The international system of units (S.I)

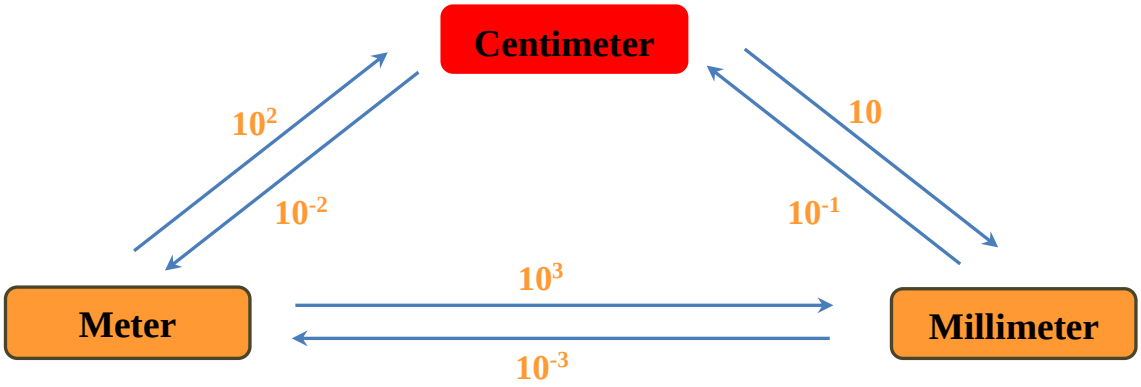
Quantity	Symbol	Unit	Symbol
Length	L	Meter	m
Mass	M	Kilogram	Kg
Time	T	Second	S
Electric current	I	Ampere	A
Temperature	t	Kelvin	^{o}K

Physical Quantity	Expressing Relation	Units		Dimensional Formula
Area	Length x Breadth		m^2	L^2
Volume	Length x Breadth x Height		m^3	L^3
Velocity	$\frac{\text{change in displacement}}{\text{change in time}} = \frac{\Delta S}{\Delta t}$	m/sec	$m.sec^{-1}$	$L.T^{-1}$
Force	Mass x acceleration (= m x a)	N	$Kg.m.sec^{-2}$	$M.L.T^{-2}$
Work, Energy	Force x displacement (= F x s)	N.m or Joule	$Kg.m^2.sec^{-2}$	$M.L^2.T^{-2}$
Work, Energy	$\frac{\text{work}}{\text{time}}$	$\frac{J}{s}$ = watt	$Kg.m^2.sec^{-3}$	$M.L^2.T^{-3}$

Weight of body = mass x acceleration due to gravity W = Mg
= M 9.8 Newton's

Conversion symbols

Deci (d) $X\ 10^{-1}$	**centi (c)** $X\ 10^{-2}$	**mili (m)** $X\ 10^{-3}$	**micro (μ)** $x\ 10^{-6}$	**nano (n)** $X\ 10^{-9}$	**pico (p)** $X\ 10^{-12}$	**femto (f)** $X\ 10^{-15}$	**kilo (k)** $X\ 10^{3}$
Mega (M) $X\ 10^{6}$	**Gega (G)** $X\ 10^{9}$	**gm** $X\ 10^{-3}$ **kg**	**ton** $X\ 10^{3}$ **kg**	**Angstrom** $A^0 \times 10^{-10}$ **m**	**liter (L)** $X\ 10^{-3}\ m^3$	**Kg weight X acceleration due to gravity → (N)**	



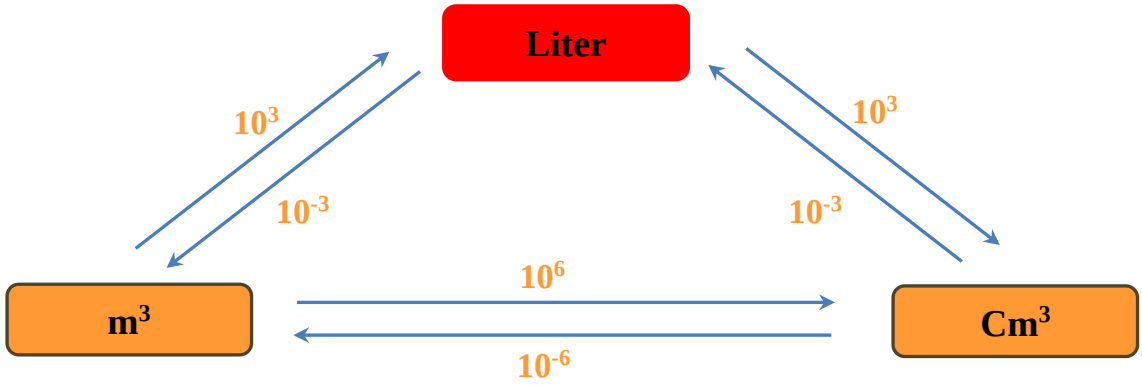
$1m = 1 \times 10^2\ cm = 10^3\ mm$

$1m^2 = 1 \times (10^2)^2\ cm^2 = (10^3)^2 mm^2$

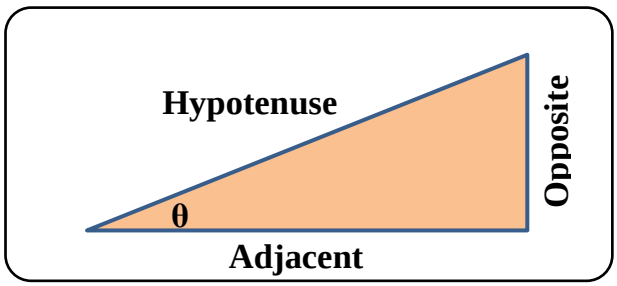
$1m^2 = 1 \times 10^4\ cm^2 = 10^6\ mm^2$

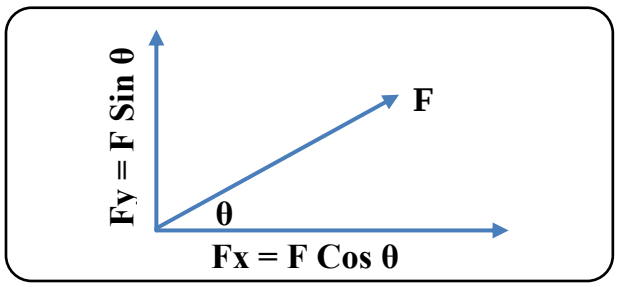
$1m^3 = 1 \times (10^2)^3\ cm^3 = (10^3)^3 mm^3$

$1m^3 = 1 \times 10^6\ cm^3 = 10^9\ mm^3$



* To analyze the vector into two components





$\sin\theta = \frac{Opp}{hyp.}$ ..... Opp. = hyp. Sin θ

$\cos\theta = \frac{Adj}{hyp.}$ ..... Adj. = hyp. Cos θ

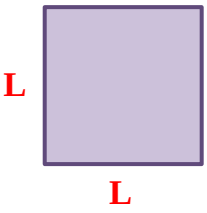
$\tan\theta = \frac{Opp}{Adj.}$ ..... Opp. = Adj. tan θ

Important Law

2. Square

Area = L^2

Perimeter = 4 L

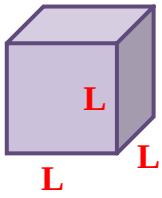


1. Cube

Area of one face = L^2

Total area = $6L^2$

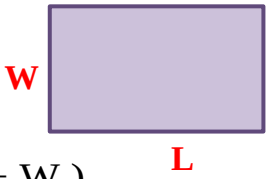
Volume = L^3



3. Rectangle

Area = L × W

Perimeter = 2 (L + W)

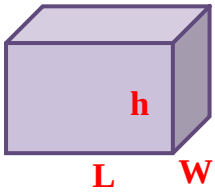


6. Cuboid

Area of base = L × W

Volume = L × W × h

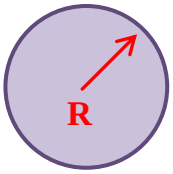
= Area of base × h



4. Circle

Area = πR^2

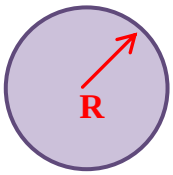
Perimeter (circumference) = $2\pi R$



7. Sphere

Surface Area = $4\pi R^2$

Volume = $\frac{4}{3}\pi R^3$



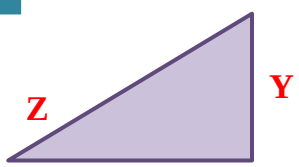
5. Triangle

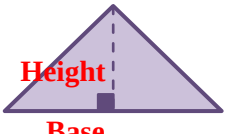
$\sin\theta = \frac{Y}{Z}$

$\cos\theta = \frac{X}{Z}$

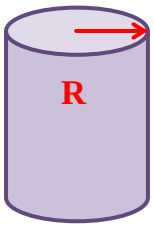
$\tan\theta = \frac{Y}{X}$

Area = $\frac{1}{2}$ base x height





8. Cylinder

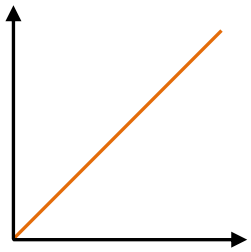


Area of base = πR^2

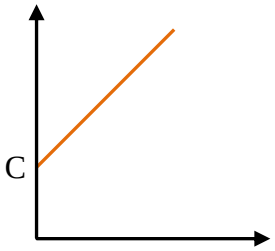
Volume = Area of base X h

= $\pi R^2 h$

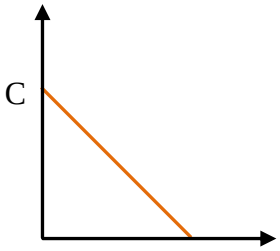
Types of Graphs



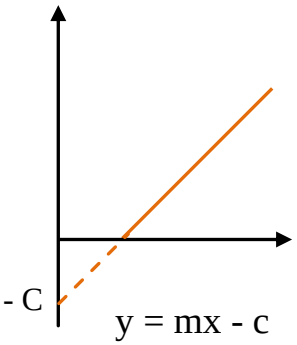
y = mx
where (m) is slope



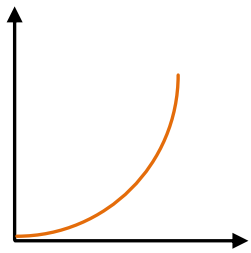
y = mx + c
where (m) is slope
(c) is constant



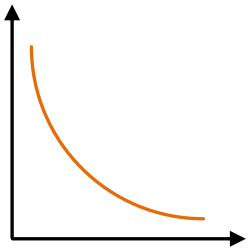
y = c - mx
where (m) is slope
(c) is constant



y = mx - c
where (m) is slope
(c) is constant



$y = ax^2$
Where (a) is constant



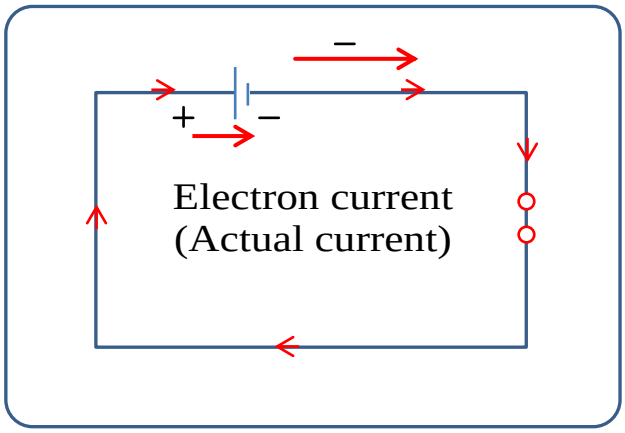
$y = \frac{a}{x}$
where (a) is constant

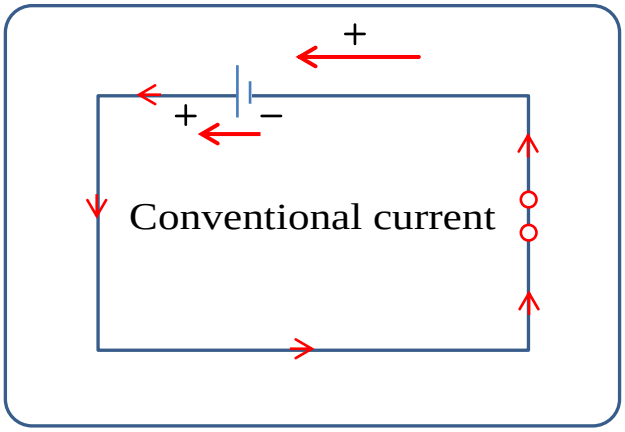
Lesson One

Electric current & Ohm's law

Electric current

It's the flow of electrons through a conductor if there is potential difference between its terminals.





Direction of the electric current:

Conventional current ⟶ It is flow of charges from (+ve) to (-ve) pole

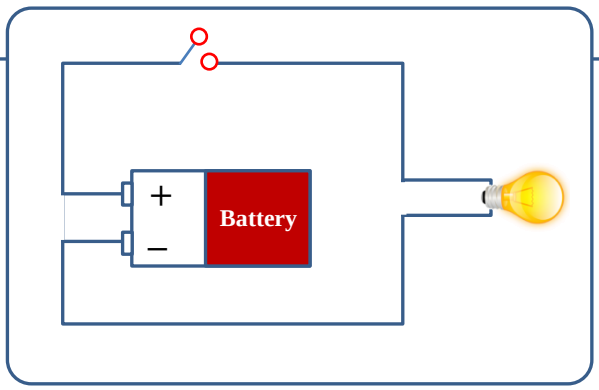
Real electron current ⟶ It is flow of electrons from (-ve) to (+ve) pole

Conditions to obtain electric current:

1- Electric source

" To create electric potential difference between the terminals the conductor "

2- Closed circuit



Materials are classified according to their electrical conductivity into:

Good conductors

1- It has large numbers of free electrons

2- For example Silver, copper and other metals

3- It has high conductivity

Bad conductors

1- It has very few free electrons

2- For example glass and porcelain and gases

3- It has low conductivity

Definition

The electric current:

It is a flow of electric charges in a conducting material.

Definition

The electric current intensity :(I)

It is the quantity of charge passing through a cross section area in one second.

$$I = \frac{Q}{t}$$

$$\left(\frac{\text{coulomb}}{\text{sec}}\right) \text{ or (ampere)}$$

Where (Q) is Quantity of charges (electricity)
(t) is Time

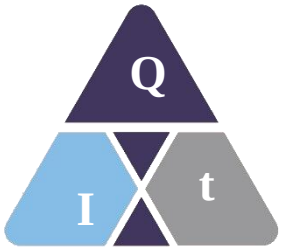
Calculating number of charges (electrons):

$$Q = n \times e$$

Where (n) is Number of charges (electrons)
(e^-) is Electron charge ($e^- = 1.6 \times 10^{-19} C$)

$I = \frac{Q}{I}$ OR Q = I x t

Coulomb Ampere second



Units Ampere = coulomb/sec.

$Q = n \times e = I \times t$ Where n is the number of electrons passing in t Sec.

The ampere

It is the current intensity of a conductor when one coulomb is the electric charge passing in it in one second.

The coulomb

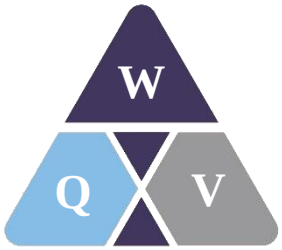
It is the quantity of electric charge passes in a given cross sectional area in one second when the current intensity is one ampere.

The potential difference between two points (p.d) (V)

It's the work done in joules to transfer a unit charge of one coulomb from one point to another. (It is measured in volts)

$V = \frac{W}{Q}$ **OR** **W** = **Q** x **V**

Joule coulomb volt



Units Joule/coulomb = volt

Volt

It is the potential difference between two points when the work done to transfer a charge of one coulomb between them is one joule.

The Electromotive Force (E.M.F of a source (V_B)

It's the work done to transfer a unit charge of one coulomb through the whole circuit.

Through the source and the external circuit]. It's measured in volts.

OR: It's the potential difference between the two poles of the source when the circuit is opened (when no current passes).

Electric energy

$W = V.Q \rightarrow$

W	=	V	x	I	x	t
Joules		Volt		Ampere		Second

Electric Power

It is the work done (electric energy) per unit time

$P = \frac{W}{t}$ = V x I → Measured in watts → Watt = J/sec = Volt. Ampere

Joule

It is the work done to transfer a charge of 1 coulomb through conductor when the potential difference across it is 1 Volt.

Watt

It is the electric power when 1 Joule is the energy consumed in one second

Solved Examples

1) A current intensity of 3.2 A passes through a conductor. Find the number of electrons that passes across its cross-section during 3 seconds given that the charge of an electron e = 1.6 x 10^{-19} coulomb.

Solution:

$Q = I \times t = n \times e \rightarrow 3.2 \times 3 = n \times 1.6 \times 10^{-19}$

$n = \frac{3.2 \times 3}{1.6 \times 10^{-19}}$ = 6 x 10^{19} electrons

I = 3.2 A t = 3 sec
n = ?? e = 1.6 x 10^{-19} c

2) Find the applied potential difference of a source if the work done needed to transfer 2 coulomb = 30J.

Solution:

$\because V = \frac{W}{Q} = \frac{30}{2}$ = 15 volt

W = 30 s Q = 2 c

3. Calculate the electric current intensity passing in a conductor which is due to the flow of quantity of electricity of 15 C through the cross-section of the conductor in a time period of 3 s

Solution:

$I = \frac{Q}{t} = \frac{15}{3} = 5A$

$Q = 15\ C$
$t = 3\ s$
$I = ?$

4. What is the number of electrons passing through a certain cross-section area of a conductor within a period of 1 second if the electric current intensity passing in the circuit 20 A and the electron charge is $1.6 \times 10^{-19} C$

Solution:

$I = \frac{Q}{t} \qquad \therefore Q = It = 20 \times 1 = 20\ C$

$n = \frac{Q}{e} = \frac{20}{1.6 \times 10^{-19}} = 1.25 \times 10^{20} \text{electron}$

$t = 1\ s$
$I = 20\ A$
$e = 1.6 \times 10^{-19} C$
$n = ?$

5. If the potential difference between the terminals of a Conductor in the electric circuit is 10 V, calculate the work done to transfer 6.25×10^{20} electrons between the terminals of the conductor (knowing that the electron charge is $.6 \times 10^{-19} C$)

Solution:

$V = \frac{W}{Q} = \frac{W}{n.e}$

$W = V.n.e = 10 \times 6.25 \times 10^{20} \times 1.6 \times 10^{-19}$

$= 1000\ J = 1\ K.J.$

$V = 10\ v$
$n = 6.25 \times 10^{20}$ electrons
$e = 1.6 \times 10^{-19}\ C$

Ohm's law

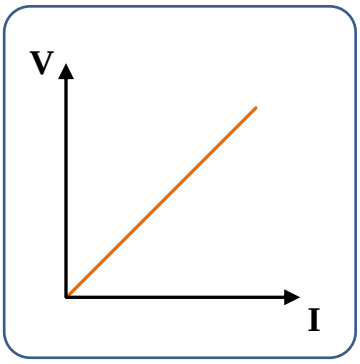
The current intensity in a conductor is directly proportional to the potential difference across its terminals at a constant temperature.

$V \alpha I$

$V = IR$

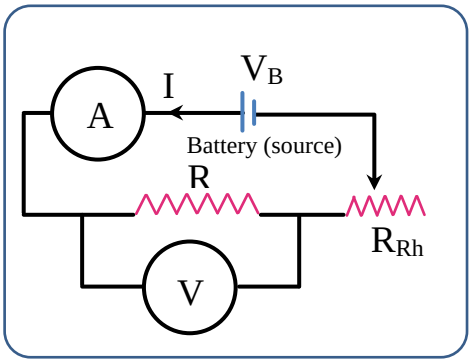
$V = (\text{constant}) I$

(Constant Temperature)



Some Electric Symbols

	Cell (battery)		Resistance
	Cells	On / Off	Key (switch)
A	Ammeter		Variable resistance (rheostat)
V	Voltmeter		



The Electric Resistance of a conductor (R)

It's the opposition of the conductor to the flow of electric current. OR It's the ratio between the potential difference across the conductor terminals and the current intensity flowing in it.

$$R = \frac{V}{I} \quad \text{measured in ohms } (\Omega) \rightarrow \text{ohms} = \frac{\text{Volt}}{\text{Ampere}}$$

Types of Resistors

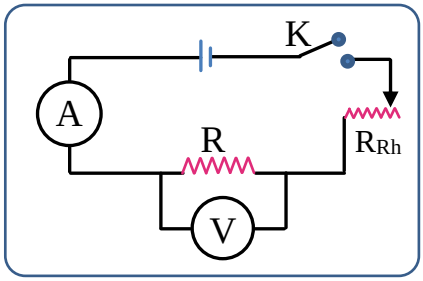
1. **Fixed resistors**: They have fixed values of resistance
2. **Variable resistors (Rheostat)**: Their resistances can be varied in order to control the current intensity flowing through the circuit.

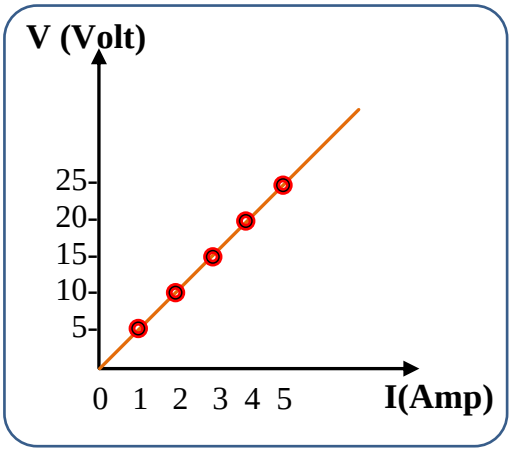
Ohm

It is the electric resistance of a conductor when 1 volt is the potential difference between its terminals and 1 ampere is the current passing in it.

Ohm's law

1- Connect circuit as shown.
2- Adjust the rheostat to allow passing suitable current
3- Record the reading of ammeter and voltmeter.
4- Repeat the previous several times
5- Plot a graph between the I and V





$V \propto I$
$V = \text{constant}.\ I$
$V = R.I$
$R = \frac{V}{I}$

I (Amp)	1	2	3	4	5
V (Volt)	5	10	15	20	25

Ohm's law

The potential difference between the terminals of the conductor is directly proportional to the intensity of the current passing through it at constant temperature.

$V = I.R$

Exercise

Problems

1- A cathode ray tube in which an electron beam passes in the rate of 10^{16} electrons per sec, find the intensity? ($e=1.6 \times 10^{-19}$ C)

(Ans. 1.6×10^{-3} amp.)

.....

.....

2- An electric current of intensity 4 ampere passes in a straight wire, calculate the electric charge passing in a section of the wire in one minute.

(Ans. 240 Coulomb)

.....

.....

3- If the work done to transfer a quantity of electricity 5C within 1 sec between two points in a conductor is 100 J, **Calculate**:

a) The potential difference between the two points?

b) The flowing electric current intensity?

c) Number of electrons passing within 2 sec?
($e = 1.6 \times 10^{-19}$ C)

(Ans. 20V, 5A, 6.25×10^{19} electrons)

.....

.....

.....

.....

4- An electric lamp written on it (200 volts – 60 watt), **Calculate**:

a) What is the meaning of number written on the lamp?

b) The intensity of the current?

c) The resistance of the lamp?

d) The quantity of electricity passing through the lamp in one hour?

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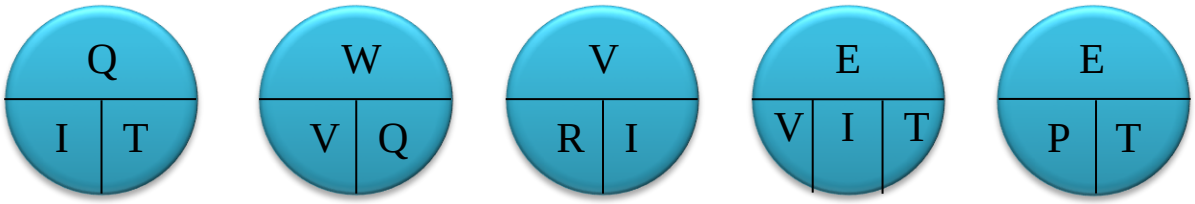

Q2 Mention the physical quantities measured using the following units and deduce the equivalent units?

The unit	The physical quantity	The equivalent unit
Coulomb		
Coulomb/ sec		
Ampere. Sec		
Joule. Coulomb^{-1}.		
Volt. Ampere		
Volt. Ampere^{-1}.		
Joule / sec		
Volt. Coulomb		
Joule / ohm. Coulomb		
Volt. Sec/ ohm.		

Model answer exercise

Chapter { 1 }
Lesson one

1) $\frac{n}{t} = 10^{16}$ *electons/sec*

$e = 1.6 \times 10^{-19} c$

$I = \frac{Q}{t} = \frac{n \times e}{t} = 10^{16} \times 1.6 \times 10^{-3}$ *amp*

2) $I = 4amp$

$t = 1min = 60sec$

$\because I = \frac{Q}{t}$

$\therefore Q = I \times t = 4 \times 60 = 240c.$

3) $Q = 5c$

$t = 1sec$

$w = 100J$

$(a) V = \frac{w}{Q} = \frac{100J}{5c} = 20Volts.$

$(b) I = \frac{Q}{t} = \frac{5}{1} = 5amp$

$(c) t = 2sec \ , \ I = \frac{Q}{t} = \frac{n \times e}{t}$

$n = \frac{I \times t}{e} = \frac{5 \times 2}{1.6 \times 10^{-19}} = 6.25 \times 10^{19}$ *elecrons*

4) *(a) that means*

- The potential difference $V = 200 volts$

- The power $= 60 walt$

(b) $\because P = VI \qquad I = \frac{P}{V} = \frac{60}{200} amp$

(c) $\because P = VI = \frac{V^2}{R} = I^2 R$

$\therefore R = \frac{V^2}{P} = \frac{(200)^2}{60} = \frac{40000}{60} \Omega$

(d) $t = one\ hour = 1 \times 60 \times 60 = 3600 sec$

$\therefore Q = I \times t = \frac{60}{200} \times 3600 sec$