QUESTION BANK

(with solution)

Class-XII

PHYSICS

Part-2

Based on latest syllabus

2016-17

UNIT- VI: OPTICS

VERY SHORT ANSWER TYPE QUESTIONS: 1 –MARK

Q1.For the same value of angle of incidence, the angle of refraction in three media A, B and C are 15^0, 25^0 and 35^0 respectively. In which medium would the velocity of light be minimum? Ans:A

Q2. Using mirror equation to deduce that an object placed between the pole and focus of a concave mirror produces a virtual and enlarged image.

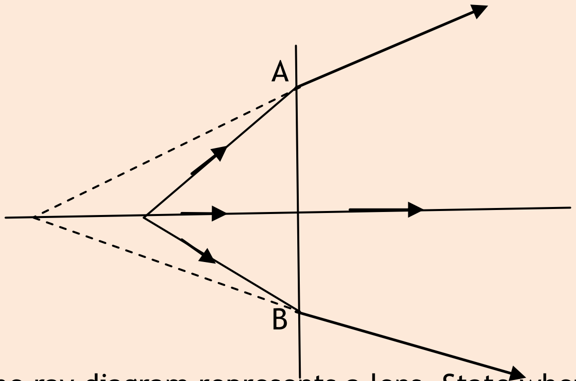
Q3. A concave lens of refractive index 1.5 is immersed in a medium of refractive index 1.65. What is the nature of the lens?

Q4. When light travels from an optically denser medium to a rarer medium, why does the critical angle of incidence depend on the colour of light?

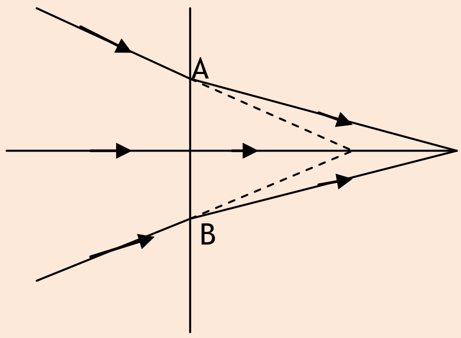
Q5. The focal length of an equiconvex lens is equal to the radius of curvature of either face. What is the refractive index of the material of the lens?

Q6.The radii of curvature of both the surfaces of a lens are equal. If one of the surfaces is made plane by grinding, how will the focal length and power of the lens change?

Q7. The line AB in the ray diagram represents a lens. State whether the lens is convex or concave.



Q8.The line AB in the ray diagram represents a lens. State whether the lens is convex or concave.



Q9. Why does bluish colour predominate in a clear sky?

Q10.Why does rising and setting sun appear red in colour?

Q11. Give one reason for using a concave mirror, rather than a lens, as an objective in a reflecting type telescope.

Q12. A convex lens is placed in contact with a plane mirror. A point object at a distance of 20 cm on the axis of this combination has its image coinciding with itself. What is the focal length of the lens?

Q13. Draw the shape of the wavefront coming out of a concave mirror when a plane wave is incident on it.

Q14. Draw the shape of the wavefront coming out of a convex lens and concave lens when a plane wave is incident on it.

Q15.Define the term—coherent sources which are required to produce interference pattern in Young's double slit experiment.

Q16.How does the angular separation between fringes in single – slit diffraction experiment change when the distance of separation between the slit and screen is doubled?

Q17. State the reason why independent sources of light cannot be considered as coherent?

Q18. In the Young's double slit experiment, the source give out white light but one of the slit is covered with red filter and other with green filter. What will be the nature of interference pattern?

Ans: The source will not act as coherent No sustained interference, Uniform general illumination of screen.

Q19.In the Young's double slit experiment, the source give out white light but one of the slit is covered so that no light enters. How will the intensity of light in the region of central maxima vary? **Ans;** intensity become ¼ rth because the amplitude become half.

Q20. What is the angle between the plane of the polariser and that of analyser, in order that the intensity of light reduces to half? **Ans** 45^0

Q21. Two polaroids are placed at 90^0 to each other and intensity of the transmitted light is zero. What will be the intensity of transmitted light when one more Polaroid is placed between these two bisecting the angle between them? Take intensity of unpolarised light as I_0.**Ans** $I= I_0/8$.

Q22. The ratio of the intensities at minima to the maxima in the Young's double slit experiment is 9: 25. Find the ratio of the amplitude of interfering waves.

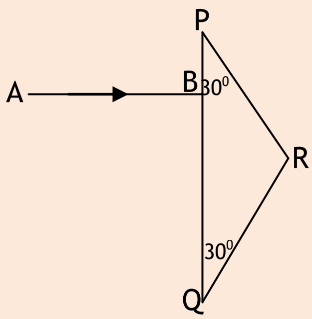
Q23. A beam of polarised light makes an angle of 60^0 with the axis of Polaroid sheet. How much is the intensity of light transmitted through the sheet? **Ans:** 25%

Q24. If μ_r be the relative permeability and K the dielectric constant of the medium. What is its refractive index? **Ans:** $\sqrt{\mu_r K}$

Q25. Material A has critical angle i_A and material B has critical angle i_B ($i_B > i_A$). In which way the light ray should made to pass through these materials for total internal reflection to occur?

Ans: A to B

Q26. Complete the ray diagram, if a light ray AB falls on a face PQ of a prism normally ($a\mu_g$ = 1.5) as shown in figure;



Q27.One surface of a lens is convex and another is concave having radii of curvature R_1 and respectively ($R_1 > R_2$). What is the nature of this lens?

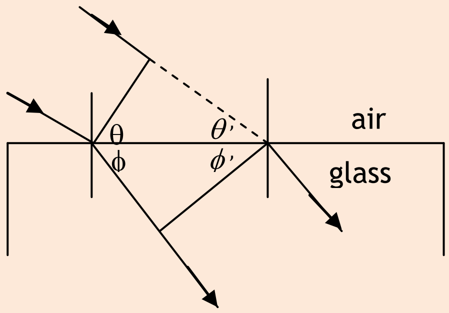
Q28.A converging lens has focal length 1m. What is minimum distance between a real object and its real image formed by this lens? Ans: 4m

Q29.The light of wavelength $7200A^0$ enters is medium of refractive index 1.5. What is its wavelength in this medium? Ans: $4800A^0$

Q30. How does the power of a convex lens change when it is immersed in the water? Ans : decreases

Q31.A plane glass slab is placed over red, blue and green letters respectively. Which letter appears more raised up? Ans: Red

Q32. Write the expression for refractive index of glass by using following figure;



Q33.For which colour of light the critical angle for glass to air is minimum. Ans: Violet colour

Q34.Why does sun appears red at sunrise and sunset? **All India 2016(C)**

SHORT ANSWER TYPE QUESTIONS: 2-MARKS

Q1.A mobile phone lies along the principal axis of a concave mirror. Show, with the help of a suitable diagram, the formation of its image. Explain why magnification is not uniform.

Q2.The speed of light in a medium is 2×10^8m/s. What is critical angle for this medium and air interface? Ans: Critical angle = $\sin^{-1}(2/3)$

Q3.A ray of light passes through an equilateral prism such that the angle of incidence is equal to the angle of emergence and each of these angles is equal to ¾ of angle of prism. What is angle of deviation?

Q4. Calculate the speed of light in a medium whose critical angle is 45^0. Does critical angle for a given pair of media depend on the wavelength of incidence light? Give reason.

Q5. Double – convex lens are to be manufactured from a glass of refractive index 1.55, with both faces of the same radius of curvature. What is the radius of curvature if the focal length is to be 20cm Ans: R = 22cm NCERT

Q6. A beam of light converges at a point P. Now a lens is placed in the path of the convergent beam 12cm from point P. At what point does the beam converge if the lens is (a) a Convex lens of focal length 20cm, and (b) concave lens of focal length 16cm. **Ans:** 7.5cm, 48cm. NCERT

Q7. A screen is placed 90cm from an object. The image of object on the screen is formed by a convex lens at two different locations separated by 20cm. Determine the focal length of the lens.**Ans:**21.4cm NCERT

Q8. Use the mirror equation to show that an object placed between f and 2f of a concave mirror produces a real image beyond 2f.

Q9. Write the important characteristic features by which the interference can be distinguished from the observed diffraction pattern.

Q10. Use the mirror formula to show that the virtual image produced by a convex mirror is always diminished in size and is located between the focus and the pole. NCERT

Q11. You are given two converging lenses of focal lengths 1·25 cm and 5 cm to design a compound microscope. If it is desired to have a magnification of 30, find out the separation between the objective and the eyepiece. Ans: 7.5

Q12.A small telescope has an objective lens of focal length 150 cm and eyepiece of focal length 5 cm. What is the magnifying power of the telescope for viewing distant objects in normal adjustment?

If this telescope is used to view a 100 m tall tower 3 km away, what is the height of the image of the tower formed by the objective lens? Ans: 30, 5cm

Q13. Draw a ray diagram for the formation of image by a compound microscope. Write the expression for total magnification when the image is formed at infinity.

Q14. (a)When a wave is propagating from a rarer to a denser medium, which characteristic of the wave does not change and why? **Ans**: Frequency since it is characteristic by source of light that cannot be affected by change of medium.

(b) What is the ratio of the velocity of the wave in the two media of refractive indices μ_1 and μ_2?

Q15.An object is placed 40 cm from a convex lens of focal length 30 cm. If a concave lens of focal length 50 cm is introduced between the convex lens and the image formed such that it is 20 cm from the convex lens, find the change in the position of the image.

Q16. A ray of light incident on one of the faces of a glass prism of angle 'A' has angle of incidence 2A.The refracted ray in the prism strikes the opposite face which is silvered, the reflected ray from it retracing its path. Trace the ray diagram and find the relation between the refractive index of the material of the prism and the angle of the prism.

Q17. A ray of light incident on an equilateral glass prism propagates parallel to the base line of the prism inside it. Find the angle of incidence of this ray. Given refractive index of material of glass prism is $\sqrt{3}$.

Q18. Write the conditions for observing a rainbow. Show, by drawing suitable diagrams, how one understands the formation of a rainbow?

Q19. A convex lens and a concave lens of focal length 10cm each are held co-axially 3cm apart. Find the position of image of an object placed 15cm in front of the convex lens.

Ans = ≈ -16cm from concave lens.

Q20. A convex lens of focal length 20cm is placed in front of a convex mirror of focal length 15cm at a distance of 5cm. An object of length 2cm is placed at common axis at a distance of 10cm from the lens. Find the final position and size of the image.

Ans: v = 9.4cm right side of convex mirror, size of object=1.5cm

Q21. Suppose the lower half of the concave mirror's reflecting surface is covered with an opaque material. What effect this will have on the image of the object? Explain.

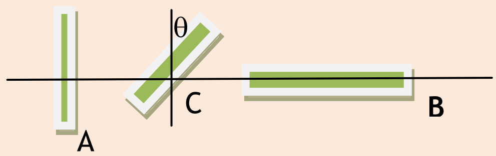
Q22. Explain the basic differences between the construction and working of a telescope and microscope.

Q23. For a single slit of width "a', the first minimum of the diffraction pattern of a monochromatic light of wavelength λ occurs at an angle "λ/a" At the same angle of "λ/a" we get a maximum for two narrow slits separated by a distance "a". Explain.

Q24.The figure *shows an experimental set-up of Young's double slit experiment with the central fringe at 'O'.*

How will the interference pattern on the screen be affected when (i) the source S is displaced upwards parallel to the plane S_1S_2 and (ii) the source S is replaced by white light?

Q25.Find an expression for intensity of transmitted light when a Polaroid sheet is rotated Between two crossed Polaroids. In which position of the Polaroid sheet will the transmitted intensity be maximum?



Q26. Define a wavefront. Using Huygens' Principle, draw the shape of a refracted wavefront, when a plane wave is incident on a glass prism.

Q27.How will the angular separation and visibility of fringes in Young's double slits experiment change when (i) screen is moved away from the plane of slits

(ii) Width of source slit is increased?

Q28. The two slits in Young's double slit experiments separated by 0.03mm and screen is kept 1.5m away. The forth bright fringe is at a distance of 1cm from the central maxima. Calculate the wavelength of light used. **Ans:** $500A^0$

Q29. What two main changes in diffraction pattern of a single slit will you observe when the monochromatic light is replaced by a source of white light?

Hint: Coloured fringes, the width of fringes will also be different due to presence of different Colours (Wavelength).

Q30. How would the angular separation of interference fringes in Young's double slit experiment change when the (i) distance between slits and screen is doubled?

(ii) Separation between slits is doubled?

Q31. A parallel beam of light of wavelength 600nm is incident normally on a slit of width (d). If the distance between the slit and the screen is 0.8m and the distance of 2^{nd} order maximum from the centre of screen is15mm. Calculate the width of the slit. **Ans:** $8x10^{-5}$m.

Hint: $X_n = 5D\lambda/2d = 15x\ 10^{-3}$mm

Q32.A slit of width 'a' is illuminated by a monochromatic light of wave length 700nm at normal incidence. Calculate the value of 'a' for the position of (i) First minimum at angle of diffraction of 30^0.(ii) First maximum at angle of diffraction 30^0.**Ans**: $14x\ 10^{-7}$m.(ii) $21x\ 10^{-7}$m.

Q33.Two Polaroids are placed at 90^0 to each other and intensity of the transmitted light is zero. What will be the intensity of transmitted light when one more Polaroid is placed between these two bisecting the angle between them? Take intensity of unpolarised light as I_0.

Ans I= $I_0/8$

Q34.Find the ratio of intensities at two points P and Q on the screen in a Young's double slit experiment when two similar waves from sources S1 and S2 have phase difference (i) 0^0 and (ii) $\pi/2$. **Ans** 2:1

Q35. What is the effect on the interference fringes in Young's double slit experiment when (i) the width of the source slit is increased; (ii) the monochromatic source is replaced by a source of white light?

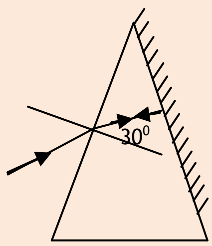
Q36.An equiconvex glass has focal length (f) and power (p). It is cut into two symmetrical halves by a plane normal to the principal axis. Obtain the focal length of each part.

Q37.In an interference experiment, third bright fringe is obtained at a point on the screen with light of wavelength 700nm. What should be the wavelength of light source in order to obtain 5^{th} bright fringe at the same point? Ans: 420nm

Q38.The light of wavelength (λ_1) travelling in a medium of refractive index (n_1) enters a in the medium of refractive index (n_2). What is new wavelength of light in second medium?

Q39. The critical angle for light going from medium X into medium Y is θ. If speed of light in medium X is 'v', and then find the speed of light in medium Y. Ans: v/ sinθ

Q40.The refractive index of material of prism is $\sqrt{2}$ and a incident ray refract at angle 30^0 from its surface. One of the surface of prism is polished so light ray returns back after refraction as shown in figure. What is angle of incident? Ans: 45^0



Q41.A, B and C are three optical media of respective critical angle C_1, C_2 and C_3. The total internal reflection of light occurs from A to B and also B to C but not from C to A. What is relation between their critical angles?

Q42. If ε_0 and μ_0 are respectively the electric permittivity of free space, ε and μ are the corresponding quantities in a medium. What is refractive index of the medium in terms of these physical quantities?

Q43. State Brewster's law.
The value of Brewster angle for a transparent medium is different for light of different colours. Give reason.

Q44. A ray PQ incident normally on the refracting face BA is refracted in the prism BAC made of material of refractive index 1.5. Complete the path of the ray through the prism. From which face the will the ray emerge? Justify your answer.

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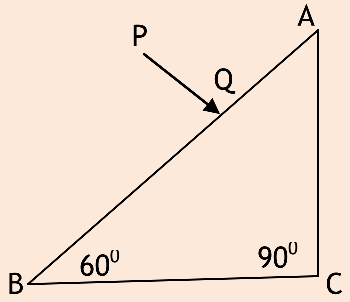


SHORT ANSWER TYPE QUESTIONS: 3-MARKS

Q1.What is total internal reflection? Why do right angled isosceles glass prisms reflect light internally? Give one advantage of these prisms over mirrors.

Q2. Explain the following giving reason:

a) If light from an ordinary source (like a sodium lamp) passes through a Polaroid sheet, its intensity is reduced to half and rotating the Polaroid has no effect on the transmitted intensity.

(b) A convex lens when immersed in a medium whose refractive index is more than that of the material of the lens, behaves like a diverging lens.

(c) Both the objective and the eyepiece of a compound microscope have short focal lengths.

Q3. A small bulb is placed at the bottom of a tank containing water to adepth of 80cm. What is the area of the surface of water through which light from the bulb can emerge out? Refractive index of water is 1.33. (Consider the bulb to be a point source) NCERT

Q4.Using mirror equation to deduce that:

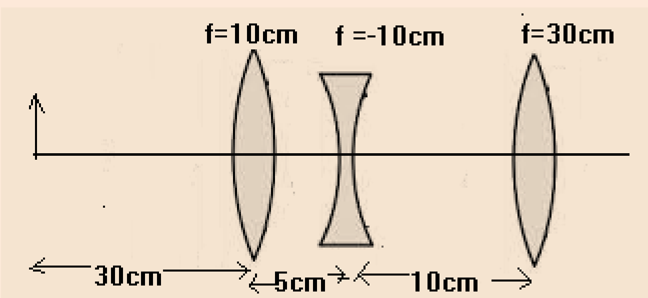
(a) An object placed between f and 2f of a concave mirror produces a real image beyond 2f.

(b) A convex mirror always produces a virtual image independent of the location of object.

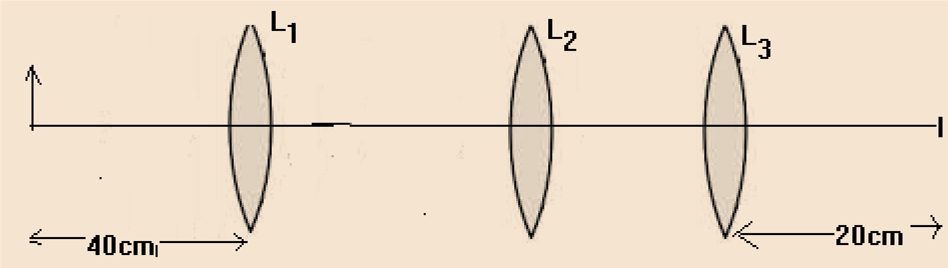
(c) The virtual image produced by a convex mirror is always diminished in size and is located between the focus and pole. NCERT

Q5.Find the position of the image formed by the lens combination using following figure:

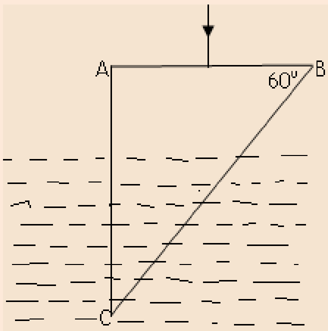
Ans: v1 = 15cm, $v_2 = \infty$, Final image v_3 = 30cm, to right of the third lens.



Q6.You are given three lenses L_1, L_2 and L_3 each of focal length 20cm. An object is kept at 40cm in front of L_1 as shown. The final image I, is formed at the focus of L_3. Find the separations between L_1, L_2 and L_3.



Q7. (a) A ray of light is incident normally on the face AB of a right-angled glass prism of refractive index $_a\mu_g$ = 1·5. The prism is partly immersed in a liquid of unknown refractive index. Find the value of refractive index of the liquid so that the ray grazes along the face BC after refraction through the prism.



(b) Trace the path of the rays if it were incident normally on the face AC.

Q8. An object is placed 15 cm in front of a convex lens of focal length 10 cm. Find the nature and position of the image formed. Where should a concave mirror of radius of curvature 20 cm be placed so that the final image is formed at the position of the object itself? **Ans**: V= 30cm, real separation = 10cm.

Q9. (a) Give two reasons to explain why reflecting telescopes are preferred over refracting type.

(b) Use mirror equation to show that convex mirror always produces a virtual image independent of the location of the object.

Q10. Derive expression for refractive index of material of prism when refraction of light takes place through a prism of angle A.

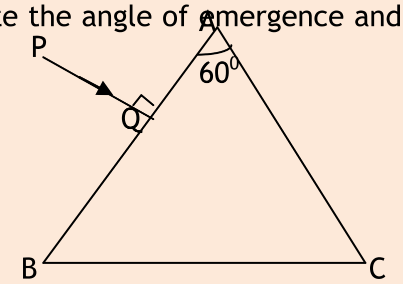
Q11. A thin converging lens made of glass of refractive index 1.5 acts as a concave lens of focal length 50 cm , when immersed in a liquid of refractive index 15/8.Calculate the focal length of converging lens in air. **Ans: 20cm**

Q12. (a) Draw a labelled ray diagram showing the formation of a final image by a compound microscope at least distance of distinct vision.

(b)The total magnification produced by a compound microscope is 20. The magnification produced by the eye piece is 5. The microscope is focussed on a certain object. The distance between the objective and eyepiece is observed to be14 cm. If least distance of distinct vision is 20 cm, calculate the focal length of the objective and the eye piece.

Ans: f_e = 5cm, f_o = 2cm

Q13. A ray PQ is incident normally on the face AB of a triangular prism of refracting angle of 60^0, made of a transparent material of refractive index $2 / \sqrt{3}$, as shown in the figure. Trace the path of the ray as it passes through the prism. Also calculate the angle of emergence and angle of deviation.



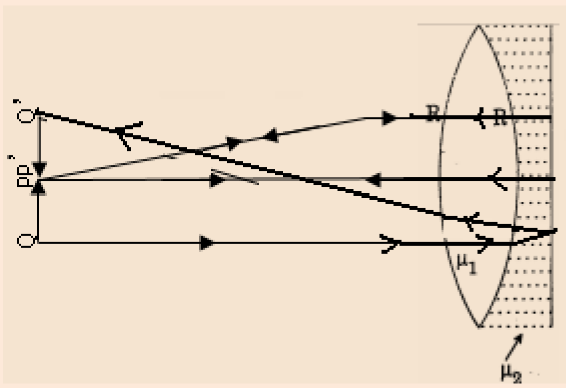
Q14.A card sheet is divided into squares each of 1mm^2 is being viewed at a distance of 9cm through a magnifying glass(a converging lens of focal length 10cm) held close to the eye.

(a) What is the magnification produced by the lens? How much is the area of each square in the virtual image?

(b) What is the angular magnification (magnifying power) of the lens?

(c) Is the magnification in (a) equal to the magnifying power?

Q15. An equiconvex lens (of refractive index μ_1= 1.5) in contact with a liquid layer on the top of a plane mirror as shown in figure. A small needle its tip on the principal axis is moved along the axis until its inverted image is found at the position of the needle. The distance of the needle from the lens is measured to be 45cm. The liquid is removed and the experiment is repeated. The new distance is measured to 30cm. What is refractive index (μ_2) of the liquid?



Q16.A biconvex lens of glass of refractive index 1·5 having focal length 20 cm is placed in a medium of refractive index 1·65. Find its focal length. What should be the value of the refractive index of the medium in which the lens should be placed so that it acts as a plane sheet of glass?

Ans: f = 14.3cm, for plane sheet μ = 1.5

Q17.Two convex lenses, of equal focal length, but of aperture A_1 and A_2 ($A_1 > A_2$), are used as the objective lenses in two astronomical telescopes having identical eyepiece. Compare the ratio of their (i) Resolving power (ii) Magnifying power (Normal adjustment) (iii) intensity of images formed by them. Which of the two telescopes should be preferred? Why?

Q18. A parallel beam of monochromatic light falls normally on a narrow slit of width ‘a’ to produce a diffraction pattern on the screen placed parallel to the plane of the slit. Use Huygens’ Principle to explain that

(i) the central bright maxima is twice as wide as the other maxima.

(ii) the intensity falls as we move to successive maxima away from the centre on either side.

Q19. Use Huygens' Principle to show how a plane wavefront propagates from a denser to rarer medium. Hence verify Snell's law of refraction.

Q20. Use Huygens' Principle to show how a plane wavefront reflects from a plane mirror. Hence verify the laws of reflection.

Q21. (a) Write the necessary conditions to obtain sustained interference fringes.

(b) In Young's double slit experiment, plot a graph showing the variation of fringe width versus the distance of the screen from the plane of the slits keeping other parameters same. What information can one obtain from the slope of the curve?

(c) What is the effect on the fringe width if the distance between the slits is reduced keeping other parameters same?

Q22. Compare and explain three distinguishing features observed in Young's double slit interference pattern with those seen for a coherently illuminated single slit producing diffraction pattern.

Q23.Write the expression for the resultant intensity at a point due to the superposition of two monochromatic waves $y_1 = a \cos \omega t$, $y_2 = a \cos (\omega t + \phi)$

where ϕ is the phase difference between the two waves and a and ω denote the amplitude and angular frequency.

In Young's double slit experiment using monochromatic light of wavelengthλ, the intensity of light at a point on the screen where path difference is λ is k units. Find the intensity at a point on the screen where path difference is $\lambda/4$.

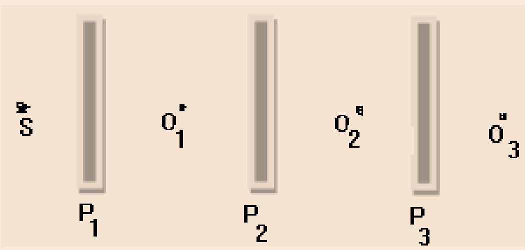
Q24. Answer the following:

(a) In what way is diffraction from each slit related to the interference pattern in a double slit experiment?

(b) When a tiny circular obstacle is placed in the path of light from a distant source, a bright spot is seen at the centre of the shadow of the obstacle. Explain, why.

(c) How does the resolving power of a microscope depend on (i) the wavelength of the light used and (ii) the medium used between the object and the objective lens?

Q25. Three identical Polaroid sheets P_1, P_2 and P_3 are oriented so that the pass axis of P_2 and P_3 are inclined at angles of 60^0 and 90^0, respectively with respect to the pass axis of P_1. A monochromatic source S is , of intensity I_0 , is kept in front of the Polaroid sheet P_1. Find the intensity of this light, as observes O_1, O_2 and O_3 , positioned as shown below. Ans: $I_1 = I_0/2$, $I_2 = I_0/8$, $I_3 = 3\ I_0/32$.



Q26. (a) Unpolarised light of intensity I_0 passes through two Polaroids P_1 and P_2 such that pass axis of P_2 makes an angle θ with the pass axis of P_1. Plot a graph showing the variation of intensity of light transmitted through P_2 as the angle θ varies from zero to 180^0.

(b) A third Polaroid P_3 is placed between P_1 and P_2 with pass axis of P_3 making an angle β with that of P_1. If I_1, I_2 and I_3 represent the intensities of light transmitted by P_1, P_2 and P_3, determine the values of angle θ and β for which $I_1 = I_2 = I_3$.

Ans: $\theta = 0^0$ or π therefore $\beta = 0^0$ or π

Q27. State clearly how an unpolarised light gets linearly polarised when passed through a Polaroid.

(i) Unpolarised light of intensity I_0 is incident on a Polaroid P_1 which is kept near another Polaroid P_2 whose pass axis is parallel to that of P_1. How will the intensities of light, I_1 and I_2, transmitted by the Polaroids P_1 and P_2 respectively, change on rotating P_1 without disturbing P_2?

(ii) Write the relation between the intensities I_1 and I_2.

Q28. (a) The light from a clear blue portion of the sky shows a rise and fall of intensity when viewed through a Polaroid which is rotated. Describe, with the help of a suitable diagram, the basic phenomenon/process which occurs to explain this observation.

(b) Show how light reflected from a transparent medium gets polarised. Hence deduce Brewster's law.

Q29. Discuss briefly, with the help of a suitable diagram, what happens when unpolarised light passes through two identical Polaroids where the orientation of one Polaroid is fixed and the second is rotated with respect to the one. Draw a graph showing the dependence of intensity of transmitted light on the angle between the polariser and analyser. Explain clearly how one understands this variation using Malus' law.

Q30. What does a Polaroid consist of? Show, using a simple Polaroid, that light waves are transverse in nature. Intensity of light coming out of a Polaroid does not change irrespective of the orientation of the pass axis of the Polaroid. Explain why.

Q31. In Young's double slit experiment, the two slits are separated by a distance of 1·5 mm and the screen is placed 1 m away from the plane of the slits. A beam of light consisting of two wavelengths 650 nm and 520 nm is used to obtain interference fringes. Find

(a) the distance of the third bright fringe for λ = 520 nm on the screen from the central maximum.

(b) the least distance from the central maximum where the bright fringes due to both the wavelengths coincide.

Q32. (a) Assume that the light of wavelength 6000 Å is coming from a star. Find the limit of resolution of a telescope whose objective has a diameter of 250 cm.

(b) Two slits are made 1 mm apart and the screen is placed 1 m away. What should be the width of each slit to obtain 10 maxima of the double slit pattern within the central maximum of the single slit pattern?

Q33. (i)Distinguish between unpolarised and linearly polarised light.

(ii) What does a Polaroid consist of? How does it produce a linearly polarised light?

(iii) Explain briefly how sunlight is polarised by scattering through atmospheric particles.

Q34.Two wavelengths of sodium light of 590 nm and 596 nm are used in turn to study the diffraction taking place at a single slit of aperture 2×10^{-6} m. The distance between the slit and the screen is1·5 m. Calculate the separation between the positions of first maxima of the diffraction pattern obtained in the two cases. **Ans** 0.00675 m

Hint: position of first maxima = $D\theta = 3D\lambda/2d$

Q35.In Young's double slit experiment, the two slits 0.15 mm apart are illuminated by monochromatic light of wavelength 450 nm. The screen is 1.0 m away from the slits.

(a) Find the distance of the second (i) bright fringe (ii) dark fringe from the central maximum

(b) How will the fringe pattern change if the screen is moved away from the slits?

Hint: position of bright fringe: $x_n = nD\lambda/d$, Dark Fringe = $(2n-1)\, D\lambda/2d$

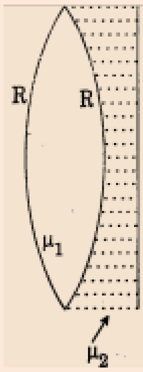
The width of fringes will increase.

Q36.Light from a monochromatic source falls on a single slit of width 0.2 mm to produce a diffraction pattern on a screen kept at a distance of 1 m from the plane of the slit. If the total linear width of the principal maxima is 4.8 mm, calculate the wavelength $\lambda$of the light used. Using this value ofλ, calculate the linear width of the second dark fringe.

Hint: Linear width = D x angular width = $D\theta = D\lambda/d$ =2.4mm

Q37. Answer the following questions:

(a) In a double slit experiment using light of wavelength 600 nm, the angular width of the fringe formed on a distant screen is 0.1°. Find the spacing between the two slits.



(b) Light of wavelength 5000 Å propagating in air gets partly reflected from the surface of water. How will the wavelengths and frequencies of the reflected and refracted light be affected? **Ans:** 0.343×10^{-3}m, 6×10^{14} Hz.

Frequency of reflected and refracted light is 6×10^{14}Hz

Wavelength of the refracted light is 0.375×10^{-6} m

Q38.(a) Calculate the distance of an object of height h from a concave mirror of radius of curvature 20 cm, so as to obtain a real image of magnification 2. Find the location of image also. **CBSE-2016-D**

(b) Using mirror formula, explain why does a convex mirror always produce a virtual image.

Q39. Draw a schematic ray diagram of reflecting telescope showing how rays coming from a distant object are received at the eye-piece. Write its two important advantages over a refracting telescope.**CBSE-2016-D**

Q40. (i) State law of Malus.

(ii)Draw a graph by showing the variation of intensity (I) of polarised light transmitted by an analyser with angle (Θ) between polariser and analyser.

(iii)What is the value of refractive index of a medium of polarising angle 60^0 .**CBSE-2016(C)**

Q41.Define the term wave front. State Huygen's Principle.

Consider a plane wave front incident on a thin convex lens. Draw a proper diagram to show how the incident wavefront traverses through the lens and after refraction focsses on the focal point of the lens, giving the shape of emergent wave front.**CBSE-2016(C)**

Q42. Explain the following, giving reasons:

(a)When monochromatic light incident on a surface separating two media, the refelected and refracted light both have the same frequency as the incident frequency.

(b)When light travels from a rarer to denser medium, the speed decreases. Does this decrease in speed imply a reduction in the energy carried by the wave?

(c)In the wave picture of light, intensity of light is determined by the square of the amplitude of the wave. What determine the intensity in the photon picture of light?**CBSE-2016(C)**

Q43.(i)What is total internal reflection? Under what conditions does it occur?

(ii)Find a relation between critical angle and refractive index.

(iii)Name one phenomenon which is based on total internal reflection.**CBSE-2016(E)**

Q44.(a) In Young's double slit experiment, two slits are 1mm apart and the screen is placed 1m away from the slits. Calculate the fringe width when light of wavelength 500nm is used.

(b)What should be width of each slit in order to obtain 10mxima of the double slits pattern within the central maximum of the single slit pattern?**CBSE-2016(E)**

Q45.(a)Draw a schematic diagram of a reflecting telescope.

(b)State the advantages of reflecting telescope over refracting telescope.**CBSE-2016(E)**

Q46. (i)Draw a schematic ray diagram of a compound microscope when image is formed at distance of distinct vision.

(ii)Write the expression for resolving power of a compound microscope. How can the resolving power of a microscope be increased? **CBSE-2016(E)**

Q47. Consider a two slit interference arrangement (shown in figure) such that the distance of screen from the slits is half the distance between two slits. Obtain the value of D in terms of λ such that the first minima on the screen falls at a distance (D) from the centre. **CBSE SQP-2016**

OP = x
CO= D
$CS_1 = CS_2 = D$

Q50.A compound microscope consists of an objective of focal length 1cm and eye piece lens of focal length 5cm separated by 12.2cm.(a) At what distance from the objective should an object be placed so that the final image is formed at least distance of distinct vision? (b) Calculate angular magnification in this case. **CBSE SQP-2016**

LONG ANSWER TYPE QUESTIONS: 5-MARKS

Q1. Draw a ray diagram to show the passage of a ray of light through a triangular prism. Use this diagram to obtain the relation for the refractive index of the material of the prism in terms of the angle of minimum deviation and the angle of the prism. Plot the nature of the graph for the angle of deviation versus the angle of incidence in a prism.

Q2. A biconvex lens with its two faces of equal radius of curvature is made of transparent medium (μ_1). It is kept in contact with medium of refractive index (μ_2) as shown in figure.

(a) Obtain the equivalent focal length of combination.

(b) Obtain the condition when this combination acts as diverging lens.

(c) Draw the diagram for the case $\mu_1 > (\mu_2 + 1)/2$, when object is kept far away from the lens. Point out the nature of image formed by the system.

Q3. (i) A thin lens, having two surfaces of radii of curvature R_1 and R_2, made of a material of refractive index μ_2 , is kept in a medium of refractive index μ_1. Derive the lens Maker's formula for this setup.

(ii) A convex lens is placed over a plane mirror. A pin is positioned so there is no parallax between the pin and its image formed by this lens-mirror combination. How can this observation be used to find the focal length of the convex lens? Give appropriate reason in support of your answer.

Q4. (a) A giant refracting telescope has an objective lens of focal length 15 m. If an eye piece of focal length 1.0 cm is used, what is the angular magnification of the telescope?

(b) If this telescope is used to view the moon, what is the diameter of the image the moon formed by the objective lens? The diameter of the moon is 3.48 × 106 m and the radius of lunar orbit is 3.8×10^8 m. **Ans**: 1500, 13.73 cm

Q5. (a) A point-object is placed on the principal axis of a convex spherical surface of radius of curvature R, which separates the two media of refractive indices n_1 and n_2 ($n_2 > n_1$). Draw the ray diagram and deduce the relation between the distances of the object (u), distance of the image (v) and the radius of curvature (R) for refraction to take place at the convex spherical surface from rarer to denser medium.

(b) Use the above relation to obtain the condition on the position of the object and the radius of curvature in terms of n_1 and n_2 when the real image is formed.

Q6. (a) Draw a labelled ray diagram showing the formation of image by a compound microscope in normal adjustment. Derive the expression for its magnifying power.

(b) How does the resolving power of a microscope change when

(i) the diameter of the objective lens is decreased,

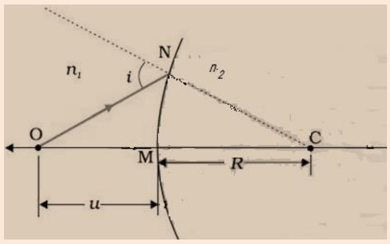
(ii) the wavelength of the incident light is increased ?

Justify your answer in each case.

Q7. (a) Draw a labelled ray diagram of an astronomical telescope to show the image formation of a distant object. Write the main considerations required in selecting the objective and eyepiece lenses in order to have large magnifying power and high resolution of the telescope.

(b) A compound microscope has an objective of focal length 1.25 cm and eyepiece of focal length 5 cm. A small object is kept at 2.5 cm from the objective. If the final image formed is at infinity, find the distance between the objective and the eyepiece.

Q8 (a) A point object 'O' is kept in a medium of refractive index n_1 in front of a convex spherical surface of radius of curvature R which separates the second medium of refractive index n_2 from the first one, as shown in the figure.



Draw the ray diagram showing the image formation and deduce the relationship between the object distance and the image distance in terms of n_1, n_2 and R.

(b) When the image formed above acts as a virtual object for a concave spherical surface separating the medium n_2 from n_1 ($n_2 > n_1$), draw this ray diagram and write the similar relation (similar to (a)). Hence obtain the expression for the lens maker's formula.

Q9. (a) A concave mirror produces a real and magnified image of an object kept in front of it. Draw a ray diagram to show the image formation and use it to derive the mirror equation.

(b) A beam of light converges at a point P. Now a lens is placed in the path of the convergent beam 12 cm from P. At what point does the beam converge if the lens is

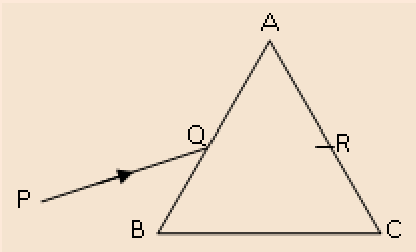
(i) a convex lens of focal length 20 cm,

(ii) a concave lens of focal length 16 cm ?

Q10. (a) State the essential conditions for the phenomenon of total internal reflection to take place.

(b) Draw a ray diagram to show how a right isosceles prism made of crown glass can be used to obtain the inverted image.

(c) Explain briefly with the help of a necessary diagram, how the phenomenon of total internal reflection is used in optical fibres. Illustrate giving an example how optical fibres can be employed for transmission of optical signals.



Q11. (a)Two thin convex lenses L_1 and L_2 of focal lengths f_1 and f_2 respectively, are placed coaxially in contact. An object is placed at a point beyond the focus of lens L_1. Draw a ray diagram to show the image formation by the combination and hence derive the expression for the focal length of the combined system.

(b) A ray PQ incident on the face AB of a prism ABC, as shown in the figure, emerges from the face AC such that AQ = AR.

Draw the ray diagram showing the passage of the ray through the prism. If the angle of the prism is 60^0 and refractive index of the material of the prism is $\sqrt{3}$, determine the values of angle of incidence and angle of deviation.

Q12. (a) State two main considerations taken into account while choosing the objective in optical telescopes with large diameters.

(b) Draw a ray diagram for the formation of image by a reflecting type telescope. What is its magnifying power?

(c) What are the advantages of a reflecting type telescope over the refracting type?

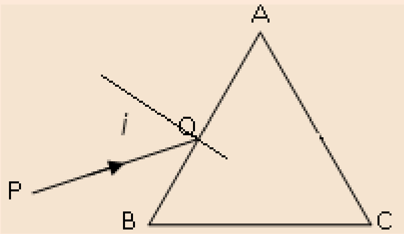
Q13. (a) Draw a ray diagram for the formation of image by a compound microscope in normal adjustment.

(b) Obtain the expression for the minimum separation between the two points seen as distinct in a microscope. What is its relation with the resolving power? Mention the factors by which the resolving power of a microscope can be increased.

Q14. (a) A ray 'PQ' of light is incident on the face AB of a glass prism ABC (as shown in the figure) and emerges out of the face AC. Trace the path of the ray. Show that

$\angle i + \angle e = \angle A + \angle \delta$

where δ and e denote the angle of deviation and angle of emergence respectively.



Plot a graph showing the variation of the angle of deviation as a function of angle of incidence. State the condition under which $\angle\delta$ is minimum.

(b) Find out the relation between the refractive index (μ) of the glass prism and $\angle$ A for the case when the angle of prism (A) is equal to the angle of minimum deviation (δ_m). Hence obtain the value of the refractive index for angle of prism A = 60^0.

Q15. (a) Draw a labelled ray diagram showing the image formation of a distant object by a refracting telescope. Deduce the expression for its magnifying power when the final image is formed at infinity.

(b) The sum of focal lengths of the two lenses of a refracting telescope is 105 cm. The focal length of one lens is 20 times that of the other. Determine the total magnification of the telescope when the final image is formed at infinity. **Ans: 20**

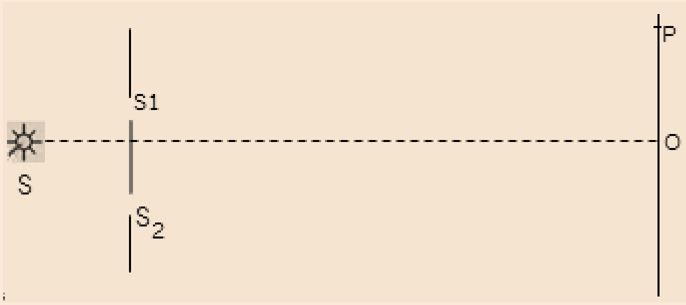
Q16. Draw a ray diagram showing the formation of the image by a point object on the principal axis of a spherical convex surface separating two media of refractive indices n_1 and n_2, when a point source is kept in rarer medium of refractive index n_1. Derive the relation between object and image distance in terms of refractive index of the medium and radius of curvature of the surface. Hence obtain the expression for lens-maker's formula in the case of thin convex lens.

Q17. (a) Define a wavefront. Given the shape of a wavefront as a plane wave at time t = 0, show using Huygens' construction, (i) how the envelopes of secondary wavelets produce the plane wave at a later time t and (ii) how the emergent wavefront becomes spherical and converges to the focus after passing through a convex lens ?

(b) Verify using Huygens' Principle, Snell's law of refraction of a plane wave propagating from a denser to a rarer medium.

Q18. The figure, drawn here, shows a modified Young's double slit experiment setup.

If $SS_2 - SS_1 = \lambda/4$



(i) State the condition for constructive and destructive interference.

(ii) Obtain an expression for the fringe width.

(iii) Locate the position of central fringe.

Q19. (a) Use Huygens ' Principle to show the propagation of a plane wavefront from a denser medium to a rarer medium . Hence find the ratio of speeds of wavefronts in two media.

(b)(i) Why does an unpolarised light incident on a Polaroid get linearly polarised?

(ii) Derive the expression of Brewster's law when unpolarised light passing from a rarer to denser medium get polarised on reflection at the interface.

Q20. (a)Using Huygens' constructions of secondary wavelets explain how a diffraction pattern is obtained on a screen due to a narrow slit on which a monochromatic beam of light is incident normally.

(b) Show that the angular width of the first diffraction fringe is half that of the central fringe.

(c) Explain why the maxima at $\theta = \left(n + \frac{1}{2}\right)\frac{\lambda}{a}$ become weaker and weaker with increasing *n*.

Q21. (a) Define a wavefront.

(b) Using Huygens' Principle, draw the diagrams to show the nature of the wavefronts when an incident plane wave front gets

(i) reflected from a concave mirror, (ii) refracted from a convex lens.

(c) Draw a diagram showing the propagation of a plane wavefront from denser to a rarer medium and verify Snell's law of refraction.

Q22. (a) In Young's double slit experiment, deduce the conditions for obtaining constructive and destructive interference fringes. Hence deduce the expression for the fringe width.

(b) Show that the fringe pattern on the screen is actually a superposition of single slit diffraction from each slit.

(c) What should be the width of each slit to obtain 10 maxima of the double slit pattern within the central maximum of the single slit pattern, for green light of wavelength 500 nm, if the separation between two slits is 1 mm?

Q23. (a) Draw a suitable diagram to demonstrate that given the shape of a wavefront at t = 0, its shape at a later time t1 can be obtained using Huygens' geometrical construction.

(b) Consider the propagation of a plane wavefront from a rarer to a denser medium and verify

(c) Snell's law of refraction. Show that when a wave gets refracted into a denser medium, the wavelength and speed of propagation decreases but the frequency remains the same.

Q24 (a) How does one demonstrate, using a suitable diagram, that unpolarised light when passed through a Polaroid gets polarised?

(b) A beam of unpolarised light is incident on a glass-air interface. Show, using a suitable ray diagram, that light reflected from the interface is totally polarised, when $\mu = \tan i_B$ is, where μ is the refractive index of glass with respect to air and i_B, is the Brewster's angle.

Q25. (a) Distinguish between linearly polarised and unpolarised light.

(b) Show that the light waves are transverse in nature.

(c) Why does light from a clear blue portion of the sky show a rise and fall of intensity when viewed through a Polaroid which is rotated?

Explain by drawing the necessary diagram.

Q26. (a) Write three characteristic features to distinguish between the interference fringes in Young's double slit experiment and the diffraction pattern obtained due to a narrow single slit.

(b) A parallel beam of light of wavelength 500 nm falls on a narrow slit and the resulting diffraction pattern is observed on a screen 1 m away. It is observed that the first minimum is a distance of 2.5 mm away from the centre. Find the width of the slit. **Ans:** 2.4×10^{-4}m

Q27. (i)In Young's double slit experiment, deduce the condition for (a) constructive, and

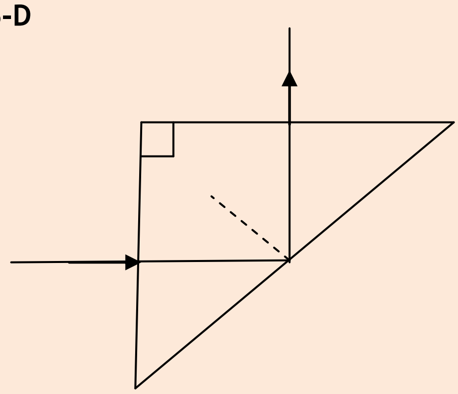
(b) destructive interference at a point on the screen. Draw a graph showing variation of intensity in the interference pattern against position 'x' on the screen.

(ii) Compare the interference pattern observed in Young's double slit experiment with single slit diffraction pattern, pointing out three distinguishing features. **CBSE-2016-D**

Q28.(i) Plot a graph to show variation of the angle of deviation as a function of angle of incidence for light passing through a prism. Derive an expression for refractive index of the prism in terms of angle of minimum deviation and angle of prism.

(ii) What is dispersion of light? What is its cause?

(iii) A ray of light incident normally on one face of a right isosceles prism is totally reflected as shown in fig. What must be the minimum value of refractive index of glass? Give relevant calculations. **CBSE-2016-D**



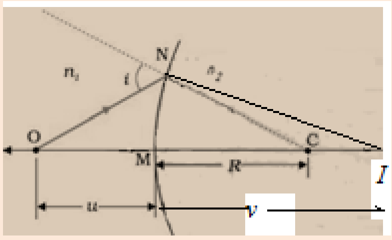
Q29.(a)Explain why the intensity of light coming out of a polaroid does not change irrespective of orientation of pass axis of the polaroid.

(b)State, using a proper diagram, the condition when unpolarized light incident on the boundary between two transparent media produces polarized light. Explain briefly.

Hence show that the angle of incident'i_β is related to the refractive index μ by the relation $\mu = \tan i_\beta$.**CBSE-2016(E)**

Q30.(a)A point O on the principle axis of a spherical surface of radius R separating two media of refractive index n_1 and n_2 forms an image I as shown in figure.

Prove that



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

(b)Use this expression to derive lens maker's formula. Draw the necessary diagram.

(c)A convex lens is placed over plane mirror. A pin is now positioned so that there is no parallax between the pin and its image formed by this lens-mirror combination. How will you use this observation to find focal length of the lens? Explain briefly. **CBSE-2016(E)**

Q30.(i) Derive the mathematical relation between refractive indices n_1 and n_2 of two radii and radius of curvature R for refraction at convex spherical surface. Consider the object to be a point object since lying on the principal axis in rarer medium of refractive index n_1 and real image formed in the denser medium of refractive index n_2. Hence, derive lens maker's formula.

(ii)Light from source in air on a convex spherical glass surface of refractive index 1.5 and radius of curvature 20cm. The distance of light source from the glass surface is 100cm. At what position is the image formed? **CBSE-2016(C)**

Q31 (a) Draw the labelled ray diagram to obtain the real image formed by an astronomical telescope in normal adjustment position. Define its magnifying power.

(b)You are given three lenses of power 0.5D, 4D and 10D to design a telescope.

(i)Which lenses should he used as objective and eyepiece? Justify your answer.

(ii)Why is the aperture of the objective preferred to be large? **CBSE-2016(C)**

VALUE BASED QUESTIONS: 4 MARKS

Q1.It was very cold morning. Anand was going to appear in a competitive exam with his father. The examination centre was about 20km away from his home. His father was driving the car and the road was not clearly visible due to dense fog. When his father switched on yellow light of his car, now he able to drive the car quite smoothly. Anand was watching all this carefully. Next day, he discussed about the incidence with his physics teacher that he observed yesterday. He was able to know the proper reason of invisibility.

Give the answers of following questions.

(a) Why do we not able to see through the fog in normal light? Define the phenomenon behind it.

(b) Give an example based on similar phenomenon from your daily life.

(c) Write one value shown by Anand and his father each in above case.

Q2. When Puja, a student of 10^{th} class, watched her mother washing clothes in the open, she observed coloured soap bubbles and was curious to know why the soap bubbles appear coloured. In the evening when her father, an engineer by profession, came home, she asked him this question. Her father explained to her the basic phenomenon of physics due to which the soap bubbles appear coloured

(a) What according to you are the values displayed by Puja and her father?

(b) State the phenomenon of light involved in the formation of coloured soap bubbles.

(c) Why does colour pattern in soap bubble keep on changing?

(d) Which phenomenon is basically involved in rainbow having brilliant colours?

UNIT- VII: Dual Nature of Matter and Radiation:

VERY SHORT ANSWER TYPE QUESTIONS: 1 –MARK

Q1. Define work function of a photosensitive surface and write down its unit.

Q2. What is matter wave?

Q3. Plot the graph showing the variation of de-Broglie wavelength (λ) associated with an electron with accelerating voltage (V)

Q4. Ultraviolet light is incident on two photosensitive materials having work function ϕ_1 and ϕ_2 ($\phi_1 > \phi_2$). In which of the case will K.E. of emitted electrons be greater? Why?

Ans: KE will be more for the surface having low work function for same incident energy.

Q5. Two beams, one of red light and another of blue light, of same intensity are incident on a metallic surface to emit photoelectrons. Which one of two beams emits electrons of greater kinetic energy? **Ans:** Blue light

Q6. What is de-Broglie wavelength associated with an electron, accelerated through a potential difference of 100V? **Ans:** 1.227A^0

Q7. What is significance of Davison-Germer experiment? **Ans:** To establish wave nature.

Q8. Show graphically how the stopping potential for a given photosensitive surface varies with the frequency of incident radiations.

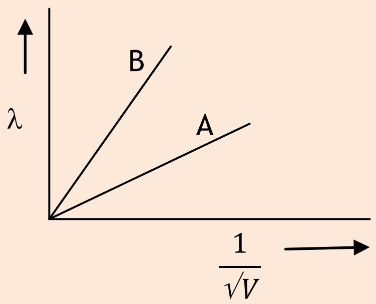
Q9. What is effect of decrease in wavelength of incident light on the velocity of photoelectrons?

Ans: velocity increases as K.E. α $1/\lambda$.

Q10. The blue light is made to fall on a photosensitive surface and just able to initiate the emission of photoelectrons. What will happen if this surface is illuminated by red light of same intensity? **Ans;** No emission of photoelectrons possible.

Q11. On what factor does the stopping potential of a photosensitive surface depend?

Q12. Two lines A and B shown in the graph plot the de- Broglie wavelength (λ) as a function of $\frac{1}{\sqrt{V}}$ (Where V is stopping potential) for two particles having same charge. Which of the two represents the particle of heavier mass?. **Ans: A**



Q13. On what factor the magnitude of saturation photoelectric current depend?

Ans: Intensity of radiation

Q14. When green light is incident on a certain metal surface, electrons are emitted, but no electrons are emitted by yellow light. What will happen when red light is incident on the same metal surface? **Ans:** No emission

Q15. When the radiations of fix intensity are made to fall on a photosensitive surface, why does photo electric current increases with anode potential and get saturated?

Q16. Why does the stopping potential increase with increase of frequency of incident radiation above threshold frequency?

Q17. Why does photoelectric current increase with increases of intensity of incident radiation?

Q18. Every metal has a definite work function. Why do all photoelectrons not come out with same energy if incident radiation is monochromatic?

Q19. The number of ejected photoelectrons increases with increase in intensity of light but not with increase of frequency. Why?

SHORT ANSWER TYPE QUESTIONS: 2-MARKS

Q1.A monochromatic source emitting light of wave length 600nm, has a power output of 66W. Calculate the number of photons emitted by the source in 2min. **Ans:** 2.4×10^{22} photons.

Hint: No. of photons emitted per second n = Power (P) / Energy, where $E = hc/\lambda$

Q2. A proton and an α-particle have the same de-Broglie wavelength. Determine the ratio of (i) their accelerating potentials (b) their speeds. **Ans**: 8:1 (ii) 4:1

Q3.The wavelength of light from the spectral emission line of sodium is 589 nm. Find the kinetic energy of the electron for which it would have the same de Broglie wavelength. **Ans**: $6.95\text{x}10^{-25}$J

Q4. Deuterons and α-particles are accelerated through the same potential. Find the ratio of the associated de Broglie wavelengths of the two. **Ans:** 2:1

Q5.How does one explain, using de Broglie hypothesis, Bohr's second postulate of quantization of orbital angular momentum?

Q6. The equivalent wavelength of a moving electron has the same value as that of a photon of energy 6×10^{-17} J. Calculate the momentum of the electron. **Ans:** $2\text{x}10^{-25}$kgm/s

Q7. Write Einstein's photoelectric equation in terms of the stopping potential (V_0) and the frequency of the incident radiation (ν) for a given photosensitive surface. Draw a suitable graph to show how one can get the information about (i) the work function of the material and (ii) value of Planck's constant from this graph.

Q8. An electron and a photon each have a wavelength 3.315 nm. Find the ratio of the kinetic energy (K) of the electron to the energy of the photon. **Ans**: $3.66\text{x}10^{-4}$

Q9. An electron is revolving around the nucleus with a constant speed of 2.5×10^{8} m/s. Find the de-Broglie wavelength associated with it. **Ans**: $2.9\text{x}10^{-12}$m

Q10. (i) Define the term 'threshold frequency' as used in photoelectric effect.

(ii) Plot a graph showing the variation of photoelectric current as a function of anode potential for two light beams having the same frequency but different intensities I_1 and I_2 ($I_2 > I_1$).

Q11. A deuteron and an alpha particle are accelerated with the same accelerating potential. Which one of the two has

(i) greater value of de-Broglie wavelength, associated with it and Ans**:** Deutron

(ii) less kinetic energy ? Explain. **Ans:** α- particle

Q12. (i) Monochromatic light of frequency 5.0×10^{14} Hz is produced by a laser. The power emitted is 3.0×10^{-3} W. Estimate the number of photons emitted per second on an average by the source.

Hint: Power (P) = nhν

$$n = P / h\nu = 9.1 \times 10^{15} \text{ photons/s}$$

(ii) Draw a plot showing the variation of photoelectric current versus the intensity of incident radiation on a given photosensitive surface.

Q13. Two monochromatic radiations of frequencies $v1$ and $v2$ ($v1 > v2$) and having the same intensity are, in turn, incident on a photosensitive surface to cause photoelectric emission. Explain, giving reason, in which case (i) more number of electrons will be emitted and (ii) maximum kinetic energy of the emitted photoelectrons will be more.

Q14. X-rays fall on a photosensitive surface to cause photoelectric emission. Assuming that the work function of the surface can be neglected, find the relation between the de-Broglie wavelength (λ) of the electrons emitted to the energy (E) of the incident photons. Draw the nature of the graph for λ as a function of E.

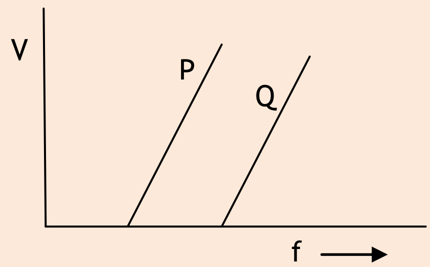
Q15. State the laws of photoelectric emission.

Q16. The maximum velocity of electrons emitted from a metal surface of negligible work function is v, when frequency of light falling on it is 'f'. What will be the maximum velocity when the incident light frequency 4f? Ans: $V_{max} = 2v$

Q17. An alpha particle and a proton are accelerated from rest through same accelerating potential V. Find the ratio of de-Broglie wavelength associated with them.

Ans: $\lambda_\alpha : \lambda_p$ 1: $2\sqrt{2}$.

Q18. The graphs between the stopping potential 'V' and frequency 'f' of incident radiation on two different metal surfaces P and Q are shown in figure.



(a) Which metal, out of P and Q, has the greater value of work function?

(b) What does the slope of lines depict?

Q19. Determine the frequency and wavelength of 2keV photon. **Ans**: 4.83×10^{17}, $6.21 A^0$

Q20. Plot a graph showing variation of de-Broglie wavelength λ versus $\frac{1}{\sqrt{V}}$, where V is accelerating potential for two particles A and B carrying same charge but of masses m1, m2 (m1 > m2). Which one of the two represents a particle of smaller mass and why ?

Q21. Calculate the de-Broglie wavelength of the electron orbiting in n =2 state of hydrogen atom. **CBSE-2016(C)**

SHORT ANSWER TYPE QUESTIONS: 3-MARKS

Q1. What reasoning led de-Broglie to put the concept of matter waves? The wavelength λ, of a photon, and de-Broglie wavelength associated with a particle of mass 'm', has the same value, say λ. Show that the energy of photon is 2λ mc/h time the KE of the particle.

Q2. (a) Write Einstein's photoelectric equation and mention which important features in photoelectric effect can be explained with the help of this equation.

(b) The maximum kinetic energy of the photoelectrons gets doubled when the wavelength of light incident on the surface changes from λ_1 to λ_2. Derive the expressions for the threshold wavelength λ_0 and work function for the metal surface. **Ans:** $\lambda_0 = \frac{\lambda_1\lambda_2}{2\lambda_2-\lambda_1}$

Q3. Define the terms 'stopping potential' and 'threshold frequency' in relation to photoelectric effect. How does one determine these physical quantities using Einstein's equation?

Q4. Define the term 'intensity of radiation' in photon picture of light.

Ultraviolet light of wavelength 2270 Å from 100 W mercury source irradiates a photo cell made of a given metal. If the stopping potential is – 1·3 V, estimate the work function of the metal. How would the photo cell respond to a high intensity (~ 105 Wm^{-2}) red light of wavelength 6300A^0 produced by a laser?

Q5. Set up Einstein's photoelectric equation using the photon picture of electromagnetic radiation. Explain briefly how this equation accounts for all the observations in the photoelectric effect.

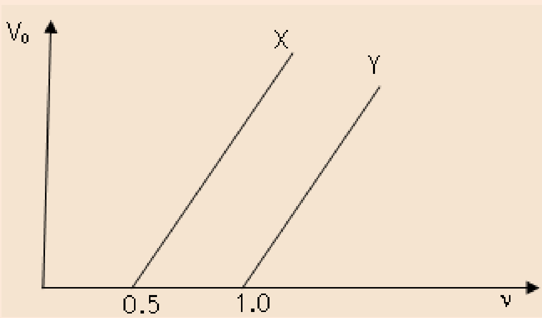
Q6. Light of intensity 'I' and frequency 'v' is incident on a photosensitive surface and causes photoelectric emission. What will be the effect on anode current when (i) the intensity of light is gradually increased, (ii) the frequency of incident radiation is increased, and (iii) the anode potential is increased? In each case, all other factors remain the same. Explain, giving justification in each case.

Q7. An electromagnetic wave of wavelength λ is incident on a photosensitive surface of negligible work function. If the photoelectrons emitted from this surface have de-Broglie wavelength λ_1.

Prove that $\lambda = \left(\frac{2mc}{h}\right)\lambda_1{}^2$

Q8. (a) Monochromatic light of frequency 6 x 10^{14} Hz is produced by a laser. The power emitted is 2.5 x 10^{-3} W. How many photons per second on an average are emitted by the source?

(b) Figure shows variation of stopping potential (V_0) vs. frequency (ν) of incident radiation for two metals X and Y. Which metal will emit electrons of larger kinetic energy for same wavelength of incident radiation? Explain.

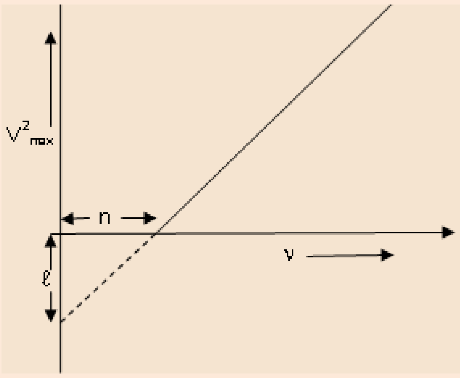


(c) If the distance between the light source and the metal P is doubled, how will the stopping potential change?

Q9. (a) Give a brief description of the basic elementary process involved in the photoelectric emission in Einstein's picture.

(b) When a photosensitive material is irradiated with the light of frequency *v*, the maximum speed of electrons is given by V_{max} . A plot of V^2_{max} is found to vary with frequency *v* as shown in the figure.

Use Einstein's photoelectric equation to find the expressions for (i) Planck's constant and (ii) work function of the given photosensitive material, in terms of the parameters ℓ, n and mass m of the electron.



Q10. (a) Define the term 'intensity of radiation' in terms of photon picture of light.

(b)Two monochromatic beams, one red and the other blue, have the same intensity. In which case (i) the number of photons per unit area per second is larger, (ii) the maximum kinetic energy of the photoelectrons is more? Justify your answer.

Q11. (a) Describe briefly three experimentally observed features in the phenomenon of photoelectric effect.

(b) Discuss briefly how wave theory of light cannot explain these features.

Q12. (a) Write the important properties of photons which are used to establish Einstein' photoelectric equation.

(b) Use this equation to explain the concept of (i) threshold frequency and (ii) stopping potential.

Q13. Write three basic properties of photons which are used to obtain Einstein's photoelectric equation. Use this equation to draw a plot of maximum kinetic energy of the electrons emitted versus the frequency of incident radiation.

Q14. In a plot of photoelectric current versus anode potential, how does;

(i)The saturation current varies with anode potential for incident radiations of different frequencies but same intensity?

(ii)The stopping potential varies for incident radiations of different intensities but same frequency?

(iii) Photoelectric current varies for different intensities but same frequency of radiations? Justify your answer in each case.

Q15. Radiations of frequency 10^{15} Hz are incident on two photosensitive surfaces A and B. Following observations are recorded:

Surface A: No photoemission takes place.

Surface B: Photoemission takes place but photo electrons have zero energy.

Explain the above observations on the basis of Einstein's photoelectric equation. How will the observation with surface B change when the wavelength of incident radiations is decreased?

Q16.If the frequency of the incident radiation on the cathode of a photocell is doubled, how will the following change. Justify your answer.

(i) Kinetic energy of photoelectrons

(ii)Photoelectric current

(iii)Stopping potential

Q17.The work function of metal is 2.14eV. When light of frequency $6x10^{14}$Hz is incident on the metal surface, photoemission of electrons occurs. What is the

(a) Maximum kinetic energy of emitted electron **Ans:** 0.34eV

(b)Stopping potential **Ans:** 0.34V

(c)Minimum speed of the emitted photoelectron. **Ans:** 347km/s

Q18. A material has work function of 1.5eV. Light of wavelength 310nm is incident on it. Find

(a)Kinetic energy of emitted photo-electron **Ans:** 2.5eV

(b)Threshold Wavelength **Ans:** 827nm

(c) Stopping Potential. **Ans:** 2.5V

Q19. Write three characteristic features in photoelectric effect which cannot be explained on the basis of wave theory of light but can be explained only using Einstein's equation.

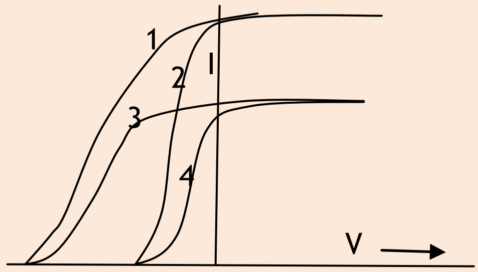
Q20.Sketch the graphs showing variation of stopping potential with frequency of incident radiations for two photosensitive materials A and B having threshold frequencies $\nu_A > \nu_{B.}$

(i)In which case is the stopping potential more and why?

(ii)Does slop of the graph depend on the nature of material used? Explain. **CBSE-2016(C)**

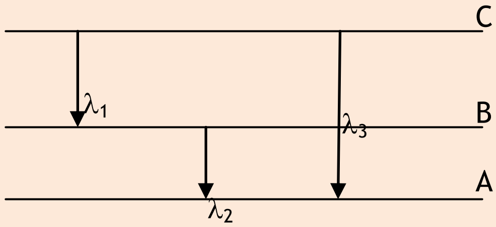
Q21. The given graph shows the variation of photoelectric current (I) with the applied voltage (V) for two different materials and for two different intensities of incident radiations. Identify and explain using Einstein's photoelectric equation the pair of curves that correspond to (i) different material but same intensity of incident radiation, (ii) different intensities but same material.

CBSE-2016(E)



Q22.(i) State Bohr's quantization condition for defining stationary orbits. How does de Broglie hypothesis explain the stationary orbits?

(ii) Find the relation between the three wavelengths λ_1, λ_2 and λ_3 from the energy level diagram shown below.**CBSE-2016-D**



Q18. Compare the photoelectric effect on the basis of the photon theory and wave theory of light and hence explain why the wave theory failed to explain it. **CBSE SQP-2016**

LONG ANSWER TYPE QUESTIONS: 5-MARKS

Q1. (a) Describe briefly how the Davisson-Germer experiment demonstrated the wave nature of electrons.

(b) An electron is accelerated from rest through a potential V. Obtain the expression for the de-Broglie wavelength associated with it.

(c) Light of wavelength $4500A^0$ falls on a metal surface whose work function is 1.8eV. Find (i) the energy of photoelectrons (ii) Stopping potential.

UNIT-VIII: Atoms & Nuclei:

VERY SHORT ANSWER TYPE QUESTIONS: 1 –MARK

Q1. Draw a plot showing variation of potential energy of a pair of nucleons as a function of their separation.

Q2.The short wavelength limit of the Lyman, Paschen and Balmer series of Hydrogen spectrum are denoted by λ_ℓ , λ_p and λ_B respectively. Arrange these wavelengths in increasing order.

Q3.What is ratio of radii of the orbits corresponding to first excited state and ground state?

Q4.What is significance of negative energy of electron in the orbit?

Q5.Name the series of hydrogen spectrum lying in ultraviolet region.

Q6. Name the series of hydrogen spectrum which has least wavelength.

Q7. Name the series of hydrogen spectrum lying in visible region of electromagnetic spectrum.

Q8.The radius of innermost electron orbit of a hydrogen atom is 5.3x 10^{-11}m . What is the radius of orbit in the second excited state? **Ans:** 4.77x 10^{-10} m

Q9. What do you mean by end point energy of β- particle?

Q10. Define activity of radioactive substance. Write down its S.I. unit.

Q11. Name the physical quantity whose S.I. unit is Becquerel (Bq)

Q12. Why is it difficult to detect the neutrino?

Q13. State the radioactive decay law.

Q14. Why is the energy distribution of beta rays continuous?

Q15. Show that the decay rate R of a sample is related to the number of radioactive nuclei N at the same instant by the expression R = Nλ.

Q16. The electron is present in its 4th excited state. How many maximum numbers of spectral lines can be obtained if it makes the transition from this state to lower states? **Ans**: 10

Q17. Name the series of hydrogen spectrum which has least wavelength and lies in infrared region.

Q18. Why nuclei have mass less than the sum of the masses of the individual nucleons in them?

Q19. A 12.5eV beam of electron is used to bombard gaseous hydrogen at room temperature.Upto which energy level the hydrogen atom would be excited? **Ans**: Second

SHORT ANSWER TYPE QUESTIONS: 2-MARKS

Q1.The electron, in a hydrogen atom, initially in a state of quantum number n_1, makes a transition to a state whose excitation energy, with respect to ground state is 10.2 eV. If the wavelength, associated with photon emitted in this transition, is 487.5nm, find the

(i) energy in electron volts and

(ii) value of the quantum number n_1 of the electron emitted in its initial stage.

Q2. Show that the radius of the orbit in hydrogen atom varies as n^2, where n is the principal quantum number of atom.

Q3. Determine the distance of closest approach when an alpha particle of kinetic energy 4·5 MeV strikes a nucleus of Z = 80, stops and reverses its direction. **Ans:** 5.12x10^{-14}m

Q4. Given the value of the ground state energy of hydrogen atom as –13·6 eV, find out its kinetic and potential energy in the ground and second excited states.

Q5 State Bohr's postulate of hydrogen atom which successfully explains the emission lines in the spectrum of hydrogen atom.

Use Rydberg formula to determine the maximum wavelength emitted in Lyman series.

Q6. Given the ground state energy E_0 = – 13·6 eV and Bohr radius a_0 = 0·53 Å. Find out how the de-Broglie wavelength associated with the electron orbiting in the ground state would change when it jumps into the first excited state.

OR

Determine the value of the de Broglie wavelength associated with the electron orbiting in ground state of hydrogen atom (Given En = – $(13\cdot6/n^2)$ eV and Bohr radius r_o = 0·53 Å). How will the de Broglie wavelength change when it is in the first excited state?

Q7. (a) In the following nuclear reaction

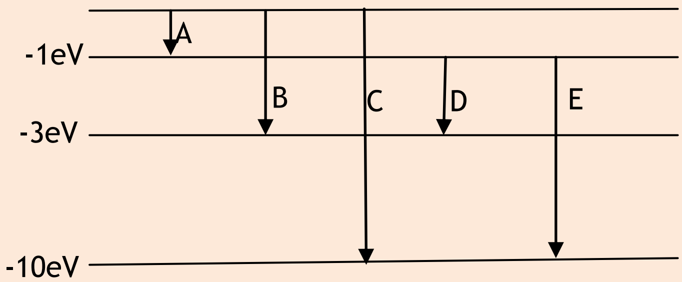
$${}_0^1n + {}_{92}^{235}U \rightarrow {}_Z^{144}Ba + {}_{36}^{A}X + 3\,{}_0^1n$$

assign the values of Z and A.

(b) If both the number of protons and the number of neutrons are conserved in each nuclear reaction, in what way is the mass converted into energy? Explain.

Q8.Two different radioactive elements with half lives T_1 and T_2 have N_1 and N_2 (undecayed) atoms respectively present at a given instant. Determine the ratio of their activities at this instant.

Q9.The energy levels of an atom are given below in the diagram.



Which of the transitions belong to Lyman and Balmer series? Calculate the ratio of the shortest wavelengths of the Lyman and the Balmer series of the spectra.

Q10.When an electron in hydrogen atom jumps from the third excited state to the ground state how would the de Broglie wavelength associated with the electron change? Justify your answer.

Q11. Calculate the shortest wavelength in the Balmer series of hydrogen atom. In which region (infra-red, visible, ultraviolet) of hydrogen spectrum does this wavelength lie ?

Q12. In both β− and β+ decay processes, the mass number of a nucleus remains the same, whereas the atomic number Z increases by one in β− decay and decreases by one in β+ decay. Explain giving reason

Q13. Calculate the shortest wavelength of Balmer series in Hydrogen atom. **CBSE-2016(C)**

Given R = 1097000m^{-1} **Ans:** 3644A^0

Q14.Calculate the shortest and longest wavelength of Lyman series in Hydrogen atom.

Q15. Calculate the ratio of energies of photons produced due to transition of electron of Hydrogen atom from its,

(a) Second permitted energy level to the first level and

(b) Highest permitted energy level to the second permitted level. **Ans: 10.2eV/3.4eV = 3**

Q16. Why a nucleus can eject electrons (β particle) though it contains no electrons?

Q17. A nucleus $^{23}_{10}Ne$ undergoes β-decay and becoming $^{23}_{11}Na$. Calculate the maximum kinetic energy of electrons emitted assuming that the daughter nucleus and anti-neutrino carry negligible kinetic energy. Given that;

mass of $^{23}_{10}Ne$ = 22. 994466u

mass of $^{23}_{11}Na$ = 22.989770u and 1u = 931MeV/c^2 Ans: 4.37MeV

Q18. The half life of $^{238}_{92}U$ against α-decay is 1.5 x10 ^{17}s. What is the activity of a sample of $^{238}_{92}U$ having 25x 10^{20}atoms? **Ans**: 1.15x 10^4 Bq

Hint: Use A = $\frac{0.693N}{T}$

Q19. a) Write symbolically the process expressing the β+ decay of $_{11}Na^{22}$ Also write the basic nuclear process underlying this decay.

(b) Is the nucleus formed in the decay of the nucleus $_{11}Na^{22}$ an isotope or isobar ?

Q20. The half life of $_{92}U^{238}$ undergoing decay is 4.5 × 10^9 years what is the activity of 1g. sample of $_{92}U^{238}$ **Ans** 1.23 × 10^4 *B*q.

Q21. In a Geiger –Marsden experiment, calculate the distance of closest approach to the nucleus of Z = 80, when an alpha particle of 8 MeV energy impinges on it before it comes momentarily to rest and reverses its direction. How will the distance of closest approach be affected when kinetic energy of the α - particle is doubled? **Ans**: 2.88x10^{-19}, half

Q22. The ground state energy of hydrogen atom is -13.6eV. If an electron makes a transition from an energy level – 0.85eV to -3.4eV. Calculate the wavelength of the spectral line emitted. To which series of hydrogen spectrum does this wavelength belong?

Ans:λ = 487.06nm. Balmer series

Q23.Complete the nuclear reaction and calculate the energy released:

$$_3Li^7 + {}_1H^1 \longrightarrow {}_2He^4 + ? + Q$$

Given that mass of lithium atom = 7.01822amu, Mass of proton = 1.00812amu

Mass of alpha particle = 4.00390amu **Ans**: 17.26MeV

Q24. The ground state energy of hydrogen atom is -13.6eV.

(i)What is the KE of an electron in the 2nd excited state? **Ans:** 1.51eV

(ii)What is the PE of the electron in the 3rd excited orbit? **Ans:** -1.7eV

(iii) If the electron jumps to ground state from the 3rd excited state, calculate the wavelength of the photon emitted. **Ans:** 97.86nm

Q25. Write two characteristics features of nuclear forces which distinguish them from coulomb force.

Q26. A nucleus with mass number A = 240 and BE/A = 7.6 MeV breaks into two fragments each of A = 120 with BE/A = 8.5 MeV. Calculate the released energy.

Q27. Calculate the energy in fusion reaction:

$^{2}_{1}H + ^{2}_{1}H \longrightarrow ^{3}_{2}H_e + n$ Where BE of $^{2}_{1}H$ = 2.23 MeV and of $^{3}_{2}H_e$ = 7.73MeV

Q28. Define ionization energy.

How would the ionization energy change when electron in hydrogen atom is replaced by a particle of mass 200 times that of the electron but having same charge? **CBSE-2016(C)**

Q29.Show mathematically how Bohr's postulate of quantization of orbital angular momentum in hydrogen atom is explained by de-Broglie hypothesis.**CBSE-2016(E)**

Q30.A hydrogen atom initially in its ground state absorbs a photon and is in the excited state with energy 12.5eV. Calculate the longest wavelength of the radiation emitted and identify the series to which it belongs.[Take Rydberg constant R = 1.1x107m^{-1}]**CBSE-2016(E)**

Q31.Use Bohr model of hydrogen atom to calculate the speed of electron in first excited state. **CBSE-2016(E).**

SHORT ANSWER TYPE QUESTIONS: 3-MARKS

Q1.In the study of Geiger-Marsden experiment on scattering of α-particles by a thin foil of gold draw the trajectory of α-particles in the coulomb field of target nucleus. Explain briefly how one gets the information on the size of the nucleus from this study. From the relation $R = R_0 A^{1/3}$, where R_0 is constant and A is the mass number of the nucleus, show that nuclear matter density is independent of A.

Q2. Distinguish between nuclear fission and fusion. Show how in both these processes energy is released. Calculate the energy release in MeV in the deuterium-tritium fusion reaction:

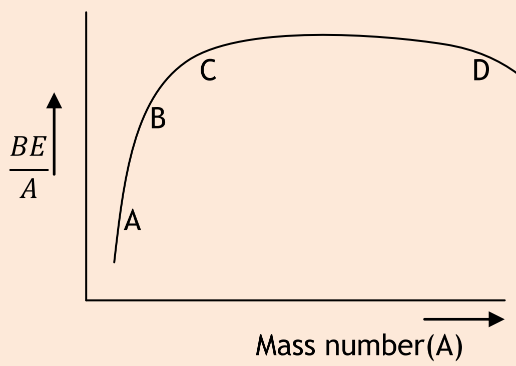
$^{2}_{1}H + ^{3}_{1}H = ^{4}_{2}He + n$

Using the data:

m ($^{2}_{1}H$) = 2.014102 u, m ($^{3}_{1}H$) = 3.016049 u, m ($^{4}_{2}He$) = 4.002603 u

m_n = 1.008665 u, 1u = 931.5 MeV/c^2 Ans: 17.589514 MeV

Q3.(a) The figure shows the plot of binding energy (BE) per nucleon as a function of mass number A. The letters A, B, C, D and E represent the positions of typical nuclei on the curve. Point out, giving reasons, the two processes (in terms of A, B, C, D and E), one of which can occur due to nuclear fission and the other due to nuclear fusion.



(a) Identify the nature of the radioactive radiations emitted in each step of the decay process given below.

$$_{Z}^{A}X \longrightarrow {}_{Z-2}^{A-4}Y \longrightarrow {}_{Z-1}^{A-4}W$$

Q4. Define the activity of a radioactive sample. Write its S.I. unit.

A radioactive sample has activity of 10,000 disintegrations per second (dps) after 20 hours. After next 10 hours its activity reduces to 5,000 dps. Find out its half life and initial activity.

Q5. Write symbolically the nuclear β+ decay process of ${}_{6}^{11}C$. Is the decayed product X an isotope or isobar of ${}_{6}^{11}C$?

Given the mass values m (${}_{6}^{11}C$) = = 11·011434 u and m (X) = 11·009305 u. Estimate the Q-value in this process.

Q6.Use Bohr's postulates of hydrogen atom to deduce the expression for the kinetic energy (K.E.) of the electron revolving in the n^{th} orbit and show that K.E. = $\frac{e^2}{8\pi\epsilon_0 r_n}$ where r_n is the radius of the nth orbit. How is the potential energy in the n^{th} orbit related to the orbital radius r_n?

Q7. (a) Plot a graph showing the variation of binding energy per nucleon as a function of mass number. Which property of nuclear force explains the approximate constancy of binding energy in the range 30 < A < 170?

(b) A radioactive nucleus 'A' undergoes series of decays shown in the following scheme :

$$A \xrightarrow{\alpha} A_1 \xrightarrow{\beta} A_2 \xrightarrow{\gamma} A_3$$

If the mass number and atomic number of A_3 are 176 and 69 respectively, find the mass number and atomic number of A.

Q8. (a) Write the relation for binding energy (BE) (in MeV) of a nucleus of mass M, atomic number (Z) and mass number (A) in terms of the masses of its constituents — neutrons and protons.

(b) Draw a plot of BE/A versus mass number A for $2 \leq A \leq 170$. Use this graph to explain the release of energy in the process of nuclear fusion of two light nuclei.

Q9. (i) Draw the graph showing the variation of potential energy of a pair of nucleons as a function of their separation. Indicate the region in which the nuclear force (a) attractive (b) repulsive.

(ii) Write two characteristics features which distinguish it from the Coulomb force.

Q10. Obtain the relation between the decay constant and half life of a radioactive sample.

The half life of a certain radioactive material against α-decay is 100 days. After how much time, will the undecayed fraction of the material be 6·25%?

Q11. (a) Write three characteristic properties of nuclear force.

(b) Draw a plot of potential energy of a pair of nucleons as a function of their separation. Write two important conclusions that can be drawn from the graph.

Q12. (i) Define the term 'mass defect' of a nucleus. How is it related with its binding energy?

(ii) Determine the Q-value of the following reaction:

$${}_1^1H + {}_1^3H \rightarrow {}_1^2H + {}_1^2H$$

Given m (${}_1^2H$) = 2.014102u, m (${}_1^3H$) = 3.016049 u, m (${}_1^1H$) = 1.00783 u

1 u = 931.5 MeV/c^2

Ans: (ii) -4.03MeV

Q13. (i) A hydrogen atom initially in the ground state absorbs a photon which excites it to the n = 4 level. Determine the wavelength of the photon.

(i) The radius of innermost electron orbit of a hydrogen atom is 5.3 x 10^{-11} m. Determine its radius in n = 4 orbit. **Ans** (i) λ = 970A^0 (ii) R = $(n)^2$ r_0 = $(4)^2$ x 5.3x10^{-11} m = 8.48A^0

Q14. A 12.3 eV electron beam is used to bombard gaseous hydrogen at room temperature. Up to which energy levels the hydrogen atoms would be excited?

Calculate the wavelengths of the second member of Lyman series and second member of Balmer series.**Ans:** Lyman series λ = 102.5nm, For Balmer series λ = 486nm

Q15. (a) Deduce the expression, N= $N_0\,e^{-\lambda t}$, for the law of radioactive decay.

(b) (i) Write symbolically the process expressing the β^+ decay of ${}_{11}^{22}Na$ Also write the basic nuclear process underlying this decay.

(ii) Is the nucleus formed in the decay of the nucleus, ${}_{11}^{22}Na$ an isotope or isobar?

Q16. (a) The orbital radius of the electron in the first excited state of hydrogen atom is 21.2 x 10^{-11} m. Find out its radius in the second excited state.

(b) The total energy of the electron in the ground state is –13.6 eV. Find out (i) its kinetic energy and (ii) potential energy in the first excited state.

Q17.The value of ground state energy of hydrogen atom is – 13.6 eV and Bohr radius is 0.53 Å. Calculate (i) the energy required to move an electron from the ground state to the second excited state. (ii) (a) the kinetic energy and (b) the orbital radius in the second excited state of the atom.

Q18.Calculate the binding energy and binding energy per nucleon of ${}_{26}^{56}Fe$, given that: m (${}_0^1n$)= 1.008665u., m(${}_1^1H$) = 1.007825u, m(${}_{26}^{56}Fe$) = 55.934932u.

Q19.Explain, with the help of a nuclear reaction in each of the following cases, how the neuron to proton ratio changes during (i) α- decay (ii) β- decay.

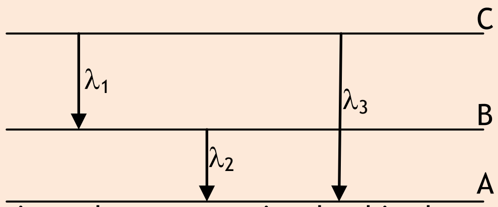
Q20.The total energy of an electron in the first excited state of the hydrogen atom is about -3.4eV. What is (a) kinetic energy (b) potential energy of the electron (c) Which of the answers above would change if the choice of the zero potential energy is changed to (i) +0.5 eV (ii) -0.5eV?

Hint: (c) K.E. will remain same

(i) P.E. (new) = -3.4-0.5 = -3.9eV (ii) P.E.(new) -3.4 –(-0.5) = -2.9eV

Q21. (i) State Bohr's quantization condition for defining stationary orbits. How does de Broglie hypothesis explain the stationary orbits?

(ii) Find the relation between the three wavelengths λ_1, λ_2 and λ_3 from the energy level diagram shown below.



Q22.(a) Write the basic nuclear process involved in the emission of β^+ in a symbolic form, by a radioactive nucleus.

(b)In the reactions given below

(i) $^{11}_{6}C \longrightarrow {}^{z}_{y}B + x + \nu$

(ii) $^{12}_{6}C + {}^{12}_{6}C \longrightarrow {}^{20}_{a}Ne + {}^{c}_{b}He$

Find the value of x, y, z, a ,b and c **CBSE-2016(C)**

Q23. Half life of $^{238}_{92}U$ against α-decay is 4.5x 10^9 years. Calculate the activity of 1g sample of $^{238}_{92}U$? Given Avagadro's number = 6x 10^{26} atoms/kmole.CBSE-2016(E)

LONG ANSWER TYPE QUESTIONS: 5-MARKS

Q1. (a)State the first two postulates of Bohr's theory of hydrogen atom. Also explain briefly the necessity for invoking these postulates to describe the structure of the atom.

(b) Using Bohr's third postulate, write the Rydberg formula for the spectrum of the hydrogen atom. With the help of this formula, calculate the wavelength of the first member of the spectral line in the Lyman series of the hydrogen spectrum (Take the value of Rydberg constant R = 1.03 x10^7 m^{-1})

Q2. (a) Give one example each for (i) α-decay and (ii) β^- -decay by writing the decay processes in symbolic form.

(b) In a given nuclear reaction,

$$^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{3}_{2}He + {}^{1}_{0}n + 3.27\text{ MeV}$$

Although number of nucleons is conserved on both sides, yet energy is released. Explain.

(c) Show that nuclear density in a nucleus, on a wide range of nuclei is constant and independent of mass number A.

UNIT- IX: Electronic Devices:

VERY SHORT ANSWER TYPE QUESTIONS: 1 MARK

Q1. Distinguish between 'intrinsic' and 'extrinsic' semiconductors.

Q2. What happens when a forward bias is applied to a p-n junction?

Q3. Why does conductivity of a semiconductor increase with rise of temperature?

Q4.Draw a graph to show the variation of resistivity of a semiconductor with rise of temperature.

Q5.Why does conductivity of an extrinsic semiconductor more than intrinsic semiconductor?

Ans: Due to very less forbidden energy gap.

Q6.What is depletion layer in p-n junction?

Q7. What is potential barrier in p-n junction?

Q8. Draw energy band diagram of n-type semiconductor.

Q9. Draw energy band diagram of n-type semiconductor.

Q10.What is threshold voltage/ potential barrier voltage for (i) Silicon diode and (ii) Germanium diode. **Ans:** (i) 0.7V (ii) 0.3V

Q11. How is the band gap, E_g is related to the maximum wavelength, λ_m that can be detected?

Ans: $\lambda_m = \frac{hc}{E_g}$

Q12.Zenor diodes have higher dopant densities as compared to ordinary p-n junction diodes. How does it affect the (i) width of depletion layer (ii) junction field?

Ans: (i) width will decrease (ii) field will be high.

Q13.How does depletion layer of p-n junction diode change with decrease of reverse bias?

Q14.Which type of biasing is done when a zenor diode work as a voltage regulator?

Ans; Reverse biasing

Q15. Why does a LED emit light, whereas an ordinary diode not emits the light when forward biased?

Q16.What change take place in the forbidden energy gap of intrinsic semiconductor when it is doped with some suitable impurity.

Ans; Decreases

Q17.The frequency of input a.c. supplied to full wave rectifier is 50Hz. What is its output frequency?

Q18.Which gates are called universal gates?

Ans; NAND and NOR

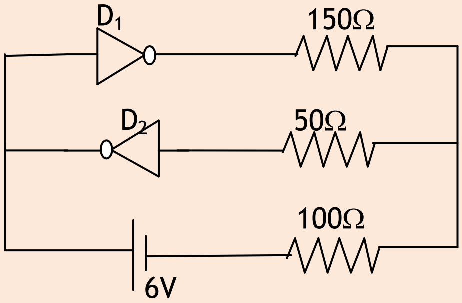
Q19.What is difference in the dopping concentration between emitter region and base region of a transistor?

Q20. A transistor consists of three regions, emitter, base and collector. When n-p-n transistor used as amplifier. In which direction the electrons move inside the transistor?

Q21.What is phase difference between input and output signals of common emitter amplifier?

Ans: 180^0

Q22. What is current in the following circuit?



Ans: I = V/ R = 6/250 = 0.03V

Q23. Write the logic symbol and truth table of the basic gate which produces an inverted version of the input.

SHORT ANSWER TYPE QUESTIONS: 2-MARKS

Q1. Explain, with the help of a diagram, the basic processes involved in the formation of p-n junction. Write briefly how the depletion region is developed.

Q2. (a) Why does width of depletion layer of p-n junction increase in reverse bias?

(b) "The output power is greater than input power when a transistor used as an amplifier" Is a transistor act as power generating device?

Q3. Draw V-I characteristics of p-n junction in (i) forward bias (ii) reverse bias.

Q4. The output of an unregulated d.c. power supply needs to be regulated. Name the device that can be used for this purpose and draw the relevant diagram.

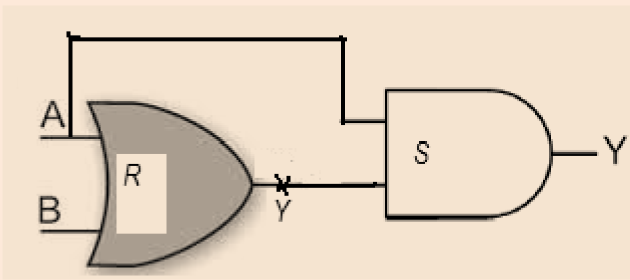
Q5. (a) How does a transistor biased when work as an amplifier?

(b) In a transistor, reverse bias is quite high as compared to the forward bias. Why?

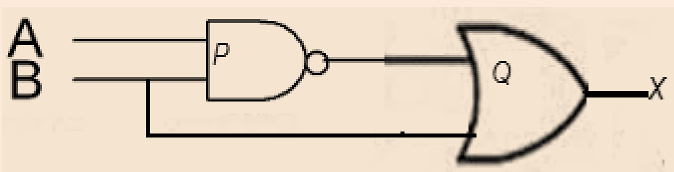
Ans: (a) Input is forward biased and output is reverse biased.

(b) In transistor, the charge carriers (electrons) move from emitter to collector through base. The reverse bias on collector is made quite high so that it may exert a large attractive force on the charge carrier to enter the collector region. These moving electrons in the collector constitute a collector current.

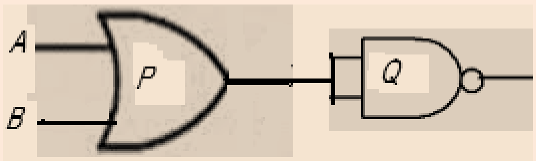
Q6. Write the truth table for the combination of the gates shown. Name the gates used.



Q7. Identify the logic gates marked for P and Q in the given circuit write truth table for the combination.

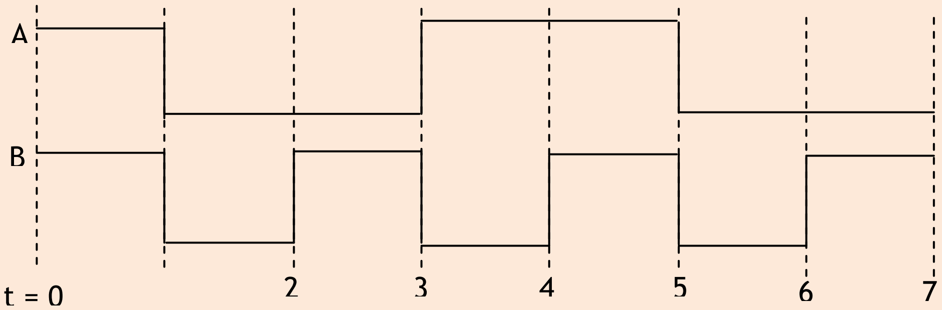


Q8. Name the gates P and Q in the logic circuit shown in the figure. Write the truth table for the combination of the gates and identify the equivalent gate.



Q9. (i) Write the truth table for an AND gate and draw its logic symbol.

(ii) The input waveforms A and B, as shown, are fed to a NAND gate. Find the output waveform.



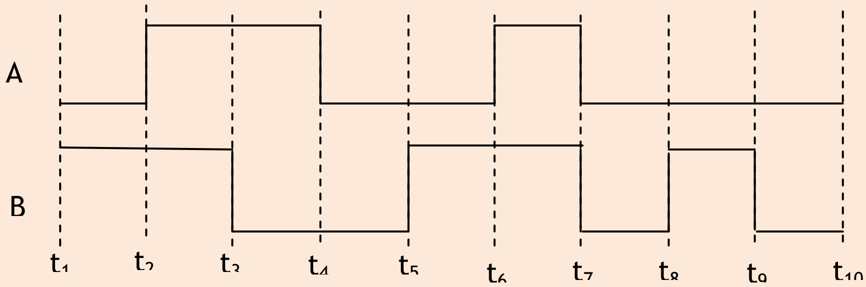
Q10. A p-n photo-diode is fabricated from semiconductor with band gap of 2.8eV. Can it detect a wavelength of 6000nm?

Q11. A p-n junction is forward biased with to battery of e.m.f. 5.5V and external resistance 5.1kΩ in series. Calculate the electric current in the circuit if the barrier potential of diode is 0.4V.

Q12. In npn transistor circuit, the collector current is 10mA. If 95% of the electrons emitted reach the collector, what is the base current? **Ans:** I_B = 0.53mA

Q13. In common emitter transistor has current gain of 100. If emitter current is 8.08mA, find the base and collector. **Ans:** I_B = 0.08mA and I_C = 8mA

Q14. Two signal A and B are used as inputs of a NOR gate. Draw the output wave form.**CBSE-2016(E)**



SHORT ANSWER TYPE QUESTIONS: 3-MARKS

Q1. Draw the necessary energy band diagrams to distinguish between conductors, semiconductors and insulators.

How does the change in temperature affect the behaviour of these materials? Explain briefly.

Q2. Explain, with the help of suitable diagram, the two important processes that occur during the formation of p-n junction. Hence define the terms: depletion region and barrier potential.

Q3. (a) Explain with the help of a diagram, how depletion region and potential barrier are formed in a junction diode.

(b) If a small voltage is applied to a p-n junction diode, how will the barrier potential be affected when it is (i) forward biased, and (ii) reverse biased ?

Q4.Draw the circuit arrangement for studying the V – I characteristics of a p-n junction diode (i) in forward bias and (ii) in reverse bias. Draw the typical V – I characteristics of a silicon diode.

Describe briefly the following terms:

(i) ''minority carrier injection'' in forward bias

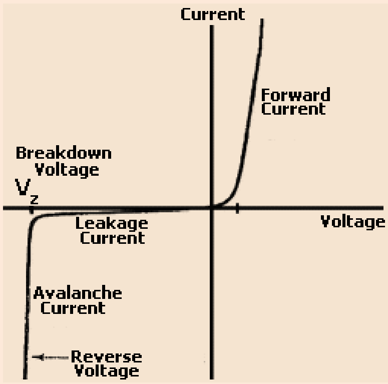
(ii) ''breakdown voltage'' in reverse bias

Q5.Figure shows V-I characteristics of a semiconductor diode.

(i) Identify the diode used.

(ii) Draw circuit diagram to obtain the given characteristics of the device.

(iii) Explain briefly how this diode can be used as a voltage regulator.



Q6. On what principle pn junction diodes work as rectifier? Draw a neat and labelled circuit diagram to show how junction diode acts as a half wave rectifier.

Q7. With the help of a circuit diagram, explain the working of a junction diode as a full wave rectifier. Draw its input and output waveforms. Which characteristic property makes the junction diode suitable for rectification?

Q8.Draw a labelled circuit diagram of a full wave rectifier. Explain its underlying principle and working. Depict the input and output waveforms.

Describe briefly the role of a capacitor in filtering.

Q9. How is a light emitting diode fabricated? Briefly state its working. Write any two important advantages of LEDs over the conventional incandescent low power lamps.

Q10. How is a Zener diode fabricated? What causes the setting up of high electric field even for small reverse bias voltage across the diode?

Describe, with the help of a circuit diagram, the working of Zener diode as a voltage regulator.

Q11.Write two important considerations used while fabricating a Zener diode.

Explain, with the help of a circuit diagram, the principle and working of a Zener diode as voltage regulator.

Q12. With what considerations in view, a photodiode is fabricated? State its working with the help of a suitable diagram. Even though the current in the forward bias is known to be more than in the reverse bias, yet the photodiode works in reverse bias. What is the reason?

Q13. Describe briefly using the necessary circuit diagram, the three basic processes which take place to generate the emf in a solar cell when light falls on it. Draw the I – V characteristics of a solar cell. Write two important criteria required for the selection of a material for solar cell fabrication.

Q14. Draw a circuit diagram of a transistor amplifier in CE configuration. Define the terms:

(a) Input resistance and (b) Current amplification factor.

How are these determined using typical input and output characteristics?

Q15.Draw a circuit diagram of a C.E. transistor amplifier. Briefly explain its working and write the expression for (i) current gain, (ii) voltage gain of the amplifier.

Q16. Explain briefly, with the help of a circuit diagram how an n-p-n transistor in C.E. configuration is used to study input and output characteristics.

Q17. When is a transistor said to be in active state? Draw a circuit diagram of a p-n-p transistor and explain how it works as a transistor amplifier. Write clearly, why in the case of a transistor (i) the base is thin and lightly doped and (ii) the emitter is heavily doped.

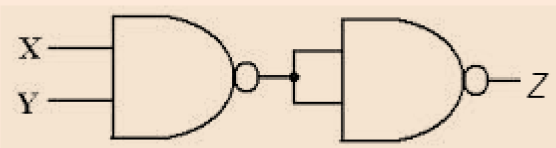
Q18.Draw a circuit diagram to study the input and output characteristics of an n-p-n transistor in common emitter configuration. Explain briefly how this arrangement is used to obtain the typical input/output characteristics of a transistor. Draw the graphs showing the nature of input/output curves.

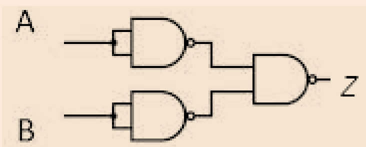
Q19. A pnp transistor is used in common in common – emitter mode in an amplifier circuit. A change of 40 μA in base current bring a change of 2mA in collector current and 0.04V in base emitter voltage. Find (i) input resistance (ii)the base current amplification factor (β). If a load resistance of 6kΩ is used, then also find the voltage gain of the amplifier.

Ans: $R_i = 1k\Omega$, $\beta = 50$, $A_V = 300$.

Q20. The outputs of two NOT gates are fed to a NOR gate. Draw the logic circuit of the combination of gates. Write its truth table. Identify the gate equivalent to this circuit.

Q21.You are given two circuits (a) and (b) as shown in the figures, which consist of NAND gates. Identify the logic operation carried out by the two. Write the truth tables for each. Identify the gates equivalent to the two circuits.



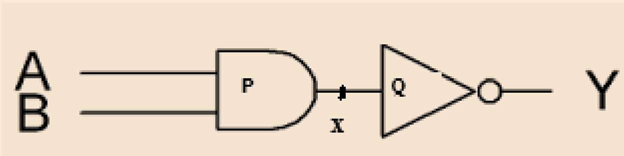


Q22. Using truth tables of AND gate and NOT gate show that NAND gate is an AND gate followed by a NOT gate. Hence write the truth table of NAND gate.

Why NAND gate is called 'Universal Gate'?

Q23. Identify the gates P and Q shown in the figure. Write the truth table for the combination of the gates shown.

Name the equivalent gate representing this circuit and write its logic symbol.



Q24. (i) Write the functions of three segments of a transistor.

(ii) Draw the circuit diagram for studying the input and output characteristics of n-p-n transistor in common emitter configuration. Using the circuit, explain how input, output characteristics are obtained. **CBSE-2016-D**

Q25. (i)Explain with the help of a diagram the formation of depletion region and barrier potential in pn junction.

(ii)Draw the circuit diagram of half wave rectifier and explain its working.**CBSE-2016(C)**

Q26. For a CE-transistor amplifier, the audio signal voltage across the collector resistance of 2kΩ is 2V.Suppose the current amplification factor is 100, find the input signal voltage and base current, if the base resistance is 1kΩ.**CBSE-2016(C)**

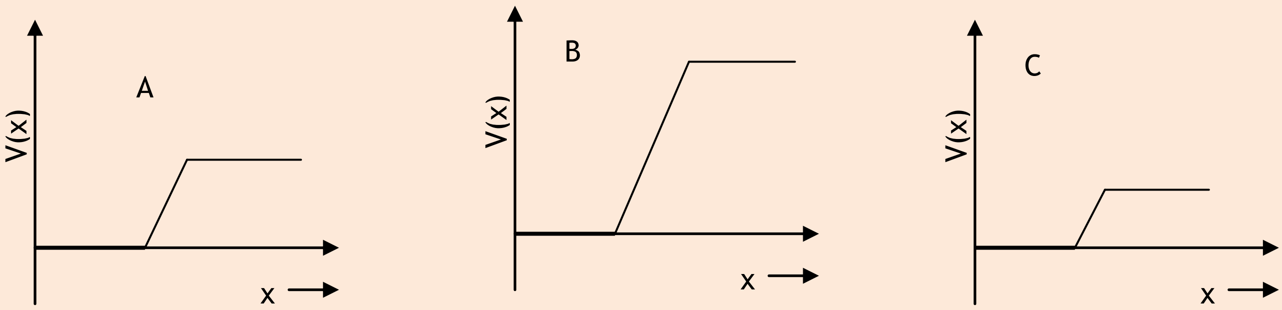
Q27. Explain briefly, with the help of a circuit diagram, the transistor action of npn transistor in CE configuration. Draw the typical shapes of input and output characteristics.**CBSE-2016(E)**

Q28.(i)Describe the working of photodiode by drawing the circuit diagram.

(ii)Draw the characteristics of a photodiode for different illumination intensities.

(iii) Why is photodiode operated in reverse bias even though the reverse bias current is much weaker than the current in forward bias? **CBSE-2016(E)**

Q29. The graph of potential barrier versus width of depletion region for an unbiased diode is shown in A. In comparison to A, graphs B and C are obtained after biasing the diode in different ways. Identify the type of biasing in B & C. Justify your answer. **CBSE-SQP-2016**



Q30.(i) Explain the following; **CBSE-SQP-2016**

(i) In the active state of the transistor, the emitter base junction acts as a low resistance while base collector region acts as high resistance.

(ii) Output characteristics are controlled by the input characteristics in common emitter transistor amplifier.

(iii) LEDs are made of compound semiconductor and not by elemental semiconductors.

LONG ANSWER TYPE QUESTIONS: 5-MARKS

Q1. (a) Draw the circuit arrangement for studying the V – I characteristics of a p-n junction diode in (i) forward and (ii) reverse bias. Briefly explain how the typical V – I characteristics of a diode are obtained and draw these characteristics.

(b)With the help of necessary circuit diagram explain the working of a photo diode used for detecting optical signals.

Q2. (a) State briefly the processes involved in the formation of p-n junction explaining clearly how the depletion region is formed.

(b) Using the necessary circuit diagrams, show how the V-I characteristics of a p-n junction are obtained in

(i) Forward biasing

(ii) Reverse biasing

How these characteristics are made use of in rectification?

Q3. (a) Explain with the help of a diagram, how a depletion layer and barrier potential are formed in a junction diode.

(b) Draw a circuit diagram of a full wave rectifier. Explain its working and draw input and output waveforms.

Q4. (a) Draw the circuit diagram of an n-p-n transistor with emitter-base junction forward biased and collector-base junction reverse biased.

Describe briefly how the motion of charge carriers in the transistor constitutes the emitter current (I_E), the base current (I_B) and the collector current (I_C). Hence deduce the relation

$I_E = I_B + I_C$.

(b) Explain with the help of circuit diagram how a transistor works as an amplifier.

Q5. (a) Differentiate between three segments of a transistor on the basis of their size and level of doping.

(b) How is a transistor biased to be in active state?

(c) With the help of necessary circuit diagram, describe briefly how n-p-n transistor in CE configuration amplifies a small sinusoidal input voltage. Write the expression for the ac current gain.

Q6. (a) Draw a circuit diagram of a common –emitter amplifier using a npn transistor. Prove that in this amplifier, the output voltage is 180^0 out of phase with the input voltage.

(b) A transistor having current gain β =100a.c. is in CE amplifier. If load is 4.5kΩ and dynamic resistance of emitter junction is 500Ω. Find the power gain. **Ans**: 90000.

VALUE BASED QUESTIONS: 4 MARKS

Q1. Sudhir argued with Anand, if a transistor amplifies the input power, it means there is violation of law of conservation of energy. Anand told him that violation of conservation law is not possible but he could not satisfy him fully. Next day they discussed the same problem with his physics teacher in the class. The teacher satisfied them.

Answer the following questions;

(i) Write the possible explanation that is given by their teacher.

(ii) Write the formula of power gain in term of current gain and input resistance and output resistance.

(iii) Is power gain possible in an ideal step up transformer?

(iv) What are the two values shown by Sudhir and Anand here?

Q2. Meeta's father was driving her to the school. At the traffic signal she noticed that each traffic light was made of many tiny lights instead of a single bulb. When Meeta asked this question to her father, he explained the reason for this.

Answer the following questions based on above information :

(i) What were the values displayed by Meeta and her father?

(ii) What answer did Meeta's father give?

(iii) What are the tiny lights in traffic signals called and how do these operate? **CBSE-2016-D**

UNIT-X: Communication Systems:

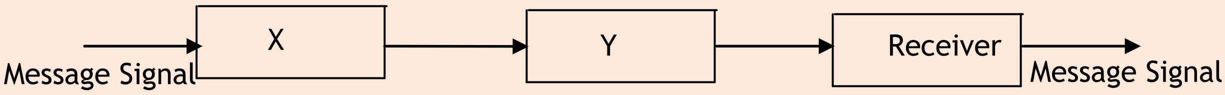
VERY SHORT ANSWER TYPE QUESTIONS: 1 –MARK

Q1. What is the function of a band pass filter used in a modulator for obtaining AM signal?

Ans: It rejects dc and **sinusoids** of frequency ωm, $2\omega m$ and $2\omega c$ and retains frequencies ωc, $\omega c \pm \omega m$.

Q2. Write the function of a transducer in communication system.

Q3. Name the boxes X and Y shown in the block diagram of a generalized communication system:



Q4. Why are repeaters used in communication system?

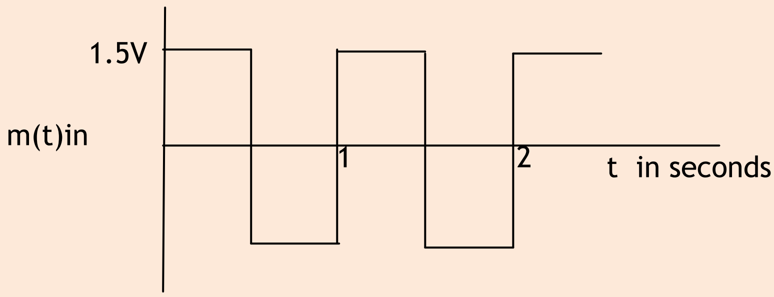
Q5. How are side bands produced?

Q6. Which basic mode of communication is used for telephonic communication?

Q7. A carrier wave c(t) is given by

$c(t) = 3 \sin (4\omega t)$ volt

The modulating signal m (t) is a square wave as shown.



Find its modulation index.

Q8. Distinguish between 'point-to-point' and 'broadcast' modes of communication.

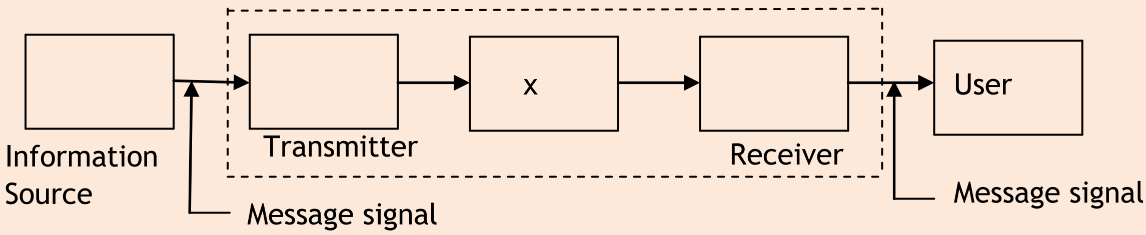
Q9. What does the term 'demodulation' in communication system mean?

Q10. Give one example of broadcast mode of communication.

Q11. Define the term 'modulation index' in communication system.

Q12. What is the meaning of the term 'attenuation' used in communication?

Q13. The figure given below shows the block diagram of a generalized communication system. Identify the element labelled 'X' and write its function.



Q14. Draw a block diagram of a detector for amplitude modulated signal.

Q15.How does the effective power radiated from a linear antenna depend on the wavelength of the signal to be transmitted ?

Q16. Why is the transmission of signals through a co-axial cable not possible for frequencies greater than 20 MHz?

Q17. What is meant by modulation?

Q18. Name the essential components of a communication system. **All India-2016(C)**

SHORT ANSWER TYPE QUESTIONS: 2-MARKS

Q1. We do not choose to transmit an audio signal by just directly converting it to an e.m. wave of the same frequency. Give two reasons for the same.

Hint: 1. Impractical length of antenna 2-To increase range 3- To avoid intermixing of signals

Q2.State two factors by which the range of TV signal can be increased?

Hint: 1. By increasing height of antennas 2 – By increasing power of signals

Q3.What characteristic of modulated carrier wave does vary in (i) Amplitude Modulation (ii) Frequency Modulation?

Q4. Differentiate between amplitude modulated (AM) and frequency modulated (FM) waves by drawing suitable diagrams. Why is FM signal preferred over AM signal?

Q5. Distinguish between 'sky wave' and 'space wave' modes of propagation. Why is the sky wave mode of propagation restricted to frequencies upto 40 MHz?

Q6. (a) Distinguish between 'Analog' and 'Digital' forms of communication.

(b) Explain briefly two commonly used applications of the 'Internet'.

Q7.Which basic mode of communication is used in satellite communication? Which type of wave propagation is used in this mode? Write the expression for the maximum line of sight distance d between two antennas having heights h_1 and h_2.

Q8. What is ground wave communication? Explain why this mode cannot be used for long distance communication using high frequencies.

Q9. Write two factors which justify the need of modulating a low frequency signal with high frequencies before transmission.

Q10.Derive an expression area around up to which a TV tower can send the signals.

Q11. A carrier wave of peak voltage 12V is used to transmit a message signal. What should be the peak voltage of the modulating signal in order to have a modulation index of 75%?

Q12. A message signal of frequency 10 kHz and peak voltage of 10 volts is used to modulate a carrier of frequency 1 MHz and peak voltage of 20 volts. Determine;

(a) modulation index,

(b) the side bands produced.

Q13. A transmitting antenna at the top of a tower has a height 32 m and the height of the receiving antenna is 50 m. What is the maximum distance between them for satisfactory communication in LOS mode? Given radius of earth 6.4×10^6 m.

Q14. For an amplitude modulated wave, the maximum amplitude is found to be 10 V while the minimum amplitude is 2 V. Determine the value of modulation indexμ. What would be the value of μ if the minimum amplitude is zero volts? Why is generally kept less than 1?

Q15. Explain the terms (i) Attenuation and (ii) Demodulation used in Communication System.

Q19. Define modulation index. Why is it kept low? What is role of band pass filter?**CBSE-2016(C)**

SHORT ANSWER TYPE QUESTIONS: 3-MARKS

Q1. Draw a block diagram of a detector for AM signal and show, using necessary processes and the waveforms, how the original message signal is detected from the input AM waves?

Q2. Name the three different modes of propagation in a communication system.

States briefly why do the electromagnetic waves with frequency range from a few MHz upto 30 MHz can reflect back to the earth. What happens when the frequency range exceeds this limit?

Q3. Draw a block diagram of a simple modulator for obtaining amplitude modulated signal. A carrier wave of peak voltage 12 V is used to transmit a message signal. What should be the peak voltage of the modulating signal in order to have a modulation index of 75% ?

Q4. (a) State three important factors showing the need for translating a low frequency signal into a high frequency wave before transmission.

(b) Draw a sketch of a sinusoidal carrier wave along with a modulating signal and show how these are superimposed to obtain the resultant amplitude modulated wave?

Q5. Draw a block diagram of a simple modulator to explain how the AM wave is produced. Can the modulated signal be transmitted as such? Explain.

Q6. Suppose you wish to transmit an electronic signal in the audio frequency range over a long distance directly. Write briefly the three important factors which prevent you from doing so and explain how you overcome these factors.

Q7. (a) What are the three basic units in communication systems? Write briefly the function of each of these.

(b) Write any three applications of the internet used in communication systems.

Q8. Define modulation index. Why is its value kept, in practice, less than one?

A carrier wave of frequency 1·5 MHz and amplitude 50 V is modulated by a sinusoidal wave of frequency 10 kHz producing 50% amplitude modulation. Calculate the amplitude of the AM wave and frequencies of the side bands produced.

Q9.What is frequency modulation? Draw a diagram to show the frequency modulation of a carrier wave. Write down its two advantages over amplitude modulation.

Q10. What are the needs of modulation of audio signals before the transmission?

Q11. What is amplitude modulation? Represent the process graphically? Write its two limitations and two advantages.

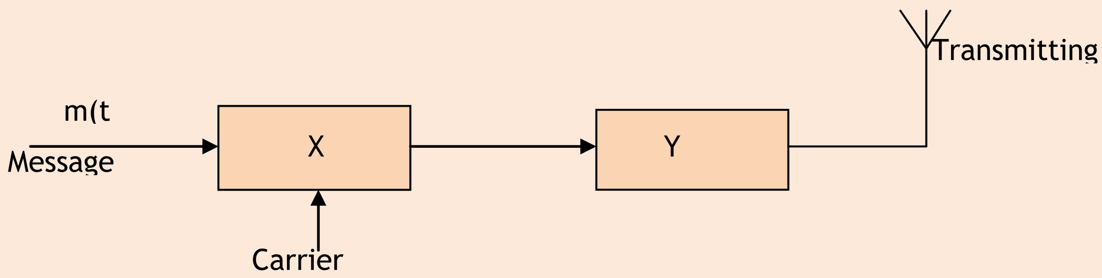
Q12. Give reasons for the following:

(a) For ground wave transmission size of antenna should be comparable to wavelength of signal.

(b) Audio Signals, converted into an em wave, are not directly transmitted as such.

(c) The amplitude of modulating signal is kept less than the amplitude of carrier wave.

Q13. The block diagram of a transmitter is given below. Identify the X and Y and write down the function of Y. What is importance of Y in the block diagram?



Q14. Describe briefly how radio waves are propagated in space wave mode of propagation?

A transmitting antenna has a height of 20 m and the height of the receiving antenna is 80 m. calculate the maximum distance between them for satisfactory communication in LOS mode. [Given, radius of Earth = 6.4 x10^6 m] **Ans:** 48km.

Q15. (a)Explain any two factors which justify the need of modulating a low frequency signal.

(b) Write two advantages of frequency modulation over amplitude modulation.

Q16.Which mode of propagation is used by shortwave broadcast services having frequencies range from a few MHz upto 30MHz? Explain diagrammatically how long distance communication can be achieved by this mode.

(ii)Why is there an upper limit to frequency of waves used in this mode? **All India-2016(C)**

Q17.(i) Write the factors that prevent a baseband signal of low frequency to be transmitted over long distances.

(ii) What is to be done to overcome these factors? Draw a block diagram to obtain the desired signal.

LONG ANSWER TYPE QUESTIONS: 5-MARKS

Q1. What is space wave propagation? Which two communication methods make use of this mode of propagation? If the sum of the heights of transmitting and receiving antennas in line of sight of communication is fixed at h, show that the range is maximum when the two antennas have a height h/2 each.

Q2. What does the term LOS communication mean? Name the types of waves that are used for this communication. With the help of suitable figure clear the meaning of “Line of sight communication”. How can we increase the range of LOS?

VALUE BASED QUESTIONS: 4 MARKS

Q1. Arnab was talking on his mobile to his friend for a long time. After his conversation was over, his sister Anita advised him that if his conversation was of such a long duration, it would be better to talk through a land line.

Answer the following questions:

(a) Why is it considered harmful to use a mobile phone for a long duration?

(b) Which values are reflected in the advice of his sister Anita?

(c) A message signal of frequency 10 kHz is superposed to modulate a carrier wave of frequency 1 MHz. Determine the sidebands produced.

Ans: 1010 kHz, 990 kHz

Answer Key

UNIT-VI: Optics:

VERY SHORT ANSWER TYPE QUESTIONS: 1 -MARK

A1. $\frac{Speed\ of\ light\ in\ vacuum}{Speed\ of\ light\ in\ the\ given\ medium} = \frac{Sin\ i}{Sin\ r} \Rightarrow Speed\ of\ light\ in\ the\ given\ medium\ \alpha$ Sin r

The speed will be minimum in that medium for which the angle of refraction is minimum
Ans: Medium A.

A2. For concave mirror f < 0: (have negative focal length)
As object is placed between the pole and focus
$\therefore$ f < u < 0 (both u and f are negative) $\therefore \left\{\frac{1}{f} - \frac{1}{u}\right\} > 0$ and $\left\{\frac{1}{f} - \frac{1}{u} = \frac{1}{v}\right\}$
$\Rightarrow \frac{1}{v} > 0$ or 'v ' is positive . It must be virtual
Also $\frac{1}{v} < \frac{1}{|u|}$ i.e. v > $|u|$ $\therefore$ the image is enlarged

A3.Convex lens

A4.Critical angle depends upon the refractive index (n) of the medium and refractive index is different for different colours of light. (μ = 1/ sinC)

A5.Using Lens maker's formula μ = 1.5

A6. Using Lens maker's formula, for equiconvex lens 1/f = (μ -1)(2/R)
For the lens whose one plane is made plane $1/f_1$ = (μ -1)(1/R)
$f_1 = 2f$

A7.Convex lens

A8. Concave lens.

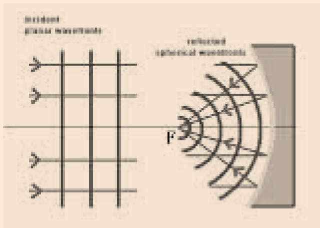
A9.Due to scattering of light.

A10. Due to scattering of light.

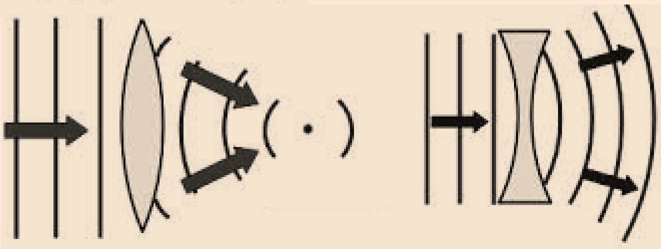
A11.It forms brighter image.
Or: It is easy to construct a concave mirror of large focal length and large aperture than that of a lens.

A12. 20cm

A13.



A14.



A15.Coherent Sources: The sources of light which emit the light waves having constant phase difference or no phase difference.

A16. $\theta = \lambda/d$ so there will be no change.

A17.because the phase difference between them varies continuously.

A18.No interference because two sources become incoherent.

A19. The intensity of central maxima become ¼ th .(because the amplitude of light become half and intensity I α (amplitude)^2

A20. $\theta = 45^0$

A21. Ans: I_0 /8 [Since Final intensity I = $(\frac{I_0}{2})\cos^2\theta.\cos^2(90 - \theta)$

$= (\frac{I_0}{2})(\frac{1}{\sqrt{2}})^2 (\frac{1}{\sqrt{2}})^2 = \frac{I_0}{8}$]

A22. **Ans:** 4:1 [Use $\frac{(a_1 - a_2)^2}{(a_1 + a_2)^2}$] = 9/25 If $a_1/a_2 = r$

$\frac{r-1}{r+1} = 3/5 \Rightarrow r = 4:1$

A23.Ans: 25%

A24.Ans: $\sqrt{(\mu_r K)}$

A25. Ans: A to B (Since $\mu \alpha \frac{1}{SinC}$)

A26. Will emerge from the face PR of the prism.

A27. Diverging, (Using lens maker formula since $(\frac{1}{R_1} - \frac{1}{R_2}) < 0$

A28. Distance between an object and its real image is 4f.

A29. $\lambda' = \frac{\lambda}{\mu} = \frac{7200}{1.5} = 4800A^0$

A30.Focal length will increase so the power will decrease.

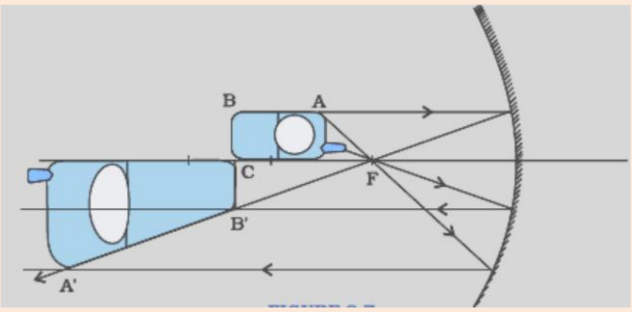
A31.Red since normal shift = t(1- $\frac{1}{\mu}$) and the μ_R is least so the shift will be maximum.

A32. $a\mu g = \frac{sin\theta}{sin\phi'}$

A33. Violet colour, $sini_c = 1/\mu$

SHORT ANSWER TYPE QUESTIONS: 2-MARKS

A1.



Magnification is non-uniform because the position of the image of different parts of the phone depends on their location with respect to the mirror. From the figure it can be observed that whereas BC = B'C, the images of the other parts of the phone, are getting magnified in accordance with their 'object distance' from the mirror.

A2. $\mu = 1 / \sin C$

$= c/ v \Rightarrow \sin C = v / c = \frac{2 \times 10^8}{3 \times 10^8}$

$C = \sin^{-1} (2/3)$

A3. Since; $A + \delta_m = 2i$

$A + \delta_m = 2 \times (3/4) A$

$\delta_m = A - A/2 = A/2$

A4. $\mu = 1/sini_c = 1/ \sin 45^0 = \sqrt{2} = 1.414$

Speed = $3 \times 10^8 / 1.414 = 2.12 \times 10^8$

Yes, because the wavelength change when the light travel from one medium to another.

A5. Using lens maker's formula; $\frac{1}{20} = (1.55 - 1) [\frac{1}{R} - (-\frac{1}{R})]$

$\frac{2}{R} = \frac{1}{20 \times 0.55}$

R = 22cm

A6. (a) $1/f = 1/v - 1/u$

Here f= 20cm, u = +12 (virtual object)

$1/20 = 1/v - 1/12$

$1/v = 1/20 + 1/12$

V = 7.5cm

(b) $-\frac{1}{16} = \frac{1}{v} - \frac{1}{20}$

$\frac{1}{v} = -\frac{1}{16} + \frac{1}{20}$

v = 48cm

A7. $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

(i) $\therefore \frac{1}{f} = \frac{1}{90-u} - \frac{1}{-u} = \frac{1}{90-u} + \frac{1}{u}$ -------------(1)

(iii) $\frac{1}{f} = \frac{1}{70-u} - \frac{1}{-(u+20)} = \frac{1}{70-u} + \frac{1}{u+20}$ ---------(2)

On solving equation (1) and (2) u =35cm

Using lens formula f = 21.4cm

A8. $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

For concave mirror f<0 and u<0

As object lies between f and 2f

(i) At u = -f

$\frac{1}{v} = -\frac{1}{f} + \frac{1}{f}$

$\Rightarrow v = \infty$

(ii) at u = -2f

$\frac{1}{v} = -\frac{1}{f} + \frac{1}{2f} = -\frac{1}{2f}$

$\Rightarrow v = -2f$

$\Rightarrow$ Hence image distance $v \geq -2f$

Since ‘v’ is negative, therefore image is real.

A9.

S.No.	Interference	Diffraction
1	All bright fringes are of same intensity	The intensity of bright fringes goes on decreasing with increasing order.
2	All bright fringes are of same width	Not of same width
3	Dark bands may be completely dark	Not completely dark

(Any two)

A10.For a convex mirror, f>0 and u<0 (negative)

$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

$\frac{1}{v} = \frac{1}{f} - \frac{1}{u}$

$\frac{1}{v} = \frac{1}{f} + \frac{1}{u}$ (using sign conventions)

$v = \frac{fu}{u+f} \Rightarrow$ v has +ve sign

$\Rightarrow v < f$ (as well as $v < u$)

The image lies between pole and focus

Magnification (m) = $\frac{v}{u}$

$\Rightarrow m < 1$ (since $v < u$)

A11. $M = m_0 \times m_e$

$M = \frac{L}{f_0}\left(1 + \frac{D}{f_e}\right)$

$30 = \frac{L}{1.25}\left(1 + \frac{25}{5}\right)$

$\Rightarrow L = 6.25$cm

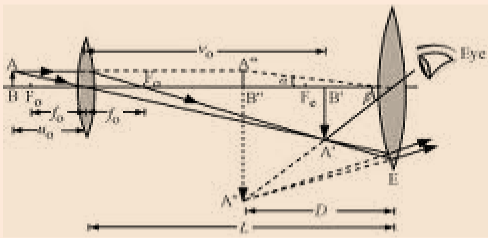
A12. $M = f_0 / f_e$

= 150/5 = 30

The angle subtended by the tower = $\frac{100}{3000} = \frac{1}{30}$radian

Angle subtended by the image produced by the objective

$\frac{h}{f_0} = \frac{h}{150}$



$\Rightarrow \frac{1}{30} = \frac{h}{150}$

$\Rightarrow$ h = 5cm

A13. Magnification when final image formed at infinity

$M = \frac{L}{f_0} \times \frac{D}{f_e}$

A14.Frequency since it is characteristics by source of light that cannot be affected by change of medium.

A15. $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ (for convex lens)

$= \frac{1}{30} = \frac{1}{v} + \frac{1}{40}$

$\frac{1}{v} = \frac{1}{30} - \frac{1}{40}$

v = 120cm

On introducing concave lens of focal length f = -50cm

u = 120 - 20 = + 100cm

Using lens formula

$\frac{1}{-50} = \frac{1}{v} - \frac{1}{100}$

$\frac{1}{v} = \frac{1}{100} - \frac{1}{50}$

v = -100cm

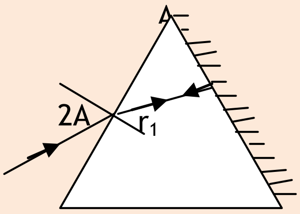
Change in position of the image = 200cm to the left of its original position.

A16. $A = r_1 + r_2$ ($r_2 = 0$)

$A = r_1$

$\mu = \frac{sini}{sinr} = \frac{sin2A}{sinA}$

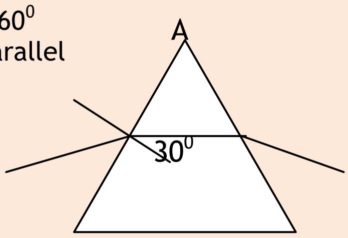
$\mu = 2cosA$



A17. Since angle of prism $=60^0$

And refracted ray is parallel to base of prism

$\Rightarrow$ angle of refraction $= 30^0$

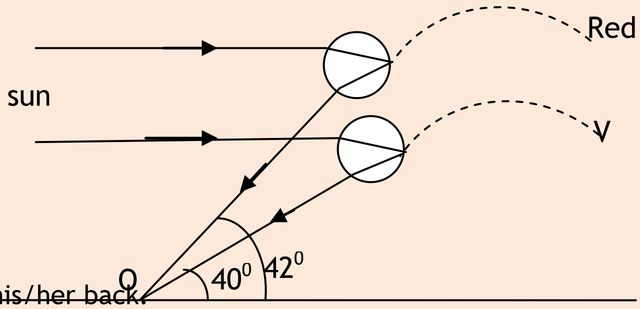


$\mu = \frac{sini}{sinr}$

$\sqrt{3} = \frac{\sin i}{\sin 30^0}$

sin i = $\sqrt{3}/2$

i = 60^0



A18. The conditions for observing a rainbow are:

i. The sun comes out after a rainfall.

ii. The observer stands with the sun towards his/her back.

A19. $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

$\frac{1}{10} = \frac{1}{v} + \frac{1}{15}$

$\frac{1}{v} = \frac{1}{10} - \frac{1}{15}$

V = 30cm

The image formed by convex lens acts as virtual object for concave lens which lies at 30 -3 = 27cm from the concave lens (right side)

u = + 27cm

$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

$-\frac{1}{10} = \frac{1}{v} - \frac{1}{27}$

$\frac{1}{v} = -\frac{1}{10} + \frac{1}{27}$

v = -15.8cm

A20. $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

The image formed by convex lens acts as virtual object for convex mirror Which lies at 20 +5 = 25cm from the convex mirror (left side)

$\frac{1}{20} = \frac{1}{v} + \frac{1}{10}$

$\frac{1}{v} = \frac{1}{20} - \frac{1}{10}$

V =-20cm

$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

$\frac{1}{15} = \frac{1}{v} - \frac{1}{25}$

$\frac{1}{v} = \frac{1}{15} + \frac{1}{25}$

V = 75/8 cm

Final image

For convex lens m = $\frac{v}{u} = \frac{I}{O}$

$\frac{-20}{-10} = \frac{I}{2}$

I = 4cm

For convex mirror,

m = $-\frac{v}{u} = \frac{I}{O}$

$= -\frac{75}{8(-25)} = \frac{I}{4}$

I = 1.5cm (final image)

A21. No effect on the size of image formed.
Intensity of image is reduced since light rays are reaching from half portion only.

A22.

a x ½ = $\frac{3}{2}\lambda$

a = 3 x 700 x 10^{-9}

= 2.1 x10^{-6} m

A23. In the first case, the overlapping of the contributions of the wavelets from two halves of a single slit produces a minimum because corresponding wavelets from two halves have a path difference of $\lambda/2$

In the second case, the overlapping of the wave fronts from the two slits produces first maximum because these wave fronts have the path difference ofλ.

A24. Fringe pattern on the screen will shift downwards with central fringe below point o, on the screen. Central fringe will be white, fringe closest on either side of central white fringe will be red and farthest will appear blue, after a few fringes, no clear pattern will be seen.

A25. $I_1 = I_0 \cos^2\theta$; where I_0 = intensity of light falling on middle Polaroid. Thus, intensity I_1 falls on the Polaroid at the end (Polaroid B) whose polarisation axis makes an angle of (90° -θ) with the polarisation axis of the angle of middle Polaroid. Therefore, the intensity of light emerging from the Polaroid B will be

$I_2 = I_1 \cos^2(90-\theta) = (I_0\cos^2\theta)\cos^2(90-\theta)$

$= I_0\cos^2\theta \sin^2\theta \quad = \frac{1}{4} I_0 (2\sin\theta\cos\theta)^2$

$= I_2 = \frac{1}{4}\sin^2 2\theta$

The transmitted light I_2 will be maximum when $\sin 2\theta = 1$ or $\theta = 45^0$

A26.Wavefront: It is the locus of points which oscillate in same phase.

A27. (i) No change, visibility will suffer (ii) No change, visibility may improve, and fringes may disappear depending upon the change in width of the source slit.

A28. Position of 4th bright fringe $y_4 = 4\frac{\lambda D}{d}$

$= 1\times10^{-2} = \frac{4\times\lambda\times1.5}{0.03\times10^{-3}}$

$= \lambda = 500A^0$

A29.i) Coloured fringes

ii) the width of fringes will also be different due to presence of different colour (Wavelengths)

A30. (i) No change because it does not depends upon D.

(ii)Angular width = $\beta/D = \lambda/d$, so it is reduced to half

A31. Position of maxima on the screen

$X_n = \frac{(2n+1)D\lambda}{2d}$

$15\times10^{-3} = \frac{5D\lambda}{2d} = \frac{5\times0.8\times600\times10^{-9}}{2d}$

d = 8×10^{-5}

A32. (i) For first order maxima; a sinθ = nλ

$a \times \sin 30^0 = 1 \times 700 \times 10^{-9}$

$a = 1.4 \times 10^{-6} m$

(ii) For first order maxima

$a \times \sin 30^0 = (2n + 1)\lambda /2$

$I_2 = I_1 \cos^2\theta = \frac{I_0}{2} \cos^2\theta$

$I_3 = I_2 \cos^2 (90-\theta) = \frac{I_0}{2} \cos^2\theta \times \cos^2 (90-\theta) = \frac{I_0}{2} \cos^2\theta \times \sin^2 \theta = \frac{I_0}{8}(2\sin\theta \times \cos\theta)^2$

$= \frac{I_0}{8} \times \sin 2\theta = \frac{I_0}{8}\sin 90^0 = \frac{I_0}{8}$ (Since $\theta = 45^0$)

A33. Let the intensity of light incident on first Polaroid = I_0

The intensity of light after passing through first Polaroid $I_1 = I_0 / 2$

Intensity of light after passing through 2nd Polaroid (middle) if it is making an angle 45^0 with first;

$I_2 = I_1\cos^2 45^0 = I_0/2 \left(\frac{1}{\sqrt{2}}\right)^2 = \frac{I_0}{4}$

Intensity of light after passing through third polaroid $I_3 = I_2 \cos^2 45^0 = \frac{I_0}{8}$

A34. Intensity $I_1 = 4a^2 \cos^2\theta/2 = 4a^2$

Similarly $I_2 = 4a^2 \cos^2 45^0 = 4a^2 \times ½ = 2a^2$

$I_1 : I_2 = 2:1$

A35. (i)Since $\frac{s}{S} \leq \frac{\lambda}{d}$ for observable interference so with increase in source slit width (s), the fringes do not remain sharp. When (s) become very wide then fringes disappear.

(ii) Central fringe will be white; fringe closest on either side of central white fringe will be red and farthest will appear blue, after a few fringes, no clear pattern will be seen.

A36. $P = (\mu -1)[\frac{1}{R} - (-\frac{1}{R})]$

$P = (\mu -1)[\frac{2}{R}]$

After cutting $R_2 = \infty$

$P' = (\mu -1)\frac{1}{R} \Rightarrow \frac{P'}{P} = \frac{1}{2}$

$P' = \frac{P}{2} \Rightarrow f' = \frac{1}{P'} = \frac{2}{P} = 2f$

A37. We know that $n_1\lambda_1 = n_2\lambda_2$, other terms are similar

$3 \times 700 = 5 \times \lambda_2 \Rightarrow \lambda_2 = 420nm$

A38. $n_1 = \frac{c}{v_1} = \frac{v\lambda}{v\lambda_1} = \frac{\lambda}{\lambda_1}$

$n_2 = \frac{c}{v_2} = \frac{v\lambda}{v\lambda_2} = \frac{\lambda}{\lambda_2}$

$\frac{n_1}{n_2} = \frac{\lambda_2}{\lambda_1} \Rightarrow \lambda_2 = \frac{n_1}{n_2}\lambda_1$

A39. X- is a denser medium

$\frac{\sin\theta}{\sin 90^0} = \frac{1}{{}_Y\mu_X} \Rightarrow {}_X\mu_Y = \sin\theta$

We know that ${}_X\mu_Y = \frac{v}{v'}$

$\sin\theta = \frac{v}{v'} \Rightarrow v' = \frac{v}{\sin\theta}$

A40. $\mu = \frac{\sin i}{\sin 30^o} \Rightarrow \sqrt{2} = 2\sin i$

$i = 45^0$

A41. Since A is denser than B and B is denser than C

$\mu_1 > \mu_2 > \mu_3$ $\left(\mu = \frac{1}{\sin i_C}\right)$

$\Rightarrow C_1 < C_2 < C_3$

A42. Refractive Index = $\frac{C}{v} = \frac{1}{\sqrt{\mu_0 \in_0}} \times \sqrt{\mu \in} = \sqrt{\frac{\mu \in}{\mu_0 \in_0}}$

A50. $\frac{1}{f_e} = \frac{1}{v_e} + \frac{1}{u_e}$ on solving **u_e** = -4.2cm

$\frac{1}{f_o} = \frac{1}{v_o} - \frac{1}{u_o}$ on solving u_o = -1.1cm

$m = \frac{v}{u}\left(1 + \frac{D}{f_e}\right) = -44$

SHORT ANSWER TYPE QUESTIONS: 3-MARKS

A1.When the light passes from denser medium to rarer medium it always bends away from the normal. When angle of incidence in denser medium becomes greater than the critical angle the, the light ray reflects internally instead of refraction. Because the light can incident at the angle greater than critical angle inside the prism.

- They form brighter image than that of mirrors.
- The image formed by prisms is free from defects like spherical aberration, chromatic aberration.

A2. (a) It is because; light which is produced from an ordinary source (like a sodium lamp) is unpolarised, when an unpolarised light wave is passed through a Polaroid sheet, it gets linearly polarised with the electric vector oscillating along the direction perpendicular to the aligned molecules at every orientation of Polaroid sheet.

b) It is because the relative refractive index of lens becomes less than 1 and $\frac{1}{f} \alpha$ (μ -1) focal length 'f' becomes -ve, hence, lens behave like a diverging lens.

c) Due to short focal length of eye piece, angular magnification of eye piece increases and magnification of objective is large when $|u_0|$ is slightly greater than f_0 ,since the microscope is used for viewing very close object therefore $|u_0|$ is small and hence , f_0 should be small.

A3. $\sin i_c$ = 1/ 1.33 = 3/4

$\tan i_c = r/h$

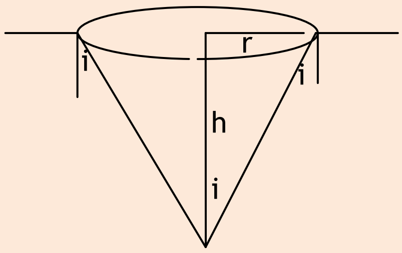
$r = h \tan i_c$

Area of through which light will emerge out

$= \pi r^2$

$= \pi h^2 \tan^2 i_c$

$= \frac{\pi h^2 \sin^2 i_C}{1 - \sin^2 i_C} = \frac{3.14 \times (0.8)^2 \times \frac{3^2}{4}}{1 - \frac{3^2}{4}} = 2.6\text{m}^2$



A4.Since u>f (given)

(a) $\frac{1}{f} = \frac{1}{v} + \frac{1}{u} \Rightarrow v = \frac{fu}{u-f}$

Using sign convention; $v = \frac{(-f)(-u)}{(-u)-(-f)} = \frac{uf}{f-u}$

Since u >f $\Rightarrow$ the difference (f - u) will be negative

$\Rightarrow$ 'v' is negative, **hence the image is real.**

Since $|f - u|$< 'u' as well as 'f'

$\Rightarrow$ **v > 2f**

(b) $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$ $\Rightarrow$ v = $\frac{fu}{u-f}$

Using sign convention; v = $\frac{f\,(-u)}{(-u)-f}$ $\Rightarrow$ v is always positive; hence the image is always virtual.

(c) As per above result v = $\frac{-fu}{-(u+f)}$ = $\frac{fu}{u+f}$ ----- (i)

m = - $\frac{v}{u}$ = $\frac{-fu}{-(u+f)u}$ = $\frac{f}{u+f}$ < 1

Hence **the image is always diminished**

From equation (i) v < f as well as u (same result as we obtain in parallel combination of resistances)

Hence the image lies between f and pole of mirror.

A5. $\frac{1}{f}$ = $\frac{1}{v}$ - $\frac{1}{u}$

$\frac{1}{10} = \frac{1}{v_1} - \frac{1}{-30}$

V_1 = 15cm

This image acts as object for concave lens, the object distance = 15 – 5 = +10cm

Using lens formula $\frac{1}{-10}$ = $\frac{1}{v_2}$ - $\frac{1}{10}$ $\Rightarrow v_2 = \infty$

For third lens u = ∞ , f = 30cm

v_3 = 30cm

A6. v_1= 40cm (the object is placed at 2f so the image formed by L_1 lies at 2f), it lies at 20cm left of L_2. i.e. at the focus of L_2 , Hence distance between L_1 and L_2 is = 40 + 20 = 60cm. As the image formed by lens L_2 lies at infinity, then the distance between L_2 and L_3 does not matter.

A7.(a)Refractive index of glass w.r.t. liquid $_\ell\mu_g = \frac{\mu g}{\mu_\ell}$

$\text{Sin}i_C = \frac{1}{_\ell\mu_g} = \frac{\mu_\ell}{\mu_g}$

$\mu_\ell = \mu_g \sin i_C = 1.5 \times \frac{\sqrt{3}}{2} = 1.299 = 1.3$

(b) (i) Angle of incident at surface BC is 30^0(inside the liquid).

A8. For lens: $\frac{1}{v}$ - $\frac{1}{u}$ = $\frac{1}{f}$

$\frac{1}{v} - \frac{1}{-15} = \frac{1}{10}$ $\Rightarrow$ v = 30cm

Nature of image- real, magnified

Final image formed will be at the object itself only if image formed by lens is at the position of centre of curvature of mirror

D = 30 + R = 30 + 20 = 50cm

(Distance of mirror from lens)

A9. (a)Reasons: Reflecting telescopes can be made to have

(i) Larger light gathering power

(ii) Better resolution

(Also: less expensive; easier to design; free from aberrations) (any two)

(b) $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$\Rightarrow$ v = $\frac{uf}{u-f}$

As „u" is always –ve for a real object and 'f 'is +ve for a convex mirror (as per Cartesian sign convention)

v is always +ve.

Hence, the image is always on the other side of the mirror (and hence, virtual for all u)

A11. **Since $\ell\mu g$ = $\frac{a\mu g}{a\mu\ell}$ = $\frac{1.5}{\frac{15}{8}}$ = $\frac{4}{5}$**

$\frac{1}{f_\ell} = (\ell^{\mu g} - 1)(\frac{1}{R_1} - \frac{1}{R_2}) \Rightarrow$- $-\frac{1}{50} = \left(\frac{4}{5} - 1\right)(\frac{1}{R_1} - \frac{1}{R_2}) \Rightarrow (\frac{1}{R_1} - \frac{1}{R_2})$ = $\frac{1}{10}$

$\frac{1}{f_a}$ = (1-5 -1)($\frac{1}{10}$) ⇒ f_a = 20cm

A12.M_e = (1+ $\frac{D}{f_e}$) ⇒ 5 = (1 + $\frac{20}{f_e}$) ⇒ f_e = 5cm

Using lens formula for Eye piece lens: f_e = 5cm, V_e = D = -20cm, we get u_e = 4cm

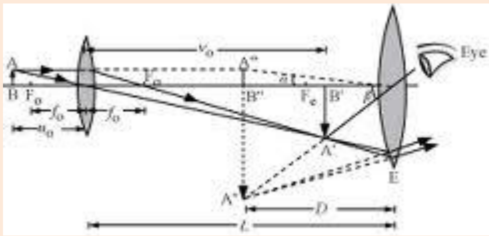
L = $|v_o|$ + $|u_0|$ = 14

⇒ v_o = 10cm

Since $\frac{v_o}{u_o}$(1 + $\frac{D}{f_e}$) = 20 ⇒ u_0 = 5/2

Using lens formula for objective lens, V_0 = 10cm, u_0 = - 5/2 ⇒ f_0 = 2cm.

A12. M = $\frac{v_e}{u_e}$



u_e = $\frac{v_e}{M}$ = $\frac{-20}{5}$ = -4 cm

$\frac{1}{v}$ - $\frac{1}{u}$ = $\frac{1}{f}$

$\frac{1}{f_e} = -\frac{1}{20} + \frac{1}{4}$

f_e = 5cm

M = Me x Mo

-20 = 5 x Mo ⇒ Mo= -4

Also $|v_o|$ + $|u_e|$ = 14

⇒ v_o = 14 -4 = 10cm

M_o = 1 - $\frac{v_o}{f_o}$ ⇒ -4 = $\frac{10}{f_0}$

⇒ f_o =2cm

A13. μ = 1 / $\text{Sin}i_C$

Since = 1/μ = √3/2 ⇒ i_C = 60^0

Hence, refracted ray grazes the surface AC.

- Angle of emergence = 90^0
- Angle of deviation = 30^0

A14. **(a) u** = - 9cm, f = + 10cm, Area of each square (Object) =1mm x1mm = $1mm^2$

Linear magnification ‘m’ = v/u

For lens 1/v = 1/f + 1/u = 1/10 - 1/9 = -1/90

⇒ v = -90cm

m = v/u = -90 /-9 = 10

Since lens produces linear magnification, area of each square in the image

= (1mmx10) x 1mm x 10) = $100mm^2$

(b) Angular magnification = M = $\frac{D}{|u|}$ = 25/9 = 2.8

(c) No, the magnification produced by lens in part (a) is v/u while the magnifying power of the lens in part (b) is D/u. Obviously, the two are not equal unless v = D, i.e. the image is formed at least distance of distinct vision

A15. Using lens maker's formula, taking R1 = R2 = R and μ = 1.5, we can calculate R = 30cm In the presence of liquid, combined focal length = 45cm, let f_2 be the focal length of the Plano-concave lens

$1/F = 1/f_1 + 1/f_2$ or $1/45 = 1/30 + 1/f_2 \Rightarrow f_2 = -90$cm

For Plano- concave lens f_2 = -90cm, R_1 = -R = -30cm, R_2 = infinity, μ_2 =?

$1/-90 = (\mu_2 - 1)(1/-30 - 1/\infty) \Rightarrow \mu_2 = 1.33$

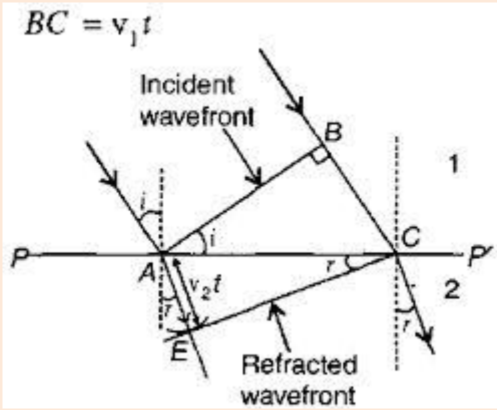
A18. (i) In diffraction pattern, intensity will be minimum at an angle $\theta = n\lambda/a$. There will be a first minimum at an angle $\theta = \lambda/a$ on either side of central maximum

width of central maxima = $2\lambda/a$

Whereas the width of other minimum/ maximum $\approx \lambda/a$

(ii) The intensity of maxima decreases as the order (n) or diffraction maxima increases. This is because, on dividing the slit into odd number of parts, the contributions of the corresponding (outermost) pairs cancel each other, leaving behind the contribution of only the innermost segment. For example, for first maximum, dividing slit into three parts out of these three parts of the slit, the contributions from first two parts cancel each other; only 1/3 rd portion of the slit contributes to the maxima of intensity. Similarly for, second maxima, dividing slit into five parts, contribution of first four parts will be zero (as they cancel each other). The remaining 1/5th portion, only, will contribute for maxima; and so on.

A19. **Refraction of Plane wavefront:**



i. According to Huygens' principle, every point on the Wave front AB is a source of secondary wavelets.

ii. The secondary wavelets from point B strikes the surface PP' at point C in t seconds.

$\therefore BC = v_1 t$

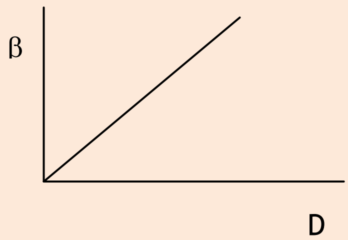
Iii. The secondary wavelets from point A will travel a distance AE in denser medium in same time

$\therefore AE = v_2 t$

$\frac{\sin i}{\sin r} = \frac{BC}{AE} = \frac{v_1}{v_2} = {}^1\mu_2$, this proves Snell's law

A21. Conditions: The two superposing sources must be coherent and obtained from the same source.

Formula: $\beta = D\lambda/d$
Slope = λ/d
λ = slope x d
Effect: the fringe width would increase



A

A23. Resultant Intensity $I = 4I_o \cos^2(\phi/2)$

OR $I_R = I_o + I_0 + 2I_0 \cos\phi$

When the path difference is λ , phase difference is 2π

$\therefore I_R = I_0 + I_0 + 2I_0$

$= 4I_0 = K$

If path difference is $\lambda/4$, phase difference is $\pi/2$

$\therefore I_R = I_0 + I_0 + 0$

$2I_0 = K/2$

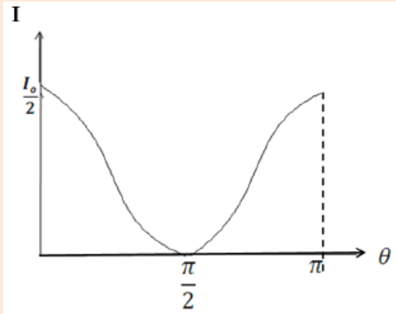
A24. (a) The intensity of interference fringes in double slit arrangement is modulated by the diffraction pattern of each slit.

OR, In double slit experiment the interference pattern on the screen is actually superposition of single slit diffraction for each slit.

(b) Waves diffracted from the edges of the circular obstacle interfere constructively at the centre of the shadow producing a bright spot.

(c) Resolving power = $\frac{2\,\mu\, sin\theta}{1.22\lambda}$

Resolving power is inversely proportional to wavelength and directly proportional to the refractive index.



A26. (a) $I_2 = I_1 \text{Cos}^2\,\theta$ (figure)

(b) I_1 light transmitted by P_1

I_3 = light transmitted by $P_3 = I_1 \cos^2\beta$

I_2 = light transmitted by $P_2 = I_3 \cos^2(\theta\text{-}\beta)$

$\therefore I_2 = I_3$

$I_1 \cos^2\beta \cos^2(\theta\text{-}\beta) = I_1 \cos^2\beta$ (as $\theta = \beta$)

Also $I_1 = I_2$

$I_1 = I_1 \cos^2\beta \cos^2(\theta\text{-}\beta)$

$\cos^2\theta = 1$

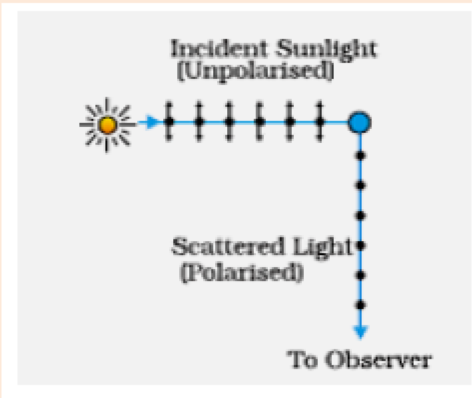
$\therefore \theta = 0^0$ Or π

A27. Let unpolarized light be incident on a polaroid; its electric vectors, oscillating in a direction perpendicular to that of the alignment of the molecules in the polaroid, are able to pass through it while the component of light along the aligned molecules gets blocked. Hence the light gets linearly polarised.

I_1 will remain unaffected whereas I_2 will decrease from maximum (=Io/2) to zero of the incident light.

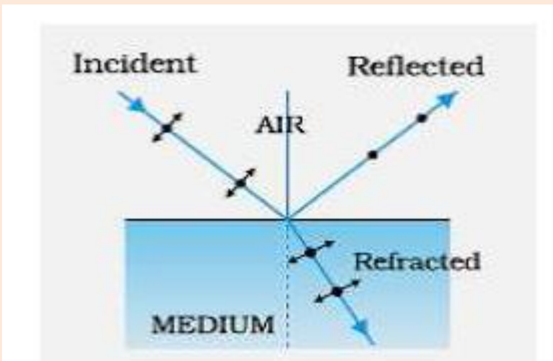
$I_2 = I_1 \cos^2\theta$, $I_2 = (Io\ /\ 2) \cos^2\theta$

A28. The basic phenomenon / process which occurs is polarisation. The incident unpolarised sun light encounter the molecules of earth's atmosphere. Under the influence of electric field of incident wave the in the molecule acquires component of motion in both these direction. If an observer is looking 900 to the direction of the Sun, charge accelerating parallel to double arrow do not radiate energy towards the observer.[Their acceleration has no transverse component.] This explain polarisation of scattered light from sky.



(b) When unpolarised light is incident at polarising angle, at the interface of a refracting medium, the reflected ray being perpendicular to the refracted ray is completely polarised.

$\mu = \frac{sini}{sinr}$



$= \frac{\sin i_p}{\sin(90^0 - i_p)}$

$\mu = \tan i_P$

A41. Definition- Locus of all points which oscillate in phase.

i. Huygen's Principle- Each point of the wave front is the source of a secondary disturbance and the wavelets emanating from these points spread out in all directions. These travel with the same velocity as that of the original wave front.

ii. The shape and position of the wave front, after time't', is given by the tangential envelope to the secondary wavelets.

A42. I.Reflection and refraction arise through interaction of incident light with atomic constituents of matter which vibrate with the same frequency as that of the incident light. Hence frequency remains unchanged.

ii.No. [Energy carried by a wave depends on the amplitude of the wave, not on the speed of wave propagation].

iii.For a given frequency, intensity of light in the photon picture is determined by the number of photon incident normally on a crossing an unit area per unit time.

A46. $T_2P = D + x$, $T_1P = D - x$

$S_1P = [(S_1T_1)^2 + (PT_1)^2]^{1/2}$

$= [D^2 + (D - x)^2]^{1/2}$

$S_2P = [D^2 + (D + x)^2]^{1/2}$

Minima will occur when $S_2P - S_1P = \lambda/2$

$D = \frac{\lambda}{2(\sqrt{5} - 1)}$

LONG ANSWER TYPE QUESTIONS: 5-MARKS

UNIT- VII: Dual Nature of Matter and Radiation

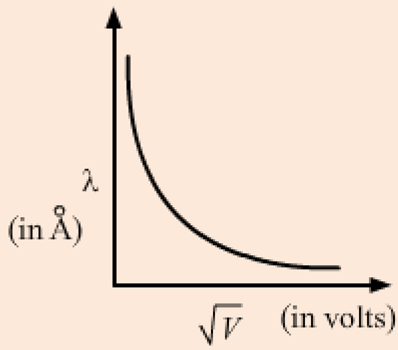
VERY SHORT ANSWER TYPE QUESTIONS: 1 -MARK

A1.**Work function:** The minimum energy required to knock out an electron from a metal surface, is called work function of that surface.

A2.The wave associated with moving material particle, is called matter wave.

Wavelength $\lambda = \frac{h}{mv}$

A3.



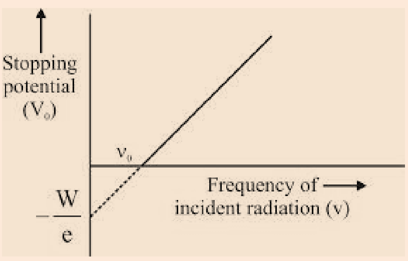
A4.The K.E. of that photoelectron will be more which are emitted from the metal surface having low work function.

A5.Blue light because frequency of blue light is more that than red light.

A6. $\lambda = \frac{12.27}{\sqrt{100}} = 1.227A^0$

A7. To establish the wave nature of light.

A8.



A9. Velocity increases as K.E. α $1/\lambda$

A10. No emission of photoelectron is possible.

A11. Stopping potential depend upon frequency of incident radiation.

A12.A because it has less slope and $\lambda \; \alpha \; \frac{1}{\sqrt{m}}$

A13.Intensity of radiation.

A14.No emission because the frequency of red light is less than green light.

A15.Because the emitted electrons have different energies, so they reach on anode accordingly.

When all emitted photo electrons get attracted by anode, the photocurrent gets saturated at particular fix intensity.

A16. As the frequency of incident radiation increases, the energy of emitted photoelectron also increases. That is why stopping potential also increases.

A17.One photon can eject only one photoelectron. To increase the intensity of radiation means to increases the number of photons striking per second, thus the photoelectric current increases with increase of intensity of radiation.

A18.because all the emitted electrons are not coming from same energy levels.

A19. One photon can eject only one photoelectron. To increase intensity means to increase the number of photons striking per second. Therefore the photoelectric current increases with intensity. Increase in frequency does not affect on the number photons in the radiation.

SHORT ANSWER TYPE QUESTIONS: 2-MARKS

A1.Photons emitted/ second (n) = $P/h\nu = P\lambda/hc$

The photoelectrons emitted in 2 min = $120 \times P\lambda/hc$

$$= \frac{66 \times 600 \times 10^{-9}}{6.62\times10^{-34}\times3\times 10^{8}} = 2.4 \times 10^{22}$$

A2.Using relation $\lambda = \frac{h}{\sqrt{2mqV}}$

Mass of proton = m and charge on proton = q

Mass of α- particle = 4m , charge on α- particle = 2q

We have $V_p / V\alpha = 8:1$ and $v_p / v_\alpha = 4:1$

A3. Since $\lambda = \frac{h}{mv} \Rightarrow m^2v^2 = \frac{h^2}{\lambda^2}$

$\therefore$ K.E. $= \frac{1}{2}\times \frac{h^2}{\lambda^2 \times m} = 6.95 \times 10^{-25}$J

A4.For deuteron mass = 2m and charge =q

Mass of α- particle = 4m, charge on α- particle = 2q

Using relation $\lambda = \frac{h}{\sqrt{2mqV}}$

$\lambda_D / \lambda_\alpha = 2:1$

A5.According to de-Broglie hypothesis

$2\pi r_n = n\lambda$

$= n.\frac{h}{mv_n}$

$2\pi r_n \, v_n = n.\frac{h}{2\pi}$

It is the Bohr's postulate of quantization of angular momentum of electron.

A6.Wavelength of photon $\lambda = \frac{hc}{E}$ (since E = hν)

$= 3.31 \times 10^{-9}$

Momentum (mv) of electron $= \frac{h}{\lambda} = \frac{6.62 \times 10^{-34}}{3.31 \times 10^{-9}} = 2 \times 10^{-25}$kgm/s.

A7. Einstein's photoelectric equation

$eV_0 = h\nu - w_0$ .... (1)

Where is the work function and it can be calculated using graph

Since $w_0 = h\nu_0$

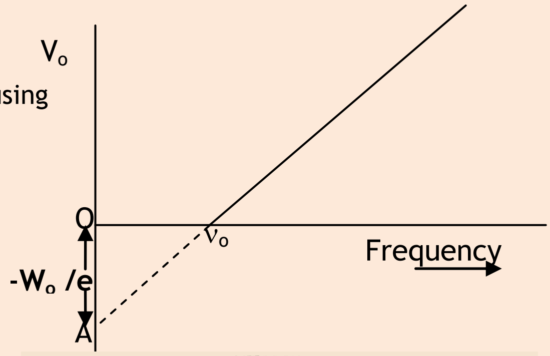
Or work function = intercept (OA) $\times$ e

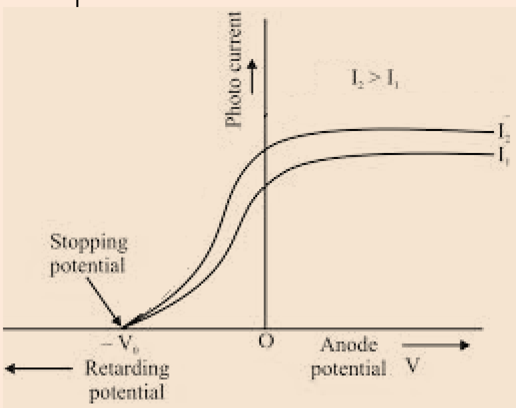
On differentiating above equation (1)

$\Delta V = \frac{h}{e}\Delta\nu$

The slope of graph $= \frac{\Delta V}{\Delta\nu} = \frac{h}{e}$

Plank's constant (h) = e $\frac{\Delta V}{\Delta\nu}$





A8.Energy of photon E = hν = $\frac{hc}{\lambda}$

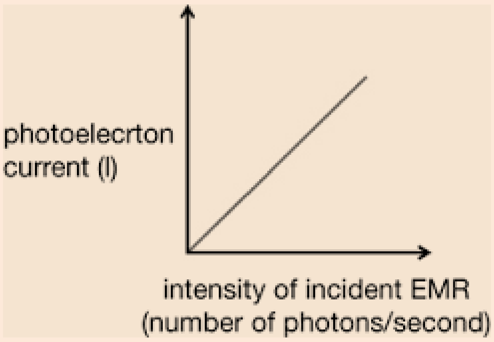
Wavelength associated with electron $\lambda = \frac{h}{\sqrt{2m_eK}}$

Kinetic Energy (K) $= \frac{h^2}{2m_e\lambda^2}$

$\frac{K}{E} = \frac{h}{2m_eC\lambda} = 3.66 \times 10^{-4}$

A9.Use $\lambda = \frac{h}{mv} = 2.9 \times 10^{-12}$m

A10. (i)Threshold frequency: The minimum frequency below which no emission of photoelectrons can take place from a particular metal surface.



A11.(i)Wavelength $\lambda = \frac{h}{\sqrt{2mqV}} = \frac{h}{\sqrt{2mK}}$

Since $m_D < m_\alpha$ so wavelength of Deuteron is greater.

(ii) Since kinetic energy (K) = qV

$q_\alpha > q_d$

for the same accelerating potential, we have

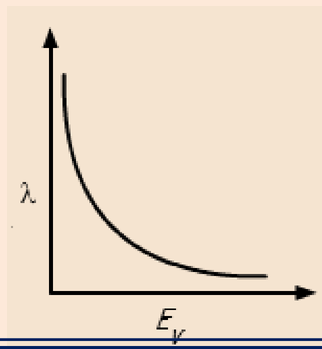
K.E. of deuteron will be less.

A12.Use P = nhν

Number of photon emitted per second (n) = 9.1×10^{15}

A13. (i) Number of emitted electrons will be same in both cases because number of emitted electrons depends upon intensity of incident radiation, not on the frequency of radiation.

(ii)More energic photoelectrons will be emitted with radiation of frequency (ν_1)



A14. Using Einstein's photoelectric equation

Energy of incident photon; $E_V = K_{max} + w_0$

As $w_0 = 0$

$\Rightarrow E_V = K_{max}$

$K_{max} = \frac{P^2}{2m} = E_v$

Momentum $P = \sqrt{2mE_v}$

Wavelength of emitted electron $\lambda = \frac{h}{P} = \frac{h}{\sqrt{2mE_v}}$

A15. Direct question

A16. Since work function is negligible

$\frac{1}{2}mv^2 = hf$

$v^2 \propto f$

$v \propto \sqrt{f}$ ----(1)

When frequency is made 4 times then, maximum velocity (V_{max})

$V_{max} \propto \sqrt{4f}$ ---------------- (2)

From equation (1) and (2)

$\frac{V_{max}}{v} = 2 \Rightarrow V_{max} = 2v$

A17. Using equation

$\lambda = \frac{h}{\sqrt{2mqV}}$ and taking mass of proton = m and charge = q

Mass of alpha particle = 4m and charge = 2q

$\frac{\lambda_\alpha}{\lambda_p} = 1 : 2\sqrt{2}$

A18.(a) Metal surface Q

(a) The slope of line gives the value of h/e.

A19. Energy of photon, $E = h\nu \Rightarrow \nu = E/h = (2\times10^3 \times 1.6\times10^{-19}) / 6.62\times10^{-34} = 4.83\times10^{17}$Hz

$\lambda = c/\nu = 6.21A^0$

SHORT ANSWER TYPE QUESTIONS: 3-MARKS

A1. The radiations have dual nature and this universe is composed of radiation and matter. Therefore de-Broglie concluded that the moving material particle must possess dual nature since nature loves symmetry.

K.E. of particle = $\frac{1}{2}mv^2 = \frac{1}{2}m \times \frac{h^2}{m^2\lambda^2}$ (since $v = h/m\lambda$)

$E_k = \frac{1}{2} \times \frac{h^2}{m\lambda^2}$

Energy of photon $E = \frac{hc}{\lambda} \Rightarrow \frac{E}{E_k} = \frac{2\lambda mC}{h}$

Energy of photon $E = \frac{2\lambda mC}{h}$ x energy of particle.

A2.(a) Einstein's Equation ; $h\nu - h\nu_0$ = K.E.

Explanation: (i) Maximum KE of emitted photoelectron depends on frequency and not on intensity.

(ii) There exists a threshold frequency (ν_0) (for which) below which no photoemission takes place.

(b) According to Einstein's photoelectric equation for wavelength λ_1

$K_{max} = \frac{hc}{\lambda_1} - \emptyset_0$ ...... (1)

For wavelength λ_2

$2\ K_{max} = \frac{hc}{\lambda_2} - \emptyset_0$

$K_{max} = \frac{hc}{2\lambda_2} - \frac{\emptyset_0}{2}$ .... (2)

From equation (1) and (2)

$= \frac{hc}{\lambda_1} - \emptyset_0 = \frac{hc}{2\lambda_2} - \frac{\emptyset_0}{2}$

$\emptyset_0 = 2hc\ (\frac{1}{\lambda_1} - \frac{1}{2\lambda_2})$

$= \frac{hc}{\lambda_0} = hc\ (\frac{2}{\lambda_1} - \frac{1}{\lambda_2})$

$= \lambda_0 = \frac{\lambda_1\lambda_2}{2\lambda_2 - \lambda_1}$

A3. **Stopping Potential:** The maximum negative potential given to anode which able to stop repel) all the emitted photoelectrons so that the photoelectric current become zero.

Threshold Frequency: Threshold frequency: The minimum frequency below which no emission of photoelectrons can take place from a particular metal surface.

$eV_0 = h\nu - h\nu_0$

Stopping potential $V_0 = \frac{h}{e}\nu - \frac{h}{e}\nu_0$

When we draw a graph between stopping potential and frequency, the point at which graph line intersect the frequency axis, this value of frequency determines the threshold frequency for a particular surface.

A4.Definition : It is defined as the number of photons (of given frequency)incident per unit area per unit time.

Work function $w_0 = \frac{hc}{\lambda} - eV_0$

$= (\frac{6.6\times10^{-34}\times3\times10^{8}}{2270\times10^{-10}\times1.6\times10^{-19}} - 1.3)eV$

Ans: 4.2eV

For red light, the incident photon energy will be less than the work function, hence no emission of Electrons.

A5. Incident photon energy($h\nu$) is used up in two ways:

(1) A part of this energy is used to remove the electrons.

(2) Remaining part of the energy imparts KE to the emitted electrons

$h\nu = K.E. + h\nu_0$

$h\nu - h\nu_0 = K.E.$

Explanation: (i) Maximum KE depends on frequency and not on intensity.

(ii) There exists a threshold frequency (for which) below which no photoemission takes place.

(iii)Basic elementary process involved is absorption of photon by e-.This process is instantaneous.

A6.(i) Current increases as the number of photons striking per second increases with increase of intensity of light.

(iv) No effect, photoelectric current is independent of frequency incident radiations.

(v) The electric current increases first and then gets saturated at particular frequency.

A7.Using; $h\nu = w_0 + K.E.$

We get $\frac{hc}{\lambda} = 0 + K.E.$

Using $\lambda_1 = \frac{h}{\sqrt{2m\,K.E.}} = \frac{h}{\sqrt{2m\frac{hc}{\lambda}}} = \sqrt{\frac{h\lambda}{2mc}}$

On squaring and adjusting, we get $\lambda = \left(\frac{2mc}{h}\right)\lambda_1{}^2$

A8.(a) Number of photon emitted = $\frac{power\ of\ source}{Energy\ of\ one\ photon} = \frac{P}{h\nu} = \frac{P\lambda}{hc}$

$= 5 \times 10^{15}$

(b) Metal X because it has less work function.

(c) No change because it does not depend upon intensity of radiation, on increasing distance the, the intensity of radiation falling on metal get change.

A9. (a) According to Einstein, packets of energy called photons, which are absorbed completely by electrons. This absorbed energy is used to eject the electron and also provide kinetic energy to the emitted electron.

(b) $\frac{1}{2}m v_{max}{}^2 = h\nu - w_0$

$v_{max}{}^2 = (\frac{2h}{m})\nu - \frac{2w_0}{m}$

Slope $\frac{2h}{m} = \frac{\ell}{n}$

$h = \frac{m\ell}{2n}$

Intercept $= \frac{2w_0}{m} = \ell$

$w_0 = m\ell/2$

A10.(a) Definition : It is defined as the number of photons (of given frequency)incident per unit area per unit time.

(b)The number of photons per unit area per second is same because both beams have same intensity.

(i) The radiation with blue colour has more frequency so the energy of emitted photoelectrons has more K.E. with blue radiation.

A11. (a) 1. There is no emission of photoelectrons i.e. no current if the frequency of the incident radiation is below a certain minimum value however large may be the intensity of the light.

2 The current varies directly with the intensity of the incident radiation.

3. The current becomes zero at a certain value of negative potential, applied at the anode, this is known as stopping potential.

4. The value of stopping potential increases with the increase in the frequency of the incident radiation.

5. Maximum kinetic energy of the photo electrons does not depend upon intensity of light.

6. Maximum kinetic energy of photoelectron increases with the frequency of the incident radiation.

7. The process of photoelectric emission is instantaneous. **(Any three)**

(b) It fails to explain why

1. The photo electric emission is instantaneous.

2. There exists a threshold frequency for a given metal.

3. The maximum KE of photoelectrons is independent of the intensity of incident radiation.

A12 i) The energy of a photon is $h\nu$.

ii) Each photon is completely absorbed by a single electron.

iii) The energy of photon should be greater than work function of metal.

$E_k = h\nu - w_0$

$h\nu = h\nu_0 + E_K$ (since $w_0 = h\nu_0$)

$= h\nu_0 + \frac{1}{2}mv_{max}^2 = h\nu_0 + eV_0$

And $E_K = h(\nu - \nu_0)$

When Incident frequency < Threshold frequency, there will be no emission of electrons. Hence, frequency of incident radiation should be greater than threshold frequency.

$E_K = eV_o = h\nu - w_0$

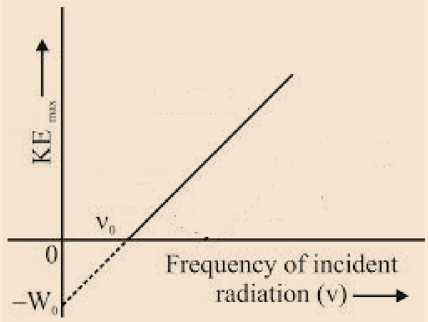
$V_0 = \frac{h}{e}\nu - w_0/e$

At $\nu = \nu_0$, $E_K = eV_o = 0$

V_o is called stopping potential.

A13.(a) As given above

(b)Graph between maximum K.E. and frequency



A14. Direct theoretical question.

A15. $E_k = h\nu - w_0$

(a) Threshold frequency of surface A is greater than 10^{15}Hz.

(b) Threshold frequency of surface B is equal to 10^{15}Hz.

If the wavelength of incident radiation is decreased the energy of incident radiation ($h\nu$) becomes greater than work function (w_0) of surface B. The photoelectrons eject out with certain energy from the surface.

A16. Max K.E. = $eV_0 = h\nu - W_0$

i) K.E. become more than double,

For first case, $h\nu = K_1 + W_0$

For second case, $2h\nu = K_2 + W_0$

$\Rightarrow 2 = \frac{K_2 + W_0}{K_1 + W_0}$ or $2K_1 + 2W_0 = K_2 + W_0$

$\Rightarrow K_2 = 2K_1 + W_0$

(ii)No change, it does not depend upon frequency of incident radiation

(iii) Stopping potential get doubled, stopping potential α frequency of radiation.

A17.(i) $E_{max} = h\nu - w_0$

$= \frac{6.62\times10^{-34}\times6\times10^{14}}{1.6\times10^{-19}} - 2.14$

= 0.34eV

(ii) eV_0 = 0.34eV

V_0 = 0.34V

(ii) $\frac{1}{2}mv^2 = h\nu - w_0$

$= 6.62\text{x}10^{-34} \text{ x } 6\text{x}10^{14} - 2.14 \text{ x} 1.6\text{x}10^{19}$

$= 5.48 \text{ x}10^{-20}$J

Velocity (v) = $3.47\text{x}10^5$m/s

A18.(a) Energy of incident photon $E= h\nu = \frac{hc}{\lambda} = \frac{6.62\times10^{-34}\times3\times10^8}{310\times10^{-9}} = 6.4 \text{ x}10^{-19}$J = 4eV

Kinetic energy of emitted photoelectron, K.E. = $h\nu - w_0$

$= 4eV - 1.5eV = 2.5eV$

(b) Threshold wavelength $\lambda_0 = \frac{hc}{w_0} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{1.5 \times 1.6 \times 10^{-19}} = 8288\ A^0$

(c) $eV_0 = 2.5eV$

$V_0 = 2.5V$

LONG ANSWER TYPE QUESTIONS: 5-MARKS

A1. (a) Direct theoretical question

(b)Derivation of formula $\lambda = \frac{h}{\sqrt{2meV}}$

(c) $K.E. = h\nu - w_0$

$= \frac{6.62 \times 10^{-34} \times 3 \times 10^8}{4500 \times 10^{-10} \times 1.6 \times 10^{-19}} - 1.8 = 0.96eV$

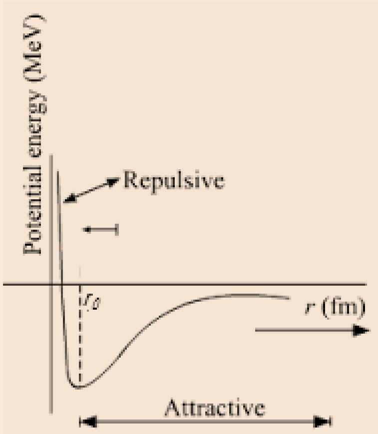
$eV_0 = K.E. = 0.96eV$

$V_0 = 0.96Volts$

UNIT- VIII: Atoms & Nuclei

VERY SHORT ANSWER TYPE QUESTIONS: 1 -MARK

A1.



A2. **Ans:** $\lambda_p > \lambda_B > \lambda_\ell$

A3. **Ans:** Since $r_n = r_0 n^2 \Rightarrow r_2 / r_1 = 4/1$

A4. **Ans:** Electron and nucleus form a bound system

A5. **Ans:**Lyman series

A6. **Ans:**Lyman series

A7. **Ans:** Balmer series

A8.$r = r_0 n^2 = 5.3x10^{-11}x (3)^2 = 4.77x10^{-10}m$

A9. The maximum energy of β- particle emitted during β- decay of radioactive substance.

A10.It is defined as the rate of disintegration of radioactive sample. Unit: Bq

A11.Activity of a radioactive substance.

A12.A neutrino is a neutral particle. It interacts very weakly with a material particle.

A13.The rate of disintegration of a radioactive sample at any instant is directly proportional to number of nuclides present at that instant.

A14.The β- particle always emitted along with antineutrino / neutrino. The energy emitted during decay process is mainly shared with β- particle and antineutrino / neutrino. Hence low energy β- particles are accompanied with high energy antineutrino / neutrino and vice-versa. Hence we get β- particle of different energy.

A15. $N = N_0 e^{-\lambda t}$

$- dN/dt = R = N_o (-\lambda)e^{-\lambda t} = \lambda N$

A16.4 +3+2+1 = 10 transition $\Rightarrow$ 10 spectral lines. Or $\frac{n(n+1)}{2} = \frac{4(4+1)}{2} = 10$

A17.Paschen series.

A18.There is always loss (defect) in mass in formation of a nucleus. This mass defect converts into binding energy that binds up all the nucleons together.

A19.$E_g = -13.6eV$, $E_{second} = -1.51eV \Rightarrow E_{second} - E_g = 12.09eV < 12.5eV$

Since $E_{third} = -0.85eV \Rightarrow E_{third} - E_g = 12.75 > 12.5eV$ $\Rightarrow$ Excitation up to Second e-level (Second excited state).

SHORT ANSWER TYPE QUESTIONS: 2-MARKS

A1. The energy associated with wavelength 487.5nm

$E = hc/\lambda = 2.55eV$

Since $E_n = -13.6/n^2$

$E_2 - E_1 = 10.2eV$ (given) {It means $E_1 = -13.6eV$ and $E_2 = -3.4eV$}. It follows that state n =2 has an excitation energy 10.2eV. Hence the electron is making transition from $n = n_1$ to n = 2, where $n_1 > 2$.

(i) Now $E_{n1} - E_2 = hc/\lambda = 2.55eV$ [hc/λ= energy of radiator)

$E_{n1} = -3.4 + 2.55 = 0.85eV$

(ii) We have , $E_{n1} = -13.6 / n_1^2$

$-13.6 / n_1^2 = -0.85 \Rightarrow n_1 = 4$

A2.Derivation of equation for orbits radius;

$$r_n = \left(\frac{h^2}{z^2 \pi m e^2}\right) n^2$$

$$r_n = r_0 \, n^2$$

A3.Using formula $r_0 = \frac{1}{4\pi\epsilon_0} \times \frac{2Ze^2}{K.E.}$

$$= \frac{9\times 10^9 \times 2 \times 80 \times (1.6\times 10^{-19})^2}{4.5 \times 10^6 \times 1.6 \times 10^{-19}} = 5.12\text{x}10^{-14}\text{m}$$

A4.For ground sate

K.E. = 13.6eV (since K.E. = -T.E.)

P.E. = 27.2eV (since P.E. = 2xT.E.)

For second excited sate (n = 3)

$K.E. = \frac{-(-13.6\text{eV})}{9} = 1.51eV$

P.E. = -3.02eV

A5. Postulate- Energy is radiated when an electron jumps from a (permitted) higher to lower orbit and it equal to the difference in energy in the two orbits.

$h\nu = E_i - E_f$

$\frac{1}{\lambda_\alpha} = R_H \left[\frac{1}{2^2} - \frac{1}{3^2}\right] = 1.03\text{x}10^7 \times \frac{5}{36}$

= 699nm

A6. $\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2mE}}$

$\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{E_2}{E_1}}$

For first excited state n = 2 , $E_2 = \frac{E_1}{4}$

$\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{1}{4}} = \frac{1}{2}$

$\lambda_2 = 2\lambda_1$

= 2x wavelength associated in ground state.

OR

K.E (K)= = 13.6eV = 2.18×10^{-18}J

$\lambda_1 = \frac{h}{\sqrt{2mK}} = 0.33nm$

$2\pi r_n = n\lambda_n$

$\lambda_{\text{ground state}} = 2\pi \times 0.53A^0 \approx 3.33A^0 = 0.33nm$

In first excited state, the de Broglie wavelength will increase.

Q6.de- Broglie wavelength $\lambda = h/mv$

$\therefore \lambda \propto \frac{1}{v}$; and $v \propto \frac{1}{n}$

$\therefore \lambda \propto n$

$\therefore$*de* -Broglie wavelength will increase OR

Other possible way can be;

As $2\pi r_n = n\lambda$; $\lambda = \frac{2\pi r_n}{n}$ $(\lambda \propto \frac{r_n}{n})$

$r_n \, \alpha \, n^2$

$\therefore \lambda \propto \frac{n^2}{n} \Rightarrow \lambda \propto n$

$\therefore$*de* Broglie wavelength will increase

A7.(a) Z = 56, A = 89

(b) Difference in the total mass of the nuclei on the two sides of the reaction gets converted into energy or vice versa

The number is conserved but the B.E. / nucleon can be different for different nuclei.

A8.Using $A = \frac{0.693N}{T}$

$A_1 = \frac{0.693N_1}{T_1}$ and A2 = $\frac{0.693N_2}{T_2} \Rightarrow \frac{A_1}{A_2} = \left(\frac{N_1}{N_2}\right)\left(\frac{T_2}{T1}\right)$

A9.Transition corresponding to Lyman: C &E

Balmer : B & D

$\frac{\lambda_L}{\lambda_B}$ = 3/10 = 0.3 $\left[Since\ \lambda_L = \frac{hc}{E_L}\right]$

A10.$\frac{\lambda_1}{\lambda_4} = \sqrt{\frac{K_4}{K_1}} = \sqrt{\frac{1}{16}} = \frac{1}{4}$ $\left(since\ \lambda = \frac{h}{\sqrt{2mK}}\right)$

$\lambda_4 = 4\lambda_1$

$\lambda_1 = \frac{1}{4}\lambda_4$

Wavelength becomes 1/4 times.

A11. $\frac{1}{\lambda} = R\left(\frac{1}{{n_1}^2} - \frac{1}{{n_2}^2}\right)$

For Lyman series =$n_1 = 1$ and $n_2 = \infty$

$\lambda_L = \frac{1}{R}$

For Balmer series =$n_1 = 2$ and $n_2 = \infty$

$\lambda_B = R/4 = 3640A^0$

A12.In β^- decay, a neutron converted into proton so the number of proton increases thus the atomic number increases by one unit.

In β^+ decay a proton converted into neutron so the number of proton decreases thus the atomic number decreases by one unit.

A13.For shortest wavelength $n_1 = 2$ and $n_2 = \infty$

$\frac{1}{\lambda} = R\left(\frac{1}{{n_1}^2} - \frac{1}{{n_2}^2}\right)$

$\lambda_B = R/4 = 3640A^0$

A14. For Lyman series =$n_1 = 1$ and $n_2 = \infty$

$\frac{1}{\lambda} = R\left(\frac{1}{{n_1}^2} - \frac{1}{{n_2}^2}\right)$

$\lambda_L = \frac{1}{R}$

A15.$E_2 - E_1$ =-3.4eV -(-13.6eV) = 10.2eV

$E\infty - E_2$ = 0 – (-3.4) = 3.4eV

Ratio = 10.2/3.4 = 3

A16.During beta decay, a neutron converted into proton, beta particle (electron) and antineutrino.

$n = p + {}_{-1}^{0}e + \bar{\nu}$

This new created electron emitted from the nucleus.

A17. Mass defect Δm = 22. 994466u – (22.989770u + ≈ 0)

= 0.004696u

E = 0.004696u x 931.5 MeV = 4.37MeV

A18. A = $\frac{0.693N}{T}$ = $\frac{0.693 \times 25 \times 10^{20}}{1.5 \times 10^{17}}$ = 1.15 x10^4Bq

A19. ${}^{22}_{11}Na \xrightarrow{Positive\ beta\ decay} {}^{22}_{10}Na + {}^{0}_{1}e + \nu$

Isobar

A20. No of atoms present in 1g of Uranium = $\frac{6.023 \times 10^{23}}{238}$ = 2.53 x10^{21}

Half life = 4.5x10^9 x 365x24x60x60 = 1.42x10^{17} second

A = $\frac{0.693N}{T}$ = $\frac{0.693 \times 2.53 \times 10^{21}}{1.42 \times 10^{17}}$ = 1.23x10^4Bq

A21. Distance of closest approach = r_0 = $\frac{1}{4\pi\epsilon_0} \frac{2Ze^2}{\frac{1}{2}mv^2}$

$\frac{9 \times 10^9 \times 2 \times 80 \times 1.6 \times 10^{-19}}{8 \times 10^9}$ = 288 x10^{-19}m

A22. Emitted energy (E) = -0.85eV-(-3.4eV) = 2.55eV

Wavelength λ = $\frac{hc}{E}$ = $\frac{6.63 \times 10^{-34} \times 3 \times 10^8}{2.55 \times 1.6 \times 10^{-19}}$ = 487.5nm

Balmer Series

A23. ${}_3Li^7 + {}_1H^1 \longrightarrow {}_2He^4 + {}_2He^4 + Q$

Total mass of Nuclei on left = 8.02634u

Total mass of Nuclei on right = 8.00780

Mass defect Δm = 8.0263 – 8.0078 = 0.01854

Energy released = 0.01854 x 931= 17.26MeV

A24. K.E. = -(total energy)

= - (- $\frac{13.6}{9}$) = 1.51eV

P.E. in 3rd excited state = 2 x T.E.

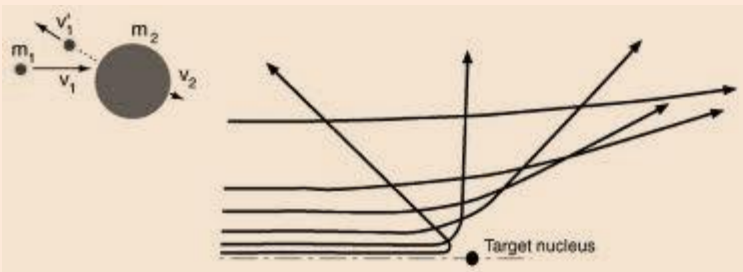
= 2 x $\frac{13.6}{16}$ = 2 x 0.85 = 1.7eV

SHORT ANSWER TYPE QUESTIONS: 3-MARKS

A1. Only a small fraction of the incident α-particles rebound. This shows that the mass of the atom is concentrated in a small volume in the form of nucleus and gives an idea of the size of the nucleus.

Radius of nucleus

$R = R_0 A^{1/2}$



Density = $\frac{mass}{volume}$

= $\frac{mA}{\frac{4}{3}\pi R^3}$

= $\frac{mA}{\frac{4}{3}\pi (R_0 A^{\frac{1}{3}})^3}$

= $\frac{3m}{4\pi {R_0}^3}$

$\Rightarrow$ Nuclear density is independent of mass number A.

A2. **Nuclear Fission:** The breaking of heavy nucleus into smaller fragments is called nuclear fission.

Nuclear Fusion: The joining of lighter nuclei to form a heavy nucleus is called nuclear fusion.

Binding energy per nucleon, of the daughter nuclei, in both processes, is more than that of the parent nuclei. The difference in binding energy is released in the form of energy. In both processes some mass gets converted into energy.

Total mass of reactants= 2.014102 + 3.016049 = 5.030151u

Total mass of products = 4.002603 +1.008665 = 5.011268

Mass defect = 5.030151u -5.011268 = 0.018883u

Energy released = 0.018883 x 931.5 = 17.5895145MeV

A3. a) Nuclear fission of E to D and C; as there is increase in binding energy / nucleon

Nuclear fusion of A to B to C; as there is an increase in binding energy/ nucleon.

b) α- Particle, β - particle.

A4. **Activity:** It is defined as rate of disintegration of radioactive substance.

A = $-\frac{dN}{dt}$ = λN

S.I. unit: Becquerel (Bq)

Activity after 20hrs from a moment = 10,000dps

After 10 hrs thereafter:

Activity of sample become 5000dps i.e. half of the previous rate

$\Rightarrow$ Half life = 10hrs

Activity after 20hrs = $\frac{1}{2^2} = \frac{1}{4}$ times of initial activity

$\therefore$ Initial activity = 10000 x 4dps

= 40000dps.

<u>Alternate method;</u>

R = $R_0 e^{-\lambda t}$

100000 = $R_0 e^{-\lambda \times 20}$

50000 = $R_0 e^{-\lambda \times 30}$

On dividing above equations

2 = $e^{\lambda \times 10}$

Log2 = 10λ

= $\frac{log2}{T} \times 10$

T= 10hrs

Initial activity = 10000 $\times$ $(2)^2$

= 40000dps

A5. ${}^{11}_{6}C \rightarrow {}^{11}_{5}X + {}^{0}_{1}e$ (β^+ particle) + Q

${}^{11}_{5}X$ is a isobar of ${}^{11}_{6}C$

Mass defect: 11.011434u – 11.009305u = 0.002129u

Energy released = 0.002129 x 931 = 1.9821MeV

A6. The coulomb's force between electron and nucleus of hydrogen atom:

$$F = \frac{1}{4\pi\epsilon_0}\frac{e \times e}{{r_n}^2}$$

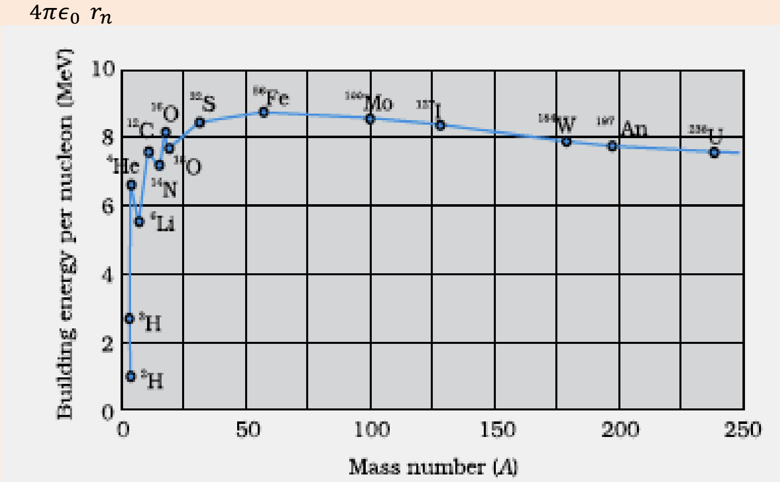
This force provides necessary centripetal force for electron revolving with velocity v_n;

$$\frac{m{v_n}^2}{r_n} = \frac{1}{4\pi\epsilon_0}\frac{e \times e}{{r_n}^2} \qquad \Rightarrow m{v_n}^2 = \frac{e^2}{4\pi\epsilon_0\, r_n}$$

Now, K.E$_n$ = $\frac{1}{2}$ m${v_n}^2$ = $\frac{1}{2}.\frac{e^2}{4\pi\epsilon_0 r_n}$ = $\frac{1}{8}.\frac{e^2}{\pi\epsilon_0 r_n}$

P.E$_n$ = $\frac{1}{4\pi\epsilon_0}\frac{e}{r_n}(-e) = -\frac{1}{4\pi\epsilon_0}\frac{e^2}{r_n}$

(Using formula P. E. = $\frac{q_1 q_2}{4\pi\epsilon_0 r_n}$)



A7. a) Nuclear forces are short range/ saturated

b) Mass number of A = 180

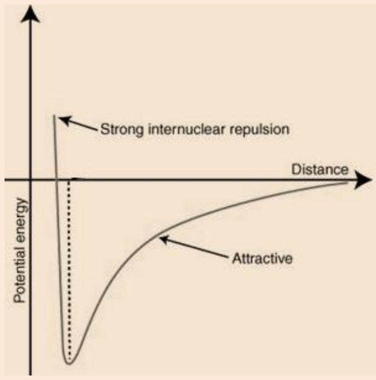
Atomic number of A is 70

A8.a) Mass defect (Δm) =

=[Z m_p + (A-Z)m_n] - ${}^{A}_{Z}M$

Binding energy = Δm x 931.5 MeV

b) From the binding energy per nucleon curve, it is clear that binding energy per nucleon, of the fused nuclei is more than those of the lighter nuclei taking part in nuclear fusion. Hence energy gets released in the process.



A9.1.They are strongest attractive force only whereas the Coulomb forces are attractive as well as repulsive.

2. They don't follow the inverse square law.

3. They are short range forces (any Two)

A10. We know, N = $N_0\, e^{-\lambda t}$

When t = $T_{1/2}$ = T (Half- life)

N = $N_o/2 \Rightarrow \frac{N_0}{2}$ = $N_o\, e^{-\lambda T}$

$\frac{1}{2} = e^{-\lambda T}$

-λT = $\log_e 2$ = 2.303 $\log_{10} 2$ = 2.303 x 0.3010

T = $\frac{0.693}{\lambda}$

$N/N_0 = (\frac{1}{2})^n = \frac{6.25}{100} = \frac{625}{10000} = \frac{1}{16} = (\frac{1}{2})^4$

n = 4 Half life's

= 4 x 100= 400days

A11.(a) 1. They are strongest attractive fundamental forces in nature.

2. They are charge independent.

3. They are short range forces.

4. They are spin dependent and not follow inverse square law.

(b) See the graph of Q-(9)

A12. (i) Mass Defect: It is defined as the difference between the mass of the constituent nucleons of the nucleus in the free state and the mass of the nucleus.

Mass defect (Δm) = {mp Z + m_n (A-Z)} – M

Binding Energy = (Δm) $\times$ c^2

(ii) Mass defect = (1.00783 + 3.016049) – (2 x 2.014102)

= 4.023879 – 4.028204 = - 0.004325

Energy = - 0.004325 x 931.5 = - 4.03MeV

A13.(i) Energy of ground state = -13.6eV

Energy of n = 4 excited state = -13.6/16 = -0.85eV

Therefore the energy photon absorbed = E_2 -E_1 = -0.85 - (-13.6) = 12.75eV = 12.75 x 1.6 x10^{-19}J

$\frac{hc}{\lambda}$ = 12.75 x 1.6 x10^{-19}

$\lambda = \frac{6.63\times10^{-34}\ \times3\times10^{8}}{12.75\times1.6\times10^{-19}}$ = 0.975 x 10^{-7} = 975 A^0

(ii) R = $(n)^2\, r_0$ = $(4)^2$ x 5.3x10^{-11} m = 8.48A^0

A14. **E_n = -13.6eV/n^2**

Energy required to excite hydrogen atoms from ground state to the second state

= E_{final} - $E_{initial}$

$= -1.51 - (-13.6)eV = 12.09\ eV < 12.3eV$

Hence the electron will go to second excited state or third energy level.

For second member of Lyman series: $n_1 = 1$ and $n_2 = 3$

$\frac{1}{\lambda} = R\left(\frac{1}{{n_1}^2} - \frac{1}{{n_2}^2}\right) = R\left(\frac{1}{1} - \frac{1}{3^2}\right) = \frac{8R}{9}$

$\lambda = \frac{9}{8R} = \frac{9}{8 \times 1.097 \times 10^7} = 1.027 \times 10^{-7}$ m = 102.5 nm

For second member of Balmer series: $n_1 = 2$ and $n_2 = 4$

$\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{4^2}\right) = \frac{3R}{16}$

$\lambda = \frac{16}{3 \times 1.097 \times 10^7} = 4.86 \times 10^{-7}$m = 486nm

A15. (a) "The rate of disintegration of radioactive substance at any instant is directly proportional to the number of nuclei / atoms in the radioactive substance at that instant".

$-\frac{dN}{dt} \alpha\ N$

This equation can be written as $\frac{dN}{N} = -\lambda dt$

Integrating both side, we get $\int \frac{dN}{N} = -\int \lambda dt$

$\log_e N = -\lambda t + K$ (Where k is constant of integration)

when $t = 0$, $N = N_0$

So we have, $\log_e N_0 = K$

$\log_e N = -\lambda t + \log_e N_0$

$\log_e N - \log_e N_0 = -\lambda t$

$\log_e \left(\frac{N}{N_0}\right) = -\lambda t$

or $N = N_0\, e^{-\lambda t}$, N_0 is the initial number of atoms at $t = 0$

(b) ${}^{22}_{11}Na \rightarrow {}^{22}_{10}N_e + e^+ + \nu$

OR ${}^{22}_{11}Na \rightarrow {}^{22}_{10}X + e^+ + \nu$

Basic process; $p \rightarrow n + e^+ + \nu$

Product is **Isobar**

A16. **(a)** $r_n = n^2 r_0$

$\frac{r_1}{r_2} = \frac{2^2}{3^2}$

$\frac{21.2 \times 10^{-11}}{r_2} = \frac{4}{9}$

$r_2 = \frac{21.2 \times 10^{-11} \times 9}{4}$

Ans; 4.77×10^{-10}m

(b) As KE = - (Total Energy)

= -(-13.6eV) = 13.6eV

K.E. in first excited state = 13.6/4 = 3.4eV,

P.E. = -2xKE = -6.4eV

A17.(i) Energy of electron in 2nd excited state = $-\frac{13.6}{9} = -1.51eV$

Energy required moving an electron from ground state to 2nd excited state;

= -1.51 -(-13.6) = 12.09eV

(ii) (a) K.E. in second excited state = -(T.E.) = - (-1.51) = 1.51 eV

(b) Orbital Radius = r_3 = $(3)^2$ x 0.53 x10^{-10}m = 4.77 x 10^{-10}m

A18.Mass of 26 Protons = 26x 1.007825 = 26.20345u

Mass of 30 Neutrons = 30 x 1.008665 = 30.25995u

Mass of Nucleons' = 56.25995u

Mass defect = 56.4634 – 55.934932 = 0.5285u

B.E. = 0.5285 x 931 = 492.003708MeV

B.E./Nucleon = 492.003708/ 56 = 8.79MeV.

A19. α- decay is given as

$${}^{238}_{92}U \quad \rightarrow \quad {}^{234}_{90}Th \ + {}^{4}_{2}He$$

In this case initial ratio of N/Z (for ${}^{238}_{92}U$) 146/92 = 1.59

Final ratio after decay (N/Z) = 144/90 = 1.6 so ratio increases.

$\bar{\beta}$- decay is given as

$${}^{32}_{15}P \quad \rightarrow \quad {}^{32}_{16}S \ + {}^{0}_{1}e(\bar{\beta}) \ + \bar{\nu}$$

Initial value N/Z = 17/15 = 1.13

Final value N/Z = 16/16 =1 so ratio decreases.

β^+ decay : ${}^{12}_{6}C \ \rightarrow {}^{11}_{5}B + {}^{0}_{1}e$ (β^+)

Initial N/Z = 6/6 = 1, Final N/Z = 6/5 = 1.2 so ratio increases.

LONG ANSWER TYPE QUESTIONS: 5-MARKS

A1 i. An electron in an atom revolves in certain stable orbit without the emission of radiant energy.

ii. Electron revolves around the nucleus only in those orbit for which the angular momentum is an integral multiple of h/2π.

According to classical electromagnetic theory, an accelerated electron emits radiation in the form of electromagnetic waves. Therefore energy of electron would decrease continuously and electron would spiral inward and eventually fall into the nucleus, such an atom can not be stable. As the electrons spiral inwards, their frequency would change continuously, thus they would emit a continuous spectrum in contradiction to the line spectrum observed. . To overcome above shortcomings, Bohr's theory came into existence.

Rydberg formula $\frac{1}{\lambda}$ = R ($\frac{1}{{n_1}^2}$ - $\frac{1}{{n_2}^2}$)

For wavelength of first member of Lyman series of hydrogen spectrum; n_1 = 1 and n_2 = 2

$$\lambda = 4\ /3R = \frac{4}{3 \times 1.03 \times 10^7} = 1.2945 \times 10^{-7}\ m = 1294A^0$$

A2. (a) (i) ${}^{238}_{92}U \rightarrow {}^{234}_{92}Th + {}^{4}_{2}He$ + Q OR ${}^{A}_{Z}X \ \rightarrow {}^{A-4}_{Z-2}Y + {}^{4}_{2}He$ + Q

(ii) ${}^{32}_{15}P \rightarrow {}^{32}_{16}S$ + e^- + $\bar{\nu}$ OR ${}^{A}_{Z}X \ \rightarrow {}_{Z+1}{}^{A}Y$ + e^- + $\bar{\nu}$

(b) Binding energy per nucleon of the fussed nuclei (${}^{3}_{2}He$) is more than the binding energy per nucleon of the lighter nuclei (${}^{2}_{1}H$) i.e. final system is more tightly bound than the initial system therefore energy is released.

(c) The radius of nucleus R =$R_0A^{1/2}$

Density = $\frac{mass}{volume}$ = $\frac{mA}{\frac{4}{3}\pi R^3}$ = $\frac{mA}{\frac{4}{3}\pi (R_0 A^{\frac{1}{3}})^3}$ = $\frac{3m}{4\pi {R_0}^3}$ $\Rightarrow$ Nuclear density is independent of mass number A.

UNIT- IX: Electronic Devices:

VERY SHORT ANSWER TYPE QUESTIONS: 1 –MARK

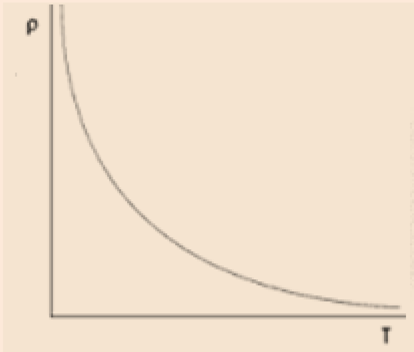
A1.**Intrinsic Semiconductor**: A semiconductor which is pure and contains no impurity is known as an intrinsic semiconductor. In an intrinsic semiconductor, the number of free electrons and holes are equal.

Extrinsic Semiconductor: The semiconductor in which a small quantity of impurity (pentavalent or trivalent) is added is called extrinsic semiconductor.

A2.The depletion layer decreases and the diode may conduct.

A3.because the electrons present in valance band jump to conduction band and take part in conduction after getting energy.

A4. Variation of resistivity with temperature:



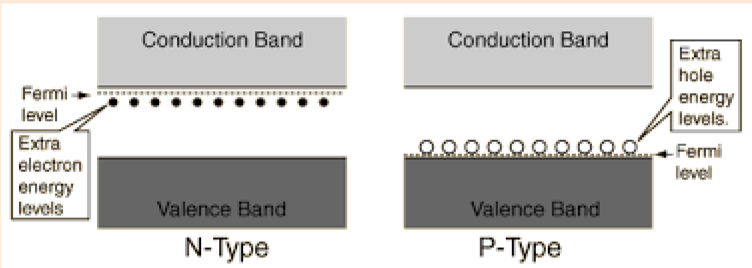
A5. Due to very less forbidden energy gap.

A6.**Depletion Layer:** A layer formed near the junction which is depleted from charge carriers (holes and electrons), is called depletion layer.

A7.**Potential Barrier**: A potential difference developed across the depletion layer due to recombination of charge carriers (holes and electrons), is called potential barrier.

A8.

A9.



(Energy band diagram of n-type and p-type semiconductor)

A10.For silicon diode: 0.7V and for germanium: 0.3V.

A11.$\lambda_m = \frac{hc}{E_g}$: where h: Plank's constant, c = velocity of light.

A12. (i) Width will decrease (ii) field will be high.

A13. Width of deletion layer decreases with decrease of reverse bias.

A14.Reverse bias.

A15. When a diode is forward biased, the recombination of holes and electrons take place and the energy is released. In ordinary diodes, this energy lies in infrared region whereas in LED is lies in visible region.

A16.Decreases

A17.Output frequency =100Hz

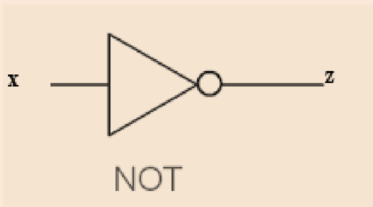
A18.NAND and NOR gates.

A19. Emitter region is highly dopped and base region is lightly dopped.

A20. Electrons move from base to collector region **or** emitter to collector region bia base region.

A21.80^0

A22. Current: I = V/R = 6/250 = 0.03V

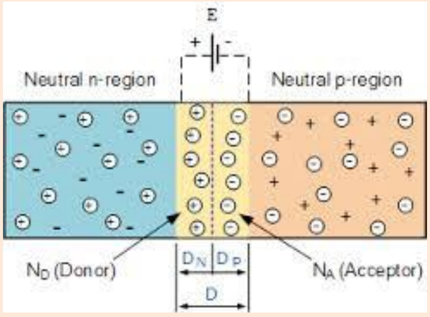


NOT Gate Truth Table

X	Z
0	1
1	0

A23. NOT gate and its truth table.

SHORT ANSWER TYPE QUESTIONS: 2-MARKS



A1. When PN junction is formed, the diffusion of majority charge carrier take place from one section to another section due to presence different nature of charge carriers in P and N sections. The holes and electrons recombine with each other near the junction and deletion layer is formed.

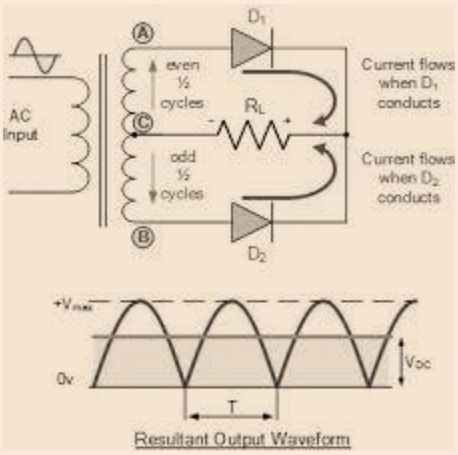
Due to recombination of charge carriers, an electric field is created across the deletion layer and potential barrier is created.

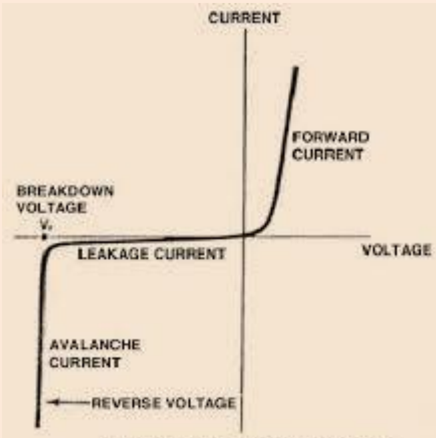
A2. (a) Because the applied electric field and the electric field across the depletion layer support each other.

(b) The transistor is not a power generating device. The energy for the higher ac power at the output is supplied by the biasing batteries.

A3.V-I characteristics of p-n junction:

A4.Full wave rectifier





V-I characteristics of a real diode

A5.(a) The base-emitter junction (input) is forward biased whereas the collector- base junction (output) is reversed biased.

(b)The reverse bias on collector is made quite high so that it may exert a large attractive force on the charge carriers to enter the collector region.

A6. R - OR gate and S-AND gate

A	B	Y
0	0	0
0	1	0
1	0	1
1	1	1

A7. P= NAND Gate

Q = OR gate

A	B	X
0	0	1
1	0	1

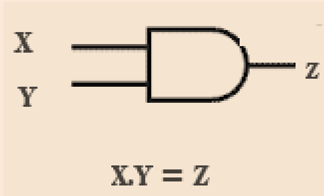
0	1	1
1	1	1

A8.P- OR gate

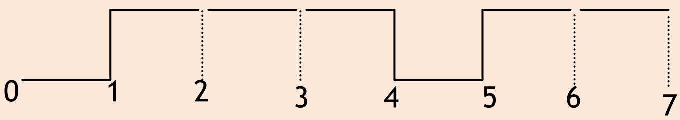
Q= NAND gate

A	B	X
0	0	1
1	0	0
0	1	0
1	1	0

A9.



A	B	X
0	0	1
1	0	0
0	1	0
1	1	0



A10. Energy associated with given wavelength:

$E = \frac{hc}{\lambda} = \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{6000 \times 10^{-10}} = 3.315 \times 10^{-19} J = \frac{3.315 \times 10^{-19}}{1.6 \times 10^{-19}} = 2.07eV$

Since $E < E_g$ so it will not be detected .

A11. V = 5.5V - 0.4V = 5.1V hence

$= \frac{5.1}{5.1 \times 10^{3}} = 10^{-3} A = 1$ mA

A12.I_c = 10mA

$I_c = 0.95 I_e$

$10 = 0.95 I_e$

I_e = 1000/95 = 10.53mA

$I_E = I_C + I_B$

$10.53 = 10 + I_b$

I_b = 10.53 - 10 = 0.53mA

A13. $\beta = 100$, I_e = 8.08mA

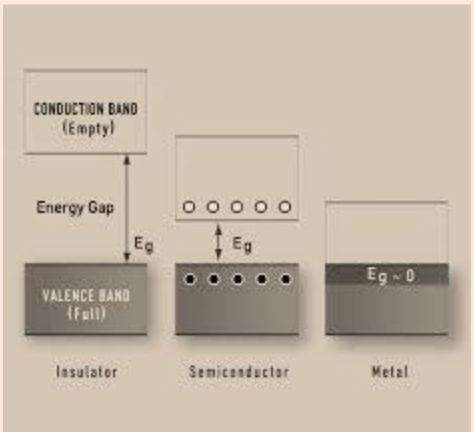
$\beta = \frac{I_c}{I_b} \Rightarrow I_c = 100 I_b$

$I_E = I_C + I_b$

$8.08 = I_b + 100 I_b$

I_b = 0.08mA

I_c = 8mA



SHORT ANSWER TYPE QUESTIONS: 3-MARKS

A1. (i) In conductors, collision become more frequent at highter temperature lowering conductivity.

(ii) In semiconductors, more electron hole pairs become available at higher temperature so conductivity increases.

(iii) In insulators, the band gap is unsurpassable for ordinary temperature rise. Hence there is practically no change in their behaviour.

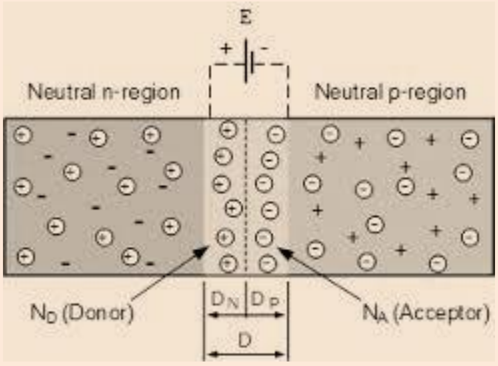
A2. Two important process involved during the formation of p-n junction is:

(i) Diffusion (ii) drift

Diffusion is the movement of majority charge carrier across the junction. Diffusion results in the formation of negative and positive space charge region around the junction.

Drift is the movement of minority charge carriers across the junction.

Depletion Region: The depletion layer is the negative and positive space charge region formed around the junction.



Potential Barrier: The potential developed across he junction that opposes the flow of majority carriers.

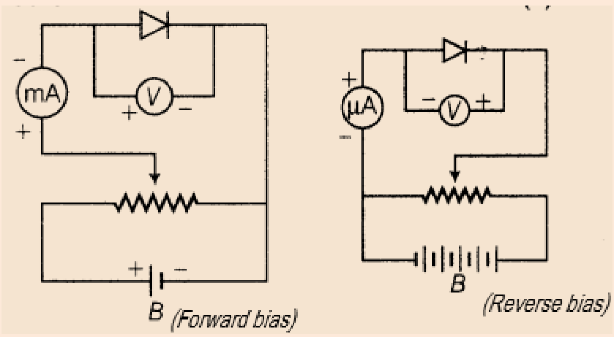
A3. (a)As soon as the junction is formed, the electrons crossing the junction from N-region into the P region recombine with holes in the P-region very close to the junction. Similarly holes crossing the junction from the P-region into the N-region, recombine with electrons in the N-region very close to the junction.

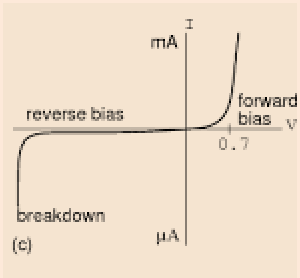
The space charge region on either side of the junction which get devoid of mobile charge carrier is known as the depletion layer.

The loss of electrons from n-side and holes from p-side cause a potential difference across the junction, it is known as potential barrier.

(b) Barrier potential decreases in forward bias and potential barrier increases in reverse bias.

A4.(i)





(i) During forward bias majority charge carriers (electrons) enter from n region to p region which are actually minority carriers in p. This is called minority injection.

(ii) At very high reverse bias voltage, the current suddenly increases. This voltage is called breakdown voltage.

A5. (i) Zener diode

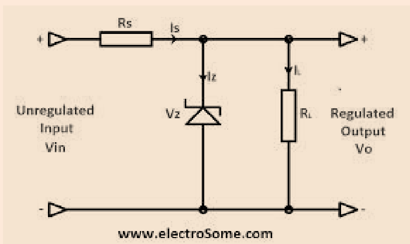
A8. Capacitor smoothen the output. Or capacitor bypasses the a.c. (if any) and blocks d.c.

A9. LED is fabricated by;

(i) LED is fabricated from semiconductor having a band gap $\geq 1.8eV$.

(ii) Heavy doping of both p and n regions.

(iii) Providing transparent thin cover so that light can come out. (Any one point)



Working: When diode is forward bias electrons are sent from n side to p- side and holes fron p- side to n-side. At the junction boundary, the excess minority charge carriers on either side of junction recombine with majority carriers.

This releases energy in visible region in the form of photon $h\nu = E_g$

Advantages: Low operational voltage, long life, Fast on/off switching capability, no warm-up time required.(Any two)

A10. Two important consideration in fabrication of Zener diode:

(i) Zener diode is fabricated by heavy doping of its p and n sections.

(ii) Appropriate 'breakdown voltage' under reverse bias.(any one)

Since doping is high, the depletion layer becomes very thin. Hence electric field (V/d) high even for a small reverse bias.

Working: If input d.c. voltage increases / decreases, current through Zener diode will also increases/ decreases. It increases / decreases voltage drop across R_s without any change in voltage across R_L (as potential across Zener diode does not change in break down region) giving the regulated output voltage.

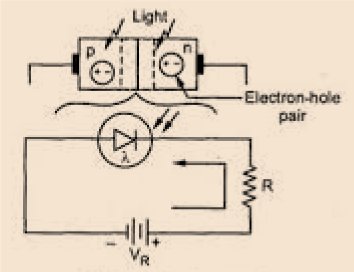
A11. Answer as above.

A12. It is fabricated with a transparent window to allow light to fall on diode.

Working: When the photodiode is illuminated with photons of energy ($h\nu > E_g$) greater than the energy gap of the semiconductor, electron – holes pairs are produced.

These gets separated due to the junction electric field (before they recombine) produces an emf.

When an external load is connected, current flows through it. The magnitude of this current is proportional to the intensity of light incident on photodiode.



(b) Principle of operation

Reason: It is easier to observe the change in the current, with change in light intensity, if reverse bias is applied.

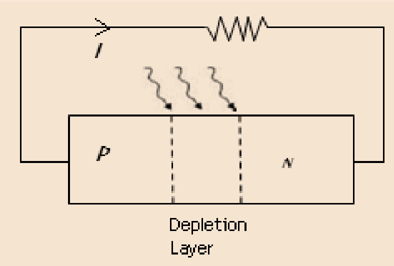
A13. Three basic processes which take place to generate the emf in a solar cell are;

(i)Generation of electron hole pairs due to the light incident close to the junction.

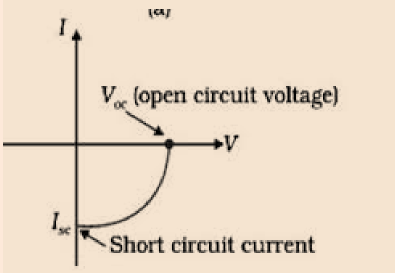
ii) Separation of electrons and holes due to the electric field of depletion region.

(iii) Collection of electrons and holes by n-side and p-side respectively.

Circuit diagram



I-V characteristics of solar cell



Any two criteria of the following,

(i) Small band gap (1.0 to 1.8eV)

(ii) High optical absorption

(iii)Electrical conductivity

(iv) Availability of raw material

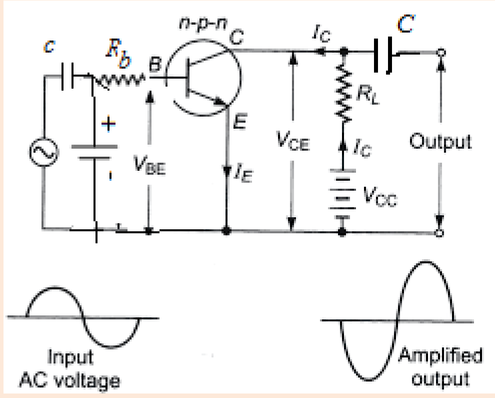
(v) Cost

A14. Input resistance

$R_i = \left(\frac{\Delta V_{BE}}{\Delta I_B}\right)_{V_{CE}}$

Current amplification:

$\boldsymbol{\beta_{ac}} = \left(\frac{\Delta I_c}{\Delta I_B}\right)_{V_{CE}}$

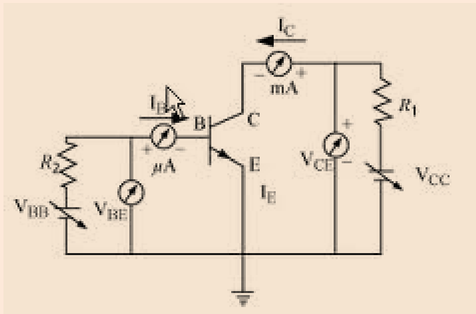


The value of input resistance is determined from the slope of I_B verses V_{BE} plot at constant $V_{CE.}$ (Input characteristics).

The value of current amplification factor is obtained from the slope of collector I_C verses V_{CE} plot using different values of I_B. (output characteristics).

A15. Circuit diagram (same as above)

Working: The input signal connected between the emitter and base, along with forward bias, causes corresponding large change in output voltage.



Current gain: $\boldsymbol{\beta_{ac}} = \left(\frac{\Delta I_c}{\Delta I_B}\right)_{V_{CE}}$

Voltage gain: Av = $\frac{\Delta V_o}{\Delta V_i}$

A16. Input Characteristics:

(i) This characteristics is drawn between I_B and V_{BE} .

(ii) Keeping the value of V_{CE} constant, we obtain different value of I_B with variation of base –emitter voltage (V_{BE}).

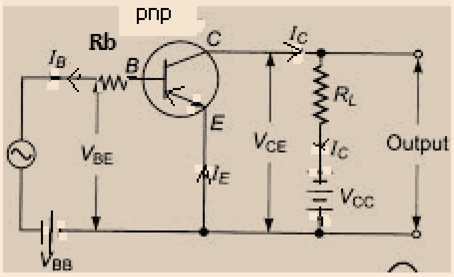
Output characteristics:

(i) This characteristics is drawn between I_C and $V_{CE.}$

(ii) Keeping the base current I_B constant, we obtain the different value of collector current (I_C) with variation of collector- emitter voltage (V_{CE}).

A17. Active State:

When the emitter- base junction is forward biased and the base collector junction is reverse biased with $V_i > 0.6V$ or $V_i > 0.3V$.



Explanation:

If +ve or -ve cycle of a.c. is applied to input, it changes V_{BE}. This results change in I_C and hence changes in $V_{CE,}$ which will appear in amplified form.

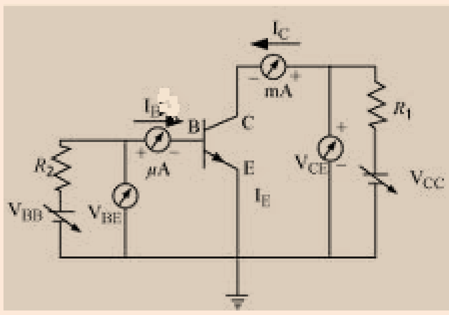
Base is made thin so that there are few majority carriers in it.

Emitter is heavily doped so that it supplies more number of majority charge carriers.

A18. For input characteristics

Keep V_{CE} as fixed value

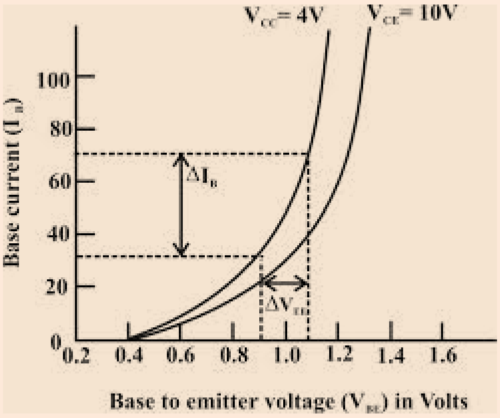
Study the dependence of I_B on V_{BE}

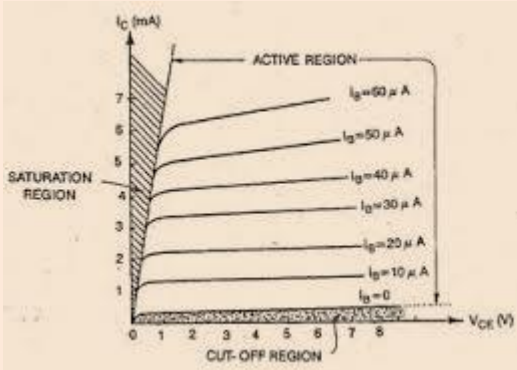


For output characteristics

Keep I_B as constant

Study the dependence of I_C on V_{CE}



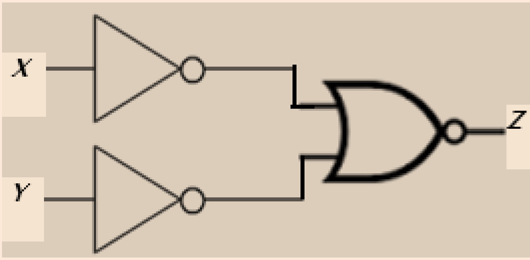


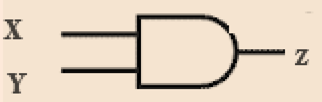
Q19. $R_i = \frac{\Delta V_{BE}}{\Delta I_B}$ = 0.04/40x10^{-6} = 1000Ω

$\beta = \frac{\Delta I_C}{\Delta I_B} = \frac{2\times10^{-3}}{40\times10^{-6}} = 50$

Av = $\beta\frac{R_o}{R_i}$ = 50x$\frac{6000}{1000}$ = 300.

A20.





Equivalent Gate = AND

AND Gate Truth Table

X	Y	Z
0	0	0
0	1	0
1	0	0
1	1	1

A21. (a)

Logic operation Z = X.Y

(b) Z = A + B

Identification:

(a) AND gate, (b) OR gate Truth Tables of both gates:

A22.

A	B	Output of AND gate (Input of NOT gate)	Output of NOT gate
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0

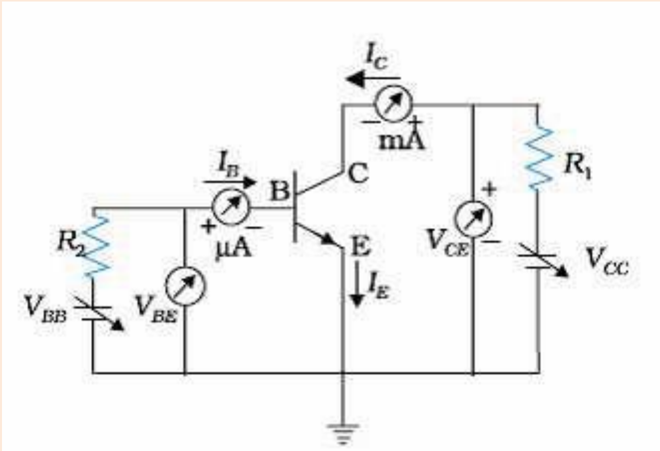
TRUTH TABLE :NAND GATE

X	Y	Z
0	0	1
0	1	1
1	0	1
1	1	0

NAND gate is called universal gate because all other basic gates like AND, OR, NOT gates can be realised by using NAND gate only.

A23.P- AND, Q – NOT gate

Equivalent gate: NAND gate



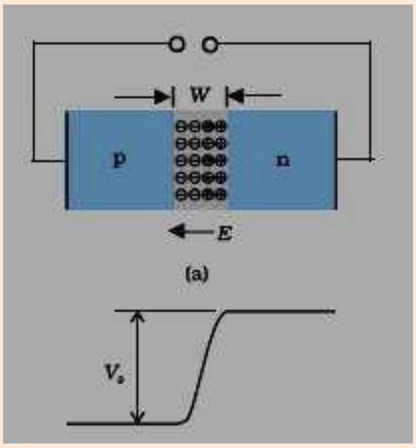
A24. Emitter: Supplies the large number of majority charge carriers for the flow of current through the transistor.

Base: Controls the movement of charge carriers coming from emitter region

Collector: Collects a major portion of the majority carriers supplied by the emitter.

Input characteristics are obtained by recording the values of base current, for different values of at constant

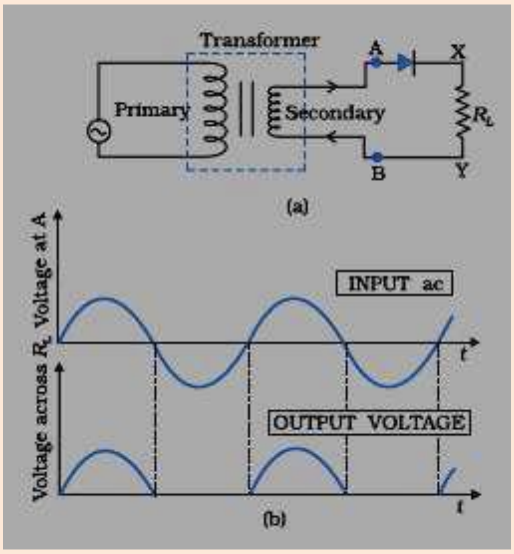
Output characteristics are obtained by recording the values of for different values of at constant



A25. i.Due to diffusion and drift, the electrons and holes move across the junctions, creating a final stage in which a region is created across the junction wall, which gets devoid of the mobile charge carriers. This region is called depletion region; the potential difference across the region is called Barriers potential

(ii) Working- If an alternating voltage is applied across a diode in series with a load, a pulsating voltage will appear across the load only during that half cycle of the ac input during which the diode is forward biased.

Therefore, in the positive half – cycle of ac input there is a current through the load resistor RL and we get an output voltage. There is no output during the negative half cycle. Thus, the output voltage is restricted to only one direction and is said to be rectified.



A26. AC collector current $I_C = \frac{V_{CE}}{R_C}$ **= 1.0mA**

Base current $I_b = \frac{I_C}{\beta} = \frac{1.0mA}{100}$ **= 0.1mA**

Base signal Voltage=I_b R = 0.01mA x1kΩ =10mv

A29.B: reverse biased

C: forward biased

Related justification

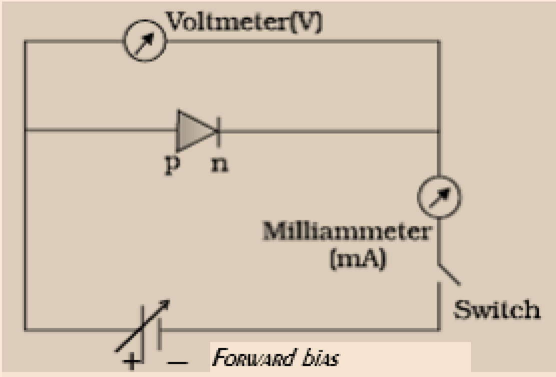
A30(i) Emitter base junction is forward biased whereas base collector junction is reversed biased.

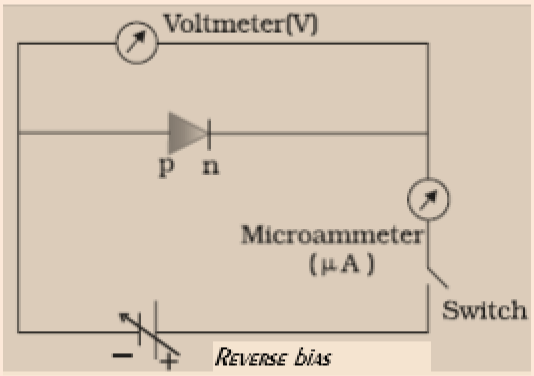
(ii) Small change in the current I_B in the base circuit controls he large current I_C in the collector circuit I_C in the collector circuit. $I_C = \beta I_B$

(iii) Elemental semiconductor's band gap is such that the emitted wavelength lies in IR region. Hence cannot be used in making LED.

LONG ANSWER TYPE QUESTIONS: 5-MARKS

A1.





The V-I characteristics are obtained by connecting the battery, to the diode, through a rheostat in two different ways as shown in figure above. The applied voltage to the diode is changed. The value of current, for different values of voltage, are noted and a graph between V and I is plotted in two different cases.

(b) Working as given in Q.No.12- 3 Marks

A4. Circuit diagram: Q.No.15

The emitter –base junction is forward biased, the majority charge carrier (electrons), from the emitter section, flow into the base region constituting the emitter current (I_E)

The base region, being very thin, only a very small fraction, of these charge carriers, swamps the holes present in the base region resulting in a small base current(I_B).

The majority of these charge carriers are attracted by the (Reverse biased) collector. These make up the collector current (I_C).

It is clear, therefore that: $I_E = I_B + I_C$

(b) Circuit diagram: Q.No.14

Working of Transistor as an amplifier:

If a small sinusoidal voltage is superimposed on the dc base bias by connecting the source of this signal in series with V_{BB} supply.

Then the base current has sinusoidal variations superposed on the I_B.

As consequence the collector current also will have sinusoidal variation superimposed on the value of I_C producing in turn corresponding amplified changes in the output voltages V_O.

A5. (a) Emitter: It is moderate size and heavily dopped.

Base: It is very thin and lightly dopped.

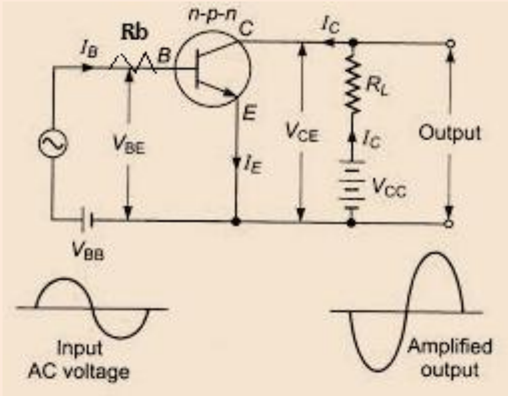
Collector: It is moderately doped and larger in size.

(b) Transistor is said to be in active state when its emitter – base junction (input) is suitably forward Biased and collector- base junction is reversed biased.

(c) Circuit and working is given above.

A6. **Phase reversal of input signal in output in CE configuration of a transistor:**

- The collector - emitter voltage (output voltage) $V_{CE} = V_{CC} - Ic.R_L$
- When positive half cycle a.c. signal is applied, this increases the forward biasing of input.
- This results increase in emitter current (I_E), consequently collector current (I_C) also increases, hence the value of product $Ic.R_L$ increases.
- According to above equation, the output voltage (V_{CE}) decreases as V_{CC} is fixed or we can say that the output tends to become more and more negative.



Hence we can say that positive half cycle of a.c. at input is converted into negative half cycle with amplification at output. This explains phase reversal of a.c. in CE configuration.

(b)Power gain $A_p = \beta^2 \frac{R_o}{R_i} = (100)^2 \times \frac{4500}{500} = 90000.$

UNIT-X: Communication System

VERY SHORT ANSWER TYPE QUESTIONS: 1 -MARK

A1.It rejects dc and sinusoidal of frequency ω_m, $2\omega_m$, $2\omega_c$ and retain the frequencies ω_c , $\omega_c \pm\omega_m$.

A2.It converts one form of energy into another form of energy. Example: Microphone

A3.X – Transmitter Y- Communication channel

A4. Repeaters are used to increase / extend the range of a communication system.

A5.Sidebands are produced due to the superposition of modulating signal of frequency ω_m over carrier waves of frequency ω_c.

A6.Point to point communication.

A7.Mdulating Index (m_a) = $\frac{E_m}{E_c}$ = 1.5 /3 = 0.5

A8. Point to point: One transmitter and one receiver

Broadcast: One transmitter and many receivers

A9.Demodulation: It is the process of recovering the modulating signal from the modulated carrier wave.

A10.T.V. Signals

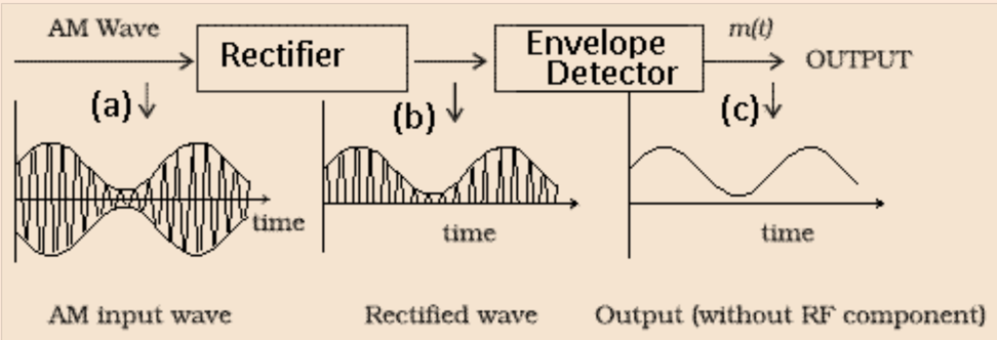
A11. **Modulation Index (M_a):** It is defined as the ratio of amplitude of modulating signal to the amplitude of carrier wave.

$$m_a = \frac{E_m}{E_c}$$

A12. **Attenuation:** The loss of strength or power of transmitted signals while travelling through communication channel.

A13.X- Communication Channel: The medium through which the transmitted signals travel between transmitter and receiver.

A14.



A15.Effective Power radiated by antenna P $\alpha \frac{1}{\lambda^2}$

A16.The signals having frequencies greater than 20Hz leak out from co-axial cable.

A17. **Modulation**: The process of superposing low frequency audio signals on waves with high frequency is called modulation.

A18.Transmitter, communication channel, receiver

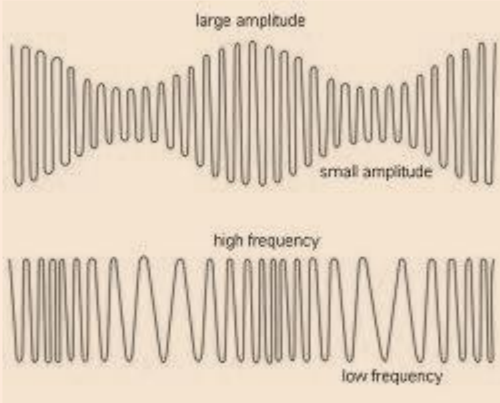
SHORT ANSWER TYPE QUESTIONS: 2-MARKS

A1.(i) Impractical length of antenna.(ii). To avoid intermixing of signals.

A2.(i) By increasing height of antenna (ii)By increasing power of signals.

A3. (i) Amplitude (ii) Frequency

A4. Amplitude modulated Wave



Frequency Modulated wave

Why FM is preferred over AM?

(i) Low noise / disturbance

(ii) Reduced channel interference

(iii) More power can be transmitted. (Any one)

A5.

Space Wave	Sky Wave
In space wave mode, the waves travel in straight line directly from transmitter to receiver.	The transmitted waves get reflected from ionosphere

Because frequencies are greater than 40MHz do not reflected from ionosphere.

A6.(a)

Analog signal	Digital signal
It is single valued function of time or varies continuously with time.	These signals take only discrete set of values i.e. 0 or 1

(b) Use of internet: (Any two)

E-mail, E-banking, chatting, file transfer, e-shaping, e-ticketing, surfing.

A7.Line of sight

Space wave

d = $\sqrt{2R\,h_1}$ + $\sqrt{2Rh_2}$

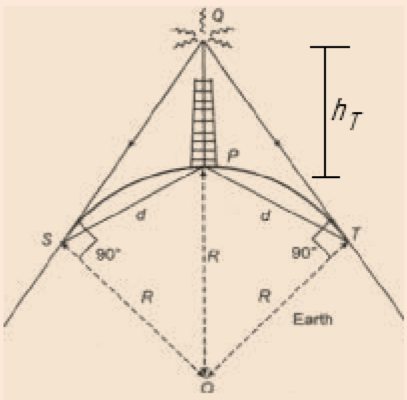
A8.In ground wave communication, the e.m. wave glides over the earth's surface.

At high frequencies, the rate of energy dissipation of signal increases and signal gets attenuated over a short distance.

OR

As the ground wave glides over the earth surface, its changing magnetic field induces an electric current, on the surface.

At higher frequency the rate of variation of (magnetic field) is larger inducing a larger current, so energy dissipation of the signal is more. So the higher the frequency the more rapid is the signal attenuated.



A9.1. Appropriate size of the antenna

2. Increase in effective power radiated by an antenna (P $\alpha \frac{1}{\lambda^2}$)

3. To minimize mixing of signals from different transmitters (Any two)

A10. OS = OT = OP = R (radius of earth)

PS= PT = d : and QP = h_T

From right angle triangle QSO

$(QO)^2 = (QS)^2 + (OS)^2$

$(QO)^2 = (PS)^2 + (OS)^2$ (since QS ≈ PS)

$(R + h_T)^2 = d^2 + R^2$

$R^2 + h_T^2 + 2Rh_T = d^2 + R^2$

$d^2 = h_T^2 + 2Rh_T$

Since $R >>> h_T$, so h_T^2 can be neglected

$d = \sqrt{2Rh_T}$

Area covered by transmitting antenna = $\pi d^2 = 2\pi R h_T$

A11. $m_a = \frac{E_m}{E_c} \Rightarrow 0.75 = \frac{E_m}{12}$

$E_m = 7.8V$

A12. $m_a = \frac{E_m}{E_c} = \frac{10}{20} = 0.2$

Lower side band = $\nu_c - \nu_m$ = 1000 KHz – 10 KHz = 990 Hz

Upper side band = $\nu_c + \nu_m$ = 1000 KHz + 10KHz = 1010KHz

A13. Maximum distance: dm = $\sqrt{2R\,h_T} + \sqrt{2Rh_R}$

$= \sqrt{2 \times 6.4 \times 10^6 \times 32} + \sqrt{2 \times 6.4 \times 10^6 \times 50}$

= 20.2 + 25.3 = 45.5m

A14. $A_c + A_m = 10V$

$A_c - A_m = 2V$

On solving, $A_m = 4V$, $A_c = 6$ V

$m_a = A_m / A_c = 2/3$

If the value of minimum amplitude, $A_c - A_m = 0$, $A_c = A_m = 5V$

Then, ma = $A_m / A_c = 1$

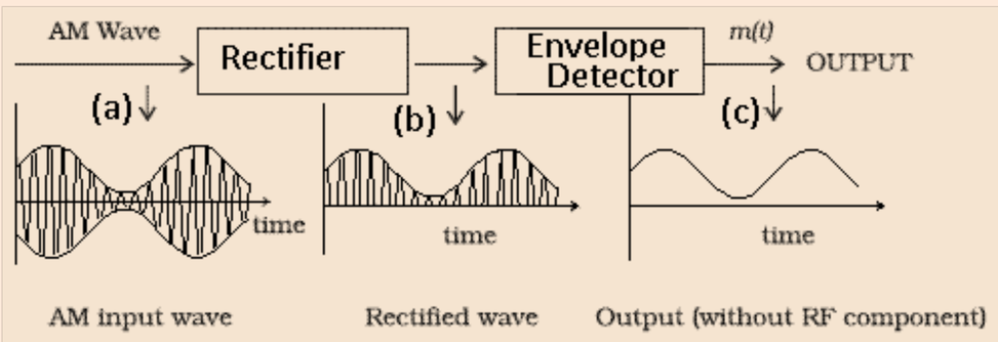
'm_a' is kept less than one to avoid distortion.

A15.Attenuation: Loss of power of signals when it is transmitted from transmitter to receiver.

Demodulation: Extraction of audio signal from modulated wave at the receiving end, is called demodulation.

SHORT ANSWER TYPE QUESTIONS: 3-MARKS

A1.



(i). The AM waves is passed through rectifier which retains +ve half of AM wave. The envelope of signal (b) is the message signal m(t).

(ii). The message signal is obtained (retrieved) by passing it through envelope detector which consists of simple RC circuit.

(iii). The low valued capacitor (C) offers very low impedance to high frequency a.c. component and very high impedance for low frequency signal.

(iv) The capacitor is charged and discharged in accordance with modulating signal through R.

A2.Thee modes of propagation are:

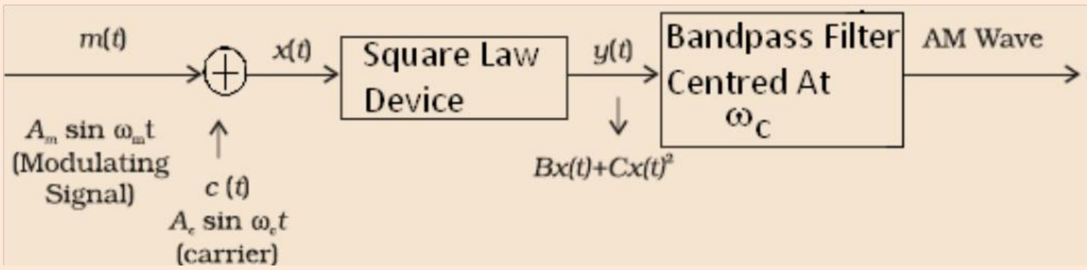
i) Ground waves propagation

ii) Sky wave propagation

iii) Space waves propagation,

The ionosphere acts as a reflector for the range of frequencies from 2MHz to 30MHz. The ionospheric layers bend the radio waves back to the Earth. The waves of frequencies greater than 30MHz penetrate the atmosphere and escape.

A3.



A_c = 12V

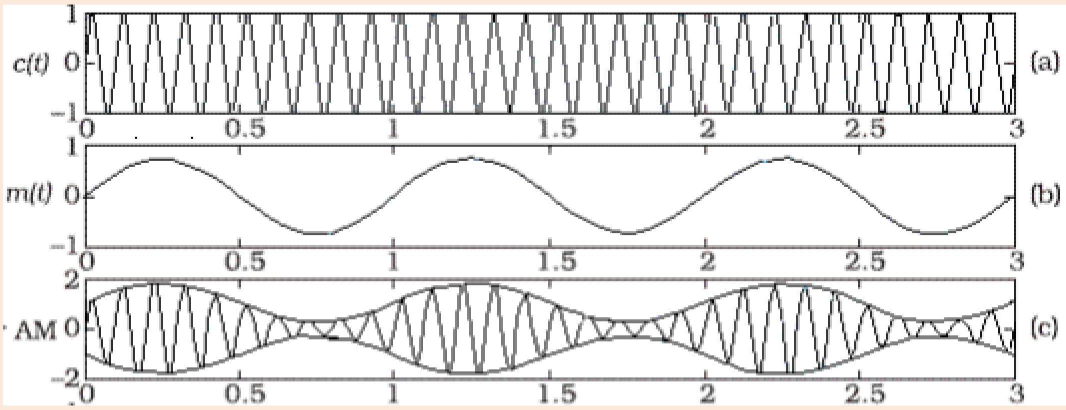
$m_a = \frac{A_m}{A_c} = \frac{75}{100}$ = 0.75

A_m = 0.75 x12 = 9V

A4. Need: a) Appropriate Size of antenna

b) Effective power radiated by an antenna P α $\frac{1}{\lambda^2}$,

c) To avoid the mixing up of signals from different transmitters.



A5. Figure as given in Q.No.3.

The AM wave is fed to power amplifier to increase the power of signals before transmission.

A6.1.Size of Antenna

2. Power radiated by the antenna

3. Intermixing of signals

To overcome these factors:

i) Size of antenna should be comparable to wavelength (around (λ/4)

ii) Power radiated increases with decrease of wavelength.

iii) Message signal should be used to modulate a high frequency carrier wave so that a band of frequencies can be allotted to each message signal.

A7. (a) (i) Transmitter: It is a set-up which processes a message signal into a form suitable for transmission and then transmits it to the receiving end through communication channel.

(ii) Communication Channel: It is the medium or physical path that connects a transmitter to a receiver and carries modulated wave.

(iii)Receiver: It is a set-up that receives the transmitted signals from the medium and converts those signals back to their original form.

Three applications of internet: (i) e-banking (ii) e- ticketing (iii) e- shopping / E- commerce

A8. Modulation Index (Ma): It is defined as the ratio of amplitude of modulating signal to the amplitude of carrier wave.

$$m_a = \frac{E_m}{E_c} = \frac{E_{max} - E_{min}}{E_{max} + E_{min}}$$

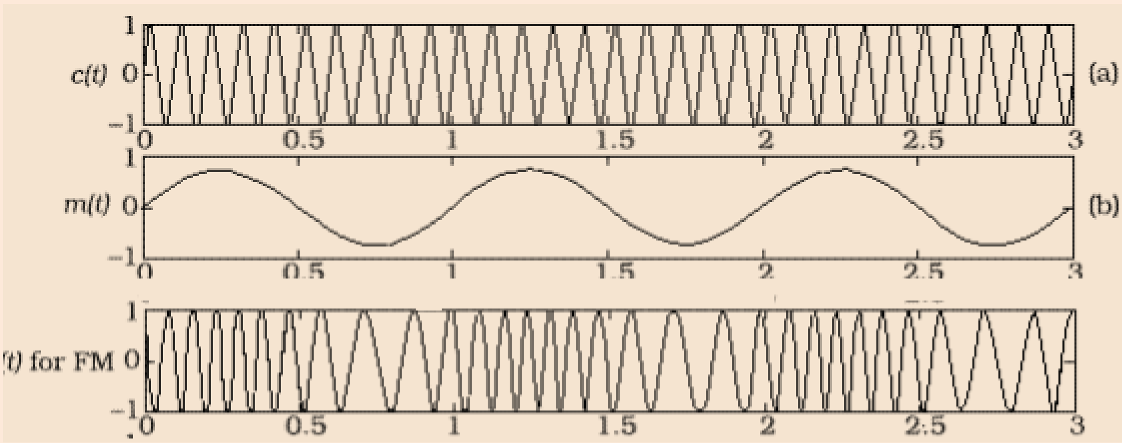
$$ma = \frac{E_m}{50}$$

$$0.5 = \frac{E_m}{50} \Rightarrow E_m = 25V$$

Upper side band: 1500KHz + 10 KHz = 1510 KHz

Lower side band: 1500 KHz – 10 KHz = 1490 KHz

A9. **Frequency Modulation:** The process in which the frequency of carrier wave changes in accordance with instantaneous voltage of information signal.



Two Advantages: 1.The F.M. transmission produce better noise free signals at receiver end than A.M. because amplitude remains constant in F.M.

2. F.M. transmission is highly efficient because all the power is useful but in A.M. transmission, most of the power goes waste in the transmitting the carrier wave.

A10. (i).Size of antenna (h) = λ/4 so, for low frequency (high wavelength) transmission, the height of antenna will be quite large which is practically impossible.

(ii) Effective power radiated by an antenna P α $\frac{1}{\lambda^2}$, for the effective power radiation, the frequency of signals must be high (or low wavelength).

(iii) Mixing up of signals from different transmitters take place if the transmission is done at low frequencies because in that case available band width of signals will be very less.

A11. **Amplitude Modulation:**

The process of changing the amplitude of carrier wave in accordance with instantaneous voltage of information (or message) signal is known as amplitude modulation (AM).

Fig: same as given in question no.4 of three marks

Limitations:

(i) Quality of audio signals is poor.

(ii) Efficiency of AM transmission is low.

Advantages:

(i) It is an easier method for transmitting and receiving voice signals.

(ii) It requires simple and cheaper transmitter and receivers.

A12.(i) To radiate signals with high efficiency, the antennas should have a size comparable to the wavelength of the signal (at least $\lambda/4$).

(ii) Due to impractical length of antenna.

Let the transmitted audio signal have frequency 15000Hz, the corresponding wavelength will be;

$\lambda = c/\nu = 3\times10^8/15000 = 20000$m

Hence the length of antenna = $\lambda/4$ = 20000/4 = 5000m = 5km, which is practically not possible.

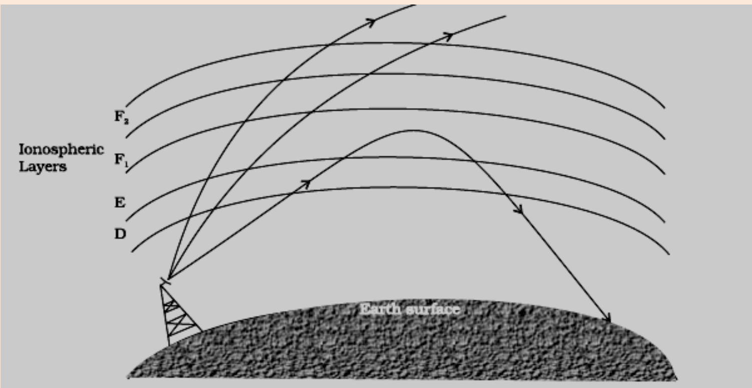
(iii)To avoid the distortion in the transmitted signal due to over modulation, amplitude of modulating signal is kept less than.

A13. X- Amplitude Modulator, which modulate the carrier wave.

Y- Power amplifier, it provides necessary power and then modulated signal is fed to an antenna of appropriate size for radiation.

A16.(a) Long distance communication can be achieved by reflection of radio waves by the ionosphere, back towards the Earth. This ionosphere layer acts as a reflector only for a certain range of frequencies.(few MHz to 30MHz)

b) Electromagnetic waves of frequencies higher than 30MHz, penetrate the ionosphere and escape whereas the waves less than 30MHz are reflected back to the earth by the ionosphere.



A17.(i) Size of antenna

Effective power radiated by antenna

Mixing up of signals from different transmitters

(ii)Modulation

Block diagram of amplitude modulation

LONG ANSWER TYPE QUESTIONS: 5-MARKS

A1. **Space wave propagation:**

A mode of wave propagation in which the radio waves emitted from the transmitting antenna reach directly to the receiving antenna through space is called space wave propagation.

(i) Line of sight communication

(ii) Satellite communication

Let height of both transmitting and receiving antennas are h_1 and h_2 respectively, as per the condition given; $h_1 + h_2 = h$ (constant)

Maximum distance of LOC = H = $\sqrt{2R\,h_1} + \sqrt{2Rh_2}$

$$H = \sqrt{2R\,h_1} + \sqrt{2R\,(h - h_1)}$$

On differentiation; $\frac{dH}{dh_1} = \sqrt{2R} \times \frac{1}{2} \times h_1^{-\frac{1}{2}} + \sqrt{2R} \times \frac{1}{2} \times (h - h_1)^{-\frac{1}{2}}$ (-1)

For maxima $\frac{dH}{dh_1} = 0$

$\Rightarrow h_1 = h - h_1$

$= 2h_1 = h \quad \Rightarrow h_1 = h/2$

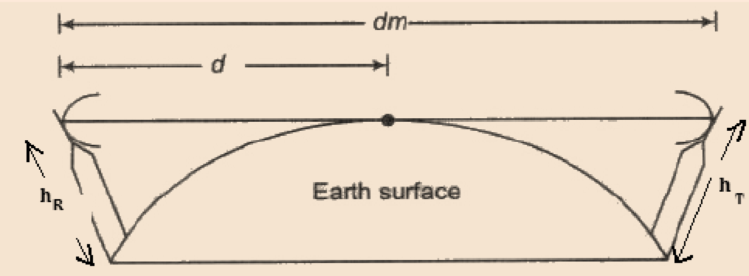
$\Rightarrow h_1 = h_2 = h/2$, hence proved

A2. LOS means line of sight communication, communication in the signals travels in straight lines from transmitting antenna to receiving antenna.

Microwaves or very high frequency waves (above 30MHz) are used in this communication.

h_R = height of receiving antenna, h_T = height of transmitting antenna, dm = maximum range of LOS

Range of LOS can be increased by increasing height of transmitting and receiving antenna and by using repeaters.



VALUE BASED QUESTIONS: 4 MARKS

A1. (a) Ultra high frequency em radiations, continuously emitted by a mobile phone, may harm the human body.

(b) Sister Anita shows

(i) Concern about her brother

(ii) Awareness about the likely effects of em radiations on human body.

(iii) Sense of responsibility. (any two)

(c) The sidebands are; $\nu_c - \nu_m$, and $\nu_c + \nu_m$

Or (1000 – 10) kHz and (1000 + 10) kHz

990 kHz and 1010 kHz