केंद्रीय विद्यालय संगठन क्षेत्रीय कार्यालय रायपुर

Kendriya Vidyalaya Sangathan Regional Office Raipur

PHYSICS

Class - XII

Question Bank Term- II 2021-22

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Kendriya Vidyalaya Sangathan Regional Office Raipur

MESSAGE FROM DUPUTY COMMISSIONER

It gives me immense pleasure to bring out the study material for 2nd Term in different subject of Classes X and XII for Raipur Region. All of us know that in the 1st Term Examination questions were objective but in 2nd Term questions will be subjective so once again to get our children acquainted and familiarized with the new scheme of examination and types of questions, it is of utmost significance that an extensive study material should be provided to our children. This question bank is in complete consonance with CBSE Circular Number 51 and 53 issued in the month of July 2021. It will help students to prepare themselves better for the examination. Sound and deeper knowledge of the Units and Chapters is must for grasping the concepts, understanding the questions. Study materials help in making suitable and effective notes for quick revision just before the examination.

Due to the unprecedented circumstances of COVID-19 pandemic the students and the teachers are getting very limited opportunity to interact face to face in the classes. In such a situation the supervised and especially prepared value points will help the students to develop their understanding and analytical skills together. The students will be benefitted immensely after going through the question bank and practice papers. The study materials will build a special bond and act as connecting link between the teachers and the students as both can undertake a guided and experiential learning simultaneously. It will help the students develop the habit of exploring and analyzing the ***Creative & Critical Thinking Skills***. The new concepts introduced in the question pattern related to case study, reasoning and ascertain will empower the students to take independent decision on different situational problems. The different study materials are designed in such a manner to help the students in their self-learning pace. It emphasizes the great pedagogical dictum that *'everything can be learnt but nothing can be taught'*. The self-motivated learning as well as supervised classes will together help them achieve the new academic heights.

I would like to extend my sincere gratitude to all the principals and the teachers who have relentlessly striven for completion of the project of preparing study materials for all the subjects. Their enormous contribution in making this project successful is praiseworthy.

Happy learning and best of luck!

Vinod Kumar
(Deputy Commissioner)

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Kendriya Vidyalaya Sangathan Regional Office Raipur

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CONTENT TEAM

UNIT	NAME OF TEACHER
CHAPTER 8: ELECTROMAGNETIC WAVES CHAPTER 9: RAY OPTICS AND OPTICAL INSTRUMENTS	SMT AMITA SINGH K V BILASPUR
CHAPTER 10: WAVE OPTICS	SH SIMANCHAL PRADHAN K V NO.1 RAIPUR (SHIFT-1)
CHAPTER 12: DUAL NATURE OF MATTER AND RADIATION	SH VINOD KUMAR K V NO.4 KORBA
CHAPTER 13: ATOMS CHAPTER 14: NUCLEI	SMT RUNA CHOUDHARY K V CISF BHILAI
CHAPTER 14: SEMICONDUCTOR-ELECTRONICS-: MATERIALS DEVICES AND SIMPLE CIRCUITS	SH AMITAV ADHIKARI K V DONGARGARH
PREPARATION OF SAMPLE PAPER	SH B R GAJPAL K V NO.1 RAIPUR (SHIFT-1) MS KAMALPREET K V DHAMTARI SH H S TRIPATHI K V MAHASAMUND
REVIEW COMMITTEE	SMT SUNITA KHIRBAT K V BVMY BHILAI SH N D SAHU K V NO.1 RAIPUR SHIFT 2

ELECTROMAGNETIC WAVES

FORMULA

Equation for travelling electromagnetic waves along Z – axis

$E = E_X(t) = E_0 \sin(kz - \omega t)$

$B = B_y(t) = B_0 \sin(kz - \omega t)$

	Gamma rays	X-rays	UV rays	Visible Light	IR waves	Micro waves	Radio waves
Wave length range (m)	10^{-14} to10^{-10}	10^{-13} to10^{-8}	$6x10^{-10}$ to $4x10^{-7}$	$4x10^{-7}$ to $7x10^{-7}$	$7x10^{-7}$ to 10^{-3}	10^{-3} to 10^{-1}	>0.1
Frequency (Hz)	10^{23} to 10^{18}	10^{21} to 10^{16}	10^{17} to 10^{14}	$7x10^{14}$ to $4x10^{14}$	10^{14} to 10^{11}	10^{12} to 10^{8}	10^{9} to $5x10^{5}$
Production	Radioactive decay of the nucleus	Bombarding high energy electrons with heavy metal targets	1.High temperature bodies 2.Sun	Electrons in atoms of an object moves from higher to lower energy level	Vibrations of atoms and molecules of hot bodies	1.Klystrons 2.Magnetrons 3.Gunn diodes	Accelerated electrons in conducting wires
Detection	1.Photographic film 2.Geiger tube 3.Ionisati on chamber	1.Photographic film 2.Geiger tube 3.Ionisat ion chamber	1.Photocell 2.Photographic film	1.Human eye 2.Photographic film 3.Photocell	1.Bolo meter 2.Thermopile 3.Photographic film	Point contact diodes	Receiver's aerial
Use	In medicine to kill the cancer cells	1.Medicine 2.Spectrscopy 3.industries	1.Eye surgery 2.Kill germs in water purifiers	Helps to view the objects	1.Earth satellites 2.Remote switches 3.Night vision cameras	1.RADAR system 2.Speed guns 3.Micro ovens	1.Radio 2.Television broadcasting 3.Communication system

QUESTIONS OF 2 MARKS

Q.1.The oscillating magnetic field in a plane electromagnetic wave is given by

$B_y = 8 \times 10^{-6} \sin (2 \times 10^{11} t + 300)]$ T

a. Calculate the wavelength of electromagnetic wave?

b. Write down the expression for the oscillating electric field.

HINTS. a. =3m, b. $E_z = 2400 \sin (2 \times 10^{11} t + 300)]$

Q.2. EM waves travel in a medium at the speed of 2×10^{8} m/s. The relative permeability of the medium is 1. Find the relative permittivity of that medium.

HINTS. $v = 2 \times 10^{8}$ m/s , $\mu r = 1$, $c = 3 \times 10^{8}$ m/s Speed of EM wave in the medium $v = 1 / \sqrt{\mu\varepsilon} = c / \sqrt{\mu r\, \varepsilon r}$ Or $\varepsilon r = c^2 / v^2 \mu r = (3 \times 10^{8})^2 / (2 \times 10^{8})^2 \times 1 = 2.25$

Q.3.Optical and radio telescopes are built on the ground while X- ray astronomy is possible only from satellites orbiting the Earth. Why?

HINTS. The earth's atmosphere is transparent to visible light and radio waves but absorbs X- rays. Satellites orbiting the earth at a height of 36000 km, where atmosphere is very thin and X-rays are not absorbed.

Q.4. The small ozone layer on top of the stratosphere is crucial for human survival. Why?

HINTS. Ozone layer absorbs ultraviolet radiation from the sun and prevent these radiations from reaching the earth which causes cancer.

Q.5. Identify the following electromagnetic radiation as per the wavelength given below. Write one application of each.

(a) 10^{-12}m (b). 10^{-4}m (c.) 10^{6}m

HINTS:- Identification:- (a.) gamma rays use- radiotherapy (b.) Infrared rays use – haze photography (c). long radio wave use in radio communication

Q.6.Give one uses of each of the following and arrange them in ascending order of frequency.

a.Microwave b. Infra-red wave c. Ultra violet radiation d. Gamma rays

QUESTIONS OF 3 MARKS

Q.7.Name the following constituent radiations of electromagnetic spectrum which-

(i) are used in satellite communication/in radar and geostationary satellite

(ii) are used for studying crystal structure of solids

(iii) are similar to the radiations emitted during decay of radioactive nuclei

(iv) are used for water purification/ are absorbed from sunlight by ozone layer

Q.8.In a plane electromagnetic wave, the electric field oscillates sinusoidaly at a frequency of 2 x 10^{10} Hz and amplitude 48 V.

(a) What is the wavelength of the wave?

(b) What is the amplitude of the oscillating magnetic field?

(c) Show that the average energy density of the E field equals the average energy density of the B field. [c = 3 x 10^8 m/s]

HINTS a) The wavelength is given by $\lambda = c/\nu = 1.5\times10^{-2}$ m

(b) Bo=Eo/c=1.6×10^{-7} T

(c) Energy density due to the electric field, $E_E = 1/2\epsilon_0 E^2$

Energy density due to the magnetic field, $E_B = 1/2B^2/\mu o$ on solving above equations, $E_E = E_B$

Q.9. What physical quantity is the same for X-rays of wavelength 10–10m, red light of wavelength 6800 Å and radio waves of wavelength 500m? A plane electromagnetic wave travels in vacuum along z-direction. What can you say about the directions of its electric and magnetic field vectors? If the frequency of the wave is 30 MHz, what is its wavelength?

Ans. The wave speed is same for all radiation, λ = 10m

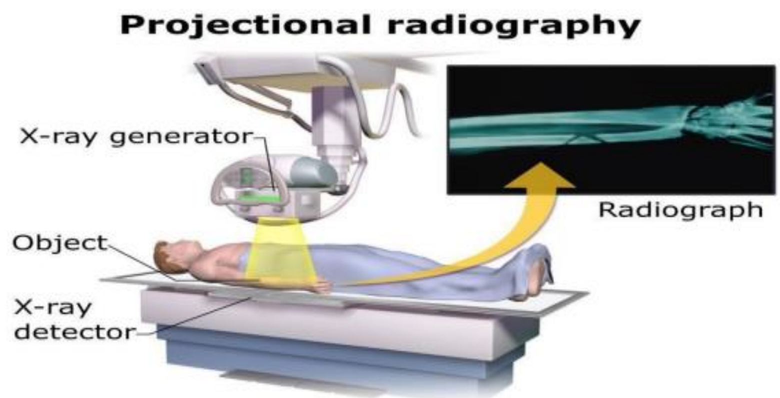
Q.10. Suppose that the electric field part of an electromagnetic wave in vacuum is E = {(3.1 N/C) cos [(1.8 rad/m) y + (5.4 × 106 rad/s)t]} ˆi . (a) What is the direction of propagation? (b) What is the wavelength λ? (c) What is the frequency ν? (d) What is the amplitude of the magnetic field part of the wave? (e) Write an expression for the magnetic field part of the wave.

Ans. (a) Negative Y direction, (b) λ = 3.5m (c) ν = 86 MHz (d) 10.3 nT

CASE STUDY BASED

1. X- Rays

X-rays are a form of electromagnetic radiation, similar to visible light. Unlike light, however, x-rays have higher energy and can pass through most objects, including the body. Medical x-rays are used to generate images of tissues and structures inside the body



Q1. What is the most common method of preparation of X rays ?

a) magnetron valve
b) vibration of atoms and molecules
c) bombardment of metal by high energy electrons
d) radioactive decay of nucleus

Q2) which of the following set of instrument /equipment can detect X- rays

a) Photocells, photographic film
b) Thermopiles, bolometer
c) Photographic film, Geiger tube
d) Geiger tube, human eye

Q3) where do X rays fall on the electromagnetic spectrum?

a) Between UV region and infrared region
b) Between gamma rays and UV region
c) Between infrared and microwaves
d) Between microwaves and radio waves

Q4) what is the use of rays lying beyond X ray region in electromagnetic spectrum

a) used to kill microbes
b) used to detect heat loss in insulated systems
c) used in standard broadcast radio and television
d) used In oncology, to kill cancerous cells.

Q5) Which of the following has the lowest frequency

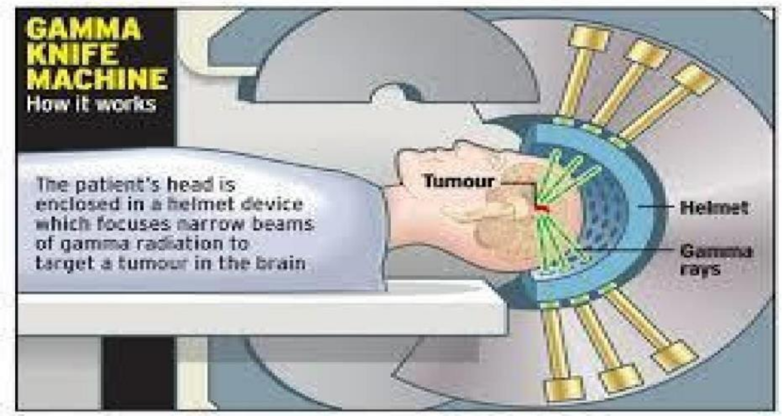
(a) microwaves (b)ultra-violet (c) X-rays (d) None

ANSWER:

Q1. c Q2. C Q3. b Q4. d Q.5.a

2. GAMMA RAYS IN TREATMENT OF CANCER

Gamma rays are used in radiotherapy to Treat cancer. They are used to spot tumors. they kill the living cells and damage malignant tumor.



Q.1. What is the source of gamma rays?

a) radioactive decay of nucleus b) accelerated motion of charges in conducting wire

c) hot bodies and molecule d) klystron valve

Q.2. How is wavelength of gamma rays

a) low b) high c) infinite d) zero

Q.3. Choose the one with correct radiation order?

a) alpha>beta>gamma b) beta>alpha>gamma

c) gamma>beta>alpha d) gamma>alpha>beta

Q.4. What is other use of gamma rays?

a) used to change white topaz to blue topaz b) used in aircraft navigation

(c)used in kill microbes d) checking fractures of bone

Q.5.What is ratio of velocity of X rays and gamma rays in vaccum.

(a) 3:2 b) 2 :3 c) 1:1 d) none

ANSWER

1) a 2) a 3) c 4) a 5)c

3. Microwave oven:

The spectrum of electromagnetic radiation contains a part known as microwaves. These waves have frequency and energy smaller than visible light and wavelength larger than it. What is the principle of a microwave oven and how does it work ? Our objective is to cook food or warm it up. All food items such as fruit, vegetables, meat, cereals, etc., contain water as a constituent. Now, what does it mean when we say that a certain object has become warmer? When the temperature of a body rises, the energy of the random motion of atoms and molecules increases and the molecules travel or vibrate or rotate with higher energies. The frequency of rotation of water molecules is about 2.45 gigahertz (GHz). If water receives microwaves of this frequency, its molecules absorb this radiation, which is equivalent to heating up water. These molecules share this energy with neighbouring food molecules, heating up the food. One should use porcelain vessels and non metal containers in a microwave oven because of the danger of getting a shock from accumulated electric charges. Metals may also melt from heating. The porcelain container remains unaffected and cool, because its large molecules vibrate and rotate with much smaller frequencies, and thus cannot absorb microwaves. Hence, they do not get heaten up. Thus, the basic principle of a microwave oven is to generate microwave radiation of appropriate frequency in the working space of the oven where we keep food. This way energy is not wasted in heating up the vessel. In the conventional heating method, the vessel on the burner gets heated first and then the food inside gets heated because of transfer of energy from the vessel. In the microwave oven, on the other hand, energy is directly delivered to water molecules which is shared by the entire food.

Q 1. As compared to visible light microwave has frequency and energy:

(a) more than visible light. (b) less than visible light.

(c) equal to visible light. (d) Frequency is less but energy is more

Q.2.When the temperature of a body rises:

(a) the energy of the random motion of atoms and molecules increases.

(b) the energy of the random motion of atoms and molecules decreases.

(c) the energy of the random motion of atoms and molecules remains same.

(d) the random motion of atoms and molecules becomes streamlined

Q.3. The frequency of rotation of water molecules is about:

(a) 2.45 MHz. (b) 2.45 kHz. (c) 2.45 GHz. (d) 2.45 THz

Q.4. Why should one use porcelain vessels and nonmetal containers in a microwave oven?

(a) Because it will get too much hot.

(b) Because it may crack due to high frequency.

(b) Because it will prevent the food items to become hot.

(d) Because of the danger of getting a shock from accumulated electric charges

Q. 5. In the microwave oven,

(a) energy is directly delivered to water molecules which is shared by the entire food.

(b) the vessel gets heated first, and then the food grains inside.

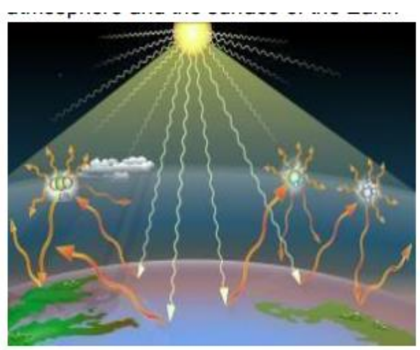
(c) the vessel gets heated first and then the water molecules collect heat from the body of the vessel.

(d) energy is directly delivered to the food grains.

ANS. 1.(b) 2.(a) 3.(c) 4.(d) 5.(a)

4. GREEN HOUSE EFFECT

The greenhouse effect is a natural process that warms the Earth's surface. When the Sun's energy reaches the Earth's atmosphere, some of it is reflected back to space and the rest is absorbed and re-radiated by greenhouse gases. The absorbed energy warms the atmosphere and the surface of the Earth



Q1. The one which is not considered as naturally occurring greenhouse gas is

(a) methane (b) CFCs

(c) carbon dioxide (d) nitrous oxide

Q2. Which of the following is not a use of infrared waves

a) Used in treatment for certain forms of cancer

b) in military and civilian applications include target acquisition, surveillance, night vision, homing, and tracking.

c) to observe changing blood flow in the skin

d) In imaging cameras, used to detect heat loss in insulated systems

Q3. which of the following is the best method for production of infrared waves

a) bombardment of metal by high energy electrons

b) radioactive decay of nucleus

c) magnetron valve

d) vibration of atoms and molecules

Q4. Wavelength of infrared radiations is

(a) shorter (b) longer

(c) infinite (d) zero

Q.5. The radiowave was discovered by

(a) Marconi (b) Faraday

(c) Austurn (d) Joule

(ANSWER KEY) Q1. b Q2. a Q3. d Q4. b Q.5.a

5. ELECTROMAGNETIC (EM) SPECTRUM

The electromagnetic (EM) spectrum is the range of all types of EM radiation. Radiation is• energy that travels and spreads out as it goes – the visible light that comes from a lamp in your house and the radio waves that come from a radio station are two types of electromagnetic radiation. The other types of EM radiation that make up the electromagnetic spectrum are microwaves, infrared light, ultraviolet rays, X-rays and gamma rays.

Q1. The classification is roughly based on?

a) Wavelength and frequency of waves. b) Production and detection of waves.

c) The way of travelling of waves. d) Year discovered.

Q2. Which of the following is NOT an example of EM RAYS.

a) Radiotherapy(medicine). b) Checking fractures.

c) Sterilisation. d) Explosives.

Q3. Identify the pair having highest frequency and highest wavelength EM WAVES.

a) UV rays and X- rays b) Gamma rays and Microwaves.

c) Gamma rays and Radio waves. d) Radio waves and UV rays.

Q4. What physical quantity is the same for X rays of wavelength 10-10m, red light of wavelength 6800 A^o and radiowaves of wavelength 500 m?

a) Speed in vacuum (c) b) frequency (f)

c) Scattering d) Energy (e)

Q.5. What is the ratio of velocity of electromagnetic waves having frequency 1MHz and 10MHz in air?

(a) 1:1 (b)2:1 (c) 1:2 (d)1:10

ANSWER KEY

1. b) 2. d) 3. c) 4. a) 5. a)

RAY OPTICS AND OPTICAL INSTRUMENTS

1. Refractive index	$n_{21} = \frac{\sin i}{\sin r} = \frac{n_2}{n_1}$ $n_{21} = \frac{Realdepth}{Apparentdepth} = \frac{t}{t_{app}}$
2. Apparent shift	$x = t - \frac{t}{n}$
3. Relation between critical angle and refractive index	$n_{12} = \frac{1}{\sin C}.$
4. Refraction at spherical surface	$\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$
5. Lens formula	$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$
6. Lens makers formula	$\frac{1}{f} = \left(\frac{n_2}{n_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$
7. Magnification	*(m) = I/O = v/u*
8. Power of lens	$P = \frac{1}{f}$
9. Combination of lens	$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$ $P = P_1 + P_2$ $m = m_1 \times m_2$
10. Relation between i, e and δ_m	$\delta_m = 2i - A$
11. Prism formula	$n_{21} = \frac{\sin\left(\frac{A + \delta_m}{2}\right)}{\sin\frac{A}{2}}$
12. Magnifying power of simple microscope	(final image at D) m = 1 + D/f

	(final image at infinity) m = D/f

QUESTIONS OF 2 MARKS

Q.1. Define the angle of deviation. Write the relation between angle of incidence i, angle of prism A and angle of minimum deviation δ_m for a glass prism.

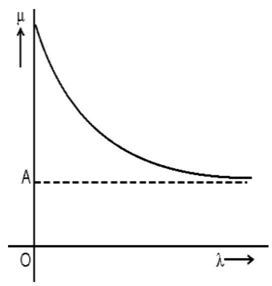
HINTS. Definition, $2i = A + \delta_m$

Q.2. It is known that the refractive index, , of the material of a prism, depends on the wavelength , , of the incident radiation as per the relation

$$\mu = A + \frac{B}{\lambda^2}$$

where A and B are constants. Plot a graph showing the dependence of μon λ.

HINTS.



Q.3.Define the power and write its SI unit. How does power of lens vary when incident red light is replaced by blue light?

HINTS: Def. and SI unit, Wavelength decreases hence power increases.

Q.4. Two thin lenses of power +6 D and – 2 D are in contact. What is the focal length of the combination?

HINTS: Net power of lens combination P = P1 + P2 = + 6 D - 2 D = + 4 D

∴ Focal length, f = 1/P = ¼ m = 25 cm

Q.5. Under what condition does a convex lens of glass having certain refractive index, acts as a plane glass sheet? Justify with mathematical calculation.

HINTS: When refractive index of lens is equal to refractive index of liquid.

Q.6.You are given following three lenses. Which two lens you will use to make objective and eyepiece of an astronomical telescope and why ?

LENS	POWER	APERTURE
L1	**3D**	**8cm**

L2	6D	1cm
L3	10D	1cm

HINTS: L1 as objective.

L3 as eyepiece , Justification

Q.7. 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? Justify with mathematical calculation.

HINTS: Since μ for lens. < μ for surrounding. It behaves like converging lens.

Q.8. A converging lens is kept coaxially in contact with a diverging lens , both the lenses being of equal focal lengths .What is the focal length of the combination?

HINTS. Focal length = infinity

Q.9. State the condition for the phenomenon of total internal reflection to occur. Name the device which work on the principle of total internal reflection.

HINTS. (a) Light travels from denser to rare medium.

(b) Angle of incidence greater than critical angle.

Q.10. Calculate the speed of light in a medium whose critical angle is 30^0

HINTS.

$$\because \quad n = \frac{1}{\sin C} = \frac{1}{\sin 30^\circ} \qquad \therefore n = 2$$

$$\Rightarrow \quad n = \frac{c}{v} = 2 \qquad \Rightarrow \frac{3 \times 10^8}{v} = 2$$

Therefore, speed of light is 1.5 X 10^8m/s

Q.11. A beam of light converges at a point P. Now a convex lens is placed in the path of the convergent beam at 15cm from P. At what point does a beam converge if the convex lens has a focal length 10cm?

HINT : 6cm

Q.12. An illuminated object and a screen are placed 90 cm apart. Determine the focal length and nature of lens required to produce a clear image on the screen, twice the size of the object.

Hint: f = 20 cm (convex lens)

Q.13. An object is placed at the principal focus of a concave lens of focal length f. Where will its image be formed? Draw the ray diagram.

Hint: Between optical centre and focus of lens: towards the side of the object.

Q.14. A prism of angle 60^0 gives a minimum deviation of 30^0 . What is the refractive index of the material of prism?

Hint: Refractive index n = 1.41

Q.15. An equi-convex lens has refractive index 1.5. Write its focal length in terms of radius of curvature R.

Hint: f = R

Q.16. Which of the following properties of light: velocity, wavelength and frequency, changes during the phenomenon (i) reflection (ii) refraction. Justify your answer

Hint: (i) No change (ii) Velocity, wavelength change

Q.17. Draw a ray diagram of compound microscope. Write the expression for its magnifying power.

SHORT AANSWER QUESTIONS (3m)

Q.1. For the same value of angle of incidence, the angle of refraction in three media is 15^0, 25^0 and 35^0respectively. In which medium the velocity of light will be minimum?

Ans.

As $\mu = \frac{\sin i}{\sin r} = \frac{c}{v}$ or $v = \frac{\sin r}{\sin i} \times c$

For a given angle of incidence $v \propto \sin r$,

$v_A \propto \sin 15°$, $v_B \propto \sin 25°$, $v_C \propto \sin 35°$

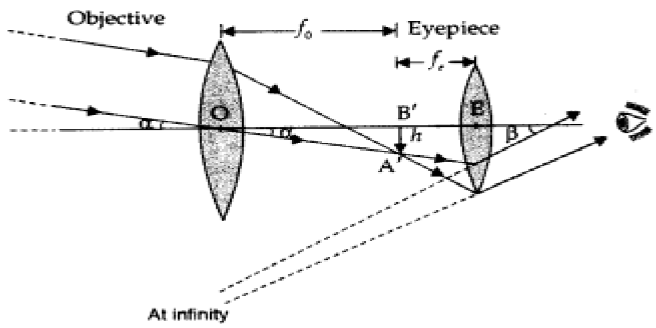
But $\sin 15° < \sin 25° < \sin 35°$

$\therefore \quad v_A < v_B < v_C$

Therefore, Velocity of light is minimum in medium A.

Q.2. Draw a ray diagram of an astronomical telescope in the normal adjustment position. State two drawbacks of this type of telescope.

Ans. (i) Magnifying power m = $-f_0/f_e$. It does not change with increase of aperture of objective lens, because focal length of a lens has no concern with the aperture of lens.



Astronomical telescope in normal adjustment

(ii) Drawbacks:

Lesser resolving power.

The image formed is inverted and faintes.

Q.3. What is the focal length of a combination of a convex lens of focal length 30cm and a concave lens of focal length 20cm ? Is the system a converging or diverging lens? Ignore thickness of the lenses.

Hint: f = -60cm

Q.4. Light from a point source in air falls on a convex spherical glass surface (μ = 1.5, radius of curvature = 20 cm). The distance of light source from the glass surface is 100 cm. At what position is the image formed?

Hint: v= +100cm. (The image is formed at a distance of 100cm from the glass surface in the direction of incident light)

Q.5. Velocity of light in a liquid is 1.5 X 10^8 m/s and in air, it is 3 X 10^8 m/s. If a ray of light passes from liquid into the air, calculate the value of critical angle.

Hint: Critical angle = 30^0

Q.6. Draw the ray diagram and derive the relation between object distance, image distance and focal length, when object is placed at the center of curvature of a convex lens.

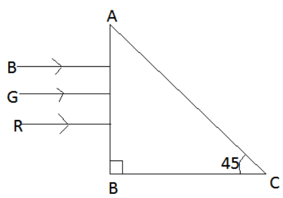
Hint: Diagram and formula 1/v - 1/u = 1/f

Q.7. (a) Write the necessary conditions for the phenomenon of total internal reflection to occur.

(b) Derive the relation between the refractive index and critical angle for a given pair of optical media. How the critical angle change when red incident light is replaced by violet incident light?

Hint: Light travel from denser medium to rare medium. $^a\mu_b$ = 1/sinC

Q.8. Three rays of light, red (R), green (G) and blue (B) are incident on the face AB of a right angled prism as shown in the figure. The refractive indices of the material prism for red, green and blue colours are 1.39, 1.44, and 1.47 respectively. Which one of the three rays will emerge out of the prism? Give reason to support your answer.



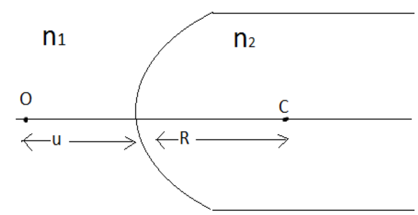
Hint: Only red ray will emerge out of the prism. (μ_R = 1.39 < 1.414)

Q.12. Derive the lens maker formula and write the assumptions.

Q.13. A convex lens of focal length 20 cm and a concave lens of focal length 15 cm are kept 30 cm apart with their principal axes coincident. When an object is placed 30 cm in front of the convex lens, calculate the position of the final image formed by the combination. Would this result change if the object were placed 30 cm in front of the concave lens? Give reason.

Hint: v = -30 cm

The result will not change on interchanging the lenses due to the principle of reversibility of light.



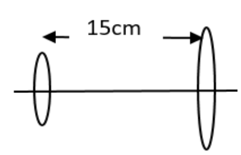
Q.14. A point object 'O' is kept in a medium of refractive index n_1 in front of a convex spherical surface of radius of curvature R which separates the second medium of refractive index n_2 from the first one, as shown in the figure. Draw the ray diagram showing the image formation and deduce the relationship between the object distance and the image distance in terms of n_1 , n_2 and R

Q.15. Why does a convex lens behave as a diverging lens when immersed in Carbon disulphide (μ=1.6). Justify with calculation.

b) 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 a material of glass prism is $\sqrt{3}$.

Q.16. (a) Draw the ray diagram of astronomical telescope in normal adjustment.

(b) convex lenses A and B of an astronomical telescope having focal lengths 5cm and 20cm respectively are arranged as shown in the figure.



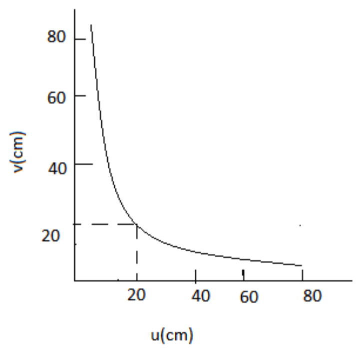
i) Which one of the two lenses you will select to use as the objective lens and why?

ii) What should be the change in the distance between the lenses to have the telescope in its normal adjustment position?

iii) Calculate the magnifying power of the telescope in the normal adjustment position?

Q.17. What is an equivalent lens. Obtain an expression for the effective focal length of two thin lenses placed in contact co-axially with each other.

Q.18. A lens forms a real image of an object. The distance of the object to the lens is 4 cm and the distance of the image from the lens is v cm. The given graph shows the variation of v with u. (i) What is the nature of the lens? (ii) Using the graph, find the focal length of this lens.

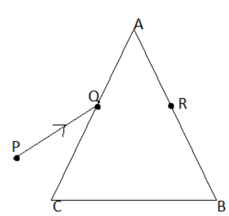


Hint: Lens is convex lens f = + 10 cm

Q.19. A small bulb is placed at the bottom of a tank containing water to depth of 80 cm. 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).

Hint: Area = 2.59 m^2

Q.20. A ray PQ incident on the face AC of a prism ABC, as shown in the figure , emerges from the face AB such that AQ = AR .



Draw the ray diagram showing the passage of the ray through the prism. If the angle of 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.

Hint: Correct diagram (QR II BC) minimum deviation position

<i = 60^0

δ= 60^0

Q.21. Draw a ray diagram of reflecting type telescope . State two advantage of this type telescope . Write magnifying power formula .

Q.22. Draw a ray diagram of compound microscope when image is formed at least distance of distinct vision . Derive magnifying power formula .How can the magnifying power of a microscope be increased ?

Q.23. Draw ray diagram to show refraction of light through a glass prism. Draw a graph, show the angle of deviation with that of the angle of incidence. For small angle prism, prove that $\delta = A (\mu-1)$, where the symbols have their usual meanings.

Q.24. A ray of light passing from air through an equilateral glass prism undergoes minimum deviation. When the angle of incidence is ¾ of angle of prism. Calculate the speed of light in prism.

Hint : 2.1×10^8 m/s

Q.25. A prism is made of glass of unknown refractive index. A parallel beam of light is incident on a face of the prism. The angle of minimum deviation is measured to be 40°. What is the refractive index of the material of the prism? The refracting angle of the prism is 60°. If the prism is placed in water (refractive index 1.33), predict the new angle of minimum deviation of a parallel beam of light

Hint: $^a\mu g$ = 1.532, $D'_w = 10^0$

Q.26. A small telescope has an objective lens of focal length 144cm and an eyepiece of focal length 6.0cm. What is the magnifying power of the telescope? What is the separation between the objective and the eyepiece?

Hint: m= 24, separation = 150 cm

Q.27. A person with a normal near point (25 cm) using a compound microscope with objective of focal length 8.0 mm and an eyepiece of focal length 2.5cm can bring an object placed at 9.0mm from the objective in sharp focus. What is the separation between the two lenses? Calculate the magnifying power of the microscope.

Hint: Separation 9.4cm, magnifying power = 88

Q.28. An illuminated object and a screen are placed 90cm apart. Determine the focal length and nature of the lens required to produce a clear image on the screen, twice the size of the object.

Hint: f = 20cm, convex lens

Q.29. A bioconvex lens of refractive index of 1.5 Having focal length of 20cm 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 plain sheet of glass.

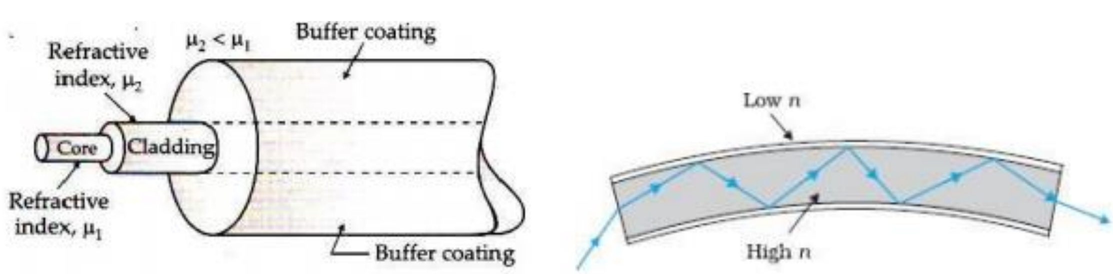
Hint: Focal length = -110 cm, refractive index = 1.5

Q.30. An object of size 3.0cm is placed 14cm in front of a concave lens of focal length 21cm. Describe the image produced by the lens. What happens if the object is moved further away from the lens?

Hint: Image is virtual, erect and is formed at 8.4cm from the lens on the same side as the object, Height of the image= 1.8cm, diminished, object is moved away from the lens, the virtual image moves towards focus of the lens(but never beyond it) and progressively diminishes in size.

CASE STUDY QUESTION

CASE STUDY 1.Optical fibres: Now-a-days optical fibres are extensively used for transmitting audio and video signals through long distances. Optical fibres too make use of the phenomenon of total internal reflection. Optical fibres are fabricated with high quality composite glass/quartz fibres. Each fibre consists of a core and cladding. The refractive index of the material of the core is higher than that of the cladding. When a signal in the form of light is directed at one end of the fibre at a suitable angle, it undergoes repeated total internal reflections along the length of the fibre and finally comes out at the other end. Since light undergoes total internal reflection at each stage, there is no appreciable loss in the intensity of the light signal. Optical fibres are fabricated such that light reflected at one side of inner surface strikes the other at an angle larger than the critical angle. Even if the fibre is bent, light can easily travel along its length. Thus, an optical fibre can be used to act as an optical pipe.



i) Which of the following statement is not true.

a) Optical fibres is based on the principle of total internal reflection.

b) The refractive index of the material of the core is less than that of the cladding.

c) an optical fibre can be used to act as an optical pipe.

d) there is no appreciable loss in the intensity of the light signal while propagating through an optical fibre

ii) What is the condition for total internal reflection to occur?

a) angle of incidence must be equal to the critical angle.

b) angle of incidence must be less than the critical angle.

c) angle of incidence must be greater than the critical angle.

d) None of the above.

iii) Which of the following is not an application of total internal reflection?

a) Mirage b) Sparkling of diamond

c) Splitting of white light through a prism. d) Totally reflecting prism.

iv) Optical fibres are used extensively to transmit

a) Optical Signal b) current c) Sound waves d) None of the above

v) Mirage is found due to,

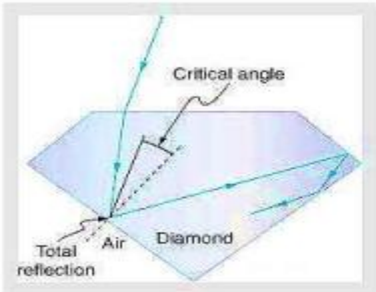
a.) Refraction of light b.) Total internal reflection

c.) Reflection of light d.) All

ANSWER

i) (b) ii) (c) iii) (c) iv) (a) v)(b)

CASE STUDY2. The total internal reflection of the light is used in polishing diamonds to create a sparking brilliance. By polishing the diamond with specific cuts, it is adjusted the most of the light rays approaching the surface are incident with an angle of incidence more than critical angle. Hence, they suffer multiple reflections and ultimately come out of diamond from the top. This gives the diamond a sparking brilliance



Q.1. T critical angle for a diamond is

a) 1.41 b) Same as glass c) 2.42 d) 1

Q.2. The basic reason for the extraordinary sparkle of suitably cut diamond is that

a) It has low refractive index

b) It has high transparency

c) It has high refractive index

d) It is very hard

Q.3. The extraordinary sparkling of diamond

a) Does not depend on its shape

b) Depends on its shape

c) Has no fixed reason

d) None

Q.4. A diamond is immersed in a liquid with a refractive index greater than water. Then the critical angle for total internal reflection will

a) Increase

b) Decrease

c) Depend on the nature of the liquid

d) Remains the same

Q.5. OFC cables work on the principle of

a) Dispersion of light

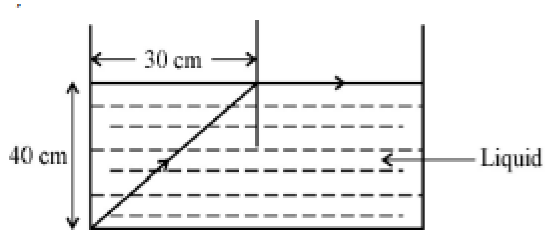
b) Refraction of light

c) Total internal reflection

d) Interference of light

<u>ANSWER:</u> 1. (c) 2. (c) 3.(b) 4.(a) 5.(c)

CA SE STUDY 3. TOTAL INTENAL REFLECTION



(i) What is refractive index of a medium (in terms of speed of light)

a) Speed of light in medium/speed of light in vacuum

b) Speed of light in vacuum/speed of light in medium speed of light in vacuum

c) Speed of light in medium

d) None of the above.

(ii) In the above diagram, calculate the speed of light in the liquid of unknown refractive index.

a) 1.2×10^8 m/s b) 1.4×10^8 m/s

c) 1.6×10^8 m/s d) 1.8×10^8 m/s

(iii) What is refractive index of a medium (in terms of real and apparent depth).

a) Real depth/ App depth b) App/ Real depth

c) App Real x depth d) Real + App depth

(iv) What is the relation between refractive index and critical angle for a medium.

a) $n = 1/\sin i_c$ b) $n = \sin i_c$

c) $1 = n/\sin i_c$ d) None of the above

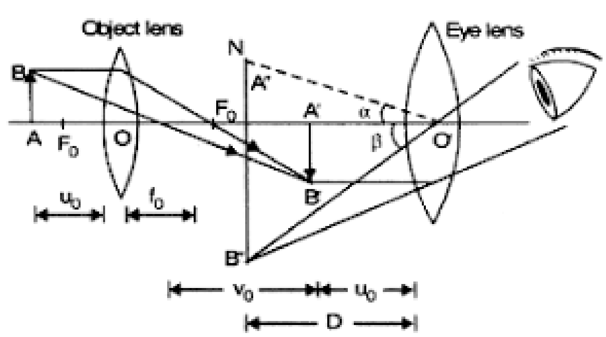
(v) What is the value of angle of incidence for ray of light travelling from a medium of refractive index √2 into the medium of refractive index 1 so that it just grazes along the surface of separation.

a) 0^0 (b)45^0 (c)30^0 (d)90^0

ANSWER: i) (b) ii) (d) iii) (a) iv) (a) v) (b)

CASE STUDY 4. Compound microscope

A compound microscope consist of two lenses. A lens of short aperture and short focal length facing the object is called the object lens and another lens of short focal length but large aperture is called the eye lens. Magnifying power is defined as the ration of angle subtended by the final image at the eye to the angle subtended by the object is seen directly, when both are placed at least distance of distinct vision



1. An objective lens consist of

(i). Short aperture and short focal length (ii).large aperture and large focal length

(iii).Short aperture and large focal length (iv).large aperture and short focal length

2. An eyepiece consist of

(i).short aperture and short focal length (ii).large aperture and large focal length
(iii).short aperture and large focal length (iv).large aperture and short focal length

3.Formula of magnifying power

(i).$M = \frac{\beta}{\alpha}$ (ii).$M = \frac{\alpha}{\beta}$

(iii).$M = 1 + \frac{\alpha}{\beta}$ (iv).$M = 1 + \frac{\beta}{\alpha}$

4. A compound microscope with an objective of 1.0 cm, focal length and eyepiece 2.0 cm . Focal length of a tube is 20 cm. Calculate the magnifying power of the microscope

(i).270 (ii).27 (iii).140 (iv).14

5. Final image formed by compound microscope

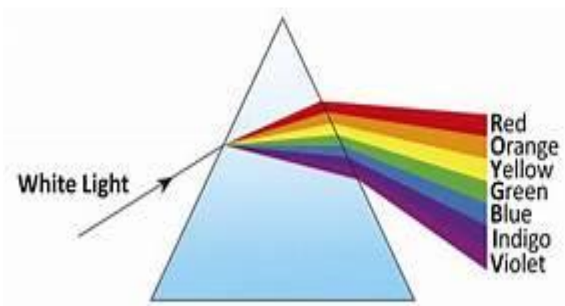
(i).inverted (ii). Erect

(iii). virtual (iv).highly diminished

ANSWER. 1 (i). 2 (iv). 3. (i). 4. (iii) 5. (iv)

CASE STUDY 6.Dispersion

Dispersion If a beam of white light is made to fall on one face of prism the light emerging from the other face of the prism consist of seven colours violet, indigo, blue, green , yellow, orange, red . The phenomena of splitting of white light into its constituent colours is called dispersion of light .



1. Which one of the following colours will suffer greatest dispersion

(i).violet (ii).indigo (iii).blue (iv).red

2. The critical angle between an equilateral prism and air is 45. If the incident ray is perpendicular to refracting surface then

(i).it is reflected totally from the second surface and emerges perpendicular from the third surface.

(ii).it gets reflected from second and third surface and emerges from the first surface.

(iii).it keeps reflecting from all the three side of the prism and never emerges out.

(iv).after deviation, it gets refracted from the second surface.

3. Which colour is taken as the mean colour(ie- mean refractive index for a material)

(i). yellow (ii).red (iii).violet (iv).green

4. A prisṁ with a refracting angle of 60 gives angle of minimum deviation 53°,51°,52° for blue, red, yellow light respectively . What is the dispersive power of the material of the prism

(i).385 (ii)0.385 (iii).0.0385 (iv).38.5

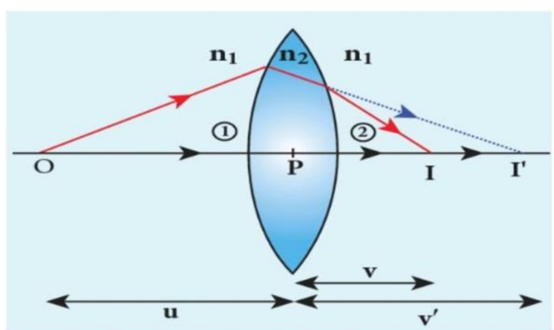
5. The refractive angle of a prism for a monochromatic light is 60° and refractive index is √2. For minimum deviation the angle of incidence will be

(i).60° (ii).45° (iii).30° (iv).75°

ANSWER. 1 (i). 2 (ii) 3 (i). 4(iii) 5(iii).

CASE STUDY 7. Lens maker's formula.

The lens maker's formula relates the focal length of a lens to the refractive index of its material and the radii of curvature of its two surfaces. This formula is used to manufacture a lens of particular focal length from the glass of a given refractive index. For this reason, it is called the lens maker's formula.



1.For a plano-convex lens of radius of curvature 10 cm the focal length is 30 cm . If the refractive index of the material of the lens is

(i).2.0 (ii).1.33 (iii).1.66 (iv).1.5

2.An image is formed on the screen by a convex lens when upper half part of lens is covered with black paper then

(i).half image is formed (ii).full image is formed

(iii)intensity of image is enhanced (iv).all of the above

3.A convex lens of focal length 20 cm is placed in contact with a diverging lens of unknown focal length. The lens combination acts as a converging lens and has a focal length of 30 cm . What is the focal length of diverging lens

(i). -90 cm (ii). -60 cm

(iii). -30 cm (iv).-10 cm

4. The focal length of a lens, made up of glass, is 5 cm in air. What would be the focal length of the same lens in water? The refractive indices of glass and water are 3/2 and 4/3 respectively. (i).12cm (ii). -`12 cm (iii). 16 cm (iv). -16cm

5. Two thin lenses of focal length 60 and -20 cm in contact have a resultant focal length of
(i).-30 (ii). +15 (iii).-15 (iv).+30

ANSWER. 1 (ii). 2 (ii) 3 (ii) 4 (iii) 5 (i)

WAVE OPTICS

I.Short Answer types Questions (2 Marks each)

1. Maximum intensity in YDSE is I0. Find the intensity at a point on the screen where. (a) the phase difference between the two interfering beams is $\pi/3$ (b) the path difference between them is $\lambda/4$

2. Two waves of equal frequencies have their amplitudes in the ratio of 3:5 . They are superimposed on each other. Calculate the ratio of maximum and minimum intensities of the resultant wave.

3. Draw a diagram to show the refraction of a plane wave front incident on a convex lens and hence draw the refracted wave front.

4. Why light ways do not diffracted around buildings, while radio waves diffract easily?

5. In double-slit experiment using light of wavelength 600 nm, the angular width of a fringe formed on a distant screen is 0.1^{o}.What is the spacing between the two slits?

6. For what distance is ray optics a good approximation when the aperture is 3 mm wide and the wavelength is 500 nm?

7. The 6563 Å Hα line emitted by hydrogen in a star is found to be red shifted by 15 Å. Estimate the speed with which the star is receding from the Earth.

8. (a) In a single slit diffraction experiment, a slit of width ‘d’ is illuminated by red light of wavelength 650 nm. For what value of‘d’ will

(i) the first minimum fall at an angle of diffraction of 30°, and

(ii) the first maximum fall at an angle of diffraction of 30°?

9. In a single slit diffraction experiment, the width of the slit is reduced to half its original width. How would this affect the size and intensity of the central maximum?

10. How does the fringe width of interference fringes change, when the whole apparatus of Young's experiment is kept in a liquid of refractive index 4/3?

II.Short Answer types Questions (3 Marks each)

1. Define the term wave front? Using Huygens's construction draw a figure showing the propagation of a plane wave reflecting at the interface of the two media. Show that the angle of incidence is equal to the angle of reflection.

2. Define the term 'wave front'. Draw the wave front and corresponding rays in the case of a (i) diverging spherical wave (ii) plane wave. Using Huygens's construction of a wave front, explain the refraction of a plane wave front at a plane surface and hence deduce Snell's law.

3. In Young's double-slit experiment a monochromatic light of wavelength λ, is used. The intensity of light at a point on the screen where path difference is λ is estimated as K units. What is the intensity of light at a point where path difference is λ /3?

4. Draw fringe patterns of Interference and Diffractions and write two difference between them.

5. State one feature by which the phenomenon of interference can be distinguished from that of diffraction. A parallel beam of light of wavelength 600 nm is incident normally on a slit of width 'a'. If the distance between the slits and the screen is 0.8 m and the distance of 2^{nd} order maximum from the centre of the screen is. 15 mm, calculate the width of the slit.

6. What is interference of light? Write two essential conditions for sustained interference pattern to be produced on the screen. Draw a graph showing the variation of intensity versus the position on the screen in Young's experiment when

7.Explain graphically the intensity of fringe pattern of single and double slit interference and write two differences between them.

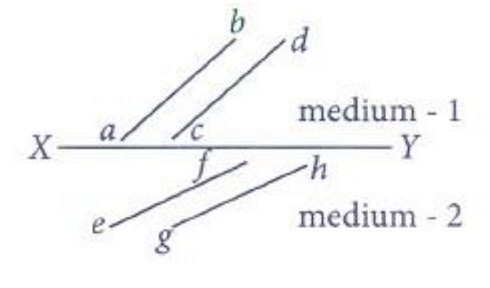
8.What do you mean by Fresnel distance? Estimate the distance for which ray optics is good approximation for an aperture of 4 mm and wavelength 400 nm.

9. In a single slit diffraction experiment first minimum for λ_1 660 nm coincides with first maxima for wavelength λ_2 . Calculate the value of λ_2

10. If in interference $\frac{I_{max}}{I_{min}} = \alpha$, Find out (a) $\frac{A_{max}}{A_{min}}$, $(b)\frac{A_1}{A_2}$ and$(c)\frac{I_1}{I_2}$

III.Case Study based Questions (5Marks)

1. Wavefront is a locus of points which vibrate in same phase. A ray of light is perpendicular to the wave front. According to Huygens principle, each point of the wave front is the source of a secondary disturbance and the wavelets connecting from these points spread out in all directions with the speed of wave. The figure shows a surface XY separating two transparent media, medium-I and medium-2. The lines ab and cd represent wave fronts of a light wave travelling in medium- 1 and incident on XY. The lines ef and gh represent wave fronts of the light wave in medium -2 after refraction.



(i) Light travels as a

(a) parallel beam in each medium (b) convergent beam in each medium

(c) divergent beam in each medium (d) divergent beam in one medium and convergent beam in the other medium.

(ii) The phases of the light wave at c, d, e and f are $\emptyset_c, \emptyset_d, \emptyset_e and\ \emptyset_f$ respectively. It is given that $\emptyset_c \neq \emptyset_f$

((a) $\emptyset_c$can not be equal to $\emptyset_d$ (b) $\emptyset_d$can be equal to $\emptyset_e$

(c) $(\emptyset_d - \emptyset_f)$ is equal to $(\emptyset_c - \emptyset_e)$ (d) $(\emptyset_d - \emptyset_c)$ is not equal to$(\emptyset_f - \emptyset_e)$

(iii) Wave front is the locus of all points, where the particles of the medium vibrate with the same

(a) phase (b) amplitude (c) frequency (d) period

(iv) A point source that emits waves uniformly in all directions, produces wavefronts that are

(a) spherical (b) elliptical (c) cylindrical (d) planar

(v) What are the types of wavefronts ?

(a) Spherical (b) Cylindrical (c) Plane (d) All of these

2) Jimmy and Johnny were both creating a series of circular waves by jiggling their legs in water. The waves form a pattern similar to the diagram as shown. Their friend, Anita, advised Jimmy and Johnny not to play with water for a long time. She then observed beautiful patterns of ripples which became very colourful. When her friend Latha poured an oil drop on it. Latha, a 12th standard girl, had explained the cause for colorful ripple patterns to Anita earlier.

(i) Name the phenomenon involved in the activity

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

(ii) A surface over which an optical wave has a constant phase is called.

(a) Wave (b) Wave front (c) Elasticity (d) None of these

(iii) Which of the following is correct for light diverging from a point source?

(a) The intensity decreases in proportion for the distance squared.

(b) The wave front is parabolic.

(c) The intensity at the wavelength does depend of the distance.

(d) None of these.

(iv) The phenomena which is not explained by Huygens's construction of wave front

(a) reflection (b) diffraction (c) refraction (d) origin of spectra

(v) Huygens's concept of secondary wave

(a) allows us to find the focal length of a thick lens

(b) is a geometrical method to find a wave front

(c) is used to determine the velocity of light

(d) is used to explain polarization

3) Geeta was watching her favorite TV programme KBC. Suddenly the picture started shaking on the TV Screen. She asked her elder brother to check the dish antenna. Her brother found nothing wrong with the antenna. A little later, Geeta again noticed the same problem on the TV Screen. At the same time she heard the sound of a low flying aircraft passing over their house. She asked her brother again. His brother being a Physics student explained the cause of shaking the picture on the TV Screen when aircraft passes over head.

(i) Why does the picture started shaking when a low lying aircraft passes overhead

a) Due to Interference b) Due to reflection

c) Due to refraction d) Due to polarization

(ii) Which of the following does not show any interference pattern?

a) Soap bubble b) Excessively thin film c) A thick film d) Wedge Shaped film

(iii) The main principle used in Interference is _____________

a) Heisenberg's Uncertainty Principle b) Superposition Principle

c) Quantum Mechanics d) Fermi Principle

(iv) When two waves of same amplitude add constructively, the intensity becomes

a) Double b) Half c) Four Times d) One-Fourth

(v) The shape of the fringes observed in interference is ____________

a) Straight b) Circular c) Hyperbolic d) Elliptical

4) Rohan observed the thin film such as soap bubble or a thin layer of oil on water show beautiful colours when illuminated by white light. He felt happy and surprised to see that. He went to his Physics teacher to understand the reason behind it. The teacher explained him that a thin film of oil spread over water shows interference of light due to interference between the light waves reflected by the lower and upper surface of the thin film. On understanding the phenomenon, Rohan than gave an example of thin film of kerosene oil which is spread over water to prevent malaria and dengue.

(i) If instead of monochromatic light white light is used for interference of light, what would be the change in the observation?

a) The pattern will not be visible

b) The shape of the pattern will change from hyperbolic to circular

c) Colored fringes will be observed with a white bright fringe at the center

d) The bright and dark fringes will change position

(ii) Zero order fringe can be identified using ____________

a) White light b) Yellow light c) Achromatic light d) Monochromatic light

(iii) The interference pattern of soap bubble changes continuously.

a) True b) False c) Neither a nor b d) Both a and b

(iv)Which of the following does not show any interference pattern?

a) Soap bubble b) Excessively thin film c) A thick film d) Wedge Shaped film

v) A thin sheet of refractive index 1.5 and thickness 1 cm is placed in the path of light. What is the path difference observed?

a) 0.003 m b) 0.004 m c) 0.005 m d) 0.006 m

5) Ram and Rahim were returning home from the cricket field, on their way they found a new 500 rupee note on the road. Rahim advised Ram to handover the money to the cashier of the charity home they did so and the cashier checked to see whether the currency was genuine or fake. He appreciated the boys and showed them how to check the currency. The number 500 at the centre of the note appears green when looked straight and blue when tilted at an angle. The cashier also explained that the colour shift on tilting is due to constructive interference of blue light produced by the variation of thickness of chemical layers specially added in the printing ink.

(i) colour shift on tilting is due to

(a) Constructive interference of blue light produced by the variation of thickness of chemical layers specially added in the printing ink.

(b) Destructive interference of blue light produced by the variation of thickness of chemical layers specially added in the printing ink.

(c) Diffraction of blue light produced by the variation of thickness of chemical layers specially added in the printing ink.

(d) None of these

(ii) Is it necessary that the amplitude be constant over a given wave front?

(a)Yes (b)No (c) Both a and b (d)Neither a nor b

(iii) Can two wave-fronts cross one another? Give reason.

(a)Yes (b)No (c) Both a and b (d)Neither a nor b

(iv) When a wave undergoes reflection at a denser medium, what happens to its phase?

(a) $\pi/2$ radian (b)$\pi/4$ radian (c) π radian (d)$\pi/ 6$ radian

(v) If a wave undergoes refraction, what will be the phase change?

(a) $\pi/2$ radian (b)$\pi/4$ radian (c) π radian (d)zero

6) CD reflecting rainbow colours:

Almost all of you have seen a rainbow formation on rainy days. Well, rainbow is formed because water droplets in the atmosphere separate white light into different colours of the rainbow. Compact Disc (CD) also resembles the same kind of colours when viewed from different angles. Recorded data on CD is stored in microscopic pits of different lengths which carries information in the CD. These pits are placed in a row of the same width and at equal distance. This forms a diffraction grating on the CD mirror surface.

(i) Formation of rainbow colours on the CD is due to

(a) Reflection (b) Refraction (c) Diffraction (d) None of these

(ii) The recorded data on the discs behaves as

(a) Diffraction grating (b) Rainbow

(c) Drops (d) Colours

(iii) Bending of light at the corners of the door is an example of

(a) Reflection (b) Refraction

(c) Interference (d) Diffraction

(iv) Which of the following is an example of diffraction?

(a) Holograms (b) Sun appears red during sunset

(c) From the shadow of an object (d) All of these

(v) The intensity of light from the central maxima goes on ……In Diffraction pattern.

(a) Increasing (b) Decreasing

(c) Both a and b (d) Neither a nor b

Answer Key

Solution of Case Study Questions of Wave Optics

1) (i) a (ii) c (iii) c (iv) a (v) c

2) (i) c (ii) b (iii) a (iv) d (v) b

3) (i) a (ii) b (iii) b (iv) c (v) c

4) (i) c (ii) a (iii) a (iv) b (v) c

5) (i) a (ii) a (iii) b (iv) c (v) d

6) (i) c (ii) (a) (iii) (d) (iv) (d) (v)

DUAL NATURE OF MATTER AND RADIATION

Important formulae

Energy of a photon, E = hν = $\frac{hc}{\lambda}$

If λ is in nm and energy of photon is in eV, then $E = \frac{1242 eV-nm}{\lambda\,(in\ nm)}$

Work function w = $h\nu_0 = \frac{hc}{\lambda 0}$

Momentum of photon p = $\frac{h}{\lambda}$

Cut-off potential (V_0) then $KE_{max} = eV_0$

$$\frac{1}{2} m v_{max}^2 = eV_0$$

Einstein's equation for photoelectric effect $h\nu = KE_{max} + W_0$

$V_0 = \frac{h}{e}(\nu - \nu_0)$

$V_0 = \frac{h}{e}(\frac{c}{\lambda} - \frac{c}{\lambda 0})$

de-Broglie matter wave equation $\lambda = \frac{h}{p} = \frac{h}{mv}$

$\frac{1}{2}mv^2 = qV$ or $v = \sqrt{\frac{2qV}{m}}$

Momentum p = mv = $\sqrt{2qVm}$

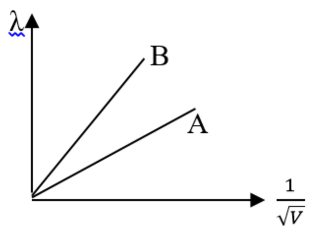
The wave length associated with moving charge is given by $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2qVm}}$

If accelerate charge is electron then $\lambda = \frac{h}{\sqrt{2qVme}}$, where m_e = mass of electron.

$$\lambda = \frac{12.27}{\sqrt{V}} \dot{A} \text{ , For electron beam}$$

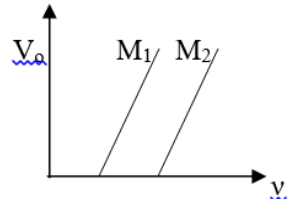
(2 Marks Questions)

1.The two lines marked A and B in the given figure show a plot of de-Broglie wavelength λ versus $\frac{1}{\sqrt{V}}$, where V is the accelerating potential for two nuclei ${}_1^2H$ and ${}_1^3H$.(i)What does the slope of the lines represent? (ii) Identify which of the lines corresponded to these nuclei.



2.Draw suitable graphs to show the variation of photoelectric current with collector plate potential for (i) a fixed frequency but different intensities $I_1 > I_2 > I_3$. (ii) a fixed intensity but different frequencies $\nu_1 > \nu_2 > \nu_3$.

3.Figure shows variation of stopping potential (V_o) with the frequency (ν) for two photo sensitive materials M_1 and M_2. (i) Why is the slope same for both lines? (ii) For which material will the emitted electron have greater kinetic energy for the incident radiation of the same frequency? Justify your answer.



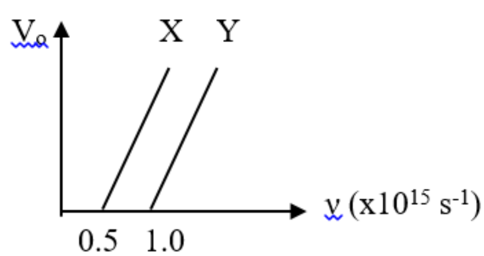
4.An electron is accelerated through a potential difference of 100 V. What is the de-Broglie wavelength associated with it? To which part of the electromagnetic spectrum does this value of wavelength correspond?

5.An α-particle and a proton are accelerated from rest by the same potential. Find the ratio of their de-Broglie wavelengths.

(3 Marks Questions)

6.Define the terms cut-off voltage and threshold frequency in relation to the phenomenon of photoelectric effect. Using Einstein's photoelectric equation show how the cut-off voltage and threshold frequency for a given photosensitive material can be determine with the help of a suitable graph.

7. The following graph shows the variation of stopping potential V_o with the frequency ν of the incident radiation for two photosensitive metals X and Y (i) Which of the metals has larger threshold wavelength? Give reason. (ii) Explain giving reason which metal gives out electrons having larger kinetic energy. For the same wavelength of the incident radiation. (iii) If the distance between the light source and metal X is halved how will the kinetic energy of electrons emitted from it change? Give reason.



8. Write two characteristic features observed in photoelectric effect which supports the photon pictures of electromagnetic radiation. Draw a graph between the frequency of incident radiation (ν) and the maximum kinetic energy of the electrons emitted from the surface of a photosensitive material. State clearly how this graph can be used to determine (i) Planck's constant and (ii) work function of the material?

9. An electron and a photon each have a wavelength 10^{-9} m. Find (i) Their momenta (ii) The energy of the photon and (iii) The kinetic energy of electron.

10. Draw a plot showing the variation of photoelectric current with collector plate potential for two different frequencies $\nu_2 > \nu_1$ of incident radiation having the same intensity. In which case will the stopping potential be higher? Justify your answer.

CASE BASED QUESTIONS (5 Marks each)

11. The photoelectric emission is possible only if the incident light is in the form of packets of energy, each having a definite value, more than the work function of the metal. This shows that light is not of wave nature but of particle nature. It is due to this reason that photoelectric emission was accounted by quantum theory of light.

Q1. Packet of energy are called

(a)electron (b) quanta (c)frequency (d)neutron

Q2. One quantum of radiation is called

(a) meter (b) meson (c) photon (d)quark

Q3. Energy associated with each photon

(a) hc (b) mc (c) hv (d)hk

Q4. Which of the following waves can produce photo electric effect

(a). UV radiation (b). Infrared radiation (c). Radio waves (d) .Microwaves

Q5. Work function of alkali metals is

(a) less than zero (b) just equal to other metals

(c) greater than other metals (d) quite less than other metals

11. Lenard observed that when ultraviolet radiations were allowed to fall on the emitter plate of an evacuated glass tube, enclosing two electrodes (metal plates), current started flowing in the circuit connecting the plates. As soon as the ultraviolet radiations were stopped, the current flow also stopped. These observations proved that it was ultraviolet radiations, falling on the emitter plate, that ejected some charged particles from the emitter and the positive plate attracted them.

Q1. Alkali metals like Li, Na, K and Cs show photo electric effect with visible light but metals like Zn, Cd and Mg respond to ultraviolet light. Why?

a) Frequency of visible light is more than that for ultraviolet light

b) Frequency of visible light is less than that for ultraviolet light

c) Frequency of visible light is same for ultraviolet light

d) Stopping potential for visible light is more than that for ultraviolet light

Q2. Why do we not observe the phenomenon of photoelectric effect with non-metals?

a) For non metals the work function is high

b) Work function is low

c) Work function can't be calculated

d) For non metals, threshold frequency is low

Q3. What is the effect of increase in intensity on photoelectric current?

a) Photoelectric current increases b) Decreases

c) No change d) Varies with the square of intensity

Q4. Name one factor on which the stopping potential depends

a) Work function b) Frequency

c) Current d) Energy of photon

Q5. How does the maximum K.E of the electrons emitted vary with the work function of metal?

a) It doesn't depend on work function b)It decreases as the work function increases

c) It increases as the work function increases d) It's value is doubled with the work function

12. The concept of 'wave nature of matter' was postulated by de Broglie in 1924. It was confirmed experimentally by Davisson and Germer a few years after its postulation. Therefore, the realization was that 'wave nature' and 'particle nature' can be viewed as the 'two sides of a coin'. Both matter and radiation can exhibit either of these 'natures', depending on the experimental situation. The phenomena of photoelectric effect and the concept of 'matter waves', have been put to very useful and interesting practical applications. We are aware of photocells, automatic doors at shops and malls, automatic light switches that turn on the lights as soon as the intensity drops.

Q1. Who confirmed experimentally the wave nature of electron?

a) De-broglie b) Davisson & Germer c) Einstein d) None of these

Q2. A proton and an electron have same kinetic energy. Which one has greater de-Broglie wavelength ?

a) Electron b) Proton c) Same d) Can't be calculated

Q3. An electron is accelerated through a potential difference of 100 volts. What is the de-Broglie wavelength associated with it?

a) 1.227 A$^{\circ}$ b) 12.27 A$^{\circ}$ c) 122.7 A$^{\circ}$ d) 1227 A$^{\circ}$

Q4. The de-broglie wavelength, associated with a proton and neutron are found to be equal. Which of the two has a higher value of K.E?

a) Proton b) Neutron c)Same for both d)Can't be calculated

Q5. An electron is accelerated through a potential difference of 300 volt. What is its energy in eV?

a) 30 eV b) 300 eV c)10 eV d) 0.3eV

HINTS

(2 Marks Questions)

1. $\lambda = \frac{h}{\sqrt{2mqV}}$

   (a) The slope of line represents $\frac{h}{\sqrt{2mq}}$

   (b) The lighter mass i.e. ${}_1^2H$ is represents by line of greater slope.

2. Two graphs
3. (a) Slope of stopping potential with frequency of incident radiation gives the value of plank's constant

   (b) The intercept of graph on stopping potential gives the value of stopping potential which is higher for M_2.

4. $\lambda = \frac{12.27}{\sqrt{V}}\dot{A}, \lambda = 1.227$ The wavelength belong to the X- Ray part of electromagnetic radiation.
5. $\lambda = \frac{h}{\sqrt{2mqV}}, \frac{\lambda_\alpha}{\lambda_p} = \frac{1}{2\sqrt{2}}$

(3 Marks Questions)

6. Definition of Cut off voltage and Threshold frequency

   Einstein's equation $Vo = \frac{h}{e}(\vartheta - \vartheta o)$ and graph

7. $\lambda = \frac{c}{v}$, $(a)\lambda_x > \lambda_y$, (b) KE_{max} for metal X is greater than Y, (c) No effect.
8. Correct answer and graph.
9. (i) = $\frac{h}{p}$, P = 6.63x10^{-25} m (ii) $E = \frac{hc}{\lambda}$ = 1243 eV (iii) $E = \frac{p^2}{2m}$ = 1.52 eV.
10. Graph and correct answer, It is clear that for higher frequency cut off potential is higher.

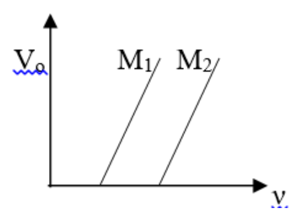
(CASE BASED 5 Marks Questions)

11. Q1.(b) Q2.(c) Q3.(c) Q4.(a) Q5.(d)
12. Q1.(b) Q2.(a) Q3.(a) Q4.(b) Q5.(b)
13. Q1.(b) Q2.(a) Q3.(a) Q4.(a) Q5.(b)

Self Assessment

2 Marks Questions

1. Draw suitable graphs to show the variation of photoelectric current with collector plate potential for (i) a fixed frequency but different intensities $I_1>I_2>I_3$. (ii) a fixed intensity but different frequencies $\nu_1>\nu_2>\nu_3$.
2. Figure shows variation of stopping potential (V_o) with the frequency (ν) for two photo sensitive materials M_1 and M_2. (i) Why is the slope same for both lines? (ii) For which material will the emitted electron have greater kinetic energy for the incident radiation of the same frequency? Justify your answer.



3. Define the terms cut-off voltage and threshold frequency in relation to the phenomenon of photoelectric effect. Using Einstein's photoelectric equation show how the cut-off voltage and threshold frequency for a given photosensitive material can be determine with the help of a suitable graph.
4. Draw a plot showing the variation of photoelectric current with collector plate potential for two different frequencies $\nu_2>\nu_1$ of incident radiation having the same intensity. In which case will the stopping potential be higher? Justify your answer.

3 Marks Questions

5. What do you mean by photo electric emission? State the laws of photo electric emission.
   In a plot of photo electric current versus anode potential, how does
   i. The saturation current varies with anode potential for incident radiation of different frequencies of incident radiation but same intensity?
   ii. The stopping potential varies for incident radiations of different intensities but same frequency?
   iii. Photo electric current vary for different intensities but same frequency of incident radiations?
6. The work function for cesium is 2.14 eV. Find (i) Threshold wavelength for cesium, (ii) The frequency of radiation incident on cesium if stopping potential is 0.60 V.

CASE BASED QUESTION

7. Studies, that followed, showed that different metals emit electrons when irradiated by different electromagnetic radiations. For example, alkali metals (sodium, cesium, potassium) emit electrons with

X–rays ultraviolet light and also with visible light, except red and orange light. Heavy metals, like zinc, cadmium, magnesium, emit electrons only when ultraviolet radiations fall on.

A. Why do we not observe the phenomenon of photoelectric effect with non-metals?

i) For nonmetals the work function is high   ii) Work function is low

iii) Work function can't be calculated   iv) For non-metals, threshold frequency is low

B. The practical application of the phenomenon of photoelectric effect and the concept of 'matter waves' is

i) Photocells   ii)Automatic doors at shops and malls

iii) automatic light switches   iv)All of them

C. What is the effect of increase in intensity on photoelectric current?

i) Photoelectric current increases   ii) Decreases

iii) No change   iv)Varies with the square of intensity

D. Name one factor on which the stopping potential depends

i) Work function   ii)Frequency

iii) Current   iv)Energy of photon

E. Alkali metals like Li, Na, K and Cs show photo electric effect with visible light but metals like Zn, Cd and Mg respond to ultraviolet light. Why?

i) Frequency of visible light is more than that for ultraviolet light

ii) Frequency of visible light is less than that for ultraviolet light

iii) Frequency of visible light is same for ultraviolet light

iv) Stopping potential for visible light is more than that for ultraviolet light

CHAPTER12: ATOMS AND CHAPTER13: NUCLEI

Section A (2 MARKS EACH)

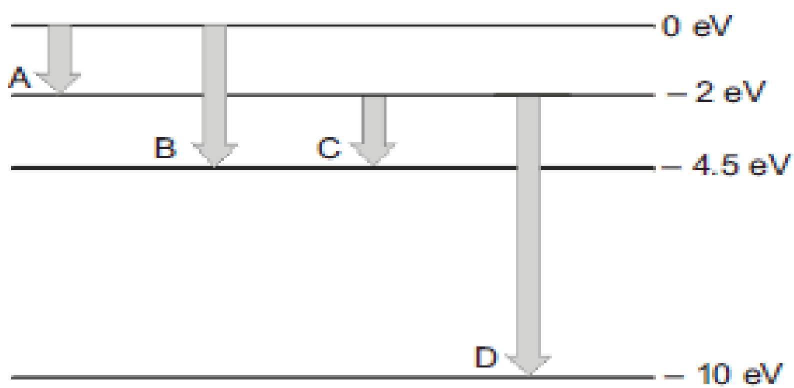
1. Determine the value of the de-Broglie wave length associated with electron orbiting in the ground state of hydrogen atom ?
2. What is the wavelength of the radiation emitted when the electron in the hydrogen atom jumps from n =α to n=1?
3. Compare the radii of two nuclei with mass number 1 and 27 respectively?

4. What is the kinetic energy and potential energy of electron in hydrogen atom in the second excited state?
5. Hydrogen atom is excited from ground state to another state with principal quantum number equal to 4 then how many spectral lines are emitted in the emission spectra?
6. If the ionization potential of the hydrogen atom is 13.6 e V. How much is the energy required to remove an electron from second orbit $(n = 2)$of the hydrogen atom?
7. A beam of alpha particles of velocity 2.1×10^7m/s is scattered by a gold foil (Z=79). Find the distance of closest approach of the Alpha particle to the gold nucleus. The value of the charge/mass of Alpha particle is $4.8 \times 10^7 Ckg^{-1}$.
8. A 12.5eV electron beam is used to excite a gaseous hydrogen atom at room temperature. Determine the wavelength and the corresponding series of the lines emitted.
9. Consider two different hydrogen atoms. The electron in each atom is in an excited state. Is it possible for electron to have different energies but same orbital angular momentum according to the Bohr model? Justify your answer.
10. Show mathematically how Bohr's postulate of quantization of orbital angular momentum in hydrogen atom is explained by the de-Broglie's hypothesis.

Section B (03 MARKS EACH)

1. Use Bohr's postulates to derive the expression for the potential and the kinetic energy of the electron moving in then n^{th} orbit of the hydrogen atom. How is the total energy of the electron expressed in terms of its kinetic and potential energy?
2. The wave length of second line of Balmer series in the hydrogen spectrum is 4861 Å · Calculate the wavelength of the first line.
3. The energy of an electron in an excited hydrogen atom is -3.4eV. Calculate the angular momentum of the electron according to the Bohr's theory.
4. (a).Define neutron multiplication factor and critical size for a fissionable material.
   (b)If 200 MeV energy is released in the fission of a single nucleus of $238U_{92}$, how many fission must occur to produce a power of 1KW?
5. (a)Draw a plot showing the variation of potential energy of a pair of nucleons as a function of their separation. Mark the regions where the nuclear force is
   (i) attractive and (ii) repulsive.
   (b)State two characteristic property of nuclear force.

6. What is wavelength of the spectral line emitted when an electron make a transaction from energy level -0.85 eV to -3.4 eV?
7. The energy level of a hypothetical atom is shown below. Which of the following transition will result in the emission of photon of wavelength 275nm? Which of these transition will result in the emission of radiation of (1) maximum and (2) minimum energy?



8. Derive an expression for the frequency of radiation emitted when an hydrogen atom de-excites from level n to level (n-1). Also show that for large values of n, this frequency equals to classical frequency of revolution of a electron.
9. How long can an electric lamp of 100 W be kept glowing by fusion of 2 kg of deuterium? Take the fusion reaction as

$$12H + 12H \rightarrow 23He + n + 3.27\ MeV$$

10. (a)State the postulates of Bohr's model of hydrogen atom.
(b)Show that the radius of the orbit in hydrogen atom varies as n^2, when n is the principle quantum number of the atom.

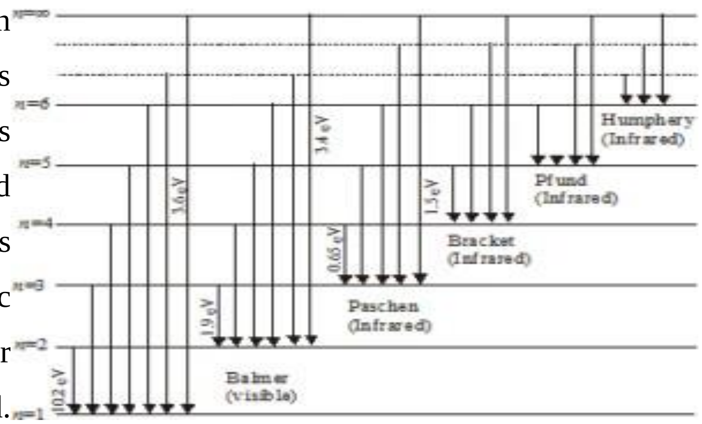
SECTION C (CASE STUDY)

1. HYDROGEN ATOM SPECTRUM

According to the third postulates of Bohr's model, when an atom makes a transition from the higher energy state with quantum number n_i to the lower energy state with quantum number n_f ($n_f < n_i$) , the difference of the energy is carried away by the photon of frequency such that

$$h\nu_{if} = E_{ni} - E_{nf}$$

Since both n_i and n_f are integers, this immediately shows that in transitions between the different atomic levels, light is radiated in various discrete frequencies. For hydrogen atom spectrum, the Balmer formula corresponds to $n_f = 2$ and $n_i = 3, 4, 5$ etc. This result of the Bohr's model suggested the presence of other series spectra for hydrogen atom-those corresponding to the transitions resulting from $n_f = 1$ and $n_i = 2, 3$ etc ; and $n_f = 3$ and $n_i = 4, 5$ etc.and so on. Such series were identified in the course of spectroscopic investigations and are known as Lyman, Balmer, Paschen, Brackett and Pfund-series. The electronic transitions correspondingto this series are shown in the figure. The various lines in the atomic spectra are produced when electrons jump from higher energy state to a lower energy state and photons are emitted.



These spectral lines are called emission lines. But when an atom absorbs a photon that has precisely the same energy needed by the electron in the lower energy state to make a transition to the higher than the state, the process is called absorption.

Thus, a photon with a continuous range of frequencies pass through a rarefied gas and then analysed with a spectrometer, a series of the spectral absorption lines appears in a continuous spectrum .The dark lines indicate the frequency that has been observed by the atoms of the gas.

This explanation of the hydrogen atom spectrum provided by the Bohr's model was a brilliant achievement which greatly stimulated progress towards the modern Quantum theory.

(i) The total energy of an electron in an atom in an orbit is-3.4eV.Its kinetic and potential Energies are respectively

(a) 3.4 eV, 3.4 eV (b) -3.4 eV ,-3.4 eV

(c) -3.4 eV ,-6.8 eV (d)3.4eV, -6.8eV

(ii).Given the value of Rydberg constant is$10^7 m^{-1}$,the wave number of the last line of the Balmer series in hydrogen spectrum will be

(a)0.5×10^7 (b)0.25×10^7

(c)2.5×10^7 (d)0.025×10^4

(iii). The ratio of wavelength of last line of Balmer series and the last line of Lyman series

(a)0.5 (b)2 (c)1 (d)4

(iv). The wave length of Balmer series lies in

(a) Ultraviolet region (b)Infrared region

(c) far infra-red region (d) visible region

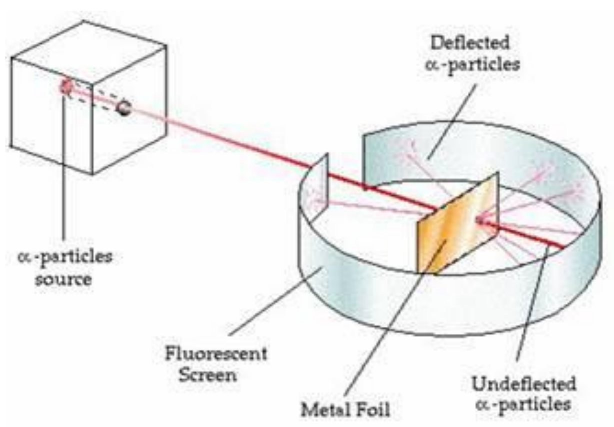
(v) In the empirical formula for the observed wavelength (λ) for hydrogen is $1/\lambda = R(1/4^2 - 1/n^2)$ Where n is integral values higher than 4 then it represents series.

(a) Balmer series (b)Brackett series

(c) Pfund series (d) Lyman series

II. RUTHERFORD ATOMIC MODEL

A radio active source emitting alpha particles was enclosed within a protective lead shield. The radiation was focused into a narrow beam after passing through a slit in a lead screen. A thin section of gold foil was placed in front of the slit and a screen coated with zinc sulfide to render it fluorescent served as a counter to detect alpha particles. As each alpha particle struck the fluorescent screen, it produced a burst of light called a scintillation, which was visible through a viewing microscope attached to the back of the screen. The screen itself was movable, allowing to determine whether or not any alpha particles were being deflected by the gold foil.



(i) The particles which were deflected backwards in Rutherford's experiment were hit upon by

(a) Nucleus (b)Empty space (c)Electrons (d)Protons

(ii) According to the Rutherford atomic model, the whole atom is

(a) Positively Charged (b)Negatively Charged

(c)Neutral (d)None of the above

(iii)Rutherford in his atomic model could not explain the behavior of which of the following

(a) Proton (b)Neutron (c)Electron (d)Neutrino (iv)Electron revolves around the nucleus in orbits which have

(a) variable energy (b)fixed energy

(c) infinite energy (d)zero energy

(v) According to Rutherford, most of the space occupied by the atom is

(a) Filled (b)partially filled

(c) empty (d) none of above

III.NUCLEAR REACTOR

Apsara is the oldest of India's research reactors. The reactor was designed by the Bhabha Atomic Research Center (BARC) and built with assistance from the United Kingdom. A nuclear reactor, formerly known as an atomic pile, is a device used to initiate and control a self- sustained nuclear chain reaction. Nuclear reactors are used at nuclear power plants for electricity generation and in nuclear marine propulsion. Heat from nuclear fission is passed to a working fluid (water or gas), which in turn runs through steam turbines.

(i) The splitting of a nucleus into smaller nuclei is

(a) Fusion

(b) Fission

(c) Half-life

(d) gamma –radiation

(ii) Name the moderator used in the nuclear reactor?

(a) Plutonium

(b) Thorium

(c) Graphite

(d) Berilium

(iii)What is the beneficial aspect of nuclear fission?

(a) The ability to absorb energy

(b) The ability to produce more energy than nuclear fusion

(c) The ability to release tremendous amounts of energy

(d) There are no beneficial aspects of nuclear fission

(iv)The energy we get in nuclear reaction comes from

(a)Energy we put into the reactor (b)The mass of the fuel

(c)Water (d)The sun

(v) Which isotope of Uranium has the capacity to sustain the chain reaction?

(a) U-230 (b) U-235 (c) U-245 (d) U-225

IV.NUCLEAR DENSITY

The Nucleus of an atom consists of a tightly packed arrangement of protons and neutrons. These are the two heavy particles in an atom and hence 99.9% of the mass is concentrated in the nucleus. Of the two, the protons possess a net positive charge and hence the nucleus of an atom is positively charged on the whole and the negatively charged electrons revolve around the central nucleus. Since the mass concentration at the nucleus of an atom is immense the nuclear forces holding the protons and the neutrons together are also large.

(i) The nuclide $92U^{238}$ has all the following except

(a)92 protons (b)146 neutrons (c)238 nucleons (d) 0 electrons

(ii) The density of a nucleus is of the order of:

(a) 10^{15} kg m^{-3} (b) 10^{18} kg m^{-3}

(c) 10^{17} kg m^{-3} (d) 10^{16} kg m^{-3}

(iii)Nuclear force is:

(a) strong, short range and charge independent force

(b) charge independent, attractive and long range force

(c) strong, charge dependent and short range attractive force

(d) long range, change dependent and attractive force

(iv)The mass no. of a nucleus is M and its atomic no. is Z. The number of neutrons in the nucleus is :

(a) M – Z (b)M (c)Z (d)M + Z

(v) The atomic mass number is equivalent to which of the following?

(a) The number of neutrons in the atom.

(b) The number of protons in the atom.

(c) The number of nucleons in the atom

(d) The number of α −particles in the atom.

V.BOHR'S MODEL

The Bohr model is a big part of Physics history. Neils Bohr proposed his model in 1913. It states that electrons orbit the nucleus at set distances. The model was an expansion on the Rutherford model overcame. Neils Bohr's model was based on his observations of the atomic emissions spectrum of the hydrogen atom. His findings said that the electron can move to a higher-energy orbit by gaining an amount of energy equal to the difference in energy between the higher-energy orbit and the initial lower-energy orbit. But time and research has proven and changed the Bohr model; Making this model one of the most famous models in Physics history.

(i) Rutherford's model of the atom concentrated on the nucleus while Bohr's model focused on the:

(a) Electrons (b)Protons (c)Quarks (d)Neutrons

(ii) When an electron jumps from outer orbit to inner orbit, energy is

(a) Absorbed (b)Released (c)No change (d)Remains constant

(iii)The orbits in which electrons move according to Bohr are

(a) Elliptical (b) Cylindrical (c) Circular (d)Oval

(iv)In Bohr's model of the atom, the energy level closest to the nucleus would be the:

(a) Valence energy level (b)Lowest energy level

(c)Average energy level (d) Highest energy level

(v) The radii of stationary orbits is proportional to

(a) n (b) n^2 (c) n^{-1} (d)n^{-2}

PRACTICE PAPER

SECTION A (02 MARK each)

1. A nucleus with mass number A is equal to 240 and B.E/ A = 7.6 eV breaks into two fragments each of A=120 with B.E/A = 8.5 eV. Calculate the released energy.

SECTION B (03 MARK each)

2. The value of ground the value of ground state energy of hydrogen atom is -13.6 eV

(a) Find the energy required to remove an electron from ground state to the first excited state of the atom.

(b) Determine (i)the kinetic energy, and (ii) the orbital radius in the first excited state of the atom.

SECTION C

CASE STUDY I

NUCLEAR FORCE

Neutrons and protons are identical particle in the sense that their masses are nearly the same and the force, called nuclear force, does into distinguish them. Nuclear force is the strongest force. Stability of nucleus is determined by the neutron Proton ratio or mass defect or packing fraction. Shape of nucleus is calculated by quadruple moment and the spin of nucleus depends on even or odd mass number. Volume of nucleus depends on the mass number. Whole mass of the atom (nearly 99%)is centered at the nucleus.

1. The correct statement about the nuclear force is are

(a) Charge independent

(b) Short range force

(c) Non conservative force

(d) all of these

2. The range of nuclear force is the order of

(a) 2×10^{-10} m (b) 1.5×10^{-20} m (c) 1.2×10^{-4} m (d) 1.4×10^{-15} m

3. A force between two protons is same as the force between proton and neutron. The nature of the force is

(a) electrical force (b)weak nuclear force

(c) gravitational force (d)strong nuclear force

4. All the nucleons in an atom are held by

(a) Nuclear forces (b) Vander Waal's forces

(c) Tensor forces (d)Coulomb forces

5. Nuclear force is:

(a) strong, short range and charge independent force

(b)charge independent, attractive and long range force

(c) strong, charge dependent and short range attractive force

(d)long range, change dependent and attractive force

Case study (II)

The emission spectrum of a chemical element or chemical compound is the spectrum of frequencies of electromagnetic radiation emitted by an atom's electrons when they are returned to a lower energy state. Each element's emission spectrum is unique, and therefore spectroscopy can be used to identify elements present in matter of unknown composition. Similarly, the emission spectra of molecules can be used in chemical analysis of substances. The emission spectrum of atomic hydrogen is divided into a number of spectral series, with wavelengths given by the Rydberg formula.

(i) When an electron jumps in n=1 orbit, the series of spectral lines obtained is called:

(a) Balmer Series (b)Pfund Series (c)Brackett Series (d)Lyman Series

(ii) The wave numbers decreases from

(a) Lyman to Pfund series (b)Pfund series to Lyman series

(c) Balmer series to Brackett series (d)None of these

(iii)Which of the series lies in Visible region of electromagnetic spectrum?

(a) Lyman (b)Balmer (c)Paschen (d)Brackett

(iv)Which of the series lies in U.V region of electromagnetic spectrum?

(a) Lyman (b)Balmer (c)Paschen (d)Brackett

(v) The value of maximum wavelength emitted in Lyman series is

(a) 1/R (b) 4/3R (c) 4/R (d)3/4R

SOLUTION

Section –A (2 MARKS EACH)

Solution-1 :

In ground state, the kinetic energy of the electron is

$$K = -E = +\frac{13.6}{12} eV = 13.6 \times 1.6 \times 10^{-19J} = 2.18 \times 10^{-19J}$$

de-Broglie wavelength $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mK}}$

$$\lambda = \frac{6.63 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 2.18 \times 10^{-19}}}$$

$$\lambda = 0.33 \times 10^{-9} m = 0.33 nm$$

Solution-2 :

Energy released when electron jumps from $n = \alpha \; to \; n = 1$

$$E = -13.6 \left[\frac{1}{\alpha} - \left(\frac{1}{1^2}\right)\right] eV = -13.6 \; eV$$

$$E = \frac{hc}{\lambda} \Rightarrow \lambda = \frac{hc}{E} = 91.17 \; nm$$

Solution-3 :

$$\frac{R^1}{R_2} = \left(\frac{1}{27}\right)^{\frac{1}{3}} = \frac{1}{3}$$

Solution-4 :

For second excited state, $n = 3$

$$E_n = \frac{-13.6}{3^2} = \frac{-13.6}{9} eV = -1.5 \; eV$$

$$K \cdot E = -E_n = 1.5 \; eV$$

$$P \cdot E = -2(K \cdot E) = -2(1.5) = -3.0 \; eV$$

Solution-5 :

Total no.of spectral lines emitted $= N = \frac{n(n-1)}{2}$

$$N = \frac{4(4-1)}{2} = 6$$

Solution-6 :

Energy of electron in ground state $E = -13.6 \; eV$

Energy of electron in $n = 2$ state = $\frac{-13.6}{2^2} = \frac{-13.6}{4}$

Energy required to remove an electron from $n = 2$ orbit $= 3.4 \; eV$

Solution-7 :

At the distance of closest approach

Electrostatic potential energy = initial kinetic energy of Alpha particle. K Ze.2e/r_o= 1/2 (mv^2)

r_o= 2KZe.2e/v^2m= **2.5×10^{-14}m**

Solution-8 :

(i) **En α $1/n^2$**

(ii) The energy level are **-13.6 eV , -3.4 eV , -1.5 eV**

Therefore 12.5 eV electron beam can excite the electron upto n = 3 level only.

(iii) Energy values , of the emitted photons, of the three possible lines are 3 →1 : (-1.5 + 13.6) eV = 12.1 eV

2→1: (- 3.4 +13.6)eV = 10.2 eV

3→2 : (- 1.5 + 3.4) eV = 1.9 eV

The corresponding wavelengths are are 102nm , 122 nm and 653 nm

Solution-9 :

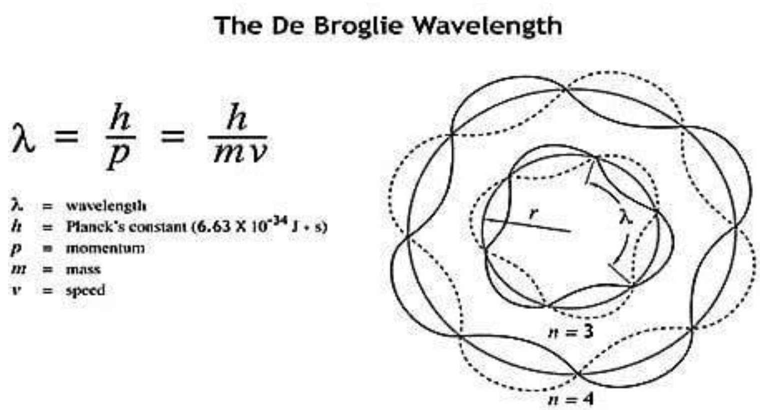
No, because according to Bohr's model

$E_n = \frac{-13.6}{n^2}$ and electron having different energies belong to different levels having different values of n. So, their angular momentum will be different, as $L = mvr = \frac{nh}{2\pi}$

Solution-10 :

According to de- Broglie hypothesis λ = h/mv

According to de de- Broglie condition for stationary orbit, the stationary orbits are those which contains complete de - Broglie wavelength 2π r= n λ



2π r =nh/mv

mvr= nh/2π

<u>Section –B (3 MARKS EACH)</u>

Solution-1:

According to Bohr's postulate, in an hydrogen atom, a single electron revolves around the nucleus of charge + e. For an electron moving with a uniform speed in a circular orbit on given radius, the centripetal force is provided by the Coulomb force of attraction between the electron and the nucleus.

$\frac{\boldsymbol{mv^2}}{\boldsymbol{r}} = \boldsymbol{k}\frac{\boldsymbol{Ze^2}}{\boldsymbol{r^2}}$

$K.E = \frac{1}{2}mv^2 = k\frac{Ze^2}{2r}$ *Potential Energy* = $\boldsymbol{PE} = \boldsymbol{k}\frac{\boldsymbol{Ze\times -e}}{\boldsymbol{r}} = \frac{\boldsymbol{-kZe^2}}{\boldsymbol{r}}$

Total Energy = $\boldsymbol{TE} = \frac{-kZe^2}{r} + \boldsymbol{k}\frac{Ze^2}{2r}$

$$\boldsymbol{E} = \frac{-kZe^2}{2r}$$

K.E = -E and *P.E = - 2 K.E*

Solution-2 :

$1/\lambda_1 = R(1/2^2 - 1/3^2) = (5/36)R$

$1/\lambda_2 = R(1/2^2 - 1/4^2) = (3/16)R$

$\lambda_1 / \lambda_2 = 27/20$

$\lambda_1 = (27/20)x4861 =$ **6562 A^o**

Solution-3:

$E_n = -13.6/n^2$, Given $E_n = -3.4$ Ev ,

$-3.4 = -13.6/n^2$ $N^2 = 4$, n=2

Angular momentum ,mvr= $nh/2\pi$ = **$2.1x10^{-34}$ Js**

Solution-4 :

(a) The neutron **multiplication factor** of fissionable mass is defined as the ratio of the number of neutrons present in the beginning of a particular generation to the number of neutrons present in the beginning of the previous generation .Multiplication factor k gives a measure of the growth rate of the neutron in a fissionable mass.

Critical size : The size of the fissionable material for which the multiplication factor k=1 , is called the critical size and the corresponding mass is called the Critical Mass

(b) Let the number of fissions per second be n.

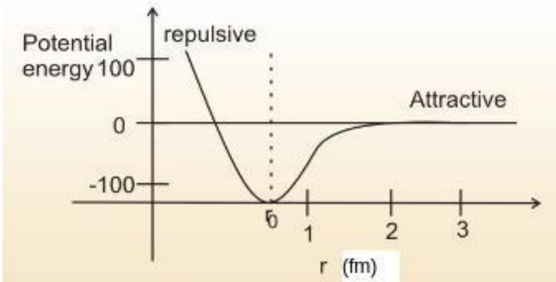
Energy released per second = nx200MeV = nx200X $1.6X10^{-19}$ J Energy required per second = 1000J

$$nx200X\ 1.6X10^{-19}\ J = 1000$$

$$n = 3.125x10^{13}$$

Solution-5 :

(a)



(b) Properties of nuclear force:

1. Nuclear forces are the strongest attractive force known in nature.
2. They are short range force.

Solution-6 :

$$E_n = -\frac{13.6}{n^2} eV$$

$$-0.85\ eV == -\frac{13.6}{n_B^2} eV \Rightarrow n_A = 4$$

$$-3.4\ eV == -\frac{13.6}{n_B^2} eV \Rightarrow n_B = 2$$

Therefore electron transaction from energy level

$$-0.85\ eV\ to - 3.4\ eV = \frac{1}{\lambda} = R\ \left(\frac{1}{n_B^2} - \frac{1}{n_A^2}\right)$$

$$\frac{1}{\lambda} = 1.097 \times 10^7 \left(\frac{1}{2^2} - \frac{1}{4^2}\right)$$

$$\lambda = 4862 Å$$

Solution-7:

Given $\lambda = 275\ nm$

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

$$E = \frac{hc}{\lambda} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{275 \times 10^{-9} \times 1.6 \times 10^{-19}} = 4.5\ eV$$

This corresponds to transition B as from the figure

(1) $\Delta E = \frac{hc}{\lambda} \Rightarrow \lambda = \frac{hc}{\Delta E},$

For maximum wavelength should be minimum.

Minimum energy corresponds to transition A.

(2) For minimum wavelength should be maximum.

Maximum energy corresponds to transition D.

Solution-8 :

Frequency of revolution of electron = f = 1/T = v/2πr = **$6.57 x 10^{15}$ m/s**

From Bohr's theory, the frequency $f = 2\pi^2 mk^2Z^2e^4/h^3\,(1/n_1^2 - 1/n_2^{\,2})$

Given

$f = 2\pi^2 mk^2Z^2e^4/h^3\,(1/(n-1)^2 - 1/n^2)$ 2

$f = 2\pi^2 mk^2Z^2e^4\,(2n-1)/h^3(n-1)^2n^2$

For large value of n , 2n-1 = 2n , n-1=n and for hydrogen atom Z=1 $f =(2\pi^2 mk^2e^4)/h^3(2n/n^4) == 4\pi^2 mk^2e^4/n^3h^3$

Velocity of electron in nth orbit = nh/2πmr Radius of nth orbit = $n^{\,2}h^2/4\pi mke^2$

The orbital frequency of electron in the nth orbit $v/2\pi r = 4\pi^2 mk^2e^4/n^3h^3$

Hence for large value of n , the classical frequency of revolution of electron in the nth orbit is same as that obtained from Bohr's theory.

Solution-9 :

No. of atoms present in $2g$ of deuterium$= 6 \times 10^{23}$

No. of atoms present in 2 kg of deuterium$= 6 \times 10^{26}$

Energy released in fusion of $2g$ deuterium atoms$= 3.27\ MeV$

Energy released in fusion of 2 kg deuterium atoms$= \frac{3.24}{2} \times 6 \times 10 \times 10^{26}\ MeV$

$$= 9.8 \times 10^{26} MeV = 15.696 \times 10^{13} J$$

Energy consumed by bulb per second $= 100\ J$

Time for which bulb will glow $= \frac{15.696 \times 10^{13} S}{100} \times 4.9 \times 10^4$ years.

Solution-10 :

(a) Bohr gave following three postulates for hydrogen atom:

1. An electron in an atom could revolve in stable orbits without the emission of radiant energy. Each atom has certain definite stable states in which it can exist, and each possible state has definite total energy. These are called the stationary states of the atom.

2. An electron revolves round the nucleus in for orbit to be stationary (or non-radiating), the angular momentum of the electron must be an integer multiple of h where it is the Planck's constant. Thus,

$\mathbf{L_n = mv_nr_n = nh/2\pi}$

3. Whenever an electron shifts from one of its specified non-radiating orbit to another orbit, it emits/ absorbs a photon whose energy is equal to the energy difference between the initial and final states .

Thus, $E_f - E_i = hc/\lambda$

(b) We know that when an electron revolves in a stable orbit, the centripetal force is provide electrostatic force of attraction acting on it due to a proton present in certain specified circular orbits in which it does not radiate energy. The centripetal force required for uniform circular motion in stationary orbit is provided by electrostatic force of attraction. Thus,

$$\frac{mv^2}{r} = k\frac{Ze^2}{r^2} \quad \text{or} \quad v^2 = k\frac{Ze^2}{mr}$$

and from Bohr's quantization condition ,

$mv_n r_n = nh/2\pi$ or

$v_n = nh/2\pi mr_n$….(2)

Squaring (2) and equating it with (i) , we get $(nh/2\pi mr_n)^2 = k\frac{Ze^2}{mr}$ or $r = \frac{n^2h^2}{4\pi^2 m\, k\, Ze^2}$

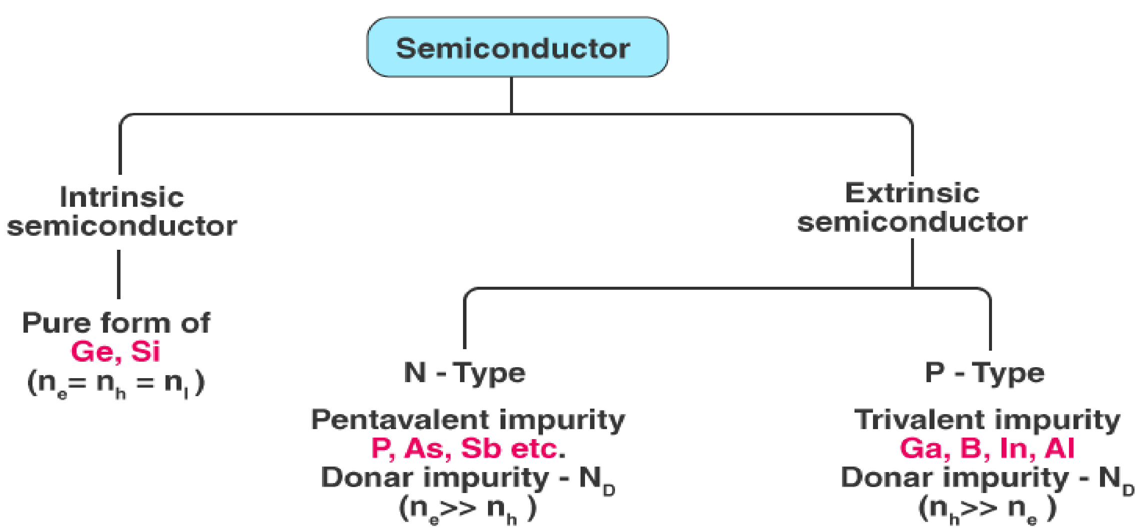
In stable orbit of hydrogen atom n = 1, and Z=1 then the Bohr's radius is $r_0 = \frac{h^2}{4\pi^2 m\, k\, e^2}$

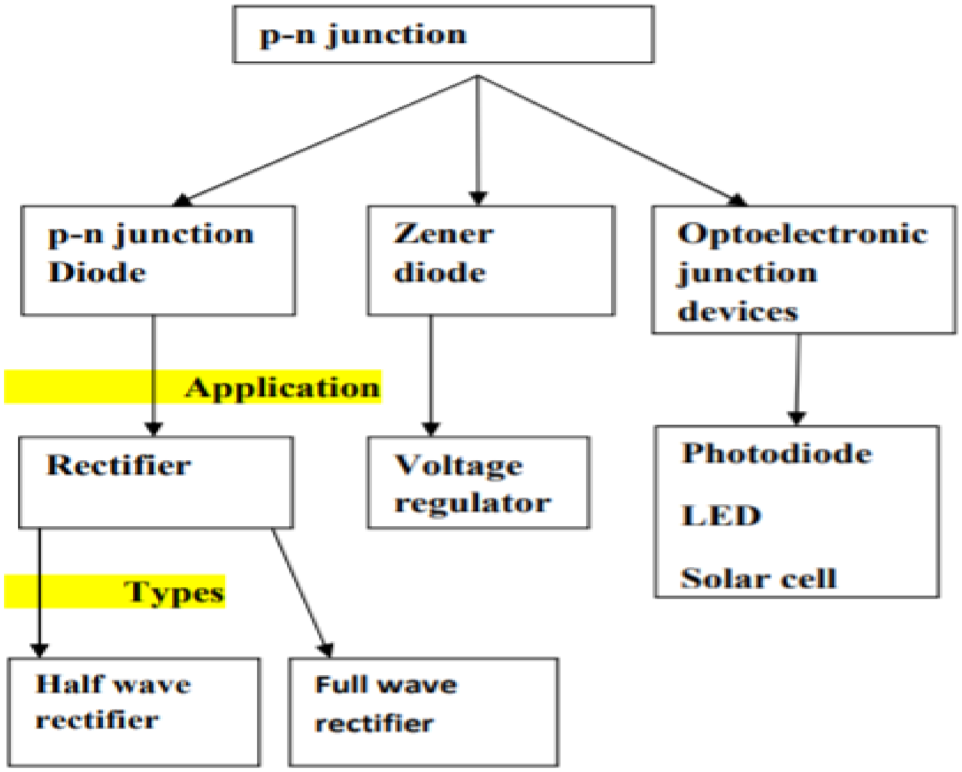
Section –C(CASE BASED)

CASE BASED	**OPTION**
(I) HYDROGEN ATOM SPECTRUM	1.d 2.b 3.d 4.d 5.b
(II) RUTHERFORD ATOMIC MODEL	1.a 2.c 3.d 4.b 5.c
(III)NUCLEAR REACTOR	1.b 2.c 3.b 4.b 5.b
(IV)NUCLEAR DENSITY	1.c 2.c 3.a 4.a 5.c
(V)BOHR'S MODEL	1.a 2.b 3.c 4.d 5.b

SEMICONDUCTOR ELECTRONICS

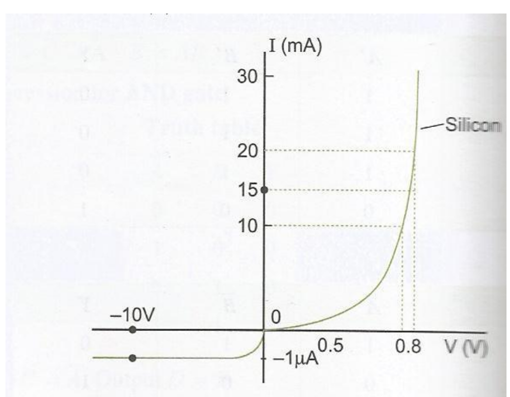
MIND MAP



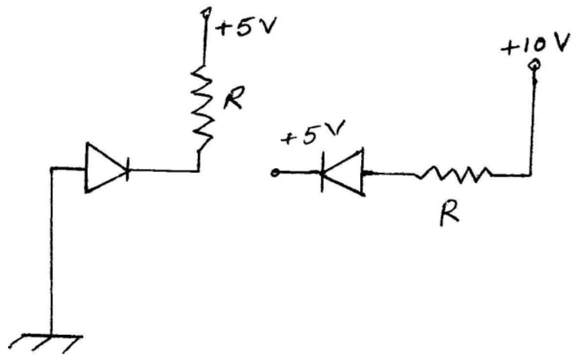


SHORT ANSWER TYPE QUESTIONS(2 MARKS)

1. The V-I characteristics of a silicon diode is shown in the figure. Calculate the resistance of the diode at
   (i) I = 10 mA and V = -10 V



2. In the following diagrams, write which of the diodes are forward biased and which are reverse biased ?



(a) (b)

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

4. An intrinsic semiconductor has $5x10^{28}$ atoms per $metre^2$ with n_i =1.5 x 10^6 m^3,If it is doped with pentavalent impurity of concentration 1 ppm, calculate the number of electrons holes in the sample.

5. Three photo diodes D_1,D_2, D_3 are made of semiconductors having bas gaps of 2.5eV,2eV and 3eV respectively .Which one will be able to detect the light of wavelength $6000A^0$?

6. Write two points of difference between intrinsic and extrinsic semiconductors.

7. Find the maximum wavelength of electromagnetic radiation which can create a hole-electron pair in Ge. The band gap in germanium is 0.65e V.

8.A p-n photodiode is fabricated from a semiconductor with band gap of 2.8 e V. Can it detect a wavelength of 6000 nm?

9. What is dynamic resistance of a diode? When the voltage drop across a p-n junction diode is increased from 0.70V to 0.071V, the change in the diode current is 10mA.What is the dynamic resistance of the diode?

10. Pure silicon at 300K has equal electron & hole concentrations of 1.5 x $10^{16}/m^3$.Doping by indium increases the hole concentration to 4.5 x $10^{22}/m^3$.Calculate the new electron concentration in the doped solution.

SHORT ANSWER TYPE QUESTIONS (3 MARKS)

1. Explain, with the help of a circuit diagram, the working of a p-n junction diode as a half wave rectifier.

2. A semiconductor has equal electron and hole concentration of 4.2 x $10^8 m^{-3}$. On doping with a certain impurity, electron concentration increases to 6 x 10^{12} m^{-3}.

(i) Identify the new semiconductor obtained after doping .(ii) calculate the new hole concentration .

3. Define the terms potential barrier and depletion region for a p – n junction diode. State how the thickness of depletion region will change when the p – n junction diode is (i) forward biased (ii) reverse biased.

4. On the basis of energy band diagrams distinguish between metals, insulators and semiconductors.

5. (i) Explain briefly the process of emission of light by an LED. (ii) Which semiconductors are preferred to make LED and why?

(iii) Give two advantages of using LEDs over conventional in candescent lamps.

6. Draw energy band diagrams of n-type and p-type semiconductors. Also write two differences between n-type and p-type semiconductors.

7. Explain, with the help of a circuit diagram, the working of a p-n junction diode as a full-wave rectifier.

8.Draw the circuit to forward bias a diode (The supply is 3V and 100mA battery).If the diode is made of silicon and knee voltage is 0.7V, and a current of 20mA passes through the diode, find the wattage of the resistor and the diode.

9. (a) Explain reverse biasing of a P-N junction diode with the help of a diagram.

(b) Draw V- I characteristics of a p-n junction diode. Answer the following questions giving reasons:

(i)Why is the current under reverse bias almost independent of the applied potential up to a critical voltage?

(ii)Why does the reverse current show a sudden increase at the critical voltage?

10. With the help of a labeled diagram, explain the working of full wave rectifier. Draw the input and output waveforms.

CASE BASED QUESTIONS (5 MARKS)

Read the Case Study given below and answer the questions that follow:

Consider a thin p-type silicon (p-Si) semiconductor wafer. By adding precisely, a small quantity of pentavalent impurity, part of the p-Si wafer can be converted into n-Si. There are several processes by which a semiconductor can be formed. The wafer contains p-region and n-region and a metallurgical junction between p-, and n- region. Two important processes occur during the formation of a p-n junction: diffusion and drift. We know that in an n-type semiconductor, the concentration of electrons (number of electrons per unit volume) is more compared to the concentration of holes. Similarly, in a p-type semiconductor, the concentration of holes is more than the concentration of electrons. During the formation of p-n junction, and due to the concentration gradient across p-, and n- sides, holes diffuse from p-side to n-side (p → n) and electrons diffuse from n-side to p-side (n → p). This motion of charge carries gives rise to diffusion current across the junction.

I.How can a p-type semiconductor be converted into n- type semiconductor?

a) adding pentavalent impurity b) adding trivalent impurity

c)not possible d) heavy doping

II. Which of the following is true about n type semiconductor?

a) concentration of electrons is less than that of holes.

b) concentration of electrons is more than that of holes.

c)concentration of electrons equal to that of holes.

d) None of these

III. Which of the following is true about p type semiconductor?

a) concentration of electrons is less than that of holes.

b) concentration of electrons is more than that of holes.

c)concentration of electrons equal to that of holes.

d)None of these

IV. Which of the following is the reason about diffusion current?

a) diffusion of holes from p to n b) diffusion of electrons from n to p

c) both (a) and (b) d) None of these

V. What are the processes that occur during formation of a p-n junction?

a) drift b) diffusion c) both (a) and (b) d)None of these .

ANSWER/HINT:

SHORT ANSWER TYPE QUESTIONS(2 MARKS)-

1. (i) $R = \Delta V/\Delta I = (0.8- 0.7)/ (20-10)\text{x } 10^{-3} = 10\ \Omega$

(ii) $R= V/I= 10/10^{-6} = 10^{7}\Omega$

2.(a)Reverse biased(b) Forward biased

3. Wavelength of incident photon ,

$\lambda = 6000\text{nm} = 6\text{x } 10^{-6}\text{m}$

energy of incident photon $E = hc/\lambda = 0.207\text{eV}$

as $E< E_g$ p-n junction can not detect the radiation.

4. $n_h = n_i^2/ n_e = 4.5 \text{ x } 10^{9}\text{m}^{-3}$

5. $E = hc /\lambda = (6.6 \text{ x } 10^{-34}) \text{ x}(3 \text{ x } 10^{8}) / (6\text{x}10^{-7}) \text{ x } 1.6 \text{ x } 10^{-19}) = 2.06\text{eV}$

Incident radiation can be detected by a photo diode if energy of incident radiation photon is greater than the band gap. This is true for D_2 ,therefore only D_2 will detect these radiation.

7.$E_g = 0.65\text{e V} = 0.65 \text{ X } 1.6 \text{ X } 10^{-19}$ J

$E_g = hc/\lambda_{max}$. $\lambda_{max} = hc/E_g = 1.9 \times 10^{-6}$ m.

8. $E = hc/\lambda = 3.313 \times 10^{-20}$ J

9. $r_d = \Delta v/\Delta I = 0.01V / 10 \times 10^{-3} A = 1\Omega$

10. $n_e = n_i^2 / n_h = 5 \times 10^9 m^{-3}$.

SHORT ANSWER TYPE QUESTIONS (3 MARKS)-

2. (i) since electron concentration increases, so the majority charge carriers in the doped semiconductor are electrons hence new semiconductor is n-type .

   (ii) $n_h = n_i^2 / n_e = 2.94 \times 10^4 m^{-3}$

8. Wattage of R =voltage drop across R x current $= 2.3 \times 20 \times 10^{-3} = 0.046W$

   Wattage of diode = Voltage drop across diode x current

   $= 0.7 \times 20 \times 10^{-3} = 0.014$ W

CASE BASED QUESTIONS-

I.Ans : a   II.Ans:b   III.Ans :a   IV.Ans. c   V.Ans: c

TEST YOURSELF

Q.1. I n a p-n- junction diode the forward bias resistance is low as compared to the reverse bias resistance. Give reason.

Q.2.Can a slab of p-type semiconductor be physically joined to another n-type semiconductor slab to form p-n junction ? Justify your answer.

Q.3.What is an ideal junction diode? How does the width of the depletion region of p-n junction diode vary, If the reverse bias applied to it decreases?

Q.4. Describe briefly using the necessary circuit diagram, the three basic processes which takes place to generate the emf in a solar cell when light falls on it. Draw the I-V characteristics of a solar cell.

Q.5. Show the biasing of a photo-diode with the help of a circuit diagram. Draw graphs to show variations in reverse bias currents for different illumination intensities.

Q.6.A semiconductor has equal electron and hole concentration of $2 \times 10^8 m^{-3}$.On doping with a certain impurity, the hole concentration increases to $4 \times 10^{10} m^{-3}$ (i) What type of semiconductor is obtained on doping?(ii) How does the energy gap vary with doping?

Q.7. A full wave rectifier has two diodes, the internal resistance of each diode may be assumed constant at 25 Ω . The transformer rms secondary voltage from centre tap to each end of the secondary is 50V and the load resistance is 975 Ω . Find the (i) mean load current(ii) rms value of load current.

Q.8. (i) Explain briefly the process of emission of light by an LED. (ii) Which semiconductors are preferred to make LED and why?

(iii) Give two advantages of using LEDs over conventional in candescent lamps.

Q.9.(i) With the help of circuit diagrams distinguish between forward biasing and reverse biasing of a *pn* junction diode.

(ii) Draw *V-I* characteristics of a *p-n* junction diode in (a) forward bias, (b) reverse bias.

(iii) Describe briefly the following terms: (a) "minority carrier injection" in forward bias, (b) "breakdown voltage" in reverse bias.

Q10. **Read the Case Study given below and answer the following questions:**

A Photodiode is again a special purpose p-n junction diode fabricated with a transparent window to allow light to fall on the diode. It is operated under reverse bias. When the photodiode is illuminated with light (photons) with energy (hν) greater than the energy gap (E) of the semiconductor, then electron-hole pairs are generated due to the absorption of photons. The diode is fabricated such that the generation of e-h pairs takes place in or near the depletion region of the diode. Due to electric field of the junction, electrons and holes are separated before they recombine. The direction of the electric field is such that electrons reach n-side and holes reach p-side. Electrons are collected on n-side and holes are collected on p-side giving rise to an emf. When an external load is connected, current flows. The magnitude of the photocurrent depends on the intensity of incident light.

I. Photo Diode is operated in

a) forward biased b) reverse biased c) Not biased

II. Which of the following is true about photodiode?

a) $E > hv$ b) $E = hv$ c) $E < hv$ d) None of these.

III. Magnitude of photocurrent depends on

a) Intensity of light b) Biasing c) Potential d) None of these

IV. Electrons and holes are separated before they recombine by:

a) Diffusion current b) Drift current c) Electric field d) Electric potential.

V. Direction of electric field is such that

a) electrons reach n- side b) holes reach p- side

c) Both (a) and (b) d) holes reach n side

SAMPLE QUESTION PAPER -1
CLASS XII
PHYSICS THEORY
TERM II SESSION 2021 – 22
BLUE PRINT

NAME OF CHAPTERS	SA-I (2 MARKS)	SA-II (3MARKS)	CASE STUDY (5 MARKS)	TOTAL
CH-8 ELECTROMAGNETIC WAVES		1(3)		17
CH-9 RAY OPTICSAND OPTICAL INSTRUMENTS		1(3) 1(3) OR	1(5)	
CH-10 WAVE OPTICS		2(3) 1(3) OR		
CH-11 DUAL NATUREOF RADIATION AND MATTER	1(2)	1(3)		12
CH-12 ATOMS		1(3)		
CH-13 NUCLEI		1(3)		
CH-14 SEMICONDUCTOR	2(2) 1(2) OR	1(3)		7
	3(2)	8(3)	1(5)	12(35)

QUESTION PAPER

TIME : 2 Hours **MM : 35**

General Instructions:

(i) There are 12 questions in all. All questions are compulsory.

(ii) This question paper has three sections: Section A, Section B and Section C.

(iii) Section A contains three questions of two marks each, Section B contains eight questions of three marks each, Section C contains one case study-based question of five marks.

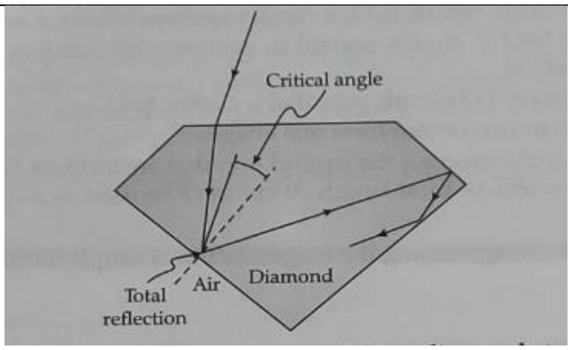
(iv) There is no overall choice. However, an internal choice has been provided in one question of two marks and two questions of three marks. You have to attempt only one of the choices in such questions.

(v) You may use log tables if necessary but use of calculator is not allowed.

	SECTION A	
Q.1	Two lines A and B in the plot given below show the variation of De Broglie wavelength λ versus $1/\sqrt{V}$. Where V is the accelerating potential difference for two particles carrying	2

	the same charge .Which one represents a particles of smaller mass.	
Q.2	Name the optoelectronic device used for detecting optical signals and mention the biasing in which it is operated. Draw its *I-V* characteristics.	2
	OR	
	Three photo diodes *D*1, *D*2 and *D*3 are made of semiconductors having band gaps of 2.5 eV, 2 eV and 3 eV respectively. Which of them will not be able to detect light of wavelength 600 nm?	2
Q.3	Write two characteristic features to distinguish between *n*-type and *p*-type semiconductors.	2
	SECTION-B	
Q.4	Draw a graph between the frequency of incident radiation (ν) and the maximum kinetic energyof the electrons emitted from the surface of two photosensitive materials A & B. State clearly how this graph can be used to determine (*i*) Planck's constant and (*ii*) work function of the material.	3
Q.5	(a) How is the size of a nucleus experimentally determined? Write the relation between the radius and mass number of the nucleus.	1
	(b)Distinguish between nuclear fission and fusion. Show how in both these processes energy isreleased. Calculate the energy release in MeV in the deuterium-tritium fusion reaction : $${}_1^2H + {}_1^3H \longrightarrow {}_2^4He + n$$ **Using the data :** $m({}_1^2H) = 2.014102$ u $m({}_1^3H) = 3.016049$ u; $m({}_2^4He) = 4.002603$ u $m_n = 1.008665$ u; $1u = 931.5$ MeV/c^2	2
Q.6	(a) Write two important limitations of Rutherford model which could not explain the observedfeatures of atomic spectra. How were these explained in Bohr's model of hydrogen atom? Use the Rydberg formula to calculate the wavelength of the H_α line. $R=1.1x10^{-7}m^{-1}$	1
	(b) Using Bohr's postulates, obtain the expression for the radius of the nth orbit in hydrogen atom.	2
Q.7	(*a*) Name the EM waves which are produced during radioactive decay of a nucleus. Write their frequency range.	3

	(*b*) Welders wear special glass goggles while working. Why? Explain. (*c*) Why are infrared waves often called as heat waves? Give their one application.	
Q.8	Draw a ray diagram for formation of image of a point object by a thin double convex lens having radii of curvature R_1 and R_2. Hence, derive lens maker's formula for a double convex lens. State the assumptions made and sign convention used.	3
	OR	
	Using the data given below, state as to which of the given lenses will you prefer to use as an eye piece & an objective to design compound microscope. Lens | Power | Aperture A | 20 D | 0.02 m B | 10 D | 0.02 m C | 10 D | 0.05 m D | 1.0 D | 0.1 m	3
Q.9.	(a) Use Huygens' principle to show how a plane wave front propagates from a denser to rarer medium. Hence, verify Snell's law of refraction.	2
	(b) In a single slit diffraction experiment , a slit of width d is illuminated by red light of wavelength 650 nm .For what value of 'd' will First minimum fall at angle of diffraction of 30°	1
Q.10.	Draw a labelled diagram of a full -wave rectifier circuit. State its working principle. Show the input-output wave forms.	3
Q.11	(a) In Young's double slit experiment, describe briefly how bright and dark fringes are obtained on the screen kept in front of a double slit. Hence obtain the expression for the fringe width. (b) 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 widths of the two slits.	3
	OR	
	In young's double slit experiment, deduce the condition for (a) constructive and 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.	3
.	**SECTION-C**	
Q.12	**Case Study based questions** **Sparking Brilliance of Diamond:**	1x5=5



The total internal reflection of the light is used in polishing diamonds to create a sparking brilliance. By polishing the diamond with specific cuts, it is adjusted the most of the light rays approaching the surface are incident with an angle of incidence more than critical angle. Hence,they suffer multiple reflections and ultimately come out of diamond from the top. This gives thediamond a sparking brilliance.

(i) Light cannot easily escape a diamond without multiple internal reflections. This is because:

(a) Its critical angle with reference to air is too large

(b) Its critical angle with reference to air is too small

(c) The diamond is transparent

(d) Rays always enter at angle greater than critical angle

(ii) The critical angle for a diamond is 24.4°. Then its refractive index is

(a) 2.42 (b) 0.413 (c) 1 (d) 1.413

(iii) The basic reason for the extraordinary sparkle of suitably cut diamond is that

(a) It has low refractive index (b) It has high transparency

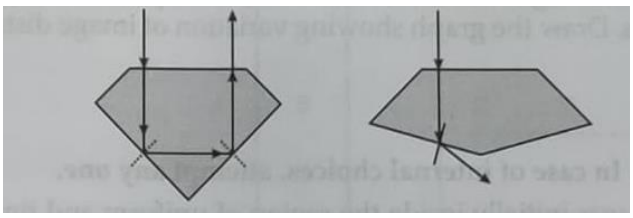
(c) It has high refractive index (d) It is very hard

(iv) A diamond is immersed in a liquid with a refractive index greater than water. Then the criticalangle for total internal reflection will

(a) will depend on the nature of the liquid (b) decrease

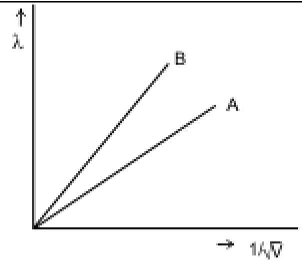
(c) remains the same (d) increase

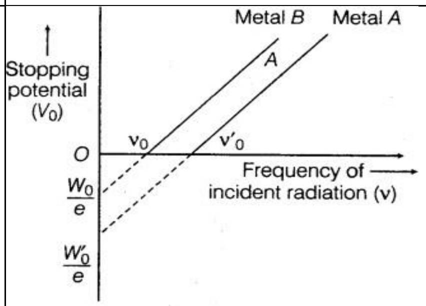
(v) The following diagram shows same diamond cut in two different shapes.

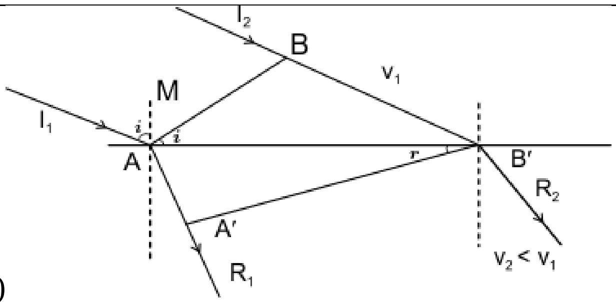


	The brilliance of diamond in the second diamond will be: (a) less than the first (b) greater than first (c) same as first (d) will depend on the intensity of light	

MARKING SCHEME

Q NO.	ANSWER	MARKS
A1	 $\lambda\sqrt{V} \propto \frac{1}{\sqrt{m}}$ $\because$ $(\text{Slope})_B > (\text{Slope})_A$ $(\lambda\sqrt{V})_B > (\lambda\sqrt{V})_A$ $\Rightarrow \frac{1}{\sqrt{m_B}} > \frac{1}{\sqrt{m_A}}$ $\Rightarrow m_B < m_A$	1+1=2
A2	Photodiode is used for detecting optical signals. It is operated in reverse biasing. I-V Characteristics:	½+1/2+1=2
A2-OR	Energy of incident light photon $E = h\nu = hc/\lambda$ 2 .06eV For the incident radiation to be detected by the photodiode, energy of incident radiation photon should be greater than the band gap. This is true only for D2. Therefore, only D2 will detect this radiation.	½+1/2+1=2
A3	n-type Semiconductor p-type Semiconductor (i) It is formed by doping pentavalent impurities. It is doped with trivalent impurities. (ii) The electrons are majority carriers and holes are minority carriers ($n_e >> n_h$). The holes are majority carriers and electrons are minority carriers ($n_h >> n_e$).	1/2X4=2

	SECTION-B	
A4	 determine (i) Planck's constant and (ii) work function	1+1+1=3
A5	By Alpha scattering $R=R_0A^{1/3}$	½+1/2=1
	Mass of reactance $=m_1H^2 + m\ _1H^3= 2.014102+3.016049=5.030151$ amu Mass of product $=m_2He^4 + m\ _0n^1= 4.002603+1.008665=5.011268$ amu Q=(5.030151-5.011268) 931MeV=17.58MeV	1/2x4=2
A6	two important limitations of Rutherford model	1/2X2=1
	expression for the radius	2
A7	(a) EM waves : γ-rays Range : 10^{19} Hz to 10^{23} Hz (b) This is because the special glass goggles protect the eyes from large amount of UV radiations produced by welding arcs. (c) Infrared waves are called heat waves because water molecules present in the materials readily absorb the infrared rays and get heated up. Application: They are used in green houses to warm the plants.	1+1+1=3
A8	Draw a ray diagram for formation of image derive lens maker's formula	1+2=3
A8 OR	$\because M = \frac{v_o}{u_o}\left(1+\frac{D}{f_e}\right) = \frac{LD}{f_o f_e}$ And $f_o << f_e$ A → objective and B → Eyepiece	1+1+1=3

A9	(a)  $\therefore \quad \angle I_1AM + \angle MAB = 90^\circ$ $\& \quad \angle MAB + \angle BAB' = 90^\circ$ $\Rightarrow \angle BAB' = i$ Similarly $\angle A'B'A = r$ $\frac{\sin i}{\sin r} = \frac{BB'/AB'}{AA'/AB'} = \frac{BB'}{AA'}$ $= \frac{v_1 t}{v_2 t} = \frac{v_1}{v_2} = \text{Constant}$ (b)$D \sin\theta = n\lambda$ $d = \sin 30 = 1\times 650 \times 10^{-9}$ d = 1300 nm.	2+1=3
A10	Diagram, working & waveform	1+1+1=3
A11	Expression for the fringe width.	2
	Intensity of light (using classical theory) is given as $I \propto$ (Width of the slit) $\propto$ (Amplitude)^2 $I_1:I_2=16:1$	1
A11-OR	condition for (a) constructive and destructive interference And interference pattern	1+1+1=3
	SECTION -C	5x1=5
A12	(b) Its critical angle with reference to air is too small	1
	(a) 2.42	1
	(c) It has high refractive index	1
	(d) increase	1
	(a)less than the first	1

SAMPLE PAPER II

BLUE PRINT

CHAPTERS	SA-I(2)	SA-II(3)	CBS(5)	TOTAL(35)
ELECTROMAGNETIC WAVES		1		3
RAY OPTICS AND OPTICAL INSTRUMENTS		2	1	11
WAVE OPTICS		1+1(OR)		3
DUAL NATURE OF RADIATION AND MATTER	OR(1)	1		3
ATOMS	1	1		5
NUCLEI		1		3
SEMI CONDUCTOR ELECTRONICS	2	1		7

QUESTION PAPER II

SECTION A

Q1. Explain, with the help of a circuit diagram, the working of a p-n junction diode as a half-wave rectifier.

Q2. Find the ratio of energies of photons produced due to transition of an electron of hydrogen atom from its

- Second permitted energy level to the first permitted level and
- The highest permitted energy level to the first permitted level.

OR

Draw a plot showing the variation of photoelectric current with collector plate potential for two different frequencies, $v_1 > v_2$, of incident radiation having the same intensity. In which case will the stopping potential be higher? Justify your answer.

Q3. Distinguish between a metal and an insulator on the basis of energy band diagram.

SECTION B

Q4. Show that the radius of the orbit in hydrogen atom varies as n^2, where n is the principal quantum number of the atom.

Q5. (i) Why is a photo diode operated in reverse bias mode?

(ii)For what purpose is a photo diode used?

(iii)Draw its I-V characteristics for different intensities of illumination.

Q6. (a) In a typical nuclear reaction, e.g.

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

although number of nucleons is conserved, yet energy is released. How? Explain.

(b) Show that nuclear density in a given nucleus is independent of mass number A.

Q7. How is a wavefront defined? Using Huygen's construction draw a figure showing the propagation of a plane wave refracting at a plane surface separating two media. Hence verify Snell's law of refraction.

Q8. Draw a ray diagram to show refraction of a ray of monochromatic light passing through a glass prism. Deduce the expression for the refractive index of glass in terms of angle of prism and angle of minimum deviation.

OR

Draw a labeled ray diagram of a refracting telescope. Define its magnifying power and write the expression for it. Write two important limitations of a refracting telescope over a reflecting type telescope.

Q9. (i) How does one explain the emission of electrons from a photosensitive surface with the help of Einstein's photoelectric equation?

(ii) The work function of the following metals is given : Na = 2.75 eV, K = 2.3 eV, Mo = 4.17 eV and Ni=5.15 eV. Which of these metals will not cause photoelectric emission for radiation of wavelength 3300 A from a laser source placed 1 m away from these metals? What happens if the laser source is brought nearer and placed 50 cm away?

Q10. A convex lens made up of glass of refractive index 1.5 is dipped, in turn,

(i) a medium of refractive index 1.6,

(ii) a medium of refractive index 1.3.

(a) Will it behave as a converging or a diverging lens in the two cases?

(b) How will its focal length change in the two media?

Q11. (i) Name the EM waves which is suitable for radar systems used in aircraft navigation. Write the range of frequency of these waves.

(ii) If the earth did not have atmosphere, would its average surface temperature be higher or lower than what it is now? Explain.

(iii) An EM wave exerts pressure on the surface on which it is incident. Justify.

OR

(i)State the importance of coherent sources in the phenomenon of interference.

(ii) In Young's double slit experiment to produce interference pattern, obtain the conditions for constructive and destructive interference. Hence deduce the expression for the fringe width. (iii) How does the fringe width get affected, if the entire experimental apparatus of Young is immersed in water?

Q12. CASE STUDY: Total Internal Refraction

Total internal reflection is the phenomenon of reflection of light into denser medium at the interface of denser medium with a rarer medium. For this phenomenon to occur necessary condition is that light must travel from denser to rarer and angle of incidence in denser medium must be greater than critical angle (C) for the pair of media in contact. Critical angle depends on nature of medium and wavelength of light. We can show that n=1/sinC

(i)Critical angle for glass air interface, where n of glass is 3/2,is

(a) 41.8^0 (b) 60° (c) 30° (d) 15°

(ii) Critical angle for water air interface is 48.6°. What is the refractive index of water?

(a) 1 (b)3/2 (c)4/3 (d)3/4

(iii) Critical angle for air water interface for violet colour is 49^0. Its value for red colour would be

(a) 49° (b) 50° (c) 48^0 (d) cannot say

(iv) Which of the following is not due to total internal reflection?

(a) Working of optical fibre. (b) Difference between apparent and real depth of a pond.

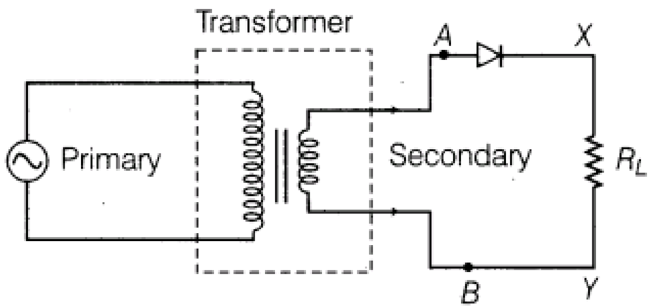
(c) Mirage on hot summer days. (d) Brilliance of diamond.

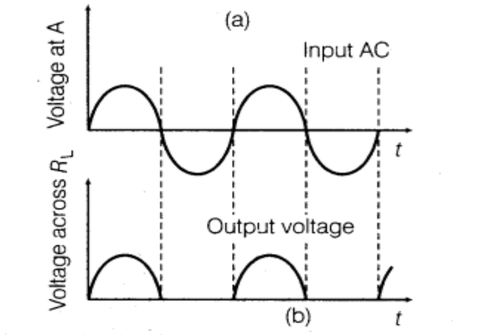
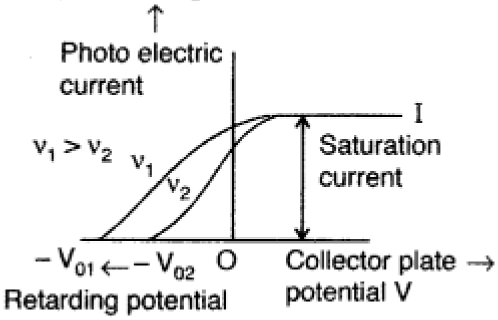
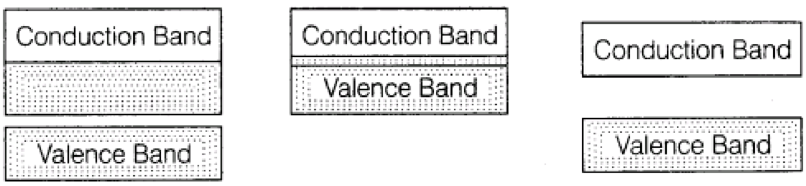
(v) Critical angle of glass is Θ_1, and that of water is Θ_2.The critical angle for water and glass surface would be (n_g = 3/2, $n_{w=}$4/3).

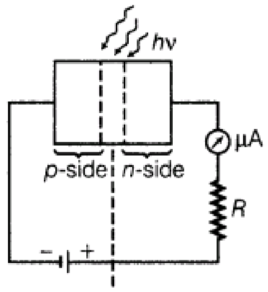
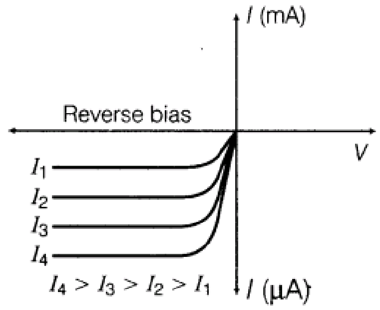
(a) less than Θ_2 (b) between Θ_1 and Θ_2

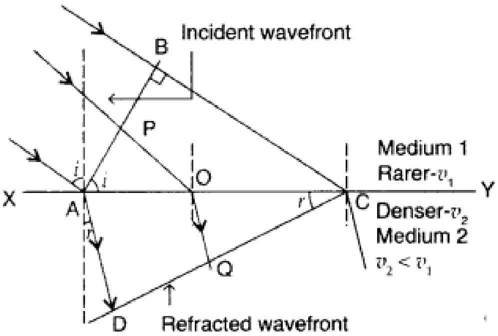
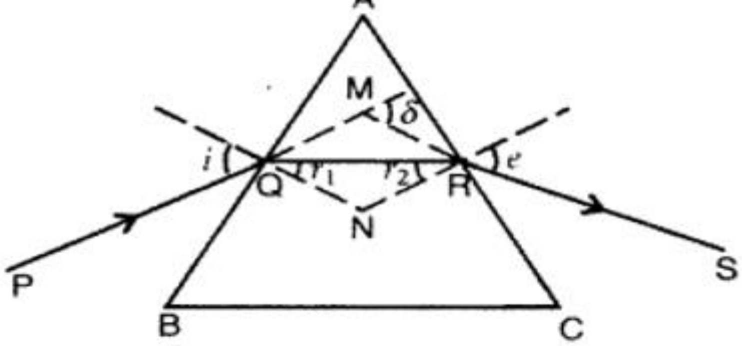
(c) greater than Θ_2 (d) less than Θ_1

MARKING SCHEME

Ans1.	AC voltage to be rectified is connected to the primary coil of a step-down transformer. Secondary coil is connected to the diode through resistors R_L, across which output is obtained. 

	During positive half cycle of the input AC, the p-n junction is forward biased. Thus, the resistance in p-n junction becomes low and current flows. Hence, we get output in the load. During negative half cycle of the input AC, the p-n junction is reverse biased. Thus, the resistance of p-n junction is high and current does not flow. Hence, no output in the load. So, for complete cycle of AC, current flows through the load resistance in the same direction.  Input and output waveforms
Ans 2	(i) Since, the second permitted energy level to the first level $= E_2 - E_1 =$ energy of photon released $= (-3.4 \text{ eV}) - (-13.6 \text{ eV}) = 10.2 \text{ eV}$ (ii) The highest permitted energy level to the first permitted level $= E_\infty - E_1 = 0 - (-13.6) = 13.6 \text{ eV}$ **Ratio of energies of photons=10.2/13.6=3/4=3:4** **OR** Stopping potential is directly proportional to the frequency of incident radiation. The stopping potential is more negative for higher frequencies of incident radiation. Therefore, stopping potential is higher in v_1. 
Ans 3	For metals, the valence band is completely filled and the conduction band can have two possibilities either it is partially filled with an extremely small energy gap between the valence and conduction bands or it is empty, with two bands overlapping each other as shown below:  for insulator, the energy gap between the conduction and valence bands are very large, also the conduction band is practically empty, as shown below:
Ans 4	When an electron moves around hydrogen nucleus, the electrostatic force between electron and hydrogen nucleus provides necessary centripetal force.

	$\frac{mv^2}{r} = \frac{1}{4\pi \epsilon_0}\frac{e^2}{r^2}$ or $mv^2r = \frac{e^2}{4\pi \epsilon_0}$ ...(i) Also we know from Bohr's postulate, $mvr = \frac{nh}{2\pi}$ or $m^2v^2r^2 = \frac{n^2h^2}{4\pi^2}$ ...(ii) Dividing (ii) by (i), we have $mr = \frac{n^2h^2}{4\pi^2} \times \frac{4\pi \epsilon_0}{e^2}$ $\therefore \quad r = \frac{n^2h^2}{4\pi^2 me^2} . 4\pi\epsilon_0 \quad \therefore \; r \propto n^2$
Ans 5	(i) Photo diode is connected in reverse bias and feeble reverse current flows due to thermally generated electron-hole pair, known as dark current. When light of suitable frequency(v) such that hv>E_g where E_g is the band gap is incident on diode, additional electron hole pair generated and current flows in the circuit (ii) **Main use of photo diode** In demodulation of optical signal and detection of optical signal. (iii) Circuit diagram of illuminated photo diode in reverse bias is shown below:  A reverse biased photodiode  Reverse bias currents through a photodiode Hence, frequency of light ν such that $h\nu > E_g$, where E_g is band gap of increasing intensity I_1, I_2, I_3, etc. The value of reverse saturation current increases with the increase of intensity of light. Thus, the measurement of charge in the reverse saturation current can give the **Intensity of incident light.**
Ans 6	(a)In all types of nuclear reactions, the law of conservation of number of nucleons is followed. But during the reaction, the mass of the final product is found to be slightly less than the sum of the masses of the reactant components. This difference in mass of a nucleus and its constituents is called mass defect. So, as per mass energy relation E = $(\Delta M)c^2$, energy is released. In the given reaction the sum of the masses of two deutrons is more than the mass of helium and neutron. Energy equivalent of mass defect is released.

	(*b*) Nuclear density = $\frac{\text{Mass of nucleus}}{\text{Volum}} = \frac{mA}{\frac{4}{3}\pi R^3}$ (*m* = **mass of each nucleon**) As $R = R_0 A^{1/3}$ **where** $R_0 = 1.2 \times 10^{-15}$ **m.** ∴ Nuclear density = $\frac{3mA}{4\pi R_0^3 A} = \frac{3m}{4\pi R_0^3}$ *i.e.* independent of Mass Number A
Ans 7	(i) Wavefront : Wavefront is defined as the continuous locus of all such particles of the medium which are vibrating in the same phase at any instant.  (ii) We take a plane wavefront AB incident at a plane surface XY. We use secondary wavelets starting at different times. We get refracted wavefront only when the time taken by light to travel along different rays from one wavefront to another is same. We take any arbitrary ray starting from point ‘P’ on incident wavefront to refracted wavefront at point ‘O’. Let total time be ‘t’. $t = \frac{PO}{v_1} + \frac{OQ}{v_2} = \frac{AO\sin i}{v_1} + \frac{OC\sin r}{v_2}$ $= \frac{AO\sin i}{v_1} + \frac{(AC - AO)\sin r}{v_2}$ $= \frac{AC\sin r}{v_2} + AO\left(\frac{\sin i}{v_1} - \frac{\sin r}{v_2}\right)$ As time should be independent of the ray to be considered The coefficient of AO in the above equation should be zero *i.e.* $\frac{\sin i}{\sin r} = \frac{v_1}{v_2} = {}^1\mu_2$ Where $'\mu_2$ is called refractive index of medium 2 w.r.t. medium 1. This is Snell’s law of refraction.
Ans 8	Ray diagram : The minimum deviation D_m, the refracted ray inside the prism becomes parallel to its base, we have 

$\delta = D_m$, *i.e.*, which implies $r_1 = r_2$

$r_1 + r_2 = A$

or $2r = A$, $\Rightarrow r = A/2$

In the $\delta = i + e - A$

$$D_m = 2i - A \qquad \text{or } i = \frac{(A + D_m)}{2}$$

The refractive index of the prism is

n_{21} (Refractive index of 2 w.r.t. 1)

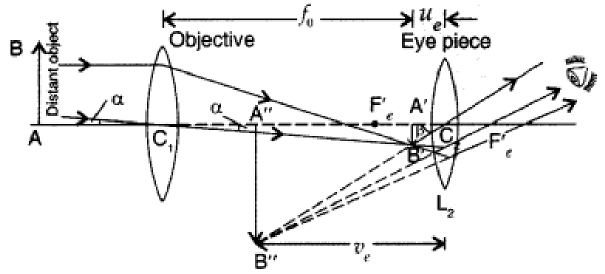
$$= \frac{n_2}{n_1} = \frac{\sin\left[\frac{(A + D_m)}{2}\right]}{\sin\left[\frac{A}{2}\right]}$$

For a small angle prism, *i.e.*, a thin prism, D_m is also very small and we get

$$n_{21} = \frac{\sin\left[\frac{(A + D_m)}{2}\right]}{\sin\left[\frac{A}{2}\right]} \approx \frac{\frac{(A + D_m)}{2}}{\frac{A}{2}}$$

$$\boxed{D_m = (n_{21} - 1)\,A}$$

OR



Magnifying power. It is defined as the ratio of angle (β) subtended by the final image on the eye to the angle (α) subtended by object on eye.

$$M = \frac{\tan\beta}{\tan\alpha} = \left(\frac{\beta}{\alpha}\right)$$

Magnifying power

$$M = \frac{-f_0}{f_e} \text{ (for comfortable view)}$$

$$= \frac{-f_0}{f_e}\left(1 + \frac{f_e}{D}\right) \text{ (for strained eye)}$$

Limitations of refracting telescope over a a reflecting type telescope :

1. It suffers from chromatic aberration due to refraction and hence the image obtained is multi coloured and blurred.
2. As a lens of large apparatus can't be manufactured easily, its light gathering power is low and hence can't be used to see faint stars

Ans 9

(*i*) Einstein's Photoelectric equation is

$$h\nu = \varphi_0 + K_{max}$$

When a photon of energy '$h\nu$' is incident on the metal, some part of this energy is utilized as work function to eject the electron

	and remaining energy appears as the kinetic energy of the emitted electron. (*ii*) $E = \frac{hc}{\lambda} = \frac{(6.63 \times 10^{-34}) \times (3 \times 10^{8})}{(3.3 \times 10^{-7}) \times (1.6 \times 10^{-19})}$ ev $= 3.77$ eV Because the work function of Mo and Ni is more than the energy of the incident photons; so photoelectric emission will not take place from these two metals Mo and Ni. When the laser source is brought nearer and placed 50 cm away, the kinetic energy of photo-electrons will not change, only photoelectric current will change.
Ans 10	**Given :** $^{a}\mu_{g} = 1.5$ Let f_{air} be the focal length of the lens in air According to lens maker formula : $\frac{1}{f_{air}} = (^{a}\mu_{g} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ $\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_{air}(1.5-1)}$ $\Rightarrow \left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f_{air}(0.5)} = \frac{2}{f_{air}}$ (*a*) *When lens is dipped in medium A :* Here $^{a}\mu_{A} = 1.6$ ...(Given) $\frac{1}{f_A} = (^{A}\mu_{g} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ **...where [f_A is the focal length of the lens, when dipped in medium A** $\frac{1}{f_A} = \left(\frac{^{a}\mu_{g}}{^{a}\mu_{A}} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ $\Rightarrow \frac{1}{f_A} = \left(\frac{1.5}{1.6} - 1\right)\frac{2}{f_{air}}$ $\Rightarrow \frac{1}{f_A} = \left(\frac{1.5-1.6}{1.6}\right)\frac{2}{f_{air}} = \frac{-1 \times 2}{16 f_{air}} = -\frac{1}{8 f_{air}}$ $\therefore f_A = -8\, f_{air}$ As the sign of f_B is opposite to that of f_{air}, the lens will behave as a diverging lens. (b) When lens is dipped in medium B : Here $^{a}\mu_{B} = 1.3$ Let f_B be the focal length of the lens, when dipped in medium B. $\frac{1}{f_B} = (^{B}\mu_{g} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ $\Rightarrow \frac{1}{f_B} = \left(\frac{^{a}\mu_{g}}{^{a}\mu_{B}} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ $\Rightarrow \frac{1}{f_B} = \left(\frac{1.5}{1.3} - 1\right)\left(\frac{2}{f_{air}}\right) = \left(\frac{1.5-1.3}{1.3}\right)\frac{2}{f_{air}}$ $= \frac{2}{13} \times 2 = \frac{4}{13}$ $\therefore f_B = \frac{13}{4} = 3.25\, f_{air}$

	As the sign of f_B is same as that of f_{air}, the lens will behave as a converging lens.
Ans 11	(*i*) The EM waves suitable for RADAR system is microwaves. The range of frequency is 3×10^{11} to 1×10^{8} Hz. **(1)** (*ii*) The temperature of the earth would be lower because the greenhouse effect of the atmosphere would be absent. **(1)** (*iii*) An EM waves has momentum, i.e. $p = \frac{\text{Energy } (E)}{\text{Velocity of light } (c)}$ When it is incident upon a surface it exerts pressure on it. **(1)** **OR** (i) Importance of coherent source : Coherent sources are necessary to produce sustained interference pattern. Otherwise the phase difference between the two interfering waves will change rapidly and the interference pattern will be lost. . (ii) For constructive interference : We will have constructive interference resulting in a bright fringe when path difference is equal to nλ. $\frac{xd}{D} = n\lambda \quad \Rightarrow x = \frac{n\lambda D}{d}$ $\therefore \; x_n = \frac{n\lambda D}{d}$ **where [*n* = 0, ±1, ±2 ...]** Since the separation between the centres of two consecutive bright fringes is called fringe width. It is denoted by β $\therefore$ Fringe width, $\beta = x_{x+1} - x_n$ $\therefore \; \boxed{\beta = \frac{(n+1)\lambda D}{d} - \frac{n\lambda D}{d} = (n+1-n)\frac{\lambda D}{d} = \frac{\lambda D}{d}}$ ***For destructive interference :*** We will have destructive interference resulting in a dark fringe when difference = $(2n+1)\frac{\lambda}{2}$ $\frac{xd}{D} = (2n+1)\frac{\lambda}{2} \Rightarrow \quad x = \frac{(2n+1)\lambda D}{2d}$ $\therefore \; x_n = \frac{(2n+1)\lambda D}{2d}$ **where [*n* = 0, ±1, ±2 ...]** Fringe width $\beta = x_{n+1} - x_n$ $= \frac{[2(n+1)+1]\lambda D}{2d} - \frac{(2n+1)\lambda D}{2d}$ $= (2n+2+1-2n-1)\frac{\lambda D}{2d} = \frac{2\lambda D}{2d} = \frac{\lambda D}{d}$ Hence all bright and dark fringes are of equal width. Fringe width is given by $\beta = \frac{\lambda D}{d}$ when whole of the apparatus is immersed in water then, $\lambda' = \frac{\lambda}{\mu}, \quad \beta' = \frac{\lambda' D}{d}$ $\Rightarrow \beta' = \frac{\lambda D}{\mu d} \quad \Rightarrow \beta' = \frac{\beta}{\mu}$ Then fringe width becomes $1/\mu$ times the original fringe width i.e., it will decrease in water.
Ans 12	(i) (a), (ii) (c) (iii) (c) (iv)(b) (v) (c)

SAMPLE PAPER III

BLUE PRINT

NAME OF CHAPTERS	SA-I (2MARKS)	SA-II (3MARKS)	LA (5 MARKS)	TOTAL
CH-8 ELECTROMAGNETIC WAVES		**1**		**17**
CH-9 RAY OPTICS AND OPTICAL INSTRUMENTS		**2**		
CH-10 WAVE OPTICS		**1**	**1**	
CH-11 DUAL NATUREOF RADIATION AND MATTER	**1**	**1**		**11**
CH-12 ATOMS		**1**		
CH-13 NUCLEI		**1**		
CH-14 SEMICONDUCTOR	**2**	**1**		**7**

QUESTION PAPER

General Instructions:

(i)All questions are compulsory. There are 12 questions in the question paper.

(ii)The question paper have three sections: Section A, Section B, Section C

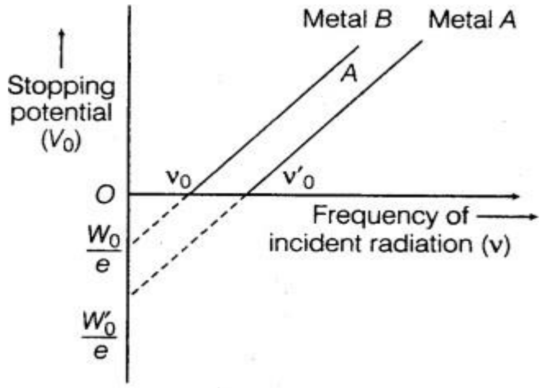
(iii)Section A contain three questions each of 2 mark. Section B contains 8 question of 3 marks each. Section C contains one case study based question of 5 marks.

(iv)There is no overall choice in the question paper. However, an internal choice has been provided in one question of two mark and two questions of three marks. You have to attempt only one of the choices in such questions.

(v)You may use log table if necessary but use of Calculator is not allowed.

SECTION A

Q1.The graph shows the variation of stopping potential with frequency of incident radiation for two photosensitive metals A and B. Which one of the two has higher value of work-function? Justify your answer.



OR

An electron and a proton are moving with equal speed. Which one has greater de- Broglie wavelength. Justify your answer.

Q2. Draw a labelled diagram of a full -wave rectifier circuit. Show the input-output wave forms.

Q3. What happens to the width of depletion layer of a p-n junction when it is (I) Forward Biased and (II) Reverse Biased

SECTION B

Q4- Name the electromagnetic waves which

(i) maintain the earth's warmth and
(ii) are used in aircraft navigation.
(iii) Used in water purifier.

Q.5 (a) State one feature by which the phenomenon of interference can be distinguish from that of diffraction.

(b)A parallel beam of light of wavelength 600 nm is incident normally on a slit of width 'a'. if the distance between the slits and screen is 0.8m and the distance of 2^{nd} order maximum from the centre of screen is 1.5mm, calculate the width of the slit.

OR

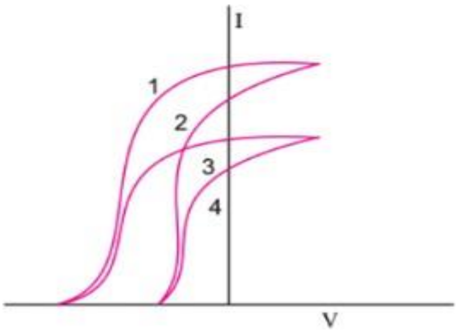
Draw a schematic ray diagram of reflecting telescope showing how rays coming from distantobjects are received at the eye-piece. Write its two important advantages over refracting telescope.

Q6. The given graph shows the variation of photo electric current (I) with the applied voltage (V) for two different materials and for two different intensities of the incident radiations. Identify and explain using Einstein's photoelectric equation for the pair of curves that correspond to (i) different materials but same intensity of incident radiation (ii) different intensities but samematerials.

Q7. The ground state energy of hydrogen atom is -13.6 eV

(i) What is the potential energy of an electron in the 3rd excited state?

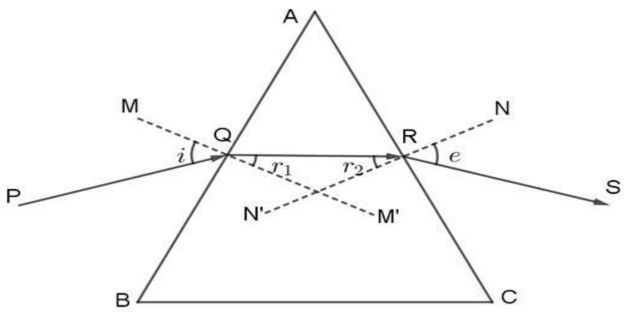
(ii) If the electron jumps to the ground state from the 3rd excited state, calculate the wavelengthof the photon emitted.



Q8. Figure shows a ray of light passing through a prism. If the refracted ray QR is parallel to the base BC, show that

(i) $r_1=r_2=A/2$

(ii) angle of minimum deviation $D_m=2i-A$



Q9. A convex lens made up of glass of refractive index 1.5 is dipped, in turn,

(i) a medium of refractive index 1.6,

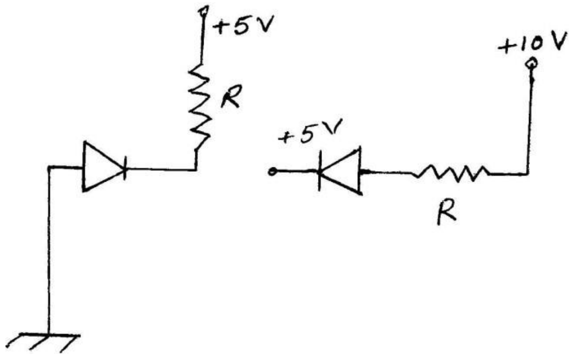
(ii) a medium of refractive index 1.3.

(a) Will it behave as a converging or a diverging lens in the two cases?

(b) How will its focal length change in the two media?

Q10. (a) How is the size of a nucleus experimentally determined? Write the relation between the radius and mass number of the nucleus. Show that the density of nucleus is independent of itsmass number.

Q11.(a) In the following diagrams, write which of the diodes are forward biased and which are reverse biased?

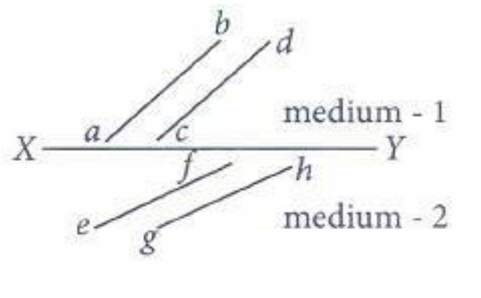


(b) A photo diode is fabricated from a semiconductor with a band gap 2.8eV. Can it detect a wavelength of 6000nm?

SECTION C

CASE STUDY BASED QUESTIONS

Wave front is a locus of points which vibrate in same phase. A ray of light is perpendicular to the wave front. According to Huygens principle, each point of the wave front is the source of a secondary disturbance and the wavelets connecting from these points spread out in all directions with the speed of wave. The figure shows a surface XY separating two transparent media, medium-I and medium-2. The lines ab and cd represent wave fronts of a light wave travelling in medium- 1and incident on XY. The lines ef and gh represent wave fronts of the light wave in medium -2 afterrefraction.



(i) Light travels as a

(a) parallel beam in each medium

(b) convergent beam in each medium

(c) divergent beam in each medium

(d) divergent beam in one medium and convergent beam in the other medium

(ii)The phases of the light wave at c, d, e and f are $\emptyset_c$, $\emptyset$, $\emptyset_e and\ \emptyset_f$ respectively. It is giventhat $\emptyset_c \neq \emptyset_f$

((a) $\emptyset_c$ cannot be equal to $\emptyset_d$ (b) $\emptyset_d$can be equal to $\emptyset_e$

(c) $(\emptyset_d - \emptyset_f)$ is equal to $(\emptyset_c - \emptyset_e)$ (d) $(\emptyset_d - \emptyset_c)$ is not equal to$(\emptyset_f - \emptyset_e)$

(iii) Wave front is the locus of all points, where the particles of the medium vibrate with the same……………..

(a) phase (b) amplitude (c) frequency (d) period

(iv) A point source that emits waves uniformly in all directions, produces wave fronts that are

(a) spherical (b) elliptical (c) cylindrical (d) planar

(v) What are the types of wave fronts?

(a) Spherical (b) Cylindrical (c) Plane (d) All of these

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