CBSE Board
Class XII Physics – Set 1
Board Paper - 2009

Time: 3 hours **[Total Marks: 70]**

General instructions:

1. All questions are compulsory.

2. There are 30 questions in total. Questions 1 to 8 are very short answer type questions and carry one mark each.

3. Questions 9 to 18 carry two marks each, questions 19 to 27 carry three marks each and questions 28 to 30 carry five marks each.

4. There is no overall choice. However, an internal choice has been provided in one question of two marks, one question of three marks and all three questions of five marks each. You have to attempt only one of the given choices in such questions.

5. Use of calculators in not permitted. However, you may use log tables if necessary.

6. You may use the following values of physical constants wherever necessary.

$c = 3 \times 10^{8}\ ms^{-1}$
$h = 6.626 \times 10^{-34}\ Js$
$e = 1.602 \times 10^{-19}\ C$
$\mu_o = 4\pi \times 10^{-7} TmA^{-1}$
$\frac{1}{4\pi\varepsilon_o} = 9 \times 10^{-9} Nm^2C^{-2}$
Mass of electron $m_e = 9.1 \times 10^{-31}\ kg$
Mass of neutron $m_n \cong 1.675 \times 10^{-27}\ kg$
Boltzmann's constant $k = 1.381 \times 10^{-23}\ J\ K^{-1}$
Avogadro's number $N_A = 6.022 \times 10^{23}\ mol^{-1}$
Radius of earth = 6400 km

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1. Defined the term of "Potential energy" of charge 'q' at a distance 'r' in an external electric field.

2. An electron does not suffer any deflection while passing through a region of uniform magnetic field. What is the direction of the magnetic field?

3. Name of EM waves used to studying crystal structure of solids. What is its frequency range?

4. The stopping potential in an experiment on photoelectric effect is 2 V. What is the maximum kinetic energy of the photoelectrons emitted?

5. Two thin lenses of power + 5 D and -2.5 D are in contact. What is the focal length of the combination?

6. How would the angular separation of interference fringes in Young would's double slit experiment change when the distance between the slits and screen is halved?

7. Give the logic symbol of AND gate.

8. Two nuclei have mass numbers in the ratio 27: 125. What is the ratio of their nuclear radii.

9. Write the function of (i) Transducer and (ii) Repeater in the context of communication system.

OR

Write two factors justifying the need of modulation for transmission of a signal.

10. Define electric flux. Write its S I units.

(i) What is the relation between critical angle and refractive index of a material?

(ii) Does critical angle depend on the color of light? Explain.

11. (i) What is the relation between critical angle and refractive index of a material?

(ii) Does critical angle depend on the color of light? Explain.

12. Define the term 'linearly polarised light'

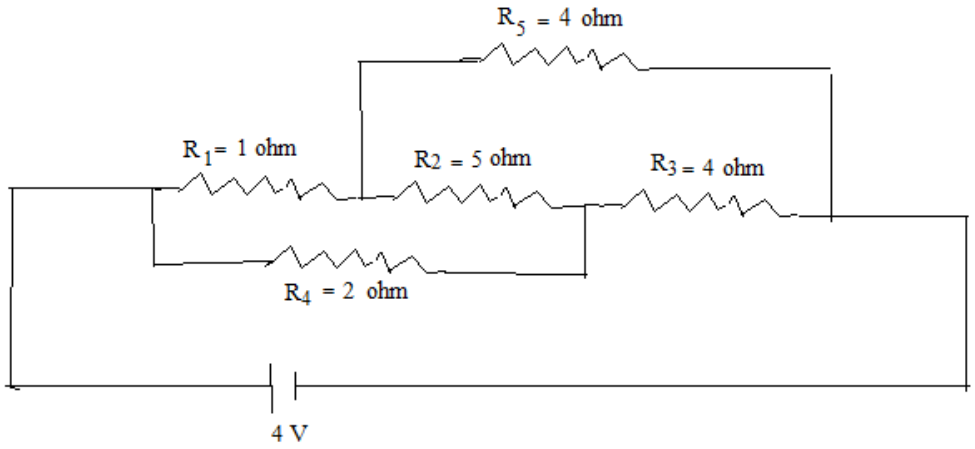
When does the intensity of transmitted light become maximum, when a polaroid sheet is rotated between two crossed polaroids?

13. (a) The mass of a nucleus in its ground state is always less than the total mass of its constituents – neutrons and protons. Explain

(b) Plot a graph showing the variation of potential energy of a pair of nucleons as a function of their separation.

14. Define current sensitivity and voltage sensitivity of a galvanometer. Increasing the current sensitivity may not necessarily increase the voltage sensitivity of a galvanometer. Justify.

15. Calculate the current drown from the battery in the given network.



16. A wire of 20 Ω resistance is gradually stretched to double of its original length. It is then cut into two equal parts. These parts are then connected in parallel across a 4.0 volt battery. Find the current drawn from the battery.

17. Draw 3 equipotential surfaces corresponding to a field that uniformly increases in magnitude but remains constant along Z – direction. How are these surfaces different from that of a constant electric field along Z- direction?

18. Answer the following questions

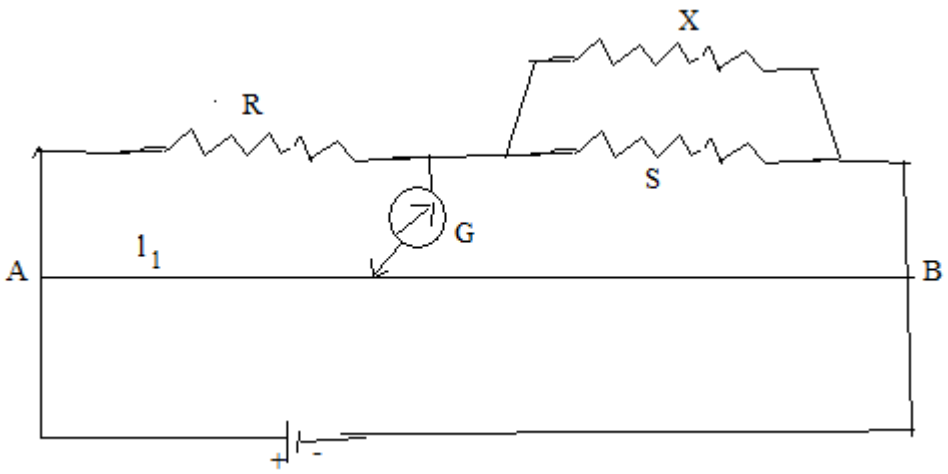
(a) Optical and radio telescopes are built on the ground while X-ray astronomy is possible only from satellites orbiting the Earth.

(b) The small ozone layer on top of the stratosphere is crucial for human survival. Why?

19. Draw a schematic arrangement of the Geiger – Marsden experiment. How did the scattering of α - particles by a thin foil of gold provide an important way to determine an upper limit on the size of the nucleus? Explain briefly.

20. (i) State the principle of working of a meter bridge.

(ii) In a meter bridge balance point is found at a distance ℓ_1 with resistances R and S as shown in the figure.



When an unknown resistance X is connected in parallel with the resistance S, the balance point shifts to a distance ℓ_2. Find the expression of X in terms of ℓ_1 ℓ_2 and S.

21. (i) State Faraday's law of electromagnetic induction

(ii) A jet plane is traveling towards west at a speed of 1800 km/h. What is the voltage differences developed between the ends of the wing having a span of 25 m, if the Earth's magnetic field at the location has a magnitude of 5×10^{-4} T and the dip angle is 30°?

22. In Young's double slit experiment, monochromatic light of wavelength 600 nm illuminates the pair of slits and produces an interference pattern in which two consecutive bright fringes are separated by 100 mm. Another source of monochromatic light produces the interference pattern in which the two consecutive bright fringes are separated by 89 mm. Find the wavelength of light from the second source.

What is the effect on the interference fringes if the monochromatic source is replaced by a source of white light?

23. A positive point charge (+q) is kept in the vicinity of an uncharged conducting plate. Sketch electric filed lines originating from the point on the surface of the plate.

Derive the expression for the electric field at the surface of a charged conductor.

OR

A parallel plate capacitor is charged by a battery. After some time the battery is disconnected and a dielectric slab of dielectric constant K is inserted between the plates. How would (i) the capacitance (ii) the electric field between the plates and (iii) the energy stored in the capacitor be affected? Justify your answer.

24. Distinguish between sky wave and space wave propagation. Give a brief description with the help of suitable diagrams indicating how these waves are propagated.

25. Explain with the help of a circuit diagram how a zener diode works as a DC voltage regulator. Draw its I – V characteristics.

26. Give a circuit diagram of a common emitter amplifier using an n – p transistor. Draw the input and output waveforms of the signal. Write the expression for its voltage gain.

27. Define the activity of a radionuclide. Write its S.I. unit. Give a plot of the activity of a radioactive species versus time.

How long will a radioactive isotope, whose half life is T years, take for its activity to reduce to $1/8^{th}$ of its initial value?

28. a. (i) Draw a labeled ray diagram to show the formation of image in an astronomical telescope for a distant object.

(ii) Write three distinct advantages of a reflecting type telescope over a refracting type telescope.

b. A convex lens of focal length 10 cm is placed coaxially 5 cm away from a concave lens of focal length 10 cm. If an object is placed 30 cm in front of the convex lens find the position of the final image formed by the combined system.

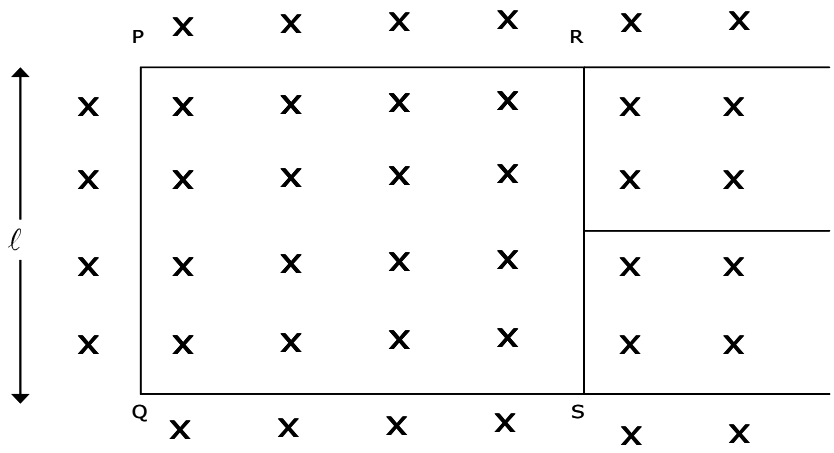
OR

a. With the help of a suitable ray diagram, derive the mirror formula for a concave mirror.

b. The near point of a hypermetropic person is 50 cm from the eye. What is the power of the lens required to enable the person to read clearly a book held at 25 cm from the eye?

29. a. What are eddy currents? Write their two applications.

b. Figure shows a rectangular conducting loop PQSR in which an RS of length 'ℓ' is movable. The loop is kept in a uniform magnetic field 'B' directed downward perpendicular to the plain of the loop. The arm RS is moved with a uniform speed 'v'.



Deduce an expression for

(i) The emf induced across the arm 'RS',

(ii) The external force required to move the arm, and

(iii) The power dissipated as heat.

OR

a. State Lenz's law. Give one example to illustrate this law. "The Lenz's law is a consequence of the principle of conservation of energy." Justify this statement.

b. Deduce an expression for the mutual inductance of two long coaxial solenoids but having different radii and different number of turns.

30. (i) Briefly explain the working of a cyclotron. Also find the expression of time period.

(ii) What is resonance condition in cyclotron?

OR

Find the force per unit length in a wire due the current flowing in wire parallel to first wire.

Also find the value of torque experienced by a loop in the magnetic field.

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Board Paper – 2009 (Solution)

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1. The electric potential energy is the external work done in bringing the charge q from infinity to the point r in the electric field . It is assumed that the potential energy of the system is zero when the charge separation is infinite.

2. The magnetic field is in the direction in which the electron moves. The force is given by F = q (vxB) and for force to be zero, v and B must be parallel to each other.

3. X-rays are used to study crystal structure of solids. The frequency range is 1nm to 10^{-3} nm.

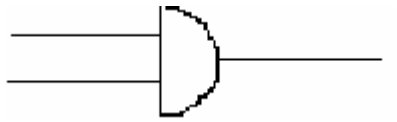
4. The maximum kinetic energy of the photoelectrons emitted,

$= 1.6 \times 10^{-19}$ C × 2V = 3.2 10^{-19} J

5. Power of the combination is the sum of the power of the two lenses.
So power = +5D + (-2.5D) = +2.5D.
Focal length = 1/power = $\frac{1}{2.5} \times 100 = 40$cm

6. Angular separation of fringes in Young's double slit experiment is given $\frac{\lambda}{d}$. So when the distance between the slits and screen is halved, the angular separation of fringes remains the same.

7. AND gate



8. The radii of the nucleus is given by
$R = R_o A^{1/3}$

$$\frac{R_1}{R_2} = \frac{A_1^{1/3}}{A_2^{1/3}} = \left(\frac{27}{125}\right)^{1/3} \frac{3}{5} =$$

So the nuclear radii are in the ratio of 3:5.

9. (i) Transducer converts energy from one form to another either at the input or at the output. For example sound signals are converted to electrical signals so that they can be transmitted through the communication channel.

(ii) Repeater stations receive the signal, amplify it and then transmit it. This helps to increase the range of transmission of signals.

OR

(i) Modulation helps to increase the frequency of the signal. This helps to transmit it over larger distances as a higher frequency signal will suffer less attenuation.

(ii) The size of the antenna required is proportional to (wavelength/4). So if waves of large wavelength are transmitted then the size of the antenna required is impractical. By increasing the frequency of the signal by modulation, its wavelength is decreased. So now shorter and more practical size antennas can be built.

10. Electric flux is the number of field lines crossing an area. It is given by. Its SI unit is $N.m^2/C$.

The electric flux through a spherical surface of radius R for a charge q enclosed by the surface is $\frac{q}{\varepsilon_o}$. If radius is reduced to half, the electric flux remains the same.

11. (i) The relation between critical angle and refractive index of a material is given by

$$n = \frac{1}{\sin i_c}$$

(ii) Yes, the critical angle will depend on the color of light. Different colors of light have different values of refractive indices, so their critical angle will also be different.

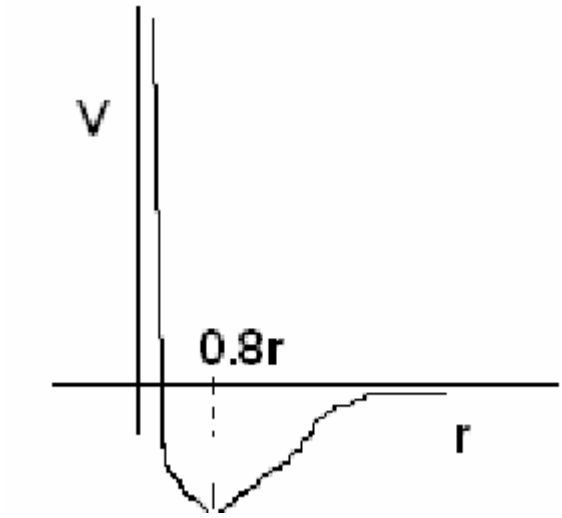
12. "Linearly polarized light" is a plane electromagnetic wave, in which the electric field is restricted to a single plane. The intensity of transmitted light is given by,

$\mathbf{I = I_o \cos^2 \theta}$

The intensity of transmitted light is maximum when $\theta = 0^o$ or the polarizing axis of the two Polaroids are parallel to each other.

13. (a) The mass of a nucleus in its ground state is always less than the total mass of its constituents because some mass is converted into energy, in accordance with the equation $E = mc^2$. This difference in mass is called the mass defect and the energy corresponding to the mass defect is the binding energy. This is the energy that has to be supplied to the nucleus to break it up into its constituents.

(b)



14. The current sensitivity of a galvanometer is the deflection per unit flow of current. Voltage sensitivity is given by deflection per unit volt.

$\theta = \frac{NiAB}{k}$

Current sensitivity

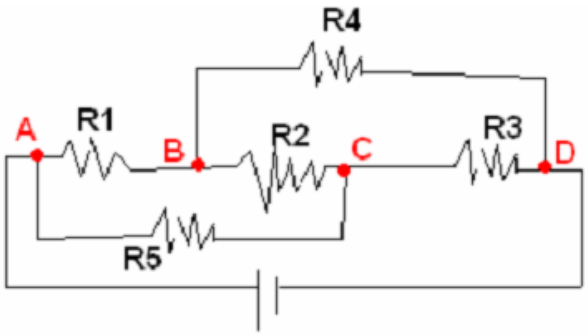
$\frac{\theta}{i} = \frac{NAB}{k}$

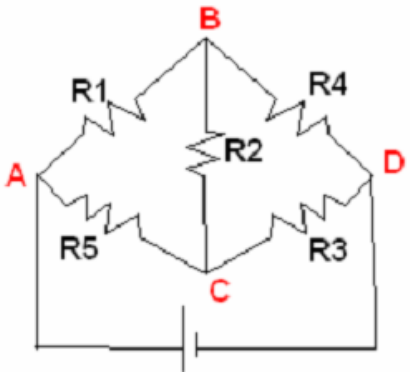
Voltage sensitivity

$\frac{\theta}{V} = \frac{NAB}{kR}$

If the current sensitivity is increased by increasing the number of turns N, the resistance R can also increase. So the voltage sensitivity might not increase, on increasing the current sensitivity.

15. The following resistors form a balanced Wheatstone bridge as $\frac{R_1}{R_5} = \frac{R_4}{R_3}$. So the current flowing through R2 is zero and the





Total resistance of the

R_1 and R_4 in series) and then (R_5 and R_3 in series).

R_{14} and R_{35} are in parallel with each other.

Total resistance of the combination is found as follows:

$R_{14} = 3\ \Omega$

$R_{35} = 6\ \Omega$

$1/R = 1/31/6$

$R = 2\,\Omega$

16. On stretching the wire to double its original length, its area of cross-section is halved. The resistance of the new wire will be 4 times the original resistance.

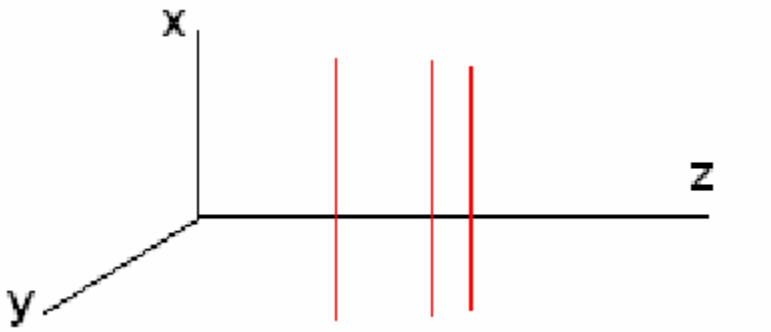
So the resistance of the stretched wire will be $20 \times 4 = 80\ \Omega$

It is cut into two equal parts. The resistance of each part will be $40\,\Omega$.

The total resistance of the parallel combination of these two parts will be $20\,\Omega$.

This combination is connected to 4.0V battery, so current = $\frac{4.0V}{20\Omega} = 0.2A$

17. Planes parallel to the x-y plane. If the field increases and equipotential surfaces are drawn for the same difference in potential then as the field increases the surfaces will become closer to each other.



18. (a) X-rays from celestial objects cannot reach the earth's surface. So for X-ray astronomy to be possible the satellite has to be present in space.
However, visible light and lower wavelengths of light emitted by celestial objects reach the surface of the earth. So these objects can be observed with optical and radio telescopes.
(b) The ozone layer is crucial for human survival as they help to block UV radiations and other high frequency harmful radiations and prevent them from reaching the earth's surface.

19. Draw a diagram of the Geiger Marsden experiment. The alpha particles that are incident head-on with the gold nucleus experience a very large force of repulsion and undergo maximum deflection. Equating the kinetic energy of the incident alpha particle with the potential energy of the alpha particle and gold nucleus, the sum of the approximate radius of the gold nucleus and alpha particle, can be found.

20. (i) A meter bridge is like a wheat stone bridge. The jockey is moved along the wire and the resistances of the arms are varied, until the balance condition is reached.
When the current in the galvanometer is zero, then $\frac{l_1}{100 - l_1} = \frac{R}{S}$

After connecting X in parallel with S

$$\frac{l_2}{100 - l_2} = \frac{R}{\frac{XS}{X + S}} = \frac{R\ X + S}{XS}$$

Taking the ratio of these two equations gives X $\frac{\frac{l_1}{100 - l_1}}{\frac{l_2}{100 - l_2}} = \frac{\frac{R}{S}}{\frac{R\ X + S}{XS}} = \frac{XX}{R\ X + S}$

$$\frac{l_1}{100 - l_1}\frac{100 - l_2}{l_2} = \frac{RX}{R\ X + S}$$

Solving the above expression X can be found.

21. (i) Faraday's law of electromagnetic induction states that the induced emf is proportional to the rate of change of magnetic flux.

$\varepsilon \frac{d\phi}{dt}$

(ii) The induced emf will be given by $\varepsilon = BlV$ where the magnetic field B is perpendicular to the length l.

In the question the earth's magnetic field is given and the angle of dip is 30 degrees, so the magnetic field perpendicular to the direction of the plane is B sin 30^o.

Hence induced emf = $(5 \times 10^{-4} \sin 30^o)$ (25 m) (1800) (5/18) m /s

= 3.125V

22. The separation between the fringes on the screen is given by $t = \frac{\lambda D}{d}$ where D is the distance of the slits from the screen and d is the distance between the slits.

$$10mm = \frac{600nm\ D}{d}$$

For the second source

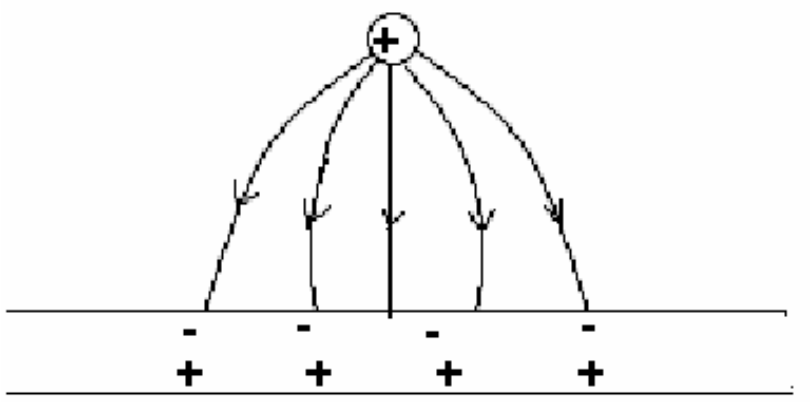
$$8mm = \frac{\lambda\ D}{d}$$

Taking the ratio of the above two equations gives

$$\frac{10mm}{8mm} = \frac{\frac{600nm\ D}{d}}{\frac{\lambda\ D}{d}}$$

$$\lambda = 480nm$$

23.



Take a charged conductor of any arbitrary shape with charge density $\sigma C/m^2$.

The total flux through a small cylindrical Gaussian surface will be given by Gauss's law as follows:

$$E.A = \frac{charge\ enclosed}{\varepsilon_o} = \frac{\sigma.A}{\varepsilon_o}$$

$$E = \frac{\sigma}{\varepsilon_o}\hat{n}$$

The electric field will be normal to the surface at all points of the conductor.

OR

(i) On inserting a slab of dielectric constant K between the plates, the capacitance of the capacitor is K times. New capacitance, $C = KC^{o}$.

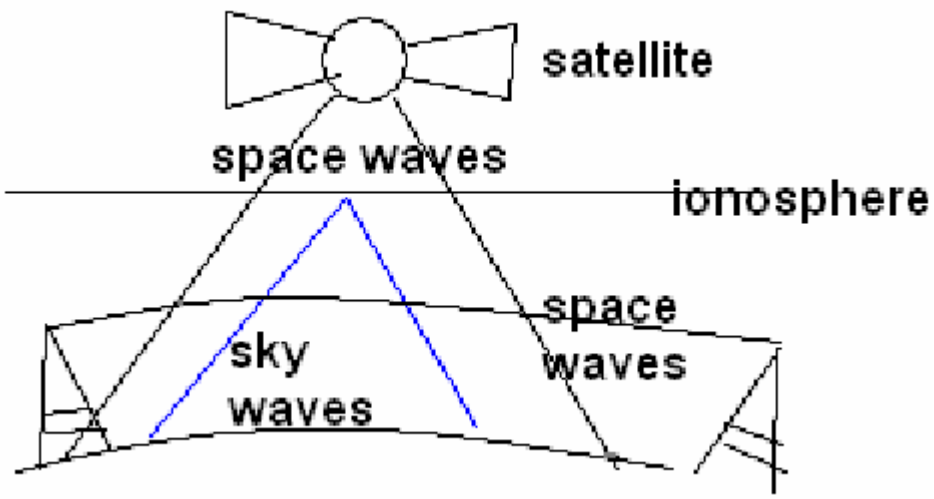
(ii) The electric field between the plates of the capacitor decreases. It becomes $E = \frac{E_o}{K}$.

(iii) The energy stored by a capacitor is

$\frac{Q_2}{2C_o}$ Which becomes $\frac{Q_2}{2C} = \frac{Q_2}{2KC_o}$.

So the energy stored becomes 1/K times its original value.

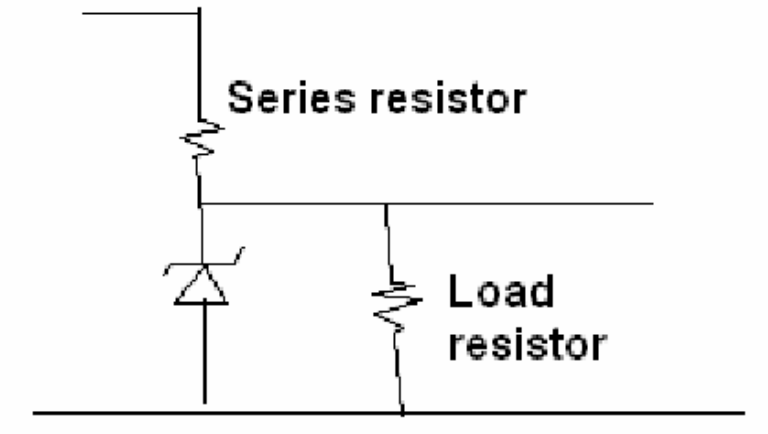
24. The sky waves are reflected from the ionosphere and received by a receiver. Space waves penetrate the ionosphere and are intercepted by a satellite. They can also be used for line of sight communication.

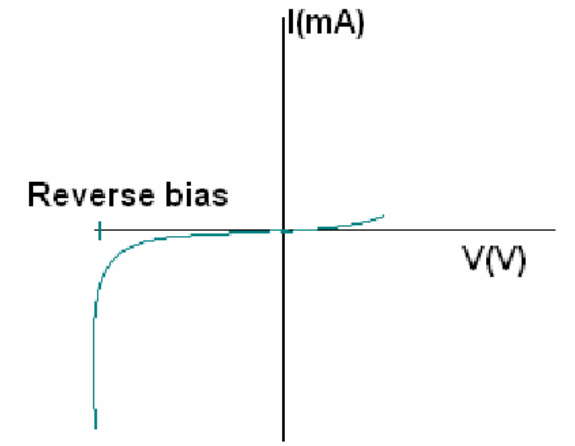


25. A series resistor is put with the Zener diode. The Zener diode is kept reverse biased. If the input voltage increases, the current through the series resistor and zener diode increases. However the zener voltage remains constant. In the breakdown region of the zener diode the voltage across it remains the same even if the current through it increases.

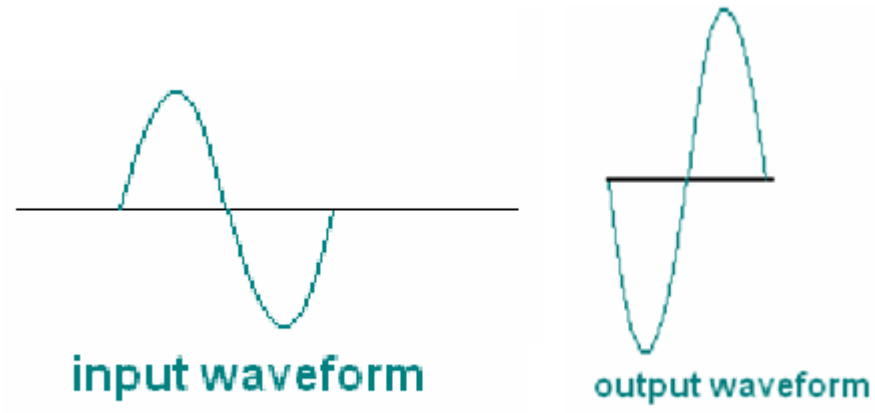
If the input voltage decreases, the current through the series resistor and zener diode decreases. The voltage across the series resistor also decreases, however the voltage across the zener diode remains the same.

Thus the voltage across the zener diode remains the same even if the input voltage changes.





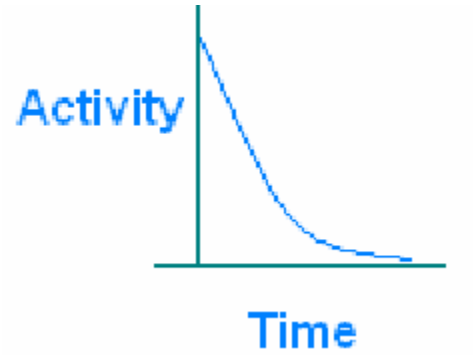
26. The circuit diagram can be found in your NCERT textbook. The output wave form is amplified but reversed in phase by 180 degrees.



Voltage gain is the product of the current gain and the ratio of the resistance of the output circuit to the resistance of the input circuit.

$$A_v = \frac{v_o}{v_i} = \frac{R_L}{r} - \beta$$

27. The decay rate or the number of nuclei decaying per unit time is the activity of the sample. Its SI unit is Bq.



The sample will decay to $1/8^{th}$ of its initial value in 3 half lifes which is 3T years.

28. (a) For diagram refer to NCERT textbook.

(ii) Advantages of reflecting over refracting are:

1. Lenses suffer from chromatic aberrations that are not there in mirrors.

2. Lenses also have spherical aberration, a parabolic mirror will be free of spherical aberration.

3. I t is easier to support large mirrors as the back surface is non- reflecting, but a lens needs support around its rim.

(b) For convex lens of f = +10cm

u = -30cm; f = +10cm

1/v -1/u = 1/f

Substituting the values you get v = +15cm.

This image is at 10cm from the concave lens that is placed at a distance of 5cm from the convex lens. It will act as a virtual object hence, u = +10cm.

For concave lens

u = +10cm, f = -10cm

1/v-1/u = 1/f

Substituting the above values we get

V = infinity. So the final image is formed at infinity.

OR

(a) Derive the mirror formula as given in the NCERT textbook.

(b) For the hypermetropic eye u = -25cm, v = -50cm

Use 1/v-1/u = 1/f

Plugging in values in this equation give f = 50cm

Hence power = 1/f (in meters) = 2D.

29. Changing magnetic flux across a conductor causes currents to flow in the body of the conductor, these are called eddy currents.

Applications are: magnetic braking of trains, electromagnetic damping of galvanometers.

(b) (i) $\varepsilon = Blv$

(ii) F = ilB and here i = $\frac{Blv}{R}$, where R is resistance of RS.

$$F = \frac{B^2l^2v}{R}$$

$$P = F.v = \frac{B^2l^2v^2}{R}$$

OR

(a) Whenever there is a change in magnetic flux linked with a loop, there is an induced emf .The direction of the induced emf is such that it opposes the cause that produces it. Hence the negative sign in the following equation. $\varepsilon = \frac{d\varphi}{dt}$.

This is a consequence of conservation of energy because a current flows in the circuit when there is a changing flux through it and this means that electrical energy is available. However, work needs to be done to make this energy available and mechanical energy is spent.

(b) Derivation given in NCERT textbook.

30. Diagram of cyclotron as given in your textbook. Charged particles are introduced between the dees. An alternating voltage applied between the dees accelerates these particles by an electric field. A magnetic field that is perpendicular to the plane of the dees exerts a force of the particles that is given by F = q (VxB). This causes the particles to follow a circular trajectory. As they reach the dees the polarity is reversed and the particles are once more accelerated. This continues and highly energetic beams of charged particles are obtained.

Magnetic field is perpendicular to dees.

$$f = qvXB$$

$$qvB = \frac{mv^2}{r}$$

$$\omega = \frac{qB}{m}$$

$$T = \frac{m}{qB}.\frac{1}{2\pi}$$

The time period is indeptt of speed and radius of circular path.

(ii) Resonance condition is when the angular frequency of the rotating charged particle and the angular frequency of the alternating voltage applied across the dees of the cyclotron match.

The charged particles are only accelerated by the electric field. The magnetic field only keeps it moving along a circular track. The acceleration happens when the charged particle crosses the gap between the two dees. At this instant the field between the dees has to be reversed so that the electric field can accelerate the charged particle.

OR

(1) Force on first wire due to current in second wire.

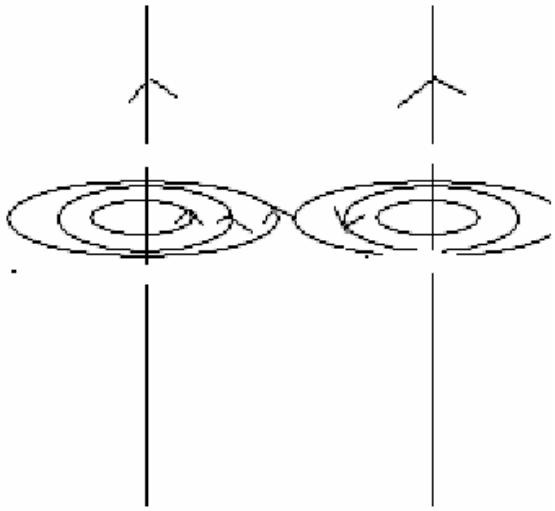
$$F_{12} = i_2 l B_2$$

$$B_2 = \frac{\mu_o i_2}{2\pi r}$$

$$F_{12} = i_1 l \left(\frac{\mu_o i_2}{2\pi r}\right)$$

$$\frac{F_{12}}{l} = i_1 \left(\frac{\mu_o i_2}{2\pi r}\right)$$

This will also be equal to force on second wire due to first wire.



The direction of the magnetic moment of the current loop will be into the paper.

(ii) The torque on the loop is maximum when plane of loop and magnetic field is same. At this position the magnetic moment and magnetic field are perpendicular to each other.

$\vec{\tau} = \vec{m} \times \vec{B} = mB\sin\theta$

Torque is maximum when $\theta = 90$

Torque is minimum when $\theta = 0$