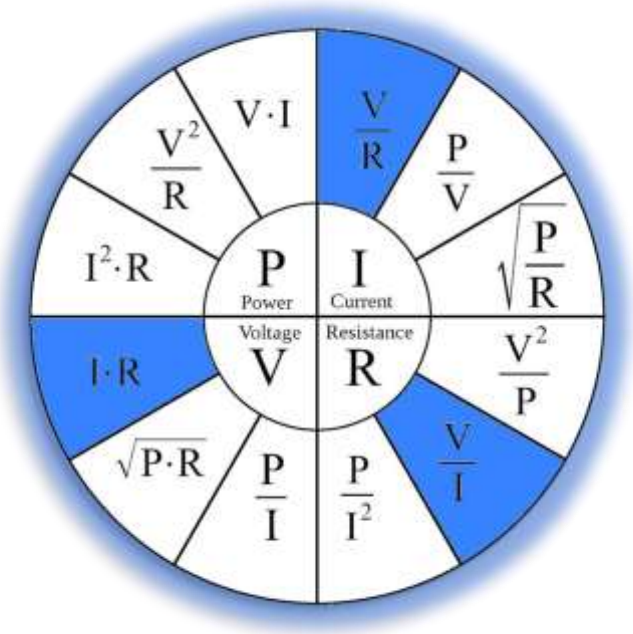
PHYSICS KNOWLEDGEBASE

2020

CURRENT ELECTRICITY II



TEACHERS OF PHYSICS

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8/31/2020

1. Define the term "e.m.f" of a cell. (1mk)
The pdf across the terminals of a cell in open circuit

2. Distinguish between electromotive force and potential difference (2mks)
Electromotive force (E.m.f) *refers to voltage across the terminals of a battery in an open circuit (when no current flows in the circuit) while* ***Potential difference (Pd)*** *refers to the voltage across the terminals of a battery in a closed circuit (when current is flowing in the circuit).*

3. Distinguish between terminal voltage and e.m.f of a battery. 2mks
Emf is the potential difference across the terminals of a cell in open circuit while terminal voltage is the potential difference across the terminals of the cell in closed circuit

4. Define the volt. (1mk)
Work done in moving a unit charge through a conductor from one point to another.

5. Distinguish between open and closed circuit. (2mk)
Closed circuit allows flow of charge while a closed circuit does not allow charge flow.

6. What is meant by the term "lost volts"? (1mk)
Voltage lost due to internal resistance of a cell

7. State Ohms Law. (1mk)
The current through a conductor is directly proportional to the potential difference across the conductor provided the temperature and other physical conditions are kept constant.

8. State the condition necessary for Ohms Law to be obeyed (1mk)
- *Temperature should be kept constant*
- *Other physical conditions should be kept constant e.g pressure.*

9. State two conditions that are necessary for a conductor to obey Ohm's law.
- *Temperature should be kept constant*
- *Other physical conditions should be kept constant e.g pressure.*

10. Other than temperature state the other factors that affect the resistance of an ohmic conductor. (1 mk)
Length /cross-sectional area

11. What causes electrical resistance in conductors? (1mk)
Collision between the free electrons and the atoms of a conductor

12. Define a non-ohmic conductor (1mk)
A conductor that doesn't obey Ohms law

13. Define electric resistance. (1mk)
Opposition of a conductor to the flow of charge

14. Eight dry cells can be arranged to produce a total e.m.f of 12v just like a car battery.

(a) What is the e.m.f of an individual cell? (2mk)

12/8=1.5V

(b) Why is it possible to start a car with the lead acid accumulator, but not with the eight dry cells in series?

With eight dry cell there is increased total internal resistance hence lower current, insufficient for starting the car.

15. **Give** a reason why fluorescent tubes are preferred to filament bulbs for domestic lighting

Uses less power to give same light as a filament bulb

16. A boy who has been driving a car in rain discovers that the movement he alights from it while touching its body he gets an electrical shock. Offer him a scientific explanation why he was not getting the shock while inside even if he touches the metallic parts of the car.

Electric shock is due to accumulated static charges on surface of the car because of friction between air and the car surface as it moved. The charges were discharge to ground through the boy's body.

17. A circuit consists of a battery, a metal wire, ammeter and a switch connected in series. The switch is closed and the ammeter reading noted. The metal wire is now heated.

(i) **State** the observations made on the ammeter reading. (1mk)

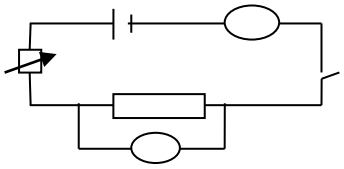
✓ Decreases

(ii) **Give one** observation for the above observation made. (1mk)

✓ *Increasing temperature, increases resistance of the wire hence current reduces*

18. Describe an experiment to verify Ohm's law given a cell, ammeter, voltmeter, switch, nichrome wire and connecting wires.

Arrange apparatus as shown.



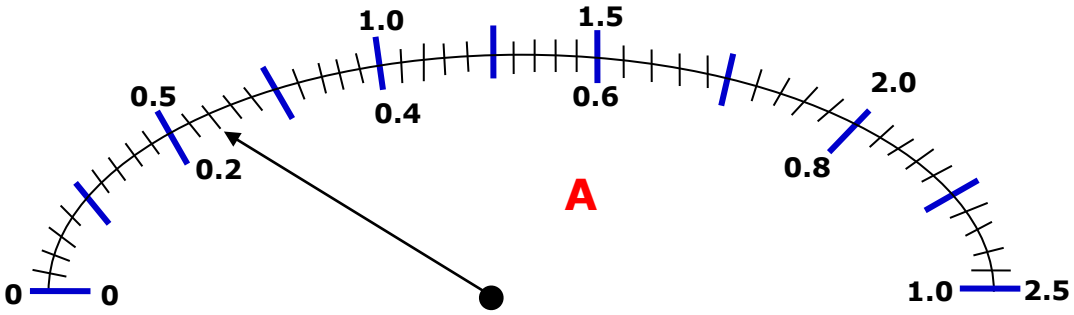
- *Close the switch and adjust the current flowing through the conductor T using the rheostat to the least possible value. Record the corresponding voltmeter reading.*
- *Increase the current in steps recording the corresponding voltmeter readings. Record your values in the table.*
- *Plot a graph of voltage against current (using values you obtained on the table). Hence determine the slope of the graph.*
- *A graph of voltage against current is a straight line through the origin. Hence voltage drop across the conductor is directly proportional to the current through it.*

19. A battery is connected to an external resistor, R. State any two factors that determine the magnitude of the current produced in the circuit. (2mk)

1. The magnitude of resistance

2. The magnitude of potential difference across the battery

20. Figure below shows an ammeter used to measure current through the conductor.



State the reading from the meter when the student is using the;

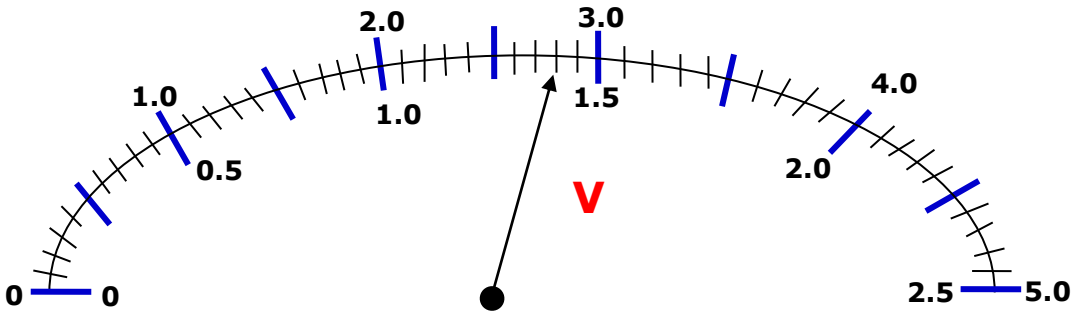
(i) Lower scale. (1mk)

✓ 0.24 A

(ii) Upper scale (1mk)

✓ 0.70A

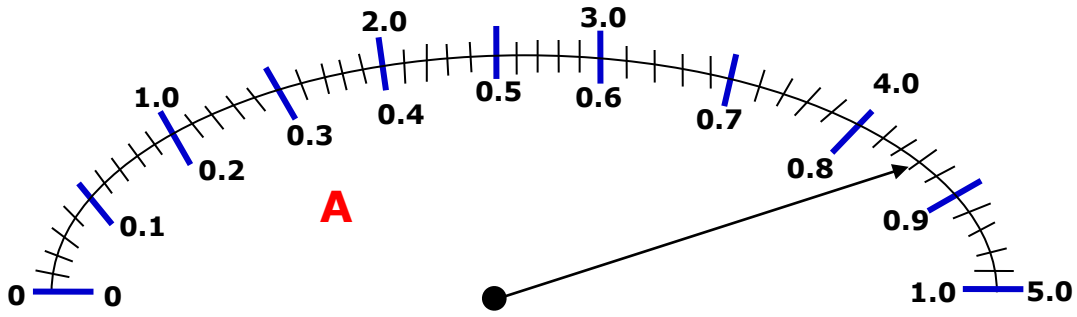
21. Figure below shows a voltmeter used to measure voltage through the conductor. The student used the upper scale.



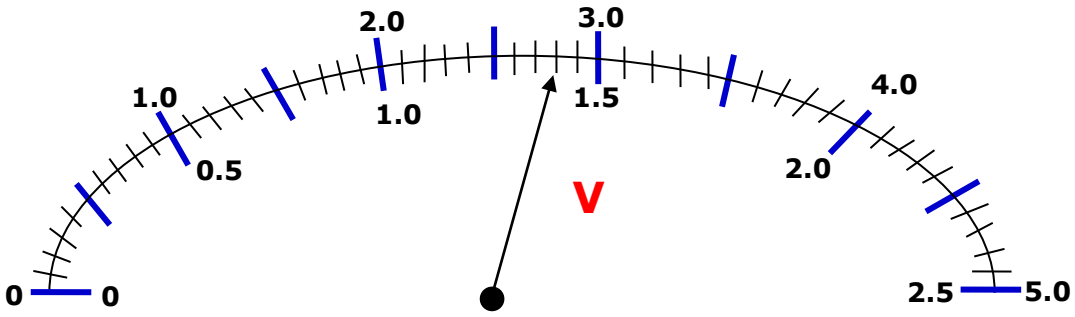
State the reading from the meter. (1mk)

✓ 2.80 V

Figure below shows an ammeter used to measure current through the conductor. The student used the lower scale. 0.86 A



22. Figure below shows a voltmeter used to measure voltage through the conductor. The student used the upper scale.



State the reading from the meter. (1mk)

✓ 2.80 V

23. State why the filament of a lamp is made of tungsten (1mk)

✓ *It has a high melting point*

24. Three identical bulbs are connected in series with a battery. At first, the bulbs shine brightly but gradually become dimmer. Using the same cells, explain how you would increase the brightness of the bulbs. (1mk)

✓ *Connecting the bulbs in parallel.*

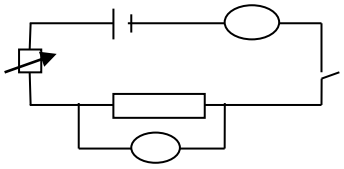
25. In large circuits, large resistors in parallel are preferred to low resistors in series. Explain.

✓ *Connection of resistors in parallel gives a cumulative lower resistance than when in series hence minimizes chances of overheating.*

26. Describe a laboratory experiment to verify ohm's law, by use of appropriate diagrams where necessary. (5mk)

To verify Ohm's law you need the following apparatus a cell, ammeter, voltmeter, switch, nichrome wire and connecting wires.

Arrange apparatus as shown.



- *Close the switch and adjust the current flowing through the conductor T using the rheostat to the least possible value. Record the corresponding voltmeter reading.*
- *Increase the current in steps recording the corresponding voltmeter readings. Record your values in the table.*
- *Plot a graph of voltage against current(using values you obtained on the table). Hence determine the slope of the graph.*

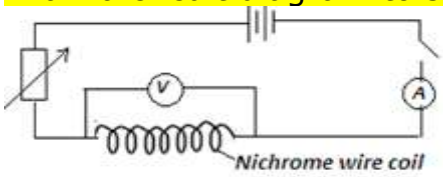
- *A graph of voltage against current is a straight line through the origin. Hence voltage drop across the conductor is directly proportional to the current through it.*

-
-

Voltage (V)

- *ΔV* *Slope= ΔV/ ΔI= resistance R*
-
-
- *ΔI Current I (A)*
-

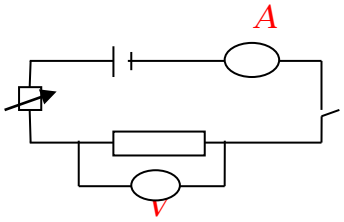
27. You are required to determine the resistance per unit length of a nichrome wire X, you are provided with a D.C. power supply an ammeter and voltmeter. Draw a circuit diagram to show how you would connect the circuit.



28. Describe with aid of a diagram and experiment to verify Ohm's law

To verify Ohm's law you need the following apparatus a cell, ammeter, voltmeter, switch, nichrome wire and connecting wires.

Arrange apparatus as shown.



- *Close the switch and adjust the current flowing through the conductor T using the rheostat to the least possible value. Record the corresponding voltmeter reading.*
- *Increase the current in steps recording the corresponding voltmeter readings. Record your values in the table.*
- *Plot a graph of voltage against current(using values you obtained on the table). Hence determine the slope of the graph.*
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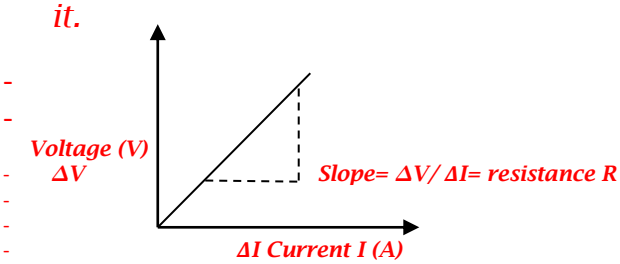
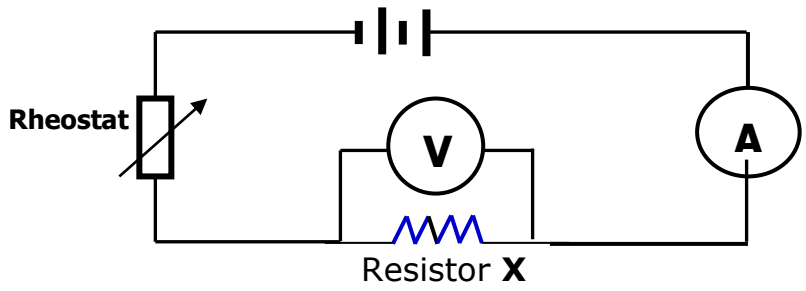


29. A student wishes to investigate the relationship between current and voltage for a certain resistor **X**. In the space provide, draw a circuit diagram including two cells, rheostat, ammeter, voltmeter and the resistor **X** that would be suitable in obtaining the desired results. Describe how you would use the circuit in (a) (i) above to determine the resistance of **x**. **(5mk)**



- *Close the switch and adjust the current flowing through the conductor T using the rheostat to the least possible value. Record the corresponding voltmeter reading.*
- *Increase the current in steps recording the corresponding voltmeter readings. Record your values in the table.*
- *Plot a graph of voltage against current(using values you obtained on the table). Hence determine the slope of the graph.*
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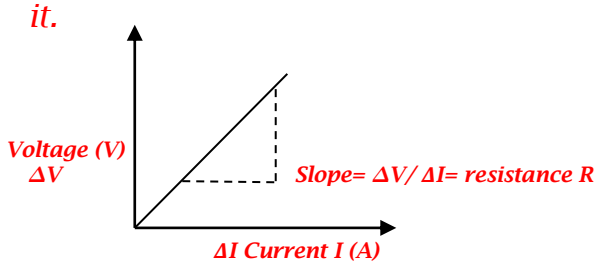
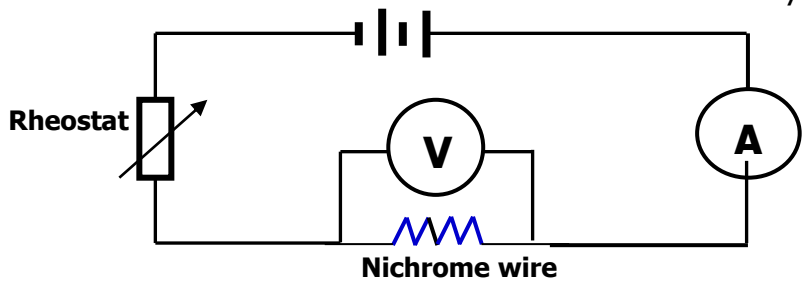


30. The figure below shows a circuit that can be used to verify Ohm's law



Explain briefly how the setup can be used to verify ohm's law (4mks)

- *Close the switch and adjust the current flowing through the conductor T using the rheostat to the least possible value. Record the corresponding voltmeter reading.*
- *Increase the current in steps recording the corresponding voltmeter readings. Record your values in the table.*
- *Plot a graph of voltage against current(using values you obtained on the table). Hence determine the slope of the graph.*
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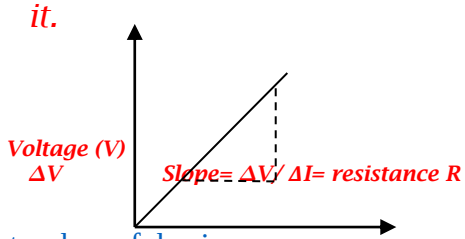
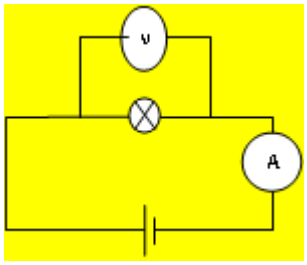


ΔI Current I (A)

31. An ammeter, a voltmeter and a bulb are connected in a circuit so as to measure the current flowing and the potential difference across both. Sketch a suitable circuit diagram for the arrangement.



32. Three identical bulbs are connected in series with a battery. At first, the bulbs shine brightly but gradually become dimmer. Using the same cells, explain how you would increase the brightness of the bulbs. (2mk)

✓ *Connecting the bulbs in parallel*

33. A student learnt that a battery of eight dry cells each 1.5V has a total e.m.f of 12V the same as a car battery. He connected in series eight new dry batteries to his car but found that they could not start the engine. Give a reason for this observation.

✓ *With eight dry cell there is increased total internal resistance hence lower current, insufficient for starting the car.*

V = IR

1. A current of 0.08A passes in a circuit for 2.5 minutes. How much charge passes through a point in the circuit?

$Q = It$

$0.08 \times 2.5 \times 60$

$12C$

2. What current will a 500Ω resistor connected to a source of 240V draw?

$V = IR$

$I = V/R = 240/500 = 0.48A$

3. Two resistors of 4Ω and 2Ω in parallel are connected in series to a 3Ω resistor and a cell of 2.0V.

Calculate

a) Equivalent resistance of the circuit. (3 marks)

$R_T = \frac{4 \times 3}{4+2} + 3 = 4.333\Omega$

b) Current through each resistor. (4 marks)

$I_T = V/R = 2/4.33 = 0.4615A$

$I_T = I_{3n} = 0.4615$

V_{Drop} *in* $3\ \Omega = IR = 0.4615 \times 3 = 1.3846V$

Voltage through 4 Ω and 2 Ω

$2 - 1.3846 = 0.6154V$

$I_{2OHMS} = V/R = 0.6154/2 = 0.3077A$

$I_{4OHMS} = V/R = 0.6154/4 = 0.1538A$

4. Three identical dry cells each of **e.m.f**. 1.6 V are connected in series to a resistor of 11.4Ω. a current of 0.32A flows in the circuit. Determine.

i) The total e.m.f. of the cell 1mk

$1.6 X3 = 4.8V$

ii) The internal resistance of each cell; 3mk

$E = I(R + r)$

$4.8 = 0.32(11.4+r)$

$R = 1.152\ \Omega = 1.152/3 = 0.384\ \Omega$

5. A wire of resistance R connected in series with 1.5V cell is found to be carrying a current of 0.05A. If the wire is now connected in parallel with an identical wire, find the new current in the circuit. (3mk)

$R = V/I\ 1.5/0.05 = 30\ \Omega$

$R_T = \frac{30\ X\ 30}{30+30} = 15\ \Omega$

$I = V/R = 1.5/15 = 0.1A$

6. Two heaters **A** and **B** are connected in parallel across a 10volts supply. Heater **A** produces 1000J of heat in one hour while B produces 200J in half an hour. Calculate the ratio $\mathbf{R_A/R_B}$. (3mks)

$H = V^2\frac{t}{R}$

$1000 = 100/R\ X\ 60^2$

$R_A = 360\ \Omega$

$R_B = 100/200\ X\ 30^2 = 450\ \Omega$

$R_A/R_B = 360/450 = 0.8$

7. A current flows through a coil wire of resistance 50Ω when it is connected to the terminals of a battery. If the potential difference is 20V, find

(i) The value of current 2 mks

$V = IR$

$I = V/R = 20/50 = 0.4A$

ii) The number of electrons that pass through the coil per second. (Take charge of electronse = 1.6 x 10^{-19} c) 3 mks

$Q = It$

$Q = ne$

$ne = It$

$n = It/e = 0.4x1/1.6\ x10^{-19} = 2.5\ x\ 10^{18}e$

8. Three identical resistors each of resistance 2.0Ω are connected so as to obtain the least effective resistance. If a battery of voltage V is connected in series to the arrangement of the resistors and supplies a current of 3A. Calculate the value of V (4mks)

Connected in parallel

$1/R_T = ½ + ½ + ½ = 3/2$

$R_T = 2/3 = 0.6667\ \Omega$

$V = IR = 3\ X\ 0.6667 = 2V$

9. Two resistors R_1 and R_2 are connected in series to a 10V battery. The current flowing then is 0.5A. When R_1 only is connected to the battery the current flowing is 0.8A.

(a) Calculate the

(i) Value of R_2

$V = IR$

$R = 10/0.8 = 12.5\ \Omega$

$R_T = R_1 + R_2$

$10 = 0.5(12.5 + R_2)$

$R_2 = 7.5\ \Omega$

ii) Current flowing when R_1 and R_2 are connected in parallel with the same batter.

$V = IR,\ R = \frac{7.5\ X12.5}{7.5+12.5} = 4.6875\ \Omega.\ I = 10/4.6875 = 2.133A$

(b) One of the 6Ω resistors has a length of 1m and cross-sectional area of $5.0 \times 10^{-5}m^2$. Calculate the resistivity of the material.

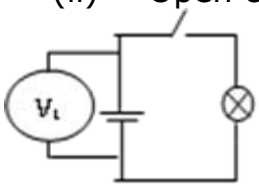
$R = ÞL/A$

$Þ = 6 \times 5 \times 10^{-5} /1 = 3.0 \times 10^{-4}\ \Omega m$

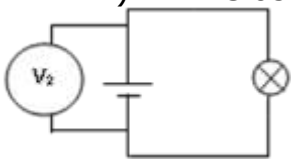
10. Suppose a high–resistance voltmeter reads 1.5V connected across a dry battery on open circuit and 1.2V when the same battery is in a closed circuit when it is supplying a current of 0.3A through a lamp of resistance R.

(a) Draw a circuit diagram to show the above experiment when in;

(ii) Open circuit



ii) Closed circuit.



(b) What is

i) The e.m.f of the battery.

$e.m.f = 1.5V$

ii) The internal resistance of the battery

$Voltage\ drop = 1.5 - 1.2 = 0.3A$

$R = V/I = 0.3/0.3 = 1\Omega$

iii) The value of R?

$E = I(R + r)$

$1.5 = 0.3(R + 1)$

$R = 4\ \Omega$

11. When a resistor is connected across the terminals of a battery a current of 0.20A flows. What is the time taken for 2.0 coulombs of charge to pass a

given point in the circuit? If e.m.f of the battery is 4.0v and its internal resistance is 0.20hm determine the rate at which heat is produced in the resistor.

$$Q = It$$
$$t = 2/0.2 = 10sec$$
$$H = I^2Rt$$
$$0.2^2 \times 0.2 \times 10 = 0.08j/sec$$

12. A cell supplies a current of 1.8A through two 2Ω resistors connected in parallel. When the resistors are connected in series, the current is 0.6A. Calculate the internal resistance of the cell. (3mk)

$$R_T = \frac{2X2}{2+2} = 1\ \Omega,\ E = I(R + r),\ E = 1.8(1 + r)$$
$$E = 1.8 + 1.8r \ldots\ldots.(i)$$
$$R_T = 2 + 2 = 4\ \Omega,\ E = I(R + r),\ E = 0.6(4 + r)$$
$$E = 2.4 + 0.6r \ldots\ldots.(ii)$$
$$Equiting\ i\ and\ ii$$
$$1.8 + 1.8r = 2.4 + 0.6r,\ -0.6 = -1.2r,\ r = 0.5\ \Omega$$

13. A cell can supply a current of 1.2A through two 2Ω resistors connected in parallel. When they are connected in series, the value of the current is 0.4A. Calculate the internal resistance of the cell. (3mks)

$$R_T = \frac{2X2}{2+2} = 1\ \Omega,\ E = I(R + r),\ E = 1.2(1 + r)$$
$$E = 1.2 + 1.2r \ldots\ldots.(i)$$
$$R_T = 2 + 2 = 4\ \Omega,\ E = I(R + r),\ E = 0.4(4 + r)$$
$$E = 1.6 + 0.4r \ldots\ldots.(ii)$$
$$Equiting\ i\ and\ ii$$
$$1.2 + 1.2r = 1.6 + 0.4r,\ -0.4 = -0.8r,\ r = 0.5\ \Omega$$

14. A battery of e.m.f. 3V drives a current through a 20Ω resistor. The p.d across the resistor is 2.8V as measured by a voltmeter. Calculate the internal resistance of the battery.

$$Voltage\ drop = 3 - 2.8 = 0.2V$$
$$V = IR,\ I = 1.8/20 = 0.14A$$
$$V = Ir,\ r = 0.2/0.14 = 1.429A$$

15. Resistors of 2Ω and 3Ω are connected in series with a cell and voltmeter connected across the 3Ω resistor reads 1V, but this increases to 1.2V when an extra 2Ω resistor is connected in parallel with the first 2Ω resistor, calculate the e.m.f and the internal resistance of the cell.

$$I = V/R = 1/3 = 0.3333A$$
$$V_{2ohms} = 0.3333 \times 2 = 0.6667A$$
$$V_T = 1 + 0.6667 = 1.6667V$$
$$E = I(R + r)$$
$$E = 1.6667 + 1.6667r \ldots\ldots..(i)$$
$$I = 1.2/3 = 0.4A$$
$$V_T = 0.4(1+3) = 1.6V$$
$$E = 1.6 + 0.4r \ldots\ldots(ii)$$
$$Equating\ (i)\ and\ (ii)$$

$E = 1.9994V$

$r = 0.9985\ \Omega$

16. A torch uses two identical dry cells connected in series. When a bulb of resistance 2.0Ω is connected across the cells the pd across the bulb is 2.0V. When a bulb of resistance 1.5 ohms is used, the p.d is 1.8V, calculate the e.m.f and internal resistance of each cell.

$I \text{ across } 2\ \Omega = 2/2 = 1A$

$I \text{ across } 1.5\ \Omega = 1.8/1.2 = 1.2A$

$E = I(R + r)$

$E = 2 + r$ ……..(i)

$E = 1.8 + 1.2r$ …….(ii)

Equating (i) and (ii)

$r = 1\ \Omega$

$E = 3V$

17. A cell drives a current of 3.2A through a 2.8 Ω resistor. When it is connected to 1.6Ω resistor, the current that flows is 5A. Find the:

(i) E.m.f (E) for the cell. (2mk)

$E = I(R + r)$

$E = 3.2(2.8 + r)$

$E = 8.96 + 3.2r$..... (i)

$E = 5(1.6 + r)$

$E = 8 + 5r$ …….(ii)

Equating (i) and (ii)

$8.96 + 3.2r = 8 + 5r$

$E = 10.667V$

(ii) Internal resistance (r) for the cell. (2mk)

$8.96 + 3.2r = 8 + 5r$

$r = 0.533\Omega$

18. A cell drives a current of 8A through a 1.2Ω resistor when the same cell is connected to a 1.8Ω resistor, the current that flows is 6.0A. **Determine**

(i) The internal resistance. (4mks)

$E = I(R + r)$

$E = 8(1.2 + r)$

$E = 9.6 + 8r$..... (i)

$E = 6(1.8 + r)$

$E = 10.6 + 6r$ …….(ii)

Equating (i) and (ii)

$9.6 + 8r = 10.8 + 6r$

$-1.2 = -2r$

$r = 0.6\Omega$

(ii) E.m.f of the cell. (2mks)

$E = 9.6 + (8 \times 0.6) = 14.4V$

A cell supplies a current of 0.5A when connected to a 2Ω resistor and 0.25A when connected to a 5Ω resistor. Find the e.m.f and the internal resistance of the cell. (4mks)

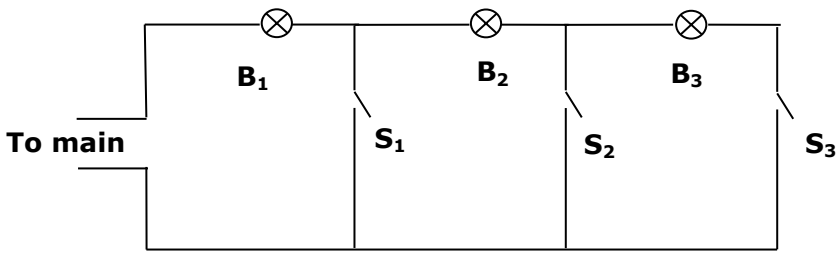
$$E = I(R + r)$$
$$E = 0.5(2 + r)$$
$$E = 1 + 0.5r \text{..... (i)}$$
$$E = 0.25(5 + r)$$
$$E = 1.25 + 0.25r \text{ .....(ii)}$$
Equating (i) and (ii)
$$1 + 0.5r = 1.25 + 0.25r$$
$$-0.25 = -0.25r$$
$$r = 1\Omega$$
$$E = 1 + (0.5 \times 1) = 1.5V$$

19. A wire of resistance X connected in series with a 1.5 V battery is found to carry a current of 0.075 A. If the wire is now connected in parallel with an identical wire, find the total current in circuit. (3mk)

$$V = IR,\ 1.5 = 0.075X$$
$$X = 1.5/0.075 = 20\Omega$$
$$I_n = \frac{20 \times 20}{20+20} = 10\ \Omega$$
$$V = IR$$
$$I = 1.5/10 = 0.15A$$

BULBS

1. An electrician installed electric wiring in a house and connected the bulbs and the switches as shown in the figure below.



(a) **Explain** what happens when switch

(i) S_1 is closed. (1mk)

Only bulb B_1 will light.

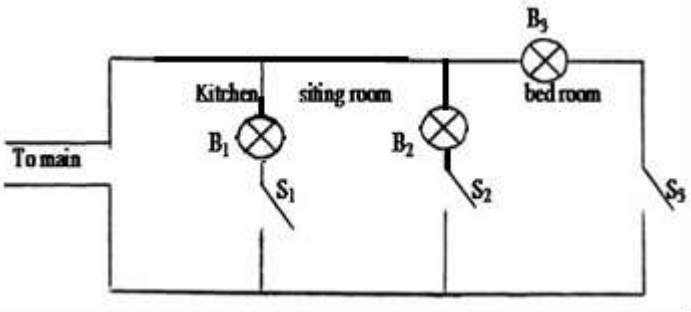
(ii) S_2 is closed. (1mk)

Bulb B_1 and B_2 lights but with less brightness because of increase in resistance.

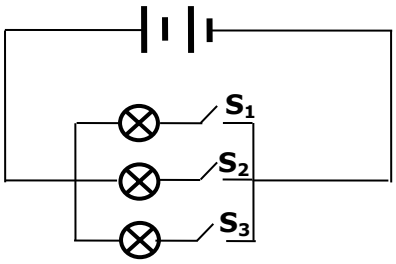
(iii) S_3 is closed. (1mk)

Bulb B_1 B_2 and B_3 will all light but with much less brightness compared to a(ii)

(b) (i) Using a red drawn diagram **show** the best position the bulbs should be installed. (3mks)

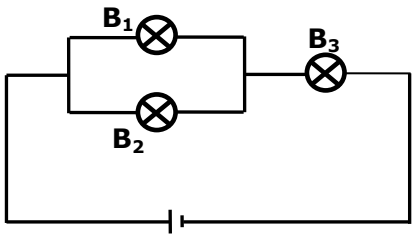


2. **State** the changes in brightness of the bulbs in the circuit diagram as the switches S_1, S_2 and S_3 are switched on one after the other. (2mks)



- *The brightness remains the same. Bulbs in parallel have the same potential difference but different amounts of current.*

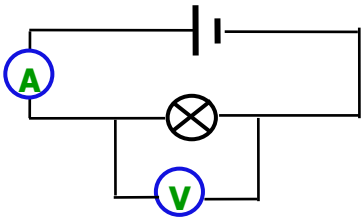
3. Figure below shows a circuit diagram containing three identical bulbs.



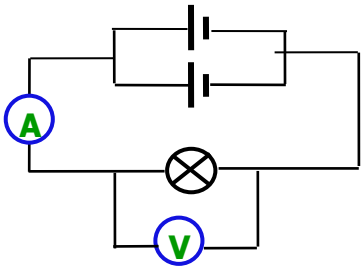
Compare the brightness of the bulbs (2mks)

Bulbs B1 and B2 light less bright compared to bulb B3.

4. The voltmeter and the ammeter in figure (a) below read 2.1v and 0.35A respectively.



(a)

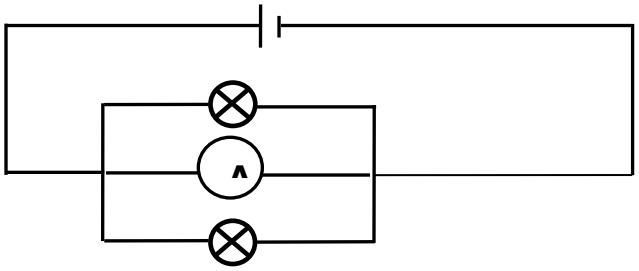


(b)

Determine the reading in the voltmeter and ammeter in figure(b) respectively. (The lamps are identical to those in (a)

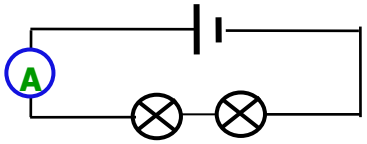
Voltmeter reading will be 2.1V and ammeter reading is 0.35A. the cells connection is in parallel.

5. A student set up the circuit shown in Fig. 3. The lamps didn't light when she closed the switch S.

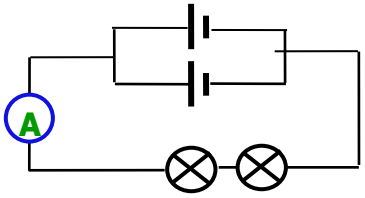


Suggest a reason for this observation. (2mk)

6. Figure below shows two circuits with identical dry cells and identical bulbs;



(A)



(B)

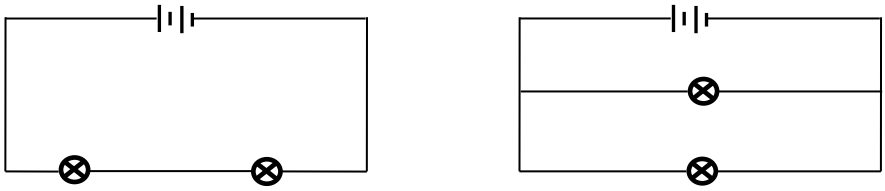
(i) In which circuit will the bulbs be brighter (1mk)

Their brightness is the same.

(ii) Give a reason for your answer in (i) above (1mk)

They both have the same potential difference.

7. A student was investigating the brightness of bulbs when setup in an electric circuits. She used identical bulbs and cells. The circuits shown in figure 3(a) and (b) were what she setup.

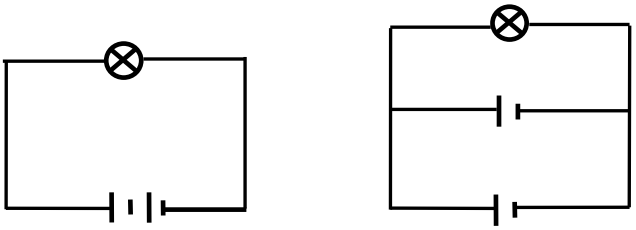


(a) **(b)**

Which setup was the bulb brightest? Give a reason for your answer. (2mk)

Bulbs in (b) arrangement light brighter than those in (a) arrangement. Bulbs in (a) have increased resistance than in (b)

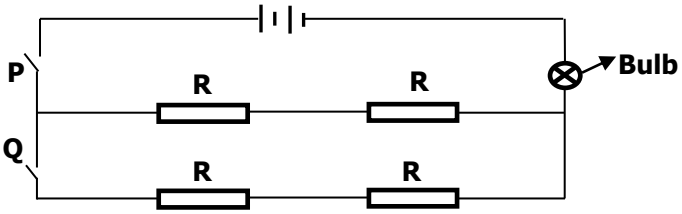
8. Fig (a) and (b) show two possible arrangements of a bulb to a source of power.



In which of the arrangement above would the cells drain faster. Explain your answer. (2mk)

The cells in the first diagram drain faster than in the second diagram. The bulb uses an emf equivalent to the emf of one cell which means less emf hence longer time.

9. The circuit diagram in figure below has two switches P and Q. The brightness of the lamp is observed when P only is closed and when P and Q are both closed.



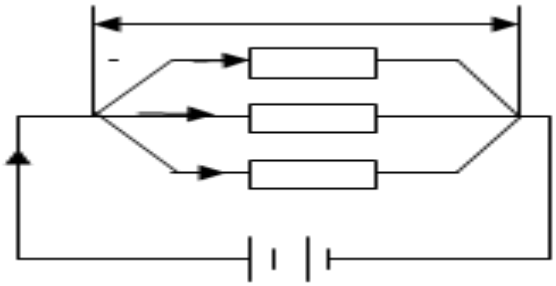
Compare the brightness of the lamp in the two cases. State a reason for your answer. (2mks)

The brightness remains the same. The current recombines since the bulb is in series with the resistors.

CIRCUITS

1. Three resistors of resistance 2 Ω, 3 Ω and 4 Ω, are to be connected to a cell such that they have the least effective resistance.

(i) Draw a circuit to show how they can be connected to achieve this.(2mk)



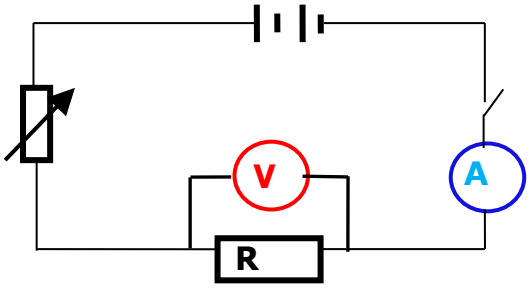
(iii) Determine the least effective resistance of the three resistors. (3mk)

$1/R_T = ½ + 1/3 + ¼ = 1/R_2 = 13/12$
$R_T = 0.9231\Omega$

(iii) State two factors that determine the resistance of a metallic conductor. (2mk)

The temperature of the metallic conductor.
The length of the conductor
The Cross- section area of the conductor

2. Figure shows a voltmeter connected across the cell. The voltmeter reads 1.5V when the switch S, is open and 1.2V when the switch is closed.

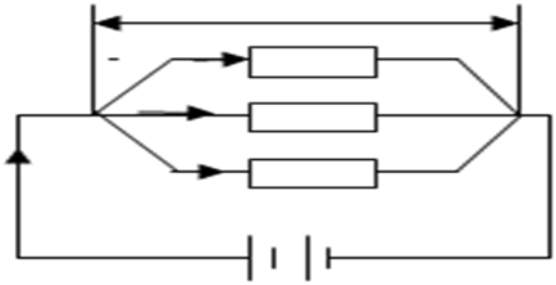


(i) What is the e.m.f. of the cell. (1 mk)
1.5V

(ii) What is the terminal voltage of the cell. (1 mk)
1.2V

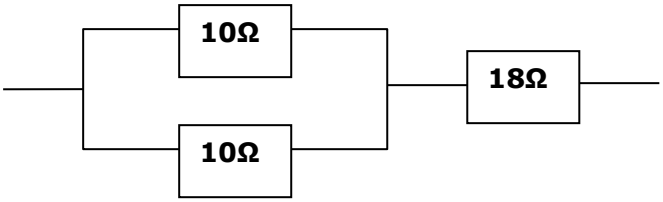
(iii) Calculate the internal resistance of the cell. (3 mks)
$E = I(R+r)$
$1.5 = 1.2 + Ir$
$r = 0.3/I$

3. You are provided with three resistors of **3Ω, 2Ω**and**1Ω**. Arrange the resistors in the circuit so as to have minimum resistance. Determine the effective resistance in the above circuit (3mk)



$1/R_T = 1/3 + 1/2 + 1/1 = 1/R_2 = 11/6$
$R_T = 0.5454\Omega$

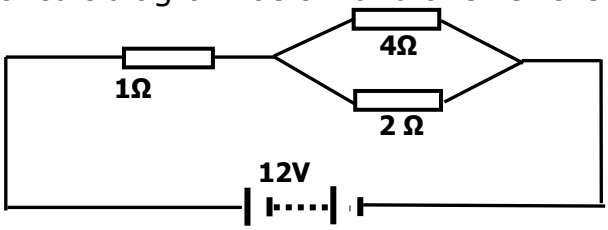
4. Figure below shows part of an electric circuit. The current through the 18Ω resistor is observed to be 2A.



State the value of the current through each of the 10Ω resistors. (1mk)

2/2 =1.0 A

5. **Study** the circuit diagram below and answer the questions that follow.



Calculate

(i) The current flowing through the ammeter. (3mks)

$R_T = 1 + \frac{4 X 2}{4+2} = 1 + 1.3333 = 2.3333\ \Omega$

$I = V/R = 12/2.3333 = 5.143A$

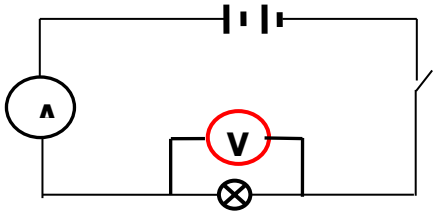
(ii) The P.d. across AB (2mks)

P.D drop = V = IR = 5.143 X 1.3333 =6.85562V

(iii) The current through the 4Ω resistor (2mks)

$I = V/R = 6.85562/4 = 1.714A$

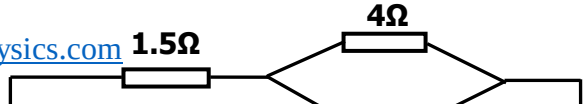
6. The figure below shows an electric circuit. When the switch is closed the ammeter reading is 0.3A.



Determine the voltmeter reading. (3mks)

V = IR = 0.3XR

7. In the circuit diagram below, the battery source has a voltage of **12V** and an internal resistance of **0.5Ω.**



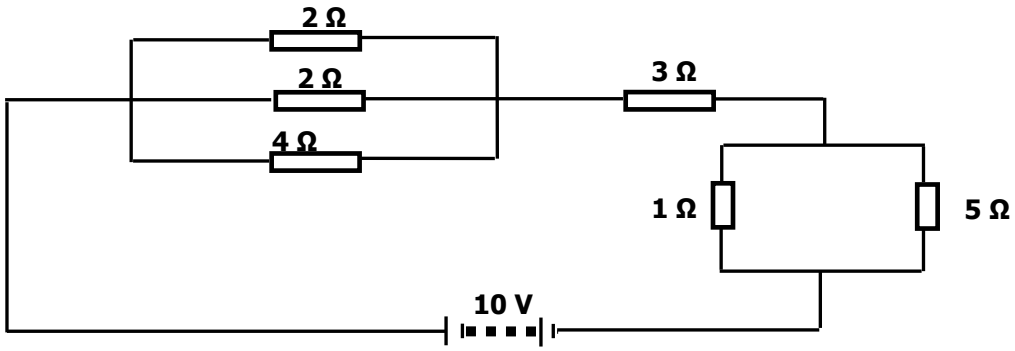
(i) Calculate the total resistance in the circuit. **(3mk)**

$R_T = 1.5 + \frac{4 X 6}{4+6} + 1.6 = 5.5\Omega$

(ii) Calculate effective current in the circuit. **2mk)**

$I = V/R = 12/5.5 = 2.1818A$

8. Use the circuit in figure below to answer the questions that follow



(i) Calculate the total resistance in the circuit (3mk)

$1/R_T = ½ + ½ + ¼ = 5/4, R_T = 0.8\ \Omega$

$R = \frac{1 X 5}{1+4} = 5/5 = 1\ \Omega$

$TOTAL\ R_T = 0.8 + 3 + 1 = 4.8\ \Omega$

(ii) Determine the current flowing through the 5Ω resistor (3mk

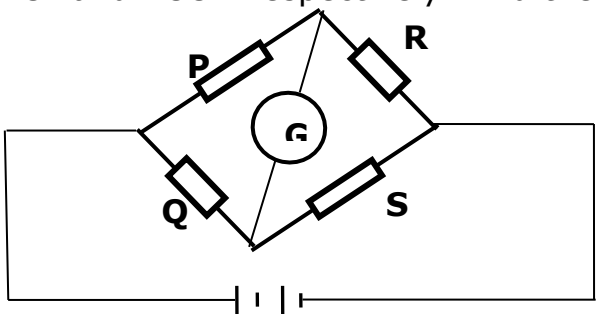
$I = 10/4.8 = 2.0833A$

$V = IR$

$Voltage\ drop\ across = 2.0833\ X\ 1 = 2.0833V$

$I = 2.0833/5 = 0.4167A$

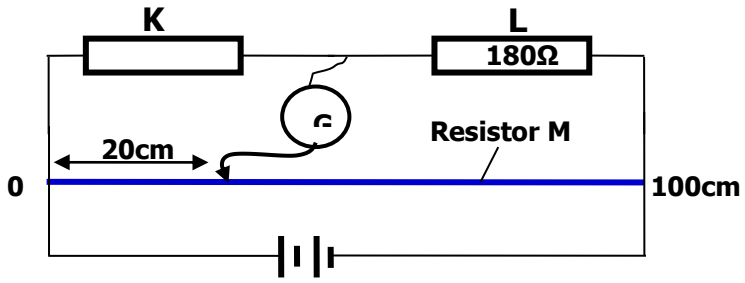
9. In a balanced condition, the resistance of resistors **P,Q** and **R** is **80Ω ,120Ω**and **100Ω** respectively. Find the resistance **S.** (3mk)



$P/R = Q/S = 80/100 = 120/S$

$S = 150\ \Omega$

10. Two resistors K and L are placed in the gaps of the metre bridge as shown



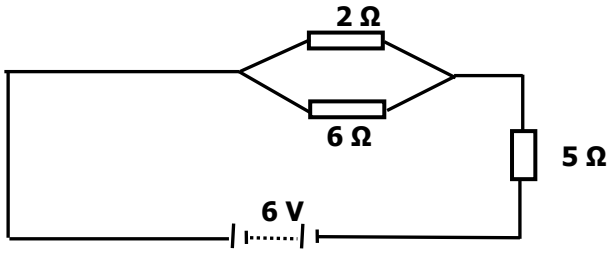
(i) State the purpose of the resistor M. (1mk)

To balance the bridge until there is no deflection on galvanometer.

(ii) Find the resistance K below if the Jockey balances the galvanometer at the **20cm** mark.

$\frac{X}{R} = \frac{L_1}{L_2}$ = *K/180 = 0.2/0.8 = 45Ω*

11. The figure below shows a 6V battery connected to an arrangement of resistors. Determine the current flowing through the 2 Ω resistor. (3mk)



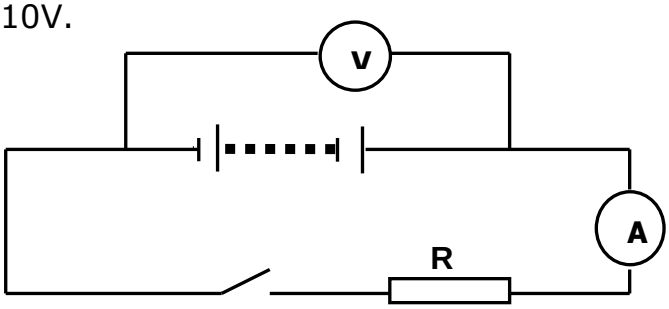
Total resistance = $\frac{2 \times 6}{2+6}$ + 5 = 6.5 Ω

I = 6/6.5 = 0.923A

p.d across = 0.923 x 1.5 = 1.3845V

$I_{2\Omega}$ = *1.3845/2 = 0.69225A*

12. It was noted that for the circuit diagram below, when the switch is open, the voltmeter gives a reading of 12V, but when the switch is closed the voltmeter drops to 10V.



(a) Give an explanation for the difference in reading on the voltmeter when the switch is open and when it is closed. (2mk)

Some electrical energy is lost is moving charges against the resistance in the circuit.

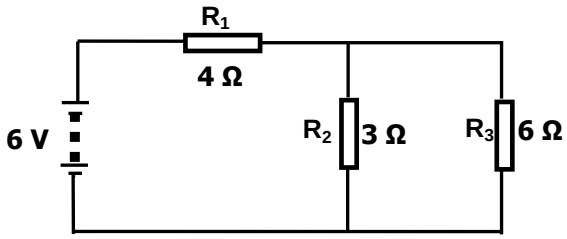
(b) If the ammeter gives a reading of 0.8A when the switch is closed, determine the value of R. (1 mk)

$$E = I(R + r)$$
$$12 = 0.8R + 2$$
$$0.8R = 10V$$
$$R = 12.5\Omega$$

(c) Determine the internal resistance of the accumulator (2mk)

$$E = I(R + r)$$
$$12 = 10 + 0.8r$$
$$0.8r = 2v$$
$$r = 2.5\Omega$$

13. The figure below shows a series – parallel circuit.



Calculate:

(i) Total resistance of the circuit. (3mks)

$$4 + \frac{3x6}{3+6} = 6\Omega$$

(ii) Total current flowing in the circuit. (2mks)

$$I_T = 6/6 = 1^a$$

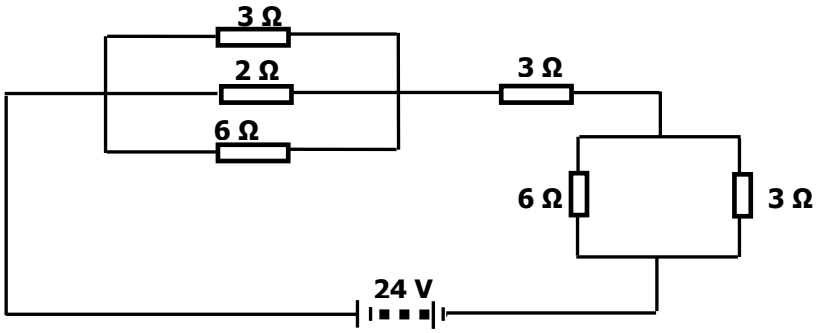
(iii) Voltage drop across R_1 (2mks)

$$V_{R1} = IR = 1x4 = 4V$$

(iv) Current through the 3Ω resistor. (3mks)

$$V = IR,\ 2X1 = 2\ \Omega$$
$$I = 2/3 = 0.6667^a$$

14. Use the circuit in fig below to answer the questions that follow.



(i) Calculate the total resistance in the circuit. (2mk)

$1/R_T = 1/3 + ½ + 1/6 = 6/6,\ R_T = 1\ \Omega$

$R = \frac{6\ X\ 3}{3+6} = 5/5 = 2\ \Omega$

$TOTAL\ R_T = 1 + 3 + 2 = 6\ \Omega$

(ii) Calculate effective current in the circuit. (2mk)

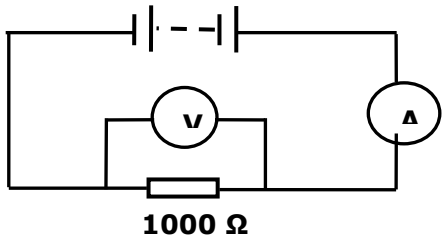
$I = V/R = 24/6 = 4A$

(iii) Calculate current through the 2**Ω** resistor. (2mk)

$V = 4\ X1 = 4V$

$I_{2\Omega} = 4/2 = 2A$

15. A large battery is connected as shown in figure 5 to a resistor of resistance **1000Ω.** The voltmeter across the resistor reads 50V.



(i) What is the reading of the ammeter (A)? (3mk)

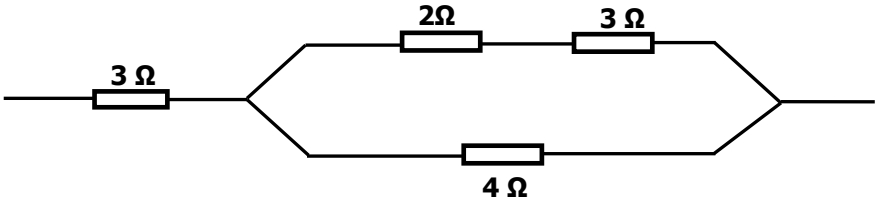
$I = V/R = 50/1000 = 0.05A$

(ii) Determine the electrical energy dissipated by the resistor in one minute. (3mk)

$E = I^2Rt$

$E = 0.05^2\ X\ 1000\ X60 = 150J$

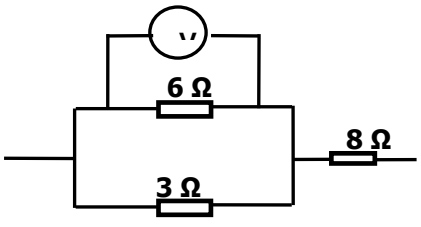
16. Determine the effective resistance in figure below. (3mk)



$2 + 3 = 5\Omega$

$R_T = 3 + \frac{5\ X\ 4}{5+4} = 3 + 2.222 = 5.222\ \Omega$

17. Figure shows three resistors connected as shown.



If the voltmeter reads **4V**, find the

(i) Effective resistance. (2mks)

$R_{eff} = 8 + \frac{6\ x\ 3}{6+3} = 10\ \Omega$

(ii) Current through the 3Ω resistor. (2mks)

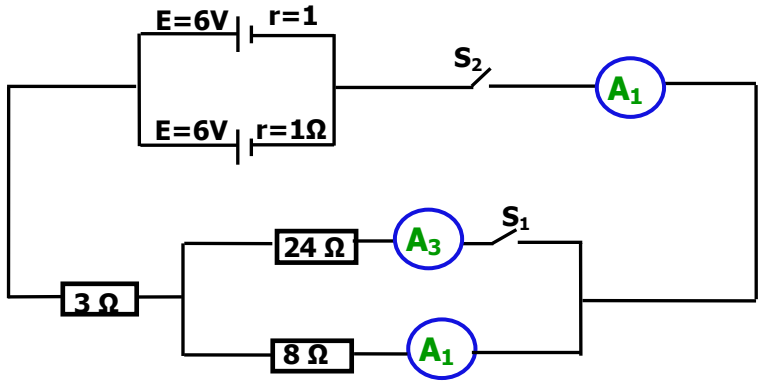
$V_{3\Omega} = 4V$ *in parallel with* $6\ \Omega$

$V = 4/3 = 1.333A$

(iii) Potential difference across the 8Ω resistor. (2mks)

$I_{TOTAL} = 1.3333 + 4/6 = 2A$
$V_{8\Omega} = IR = 2\ x8 = 16V$

18. In the circuit diagram shown in figure below, determine the reading of the meters if:



(i) The switch S_1 is open and S_2 closed. (3mks)

$R_T = 1 + 3 + 8 = 12\ \Omega$
$I = 6/12 = 0.5A$
$A_1 = 0.5A$

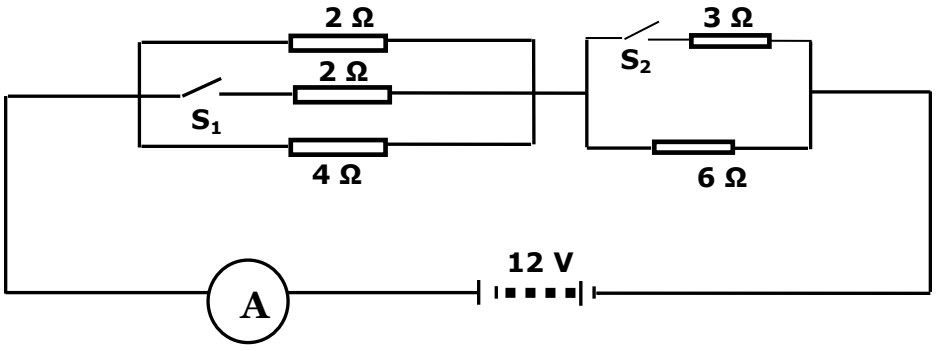
(ii) Switch S_1 closed, S_2 open. (1mk)

$A1=0$
$A3 = 0$

(iii) Both switches are closed. (6mks)

$R_{eff} = 1+3 + \frac{24x8}{24+8} = 10\ \Omega$
$I = 6/10 = 0.6A$
$V_{across\ 24\Omega\ and\ 8\Omega} = 6\ x\ 0.6 = 3.6V$
$A_3 = 3.6/24 = 0.15A$
$A_2 = 3.6/8 = 0.45A$

19. Study the circuit shown in fig below.



(i) Determine the effective resistance when both switches **S_1** and **S_2** are open. (3mk)

$R_{eff} = \frac{2x4}{2+4} + 6 = 7.333\ \Omega$

(ii) Determine the effective resistance when both switches S_1 and S_2 are closed. (3mk)

$1/R_T = 1/R1 + 1/R2 + 1/R3$

$1/R_T = ½ + ½ + ¼ = 5/4\ \Omega$

$R_T = 4/5 = 0.8\ \Omega$

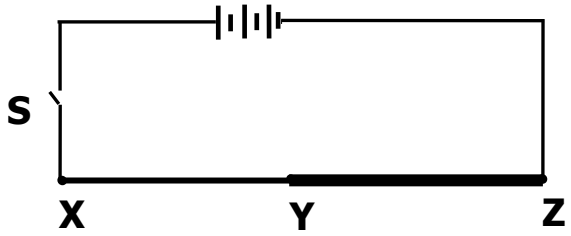
$R_{TB} = \frac{3X6}{3+6} = 2\ \Omega$

$R_T = 0.8 + 2 = 2.8\ \Omega$

(iii) Determine the ammeter reading when both switches are closed. (2mk

$I = V/R = 12/2.8 = 4.286A$

20. Figure represents a 4.8V battery connected to two conductors XY and YZ of the same Material and same length welded together at Y. The radius of XY is half that of YZ. The resistance of YZ is 1.6Ω.



a) Calculate;

i) The resistance of the conductor XZ (5mks)

let radius of be r

$$\rho = \frac{RA}{l}$$

$Rxy = \frac{\rho L}{\pi r x r}$

$Ryz = \frac{\rho L}{\pi r x r}$ $Ryz/Rxy = ¼$

$Rxy = 4Ryz$

$Rxy = 4x1.6 = 6.4$

$Rxz = 1.6 + 6.4 = 8\Omega$

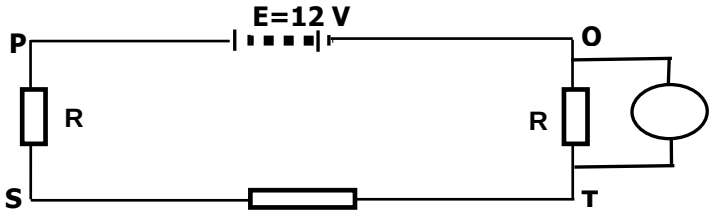
ii) The current which flows in the circuit when the switch S is closed(3mks)

$I = V/R = 4.8/8 = 0.6A$

iii) The potential drop across the conductor XY (2mks)

$Pdxy = IR = 0.6\ X\ 6.4 = 3.84V$

21. The circuit diagram in figure shows three identical resistors connected to a cell of e.m.f. 12V.



(i) Determine the reading of the voltmeter. (2mk)

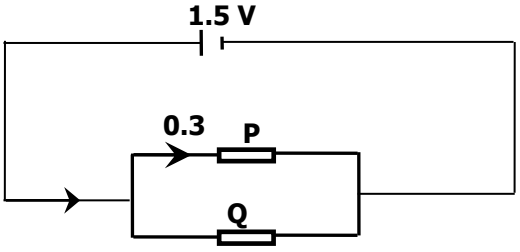
$I = 12/3R$, $Vreading = RX12/3R = 4V$

(ii) If another identical resistor R is connected parallel to PT, determine the potential difference across QS

$R_T = R + \frac{R\ X\ 2R}{R+2R} = R + 0.6667\Omega$

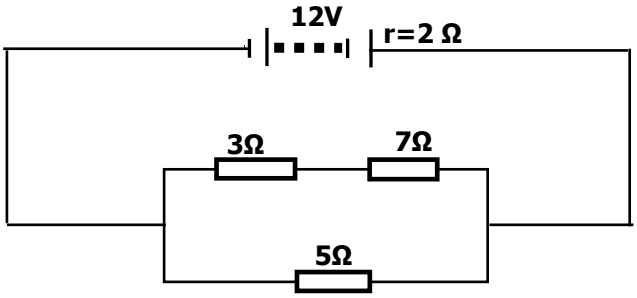
$R_T = 1.6667R$

22. In the circuit below figure, the e.m.f of the cell is 1.5V. Its internal resistance is r ohms. Resistors P and Q are each **3Ω.** If 0.3A current flows through P. find the value of r.



$E = IR + Ir$
$V_P = 0.3X3 = 0.9V$
$I_Q = 0.9/3 = 0.3A$
$I = 0.6A$
$R_T = \frac{3X3}{3+3} = 1.5\Omega$
$1.5 = 0.6r + 0.6 \text{ x } 1.5$
$r = 1\ \Omega$

23. Fig shows three resistors connected to a **12V** battery of internal resistance **2Ω**



Calculate

i) The current drawn from the cell.

$R_T = 2 + \frac{10\ X5}{10+5} = 2 + 3.3333 = 5.3333\ \Omega$
$I = 12/5.3333 = 2.50A$

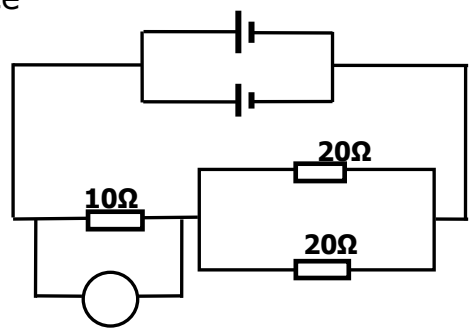
ii) The "Lost voltage", in the cell

$Lost\ voltage = 2\ x2.25 = 4.5V$

iii) The potential different across the 7Ω resistor.

$V = 2.25\ X3.3333 = 7.499V$
$I = V/R$
$I = 7.499/10 = 0.7499A$
$P.D = 0.7499\ X\ 7 = 5.249V$

24. The cells shown in the figure below have each an e.m.f of 2.1V and negligible internal resistance



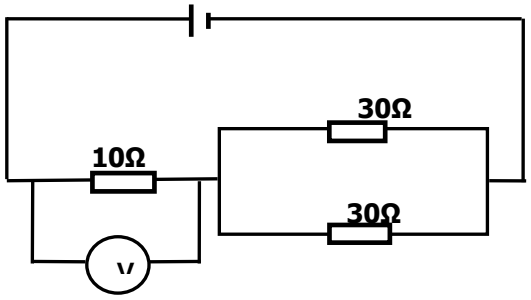
Determine the reading of the voltmeter (3mk)

$R_T = 10 + \frac{20\ X20}{20+20} = 20\Omega$

$I = 2.1/20 = 0.105A$

Voltmeter reading = 0.105 x 10 = 1.05v

25. The cell in figure has an e.m.f of **2.1V** and negligible internal resistance.



Determine the

(i) Total resistance in the circuit (2mk)

$R_T = 10 + \frac{30\ X30}{30+30} = 25\Omega$

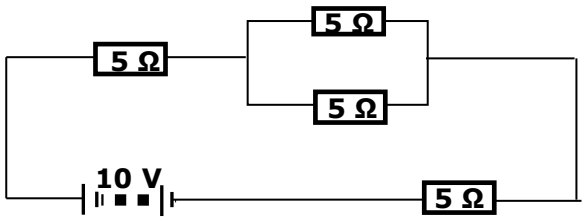
(ii) Current in the circuit (1mk)

$I = V/R =, 2.1/25 = 0.084A$

(iii) Reading on the voltmeter (2mk)

Reading of voltmeter = 10 x 0.084 = 0.84v

26. Four 5Ω resistors are connected to a 10V d. c. supply as shown in the diagram below.



Calculate;-

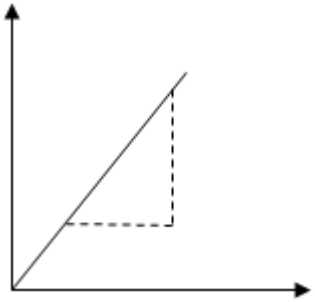
i) The effective resistance in the circuit.

$R_T = 5 + 5 + \frac{5\ X5}{5+5} = 12.5\Omega$

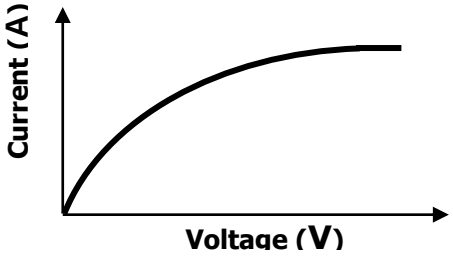
ii) The current I following in the circuit.

$I = V/R = 10/12.5 = 0.8A$

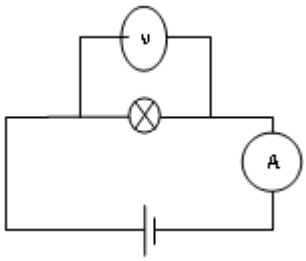
27. Sketch a graph current against voltage for an electrolyte solution such as dilute sulphuric acid.



28. For a particular bulb, a series of readings of the current through the bulb for different potential differences across it is taken and plotted as shown.



a) Draw the circuit diagram you would use for the experiment.(2mks)



b) Explain how the resistance of the bulb changes (3mks)

The resistance of the bulb increases as the current increases. As current increases the temperature of filament increases hence increase in resistance.

c) How would the resistance of the bulb change if

(I) The length were doubled (2mks)

The resistance increases, resistance increases with increase in length.

(II) The diameter were doubled (2mks)

The resistance reduces . resistances reduces with increase in diameter.

29. The graph below shows results obtained in an experiment to determine the **e.m.f.(E)** and the internal resistance, **r**, of a cell.

(i) Determine the slope of the graph

$Slope = \frac{2.3-0.8}{2.3-0.0} = 0.739\Omega/V$

Given that the equation of the graph is $\frac{\mathbf{E}}{\mathbf{V}} = \frac{\mathbf{r}}{\mathbf{R}} + \mathbf{1}$ Determine

(ii) The e.m.f **E** of the cell.

$Y = MX + C$

$\frac{1}{V} = \frac{r}{RE} + \frac{1}{E}$

$Gradient = r/E$

$y\text{-}intercept = 1/E$

$0.8 = 1/E$

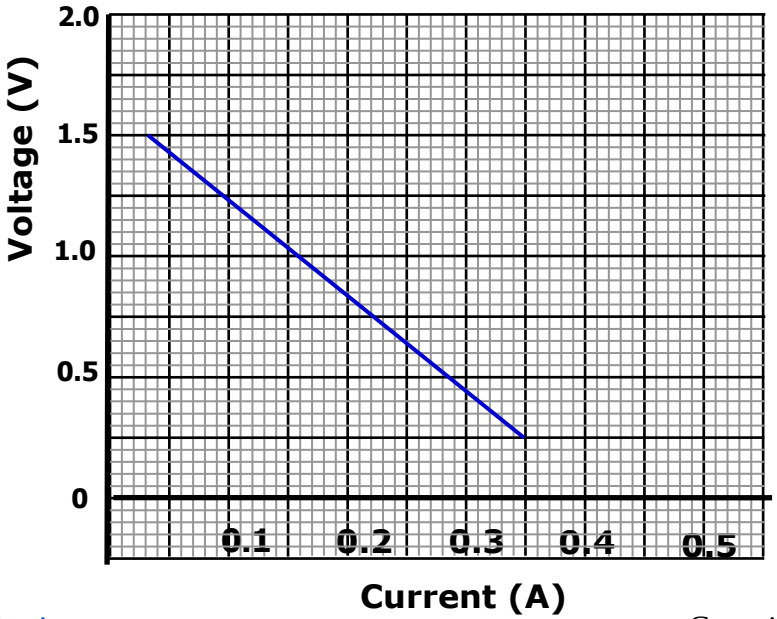
$E = 1.25V$

(iii) The internal $\boldsymbol{r}$ resistance of the cell.

$0.739 = r/1.25$

$r = 0.92375\Omega$

30. The graph below shows the Voltage current relationship for a certain battery.



Determine:

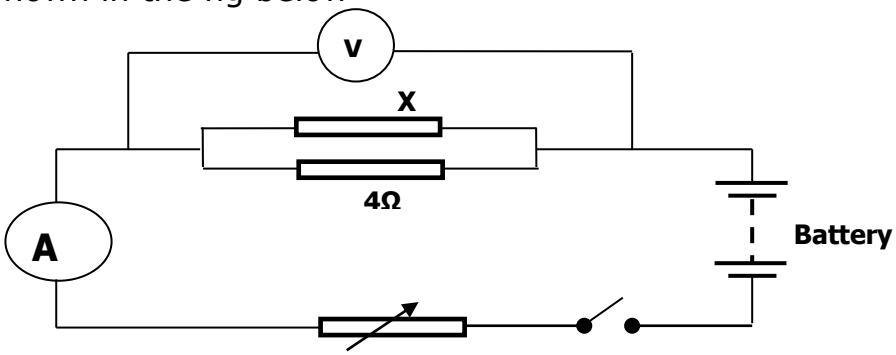
(i) The e.m.f of the cell. (1mk)

$$E.m.f = y\text{-}intercept$$
$$E.m.f = 1.65V$$

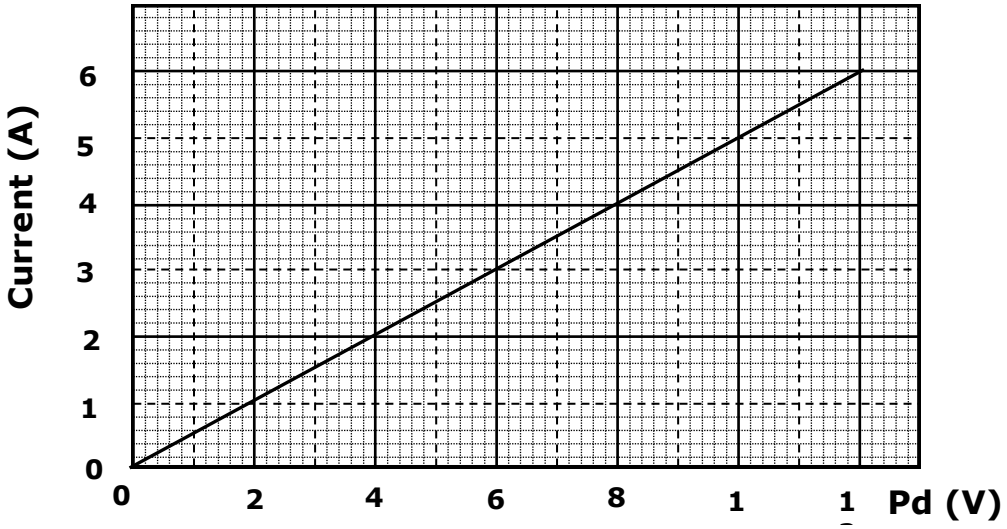
(ii) The internal resistance of the cell. (4mks)

$$E = V + Ir$$
$$V = E - Ir$$
$$Gradient = r$$
$$Gradient = \frac{0.25-1.05}{0.35-0.15} = r = -0.8/0.2 = 4\Omega$$

31. Two resistors 4Ω and the other unknown resistor x are connected in a circuit as shown in the fig below



The current I passing through the combination is measured for various potential differences, A graph of p.d. against current is shown in the grid below.



(i) Use the graph to determine the total resistance of the combination. (3mk)

$$Gradient = 1/R = \frac{5-2}{10-4} = 0.5\Omega^{-1}$$
$$R = 1/0.5 = 2\Omega$$

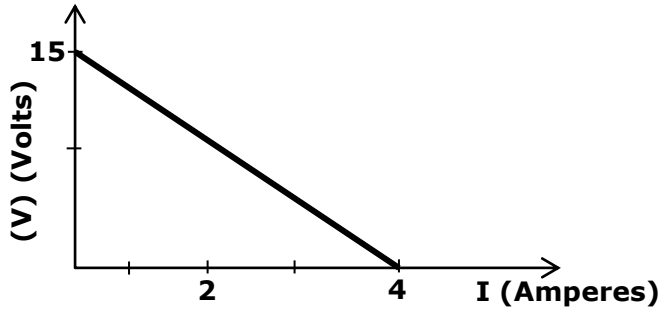
(ii) Determine the value of the unknown resistance x (2mk)

$\frac{4\,xX}{4+X}$=2 Ω

$4X = 8 + 2X$

$X = 4\ \Omega$

32. Figure 12 shows the variation of voltage against current.



Given the equation; E = V + Ir

Find from the graph.

(i) the e.m.f, E of the cell. (1mk)

$E.m.f = 15V$

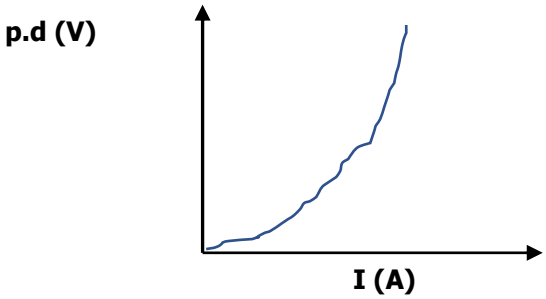
(ii)the internal resistance, r, of the cell. (3mks)

$-r = gradient$

$Gradient = \frac{0-15}{4-0} = -\frac{15}{4} = -3.75\Omega$

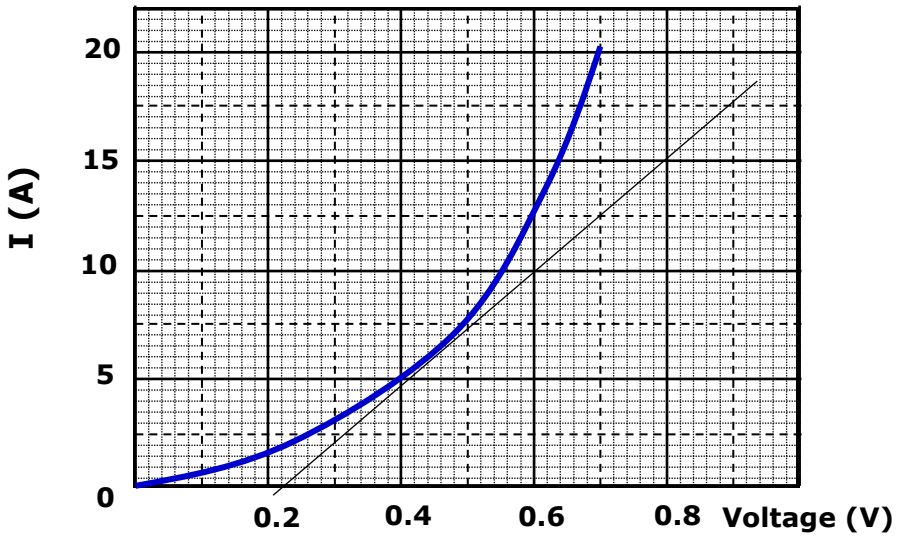
$r = 3.75\ \Omega$

33. On the axes provided, sketch a graph to show how current, I varies with potential difference, V, across a metallic conductor that is being heated at the same time. Explain your answer (2mks)



The resistance increases opposition to slow of electrons with increases in temperature. Also atoms vibrations increases per cross – sectional area hence increasing resistance.

34. The graph below shows how the voltage, V, varies with the current, I for a filament lamp.



(i) From the graph, determine the resistance of the lamp when a current of 0.5A flows. (3mks)

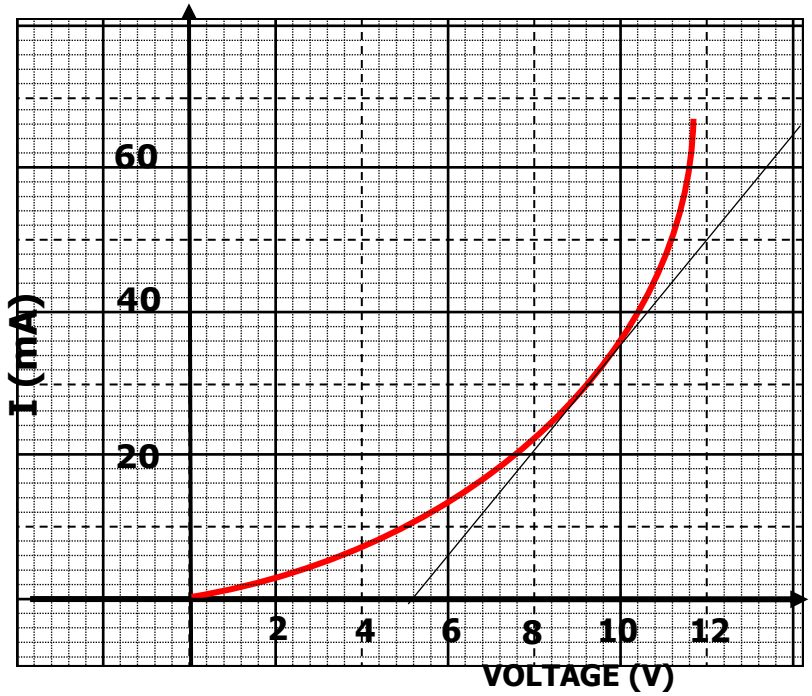
Gradient = 1/R = $\frac{15-5}{0.8-0.4}$ *= 25Ω⁻¹*

R = 1/25 = 0.04Ω

(ii) State with a reason whether the device is ohmic or non-ohmic. (2mks)

It is a non – ohmic because voltage is not directly proportional to current.

35. The graph in fig. shows the current – voltage characteristics of a certain device Q.



(i) State with a reason whether the device obeys ohm's law. (2mk

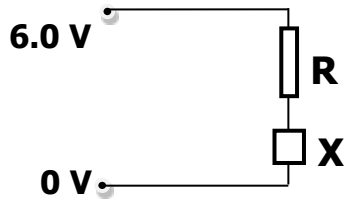
It doesn't obey ohms law. Current flowing through it is not directly proportional to voltage across it.

(i) Determine the resistance of the device, Q when current through it is 30mA. (3mk)

Gradient = $1/R = \frac{50-0}{12-4.6} = 0.6757 \times 10^{-3}\ \Omega^{-1} = 0.0006757\ \Omega^{-1}$

$R = 1/0.0006757 = 1479.95\Omega$

iii) When the device, X, is connected in the circuit below, the voltage across it is 0.70V.



Calculate the value of the resistance R.

$E = V_1 + 0.70V$

$V_1 = 6 - 0.7 = 5.3V$

$I = V/R = 5.3/1479.95 = 0.003581A$

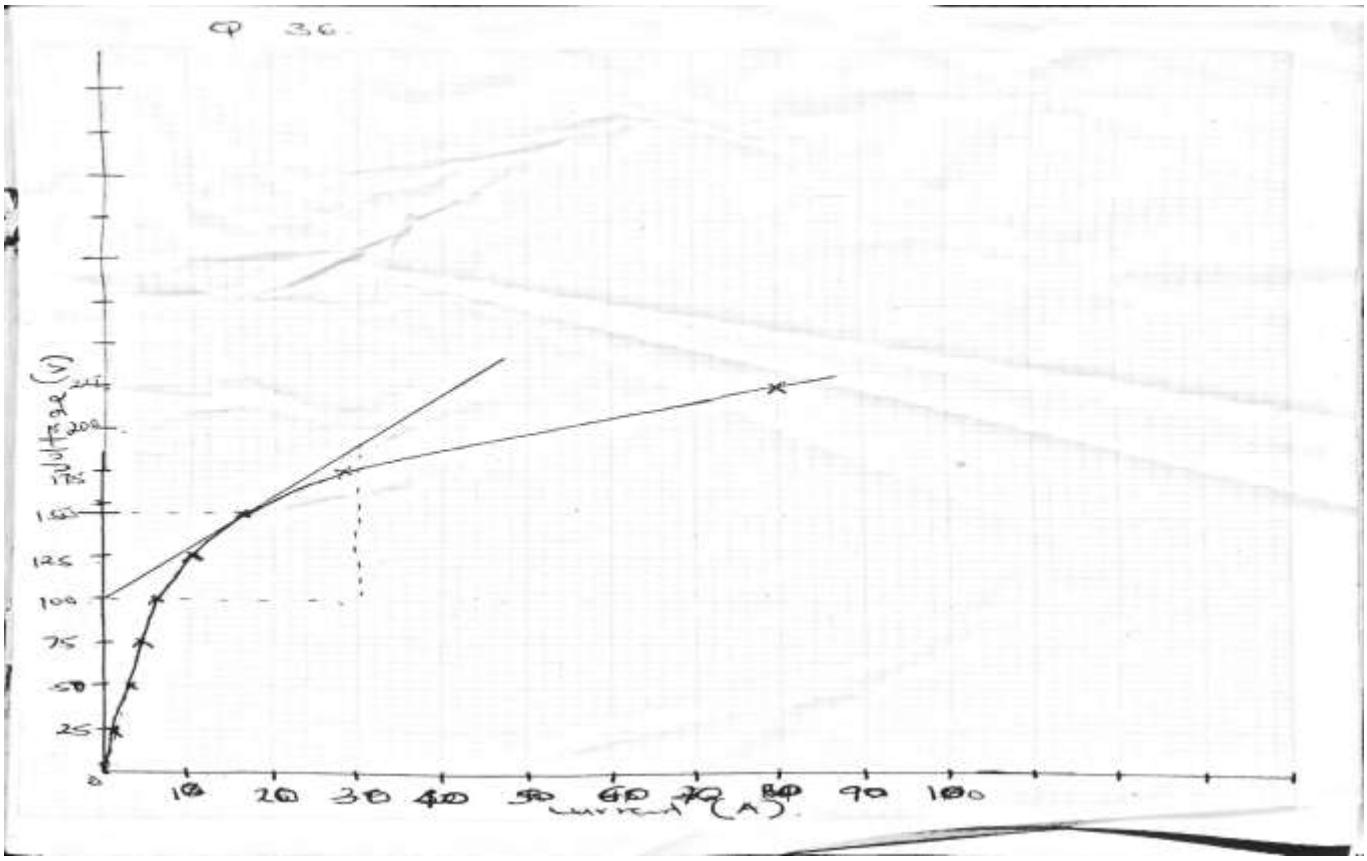
$V = IR$

$R = V/I = 0.7/0.003581 = 195.47\ \Omega$

36. The current I through a given diode for various values of voltage V between anode and cathode is given in the table below.

V (volts)	**0**	**25**	**50**	**75**	**100**	**125**	**150**	**175**	**225**
I(mA)	**0**	**1.0**	**3.0**	**4.0**	**6.0**	**10.0**	**16.0**	**28.0**	**80.0**

(iv) **Draw** the characteristic graph of the diode using the data. (5mks)



(v) **Explain** the nature of graph. (2mks)

As current increases the resistance reduces because of increased temperature causes more electrons to jump to conduction band creating more electrons and holes responsible for conductivity.

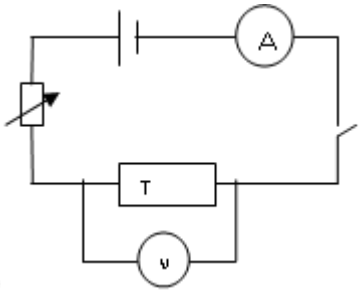
(vi) **Determine** the resistance of the diode when the voltage is 150V. (3mks)

$R = \frac{190-100}{30-0} = 90/30 = 3\Omega$

37. A battery is connected in series with an ammeter and a variable resistor R. The resistor is varied and the corresponding readings of the ammeter recorded in the table below.

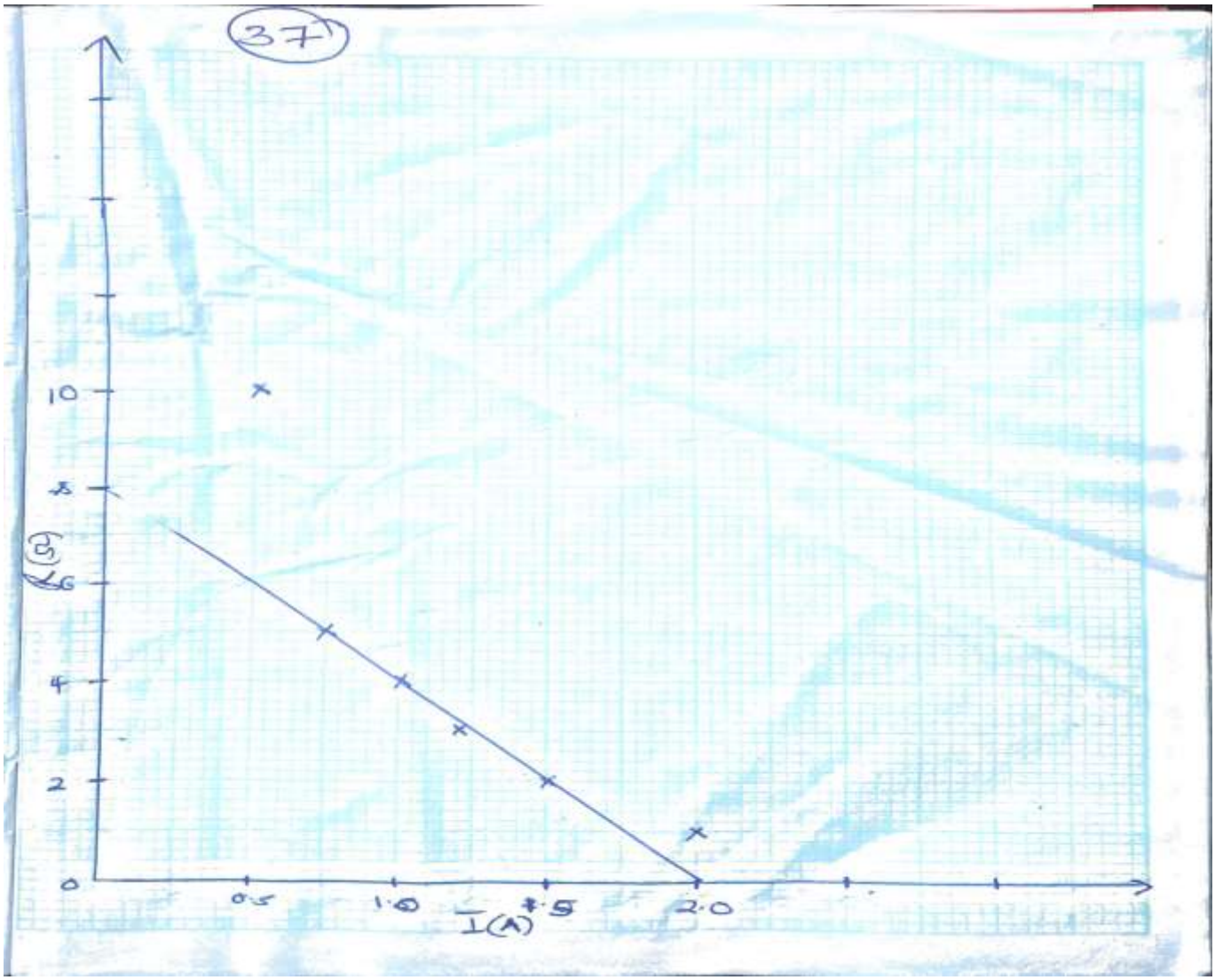
Resistance R (Ω)	**1.0**	**2.0**	**3.0**	**4.0**	**5.0**	**10.0**
Current I (A)	**2.0**	**1.5**	**1.2**	**1.0**	**0.75**	**0.5**

(i) Draw a circuit diagram of the circuit that was used to perform this



experiment. (1mk)

(ii) On the grip provided, plot a graph of **R** (y-axis) against **I** (x-axis). (5mk)



(iii) Use your graph to determine the internal resistance of the battery. (2mk)

(iv) Determine the e.m.f of the cell. (2mk)

38. A student carried out an experiment to investigate how current varies with potential difference
applied across a filament lamp. The following readings were obtained.

P.d.(V)	**0**	**0.20**	**0.40**	**0.60**	**0.80**	**1.20**	**1.60**	**2.40**
I (A)	**0.0**	**0.11**	**0.20**	**0.28**	**0.34**	**0.43**	**0.50**	**0.58**

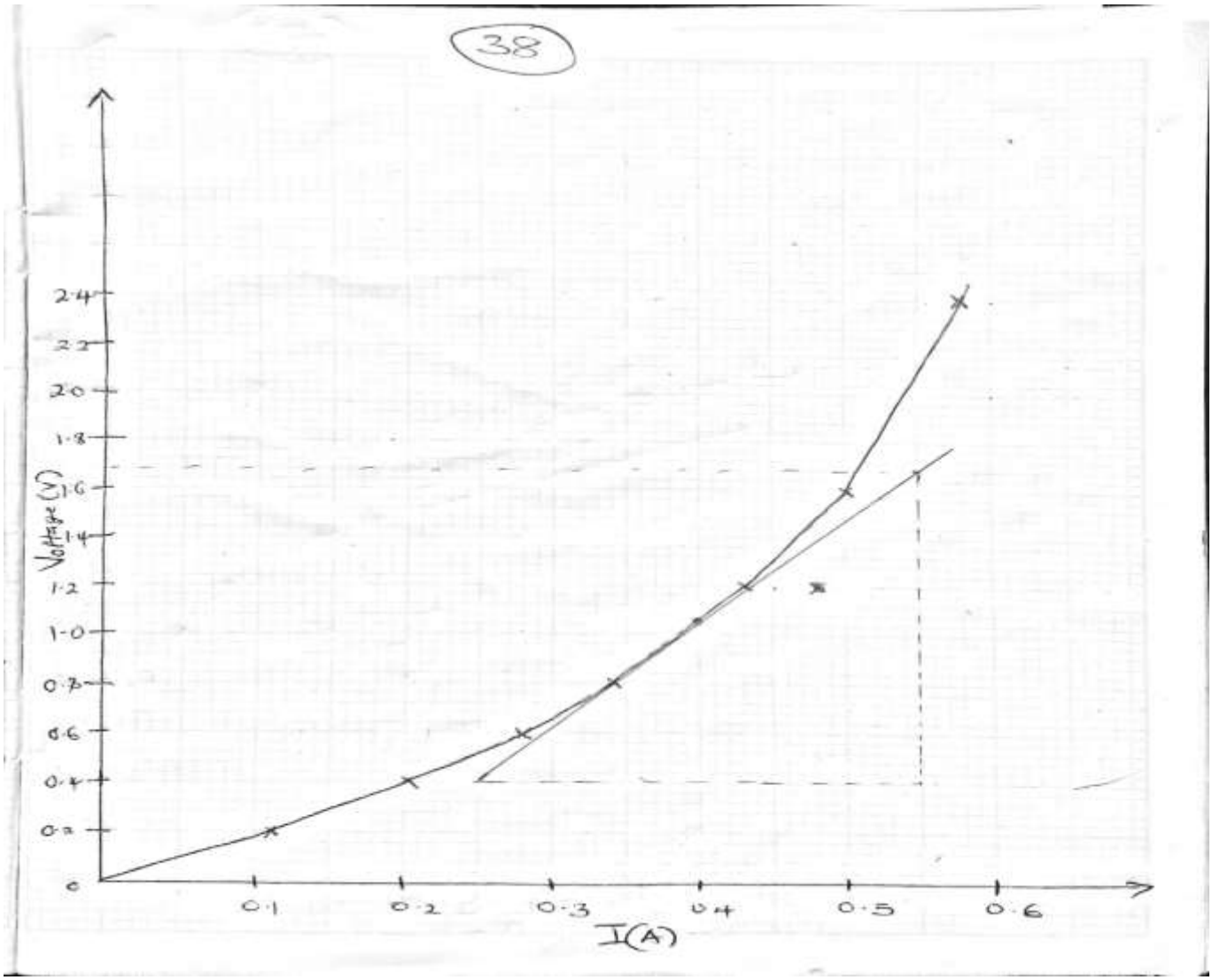
(a) **Draw** a diagram for the circuit used to obtain the values. (2mks)

(b) **Describe** briefly how the experiment was carried out. (2mks)

Vary current to minimum and record in table V and I

Increase current in steps and fill V and corresponding I to fill the table for different values.

(b) **Plot** a graph of V against I for the values presented in the table. (5mks)



(d) **Determine** the resistance of the lamp when a current of 0.4A flows through it. (3mks)

R = gradient of tangent

$R = \frac{1.68-0.4}{0.55-0.25} = 1.28/0.3 = 4.2667\Omega$

(e) **Explain** why a filament lamp does not obey Ohm's law. (2mks)

As current increases the filament gets hot and resistance increases due to increased opposition to flow of current.