Physics - 2014

General Instructions :

- Group-A has 15 objective type questions each of 1 mark. खण्ड-अ में 15 वस्तुनिष्ठ प्रश्न हैं, प्रत्येक 1 अंक का है।
- Group-B has 8 questions, each of 2 marks. खण्ड-ब में 8 प्रश्न हैं, प्रत्येक का मान 2 अंक है।
- Group-C has 8 questions, each of 3 marks. खण्ड-स में 8 प्रश्न हैं, प्रत्येक का मान 3 अंक है।
- Group-D has 3 questions, each of 5 marks. खण्ड-द में 3 प्रश्न हैं, प्रत्येक का मान 5 अंक है।

Group-A

Q.1. Answer the following questions:

(i) The unit for permittivity of free space (ϵ_0) is

(a) CN^2m^{-2} (b) $C^2N^{-1}m^{-2}$

(c) CNm^{-2} (d) $CN^{-1}m^{-2}$

Ans. (b) $C^2N^{-1}m^{-2}$

(ii) Torque acting on an electric dipole of moment ($\vec{p}$) placed in a uniform electric field ($\vec{\varepsilon}$) is given by

(a) $p\varepsilon$ (b) $\vec{p}.\vec{\varepsilon}$

(c) $\vec{p}\times\vec{\varepsilon}$ (d) $\vec{\varepsilon}\times\vec{p}$

Ans. (c)

(iii) If the air between two plates of a parallel plate condenser is displaced by a medium of relative permittivity κ, then its capacity

(a) increases κ times
(b) decreases κ times
(c) remains constant
(d) none of these.

Ans. (a) increases κ times

(iv) As temperature increases, the resistance of a conductor

(a) increases (b) decreases
(c) remains constant (d) depends upon conductor.

Ans. (a) increases

(v) Kirchhoff's point rule is a direct consequence of law of conservation of

(a) energy (b) linear momentum
(c) angular momentum (d) charge.

Ans. (d) charge.

(vi) Lorentz force is given by

(a) $q(\vec{\varepsilon}+\vec{\beta})$ (b) $q(\vec{\varepsilon}+\vec{v}.\vec{\beta})$

(c) $q(\vec{\varepsilon}+\vec{\beta}\times\vec{v})$ (d) $q(\vec{\varepsilon}+\vec{v}\times\vec{\beta})$

Ans. (d) $q(\vec{\varepsilon}+\vec{v}\times\vec{\beta})$

(vii) Henry is a unit for

(a) self-inductance
(b) mutual inductance
(c) both self & mutual inductance
(d) none of these.

Ans. (c) both self & mutual inductance

(viii) Which of the following electromagnetic waves has the longest wavelength?

(a) x-rays (b) UV rays
(c) IR rays (d) microwaves.

Ans. (d) microwaves.

(ix) When a lens is immersed in water its focal length

(a) increases (b) decreases
(c) remains same (d) none of these.

Ans. (a) increases

(x) Which of the following phenomena explains that light does not travel

(a) Reflection (b) Refraction
(c) Diffraction (d) Polarization

Ans. (c) Diffraction

(xi) The magnification produced by an Astronomical telescope in normal

(a) f_o+f_e (b) $f_o\times f_e$

(c) f_o/f_e (d) f_e/f_o

Ans. (c) f_o/f_e

(xii) Which of the following phenomena establishes the particle nature of light?

(a) Interference (b) Diffraction
(c) Polarization (d) Photoelectric effect.

Ans. (d) Photoelectric effect.

(xiii) Which of the following can be deflected by applying magnetic field?

(a) α-rays (b) β-rays

(c) γ-rays (d) Both α- and β- rays.

Ans. (d) Both α- and β- rays.

(xiv) When boron is added as impurity to silicon, the resulting material is

(a) *n*-type semiconductor
(b) *p*-type semiconductor
(c) *n*-type conductor
(d) *p*-type conductor.

Ans. (b) *p*-type semiconductor

(xv) Which of the following logic gates is a universal logic gate?

(a) OR (b) AND
(c) NOT (d) NAND.

Ans. (d) NAND.

Group-B

Answer the following questions:

Q.2. What is quantization of charge? Find the number of electrons present in charge (–6.4) nC.

Ans. Given

$Q = -6.4C$

$e^- = -1.6 \times 10 - 19C$

$\because$ we know that

$Q = ne^-$ (from quantisation of charge)

$$n = \frac{Q}{e^-}$$

$$= \frac{-6.4 \times 10^{-9}}{-1.6 \times 10^{-19}}$$

$$= 4 \times 10^{10} C.$$

Q.3. Write formula for equivalent resistance for the combination of resistances in
(a) series, (b) parallel.

Ans. (a) $R_s = R_1 + R_2 + R_3 + R_4 + ... + R_n$

(b) $$\frac{1}{R_p} + \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + ... + \frac{1}{R_n}$$

Q.4. What is magnetic field line? Give any two properties of magnetic field lines.

Ans. Magnetic field line:- It is a imaginary curve straight line in which tangent to any point gives the direction of strength of magnetic field.

(i) They never intersect each other.

(ii) They are equal spaced in uniform magnetic field and unequally spaced in non-uniform magnetic field.

Q.5. Give expressions for reactance of an inductance and a capacitance. How do they vary with applied frequency?

Ans. Inductive reactance is given by,

$X_L = L\omega$

and inductive capacitance is given by,

$$X_c = \frac{1}{\omega C}.$$

X_L increases with increase in frequency nd

X_c decreases with increase in frequency.

For X_L, we have

$X_L = \omega L = L \times (2\pi v)$ frequence

For X_c, we have

$$X_c = \frac{1}{\omega C} = \frac{1}{C \times 2\pi v}$$

$\because$ Freq. is inversly proportional to X_c. So, X_c decrease with increase in freq. and freq. X_L are directly proportional . So X_L increases with increase in frequency.

Q.6. Write a formula for velocity of electromagnetic waves in free space. What are the different modes of propagation of electromagnetic waves?

Ans. Formula for velocity of light in e.m. wave is

$$C = \frac{1}{\sqrt{\mu_o \epsilon_o}} = 3 \times 10^8 m/sec$$

Diff. modes of propagation of em.m wave are t Sky wave, Ground wave.

Q.7. What is mass defect? Give its unit.

Ans. Mass defect:- It is the difference between mass or constituents of nucleons in free state to the mss of nucleus.

i.e. Mass of proton $= MpZ$

Mass of neutron $= Mn(A - Z)$

$\therefore$ Δ mc mss defect $= (bMpZ + Mn(A - Z)\} - M$

It unit is a.m.u.

Q.8. Give the truth tables for AND gate and NOR gate.

Ans. Truth table for AND Gate.

x	y	z = x.y
0	0	0
0	1	0
1	0	0
1	1	1

Truth table for NOR Gate is t

x	y	z = x.y	$z = \bar{y}$
0	0	0	1
0	1	1	0
1	0	1	0
1	1	1	0

Q.9. What transducer? Give one example.

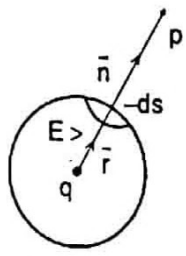
Ans. Transducer:- It is an device which convert one form of energy into other form of energy.

e.g. Microphone.

Group - C

Q.10. State and prove Gauss's theorem.

Ans. Gauss's Law:- It explain that total electrid flux passing through closed surface is equal to the $\frac{1}{\epsilon_o}$ time the ch arge L enclosed in that closed surface.



$\therefore$ $$\phi_E = \oint \vec{E}.\vec{ds} = \frac{q}{\epsilon_o}$$

$$= \oint \vec{E}.\vec{ds}.$$

$$= \oint \frac{q}{4\epsilon_o r^2} \vec{ds}.\hat{r}.\hat{n}$$

$\because$ $\vec{r}$ & $\vec{n}$ are unit vector along $\vec{ds}$ & E and both are in same direction.

$\because$ $\hat{r}.\hat{n} = \hat{r}.\hat{n}\cos 0$

$= 1.1.1$ $(\because \cos\theta = \cos 0 = 1)$

$= 1$

$\therefore$ $$\frac{q}{r^2 4\pi\epsilon_o r} \int ds$$

$$= \frac{q}{4\pi\epsilon_o r^2}.4\pi r^2 \quad (\because ds = \text{surf. area of sphere})$$

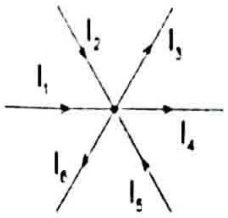
$= \frac{Q}{C_1}$ Proved

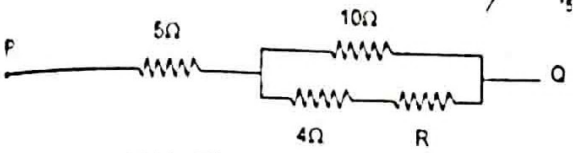
Q.11. What is Kirchhoff's point (junction) rule for electrical networks? If equivalent resistance between P & Q is 10Ω, find R.

Ans. Kirchoff's pt. rule state that, the sum of current passing through (entering or leaving) a pt is zero.

i.e $\sum_{i=1}^{n} I = I_1 + I_2 + I_3 + \ldots + I_n = 0$

given





$$R_r = \frac{10(4+R)}{10+4+R}$$

$$= \frac{40+10R}{14+R}$$

$$R_{PQ} = 5 + \frac{40+10R}{14+R}$$

$$10 = \frac{70+5R+40+10R}{14+R}$$

$$140+10R = 110+5R+10R$$

$$5R = 30$$

$$R = \frac{30}{5} = 6\Omega$$

Q.12. What is equivalent lens? The equivalent forcal length of two thin lenses in contact is 20 cm. If power of one lens is (–3D), find the focal length of other lens.

Ans. Equivalent lens t when two this lens come in constant and act as single lens then the these lenses are termed as equivalent lens.

Given

$F_1 = 20cm$

$P_2 = -3D$ $\qquad F_2 = ?$

$\because \quad \frac{1}{F} = \frac{1}{F_1} + \frac{1}{F_2}$

$$\frac{1}{20} = \frac{1}{-33} + \frac{1}{F_2}$$

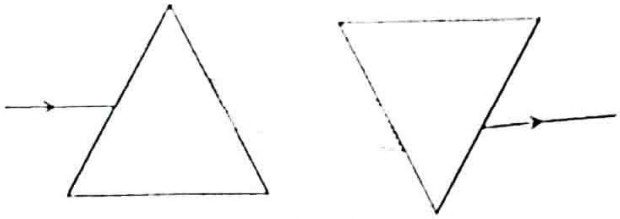
$$\frac{1}{20} + \frac{1}{33} = \frac{1}{F_2}$$

$$\frac{20+33}{660} = \frac{1}{F_2}$$

$\therefore \quad F_2 = \frac{660}{53} = 12.4cm$

Q.13. Find the condition that a combination of two thin prisms, produces no deviation. Hence, find the dispersion produced by this combination

Ans. When two prism P_1 & P_2 the arranged in inverted position with respect to each other then there is no deviation produces



There is no dispersion produced in these combination

Q.14. Establish Einstein's formula for photoelectric effect. A photon of energy 2 eV is incident on a metal surface of work function 0.8 eV. Find the stopping potential.

Ans. We know,

$E = h\nu$ (energy of photon) ...(i)

$\because \quad h\nu = \phi_o + K.E.$ ...(ii)

when free e^- is ejected the K.E. of the free e^- is O,

$\therefore \quad h\nu_o = \phi_o$ ...(iii)

substituting values of (iii) in (ii) we get,

$h\nu = h\nu_o + K.E.$

$\Rightarrow \quad K.E. = h\nu_o - h\nu$

$\Rightarrow \quad K.E. = h(\nu_o - \nu)$ ...(iv)

Eq^n. (iv) is known as Einstein's Photo electric equation

$h\nu = 2eV; \qquad \phi_o = 0.8eV$

Given

$h\nu - \phi_o = eV_o$

$$V_o = \frac{1}{e}\left[h\nu - \phi_o\right]$$

$$= \frac{1}{e}[2eV - 0.8eV]$$

$$= \frac{1}{e} \times 1.2eV$$

$$= \frac{1}{1.6\times10^{-19}} \times 1.2 \times 1.6 \times 10^{-19}$$

$V = 1.2V$

Q.15. Give Rutherford's nuclear model of atom. What are its drawbacks?

Ans. According to Rutherford's atomic model,

(i) An atom consist of positively charged prticle or nucleus in the center of an atom.

(ii) And the e^- revolve around the nucleus with radiating energy.

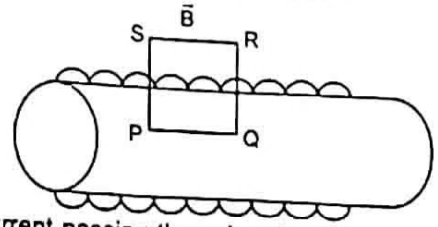
Drawback

(i) The e^- in the atom rdiate energy due to which e^- move in a spiral path and collapse into the nucleus. But the e^- revolve in a constant circular path.

Since, the stability of e^- in an atom is not explained.

(ii) It doesn't show it +1-spectrum.

Mag. field out side the solenoid is very small almost zen because it spread out into past space.



Let, I = current passing through solenoid.
n = no. g turns/unit length.
B = magnitude of mag. field insi de the solenoid using A-S-L for a realingular closed pth PQRSP. the line integral of may. field $\vec{B}$ over a closed path is

$$\oint \vec{B}.\vec{dl} = \int_P^Q B.dl + \int_Q^R B.dl + \int_R^S B.dl + \int_S^P B.dL$$

Now,

& $\int_P^Q B.dl = \int_S^P B.dl = 0 \quad [\because < b/w \vec{B} \& \vec{dl} = 90°]$

& $\int_R^S B.dl = 0$ [∵ mag. field outside the solenoid is zero]

$\therefore \oint B.dl = Bl$ ...(i)

According to A-C-L

$\oint \vec{B}.\vec{dl} = \mu_o \times$ current enclosed by PQRSP.

$= \mu_o \times$ no.of trans in PQRSP $\times$ L

$= \mu_o \times nl$ ...(ii)

from eq^n. (i) & (ii)

$Bl = \mu_o nl$

$\Rightarrow B = \mu_o nL$ ...(iii)

Q.20. What do you mean by electromagnetic induction? Find a formula for *emf* induced in a coil rotating in a uniform magnetic field. What is Lenz's law?

Ans. E.M.I → When ever the magnetic lines force or magnetic flux linked with a closed ckt, changes an emf in the ckt. The resulting current is called induced current. This phenomenon is called the electromagnetic induction.
According Faraday's law of E.M.I., the mapnitude of the induced emf in directly proportional to rate of change of flux linkage or rate of fulx change.

i.e. $E \propto \frac{d\phi}{dt}$

$E = a\,const \times \frac{d\phi}{dt}$

The const. is taken to be one.

$E = \frac{d\phi}{dt}$

Suppose the flux passing through a coil of one turn changes from ϕ_1 to ϕ_2 is 't' sec. change of flux linked with coil $= \phi_2 - \phi_1$

Rate of change of flux $= \frac{(\phi_2 - \phi_1)}{t}$

According to faraday's law the rate of change of flux is proportional to the e.m.f induced in the coil.

i.e. $E \propto \frac{(\phi_2 - \phi_1)}{t}$

$E = a\,const \frac{\phi_2 - \phi_1}{t}$

It const = one then.

$E = \frac{\phi_2 - \phi_1}{t}$.

Lenz's Law: The direction of the induced e.m.f. is such that it opposes the cause producing the changes flux.

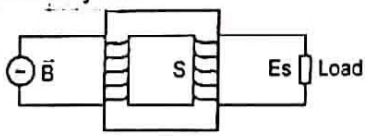
I.e. Induced e.m.f $\Rightarrow E = -\frac{d\phi}{dt}$.

Or, What is a transformer? Describe with principle, the construction and working of a transformer.

Ans. Transformer is a device used to convert law a.c. voltage at higher current into high a.c. voltage at lower current & vice-versa.

Principle: A transformer is based on the principle of mutual induction.

An e.m.f. induced in a coil, when it changing current flows though its nearby coil.



Construction: It consists of the separate coils of insulated wire wound on same iron core. one of the coils connected to a.c. input is called primary (p) & the other winding giving output is called secondary (s) coil.
The primary coil is connected to a source of a.c. voltage (Ep). The primary coil alongwith a source of a.c. voltage is called primary ckt. The output a.c. voltage (Es) is taken across the secondary coil & the load is connected to this winding. The secondary coil along with load is called secondary ckt.

Working: According to Faraday's low of e.m.f. induction, the induced e.m.f. in the primary coil

$Ep = -Np\frac{d\phi}{dt}$ ...(i)

& induced e.m.f. in the secondary coil

$Es = -Ns\frac{d\phi}{dt}$ ...(ii)

Dividing (ii) by (i) we got

$\frac{Es}{Ep} = \frac{Ns}{Np}$

where, $\frac{Ns}{Np} = k$, the transformation ratio or turne ratio.

then $\frac{Es}{Ep} = \frac{Ns}{Np} = k$

K<1 for step down transformer.
K>1 for step up transformer.

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