HIGHER SECONDARY SECOND YEAR HALF-YEARLY EXAMINATION – DECEMBER 2023

PHYSICS KEY ANSWER

Note:

1. Answers written with **Blue** or **Black** ink only to be evaluated.
2. Choose the most suitable answer in Part A, from the given alternatives and write the option code and the corresponding answer.
3. For answers in Part-II, Part-III and Part-IV like reasoning, explanation, narration, description and listing of points, students may write in their own words but without changing the concepts and without skipping any point.
4. In numerical problems, if formula is not written, marks should be given for the remaining correct steps.
5. In graphical representation, physical variables for X-axis and Y-axis should be marked.

PART – I

Answer all the questions. 15x1=15

Q. No.	OPTION	TYPE – A	Q. No.	OPTION	TYPE – B
1	(a)	3×10^{-2}C	9	(d)	Polarization
2	(d)	Diode	10	(b)	1:3
3	(c)	1 A	11	(b)	13.6 V
4	(b)	45^0	12	(c)	1:4:9
5	(a)	1.67 H	13	(a)	There the mobile charges exist
6	(d)	$\frac{1}{8}$	14	(b)	Frequency Modulation
7	(a)	1.414×10^{-8}T	15	(c)	Albert Einstein
8	(a)	Dispersion and Total Internal reflection			

PART – II

Answer any **six** questions. Question number **24** is compulsory. 6x2=12

16	**Capacitance of a capacitor.** The capacitance of a capacitor is defined as **the ratio of the magnitude of charge (Q) on either of the conductor plates to the potential difference (V)** existing between the conductors. (i.e) $C = \frac{Q}{V}$ Its unit is **farad (F) or C V^{-1}**	1½ ½	2

<table>
<tr><td>17</td><td>Peltier effect.
When an electric current is passed through a circuit of a thermocouple, heat is evolved at one junction and absorbed at the other junction. This is known as Peltier effect. Peltier effect is reversible.</td><td>2</td><td>2</td></tr>
<tr><td>18</td><td>Phase modulation (PM)
The instantaneous amplitude of the baseband signal modifies the phase of the carrier signal keeping the amplitude and frequency constant is called phase modulation.</td><td>2</td><td>2</td></tr>
<tr><td>19</td><td>Lenz's law.
Lenz's law states that the direction of the induced current is such that is always opposes the cause responsible for its production.</td><td>2</td><td>2</td></tr>
<tr><td>20</td><td>The cut-off wavelength of the characteristic x-rays is $\lambda_0 = \frac{12400}{V}$ Å
$= \frac{12400}{20000}$ Å ; = 0.62 Å
The corresponding frequency is $\nu_0 = \frac{c}{\lambda_0}; = \frac{3 \times 10^8}{0.62 \times 10^{-10}}$
= 4.84×10^{18} Hz</td><td>1
1</td><td>2</td></tr>
<tr><td>21</td><td><table>
<tr><th>Fresnel diffraction</th><th>Fraunhofer diffraction</th></tr>
<tr><td>Spherical or cylindrical wave front undergoes diffraction</td><td>Plane wave front undergoes diffraction</td></tr>
<tr><td>Light wave is from a source at finite distance</td><td>Light wave is from a source at infinity</td></tr>
<tr><td>For laboratory conditions, convex lenses need not be used</td><td>In laboratory conditions, convex lenses are to be used</td></tr>
<tr><td>difficult to observe and analyze</td><td>Easy to observe and analyze</td></tr>
</table></td><td>4x ½
=2</td><td>2</td></tr>
<tr><td>22</td><td>The constituent particles of neutron and proton:
Protons and neutrons are made up of quarks which are now considered as elementary particles. According to quark model,
1) Proton is made up of two up quarks $\left(+\frac{2}{3}e\right)$
and one down quark $\left(-\frac{1}{3}e\right)$
2) Neutron is made up of one up quark $\left(+\frac{2}{3}e\right)$
and two down quarks $\left(-\frac{1}{3}e\right)$ 1</td><td>1
1</td><td>2</td></tr>
</table>

23	**De-Morgan's theorems.** **Theorem - 1 :** The complement of the sum of two logical inputs is equal to the product of its complements. $\overline{A + B} = \overline{A} \, . \, \overline{B}$ **Theorem - 2 :** The complement of the product of two logical inputs is equal to the sum of its complements. $\overline{A.B} = \overline{A} + \overline{B}$	1 1	2
24	The force between two poles are given by $\vec{F} = k \frac{q_{mA} q_{mB}}{r^2} \hat{r}$ The magnitude of the force is F = $k\frac{q_{mA} q_{mB}}{r^2}$ Given : F = 9 x 10^{-3}N, r = 10 cm = 10 x 10^{-2} m Therefore, 9 x 10^{-3} = 10^{-7} x $\frac{q_m^2}{(10 \text{ x } 10^{-2})^2} \Longrightarrow$ 30 NT^{-1}	1 1	2

PART – II

Answer **any six** questions. Question number **33 is compulsory.** 6x3=18

25	**Kirchhoff's first law (current rule or junction rule)** It states that the **algebraic sum of currents at any junction** in a circuit **is zero**. ($\sum I = 0$). It is a statement of conservation of electric charge. **Kirchhoff's second law (voltage rule or loop rule)** It states that in a closed circuit the **algebraic sum of the products** of the **current and resistance of each part of the circuit is equal** to the total emf included in the circuit ($\sum IR = \sum \xi$). It is a statement of conservation of energy for an isolated system.	1 2	3
26	**List the properties of Diamagnetic materials.** **Properties of Diamagnetic materials:** **Magnetic susceptibility is negative.** Relative permeability is slightly less than one. The magnetic field lines are excluded by diamagnetic materials when placed in a magnetic field. **Susceptibility is nearly temperature independent.** **Properties of Paramagnetic materials:** Magnetic susceptibility is **small positive value**. Relative permeability is greater than one. The magnetic field lines are attracted in to paramagnetic materials when placed in a magnetic field. **Susceptibility is inversely proportional to temperature.**	1 1	3

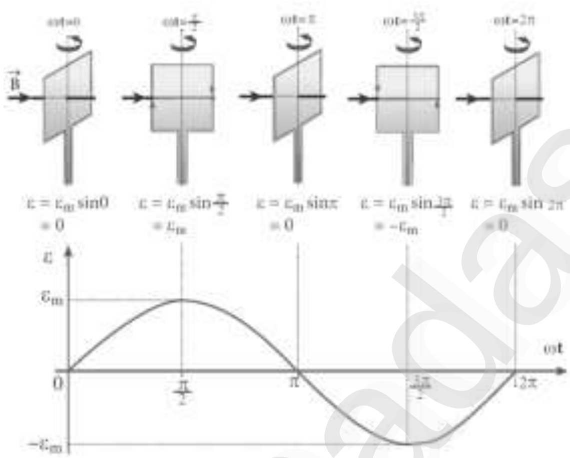
	Properties of Ferromagnetic materials: Magnetic susceptibility is **positive and large,** Relative permeability is very, very greater than one, the magnetic field lines are strongly attracted in to the ferromagnetic materials when placed in a magnetic field. **Susceptibility is inversely proportional to temperature.**	1	
27	i) $AA + A\overline{B} + AB + B\overline{B}$ $A + A$ A ii) (A+B)(A+C) = AA+AC+Ba+BC =A+AC+AB+BC =A(1+C+B)+BC; = A+BC	1 ½ 1 ½	3
28	$\oint \vec{E}.\vec{dA} = \frac{Q_{Closed}}{\varepsilon_0}$ $\oint \vec{B}.\vec{dA} = 0$ $\oint \vec{E}.\vec{dl} = \frac{d\phi_B}{dt}$ $\oint \vec{B}.\vec{dl} = \mu_0(I_C + I_D)$ (or) $\oint \vec{B}.\vec{dl} = \mu_0 I_C + \mu_0 \varepsilon_0 \frac{d}{dt}\int \vec{E}.\vec{dA}$ (or) explanation	3	3
29	**Gamma decay:** In α and β decay, the **daughter nucleus is in the excited state most of the time**. So this excited state nucleus immediately returns to the ground state or lower energy state by emitting highly energetic photons called γ rays. During gamma decay there is **no change in atomic number and mass number**. ${}^{A}_{Z}X^{*} \rightarrow {}^{A}_{Z}X$ +gamma rays (γ) It undergoes beta decay directly into ground state carbon (${}_{6}C^{12}$) by emitting an electron of maximum of energy 13.4 MeV. It undergoes beta ray emission to an excited state of carbon (${}_{6}C^{12*}$) by emitting an electron of maximum energy 9.0 MeV followed by gamma decay to ground state by emitting a photon of energy 4.4 MeV. It is represented by (e.g.) ${}^{12}_{5}B \rightarrow {}^{12}_{6}C^{*} + {}^{0}_{-1}e + \bar{\nu}$; ${}^{12}_{6}C^{*} \rightarrow {}^{12}_{6}C + \gamma$	1 1 1	3

30	Prism can be designed to reflect light by 90^0 or 180^0 by making use of total internal reflection. The critical angle 1c for the material of the prism must be less that 45^0. This is true for both crown glass and flint glass. Prisms are also used to invert images without changing their size.	3	3
31	Capacitor is a device used to **store charges and energy.** When a battery is connected to the capacitor, electrons of total charge '-Q' are transferred from one plate to other plate. For this work is done by the battery. This work done is stored as electrostatic energy in capacitor. To transfer 'dQ' for a potential difference 'V', the work done is $dW = VdQ = \frac{Q}{C} dQ \quad [\because V = \frac{Q}{C}]$ The total work done to charge a capacitor, W = $\int_0^Q \frac{Q}{C} dQ$; $= \frac{1}{C}\left[\frac{Q^2}{2}\right]_0^Q = \frac{Q^2}{2C}$ This work done is stored as electrostatic energy of the capacitor, (i.e) $U_E = \frac{Q^2}{2C} = \frac{1}{2} CV^2 \quad [\because Q = CV]$	3	3
32	**Advantages of robotics:** The robots are much cheaper than humans. Robots never get tired like humans. Hence absenteeism in work place can be reduced. Robots are more precise and error free in performing the task. Stronger and faster than humans Robots can work in extreme environmental conditions: extreme hot or cold, space or underwater. In dangerous situations like bomb detection and bomb deactivation, In warfare, robots can save human lives. Robots are significantly used in handling materials in chemical industries especially in nuclear plants which can lead to health hazards in humans. **Disadvantages of robotics:** Robots have no sense of emotions or conscience; they lack empathy and hence create an emotionless workplace. If ultimately robots would do all the work, and the humans will just sit and monitor them, health hazards will increase rapidly. Unemployment problem will increase. Robots can perform defined tasks and cannot handle unexpected situations the robots are well programmed to do a job and if a small thing goes wrong it ends up in a big loss to the company. If a robot malfunctions, it takes time to identify the problem, rectify it, and even reprogram if necessary. This process requires significant time. Humans cannot be replaced by robots in decision making. Till the robot reaches the level of human intelligence, the humans in work place will exit.	1 2	3

33	L = 500 x 10^{-6} ; C = $\frac{80}{\pi^2}$ x 10^{-12} F ; R = 628 Ω i) Resonant frequency is $f_r = \frac{1}{2\pi\sqrt{LC}}$; = $\frac{1}{2\pi\sqrt{500 \times 10^{-6} \times \frac{80}{\pi^2} \times 10^{-12}}}$; = $\frac{1}{2\sqrt{40{,}000 \times 10^{-18}}}$ = $\frac{10{,}000 \times 10^{3}}{4}$; f_r = 2500 KHz ii) Q- factor = $\frac{\omega_r L}{R}$; = $\frac{2 \times 3.14 \times 2500 \times 10^{3}2 \times 500 \times 10^{-6}}{628}$ Q = 12.5	1 ½ 1 ½	3

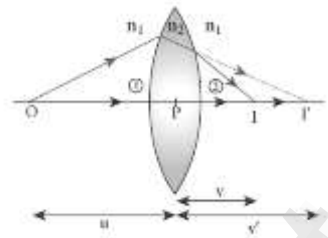
PART – IV

Answer **all** the questions. 5x5=25

34	**Induction of emf by changing relative orientation of the coil with the magnetic field:**  Consider a rectangular coil of 'N' turns kept in a uniform magnetic field 'B'. The coil rotates in anti-clockwise direction with an angular velocity 'ω' about an axis. Initially let the plane of the coil be perpendicular to the field (θ = 0) and the flux linked with the coil has its maximum value. (i.e.) $\Phi_m = B\ A$ In time't', let the coil be rotated through an angle θ (= ωt), then the total flux linked is, $N\Phi_B = N\ B\ A \cos \omega t = N\Phi_m \cos \omega t$ According to Faraday's law, the emf induced at that instant is, $\epsilon = -\frac{d}{dt}(N\Phi_B) = -\frac{d}{dt}(N\Phi_m \cos \omega t)$ $-N\Phi_m(-\sin \omega t)$ $\epsilon = \boldsymbol{N\Phi_m \omega \sin \omega t}$ .... (1) When $\theta = 90°$, then the induced emf becomes maximum and it is given by, $\epsilon_m = \boldsymbol{N\Phi_m\omega}$; = **N B A $\boldsymbol{\omega}$** .... (2) Therefore, the value of induced emf at that instant is then given by, $\epsilon = \epsilon_m$ **sin $\boldsymbol{\omega t}$**................. (3) Thus the induced emf varies as sine function of the time angle and this is called sinusoidal emf or alternating emf. If this alternating voltage is given to a closed circuit, a sinusoidal varying current flows in it. This current is called alternating current an is given by, $\boldsymbol{i} = I_m$ **sin $\boldsymbol{\omega t}$** – – – – – – (4) Where, I_m → peak value of induced current	1 1 1 1 1	5

34 **Lens maker's formula:**

A thin lens of refractive index n_2 is placed in a medium of refractive index n_1. Let R_1 and R_2 be radii of curvature of two spherical surfaces ① and ② respectively



Let P be pole of the lens and O be the Point object. 1

Here I' be the image to be formed due the refraction at the surface ① and I be the final image obtained due the refraction at the surface ②

We know that, equation for single spherical surface

$$\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$$

For refracting surface ①, the light goes from n_1 to n_2, Hence 1

$$\frac{n_2}{v'} - \frac{n_1}{u} = \frac{n_2 - n_1}{R_1} \quad \text{..............} (1)$$

For refracting surface ②, the light goes from n_2 to n_1, Hence

$$\frac{n_1}{v} - \frac{n_2}{v'} = \frac{n_1 - n_2}{R_2} \quad \text{..............} (2)$$

Adding equation (1) and (2), we get,

$$\frac{n_2}{v'} - \frac{n_1}{u} + \frac{n_1}{v} - \frac{n_2}{v'} = \frac{n_2 - n_1}{R_1} + \frac{n_1 - n_2}{R_2}$$

$$\frac{n_1}{v} - \frac{n_1}{u} = (n_2 - n_1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$ 1

$$\frac{1}{v} - \frac{1}{u} = \frac{(n_2 - n_1)}{n_1}\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

$$\frac{1}{v} - \frac{1}{u} = \left(\frac{n_2}{n_1} - 1\right)\left[\frac{1}{R_1} - \frac{1}{R_2}\right] \quad \text{...........}(3)$$

If the object is at infinity, the image is formed at the focus of the lens. Thus, $u = \infty, v = f$ 1

Then equation becomes, $\frac{1}{f} - \frac{1}{\infty} = \left(\frac{n_2}{n_1} - 1\right)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

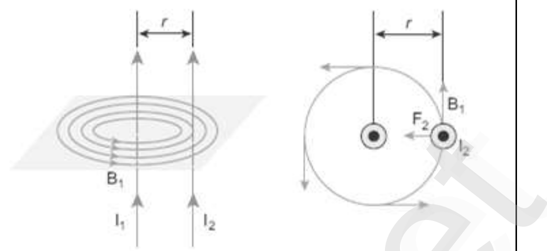
$$\frac{1}{f} = \left(\frac{n_2}{n_1} - 1\right)\left[\frac{1}{R_1} - \frac{1}{R_2}\right] \quad \text{..............}(4)$$

Here first medium is air and hence $n_1 = 1$ and let the refractive index of second medium be $n_2 = n$. Therefore $\frac{1}{f} = (n-1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$..............(5)

The above equation is called lens maker's formula. 1

By comparing equation (3) and (4) $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

This equation is known as lens equation. 5

35	**Force between two parallel conductors carrying current:** Consider two straight parallel current carrying conductors 'A' and 'B' separated by a distance 'r' kept in air. Let I_1 and I_2 be the currents passing through the A and B in same direction (z-direction) . The net magnetic field due to I_1 at a distance 'r'.  $\vec{B}_1 = \frac{\mu_0 I_1}{2\pi r}(-\hat{\imath}) = -\frac{\mu_0 I_1}{2\pi r}\hat{\imath}$ Here $\vec{B}_1$ acts perpendicular to plane of paper and inwards. Then Lorentz force acts on the length element dl in conductor 'B' carrying current I_2 due to this magnetic field $\vec{B}_1$ $\vec{dF} = I_2\vec{dl} \times \vec{B}_1 = -I_2 dl\,\hat{k} \times \frac{\mu_0 I_1}{2\pi r}\hat{\imath}$ $\vec{dF} = -\frac{\mu_0 I_1 I_2 dl}{2\pi r}(\hat{k} \times \hat{\imath})$; $\vec{dF} = -\frac{\mu_0 I_1 I_2 dl}{2\pi r}\hat{\jmath}$ By Fleming's left hand rule, this force acts left wards. The force per unit length of the conductor B. $\frac{\vec{F}}{l} = -\frac{\mu_0 I_1 I_2}{2\pi r}\hat{\jmath}$ - - - - - - - (1)	2 ½	5
	Similarly, net magnetic field due to I_2 at a distance 'r' is $\vec{B}_2 = \frac{\mu_0 I_2}{2\pi r}\hat{\imath}$ Here $\vec{B}_2$ acts perpendicular to plane of paper and outwards. Then Lorentz force acts on the length element dl in conductor 'A' carrying current I_1 due to this magnetic field $\vec{B}_2$. $\vec{dF} = I_1\vec{dl} \times \vec{B}_2 = I_1 dl\,\hat{k} \times \frac{\mu_0 I_2}{2\pi r}\hat{\imath}$ $\vec{dF} = \frac{\mu_0 I_1 I_2 dl}{2\pi r}(\hat{k} \times \hat{\imath})$; $\vec{dF} = \frac{\mu_0 I_1 I_2 dl}{2\pi r}\hat{\jmath}$ By Fleming's left hand rule, this force acts right wards. The force per unit length of the conductor A. $\frac{\vec{F}}{l} = \frac{\mu_0 I_1 I_2 dl}{2\pi r}\hat{\jmath}$ - - - - - - - (2) Thus the force experienced by two parallel current carrying conductors is attractive if they carry current in same direction. On the other hand, the force experienced by two parallel current carrying conductors is repulsive if they carry current in opposite direction.	2 ½	

35

Law of radioactivity:

At any instant t, **the number of decays per unit time, called rate of decay $\left(\frac{dN}{dt}\right)$ is proportional to the number of nuclei (N) at the same instant. This is called law of radioactive decay.** 1

Expression: 1

Let N_0 be the number of nuclei at initial time (t = 0)

Let 'N' be the number of un-decayed nuclei at any time 't'

If 'dN' be the number of nuclei decayed in time 'dt' then,

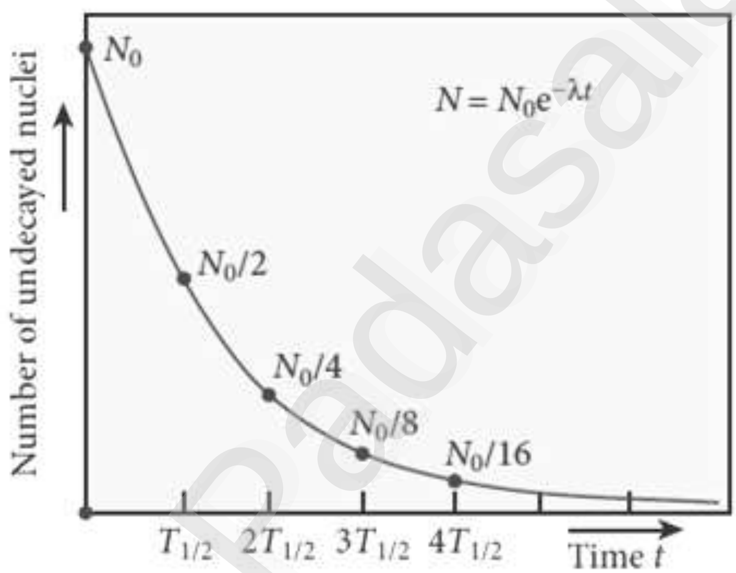
rate of decay = $\frac{dN}{dt}$

From law of radioactivity, $\frac{dN}{dt} \propto N$ (or) $\frac{dN}{dt} = -\lambda N - - - - - (1)$

Here, $\lambda \longrightarrow$ decay constant

Decay constant (λ) is different for different radioactive sample and the negative sign in the equation implies that the N is decreasing with time.

1



5

By rewriting the equation (1), we get $\frac{dN}{dt} = -\lambda dt$

Integrating on both sides, $\int_{N_0}^{N} \frac{dN}{N} = -\lambda \int_0^t dt$; $[In\ N]_{N_0}^{N} = -\lambda t$ 1

$[In\ N - In\ N_0] = -\lambda t$; $\ln\left[\frac{N}{N_0} = -\lambda t\right]$

Taking exponential on both sides, $\frac{N}{N_0} = e^{-\lambda t}$

$N = N_0 e^{-\lambda t} - - - - - (2)$

Equation (2) is called the law of radioactive decay. Here the number of atoms is decreasing exponentially over the time. 1

This implies that the time taken for all the radioactive nuclei to decay will be infinite.

36	**Emission spectra:** The **light from self-luminous source gives emission** spectrum. Each source has its own characteristic emission spectrum. The emission spectrum can be divided in to three types;	1	5
	(i) Continuous emission spectra: Incandescent solids, liquids give continuous spectra. It consists of wavelengths containing all the visible colours ranging from violet to red. **(e.g.) Spectrum obtained from carbon arc, incandescent filament lamp, etc**	1	
	(ii) Line emission spectra: **Light from excited atoms gives line spectrum. They are also known as discontinuous spectra.** The line spectra are sharp lines of definite wavelengths or frequencies. It is different for different elements **(e.g.) spectra of atomic hydrogen, helium, etc**	1 ½	
	(iii) Band emission spectra: **The light from excited molecules gives band spectrum. It consists of several numbers of very closely spaced spectral lines which overlapped together forming specific coloured** bands. This spectrum has a sharp edge at one end and fades out at the other end. Band spectrum is the characteristic of the molecule. **(e.g.) spectra of hydrogen gas, ammonia gas in the discharge tube, etc**	1 ½	

36	**De Broglie wavelength of electrons:** i) An electron of mass m is accelerated through a potential difference of V volt. The kinetic energy acquired by the electron is given by $\frac{1}{2}mv^2 = ev$ Hence the speed of the electron is , $v^2 = \frac{2\,\mathrm{e\,V}}{\mathrm{m}}$; $v = \sqrt{\frac{2\,\mathrm{e\,V}}{\mathrm{m}}}$ ....(1) The de Broglie wavelength of electron is $\lambda = \frac{h}{mv} = \frac{h}{m\sqrt{\frac{2\,e\,V}{m}}}$ $\lambda = \frac{\mathrm{h}}{\sqrt{2\,\mathrm{m\,e\,V}}}$ ....(2) Where, h = 6.626 x 10^{-34} JS. **e = 1.6 x 10^{-19} C. m = 9.11 x 10^{-31} kg** $\therefore\ \lambda = \frac{12.27 \times 10^{-10}}{\sqrt{\mathrm{V}}} = \frac{12.27}{\sqrt{\mathrm{V}}}\,\mathrm{\mathring{A}}$ ii) Momentum of the electron is p = $\sqrt{2mK}$ = $\sqrt{2 \times 9.1 \times 10^{-31} \times 2 \times 1.6 \times 10^{-19}}$; $\sqrt{58.24 \times 10^{-50}}$ p = 7.63 x 10^{-25} kg ms^{-1} Its de Broglie wavelength is = $\frac{h}{p} = \frac{6.634 \times 10^{-34}}{7.63 \times 10^{-25}}$; = 0.868 x 10^{-9} m $\lambda = 8.68\ \mathrm{\mathring{A}}$	1 1 1 1 1	5

37 **Van de Graff Generator:**

It is designed by Robert Van de Graff.

It produces large **electro static potential difference** of about **10^7 V**

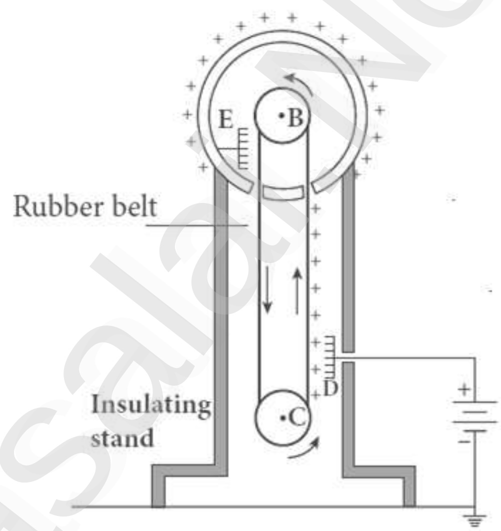
Principle: 1

Electro static induction, Action of points

Construction:

It consists of large **hollow spherical conductor 'A'** fixed on the insulating stand. **Pulley 'B'** is mounted at the centre of the sphere and another **pulley 'C'** is fixed at the bottom. A belt made up of insulating material like silk or rubber runs over the pulleys.

The **pulley 'C'** is driven continuously by **the electric motor**. Two comb shaped metallic conductor D and E are fixed 1 near the pulleys. The comb 'D' is maintained at a **positive potential of 10^4 V** by a power supply. The upper **comb 'E'** is connected to the inner side of the **hollow metal sphere.**



Working:

Due to the high electric field near comb 'D', air between the belt and comb 'D' gets ionized. **The positive charges are pushed towards the belt** 5 **and negative charges are attracted** 1 **towards the comb 'D'.**

The positive charges stick to the belt and move up. When the positive charges reach the comb 'E' a large amount of negative and positive charges are induced on either side of comb 'E' due to electrostatic induction.

As a result, the positive charges are pushed away from the **comb 'E' and they reach the outer surface of the sphere.**

These positive charges are distributed uniformly on the outer surface of the hollow sphere. At the same time, **the negative charges neutralize the positive charges in the belt due to corona discharge before it passes over** 1 **the pulley.** When the belt descends, it has almost no net charge.

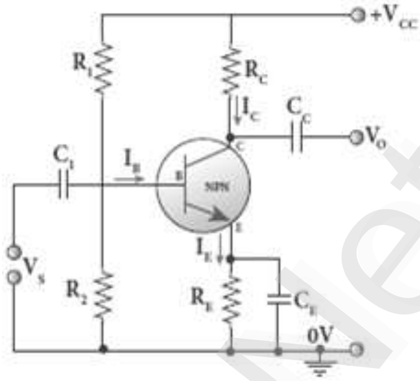
This process continues until the outer surface produces the **potential difference of the order of 10^7 V** which is the limiting value. Beyond this, the charge starts leaking to the surroundings due to ionization of air. It is prevented by enclosing the machine in a gas filled steel chamber at very high pressure.

Applications: 1

The high voltage produced in this **Van de Graff generator** is used to **accelerate positive ions (Protons and Deuterons)** for nuclear disintegrations and other applications.

37 **Transistor as an amplifier:**

Amplification is the process of increasing the signal strength (increase in the amplitude). If a large amplification is required, multistage amplifier is used. ½ Here, the amplification of an electrical signal is explained with a single stage transistor amplifier.



Single stage indicates that the circuit consists of one transistor with the allied components. An NPN transistor is connected in the common emitter configuration. A load resistance, R_C is connected in series with the collector circuit to measure the output voltage. 1 ½

The capacitor C_1 allows only the ac signal to pass through. The emitter bypass capacitor CE provides a low reactance path to the amplified ac signal.

The coupling capacitor CC is used to couple one stage of the amplifier with the next stage while constructing multistage amplifiers. V_S is the sinusoidal input signal source applied across the base-emitter. The output is taken across the collector-emitter. $I_C = \beta I_B$

Applying Kirchhoff's voltage law in the output loop, the collector-emitter voltage is $V_{CE} = V_{CC} - I_C R_C$ 5

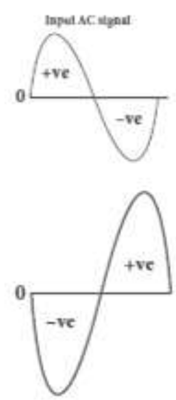
Working of the amplifier:

(1) During the positive half cycle: Input signal (Vs) increases the forward voltage across the emitter-base. As a result, the base current (I_B) increases. Consequently, the collector current (I_C) increases β times. This **increases the voltage drop across R_C which in turn decreases the collector-emitter voltage (V_{CE}).** 1 ½

Therefore, the input signal in the positive direction produces an amplified signal in the negative direction at the output. Hence, the output signal is reversed by 180⁰.

(2) **During the negative half cycle:** 1 ½

Input signal (Vs) decreases the forward voltage across the emitter-base. As a result, base current (IB) decreases and in turn increases the collector current (I_C). The increase in collector current (I_C) decreases the potential drop across RC and increases the collector-emitter voltage (V_{CE}).



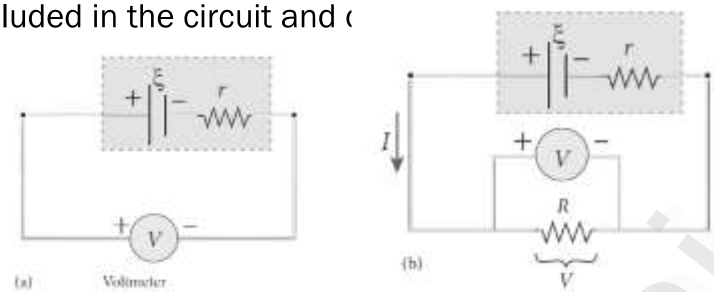
Thus, the input signal in the negative direction produces an amplified signal in the positive direction at the output. Therefore, **180⁰ phase reversal is observed during the negative half cycle of the input signal**

<table>
<tr>
<td>38</td>
<td>

Internal resistance of a cell:

A real battery is made of electrodes and electrolyte. There is resistance to the flow of charges within the battery and this resistance is called internal resistance (r)

The **emf of the cell** is measured by **connecting high resistance** voltmeter across it without connecting the external resistance R. This circuit may be considered as open, the voltmeter reading gives the emf (ξ) of the cell. Then external resistance is included in the circuit and (the circuit.



This circuit is then considered as close, the voltmeter reading gives the potential difference (V) across 'R'

By Ohm's law, = IR (or) $I = \frac{V}{R}$ ....(1)

Due to internal resistance of the cell, the voltmeter reads the value "V" which is less than the emf (ξ). It is because, certain amount of voltage (Ir) has dropped across the internal resistance 'r'. Hence

$V = \xi - Ir$ – – – – (2) (or) $Ir = \xi - V$

$\therefore \quad r = \frac{\xi - V}{I}$; $= \left[\frac{\xi - V}{V}\right]R$

Since ξ, V and R are known, internal resistance 'r' and total current 'I' can be determined.

The power delivered to the circuit is,

$I = I\xi$; $= I(V + Ir)$; $= I(IR + Ir)$

$P = I^2R + I^2r$

where, $I^2R \rightarrow$ power delivered to R

$I^2r \rightarrow$ power delivered to r

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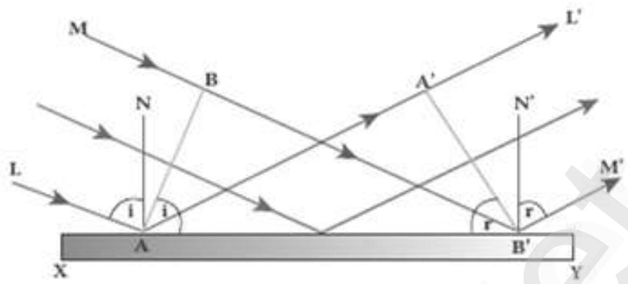
38	**Laws of reflection - Proof:** XY − Reflecting surface, AB −Incident plane wave front. The incident rays from L and M are perpendicular to this incident wave front. Initially the point 'A' reaches reflecting surface. Then the successive points between AB reach the surface.  Finally, by the time B reaches B', the point A would have reached A' This is applicable to all the points on the wave front AB. Thus the reflected wave front $A'B'$ emanates as a plane wave front. The line from L' and M' perpendiculars to $A'B$ represent reflected rays. .As the reflection happens in the same medium, the speed of light is same before and after reflection. Hence, $AA' = BB'$ **Law (1):** The incident rays, the reflected rays and the normal are in the same plane. **Law (2)**: Angle of incidence, $\angle i = \angle NAL = 90^0 - \angle NAB = \angle BAB'$ Angle of reflection, $\angle r = \angle N'B'M' = 90^0 - N'B'A' = \angle A'B'A$ In $\Delta ABB'$ and $\Delta B'A'A$, $\angle B = \angle A' = 90^0$; $AA' = BB'$ and Hypotenuse AB' is common Thus the two triangles are congruent. (i.e) $\angle BAB' = \angle A'B'A$ $\therefore \angle \boldsymbol{i} = \angle \boldsymbol{r}$ Hence laws of reflection are proved.	1 1 1 1 1	