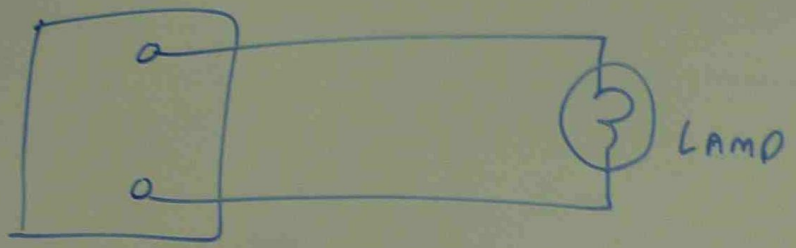
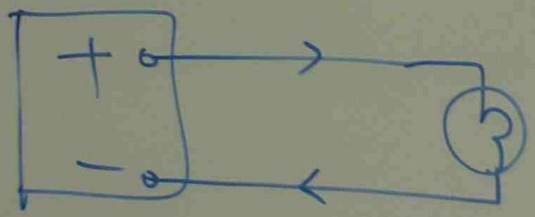
G012 ELECTRICAL FUNDAMENTAL



BATTERY

(SIMPLE CIRCUIT DIAGRAM)



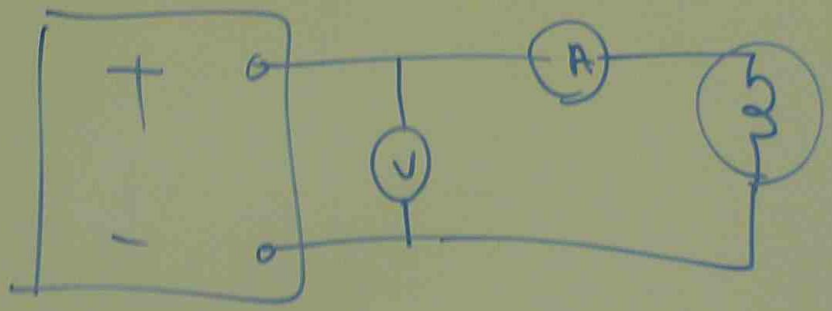
DIRECTION of CURRENT FLOW.

AL

MEASURING VOLTAGE AND CURRENT

VOLT METER - MEASURE VOLTAGE

AMMETER - MEASURE CURRENT



VOLT METER & AMMETER IN CIRCUIT.

EFFECT OF ELECTRICAL CURRENT

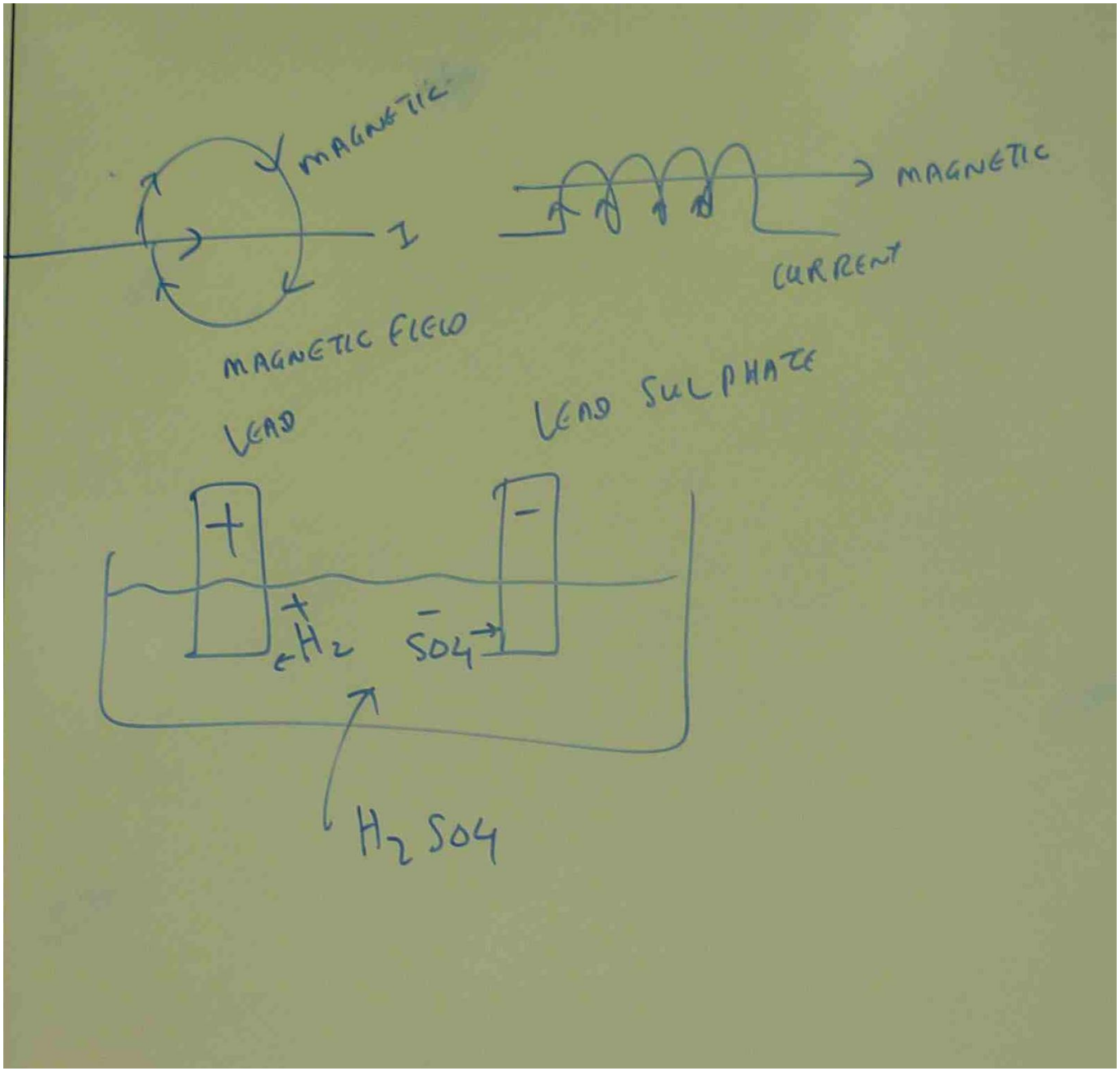
MAGNETIC FIELD - A CONDUCTOR MOVING IN A MAGNETIC FIELD HAS AN INDUCED CURRENT FLOW.

PIEZO ELECTRIC EFFECT - A QUARTZ (OR) OTHER SPECIAL CRYSTAL WHEN STRESSED CAUSES A POTENTIAL DIFFERENCE BETWEEN IT'S SURFACES

CHEMICAL - A CHEMICAL REACTION CAUSES A POTENTIAL DIFFERENCE IN A CHEMICAL SOLUTION (OR) PASTE

HEAT - HEAT ENERGY IS DIRECTLY CONVERTED TO POTENTIAL DIFFERENCE

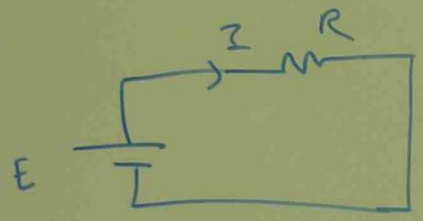
SOLAR | LIGHT - LIGHT ENERGY FROM THE SUN OR OTHER SOURCES CAN BE DIRECTLY CONVERTED TO POTENTIAL DIFFERENCE IN A SEMI CONDUCTOR.


MAGNETIC
I
MAGNETIC FIELD
MAGNETIC
CURRENT
LEAD
LEAD SULPHATE
+
−
+
H_2
−
SO_4
H_2SO_4

ELECTRICAL COMPONENTS

RESISTORS

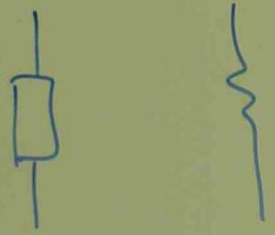
A RESISTOR IS A DEVICE THAT CONTROLS THE CURRENT FLOW BY THE AMOUNT OF ELECTRICAL RESISTANCE.



$$I = \frac{E}{R}$$

$$I \propto E$$

$$I \propto \frac{1}{R}$$

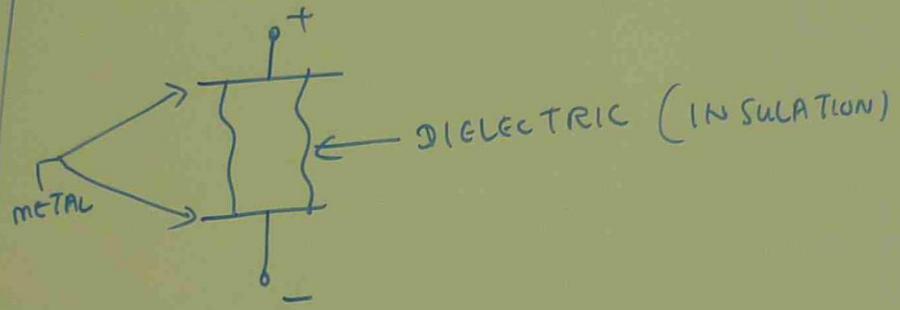


FIXED

VARIABLE

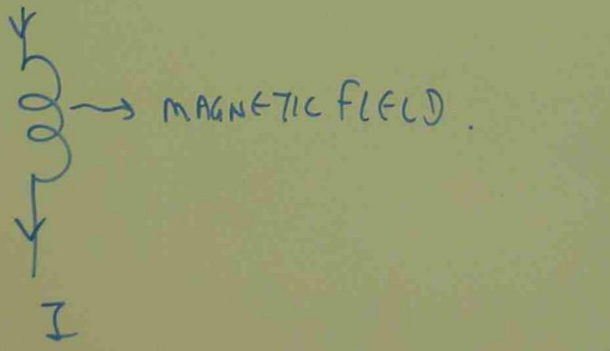
CAPACITORS

CAPACITORS ARE DEVICES THAT STORE ELECTRIC CHARGE.



INDUCTORS

THE CURRENT CARRYING CONDUCTOR CAUSES A MAGNETIC FIELD AROUND IT SELF.



SEMI CONDUCTORS

SEMI CONDUCTORS ARE PRIMARILY BASED ON VERY PURE SILICON WHICH IS PROCESSED TO HAVE CONTROL OVER THE MOVEMENT OF ELECTRONS.

SEMI CONDUCTOR DEVICES ARE THE MAIN CONTROL ELEMENTS IN ELECTRONIC CIRCUITS of ALL TYPES: EXAMPLES ARE TRANSISTOR, DIODE, INTEGRATED CIRCUITS (CHIPS)

$$R = \frac{\rho L}{A}$$

R = RESISTANCE (Ω)

ρ = RESISTIVITY (Ω-m)

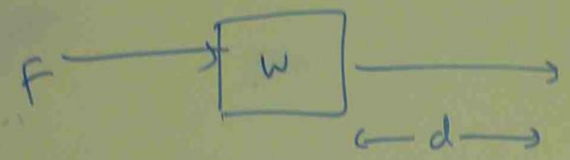
A = CROSS SECTIONAL AREA (m^2)

L = LENGTH OF MATERIAL USED.

MATERIAL	RESISTIVITY, OHM METER
SILVER	1.63×10^{-8}
COPPER	1.72×10^{-2}
GOLD	2.44×10^{-8}
ALUMINIUM	2.83×10^{-8}
NICHROME	112×10^{-8}
CARBON	3.5×10^{-3}

ENERGY, WORK, POWER

WORK



WORK = FORCE × DISTANCE

(JOULES) (N) (m)

WHEN FORCE IS OVERCOME THROUGH ANY DISTANCE, WORK IS SAID TO BE DONE.

ENERGY

ENERGY IS DEFINED AS THE CAPACITY TO DO THE WORK

ENERGY MAY BE IN SEVERAL FORMS, THE MOST COMMON BEING ELECTRICAL HEAT, CHEMICAL AND MAGNETIC

POWER

POWER IS THE RATE OF DOING WORK.

$$\text{POWER} = \frac{\text{WORK}}{\text{TIME}} = \frac{F \times d \text{ (JOULES)}}{t \text{ (sec)}}$$

(WATT)

1 KW (KILO WATT) = 10^3 WATT

ENERGY = J (Joules)

1 KJ = 10^3 J

ELECTRICAL ENERGY

1 KWH = 10^3 WATT x 3600 sec

= 3.6×10^6 Joules.

ENERGY

ENERGY IS DEFINED AS THE CAPACITY TO DO THE WORK

ENERGY MAY BE IN SEVERAL FORMS, THE MOST COMMON BEING ELECTRICAL HEAT, CHEMICAL AND MAGNETIC

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ELECTRICAL ENERGY

$1 KWH = 10^3 \text{ WATT} \times 3600 \text{ sec}$

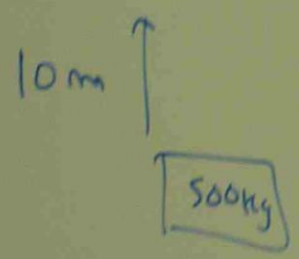
$= 3.6 \times 10^6$ Joules.

Pb ①

TO MOVE A TROLLEY ALONG A WORKSHOP FLOOR THROUGH A DISTANCE OF 100 METRES A FORCE OF 80 NEWTONS WAS REQUIRED. DETERMINE THE WORK DONE.

$$W = f \times d = 80\,N \times 100\,m = 8000\ \text{Joules} = 8\,kJ$$

Pb ② AN ELECTRIC MOTOR OF MASS 500 kg WAS LIFTED THROUGH A HEIGHT OF 10 METRES. DETERMINE THE WORK DONE ON THE MOTOR.



$$W = mgh$$

$$= 500 \times 9.8 \times 10$$

$$= 9.8 \times 5000$$

$$= 49000\,J = 49\,kJ$$

Pb ③ THE WORK DONE BY A CRANE IS 80 KJ WHEN A SWITCH BOARD IS LIFTED THROUGH A VERTICAL HEIGHT OF 40 METRES, DETERMINE THE FORCE REQUIRED.

$W = mgh$ $\quad F = mg$

$W = F \times h$

$80{,}000 = F \times 40 \longrightarrow F = \frac{80{,}000}{40} = 2000\ N$

Pb ④ AN ELECTRICALLY OPERATED LIFT IS DESIGNED TO RAISE A LOAD OF MASS 1500 kg A HEIGHT OF 30 METRES IN 30 SECONDS. CALCULATE THE WORK DONE.
(a) IN 30 SECONDS (b) 1 SECONDS.

(a) $P = \frac{mgh}{t} = \frac{1500 \times 9.8 \times 30}{30} = 14700\ W$
$= 14.7\ kW$

(b) $P = \frac{mgh}{t}$
$= \frac{1500 \times 9.8 \times 30}{1}$
$= 441000\ J = 441\ kJ$

ELECTRICAL POWER

ELECTRICAL POWER = VOLTAGE × CURRENT

$$P_{(WATT)} = V \times I$$

$$(V = IR) \rightarrow P = (IR) \times I = I^2 R$$

R : RESISTANCE

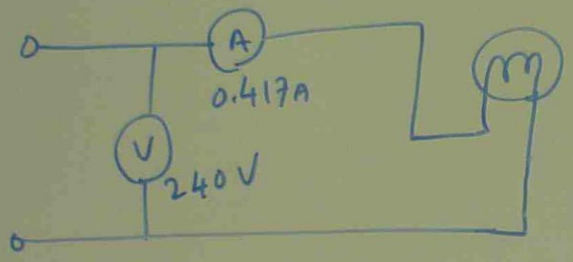
$$I = \frac{V}{R} \rightarrow P = V \times \frac{V}{R} = \frac{V^2}{R}$$

1 KILOWATT (kW) $= 10^3$ WATT

1 MEGAWATT (MW) $= 10^6$ WATT

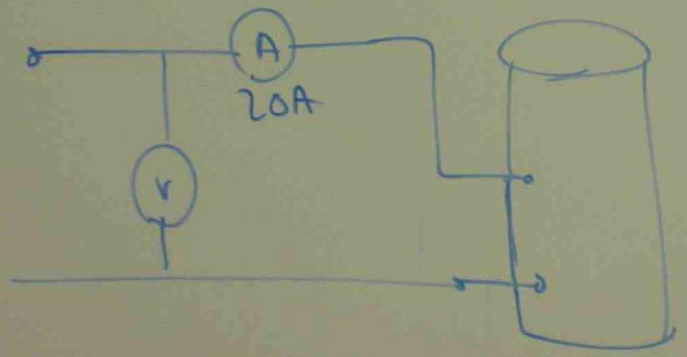
Pb (1)

CALCULATE THE POWER CONSUMED BY THE GIVEN LIGHT GLOBE.



$P = V \times I = 240 \times 0.417 = 100\ W$

Pb (2) CALCULATE THE POWER CONSUMED BY THE HEATER ELEMENT OF GIVEN HOT WATER SYSTEM.



$R = 12\ \Omega$

$P = I^2 R$

$= (20)^2 \times 12$

$= 400 \times 12$

$= 4800\ W$

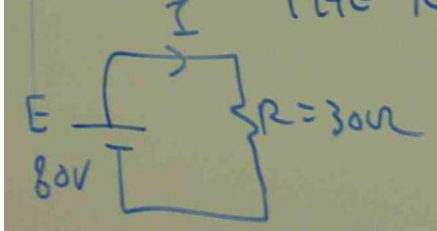
Pb (3) A MOTOR CONSUMES 12 KW OF POWER WHEN CONNECTED TO A 240V SUPPLY. CALCULATE MOTOR CURRENT.

$$P = V\ I$$

$$12000 = 240 \times I \longrightarrow I = \frac{12000}{240} = 50A$$

Pb (4) A RESISTANCE OF 30Ω IS CONNECTED TO A 80V DC SUPPLY. DETERMINE

(a) CIRCUIT CURRENT (b) POWER DISSIPATED BY THE RESISTOR.



$$I = \frac{E}{R} = \frac{80}{30} = 2.67\ Amp$$

$$P = I^2 R = (2.67)^2 \times 30 = 213.33W$$