TOPIC WISE MULTIPLE CHOICE QUESTIONS

9.1 WAVEFRONTS

(1) The blue colour of sky is due to: **LHR-2018 (G-I)**

(a) diffraction of light **(b)** reflection of light
(c) polarization of light **(d)** scattering of light

(2) Angle between ray of light and wave front: **LHR 2015 (G-II)**

(a) 0^o **(b)** 60^o
(c) 90^o **(d)** 120^o

(3) Phase difference between two points of a wave front is **SGD-2016 (G-I)**

(a) zero **(b)** $\pi/2$
(c) π **(d)** $3\pi/2$

(4) When a ray of light enters from denser into a rare medium wavelength of light ray will: **FSD-2016 (G-I)**

(a) increase **(b)** decrease
(c) unchanged **(d)** cannot be determined

(5) The locus of all points in the same phase of vibration is: **BWP-2019 (G-II)**

(a) wave front **(b)** wavelength
(c) crest **(d)** trough

(6) In case of point source, the shape of wave-front is **DGK-2018 (G-II), MTN-2019 (G-I)**

(a) plane **(b)** spherical
(c) cylindrical **(d)** circular

(7) Light waves are: **MTN-2018 (G-I)**

(a) longitudinal waves **(b)** transverse waves
(c) stationary waves **(d)** mechanical waves

(8) A ray of light shows the direction of propagation of light. It is a line which is: **MTN-2018 (G-I)**

(a) normal to the wave front **(b)** parallel to wave front
(c) opposite to wave front **(d)** equal to wave front

(9) The wave nature of light was proposed by

(a) Newton **(b)** Joule
(c) Maxwell **(d)** Huygen

(10) Electromagnetic wave nature of light was proposed by

(a) Hertz **(b)** Maxwell
(c) Einstein **(d)** Huygen

(11) Small segments of a large spherical wavefronts approximately

(a) a circular wavefront **(b)** cylindrical wavefront
(c) plane wavefront **(d)** spherical wavefront

(12) Such a surface on which all the points have the same phase of vibration is called
(a) crest **(b)** trough
(c) wavelength **(d)** wavefront

(13) A line normal to the wavefront, showing the direction of propagation of light is called
(a) beam of light **(b)** ray of light
(c) both a and b **(d)** none of these

(14) Which experiment was performed by Huygens?
(a) Diffraction **(b)** Polarization
(c) Interference **(d)** Refraction

(15) Which one of the following properties of light does not change with the nature of medium?
(a) velocity **(b)** wavelength
(c) amplitude **(d)** frequency

(16) Light waves are
(a) matter waves **(b)** mechanical waves
(c) electromagnetic waves **(d)** none of these

(17) Young's experiment performed for the first time in_________ proved wave nature of light
(a) 1981 **(b)** 1801
(c) 1765 **(d)** 1678

(18) Wave nature of light is confirmed by phenomena
(a) Polarization **(b)** Interference
(c) Diffraction **(d)** All of these

(19) Sun emits
(a) yellow light **(b)** red light
(c) blue light **(d)** white light

(20) According to Newton light travels in the form of
(a) waves **(b)** photons
(c) corpuscles **(d)** all of these

9.2 HUYGEN'S PRINCIPLE

(21) According to Huygen's principle, each point on a wave front acts as a source of: **LHR-2017 (G-II)**
(a) secondary wavelet (b) primary wavelet
(c) new wave front (d) sound

(22) Huygen's principle enables us to determine the
(a) frequency and wavelength of new wavefront
(b) shape and location of new wavefront
(c) amplitude and location of new wavefront
(d) shape and size of new wavefront

(23) According to Huygen's principle, phase difference between two points on a wavefront
(a) 0 **(b)** π
(c) $\pi/2$ **(d)** $\pi/4$

(24) According to Huygen's principle, the new wavefront at time t + Δt is a
(a) secant envelope to all secondary wavelets
(b) tangent envelope to all secondary wavelets
(c) tangent envelope to all primary wavelets
(d) secant envelope to all primary wavelets

(25) The phase difference between two successive wave fronts of light is

(a) $\frac{\pi}{2}$ **(b)** π
(c) 2π **(d)** zero

(26) The distance traveled by the light between primary wave front to a secondary wave front is given by

(a) $\frac{c}{\Delta t}$ **(b)** $c\Delta t$
(c) $\frac{\Delta t}{c}$ **(d)** $\frac{c\Delta t}{t}$

(27) Wavelet of light moves in

(a) Backward direction **(b)** Forward direction
(c) All direction **(d)** Any direction

9.3 INTERFERENCE OF LIGHT WAVES

(28) Soap film shows colors due to: **RWP-2019 (G-I)**

(a) Interference **(b)** Diffraction
(c) Polarization **(d)** Reflection

(29) The sources are said to be coherent if they

(a) have constant phase difference **(b)** are very less distance apart
(c) are monochromatic **(d)** both a & c

(30) Can two head lights of a car produce interference

(a) yes **(b)** no
(c) partially produce **(d)** both a & c

(31) Sodium chloride in a flame gives

(a) pure yellow light **(b)** pure blue light
(c) pure green light **(d)** pure red light

(32) To observe the phenomenon of interference

(a) light should be monochromatic **(b)**light must be coherent
(c) the sources should close to each other **(d)** all of these

(33) If two light waves are not coherent then which of the phenomena cannot take place

(a) diffraction **(b)** interference
(c) polarization **(d)** all of these

(34) The two different flashlights will not produce an interference pattern, because

(a) light beams are not coming from the coherent sources
(b) light beams are coming from the coherent sources
(c) light beams are not coming from the transmitted light sources
(d) light beams are coming from the transmitted light sources

(35) If the waves interfere constructively then the amplitude of the resultant wave will be

(a) greater then either of individual wave **(b)** Less then either of individual wave
(c) equal to either of individual wave **(d)** none of these

(36) Monochromatic light means having

(a) one colour light **(b)** two colour light
(c) three colour light **(d)** colourless light

9.4 YOUNG'S DOUBLE SLIT EXPERIMENT

(37) Fringe spacing increases if we use: **LHR-2019 (G-II)**

(a) red light **(b)** blue light
(c) yellow light **(d)** green light

(38) For which of the following colours will the fringe width be minimum in the double slit experiment: **GRW-2019 (G-II)**
(a) violet **(b)** red
(c) green **(d)** yellow

(39) Fringe spacing increases if we use: **RWP-2019 (G-I)**
(a) lowest order **(b)** highest order
(c) red light **(d)** blue light

(40) In Young's double slit experiment, the position for bright fringes is: **FSD-2017**
(a) $Y_m = m\frac{\lambda d}{L}$ **(b)** $Y_m = m\frac{m\lambda}{Ld}$
(c) $Y_m = \frac{m\lambda L}{d}$ **(d)** $Y_m = m\frac{\lambda d}{L}$

(41) In Young's double slit experiment, the distance between two adjacent bright or dark fringes **SWL-2018, RWP-2016 (G-I)**
(a) $\frac{d}{L\lambda}$ **(b)** $\frac{d\lambda}{L}$
(c) $\frac{dL}{\lambda}$ **(d)** $\frac{L\lambda}{d}$

(42) Fringe spacing is inversely proportional to: **BWP-2017 (G-II)**
(a) wave-length **(b)** slit separation
(c) distance between the slits and screen **(d)** frequency of light

(43) The fringe spacing in double slit experiment can be increased by decreasing
(a) width of the slits **(b)** separation of the slits
(c) wavelength of light **(d)** distance between the slit and screen

(44) In Young's double slit experiment, fringe spacing will be maximum if we used
(a) yellow light **(b)** red light
(c) green light **(d)** blue light

(45) Maxima is termed as
(a) bright fringe **(b)** monochromatic light
(c) white light **(d)** dark fringe

(46) What happened to the fringe spacing, when the experiment is performed in water instead of air?
(a) enlarge **(b)** shrink
(c) disappear **(d)** no effect

(47) The condition for the constructive interference of two coherent beams is obtained, the path difference will be
(a) integral multiple of $\frac{\lambda}{2}$ **(b)** integral multiple of λ
(c) even integral multiple of λ **(d)** odd integral multiple of $\frac{\lambda}{2}$

(48) In Young's double slit experiment, the position of dark fringe is expressed as
(a) $y_m = \left(m+\frac{1}{2}\right)\frac{\lambda L}{d}$ **(b)** $y_m = \left(m-\frac{1}{4}\right)\frac{\lambda L}{d}$
(c) $y_m = \frac{m\lambda L}{d}$ **(d)** $y_m = \frac{m\lambda d}{2L}$

(49) In Young's double slit experiment, the condition for bright fringe is expressed as

(a) $d\sin\theta = \left(m - \frac{1}{2}\right)\lambda$ **(b)** $d\sin\theta = \left(m + \frac{1}{2}\right)\lambda$

(c) $2d\sin\theta = m\lambda$ **(d)** $d\sin\theta = m\lambda$

(50) The fringe spacing depends upon

(a) wavelength of light **(b)** separation between the slits

(c) the distance of screen from the slits **(d)** all of these

(51) In Young's double slit experiment, if the distance between the slits and screen is halved and the distance between the slits is doubled then the fringe spacing is

(a) half **(b)** double

(c) four times **(d)** one fourth

(52) In young's double slit experiment if blue light is used instead of red light then fringe spacing.

(a) increases **(b)** decreases

(c) remain same **(d)** none of these

(53) In young's double slit experiment, the fringe spacing can be increased by

(a) decreasing the separation of slits

(b) increasing the wavelength

(c) increasing the distance between slits and screen

(d) all of these

(54) In young's experiment if white light is used then

(a) no fringe will be seen **(b)** bright fringe will be seen

(c) few coloured fringes will be seen **(d)** dark fringe will be seen

9.6 NEWTON'S RING

(55) Newton's rings are formed as a result of: **LHR-2017 (G-I)**

(a) interference **(b)** dispersion

(c) diffraction (d) polarization

(56) In Newton's ring experimental arrangement, we observe the pattern through

(a) telescope **(b)** microscope

(c) spectrometer **(d)** interferometer

(57) In Newton's Ring, at the point of contact of the lens and the glass plate, the thickness of the film is

(a) very large **(b)** very thin

(c) almost zero **(d)** continually changes

(58) The path difference $\frac{\lambda}{2}$ means the phase change of

(a) 90^o **(b)** 60^o

(c) 180^o **(d)** 45^o

(59) By using the transmitted light, the central spot of Newton's ring appears to be

(a) bright **(b)** dark

(c) red **(d)** blue

9.7 MICHELSON INTERFEROMETER

(60) In a Michelson interferometer by moving the mirror through a distance of $\frac{\lambda}{4}$, the path difference changes by: **DGK-2018 (G-II) LHR-2016 (G-I) GRW-2019 (G-I)**
(a) $\frac{\lambda}{4}$ **(b)** $\frac{\lambda}{2}$
(c) λ **(d)** 2λ

(61) Michelson measured the length of standard meter in terms of wavelength of
(a) sodium light **(b)** red cadmium light
(c) platinum light **(d)** cesium light

(62) Which instrument is used to view the fringes in Michelson interferometer
(a) compound microscope **(b)** interferometer
(c) spectrometer **(d)** telescope

(63) Michelson's formula for the displacement L is
(a) $L = m\frac{\lambda}{2}$ **(b)** $\lambda L = \frac{m}{2}$
(c) $L = 2m\lambda$ **(d)** $\lambda L = 2m$

(64) Michelson's interferometer can also be used to find the
(a) wavelength of light **(b)** frequency of light
(c) velocity of light **(d)** velocity of sound

(65) Michelson's interferometer was devised in
(a) 1864 **(b)** 1687
(c) 1881 **(d)** 1786

(66) Michelson shows that the standard meter was equivalent to _____________ of wavelength of red cadmium light
(a) 15553163.5 **(b)** 16553153.5
(c) 1653163.5 **(d)** 1553163.5

(67) Michelson's Interferometer is an instrument that can be used to measure
(a) distance with extremely low precision **(b)** distance with extremely high precision
(c) both a and b **(d)** none

9.8 & 9.9 DIFFRACTION OF LIGHT & DIFFRACTION DUE TO NARROW SLIT

(68) Diffraction is a special type of: **(GRW 2015)**
(a) interference **(b)** polarization
(c) reflection (d) refraction

(69) The property of bending of light around the obstacle is known as **LHR 2015 (G-I)**
(a) interference **(b)** diffraction
(c) reflection **(d)** polarization

(70) Diffraction is a characteristic of
(a) particle **(b)** wave
(c) both a and b **(d)** none of these

(71) Diffraction effects are
(a) more for sharp edges **(b)** less for cylindrical
(c) less for round edge **(d)** less for sharp edge

(72) Diffraction is a property of
(a) interference **(b)** wave
(c) reflection **(d)** polarization

(73) In diffraction the phenomenon is found to be prominent when the wavelength of light is large as compared with the

(a) aperture of the slit **(b)** distance between source and slit
(c) number of the slits **(d)** all of these

(74) In diffraction pattern due to narrow slits the equation for the first minimum is

(a) $\frac{d}{2}\sin\theta = \lambda$ **(b)** $\frac{d}{2}\sin\theta = \frac{\lambda}{2}$
(c) $d\sin\theta = \frac{\lambda}{2}$ **(d)** $\frac{d}{2}\sin\theta = \frac{2}{3}\lambda$

(75) When the light passes through the pinhole opening, then the spreading of light is due to

(a) interference **(b)**diffraction
(c) polarization **(d)** scattering

(76) Which of the following waves can be diffracted

(a) sound waves **(b)** light waves
(c) water waves **(d)** all of these

9.10 DIFFRACTION GRATING

(77) The optical instrument with a regular pattern, which splits light into several beams is called

(a) slit **(b)** pinhole camera
(c) grating **(d)** grating element

(78) The distance between two adjacent lines or slits is called

(a) slit **(b)** grating
(c) grating element **(d)** narrow slit

(79) A typical diffraction grating has about

(a) 400 to 5000 lines per meter **(b)** 400 to 5000 lines per centimeter
(c) 400 to 5000 lines per cubic meter **(d)** 400 to 5000 lines per millimeter

(80) The relation of grating element can be expressed as

(a) $d = \frac{\text{length of grating element}}{\text{distance between the slits}}$

(b) $d = \frac{\text{length of grating element}}{\text{number of lines rules on it}}$

(c) $d = \frac{\text{number of lines ruled on it}}{\text{length of grating element}}$

(d) $d = (\text{length of grating element}) \times (\text{number of lines ruled on it})$

(81) On a compact disc the width of each fine ruling is about

(a) 0.5mm **(b)** 0.5cm
(c) 0.5μm **(d)** 0.5 dm

(82) When $\theta = 0^\circ$, along the direction of normal to the grating, the path difference between the rays coming out from the slits of grating will be

(a) minimum **(b)** maximum
(c) zero **(d)** none of these

(83) If a diffraction grating has 1000 lines per mm. Its grating element will be

(a) 1×10^{-3}cm **(b)** 1×10^{-5}cm
(c) 1×10^{-5}mm **(d)** 1×10^{-4}cm

(84) In diffraction grating the path difference for constructive interference should be

(a) $\frac{\lambda}{2}$ **(b)** $\frac{\lambda}{4}$

(c) λ **(d)** $\frac{\lambda}{8}$

(85) A diffraction grating used to make a diffraction pattern for yellow light and then for red light. The distance between the red spots will be ________ that for yellow light.

(a) less than **(b)** greater than

(c) disappear **(d)** no change

(86) To get more orders of spectra using a diffraction grating, the wavelength should

(a) be decreased **(b)** be increased

(c) be remained same **(d)** none of these

(87) To get orders of spectra using a diffraction grating, we can use the relation

(a) $n = \frac{\sin\theta}{\lambda}$ **(b)** $n = \frac{\sin\theta}{\lambda}$

(c) $n = \frac{\sin\theta}{d\lambda}$ **(d)** $n = \frac{d\sin\theta}{\lambda}$

9.11 DIFFRACTION OF X-RAYS BY CRYSTALS

(88) Bragg's equation is: **LHR-2019 (G-I)**

(a) $2d\sin\theta = n\frac{\lambda}{2}$ **(b)** $2d\sin\theta = n\lambda$

(c) $2\sin\theta = n\frac{\lambda}{2}$ (d) $d\sin\theta = 2\lambda$

(89) X-rays is a type of electromagnetic radiation of much shorter wavelength of the order of

(a) 10^{-10}m **(b)** 10^{-19}m

(c) 10^{-20}m **(d)** 10^{-12}m

(90) Bragg's equation is expressed as

(a) $\frac{d}{2}\sin\theta = n\lambda$ **(b)** $d\sin\theta = n\lambda$

(c) $2d\sin\theta = n\lambda$ **(d)** $2d\sin\theta = \frac{n\lambda}{2}$

(91) The study of atomic structure of crystals by X-rays was initiated in

(a) 1914 **(b)** 1901

(c) 1811 **(d)** 1931

(92) Diffraction of x-rays by crystal shows that

(a) the intensity of light is high **(b)** x-ray has shorter wavelength

(c) x-rays has greater frequency **(d)** both b & c

(93) X-rays are very useful in determining the structure of

(a) hemoglobin **(b)** double helix structure of DNA

(c) both a & b **(d)** pulse rate

(94) Which colour suffers the maximum deviation in prism

(a) yellow **(b)** blue

(c) orange **(d)** green

ANSWER KEYS

(Topic Wise Multiple Choice Questions)

1	d	16	c	31	a	46	b	61	b	76	d	91	a
2	c	17	b	32	d	47	b	62	b	77	d	92	d
3	a	18	d	33	b	48	a	63	a	78	c	93	c
4	a	19	d	34	a	49	d	64	a	79	b	94	b
5	a	20	c	35	a	50	d	65	c	80	b		
6	d	21	a	36	a	51	d	66	d	81	c		
7	b	22	b	37	a	52	b	67	b	82	c		
8	a	23	a	38	a	53	d	68	a	83	d		
9	c	24	b	39	c	54	c	69	b	84	c		
10	d	25	c	40	c	55	a	70	c	85	a		
11	c	26	b	41	d	56	b	71	a	86	a		
12	d	27	c	42	b	57	c	72	a	87	d		
13	b	28	a	43	b	58	c	73	a	88	b		
14	a	29	d	44	b	59	a	74	b	89	a		
15	d	30	d	45	a	60	b	75	b	90	c		

SHORT QUESTIONS

(From Textbook Exercise)

9.1. Under what conditions two or more sources of light behave as coherent sources?

MTN-15(G-I), GRW-15(G-I), MIRPUR (AJK) 15, MTN-16 (G-I), DGK-16 (G-II), SWL-17, FSD-17, FSD-18, LHR-18 (G-II), FSD-19 (G-I), RWP-19 (G-I)

Ans: Two or more sources are said to be coherent if light coming from these sources have same frequency, same wavelength and have constant phase difference.

9.2. How is the distance between interference fringes affected by the separation between the slits of Young's experiment? Can fringes disappear?

SGD-15(G-I)&(G-II), RWP-15 (G-I), SGD-16 (G-I), MTN-19 (G-I)

Ans: We know that fringe width is given by $\Delta y = \frac{L\lambda}{d}$

where "d" is separation between slits. It means that $\Delta y \propto \frac{1}{d}$. This relation shows that if separation between the slits increases then fringe width decreases. If separation between slits is very large then the fringes may disappear.

9.3. Can visible light produce interference fringes? Explain.

RWP-15(G-I), MTN-15(G-I) & (G-II), MIRPUR (AJK) 15, DGK-16 (G-I), & (G-II), BWP-16 (G-I), RWP-16 (G-I), GRW-16 (G-I), BWP-17 (G-II), FSD-17, SWL-18, RWP-19 (G-I), BWP-19 (G-II)

Ans: Yes, visible light can produce interference.

If white light is used for interference, then we can see colours on both side of central maxima on the screen. But the pattern will not be well defined due to overlapping of colours.

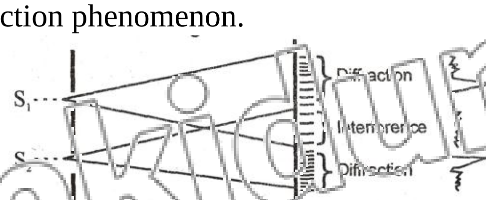
9.4. In the Young's experiment, one of the slits is covered with blue filter and other with red filter. What would be the pattern of light intensity on the screen?

Ans: Blue filter gives blue light and red filter gives red light. For interference the two waves must have same frequency. As in the case one light is red and the other is blue therefore no interference will take place. We shall observe two coloured images on the screen with constant intensity.

9.5. Explain whether the Young's experiment is an experiment for studying interference or diffraction effects of light.

DGK-18 (G-I), LHR-19 (G-I), GRW-19 (G-I), SWL-19

Ans: Young's experiment is an experiment for studying the interference of light. Although light also diffracts while passing through the slits, yet interference phenomenon is more prominent than diffraction phenomenon.



9.7. Could you obtain Newton's rings with transmitted light? If yes, would the pattern be different from that obtained with reflected light?

LHR-13(G-II), LHR-14(G-I), SGD-16 (G-II), LHR-16 (G-I), BWP-17 (G-I), SWL-18, GRW-19 (G-I)

Ans: We can obtain Newton's ring with transmitted light but the pattern will be exactly opposite from that obtained with reflected light. In case of reflected light the central spot appears dark and in the case of transmitted light central spot appears white.

9.9. How would you manage to get more orders of spectra using a diffraction grating?
DGK-15(G-I), BWP-15(G-I), RWP-15(G-I), SWL-16, MTN-16 (G-II), RWP-16 (G-I), GRW-16 (G-I), LHR-16 (G-I), SWL-18, LHR-19 (G-I), RWP-19 (G-I), SWL-19, MTN-19 (G-II), BWP-19 (G-II)

Ans: We know that for diffraction grating.

$d \sin\theta = m\lambda$

$m = \frac{d \sin\theta}{\lambda}$

where 'm' is order of diffraction.

1) This shows that order of spectra can be increased by increasing the value of d (grating element) As $d = \frac{1}{N}$, Therefore, d can be increased by decreasing number of lines (N) on the grating.

2) Using the light of shorter wavelength.

TOPIC WISE SHORT QUESTIONS

9.1 WAVE FRONTS

(1) Define wavefront? **FSD-2015, SWL-2019, SWL-2014**

Ans: Wavefront:

Such a surface on which all the points have the same phase of vibration is know as wavefront. There are two types of wavefront

- **(i) Spherical wavefront:** Set of points which determine the surface of sphere.
- **(ii) Plane wavefront:** A small part of spherical wavefront at very large distance from source of light.

(2) Define A ray of Light and spherical wave front.
FSD-2015, GRW-2013, LHR-2014, FSD-2017

Ans: Ray of Light:

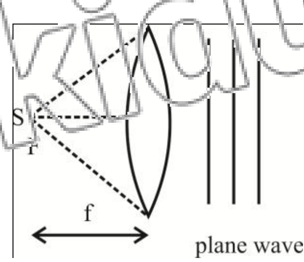
Ray of light is a line drawing normal to a wave front showing the direction of propagation of wavefront, it always makes an angle 90^o with wavefront of light.

Spherical Wavefront:

Consider a point source, S, emitting light waves in all directions. The wave fronts will be concentric spheres with centre at the source, S. Such a wave front is called "Spherical wave front".

(3) How does one can obtain a plane wave? **BWP-2019 (G-II)**

Ans: Plane wave:



A usual way to obtain a plane wave is to place a point source of light at the focus of a convex lens. The rays coming out of the lens will constitute plane waves.

(4) Define beam of light. **BWP-2019 (G-I)**

Ans: A light beam or beam of light is a directional projection of light energy radiating from a light source. For example: Sunlight forms a light beam (a sun beam) when filtered through media such as clouds or windows.

To artificially produce a light beam, a lamp is used in many lighting devices such as vehicle head lights.

9.2 HUYGEN'S PRINCIPLE

(5) Write two steps of Huygen's Principle. **BWP-2019, LHR-2014**

OR

What is the Huygen's principle?

FSD-2018, SGD 2013,2015, 2016, 2018, LHR-2016, 2019, MTN-2013, 2016 DGK-2012, 2015 BWP-2013, 2014, DGK-2015, SWL-2017

Ans: Huygen's principle consists of two steps that is given below:

(i) Every point of a wavefront may be considered as a source of secondary wavelets which spread out in forward direction with a speed equal to the speed of propagation of the wave.

(ii) The new position of the wavefront after a certain interval of time can be found by constructing a surface touches all the secondary wavelets.

9.3 INTETERFERENCE OF LIGHT WAVES

(6) What are conditions of detectable Interference? **MTN-2016, DGK-2018**

OR

What conditions must be met by interfering beams to observe the phenomena of interference? **DGK-2014**

OR

Write the conditions to observe the phenomenon of interference of light.

FSD 2013, RWP 2012

Ans: Conditions for detectable Interference are:

(i) The interfering beams must be monochromatic (Single wavelength).

(ii) The interfering beams must be coherent (Having zero phase difference are constant phase difference).

(7) How are two coherent light beams produced?

Ans: A common method of producing two coherent light beams is to use a monochromatic source to illuminate a screen containing two small holes, usually in the shape of slits. The light emerging from the two slits is coherent because a single source produces the original beam and two slits serve only to split it into two parts. Huygen's wavefront which send out secondary wavelets are also coherent source of light.

(8) What are conditions for constructive and destructive interference?

MTN-2019, GRW 2014

Ans: Constructive Interference:

If the two light waves meet at a point in such a way that they reinforce each other and bright fringe is seen on the screen. This type of interference is called constructive interference.

For constructive interference path difference is $\Delta s = n\lambda$

Destructive interference:

If the two light waves cancel each other at a point, a dark fringe is formed on screen. This type of interference is called destructive interference.

For destructive interference path difference is $\Delta s = \left(n + \frac{1}{2}\right)\lambda$

(9) What is interference of light? Write down the conditions to observe interference.

RWP 2013

Ans: Interference of Light

When two light waves of same frequency having phase coherence pass through a region simultaneously, Superimpose, they help each other at some points and cancel out each other at some other points. This helping and canceling effect is called interference.

Conditions:

Conditions for detectable Interference are:

(i) The interfering beams must be monochromatic (Single wavelength).

(ii) The interfering beams must be coherent (Having zero phase difference or constant phase difference).

9.1 YOUNG'S DOUBLE SLIT EXPERIMENT

(10) Write the equation for bright fringes in Young's double slit experiment. Also explain the terms used in the formula

Ans: Equation for bright fringes in Young's double slit experiment is

$$y = m\frac{L\lambda}{d}$$

y = Distance of fringe from the centre of screen.
m = Order of fringe
λ = Wavelength of the wave.
L = Distance between slit and source
d = Distance between the slits

(11) What is fringe spacing?

Ans: Distance between any two consecutive bright or dark fringes is called fringe spacing.

Mathematically expression for fringe spacing is

$$\Delta y = \frac{L\lambda}{d}$$

In above equation Δy is fringe spacing, L is the distance between slit, screen d is the distance between two slit and λ is the wavelength of light.

where

$$\Delta y \propto \frac{1}{d}$$

$$\Delta y \propto L$$

(12) Explain for which colour of light, the fringe spacing in double slit experiment will be maximum.

Ans: We know that equation for fringe spacing is

$$\Delta y = \frac{L\lambda}{d}$$

In above equation Δy is fringe spacing, L is the distance between slit, screen d is the distance between two slit and λ is the wavelength of light.

where

$$\Delta y \propto \frac{1}{d}$$

$$\Delta y \propto L$$

Thus Δy will be maximum for light of greater wavelength λ, i.e for red colour Δy will be maximum.

(13) How will you increase the fringe width in Young's double slit experiment?
LHR-2017 (G-I)

OR

On what factors, the distance between adjacent bright fringes in young's double slits experiment depend? **BWP-2017 (G-I)**

Ans: We know that fringe width is given by $\Delta y = \frac{L\lambda}{d}$

We can increase the fringe width by increasing distance between slits and screen (L) or by increasing wave length of light (λ) or by decreasing the slits separation (d)

(14) In the Young's experiment, one of the slits is covered with blue filter and other with red filter. What would be the pattern of light intensity on the screen? **RWP-2013**

Ans: Blue filter gives blue light and red filter gives red light. For interference the two waves must have same frequency. As in the case one light is red and the other is blue therefore no interference will take place. We shall observe two coloured images on the screen with constant intensity.

9.6 NEWTON'S RINGS

(15) Why the centre of Newton's rings is dark?

Ans: At the point of the contact of the lens and the glass plate, the thickness of the film is effective zero but due to reflection at the lower surface of air film from the denser medium an additional path difference $\frac{\lambda}{2}$ is introduced. Consequently, the centre of Newton's rings is dark.

(16) In Newton's ring, why are the fringes circular?
LHR-2017 (G-I)

Ans: **Concentric** Circular bright and dark fringes obtained due to the air film of irregular thickness is enclosed between a plano convex lens and a glass plate

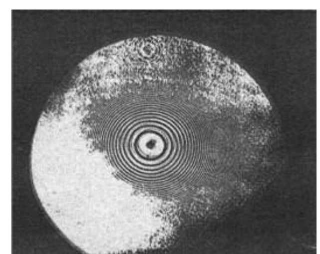


Fig. (b) A pattern of Newton's rings due to interference of monochromatic light. .

(17) Why central spot of Newton's rings is dark?
FSD 2014, GRW-2019 (G-I), BWP-2017 (G-II)

OR

The central spot is dark in Newton's Rings why? **(RWP-2012)**

OR

The center of Newton's rings in dark although the thickness of air film is effectively zero at center. Explain. **DGK-2018 (G-II)**

Ans: At the point of contact of the lens and the glass plate, the thickness of the film is effectively zero but due to reflection at the lower surface of air film from denser medium, an additional path difference of $\frac{\lambda}{2}$ is introduced. Consequently, the center of Newton rings is dark due to destructive interference

9.7 MICHELSON'S INTERFEROMETER

(18) Who measured the length of a standard meter? How much wavelength are there in a meter?

Ans: Michelson measured the length of standard meter in terms of the wavelength of red Cadmium light and showed that the standard meter was equivalent to1,553,163.5 wavelength of this light.

(19) What is Michelson Interferometer?

Ans: It is an instrument that can be used to measure distance with extremely high precision. Albert A. Michelson devised this instrument in 1881 using the idea of interference of light rays. Very precise length measurement can be made with interferometer (100 nm or 10^{-4} mm)

Equation for interferometer $L = m\frac{\lambda}{2}$

(20) What is the contribution of Michelson to measure the length of standard meter using interferometer? BWP-2017 (G-I)

Ans: **Michelson used an** instrument that can be used to measure distance with extremely high precision this instrument is known as Michelson's interferometer.

Michelson measured the length of the standard meter in terms of wavelength of red cadmium light and proved that 1standard meter = 1553163.5 wavelength of this light.

9.8 DIFFRACTION OF LIGHT

(21) What is the condition for diffraction?

Ans: This Phenomenon takes place only when the wavelength of light is comparable with the size of obstacle or aperture of the slit. The diffraction of light occurs in effect, due to the interference between rays coming from different parts of the same wavefront.

(22) What is the diffraction of light? GRW 2012, 2018, SWL-2016

Ans: The property of bending of light around obstacles and spreading of light waves into the geometrical shadow of an obstacle is called diffraction.

Condition for diffraction:

Wavelength of light is comparable with the size of obstacle or aperture of the slit.

(23) What is physical difference between interference fringes and diffraction fringes?

Ans:

Interference Fringes	Diffraction Fringes
(i) Interference fringes are equal in size	(i) Diffraction fringes wide near diffracting object and become small as one move away from it.
(ii) Points of minimum intensity are perfectly dark	(ii) Points of minimum intensity are not perfectly dark
(iii) All bright bands are of uniform intensity	(iii) All bright bands are not of the same intensity.

(24) What is difference between interference and diffraction?

BWP-2016 (G-I), MTN-2019 (G-I), FSD 2012, SGD 2015(G-II)

Ans:

Interference	Diffraction
• Interference of light is defined as a phenomenon of super position of two coherent light waves of same amplitude moving in a medium at same time and in same direction.	• Diffraction of light is defined as the phenomenon of bending of a light around the edges of a opening or obstacle placed in its path
• Interference fringes are of the same intensity.	• Diffraction fringes are not of the same intensity.
• Interference fringes are of same width.	• Diffraction fringes are not of same width.
• Interference fringes are equally spaced.	• Diffraction fringes are not equally spaced.
• The points of minimum intensity are perfectly dark.	• The points of minimum intensity are not perfectly dark.
• Interference is a result of super position of only a few secondary wavelets from two coherent sources.	• Diffraction is the result of superposition of a very large number of secondary wave lets coming from single source.

9.9 & 9.10 DIFFRACTOIN DUE TO NARROW SLIT & DIFFRACTION GRATING

(25) What is grating element?

Ans: The distance between two adjacent slits d is called grating element. Its value is obtained by dividing the length L of the grating by the total number of lines ruled on it.

$$\text{Grating element} = d = \frac{\text{Length of grating}}{\text{No. of lines ruled on it}}$$

$$d = \frac{L}{N}$$

$$d = \frac{1}{No. of\ lines / cm}$$

$$d = \frac{1\text{cm}}{N}$$

(26) What is diffraction of light, write grating equation?

DGK-2016 (G-II), DGK 2012 + SGD-2016 (G-I)

Ans: The property of bending of light around obstacles and spreading of light waves into the geometrical shadow of an obstacle is called diffraction.

Grating equation:

$$d\sin\theta = m\lambda$$

where 'm' is order of diffraction and λ is the wavelength of light, d is the grating element and θ is the angle of diffraction.

(27) Define diffraction grating and grating element. **SGD-2012**

Ans: A diffraction grating is a glass plate having a large number of close parallel equidistant slits mechanically ruled on it

Grating element. The distance between two adjacent slits d is called grating element. Its value is obtained by dividing the length L of the grating by the total number of lines ruled on it.

$$\text{Grating element} = d = \frac{\text{Length of grating}}{\text{No of lines ruled on it}}$$

$$d = \frac{L}{N}$$

$$d = \frac{1}{\text{No.of lines/cm}}$$

(28) A typical diffraction grating has 5000 lines per centimeter. What will be the grating element of this diffraction grating in meters? **BWP-2017 (G-II)**

Ans: As we known that grating element $= d = \frac{\text{Length of grating}}{\text{No. of lines ruled on it}}$

$$d = \frac{L}{N}, \quad d = \frac{1}{\text{No.of lines/cm}} = \frac{1}{5000/\text{cm}} = \frac{1}{5000/10^{-2}\text{m}} = \frac{1\text{m}}{500000} = 2\times10^{-6}\text{m}$$

9.11 DIFFRACTION OF X-RAYS BY CRYSTALS

(29) Why Natural crystals are used for x-ray diffraction instead of diffraction grating?

Ans: X-rays is a type of electromagnetic radiation of much shorter wavelength, typically of the order of 10^{-10}m. In order to observe the effects of diffraction, the grating spacing must be of the order of the wavelength of the radiation used. However, the natural crystals (NaCl) have spacing comparable to the wavelength of x-rays. This spacing is sufficient for the diffraction of x-rays through natural crystals.

(30) What is Bragg's equation? Describe its applications?

Ans: The Bragg's equation is expressed as

$2d\ \text{Sin}\theta = n\lambda$

n=1,2,3……… is called order of bright fringes.

Applications

(i) It can be used to find the interplaner spacing 'd' between parallel planes of crystals.

(ii) X-rays diffraction is used to find the structure of biologically molecules such as hemoglobin.

(31) Why diffraction grating cannot be used for X-rays diffraction? **LHR-2017 (G-II)**

OR

Why X-rays cannot be diffracted by ordinary glass grating? **DGK-2013 (G-II)**

Ans: X-rays have smaller wavelength and high energy which cannot be diffracted by diffraction grating because size of grating element is much greater than the wavelength of x-rays which is of the order of 10^{-10}m. x-rays diffraction can be study by crystal.

(32) What is Bragg's law? Derive Bragg's equation. **LHR-2019 (G-I)**

Ans: When x-ray are scattered from a crystals lattice, peaks of scattered intensity are observed which correspond to the following conditions:

(i) The angle of incidence = angle of scattering.

(ii) The path length difference is equal to an integer number of wavelength.

$\boxed{2d\sin\theta = n\lambda}$ Where n = 1,2,-----------.

This equation is known as Bragg's equation.

By using Bragg's law we can calculate details about the crystal structure and wavelength of x-rays incident upon the crystal.