2015

Set: I

Question: 1 – 30 ii – xii

Set: I

Question: 1

Define electrical conductivity of a conductor and give its S.I. unit. [1]

Answer:

The reciprocal of resistivity of the material of a conductor is called its conductivity. i.e., $\sigma = \frac{1}{\rho}$

Question: 2

What happens to the power dissipation if the value of electric current passing through a conductor of constant resistance is doubled? [1]

Answer:

When current is doubled, the dissipation increases four times because $P \propto I^2$.

Question: 3

How does the (i) pole strength and (ii) magnetic moment of each part of a bar magnet change if it is cut into two equal pieces transverse to its length? [1]

Answer:

Pole strength of each part is same as the original magnet but magnetic moment is halved.

Question: 4

Write S.I. unit of magnetic flux. Is it a scalar or a vector quantity? [1]

Answer:

SI unit of magnetic flux is weber. It is a scalar quantity.

Question: 5

Name the factor which decides the quality of reproduced document sent by Fax. [1]

Answer:

It depends on the quality of the optical scanning of the original document.

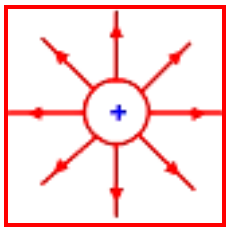
Question: 6

Mention any two properties of electric lines of force. Sketch them for an isolated positive point charge. [1]

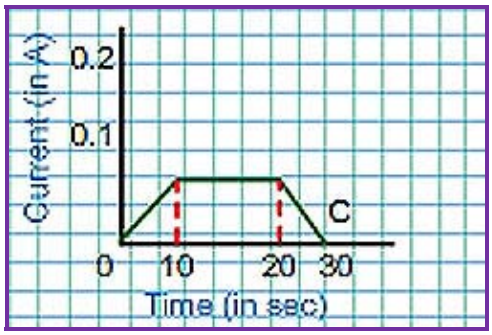
Answer:

- Lines of force are continuous curves which start from a positive charge and end on a negative charge.
- No two lines of force intersect each other.

Below figure shows the lines of force of a positive point charge.



Question: 7



In a copper voltammeter, a varying electric current, as shown in graph, is passed. The mass of copper deposited at the end of 30 seconds is m grams. Using the graph, find the value of e.c.e. of copper in gC^{-1}. [1]

Answer:

Total charge passed = Area of trapezium OABC:

$= \frac{1}{2}$ (10 + 30) x 0.1

= 2C

By "Faraday's first law, e.c.e:

$= \frac{m}{q} = \frac{m}{2}$

$= 0.5m\ gC^{-1}$

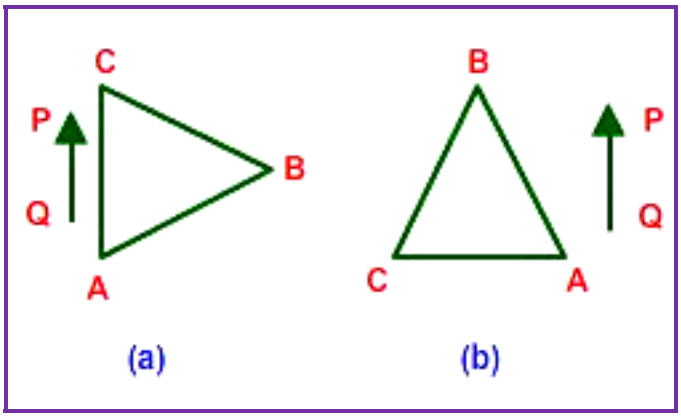
Question: 8 *(**)*

An AC voltage $E = E_0 \sin \omega t$ is applied across an inductor L. Obtain an expression for current I. [2]

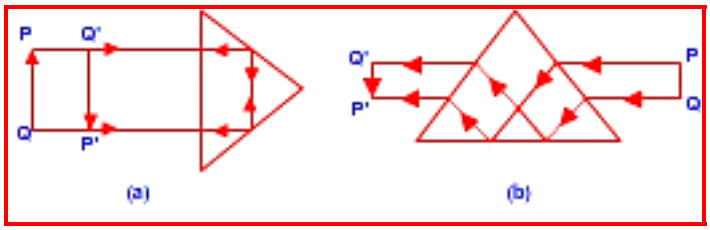
Question: 9 [2]

An object is placed in front of a right angled prism ABC in two positions (a) and (b) as shown. The prism is made of crown glass with critical angle of 41^0. Trace the path of two rays from P and Q,

i. In (a), normal to the hypotenuse
ii. In (b), parallel to the hypotenuse.



Answer:



Question: 10 [2]

Name the reaction which takes place when a slow neutron beam strikes $^{235}_{92}U$ nuclei. Write the nuclear reaction involved.

Answer:

When a slow neutron strikes $^{235}_{92}U$ nuclei, nuclear fission takes place.

$$^{235}_{92}U + {}_0n^1 \rightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr + 3{}_0n^1 \text{ Energy}$$

OR

The work function of lithium is 2.3 eV. What docs it mean? What is the relation between the work function 'W' and threshold wavelength λ of a metal?.

Answer:

The work function of lithium is 2.3eV. This means that to remove the outermost electron from the ground shell of a lithium atom, an energy of 2.3 eV is required.

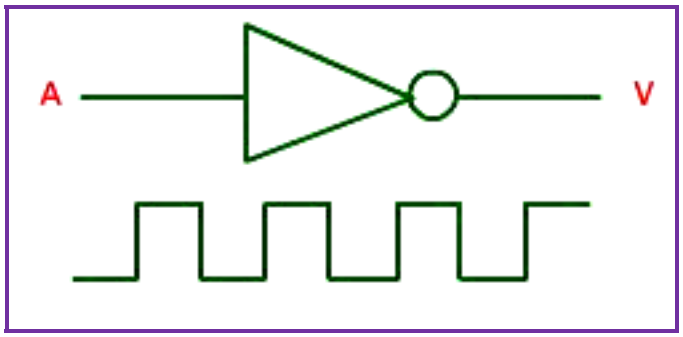
The work function W and threshold wavelength λ are related as

$$W = \frac{hc}{\lambda}$$

Question: 11 (**)

In the series of radioactive disintegration of $^{Z}_{A}X$ first an alpha particle and then a beta particle is emitted. What is the atomic number and mass number of the new nucleus formed by these successive disintegration? [2]

Question: 12 [2]



In the figure above, circuit symbol of a logic gate and input wave from is shown.
i. Name the logic gate,

Answer:
The logic gate is NOT gate.

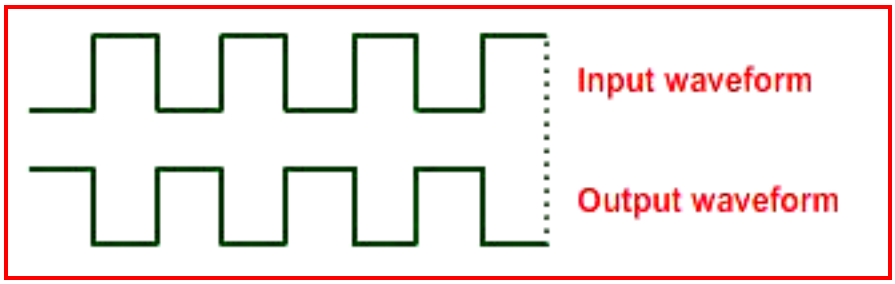
ii. Write its truth table and

Answer:
Truth table of NOT gate

Input A	Output Y = $\overline{A}$
0	1
1	0

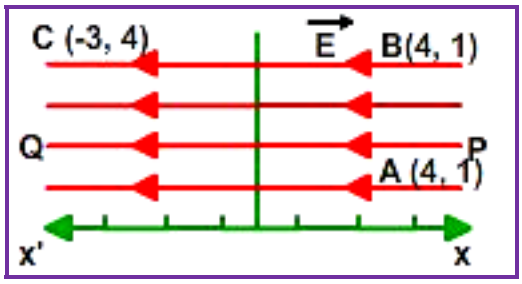
iii. Give the output wave form.

Answer:



Question: 13

What is an equipotential surface? A uniform electric field of $\vec{E}$ 300 NC^{-1} is directed along PQ. A, B and C are three points in the field having x and y coordinates (in meters) as shown in the figure. Calculate potential difference between the points (i) A and B and (ii) B and C. [2]



Answer:

Any surface that has same electric potential at its every point is called an equipotential surface.

Numerical:

i. No work is one in taking a positive chare from A to B because the charge moves perpendicular to the electric field.

∴ P.D between A and B = 0

ii. As $E = -\frac{\Delta V}{\Delta x}$

P.D between B and C,

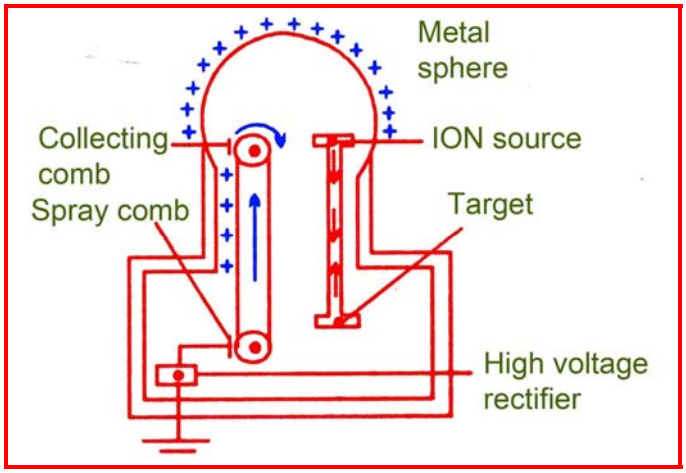
$\Delta V = -E\,\Delta x$
$= -300 \times 7$
$= -2100$ V.

Question: 14

Draw a labeled diagram of Van de Graff generator. State its principle of working [2]

Answer:

Principle of Van de Graff generator: Electric discharge takes place in air or gases readily at pointed conductors and that a hollow conductor continues accepting of charge of charge through its inner surface irrespective of the fact, however large its potential may be'.



Question: 15 [3]

What is meant by 'drift velocity of free electrons'? Derive Ohm's law on the basis of the theory of electron drift.

Answer:

Drift velocity: When a potential difference is applied across a conductor, the free electrons drift velocity a small average velocity (10-4 m/s) in the opposite direction of the applied field. This velocity is called drift velocity.

Derivation of Ohm's law. Current through a conductor is

$I = en A v_d$

Drift velocity:

$v_d = \frac{eE}{m}\tau$

$\therefore I = enA.\left(\frac{eE\tau}{m}\right)$

$= \frac{ne^2A\tau}{m}.E$

But $E = \frac{V}{l}$

$\therefore I = \frac{ne^2A\tau}{m}.\frac{V}{l}$

or $\frac{V}{I} = \frac{ml}{ne^2\tau A}$

$\frac{V}{I} = R = constant$

$R = \frac{ml}{ne^2A\tau}$

OR

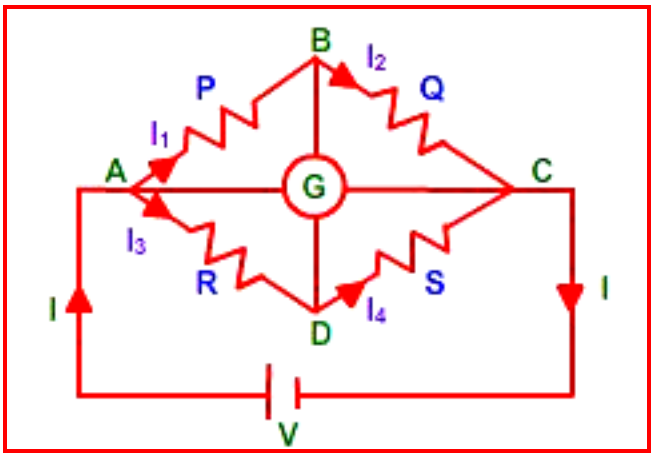
What is Wheatstone bridge? Deduce the condition for which Wheatstone bridge is balanced.

Answer:

Wheatstone bridge is an arrange of four resistances which is used to determine an unknown resistance.

The four resistance P,Q,R and S are so adjusted that no current flows through the galvanometer G. the Wheatstone bridge is said to be balanced.

In this condition, $I_1 = I_2$ and $I_3 = I_4$



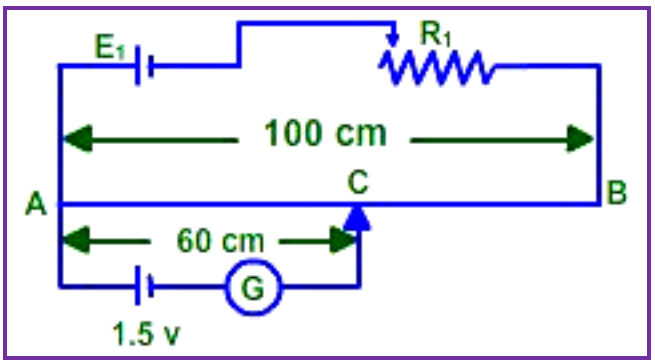
Applying Kirchhoff's second law to the meshes ABDA and BCDB, we get
$I_1P - I,$
$R = 0$
or $I_1 P = I, R$

And, $I_2Q - I_4 S = 0$
or $I_2Q = I_4S$

$$\therefore \frac{I_1P}{I_2Q} = \frac{I_3R}{I_4S}$$

$$\text{or, } \frac{P}{Q} = \frac{R}{S}$$

Question: 16 [3]



What is meant by the sensitivity of a potentiometer?

A battery E_1 of 4 V and a variable resistance R_h are connected in series with the wire AB of the potentiometer. The length of the wire of the potentiometer is 1 meter. When a cell E_2 of e.m.f. 1.5 volt is connected between points A and C, no current flows through E_2 Length of AC = 60 cm.

i. Find the potential difference between the ends A and B of the potentiometer.
ii. Would the method work, if the battery E< sub.1 is replaced by a cell of e.m.f. of 1 V?

Answer:
A potentiometer is sensitive if it has small potential drop per unit length.

Numerical:

i. As, $\frac{E_2}{E_1} = \frac{l_1}{l_2}$

P.D between A and B is

$\therefore E_2 = \frac{l_1}{l_2} \times E_1$

$= \frac{100cm}{60cm} \times 1.5V$

= 2.5V

Question: 17 *(**)*

Two straight, parallel, current carrying conductors are kept at a distance 'r' from each other, in air. The direction of current in both the conductors is the same. Find the magnitude and direction of the force between them. Hence define one ampere. [3]

Question: 18 [3]

Distinguish between diamagnetic and ferromagnetic materials in respect of their

i. Intensity of magnetization,
ii. Behavior in a non-uniform magnetic field
iii. Susceptibility.

Answer:

i. Intensity of magnetization is small negative for a diamagnetic substances and large positive for a ferromagnetic substance.
ii. In a non-uniform magnetic field, a diamagnetic substance tens to move form stronger to weaker part while the ferromagnetic substance tends to more from weaker to stronger part of the field.
iii. Susceptibility is small negative for a diamagnetic substance and large positive for ferromagnetic substance.

Question: 19

State Huygens's Principle. For reflection of a plane wave front at a plane reflecting surface, construct the corresponding reflected wave front. Using this diagram, prove that angle of incidence is equal to angle of reflection. [3]

Answer:

See topics on 'Huygens' principle'.
See topics on 'Laws of reflection'.

Question: 20

What is meant by interference of light?

In a double slit experiment with monochromatic light, fringes are obtained on a screen placed at some distance from the slits. If the screen is moved by 5 x 10^{-2} m towards the slits, the change in fringe width is 3x 10^{-5} m. If the distance between slits is 10^{-3} , calculate the wavelength of light used. [3]

Answer:

'the phenomenon of redistribution of light energy in a medium on account of superposition of light waves from two coherent sources is called interference.

$\beta = \frac{D\lambda}{\lambda}$, and, $\beta' = \frac{D'\lambda}{d}$

$\therefore \beta - \beta' = \frac{(D - D')}{d}$

or $\lambda = \frac{(\beta - \beta')}{D - D'}$

$= \frac{3 \times 10^{-5} \times 10^{-3}}{5 \times 10^{-2}}$

$= 0.6 \times 10^{-6}$ m

$= 6000 \overset{\circ}{A}$

Question: 21 (**)

Why is de-Broglie waves associated with a moving football not visible? The wavelength, λ of a photon and the de-Broglie wavelength of an electron have the same value. Show that the energy of the photon is $\frac{2\lambda mc}{h}$ times the kinetic energy of the electron, where m, c and h have their usual meanings. [3]

Question: 22 (**)

Define Antenna. Write a short note or Antenna. Name two types of antenna. [3]

Question: 23

What is meant by the term 'modulation'? Explain with the help of a block diagram, how the process of modulation is carried out in radio broadcasts. [3]

Answer:

An antenna is a vital component of any communication system. It is employed both at the transmitting as well as at the receiving end. At the transmitter it radiates electromagnetic waves into the free space. While at the receiving end it picks up the transmitting signal. An antenna is basically a length of conductor and acts as a conversion device.

- Dipole Antenna is omni direction and is employed in transmission of radio waves.
- Dish type antenna: In this type of antenna, the basic active component, usually dipole is placed at the focus of a parabolic reflector or spherical dish. The dish collects electromagnetic energy and thus focuses it all on the active element where from

Question: 24

Write three special characteristics of the light source used in optical communication. Name any one optical detector. Explain the meaning of the term 'sensitivity' and 'responsivity' of a detector. [3]

Answer:

Characteristics of the light sources:

- Size of source should be small.
- It should produce monochromatic light
- Should be capable of rapid switching

Silicon photo-diodes are optical detectors. Sensitivity: it is the measure of ability of a detector and determines how weak a signal can be detected.

Responsivity
The ability of the optical detector to respond quickly to the changing light pulses that are rapidly switching on and off is called responsivity.

Question: 25 *(**)*

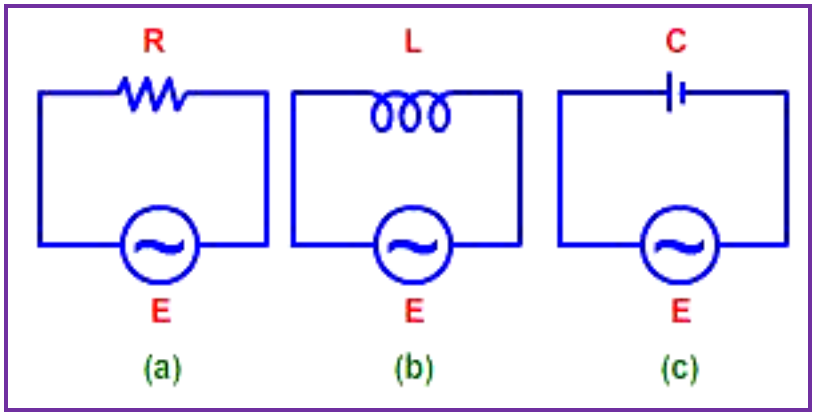
Derive the relation between distance of object, distance of image and radius of curvature of a convex spherical surface, when refraction takes place from a rarer medium of refractive index μ_1 it to a denser medium of refractive index μ_2 and the image produced is real. State assumptions and convention of signs used.

OR

Draw a ray diagram to show the formation of image of an object placed between the optical centre and focus of the convex lens. Write the characteristics of image formed.

Using this diagram, derive the relation between object distance, image distance and focal length of the convex lens. Write the assumptions and convention of signs [3]

Question: 26 *(**)*



What is a choke coil? Why is it preferred to resistance in AC circuits? In above figure (a), (b) and (c) are shown three AC circuits with equal currents. If the frequency of e.m.f. be increased, then what will be the effect on the currents flowing in them? Explain with reason.

Question: 27

Draw a circuit diagram of a common emitter amplifier using n-p-n transistor. Show input and output voltages graphically. The current gain for common emitter amplifier is 59. If the emitter current is 6.0 mA, find (i) base current and (ii) collector current. [5]

Answer:
See topics on 'transistor as an amplifier (common emitter amplifier)'.

Numerical:
$\beta = 59$

$$\therefore \alpha = \frac{\beta}{1+\beta}$$

$$= \frac{59}{60}$$

But, $\alpha = \frac{I_C}{I_E}$

$\therefore I_C = \alpha . I_E$

$= \frac{59}{60}$ x 6mA

$= 5.9mA$

$I_B = I_E - I_C$
$= 6.0 - 5.9$
$= 0.1$ mA

Question: 28 *(**)* [5]

a. A potential difference V is applied to a copper wire of diameter d and length L. what is the effect on the electron drift speed of doubling (i) Voltage V (ii) Length (iii) diameter.

b. A n-type silicon sample of width 4 x 10^{-3} thickness 25 x 10^{-5} and length 6 x 10^{-2}m, carries a current of 4.8 mA when the voltage is applied across the length of the sample. What is the current density?

If the free e- density is 1022 m^{-3}, then find how much time does it take fro the electron to travel the full-length of the sample?

Question: 29 *(**)*

For a given AC circuit, distinguish between resistance, reactance and impedance. An AC source of frequency 50 hertz is connected to a 50 m H inductor and a bulb. The bulb glows with some brightness.

Calculate the capacitance of the capacitor to be connected in series with the circuit, so that the bulb glows with maximum brightness. [3+2]

Question: 30

Drawing a labeled circuit diagram, explain the working principle of a common emitter transistor amplifier. State the phase relation between input and output signals. [5]

Answer:
See topics on 'Common Emitter'.

(**) Currently out of syllabus. Answer can be provided up on request.