I. UNITS, DIMENSIONS AND VECTORS

1. The fundamental unit of length in SI system is
   (a) metre
   (b) foot
   (c) mile
   (d) yard

2. The SI unit of capacitance is
   (a) Henry
   (b) Farad
   (c) Ohm
   (d) Lux

3. Which of the following is not SI base unit?
   (a) kilogram
   (b) Ampere
   (c) mole
   (d) Rutherford

4. Curie is the unit of
   (a) luminous intensity
   (b) radioactivity
   (c) amount of substance
   (d) electric current

5. Which of the following is not a unit of radioactivity?
   (a) Curie
   (b) Becquerel
   (c) Ruthford
   (d) Candela

6. The SI derived unit of magnetic flux is
   (a) Lumen
   (b) Tesla
   (c) Henry
   (d) Weber

7. Lux is the SI unit of
   (a) luminous flux
   (b) illuminance
   (c) magnetic flux
   (d) inductance

8. Candela is the SI base unit of
   (a) illuminance
   (b) luminous flux
   (c) luminous intensity
   (d) radiant intensity

9. Candela per square is the SI unit of
   (a) luminous flux
   (b) luminous intensity
   (c) luminance

10. The SI unit of magnetic flux density is
    (a) Tesla
    (b) Henry
    (c) Weber
    (d) Ohm

11. In CGS system, the unit of magnetic field intensity is
    (a) Oersted
    (b) Ampere per meter
    (c) Ampere
    (d) Farad

12. The SI unit of solid angle is
    (a) steradian
    (b) radian
    (c) degree
    (d) Joule

13. Which of the following is not a unit of plane angle?
    (a) degree (b) radian
    (c) Gradian (d) steradian

(b) π (pi)
(c) decibel
(d) force

15. Generally one housepower (HP) is equal to how many watts?
(a) 546 W
(b) 646 W
(c) 746 W
(d) 846 W

16. In SI system, volt per meter is the unit of
(a) electric filed strength
(b) magnetic field strength
(c) magnetic flux density
(d) magnetic flux

17. In SI system, Ohm is the unit of
(a) electrical conductance
(b) electrical resistance
(c) inductance
(d) capacitance

18. A light-year is a unit of
(a) mass
(b) time
(c) temperature
(d) length

19. Which of the following is not a unit of length?
(a) micron
(b) yard
(c) inch
(d) Kelvin

20. One micron is equivalent to
(a) 10^{-2} m (b) 10^{-4} m
(c) 10^{-6} m (d) 10^{-8} m

(d) work

22. Which of the following does not have the same dimensions?
(a) energy, work, heat
(b) pressure, stress, young's modulus
(c) voltage, electromotive force, potential difference
(d) electric flux, electric field, electric dipole moment

23. The dimensions of force are
(a) MLT^{-2}
(b) ML^2T^{-2}
(c) $M^2L^2T^{-2}$
(d) ML^2T^{-1}

24. The dimensions of torque are
(a) MLT^{-1}
(b) $ML^2\,T^{-1}$
(c) $ML^2\,T^{-2}$
(d) $M^2L^2\,T^{-2}$

25. Out of the following pairs, which one does not have the same dimension?
(a) force and weight
(b) pressure and stress
(c) energy and work
(d) capacitance and resistance

26. Siemens is the SI unit of
(a) electric resistance
(b) electric conductance
(c) electric capacitance
(d) electric inductance

27. The dimensions of stress are
(a) $M\,L^{-1}\,T^{-2}$ (b) $ML^{-1}\,T^{-2}$

(b) $M L^{-1} T^{-2} A^{-1}$

(c) $M L^{2} T^{-3} A^{-3}$

(d) $M L^{2} T^{-3} A^{-2}$

29. The SI unit of absorbed radiation dose of ionizing radiation is
    (a) Radian
    (b) Joule
    (c) Watt
    (d) Gray

30. The SI unit of catalytic activity is
    (a) Katal
    (b) Angstrom
    (c) Sievert
    (d) Gray

31. The SI unit of power is
    (a) Henry
    (b) Watt
    (c) mil
    (d) Sievert

32. The SI derived unit of dose equivalent is
    (a) Gray (b) Katal
    (c) Sievert (d) Henry

33. One electronvolt (ev) is a unit of energy equal to approximately
    (a) 1.602×10^{-9} J
    (b) 1.602×10^{-19} J
    (c) 1.602×10^{-29} J
    (d) 1.609×10^{-39} J

34. The dimension of gravitational constant G are
    (a) $M^{-1} L^{-1} T^{-1}$
    (b) $M^{-1} L^{-2} T^{-2}$

physical constants. Which of the following is a natural unit?
    (a) speed of light (c)
    (b) electric charge (e)
    (c) characteristic impedance of free space (z_0)
    (d) all of the above

36. The dimensions of Coulomb constant (k) are
    (a) $Q^{-1} M^{-2} L^{-2} T^{-2}$
    (b) $Q^{-2} M L^{3} T^{-1}$
    (c) $Q^{-1} ML^{2} T^{-2}$
    (d) $Q^{-2} ML^{-3} T^{-2}$

37. What are the dimensions of electric constant ($\in_0$)? (It is also called perimttivity of free space)
    (a) $Q^{2} M^{-2} L^{-2} T^{-2}$
    (b) $Q^{-2} M^{-2} L^{-1} T^{-3}$
    (c) $Q M^{-1} L^{-3} T^{-1}$
    (d) $Q^{2} M^{-1} L^{-3} T^{-2}$

38. Which of the following is SI base unit for temperature?
    (a) Celsuis
    (b) Kelvin
    (c) Fahrenheit
    (d) Rankine

39. Debye (D) is a CGS unit of
    (a) electric dipole moment
    (b) density
    (c) temperature
    (d) mass

40. In SI units, a day consists of
    (a) 56400 sec
    (b) 66400 sec

(b) Neper
(c) Ampere
(d) Volt

42. The Coulomb (C) is the SI derived unit of
(a) electric current
(b) electric voltage
(c) electric charge
(d) electric field

43. The tonne (t) is a unit of mass equal to
(a) 10 kg
(b) 100 kg
(c) 1000 kg
(d) 10,000 kg

44. The SI unit for force is
(a) Volt
(b) Ampere
(c) Hertz
(d) Newton

45. The SI unit for frequency is
(a) hectre
(b) Volt
(c) Farad
(d) Hertz

46. The volt (V) is a SI derived unit of electromotive force, commonly called
(a) voltage
(b) current
(c) charge
(d) power

47. The smallest unit of mass; yoctogram (yg) equals
(a) 10^{-15} g
(b) 10^{-18} g

(a) 0.609 km
(b) 1.609 km
(c) 2.609 km
(d) 3.609 km

49. Which of the following SI units is not named after any physicist?
(a) Hertz
(b) Joule
(c) Volt
(d) Candela

50. One yard is equivalent to
(a) 1 foot (b) 2 feet
(c) 3 feet (d) 4 feet

51. When two vectors have opposite directions, we can say that they are
(a) parallel
(b) perpendicular
(c) antiparallel
(d) none of these

52. Which of the following is a scalar quantity?
(a) weight
(b) force
(c) velocity
(d) kinetic energy (K.E.)

53. Which vector can be used to locate the center of mass of a collection of particles?
(a) unit vector
(b) position vector
(c) distance vector
(d) none of the above

54. Which are the two basic properties of a vector?
(a) curvature and direction
(b) magnitude and direction

(a) they are antiparallel
(b) they are the same curvature
(c) they are same magnitude
(d) they are perpendicular

56. Let i, j and k be unit vectors. If $a = 3i - j + 2k$, what is the magnitude of the vector a?
(a) 4
(b) 12
(c) 14
(d) $\sqrt{14}$

57. Which vector gives the displacement from one point to another in space?
(a) unit vector
(b) position vector
(c) distance vector
(d) none of the above

58. Which of the following is a scalar quantity?
(a) work
(b) energy
(c) power
(d) all of the above

59. A plane flying 500 MPH due north has a tail wind of 45 MPH. The resultant velocity is
(a) 545 mph due south
(b) 455 mph due north
(c) 545 mph due north
(d) 455 mph due south

60. A man walks 3 miles north and then walks 4 miles east. The resultant displacement is
(a) 1 mile NE
(b) 7 miles NE
(c) 5 miles NE
(d) 5 miles SE

(c) 75 N
(d) 0 N

62. The resultant magnitude of two vectors
(a) is always positive
(b) can never be zero
(c) can be negative, positive or zero
(d) is usually zero

63. Which of the following is not true?
(a) velocity can be negative
(b) velocity is a vector
(c) speed is a scalar
(d) speed can be negative

64. Poynting vector is closely related to
(a) power
(b) intensity of filed
(c) energy density
(d) none

65. What is the rates of 1 nanometer to 1 attometer?
(a) 10^6 (b) 10^7
(c) 10^8 (d) 10^9

66. Which of the following units is different from others?
(a) volt
(b) kilo-watt-hour
(c) watt-sec
(d) electron-volt

67. The dimensional formula for torque is identical to
(a) kinetic energy
(b) pressure energy
(c) momentum of force
(d) all of the above

(d) 6 units

69. If $P = 2i + 3j - k$ and $Q = 4i + 6j - 2j$, then the angle between P and Q will be
(a) 0°
(b) 45°
(c) 60°
(d) 75°

70. Choose the only scalar?
(a) kinetic energy
(b) momentum
(c) torque
(d) angular momentum

71. The magnitude of resultant of two equal forces is equal to either of the force. What is the angle between the two forces?
(a) 0°
(b) 60°
(c) 120°
(d) 180°

72. If a body's momentum increases by 20%, the percentage increase in its K.E. will be
(a) 30
(b) 40
(c) 44
(d) 54

73. Which of the following physical quantity has different units as compared to others?
(a) weight of a body
(b) tension in string
(c) buoyant force
(d) electromotive force (e.m.f.)

(c) 1: 12
(d) 12: 1

75. The moment of linear momentum is called
(a) impulse
(b) torque
(c) couple
(d) angular momentum

76. When net torque acting on a system is zero, which of the following will be constant?
(a) force
(b) linear momentum
(c) angular momentum
(d) linear impulse

77. What is the ratio of the inertial mass to gravitational mass?
(a) 0.5 (b) 1
(c) 2 (d) 3

78. The dimensional formula for velocity gradient is identical to that of
(a) velocity
(b) time-period
(c) frequency
(d) angular acceleration

79. The momentum of a body decreases by 20%, the percentage decrease in K.E. will be
(a) 28% (b) 36%
(c) 44% (d) 56%

80. Choose the physical quantity whose dimensions are different from others?
(a) kinetic energy (K.E.)
(b) pressure energy
(c) moment of force
(d) moment of momentum

82. ML^2T^0 is dimensional formula for
(a) inertia
(b) energy
(c) moment of inertia
(d) moment of momentum

ANSWERS

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

II. NEWTON'S LAWS OF MOTION, GRAVITATION, WORK AND ENERGY

1. Initial velocity of a body moving with uniform acceleration of 5 m/s^2, is 10 m/s. What will be the distance covered in 10 sec?
(a) 150 m
(b) 250 m
(c) 350 m
(d) 450 m

(d) force

3. The action and reaction forces referred in Newton's third law of motion
(a) must act upon the same body
(b) must act upon different bodies
(c) must be equal in magnitude but need not have the same line of action
(d) need not to be equal in magnitude but must have the same line of action

4. If a person can thrown ball to a minimum height h (vertically up) then the maximum distance up to which he can throw the ball is
(a) h
(b) 2h
(c) 3h
(d) 4h

5. When a particle is thrown up, it will have
(a) different speed at the same height during ascent and during descent
(b) same speed at the same heights during ascent and during descent
(c) same speed at different heights during ascent and during descent
(d) different speed at different height during ascent and during descent

6. A carpet can be cleaned by beating. This is in accordance with Newton's
(a) first law
(b) second law
(c) third law
(d) none of the above

(c) 200 m/s
(d) 2000 m/s

8. Which law of motion explains the phenomenon of swimming?
   (a) first
   (b) second
   (c) third
   (d) none of these

9. What acceleration will a force of 5N produce in a mass of 5 kg?
   (a) 1 m/s^2
   (b) 25 m/s^2
   (c) 1 m/s
   (d) 25 m/s

10. A fielder caught a ball of 150 gm moving at a rate of 20 m/s. If the catching process was completed in 0.1 sec, the force of the blow exerted by ball on the hands was
   (a) 30,000 N
   (b) 30,000 N
   (c) 300 N
   (d) 30 N

11. When a body accelerates,
   (a) its direction always changes
   (b) its mass always
   (c) its velocity always changes
   (d) it falls towards the earth

12. A rope attached to a post in the ground is pulled horizontally with a force of 100 N. The pole pulls back with a force of
   (a) 25 N
   (b) 50 N
   (c) 100 N
   (d) 200 N

(d) accelerate

14. If the initial velocity, the distance travelled and the time elapsed are known, which equation would you use to find acceleration?
   (a) $v_f = v_i + at$
   (b) $v_f^2 - v_i^2 = 2as$
   (c) $s = v_i t + \frac{1}{2} at^2$
   (d) $s = vt$

15. Which of the following will not accelerate?
   (a) the moon in its orbit
   (b) a tennis ball rebounding from ground
   (c) a stone in free fall
   (d) a car in which the engine thrust is equal to the friction

16. A body is moving with a velocity of V_1 m/s and after to seconds, the velocity changes to V_2 m/s. The average acceleration of body will be
   (a) $\frac{V_1 - V_2}{t}$ m/s^2
   (b) $\frac{V_2 - V_1}{t}$ m/s^2
   (c) $\frac{V_1 - V_2}{t}$ m/s^2
   (d) $V_1 + V_2 = m/s^2$

17. A car accelerates for 105 at 6 m/s^2. What is its final speed if its initial was 4 m/s?
   (a) 30 m/s
   (b) 60 m/s
   (c) 34 m/s
   (d) 64 m/s

(b) $40\sqrt{2}$ miles/hr E – s
(c) 80 miles/hr E – s
(d) none

19. A force of 6N acts on a body of mass 1 kg during which the body attains a velocity of 30 m/s. The time for which the force acts on a body is
(a) 26 seconds
(b) 5 seconds
(c) 6 seconds
(d) 2 seconds

20. Which of the following is not necessary for work to be done?
(a) a constant speed
(b) an applied force
(c) a displacement
(d) force component along the displacement

21. A body at rest may have
(a) speed
(b) momentum
(c) energy
(d) velocity

22. What is the weight of 10 kg block?
(a) 10 N
(b) 9.8 N
(c) 98 N
(d) 0.98 N

23. A fixed pulley is employed to
(a) same work
(b) change the direction of force
(c) do more work with the same force but without using the pulling
(d) have mechanical advantage greater than one
(d) all of the above

25. The static friction is
(a) always equal to dynamic friction
(b) always less than dynamic friction
(c) always greater than dynamic friction
(d) sometimes greater and sometimes less than the dynamic friction

26. The force of friction that comes into action after the motion has started is known as
(a) static friction
(b) dynamic friction
(c) friction only
(d) limiting friction

27. A body in equilibrium may not have
(a) velocity
(b) momentum
(c) acceleration
(d) kinetic energy (K.E.)

28. A body is termed as perfectly elastic if
(a) it can move freely
(b) its surface is perfectly smooth
(c) it is not affected by external force
(d) it recovers its original shape when the deforming force is removed

29. If two bodies undergo a collision that is not perfectly elastic, then
(a) K.E. is conserved but momentum is not
(b) momentum is conserved but K.E. is not
(c) neither K.E nor momentum is conserved
(d) both K.E. and momentum are conserved

(d) a decreasing distance

31. If the average velocity of an object is zero in some time interval, the displacement of the object for that interval will be
    (a) infinite
    (b) zero
    (c) increasing
    (d) decreasing

32. A car is moving at constant speed toward the east, on a free way. Its acceleration is
    (a) zero
    (b) positive
    (c) negative
    (d) infinite

33. The average velocity depends on the
    (a) displacement vector and not on the path covered
    (b) both displacement vector and on the path travelled
    (c) neither displacement vector nor the path traveleld
    (d) none of these

34. The magnitude of the instantaneous velocity is called the
    (a) displacement
    (b) speed
    (c) acceleration
    (d) length

35. The path of a projectile is a
    (a) triangle
    (b) circle
    (c) ellipse
    (d) parabola

37. In the absence of non-zero net force, the center of mass of a body either remains at rest, or moves at a constant speed in a straight line. This is a statement of Newton's
    (a) first law of motion
    (b) second law of motion
    (c) third law of motion
    (d) none of the above

38. The acceleration of an object is proportional to the net force acting on it and inversely proportional to its mass. This is a statement Newton's
    (a) first law of motion
    (b) second law of motion
    (c) third law of motion
    (d) all of the above

39. The total force applied on a body is equal to the time derivative of a linear momentum of the body. This is Newton's
    (a) Ist law of motion
    (b) 2nd law of motion
    (c) 3rd law of motion
    (d) none of the above

40. Which law of motion is sometimes referred to as the action-reaction law?
    (a) 1st law of motion
    (b) 2nd law of motion
    (c) 3rd law of motion
    (d) none of the above

41. The three laws of motion were first publishes in 1687 by Sri Isaac Newton in his work
    (a) Method of Fluxions (b) Optics
    (c) Philosophie Naturalis Principia Mathematica
    (d) Arithmetic Uniersalis

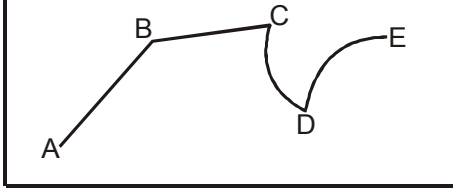
(c) third law
(d) none of the above

43. Newton's third law fails in certain cases of
(a) electrostaties
(b) electronics
(c) springs
(d) both a and b

44. If two different masses have same momentum, then the lighter one has more
(a) K. E. (also more velocity)
(b) potential energy (P.E.)
(c) both K.E. and P.E.
(d) none of the above

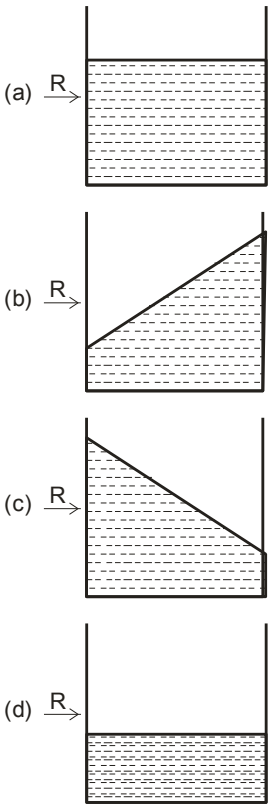
45. Two bodies of 1 kg and 4 kg are moving with equal K.Es. The ratio of the magnitudes of their linear momenta is
(a) 1: 4
(b) 8: 1
(c) 1 : 16
(d) 1 : 2

46. Which of the following is the magnitude of the gravitational force and is not the inherent property of body?
(a) mass
(b) weight
(c) speed
(d) length



(a) AB
(b) BC
(c) CD
(d) DE

48. A jar containing water in placed in a train. The train accelerates from left to right. Which of the following figures shows the water level in a jar correctly?



(a) A will go higher than B
(b) B will go higher than A
(c) the two bodies will reach the same height
(d) none of the above

50. Superman throws a 2400-N boulder at an adversary. What force must be apply to that stone to give it a horizontal acceleration of 12 m/s^2?
(a) 244 N
(b) 294 N
(c) 2940 N
(d) 29400 N

51. If the vector sum of forces on a body is not zero, the body
(a) accelerates
(b) decelerates
(c) remains at rest
(d) none of the above

52. Planets move around the sun due to
(a) centrifugal force
(b) centripetal force
(c) gravitational pull between them
(d) none of the above

53. Two bullets A and B have masses 1kg and 2kg respectively.
(a) the k.E of B wil be twice that of A
(b) the K.E. of A will be twice that of B
(c) K.E. will be the same
(d) none of the above

54. Both linear momentum and K.E. are conserved in
(a) elastic collision
(b) inelastic collision
(c) both of the above
(d) none of the above

(d) none of the above

56. The velocity of an object when projected from the earth in order to escape the earth's gravitational field is called the
(a) terminal velocity
(b) average velocity
(c) instantaneous velocity
(d) escape velocity

57. Which of the following is not an elastic collision?
(a) a man jumps on a cart
(b) a bullet embedded in a block
(c) collection of two glass balls
(d) none of the above

58. A shell explodes and many pieces fly off in different directions. The following is conserved
(a) momentum
(b) K.E.
(c) both of the above
(d) none of above

59. When the velocity of a body is doubled, which one is doubled too?
(a) K.E.
(b) acceleration
(c) momentum
(d) P.E.

60. K.E. of a body of mass m and momentum p is given by
(a) p^2m
(b) $m^2/2p$
(c) mp
(d) $p^2/2m$

(c) double
(d) four times

62. Two bodies of mass m_A and m_B have equal K.E.. The ratio of their momentum is
(a) $\sqrt{m_A}:\sqrt{m_B}$
(b) $m_A:m_B$
(c) $m_A^2: m_B^2$
(d) $m_B: m_A$

63. Which of the following quantities is zero about the centre of mass of a body?
(a) mass
(b) acceleration
(c) moment
(d) angular acceleration

64. Where should be the center of gravity of a body?
(a) it must be within the body
(b) it may be near but not essentially within the body
(c) it must be outside the body
(d) it changes its position after some time

65. If the earth stopped rotating, the weight of objects at either pole would
(a) be greater
(b) be less
(c) vary with latitude
(d) be the same before

66. The force of gravity between two objects does not depend upon
(a) the constant of gravitation
(b) the separation
(c) the product of their masses
(d) the sum of their masses (SHM)
(d) simple harmonic motion

68. The escape velocity
(a) is independent of mass of the body
(b) increases with the increase of mass of the body
(c) decreases with the decrease of the body mass
(d) depends upon the type of body used

69. What will happen to the force of gravity if the mass of one of the objects is tripled?
(a) triple the original force of gravity
(b) divide by 1/3rd of the original gravitational force
(c) the gravitational force will remain the same
(d) none of the above

70. If you have a hocky puck sliding along a table, it will eventually come to a stop. Which Newton's law this example illustrate?
(a) Ist (b) 2nd
(c) 3rd (d) none of these

71. Which Newton's law states the need to wear seatbelts?
(a) Ist law
(b) 2nd law
(c) 3rd law
(d) none of these

72. What is another name of the Newton's Ist law?
(a) law of mass
(b) law of inertia
(c) law of velocity
(d) law of acceleration

(c) 3rd (d) none of these

74. German astronomer Kepler described the motion of planets in ———— laws
(a) 2 (b) 3
(c) 4 (d) 5

75. Which law of Kepler states that the planets revolve around the sun in then elliptical orbits with sun at one of the two foci?
(a) Ist (b) 2nd
(c) 3rd (d) none of these

76. Which of the Kepler's law is called the harmonic law?
(a) Ist (b) 2nd
(c) 3rd (d) none of these

77. A region of space from which nothing (not even light) can escape is called
(a) nova
(b) black hole
(c) white hole
(d) none of these

78. What is the period of geostationary satellite?
(a) 0 hour
(b) 12 hours
(c) 18 hours
(d) 24 hours

79. A wheel is 1m in diameter. When it makes 30 RPM the linear speed of a point on its circumference (in m/s) is
(a) π (b) $\pi/2$
(c) 30π (d) 60π

80. The angular speed of the second's hand of a watch in rad/see is
(a) π (b) $\pi/3$
(c) $\pi/2$ (d) $\pi/30$

17. d	18. d	19. b	20. a
21. c	22. c	23. b	24. d
25. d	26. d	27. c	28. d
29. b	30. a	31. b	32. a
33. a	34. b	35. d	36. d
37. a	38. b	39. b	40. c
41. c	42. c	43. d	44. a
45. d	46. b	47. a	48. c
49. a	50. c	51. a	52. b
53. a	54. a	55. b	56. d
57. c	58. a	59. c	60. d
61. c	62. a	63. c	64. b
65. d	66. d	67. b	68. d
69. a	70. a	71. a	72. b
73. a	74. b	75. a	76. c
77. b	78. d	79. b	80. d

III. FLUID MECHANICS

1. Viscosity in fluids refers to
(a) the density of a fluid
(b) the compresibility of a fluid
(c) tangential force exerted on solid surface by the flowing fluid
(d) normal forces exerted on solid surface by the flowing fluid

2. Viscosity is a measure of the resistance of a fluid that is being deformed by either shear stress or tensile stress. Which of the following is more viscous?
(a) air (b) honey
(c) ketchup (d) water

3. Which law states that the pressure change in a confined incompressible fluid is transmitted equally in all directions throughout the fluid and to the walls of the container?
(a) Ohm's law
(b) Pascal's law
(c) Kirchoff's law
(d) Newton's law

(d) surface tension

5. Which principle states that for an ideal fluid, an increase in the speed of fluid occurs stimultaneously with a decrease in fluid's pressure or P.E.?
   (a) Bernulli's principle
   (b) Archimedes' principle
   (c) both of the above
   (d) none of the above

6. The nib of fountain pen is split to convey ink down the nib by the phenomenon of
   (a) Adhesion
   (b) Cohesion
   (c) Osmosis
   (d) Capillary

7. The buoyancy depends upon the
   (a) depth to which the body is immersed
   (b) shape of the body
   (c) mass of body
   (d) mass of the liquid displaced

8. Which principle states that buoyant force on a submerged object is equal to the weight of the fluid displaced by the object
   (a) Bernoulli's principle
   (b) Archimedes' law
   (c) both of the above
   (d) none of the above

9. Bernoulli's equation includes a special case of
   (a) Archimede's law
   (b) Hooke's law
   (c) Torrcelli's law
   (d) Newton's law

(d) the compressibility of a fluid

11. Turbulent flow of a fluid occurs when the Reynold number is a above about
   (a) 1000
   (b) 2000
   (c) 3000
   (d) 4000

12. Fluid flows a laminar for Reynold numbers up to
   (a) 500 (b) 1000
   (c) 2000 (d) 4000

13. For the Bernoulli's theorem to the applicable, the fluid flow should be
   (a) rotational and compressible
   (b) irrational and incompressible
   (c) irrotational (non-trubulent) and compressible
   (d) irrotational and incompressible

14. The ratio of the speed of an object moving through air to the speed of sound is called
   (a) Reynold number
   (b) Mach number
   (c) Avogadro's number
   (d) Feigenbaum number

15. Surface tension of a liquid may be defined as
   (a) heat energy per unit area
   (b) potential energy per unit area
   (c) surface energy per unit area
   (d) kinetic energy per unit area

16. Powder clings to the face due to
   (a) compression
   (b) capillary action
   (c) cohesion
   (d) adhesion

flow, turbulent

(c) nonviscous, compressible, steady flow, turbulent

(d) nonviscous, incompressible, steady flow, turbulent

18. A beaker is full of water with an ice piece floating. The ice piece has a lead piece in it. When ice cube melts them
    (a) water overflows
    (b) level falls
    (c) level remains unchanged
    (d) none of these

19. The velocity at which laminar (steady) flow changes to turbulent (eddy) flow is called
    (a) terminal velocity
    (b) escape velocity
    (c) critical velocity
    (d) uniform velocity

20. The Magnus effect is equivalent to
    (a) Bernoulli's theroem
    (b) Archimedes' principle
    (c) Pascal's law
    (d) none of these

21. The viscosity of an ideal fluid is
    (a) infinity
    (b) unity
    (c) zero
    (d) 0.5

22. Out of the following, the maximum viscosity is of
    (a) oxygen
    (b) mercury
    (c) water
    (d) glycerine

24. The absolute viscosity of a fluid is primarily function of
    (a) density
    (b) temperature
    (c) pressure
    (d) velocity

25. Fluid mechanics is the study of how fluids move and the ———— on them.
    (a) energy
    (b) velocity
    (c) forces
    (d) position

26. Birds, planes and boats are streamlined to reduce
    (a) turbulence
    (b) thrust
    (c) lift
    (d) drag

27. Any substance that can flow is a
    (a) solid
    (b) gas
    (c) liquid
    (d) fluid

28. The design of an airfoil uses
    (a) Archimedes' principle
    (b) Bernoulli's principle
    (c) both of the above
    (d) none of the above

29. The force that moves a rocket or a plane forward is called
    (a) lift
    (b) drag
    (c) turbulence
    (d) thrust

(d) Archimedes

31. Which force pushes up a body in a fluid?
    (a) thrust
    (b) lift
    (c) buoyant
    (d) pressure

32. When air moves an airfoil, ———— is generated
    (a) thrust
    (b) lift
    (c) drag
    (d) turbulence

33. The study of the deformation and flow of matter, primary in the liquid state is called
    (a) Rheology
    (b) Geology
    (c) Physiology
    (d) Cosmology

34. In flow through a straight, smooth, pipe, the critical Reynolds number for transition to turbulence is generally taken to be
    (a) 1500
    (b) 2300
    (c) 4000
    (d) 10,000

35. Minor losses through valves, fittings, bends, etc., are modelled as proportional to
    (a) velocity head
    (b) static head
    (c) total head
    (d) pressure drop

(d) first increases then decreases

37. A gas behaves as an ideal gas at
    (a) low pressure and high temperature
    (b) high pressure and low temperature
    (c) low pressure and low temperature
    (d) high pressure and high temperature

38. The colour of a star is an indication of its
    (a) size
    (b) weight
    (c) temperature
    (d) distance from the earth

39. What is measured by a Bolometer?
    (a) specific heat
    (b) thermal conductivity
    (c) heat radiation
    (d) e.m.f.

40. Newton's law of cooling is a special case of
    (a) Stefan's law
    (b) Wien's law
    (c) Kirchoff's law
    (d) Planck's law

41. What is the absorption power of perfect black body?
    (a) 1 (b) -1
    (c) 0 (d) infinity

42. The spectrum of a black body is
    (a) line
    (b) band
    (c) continuous
    (d) none of the above

17. a	18. b	19. c	20. a
21. c	22. d	23. a	24. b
25. c	26. d	27. d	28. b
29. d	30. d	31. c	32. b
33. a	34. b	35. a	36. a
37. a	38. c	39. c	40. a
41. a	42. c		

IV. PERIODIC MOTION

1. Which law states in simple terms that stress (force per unit area) is directly proportional to strain (fractional deformation)?
   (a) Newton's
   (b) Hooke's
   (c) Kepler's
   (d) Ohm's

2. In simple harmonic motion (SHM), we have the conservation of
   (a) kinetic energy
   (b) potential energy
   (c) total energy
   (d) electrical energy

3. The angular frequency, time period and frequency in SHM does not depend upon
   (a) mass
   (b) force constant
   (c) amplitude
   (d) all of the above

4. The angular frequency, time period and frequency of a simple pendulum depends only on the
   (a) mass and amplitude
   (b) mass and acceleration (g)
   (c) amplitude and mass
   (d) length (L) and acceleration (g)

(b) velocity
(c) time
(d) frequency

6. A body that undergoes simple harmonic motion is called a harmonic
   (a) oscillator
   (b) amplifier
   (c) pendulum
   (d) none of the above

7. Which of the following physical systems are examples of simple harmonic oscillator?
   (a) mass on spring
   (b) mass on a pendulum
   (c) uniform circular motion
   (d) all of the above

8. The period of pendulum is determined by its
   (a) mass
   (b) amplitude
   (c) speed
   (d) length

9. SHM may be assumed as a projection of uniform circular motion along a
   (a) diagonal
   (b) hypotenuse
   (c) radius
   (d) diameter

10. A body experiences SHM with an amplitude. When this body is at its maximum displacement its phase is
    (a) $\pi/4$
    (b) $\pi/2$
    (c) π
    (d) 2π

(d) none of the above

12. Two particles are executing SHM of same period. If the second particle starts form mean position T/2 later than the first the phase difference between the two particles at any instant of time is

(a) $\frac{3\pi}{2}$ (b) $\frac{\pi}{4}$

(c) $\frac{\pi}{2}$ (d) π

13. The total energy of a body executing SHM is directly proportional to
(a) the amplitude
(b) the square of the amplitude
(c) square root of the amplitude
(d) reciprocal of the amplitude

14. The circular motion of a particle with constant speed is
(a) periodic and SHM
(b) periodic and SHM
(c) periodic but not SHM
(d) neither periodic nor SHM

15. Two SHM are represented by $y_1 = 0.1 \sin (100 \pi t + \pi/3)$ and $y_2 = 0.1 \cos \pi t$. The phase difference of the velocity of 1st with respect to 2nd is

(a) $\frac{\pi}{3}$ (b) $\frac{\pi}{2}$

(c) $\frac{\pi}{6}$ (d) $\frac{\pi}{6}$

16. If E is the total energy of a particle experiencing SHM and A is the amplitude; the E and A are related as

(a) $E \propto \frac{1}{A_2}$

17. The displacement of particle in SHM in one time period is
(a) zero
(b) a
(c) 2a
(d) 4a

18. The frequency of SHM is 100 Hz. Its time period is
(a) 0.1 s
(b) 0.01 s
(c) 1s
(d) 100 s

19. Which of the following is not essential for the free oscillation of a mass attached to a spring?
(a) elasticity
(b) gravity
(c) inertia
(d) restoring force

20. Which of the following quantities associated with SHM do not vary periodically?
(a) velocity
(b) displacement
(c) acceleration
(d) total energy

21. What is the number of degrees of freedom of an oscillating simple gravity pendulum?
(a) 1 (b) 2
(c) 3 (d) 4

22. The graph between restoring force and time in SHM is
(a) straight line
(b) parabola
(c) sine curve
(d) circle

(c) 2π (d) 0

24. What is the time period of a seconds pendulum?
(a) 1 sec (b) 2 sec
(c) 3 sec (d) 4 sec

25. The time period of the hour hand of a watch is
(a) 1 h (b) 6 h
(c) 12 h (d) 24 h

26. The curve between the acceleration and velocity of body in SHM is a(an)
(a) circle
(b) parabola
(c) ellipse
(d) triangle

27. Which of the following exhibits chaotic behaviour?
(a) double pendulum
(b) inverted pendulum
(c) pendulum
(d) none of the above

28. The potential energy of a simple pendulum at rest is 10 J and its mean kinetic energy is 5 J. Its total energy at any instant will be
(a) 5 J (b) 10 J
(c) 15 J (d) 20 J

29. The time period of a torsional pendulum is
(a) $T = \pi\sqrt{\frac{C}{I}}$ (b) $T = 2\pi\sqrt{\frac{C}{I}}$
(c) $T = 2\pi\sqrt{\frac{I}{C}}$ (d) $T = \pi\sqrt{\frac{I}{C}}$

(d) nonconservative

31. The time period of the second's hand of a watch is
(a) 1 s (b) 1 min
(c) 1 h (d) 12 h

32. The mean kinetic energy of a harmonic oscillator with respect to position is
(a) $\frac{Ka^2}{2}$ (b) $\frac{Ka^2}{3}$
(c) $\frac{Ka^2}{4}$ (d) $\frac{Ka^2}{6}$

33. What is the maximum time period of a simple pendulum?
(a) 84.6 min
(b) 1 day
(c) 12 h
(d) 1 year

34. The differential equation representing SHM of a particle is $\frac{d^2y}{dt^2} + \omega^2 y = 0$
(a) ω (b) $\frac{\omega}{\pi}$
(c) $\frac{\omega}{2\pi}$ (d) $2\pi\omega$

35. The equation of a harmonic oscillator is given by $\frac{d^2y}{dt^2} + ky = 0$, where k is a positive constant. What is the time period of motion?
(a) $\frac{2\pi}{k}$ (b) $2\pi k$
(c) $\frac{2\pi}{\sqrt{k}}$ (d) $2\pi\sqrt{k}$

(b) $a - b$

(c) $a^2 + b^2$

(d) $\sqrt{a^2 + b^2}$

37. A spring of force constant k is cut into three equal parts. The force constant of earth part will be

(a) k (b) 3k

(c) $\frac{k}{3}$ (d) zero

38. A particle is executing SHM with an amplitude 4 cm. At what displacement its energy is half kinetic and half potential?

(a) 2 cm (b) 1 cm

(c) $\sqrt{2}$ cm (d) $2\sqrt{2}$ cm

39. A particle executing SHM has velocity 10 cm/s and 8 cm/s at distances 4 cm and 5 cm respectively. The period of

40. A simple pendulum suspended from the ceiling form a lift has a period T, when the lift falls freely, the time-period of pendulum will become

(a) zero (b) $\frac{T}{9.8}$

(c) 9.8 T (d) infinity

ANSWERS

1. b	2. c	3. c	4. d
5. a	6. b	7. d	8. d
9. d	10. b	11. b	12. d
13. b	14. c	15. d	16. d
17. a	18. b	19. b	20. d
21. b	22. c	23. b	24. b
25. c	26. c	27. a	28. b
29. c	30. c	31. b	32. b
33. a	34. c	35. c	36. d
37. c	38. d	39. a	40. d

SIMPLE HARMONC MOTION, MECMANICAL WAVES SOUND & HEARING.

SIMPLE HARMONIC MOTION (SHM)

Concepts and equation

Periodic Motion: If a moving body repeats its motion after regular intervals of time, the motion is said to be **harmonic or periodic.** The time interval after which it repeats the emotion is called **time period.** If the body moves **to and fro** on the same path, the motion is called **oscillatary.** In simple harmonic motion the particle moves in a straight line or along the angle and the acceleration of the particle is always directed towards a fixed point on the line. This fixed point is called means position or centre of oscillation. The acceleration in SHM is given by

$a = -(w^2x$ or $F = -mw^2x$ or $F = -kx$

where $k = m\omega^2$ is called force constant or spring constant.

The force which brings the particle back towards the equilibrium or mean position is called "restoring force". Such a motion is also called "isochronous".

SHM may be assumed as a **projection of uniform circular on along a diameter**

$x = r\cos\ \omega t$; $y = r\sin\omega t$; $a = -\omega^2 x$

or $\frac{d^2x}{dt^2} = -\omega^2 x$. This differential equation gives the solution

$x = x_o \sin \omega t$ (if the particle starts from mean position)

Fig

Fig 2.1

$x = x_o \cos\ \omega t$ (if the particle starts from extreme position)

$x = x_o \sin (\omega t \pm \phi)\}$ (if the particle starts in between mean and extreme position)

$x = x_0 \cos(\omega t \pm \phi))$.

The solution of differential equation in exponential form is $x = x_o^{\pm(\omega t \pm \phi)}$

Here x is instantaneous displacement, x_o is amplitude (maximum displacement), ϕ is initial phase angle or epoch or angle of repose and, ω is angular frequency.

Linear frequency $f = \frac{1}{T} = \frac{\omega}{2\pi} T$ being time period.

Velocity of the particle executing SHM

Assume $x = x_o \sin \omega t$. then $v = \frac{dx}{dt}\ x_o$ $\omega \cos \omega t$

$V = x_o\omega\ \sqrt{1-\sin^2 \omega t} = \omega\sqrt{x_o^2 - x^2}$

time.

Fig

Fig 2.2 (a) Velocity — displacement graph

fig

Fig 2.2 (b) Velocity — time graph

Fig. 12.3 (a) and (b) shows graph between acceleration .and displacement and acceleration and time

fig

Fig 2.3 **(a)** Acceleration — displacement graph

Fig

Fig 2.3 (b) Acceleration — time graph

N.B. The graph between velocity and acceleration is an ellipse.

N.B: Velocity leads the displacement by $\frac{\pi}{2}$

but velocity lags the acceleration by $\frac{\pi}{2}$

$a_{max}\ x_o\ \omega^2$

$v = x_o\ \omega \cos \omega t$

$\frac{dv}{dt} = -\ xo\ \omega^2\ \sqrt{1-\cos^2 wt}$

or $a = -\ \omega^2 x$, $amax = \omega^2 x_o$

$a = -\ \omega \sqrt{(x_o\omega)^2 - (x_o\omega \cos \omega t}$

$a = -\ \omega\ \sqrt{v_o^2 = 1}$

or $\frac{a^2}{\omega^2 v_o^2} + \frac{v^2}{v_o^2} = 1$

N.B: Velocity is manimum at mean position and acceleration is zero at mean position. Velocity is zero at extreme position and acceleration is maximum at extreme position. Kinetic energy *(KE)* of a particle executing SHM = $\frac{1}{2}\ m\omega^2\ (x^{o^2} - x^2$

Potential energy *(PE)* of a particle executing SHM = $\frac{1}{2}\ m\omega^2 x^2$.

Total energy = *KE* + *PE* = $\frac{1}{2} - m\omega^2 x^2$

Fig

Fig 2.4 KE, PE and total energy depiction.

In SHM, velocity displacement curve is an ellipse, see Fig. 2.5

Fig

Fig. 2.5 (a) Velocity displacement graph

$x = x_o \sin \omega t;$

$v = x_o \omega \cos \omega t$

or $\frac{x}{x_0} = \sin \omega t$

$\frac{x}{x_0 \omega} = \cos \omega t$

Square and add (1) and (2)

$$\frac{x^2}{x_0^2} + \frac{v^2}{x_0^2 \omega^2} = 1$$

acceleration – velocity relationship in SHM is an ellispe

$a = - \omega^2 x_o \sin \omega t;$

$\nu = x_o \omega \cos \omega t$

Fig

Fig 2.5 (b) Acceleration – velocity graph

If a tunnel is dug in the earth diametrically or along a chord irrespective of its position or angle then $T = 2\pi \sqrt{\frac{R}{g}}$ = 84 min 36 s for a particle released in the tunnel. See Fig. 2.6

Fig

Fig 2.6 SHM in tunnel in the earth

If a point charge q is tunneled in a uniformly charged sphere having charge Q and radius R then

$$T = 2\pi \sqrt{\frac{4\pi\varepsilon_0 R^3 m}{Qq}}$$

Fig

Fig 2.7

Angular SHM A body free to rotate about a given axis can make angular oscillations when it is slightly pushed aside and

(b) The body is displaced through an angle fro the mean position, a resultant torque α θ (angular displacement) acts.

(c) The nature of the torque (clockwise or anticlockwise) is to bring the body towards means position.

$R = - k \theta$ i.e

$\alpha \ell = - k \theta$ or $\alpha = - \frac{k}{\ell} \theta$

$\alpha = - w^2 \theta$

$w = \sqrt{\frac{k}{\ell}}$ or $T = 2\pi \sqrt{\frac{\ell}{k}}$

solution of the equation $\alpha = - \omega^2 \theta$ is

$\theta = \theta_o \sin \omega t$ if the particle starts from mean position

$\theta = \theta_o \sin \omega t$ if the particle starts from extreme position

$\theta = \theta_0 \sin (\omega t \pm \phi)$ if the particle starts from in between mean and extreme.

$\theta = \theta_0 \cos (wt \pm \phi)$ $\Omega = \frac{d\theta}{dt} = \theta_o \omega \cos \omega t$

Pendulums may be of 5 types: **simple pendulum, spring pendulum, conical pendulum, physical or compound and torsional pendulum.** Note the time period of each of them.

(fig.)

Fig 2.8 (a) Simple Pendulum

$\theta = \theta_0$

Fig 2.8 (b) Spring Pendulum

$$T = 2\pi \sqrt{\frac{M}{k}}$$

N.B: No effect of 'g' on spring pendulum.

Fig. 2.8 (c) Conical Pendulum

$$T = 2\pi \sqrt{\frac{h}{g}}$$

or $$T = 2\pi \sqrt{\frac{L \cos \theta}{g}}$$

$$T = 2\pi \sqrt{\frac{\ell}{mg\ell}}$$

or $$T = 2\pi \sqrt{\frac{k^2 + 1^2}{\ell g}} 2\pi \sqrt{\frac{(k+\ell)^2 - 2k\ell}{\ell g}}$$

Fig. 2.8 (d) Physical Pendulum

Fig

Fig. 2.8 (e) Torsional Pendulum

N.B: In physical pendulums T is maximum if $\ell = 0$ or $\ell = \infty$ and T is minimum if $k = \ell$.

Seconds pendulum: If the time period of a simple pendulum is 2s, it is called "seconds pendulum."

Longest time period (for $T = 2\pi\sqrt{\frac{1}{g\left(\frac{1}{I}+\frac{1}{R}\right)}}$ if $I \to \infty$ $T = 2\pi\sqrt{\frac{R}{g}}$ = 84 min. 36s. for an infinitely long simple pendulum) where R is radius of the earth.

If I = R, the radius of the earth then $T = 2\pi\sqrt{\frac{R}{2g}}$ = 60 min or 1h.

SHM under gravity: If SHM occurs due to restoring force provided by weight or acceleration due to gravity then $T = 2\pi\sqrt{\frac{\ell}{g}}$. Some of the examples of this

Fig.

fig..

(c) $T = 2\pi\sqrt{\frac{R}{g}}$ if ball does not roll

(d) $T = 2\pi\sqrt{\frac{\ell}{g}}$ but slips.

$T = 2\pi\sqrt{\frac{7(R-r)}{5g}}$ if the ball rolls.

Fig. 2.9

Effect of temperature on time period of simple pendulum

$\frac{T}{T_0} = \left[1+\frac{\alpha\Delta\theta}{2}\right]$ where α is linear expansion coefficient and $\Delta\theta$ negative or $\Delta T = T_o\left[\frac{\alpha\Delta\theta}{2}\right]$

If the upthrust of the liquid is taken into account. Then time period

$a = g = g\left(1-\frac{\sigma}{\delta}\right)$ Damping of liquid is assumed negligible.

If the suspended wire stretches due to elasticity then time period

$$T = 2\pi\sqrt{\frac{l}{g}}\left[1+\frac{Mg}{2\pi r^2 Y}\right]$$

fig.

or $$\Delta T = 2\pi\sqrt{\frac{l}{g}}\,\frac{Mg}{2\pi^{r2}Y}$$

or $\Delta T = \frac{Mg}{2\pi^{r2}Y}$ where $T = 2\pi\sqrt{\frac{l}{g}}$ and Y is young's modulus.

If a carriage (lift) is moving up with an acceleration 'a' carrying a pendulum then

fig..

$$T = 2\pi\sqrt{\frac{l}{g+a}}$$

Fig. 2.10

For spring system.

If the carriage (lift) moves down with an acceleration 'a' carrying the pendulum then.

$$T = 2\pi\sqrt{\frac{I}{(g-a)}}$$

If the carriage moves horizontally (e.g. a car) with an acceleration 'a' then

fig.

$$T = 2\pi\sqrt{\frac{I}{\sqrt{g^2+a^2}}}$$

If the carriage is in circular motion of radius R with uniform speed v then

fig..

$$T = 2\pi\sqrt{\frac{I}{\sqrt{g^2+\left[\frac{v^2}{r}\right]^2}}}$$

fig..

Fig. 2.11

fig.

fig..

Fig. 2.12

Fig. 2.13

Composition of two SHMs in same direction

$x_1 = x_{01} \sin \omega t$;

$x_2 = x_{02} \sin (\omega t + \theta)$

$x = x_0 \sin (\omega t + \phi) = x_1 + x_2$

$= x_{01} \sin \omega t + x_{02} \sin (\omega t + \theta)$

$x_0 = \sqrt{x_{01}{}^2 + x^2{}_{02} + 2x_{01}x_{02}\cos\theta}$ and tan ϕ

Composition of two perpendicular directions give rise to lissajous figures.

$x = x_o \sin \omega t$ or $\sin \omega t \ \frac{x}{x_0}$ and $\cos \omega t = \sqrt{1-\frac{x^2}{x_0^2}}$

$y = y_o \sin (\omega t + \phi)$

$= y_o \sin \omega t \cos \phi + y_o \cos \omega t \sin \phi$

$y = y_o \ \frac{x}{x_0} \cos \phi + y_o \sqrt{1-\frac{x^2}{x_0^2}} \sin \phi$

or $\left(\frac{y}{y_0} - \frac{x}{x_0}\cos\phi\right)^2 = \left(1-\frac{x^2}{x_0^2}\right) \sin^2 \phi$

or $\frac{y^2}{y_0^2} + \frac{x^2}{x_0^2} - \frac{2xy}{x_0 y_0} \cos \phi = \sin^2 \phi$

if $\phi = 0 \left(\frac{y}{y_0} - \frac{x}{x_0}\right)^2 = 0$ or $y = \frac{y_0}{x_0} x$, see Fig. 2.14 (a)

Fig. 2.14 (a)

If $0 < \phi = \frac{\pi}{2}$ for example $\phi = \frac{\pi}{4}$. Oblique elliqse as shown in Fig. 2.14 (b) is obtained.

Fig. 2.14 (b)

If $\phi = \frac{\pi}{2}$, elliqse is obtained and if $x_o = y_o$ the circle is obtained. See Fig. 2.15 (a) and (b)

Fig. 2.15

If $\phi = 180^o$ or π-radian then a straight line is obtained.

Fig. 2.16

Lissajous Figures: If the frequency of SHM in x-and y- direction are different then in Fig. 12.17 (a)

Fig. 2.17 (a)

$$\frac{\omega_x}{\omega_y} = \frac{n_y}{n_x}$$

Fig. 2.17 (b)

Types of oscillations: Oscillations may be of four types

(a) Free or natural or fundamental frequency.

(b) forced

(c) resonant

(d) damped

Free or natural oscillations depend upon dimensions and nature of the material (elastic constant).

If a periodic force of frequency other than the natural frequency of the material is applied then **forced oscillations result.**

For example if $y = y_0 \sin wt$ was the equation of SHM of a particle and a periodic force $p \sin \omega_1 t$ is applied ($\omega \neq \omega_1$)then $y = y_0 \sin \omega t + p \sin \omega_1 t$. The resultant frequency is different from natural frequency of oscillation

Resonant oscillation are a special kind of forced oscillation in which frequency of the source = frequency of the applied force, i.e., $y = y_0 \sin \omega t + p \sin \omega t = (y_0 + p) \sin \omega t$. That is amplitude increases or intensity increases or intensity increases with resonance. In damped oscillations amplitude of vibrations falls with time as shown in Fig. 2.18.

Fig.

Fig. 2.18

Amplitude at any instant is given by = $y = y_0 e^{-bt}$ where is amplitude of first vibration and y is amplitude at time t and is damping coefficient.

Damped harmonic motion

$$\frac{md^2x}{dt^2} + r\frac{dx}{dt} + kx = 0$$

or $$\frac{d^2x}{dt^2} + \frac{r}{m}\frac{dx}{dt} + \frac{k}{m}x = 0$$

or $$\frac{d^2x}{dt^2} + 2b\frac{dx}{dt} + \omega^2 x == 0$$

where $b = \frac{r}{2m}$ is called damping coefficient.

$$x = \frac{x_0}{2} e^{-bt}\left[\left(1+\frac{b}{\sqrt{b^2-\omega^2}}\right)e^{t\sqrt{b^2-\omega^2}}\right] + \left[\left(1-\frac{b}{\sqrt{b^2-\omega^2}}\right)e^{-1\sqrt{b^2-\omega^2}}\right]$$

gives amplitude at any instant.

If $\frac{r}{2m} > \sqrt{\frac{k}{m}}$ or $b > \omega$ motion is over damped and non-oscillatory.

If $\frac{r}{2m} = \sqrt{\frac{k}{m}}$ or $b = \omega$ motion is critically damped and $x = x_0 e^{-bt}$

$\sqrt{\omega^2 - b^2}$ $\sqrt{\frac{k}{m} - \frac{r^2}{4m^2}}$

If r = 0 motion is undamped and $T = 2\pi\sqrt{\frac{k}{m}}$

Wave Motion and Wave in a String

Three types of waves may be defined — mechanical, electromagnetic and matter waves as illustrated in Fig. 2.19. Here we are concerned with mechanical waves only.

Fig. 2.19 Waves description

A Wave is a disturbance which propagates energy from one place to the other without transporting matter. It is spread over region without clear-cut boundaries. It is not localized.

Diffraction It is a convincing proof of wave nature. It differentiates between particle nature and wave nature.

Mechanical waves require an elastic medium to progagate. Therefore, mechanical waves are also called **elastic waves.** Waves like electromagnetic and matter waves do not require any medium to propagate.

Shock waves are produced during earthquakes, volcanic eruptions, bomb blasts and during a sonic boom.

$y = y_0 (\omega t - kx)$ is the wave propagating along positive *x* direction.

Plane progressive wave is given by

$$y = y_0 \sin (\omega t - kx)$$

where *k* is called "propagation constant" or "wave number," ω is called "angular frequency," y_0 amplitude and v instantaneous displacement. Such a wave is called a "displacement wave."

A wave can have two types of velocities.

Wave velocity or phase velocity and group velocity or particle velocity

Wave velocity $v = \frac{dx}{dt} = \frac{w}{k} = f\lambda$

In a dispersive medium, wave travels with a group velocity

$$v_{group} = v - \lambda \frac{dv}{d\lambda}$$

MECHANICAL WAVES, SOUND AND HEARING

1. A disturbance that travels through space and time usually accompanied by energy transfer is called
   (a) wave
   (b) sound
   (c) frequency
   (d) length

2. A wave that consists of oscillation occurring perpendicular to the direction of energy transfer is called
   (a) transverse wave
   (b) longitudinal wave
   (c) stationary wave
   (d) shock wave

3. Wave that have the same direction of vibration as their direction of travel are termed
   (a) longitudinal waves
   (b) traverse waves
   (c) standing waves
   (d) hair waves

4. A water wave is an example of
   (a) transverse wave
   (b) longitudinal wave
   (c) stationary wave
   (d) shock wave

5. A sound wave is an instance of
   (a) transverse wave
   (b) longitudinal wave
   (c) hair wave
   (d) stationary wave

6. Which of the following is a transverse wave?
   (a) sound wave
   (b) shock wave
   (c) hair wave
   (d) radio wave

7. A wave that remains in a constant position is called
   (a) standing or stationary wave
   (b) transverse wave
   (c) shock wave
   (d) longitudinal wave

8. On average, there is no energy transfer in
   (a) sound waves
   (b) water waves
   (c) standing waves
   (d) mechanical waves

9. Which of the following refers to the distance from crest to crest of a wave?
   (a) frequency
   (b) wavelength
   (c) amplitude
   (d) period

10. The maximum displacement from the undisturbed position of the medium to the crest top is called
    (a) wavelength
    (b) amplitude
    (c) period
    (d) frequency

11. When waves go from one place to another, they transport
    (a) wavelength
    (b) period

ADMIN

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

13. A mechanical wave is a disturbance that travels through some material or substance called the ———— for the wave
(a) period
(b) medium
(c) frequency
(d) amplitude

14. The average amount of energy transported by a wave, per unit area per unit time is termed as
(a) wave speed
(b) wave intensity
(c) wavelength
(d) wave amplitude

15. The phase velocity is the velocity of a point that moves with a wave at constant phase. It is also called
(a) phase speed
(b) wave speed
(c) wave celerity
(d) all of the above

16. The addition of two or more waves is termed ————
(a) interference
(b) amplitude
(c) period
(d) frequency

17. The human ear is sensitive to waves in the frequency range also called the audible range from about 20 Hz to
(a) 200 Hz
(b) 2000 Hz
(b) timber
(c) pitch
(d) none of these

19. The loudness of a sound depends on its
(a) frequency
(b) amplitude
(c) both a and b
(d) neither a nor b

20. Which technique uses underwater sound propagation to detect and locate submerged objects?
(a) SONAR
(b) RADAR
(c) LIDAR
(d) none of the above

21. Sonography is an ultra-sound based imaging technique used for diagnosis. It uses sound waves of
(a) less than 20 kHz
(b) 20 kHz
(c) greater than 20 kHz
(d) none of these

22. The speed of sound is air at 20°C is
(a) 344 m/s
(b) 1402 m/s
(c) 1482 m/s
(d) 1543 m/s

23. During WWI, which device was used by submarines to detect targets while submerged?
(a) SONAR
(b) Microphone
(c) Hydrophone
(d) RADAR

25. Which of the following devices is used for playing sound recordings? (The other name of gramophone)
    (a) Phonograph
    (b) Headphone
    (c) Microphone
    (d) Amplifier

26. For polarization, the direction of oscillation has to be perpendicular to the direction of travel. Sound waves are longitudinal waves so they cannot be
    (a) reflected
    (b) deflected
    (c) diffracted
    (d) polarized

27. Transverse waves only propagate in
    (a) liquids (b) solids
    (c) gases (d) all of the above

28. Wave motion in air consist of
    (a) longitudinal waves
    (b) transverse waves
    (c) seismic waves
    (d) polarized waves

29. In an oscillating system, damping is reduction in
    (a) frequency
    (b) wavelength
    (c) amplitude
    (d) period

30. Which physical property is most responsible for resonance?
    (a) frequency
    (b) intensity
    (c) pitch
    (d) loudness

(d) harmony

32. A sonometer is also called "monochord" because it often has
    (a) one string
    (b) two strings
    (c) three strings
    (d) four strings

33. An ———— is any frequency higher than the fundamental frequency of a sound
    (a) overtone (b) beat
    (c) acoustics (d) shockwave

34. Which field of science deals with the study of all mechanical waves including vibrations sound?
    (a) electronics
    (b) acoustics
    (c) robotics
    (d) statistics

35. A ———— is an interference between two sounds of slightly different frequencies
    (a) shockwave
    (b) beat
    (c) sonic boom
    (d) none of them

36. The amplitude of a vibrating body at resonance placed is vacuum is
    (a) zero (b) maximum
    (c) minimum (d) infinite

37. Beats occur due to
    (a) reflection
    (b) refraction
    (c) interference
    (d) none of the above

(d) none of the above

39. How many antinodes must be there between two nodes?
(a) 1 (b) 2
(c) 3 (d) 4

40. The note of the lowest frequency is called the
(a) beat
(b) overtone
(c) fundamental note
(d) none of the above

41. What is the velocity of sound in vacuum?
(a) 768 mph
(b) zero
(c) 3136 mph
(d) 3315 mph

42. A bomb explodes on the Mars. How long it will take for the sound to reach the earth?
(a) 8 min
(b) 10 sec
(c) 0 sec
(d) 1 day

43. Two waves of same frequency having amplitudes a and 2a travelling in the same direction superimpose out of phase. What will be the resultant amplitude?
(a) a (b) 2a
(c) 3a (d) $\sqrt{a^2 + 2a^2}$

44. Which type of oscillations produce resonance?
(a) free (b) damped
(c) forced (d) none of these

46. What is the distance between a node and an antinode?
(a) λ (b) $\lambda/2$
(c) $\lambda/4$ (d) 2λ

47. The phase difference between the particles vibrating between two consecutive nodes is
(a) zero (b) $\frac{\pi}{2}$
(c) π (d) 2π

48. The ratio of frequencies in a stretched string is
(a) 1 : 2 : 3 (b) 1 : 3 : 5
(c) 3 : 2 : 1 (d) 2 : 4 : 6

49. What is the change in path, when sound wave is reflected from a rigid support?
(a) 2π (b) π
(c) $\pi/2$ (d) zero

50. What is the term used for the ratio of the speed of a body and speed of sound?
(a) Avogadro's number
(b) Mach number
(c) Feigenbum number
(d) Telephone number

51. In which of the following the speed of sound will be maximum under similar conditions?
(a) N_2 (b) O_2
(c) H_2 (d) CO_2

52. On which characteristics, the loudness of sound depends on?
(a) pitch
(b) amplitude
(c) speed

(c) 2 : 3 (d) 4 : 9

54. What is the best sound source to produces a pure note?
(a) flute
(b) tuning fork
(c) harmonium
(d) drum

55. In order to hear an echo, what is the minimum distance between the sound and reflecting surface?
(a) 0.65 m (b) 1.65 m
(c) 16.5 m (d) 165 m

56. What will be the sound speed if the frequency is doubled?
(a) zero (b) half
(c) double (d) unchanged

57. What is the shape of a pure tone?
(a) sinewave
(b) square wave
(c) sawtooth
(d) triangular wave

58. Which acoustical apparatus is used for measurement of the speed of sound in a gas or a solid rod?
(a) Melde's experiment
(b) Kundt's tube
(c) Michelson-Morley experiment
(d) Robert Milkan's oild-drop experiment

59. For which waves phenomenon of beats takes place?
(a) longitudinal waves
(b) transverse waves
(c) both longitudinal and transverse waves
(d) none of the above

(c) ultrasonic
(d) supersonic

61. Which characteristic successively increases in the musical scale?
(a) quality
(b) pitch
(c) loudness
(d) amplitude

62. If A is the amplitude of sound wave after covering a distance r, then
(a) $A \alpha \frac{1}{r^2}$ (b) $A \alpha \frac{1}{r}$
(c) $A \alpha r$ (d) $A \alpha r^2$

63. What will be the frequency if an empty vessel is filled with water?
(a) increases
(b) decreases
(c) remains unchanged
(d) none of the above

64. What is title for combination of notes that produce jarring effect on the ear?
(a) noise (b) melody
(c) harmony (d) discord

65. Mostly human ear cannot hear sound of intensity less than
(a) 10^{-3} W/m^2 (b) 10^{-6} W/m^2
(c) 10^{-12} W/m^2 (d) 10^{-15} W/m^2

66. What is term for the persistence of sound in a hall?
(a) resonance
(b) acoustics
(c) symphony
(d) reverberation

(d) Magnetostriction effect

68. Which phrase is used for reproduction of original sound?
(a) loyalty
(b) obedience
(c) fidelity
(d) conformity

69. Which analysis is employed to convert a complex sound into notes?
(a) Fourier theorem
(b) Milleman theorem
(c) Lissajoes theorem
(d) Demrogan's laws

70. Which law states that a musical sound is perceived by the ear as a set of a number of constituent pure harmonic tones?
(a) Kirchoff's law
(b) Ohm's acoustic law
(c) Faraday's law
(d) Hopeinson's law

71. The velocity of sound in water is ———— than that of air
(a) smaller
(b) greater
(c) unchanged
(d) none of the above

72. The beat frequency is the ———— of the two frequencies.
(a) sum (b) product
(c) difference (d) ratio

73. Which effect explains the frequency shift that occurs when there is motion of sound, a listener or both relative to the medium?
(a) Early effect
(b) Doppler effect

(b) radio waves
(c) both a and b
(d) none of the above

75. Which of the following is a mechanical wave?
(a) x-rays
(b) radio waves
(c) light
(d) sound

76. Which property of sound is not affected by change in air temperature?
(a) amplitude
(b) wavelength
(c) intensity
(d) frequency

77. As a man moves away form a steady source of sound at constant speed, the sound he hears will
(a) increase in frequency and intensity
(b) stay constant in pitch but decrease in loudness
(c) increase in frequency and intensity
(d) constant in both pitch and loudness

78. When the source and observer are moving away from each other the apparent pitch will
(a) increase (b) decrease
(c) be zero (d) be infinite

79. When wind blows in the same direction in which the sound travels, the sound velocity
(a) decreases
(b) increases
(c) remains constant

(c) remains constant
(d) none of the above

81. Who developed gramophone is 1877?
(a) Thomas Edison
(b) Graham Bell
(c) Isaac Newton
(d) Michael Faraday

82. What is the linear succession of musical tones that is perceived as a ring entity?
(a) harmony (b) noise
(c) melody (d) music

83. For how long the sensation of sound persists in our brain?
(a) 0.4 sec (b) 0.3 sec
(c) 0.2 sec (d) 0.1 sec

84. Which of the following is a conical-bore transposing musical instrument that is a member of the wood-wind family?
(a) telephone
(b) gramophone
(c) saxophone
(d) cell phone

85. What is a sound recording device used for recording speech for later playback or to be typed into print?
(a) saxophone
(b) gramophone
(c) telephone
(d) dictaphone

86. Due to which reason, echoes arise?
(a) refraction (b) diffraction
(c) reflection (d) dispersion

87. What is a sequence of musical notes in ascending and descending order
(d) Musical scale

88. Which two-pronged metal device when struck, produces a sound of constant pitch?
(a) force
(b) tuning fork
(c) samophone
(d) dictaphone

89. On which parameter, the path difference between two interfering waves depend upon?
(a) amplitude (b) pitch
(c) intensity (d) phase angle

90. To what forms of waves the phenomenon of interference applies?
(a) sinusoidal
(b) square
(c) triangle
(d) all of the above

91. Which of the following represents an elastic wave?
(a) light waves
(b) radio waves
(c) x-rays
(d) sound waves

92. When two identical (progressive) waves are super-imposed, the velocity of resultant wave
(a) increases
(b) decreases
(c) becomes zero
(d) remains unchanged

93. Which of the following properties of sound is affected by change in air temperature?
(a) frequency
(b) amplitude

(b) maximum
(c) minimum
(d) none of the above

95. What is the distance between two consecutive modes or antinodes in a stationary wavelength

(a) λ (b) $\frac{\lambda}{2}$

(c) $\frac{\lambda}{4}$ (d) $\frac{\lambda}{8}$

96. For every 1°C rise in temperature, the sound velocity
(a) increases by 61 cm/s
(b) decreases by 61 cm/s
(c) remains constant
(d) none of the above

97. The sound, velocity in moist air as compared to dry air will be
(a) more
(b) less
(c) same
(d) none of the above

98. Two sources of sound are said to be in resonance when,
(a) they look like similar
(b) they produce sound of same frequency
(c) they are enacted by the same agent
(d) none of the above

99. Beats are the result of
(a) diffraction of sound waves
(b) constructive and destructive interference
(c) both of the above
(d) none of the above

(c) polarisation
(d) any one of the above

101. A pulse on the string is inverted when it is reflected from
(a) fixed end
(b) free end
(c) free or fixed end
(d) none of the above

102. A body travels with a speed greater than the speed of sound. What would be the wavefront shape?
(a) elliptical
(b) spherical
(c) parabolical
(d) conical

103. Sweetness of sound depends on
(a) amplitude
(b) frequency
(c) velocity
(d) periodicity and regularity

104. The same notes being played on sitar and veena differ in
(a) pitch
(b) quality
(c) both quality and pitch
(d) neither quality nor pitch

105. When temperature increases, frequency of organ pipe
(a) decreases
(b) remains same
(c) increases
(d) becomes zero

106. An observer and a sound source are moving away from each other. The apparent pitch will
(a) remain the same
(b) increase

gradually

(a) red (b) violet

(c) green (d) blue

108. Doppler's principle applies to

(a) sound waves only

(b) light waves only

(c) neither sound nor light waves

(d) both sound and light waves

109. Two tuning forks have same natural frequency. One of them is now loaded with wax. When both the forks are sounded together, they will

(a) produce interference

(b) produce vibrations

(c) remain in resonance

(d) produce beats

110. In which of the following the speed of sound is greatest?

(a) air (b) ammonia

(c) water (d) steel

111. The wavelength of ultrasonic waves in air is of the order of

(a) 1 cm (b) 10^{-2} cm

(c) 10^{-4} cm (d) 10^{-8} cm

112. On the average, the maximum number of syllabus uttered by a human being per second does not exceed

(a) 2 (b) 5

(c) 8 (d) 11

113. Three tuning forks of frequencies 400, 401 and 402 Hz are sounded together. The frequency of beats per second is

(a) 0 (b) 1

(c) 2 (d) 3

(a) 52 (b) 56

(c) 60 (d) 110

115. The fundamental frequency of a sound source is 256 Hz. What is the frequency of its first harmonic?

(a) 128 Hz (b) 64 Hz

(c) 512 Hz (d) 256 Hz

116. Two waves represented by $y_1 = a_1 \sin wt$ and $y_2 = a_2 \cos wt$ are superimposed at any point at a particular instant. What is the amplitude of the resultant wave?

(a) $a_1 + a_2$ (b) $a_1 - a_2$

(c) $\sqrt{a_1^2 - a_2^2}$ (d) $\sqrt{a_1^2 + a_2^2}$

ANSWERS

1. a	2. a	3. a	4. a
5. b	6. d	7. a	8. c
9. b	10. b	11. c	12. c
13. b	14. b	15. d	16. a
17. c	18. c	19. c	20. a
21. c	22. a	23. c	24. c
25. a	26. a	27. b	28. a
29. c	30. a	31. a	32. a
33. a	34. b	35. b	36. d
37. c	38. b	39. a	40. c
41. b	42. c	43. a	44. c
45. c	46. c	47. a	48. a
49. c	50. b	51. c	52. b
53. c	54. b	55. c	56. d
57. a	58. b	59. c	60. b
61. b	62. b	63. a	64. d
65. c	66. d	67. b	68. c
69. a	70. b	71. b	72. c
73. b	74. c	75. d	76. d
77. c	78. b	79. b	80. b
81. a	82. c	83. d	84. c
85. d	86. c	87. d	88. b
89. d	90. d	91. d	92. d
93. d	94. a	95. b	96. a

CONCEPTS AND EQUATIONS

Reflection

Rebounding of light from a polished surface like a mirror is called "reflection."

Laws of Reflection

(a) Angle of incidence = angle of reflection.

(b) Incident ray, normal and reflected ray are coplanar.

If mirror is rotated by θ, reflected ray moves by 2θ.

Fig.

Fig. 3.1 Reflection from a polished surface

Diffusion

Reflection from a rough surface (such as a wall) is called "diffusion." A parallel beam will not emerge out parallel after suffering reflection because it meets different angles at the reflecting surface (see Fig. 3.2)

Characteristics of image formed with a plane mirror

(a) It is erect

(b) It is virtual

(c) Size of image = Size of object.

(d) Image distance = Object distance (measured from mirror).

(e) Lateral inversion (left appears right and right appears left).

Fig.

Fig. 3.2 Illustration of diffusion

Number of Images

If two mirrors are inclined at an angle θ the number of images formed for an object placed in front of them is given by

(a) Number of images $n = \frac{360}{\theta}$ if $\frac{360}{\theta}$ is odd and object does not lie on angle bisector or is placed symmetrically. $n = \frac{360}{\theta} - 1$ if $\frac{360}{\theta}$ is odd and object is placed on angle bisector.

(b) Number of images $n = \frac{360}{\theta} - 1$ if $\frac{360}{\theta}$ is even (object placed non-symmetric). $n = \frac{360}{\theta}$ if $\frac{360}{\theta}$ is even (object placed symmetrically).

If two mirrors are parallel ($\theta - 0$) $n = \infty$.

A, H, I, M, O, ….. U, V, X, Y etc. 11 letters show lateral symmetry.

If mirror is thick, second image (formed due to first reflection from polished surface) is the brightest.

Fig.

Fig. 3.3 Finding angle of deviation

Minimum height of a mirror so that a person can see his full image in the mirror is half the height of the mirror when standing at a distance = half the height away from the mirror.

Spherical mirrors are of two types

Convex and concave as shown in Fig. 3.4.

Fig.

Fig. 3.4 (a) Concave and (b) Convex mirror

Fig.

Fig. 3.5 Illustration of sign convention

Mirror Formulae

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f} \text{ and } f = \frac{R}{2} \text{ where}$$

v = image distance from pole to mirror

u = object distance from pole to mirror

f = focal length

R = radius of curvature

Table 3.1

Real Image	Virtual Image
1. Rays actually converge to form image.	Rays appear to diverge from image
2. Image can be obtained on screen.	Image cannot be taken as screen.
3. Image is inverted.	Image is erect.
4. Magnification is negative	Magnification is positive.

Magnification M_{lat} (lateral) or linear magnification.

$$M_{lat} = \frac{I}{o} = \frac{-v}{u} = \frac{v - f}{f} = \frac{f}{u - f}$$

See Fig. 3.6(a)

Fig.

Fig. 3.6(a) Lateral magnification

Fig.

Fig. 3.6(b) Axial magnification

Lens

The part of an isotropic transparent medium bounded by at least one curved surface. Lenses are of two types (a) convex (b) concave.

Fig.

Fig..

Fig. 3.7

Table 3.2 Image formation information for convex lens and concave mirrors

Position of object	Position of image and its nature
At ∞	At focus (real, inverted, diminished)
Away from 2f	Between f and 2f (real, inverted and diminished).
Between f and 2f	Away from 2f, (real, inverted and magnified). At ∞ (real, inverted and magnified)
Between pole and f	Behind the mirror (virtual erect and magnified). In front of lens, i.e., on the same side of object.

Remember spherical mirrors have principal focus while lenses have two principal focii one on each side as shown in Fig. 3.8.

Fig.

Fig. 3.8 Illustration of principal foci in a lens

Lens formulae for thin lenses

$\frac{1}{f} = (\mu_2 - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$ (lens maker's formula) when surrounding medium is air or vacuum.

$\frac{1}{f}\left(\frac{\mu_2}{\mu_m} - 1\right)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

if surrounding medium has refractive index μ_m.

Lens formula

$\frac{1}{v} - \frac{1}{\mu} = \frac{1}{f}$ (in air or vacuum)

Fig.

fixed at a distance D(> 4f) [Fig. 3.9]. Lens is set at L_1 to form a magnified sharp image at I_0. Then lens is displaced by d again to form a sharp image at I (diminished). Then $f = \frac{D^2 - d^2}{4d}$ and $O = \sqrt{I_1 I_2}$ where I_1 and I_2 are sizes of image in magnified and diminished position of lens L_1 and L_2 respectively O is size of object.

Lateral magnification

$$M_{lateral} = \frac{v}{u} = \frac{1}{O} \text{ for a convex lens.}$$

$$M_{lateral} = \frac{-v}{u} = \frac{1}{O} \text{ for a concave lens}$$

$$M_{lateral} = \frac{f}{u + f} = \frac{f - v}{f}$$

Axial magnification

$$M_{axial} = \frac{-v^2}{u^2} \text{ (for small objects)}$$

If object and image are formed in different media then use

$$\frac{\mu_2}{f} = \frac{\mu_2 - \mu_1}{R_1} - \frac{\mu_2 - \mu_3}{R_2} \text{ to find focal length}$$

$$\frac{\mu_3}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R_1} - \frac{\mu_2 - \mu_3}{R_2} \text{ to find v or u}$$

Fig.

Fig. 3.10 Image formation when lens lies in two different media

Fig. 3.11 Combination of two thin lenses

If two thin lenses are in contact as shown in Fig. 3.11 then $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$

Newton's formula

$x_1 x_2 = f_2$ [Fig. 3.12]

Fig.

Fig. 3.12 Focal length using Newton's formula

If focal length on two sides is not equal then $f_1 f_2 = x_1 x_2$ (in case O and I are in different mediums)

Fig.

Fig. 3.13 Combination of lenses when at a distance d apart

If two lenses are distance d apart as shown in Fig. 3.12 then their combined focal length $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 f_2}$

Focal length of a thick lens of thickness f

$$\frac{1}{f} = (\mu_2 - 1)\left[\frac{1}{R_1} - \frac{1}{R_2} - \frac{t(\mu_2 - 1)}{\mu_2 R_1 R_2}\right]$$

all)

(c) Nodal points

Flare spots

If strong light is used, more than one refraction occurs in a lens and hence more than one image is formed called spots. For nth flare spot.

$$\frac{1}{f_n} = \frac{(n+1)\mu - 1}{f(\mu - 1)}$$

Power of the lens

$P = \frac{1}{f(m)} = \frac{100}{f(cm)}$. This unit is dioptre (D).

Defects in lenses

(a) **Spherical aberration** (or monochromatic aberration): occurs as paraxial and marginal rays fail to meet at a point as illustrated in Fig. 3.14. Spherical aberration can be removed using optical stops or aplanatic lens. Astigmatism is cured by cylindrical lens.

Fig.

Fig. 3.14 Spherical aberration illustration

(b) **Chromatic aberration** A white object when seen through a lens appears coloured. Such a defect is called "chromatic aberration." Its removal is called "achromatism." For achromatic aberration a combination of a convex and a concave lens is needed such that $\frac{\omega_1}{f_1} + \frac{\omega_2}{f_2} = 0$ where

Fig.

Fig. 3.15 (a) Achromat combination

Achromatic aberration can also be removed using two lenses of same kind separated by a small distance if

Fig.

Fig. 3.15 (b) Achromatism using two convex lens

$d = \frac{\omega_1 f_2 + \omega_2 f_1}{\omega_1 + \omega_2}$ as illustrated in Fig. 3.15(b).

Note: If $\omega_1 = \omega_2$ then $d = \frac{f_1 + f_2}{2}$.

If $d = f_1 - f_2$ spherical aberration is also removed.

Thus if $f_1 = 3f_2$ and $d = 2f_2$ then both the defects can be removed simultaneously. This approach is employed in Huygen's eye piece.

Refraction

When an oblique ray of light enters from one medium to another (optically different or dispersive medium) then it changes its path. Such a phenomenon is called "refraction." (See Fig. 3.16).

Fig.

Fig. 3.16 Refraction in a dispersive medium

N.B2 It does not mean that if the ray is incident normal, it is not refracted.

Laws of Refraction

There are two laws of refraction.

(a) $1\mu_2$ or $\mu = \frac{\sin i}{\sin r}$

(b) Incident ray, normal and refracted rays are coplanar.

$\mu = \frac{\sin i}{\sin r} = \frac{c}{v}$ or $\frac{v_1}{v_2} = \frac{1}{\sin C}$ where C is critical angle.

$\mu = \frac{\text{Real depth}}{\text{Apparent depth}}$ (Apply this formula when incidence is normal)

$\mu = \frac{\lambda_1}{\lambda_2} = \tan \theta_P$ where θ_P is polarising angle and is equal to angle of incidence if angle between reflected and refracted rays is 90°.

$$\mu = \frac{\sin \frac{A + D_m}{2}}{\sin \frac{A}{2}}$$ in a prism.

$\delta = (\mu - 1)\alpha$ where α is angle of prism and δ is angle of minimum deviation in a prism of small angle α (angle of prism).

$\mu = A + \frac{B}{\lambda^2} + \frac{C}{\lambda^2}$ is called Cauchy's principle.

Fermat's Principle

When a ray of light passes from one point to another by any number of reflections or refractions, the path taken by the light is the one for which corresponding time taken is the least (or has shortest optical path).

Optical path length is μl if l is the distance travelled in a medium of refractive index μ.

$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{u_2 - \mu_1}{R}$ (See Fig. 3.19)

Fig.

Fig. 3.17 Refraction through a curved surface

Note that $\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$ can be applied for all curved surfaces with appropriate sign convention and remembering that μ_1 is the refractive index of the medium in which object lies.

Dispersion

Splitting of a complex light into its constituent colours is called "dispersion." For example, white light splits into seven colours when passed through a prism.

In a prism i + e = A + D (See fig.3.18).

Fig.

Fig. 3.18 Refraction through a prism

Fig. 3.19 shows graph between angle of deviation D and angle of incidence i. D_m is angle of minimum deviation.

Fig.

Fig. 3.19

At minimum deviation i = e and $r_1 = r_2$. The ray through the prism is a parallel to the base of the prism.

Under minimum deviation condition $\mu = \frac{\sin \frac{A + D_m}{2}}{\sin \frac{A}{2}}$.

Dispersive Power

$$\omega^1 = \frac{\delta_v - \delta_r}{\delta} = \frac{\mu_v - \mu_r}{\mu - 1}$$

where δ_v and δ_r are minimum deviations for violet and red colours, δ is mean deviation (for yellow colour). μ_v and μ_r are the refractive index for violet and red colours and μ is the refractive index for yellow or mean colour.

Note: Use $\delta =$ if δ is not given. Similarly use

Rainbow

Two types of rainbows are known: primary rainbow and secondary rainbow.

Primary rainbow is formed when one total internal reflection (TIR) and two refractions occur from the suspended raindrops as illustrated in Fig. 3.20(a). Violet colour on inner edge and red colour on outer edge are seen, as shown in Fig. 3.20(c). Angles subtended with the direction of sun are 42° (violet) above the horizon.

Fig.

Fig. 3.20(a) Primary rainbow formation

Fig.

Fig. 3.20(b) Secondary rainbow formation

Secondary rainbow is formed due to two TIRs and two refractions from the raindrops suspended in air as shown in Fig. 3.20(b). Inner edge has red colour and outer edge violet. i.e., there is colour

Fig.

Fig. 3.20(c) Rainbow

Deviation without dispersion

See Fig. 3.21(a)

Condition $(\delta_{v_1} - \delta_{r_1}) = (\delta_{v_2} - \delta_{r_2})$

or $(\mu_{v_1} - \mu_{r_1})\,\alpha_1 = (\mu_{v_2} - \mu_{r_2})\,\alpha_2$

or $\delta_1\omega_1 = \omega_2\delta_2$

Dispersion without deviation

See Fig. 3.21(b). The mean colour should be parallel to incident ray.

$(\mu_1 - 1)\,\alpha_1 = (\mu_2 - 1)\,\alpha_2$

Fig.

Fig. 3.21(a) Deviation without dispersion

Fig.

Fig. 3.21(b) Dispersion without deviation

The prisms which produce dispersion without deviation are called “direct vision prism” and are employed in direct vision spectroscope. If more than two prisms are used the resolving power of the spectroscope is increased.

5. Colour blindness

1. **Myopic** eye is treated by concave lens. (Image is formed in front of the retina).
2. **Hypermetropic** eye is treated by convex lens. (Image is formed beyond the retina).
3. **Presbyopia** eye with this defect can neither see near objects nor far objects clearly. It is treated by bifocal lens (upper half concave and lower half convex).
4. **Astigmatism** is treated by specially prepared cylindrical lens.
5. **Colour blindness** eye cannot differentiate between colours. Remedy is not available.

An alternative approach for correcting many defects of vision is to reshape the cornea. It is done using a procedure called Laser assisted in situ Keratomileusis or LASIK. An incision is made into the cornea and a flap of outer corneal tissue is folded back. A pulsed uv laser with a beam only 50 μm wide $\left(< \frac{1}{200}\text{th width of the hair} \right)$ is then used to vaporise away microscopic area underlying the tissue. The flap is then folded back to the position where it conforms to the new shape carved by the laser.

Visual acuity or resolving power of eye is $\frac{1}{60^\circ}$ or 1 min.

Near point is 15 cm and least distance of distinct vision (normal near point) = 25 cm.

Eye Pieces or Occular

Commonly used eyepieces are Huygen’s and Ramsden. In Huygen

and $d = f_1 - f_2$ removes spherical aberration. The drawback in Huygen's eyepiece is that crosswire cannot be fitted. Therefore it can be used for qualitative work. Wherever quantitative (measurements) work is involved Ramsden's species is used. Remsden eyepiece comprises of two lenses of equal focal length. $d = \frac{2}{3} f$. It is achromated for two selected colours. Spherical aberration is not removed completely. But crosswire can be connected.

Simple Microscope or Magnifier

Magnification $M = \left(1 + \frac{D}{f}\right)$

Compound Microscope

Magnification $M = \frac{v_0}{u_0}\left(1 + \frac{D}{f}\right) = \frac{L}{f_0} \cdot \frac{D}{f_e}$

for normal adjustment where L is length of the microscope tube.

$M = \frac{L}{f_0}\left(1 + \frac{D}{f_e}\right)$ for least distance vision.

Length of microscope tube or separation between two lenses $L = v_0 + u_e$.

Resolving Power of Microscope

R.P. $= \frac{\mu \sin \mu}{0.61\, \lambda}$ for self luminous points.

R.P. $= \frac{2\mu \sin \mu}{\lambda}$ for non luminous points.

N.B. Resolving power can be increased if we immerse the objective in an oil and use UV light.

Telescope (Astronomical) is of the types:

(a) Reflecting

(b) Refracting

(c) Radio telescope

Reflecting type is made with concave mirror. Focal length of concave mirror > 1 m (objective).

In refracting type telescope, objective has large focal length and large aperture $f \geq 1$ m, aperture ≥ 2 inches.

Magnification (Normal setting) $M_N = \frac{f_o}{f_e}$

and $L = f_o = f_e$.

Least distance of distinct vision setting

$M_{LD} = \frac{f_o}{f_e}\left(1 + \frac{f_e}{D}\right)$

and $L = f_o + u_e$

Resolving power of telescope R.P. $= \frac{\alpha}{1.22\lambda}$ where α is aperture.

Terrestrial Telescope

Magnification (Normal setting) $M_N = \frac{f_o}{f_e}$

and $L = f_o + 4f_{er} + f_e$ where f_{er} is focal length of erecting lens.

Least distance setting

$M_{LD} = \frac{-f_o}{f_e}\left(1 + \frac{f_e}{D}\right)$ and $L = f_o + 4f_{er} + u_e$.

Coherent source obtained with

division of wave front	division of amplitude
(i) YDSE (young's double slit experiment)	(i) Newton's rings
(ii) Fresnel biprism	(ii) Thin films
(iii) Lloyd's mirror	(iii) Interferometer

Fig.

Fig. 3.22

Rayleigh's Criterion for just Resolution

Two light sources close together are said to be just resolved if minima of one falls on the maximum of other as shown in Fig. 3.22(a).

WAVE OPTICS

Concepts and Equations

Interference

If light waves emitted form two coherent sources superpose then it results in variation of intensity with distance. At certain places intensity is maximum and at other places intensity is minimum. This phenomenon is called interference.

Coherent Sources

Two sources/wave trains are said to be coherent if there is a constant zero phase difference between them. No two different sources (except lasers) could be coherent. Coherent sources are to be derived from a single source. Their state of polarisation remains same. Laser is considered highly coherent.

Wave front is the locus of all adjacent parts at which the phase of vibration of a physical quantity associated with the wave is the same. That is, at any instant, all points on a wave front are at the same part of the cycle of their vibration. Wave fronts in general may be of three types:

(a) Spherical

(b) Cylindrical

(c) Plane or Planar

Spherical wave fronts are generated form a point source or circular slit.

Cylindrical wave front results from a line source or rectangular slit.

Plane wave front is either of the two if the source is at infinity.

Fig.

Fig. 3.23 (a) Wave front (Spherical)

Fig.

Fig. 3.23(b) Illustrated of plane wave front

Constructive interference occurs when the coherent waves superpose in phase or the path difference is integral multiple of the wavelength or even multiple of half the wavelength. This type of "interference" is also called "reinforcement" as light intensity increases, i.e., bright fringes are formed. We may call such points or curves as antinodal. See Fig. 3.24(a). Destructive interference occurs when the coherent waves superpose out of phase or path difference is an odd multiple of half the wavelength. Dark fringes are formed. We may call such points or curves as nodal as illustrated in Fig. 3.24(b)

Fig.

Fig. 3.24(a) Constructive Interference

Fig.

Fig. 3.24(b) Destructive Interference

$$\frac{I_{bright}}{I_{dark}} = \frac{I_{max}}{I_{min}}$$

$$= \left(\frac{y_{01} + y_{02}}{y_{01} - y_{02}}\right)^2 = \left(\frac{\sqrt{I_1} + \sqrt{I_2}}{\sqrt{I_1} - \sqrt{I_2}}\right)^2$$

Condition to obtain sustained interference.

Necessary Condition

The two sources emitting waves must be coherent.

Desirable Conditions

(i) Sources should be monochromatic having same frequency.

(ii) They shall have same amplitude.

(iii) They shall emit light continuously

(iv) The separation between the two sources shall be small.

In YDSE

Fringe width $\beta = \frac{\lambda D}{d}$ (Difference between two successive dark or bright fringes, i.e., $\beta = x_n - x_{n-1} = \frac{\lambda D}{d}$.

Fig.

Fig. 3.25 Fringe pattern in YDSE

$x_n = \frac{n\lambda D}{d}$ for nth bright fringe

Fig.

Fig. 3.26 Angular Fringe Width

Angular fringe width

$$\theta = \frac{\lambda}{d} = \frac{\beta}{D} \text{ (in radian)}$$

$$= \frac{\lambda}{d} \times \frac{180}{\pi} \text{ (in degrees)}$$

Fringe visibility

$$= \frac{I_{max} - I_{min}}{I_{max} + I_{min}} = \frac{\sqrt{2I_1 I_2}}{I_1 + I_2}$$

Intensity at any Point

$$I = 2y_0^2 (1 + \cos \delta) = 4I' \cos^2 \left(\frac{\delta}{2} \right).$$

Assuming both sources emit waves of equal amplitude y_0 or equal intensity I'. δ is phase shift between two superposing waves.

$$I = I_1 + I_2 + 2\sqrt{I_1}\sqrt{I_2} \cos \delta$$

$$= (y_{01}^2 + y_{02}^2 + 2y_{01}y_{02} \cos \delta)$$

If intensities or amplitude of superposing waves are unequal.

If YDSE is immersed in a liquid of refractive index μ then fringes shrink and hence fringe pattern shrinks.

$$\beta_{new} = \frac{\beta}{\mu} = \frac{\lambda D}{\mu d}$$

or $x_{n(new)} = \frac{x_n}{\mu} = \frac{n\lambda D}{\mu d}$ for nth bright fringe.

If a thin slice of thickness t and refractive index μ is inserted in front of one of the slits in YDSE, then central fringe S_1 and S_2 are virtual as shown in Fig.3.5

$$D = a + b$$

$$d = 2a\,\delta = 2a(\mu - 1)\,\alpha$$

where α is angle of biprism

$$\beta = \frac{\lambda D}{d} = \frac{\lambda(a + b)}{2a(\mu - 1)\alpha}$$

$x_n = \frac{n\lambda D}{d} = \frac{n\lambda(a + b)}{2a(\mu - 1)\alpha}$ for nth bright fringe.

$x_n = \quad = \frac{(2n - 1)\,\lambda(a + b)}{4\alpha(\mu - 1)\alpha}$ for nth dark fringe.

Fig.

Fig. 3.27 Fringe pattern in Fresnel biprism

If displacement method is used then $d = \sqrt{d_1 d_2}$.

If Fresnel biprism is immersed in a liquid of refractive index μ', then

$$\beta_{new} = \frac{\lambda}{\mu'} (a + b), 2a \left(\frac{\mu}{\mu'} - 1 \right) \alpha$$

$$= \frac{\lambda(a + b)}{2a(\mu - \mu')\alpha}$$

In Lloyd's Mirror

Condition of nth bright and dark fringe obtained in Lloyd's mirror gets reversed to what was obtained in YDSE; because of

and $x_n = \frac{(2n-1)\lambda D}{2d}$ for nth bright fringe.

In Lloyd's mirror one of the sources is real and other is virtual or image source.

Path difference = 2 $\mu t \cos r$

= $(2n + 1)\frac{\lambda}{2}$ for nth bright fringe and 2 $\mu t \cos r = n\lambda$ for nth dark fringe. In reflected light

Path difference 2 $\mu t \cos r = n\lambda$

$2 \mu t \cos r = (2n + 1)\frac{\lambda}{2}$

} for refracted or transmitted light

Wedge Shaped Film

Fringe Width $\beta = \frac{\lambda}{2\theta}$, since

$\theta = \frac{1}{x_n}$, Therefore $\beta = \frac{\lambda x_n}{2t}$

If plates are kept in a liquid of refractive index μ

$\beta = \frac{\lambda}{2\mu\theta} = \frac{\lambda x_n}{2\mu t}$ or $2\mu t = n\lambda$

$t_{min} = \frac{\lambda}{2}$. It is due to interference that a soap bubble appears bright colour or oil drops spilled on road in rainy seasons appear of brilliant hue.

Fig.

Fig. 3.28 Wedge shaped film

if path difference > L_C coherence nature is lost. Therefore we cannot keep distance between two slits or sources > 3 cm.

Diffraction

The bending of wave from the obstacles of size of the order of wavelength is termed as diffraction. Planar or plane wave front is required for diffraction to take place. Diffraction is of two types (a) Freshnel Class of diffraction (b) Fraunhoffer class of diffraction.

Table 3.3

Fresnel Class	Fraunhoffer Class
1. The source is at a finite distance.	The source is at infinite distance.
2. No optical aid is required.	Optical aid in the form of collimating lens and focusing lens are required.
3. Frings are not sharp and well defined.	Fringes are sharp and well defined.

Table 3.4

Interference	Diffraction
1. Fringes are formed due to superposition of wave trains emitted from two coherent sources.	Fringes are formed due to superposition of bent rays due to superposition of secondary wavelets.
2. Intensity of each fringe is equal.	Intensity falls as the fringe order increases.
3. Number of fringes is and quite large.	Number of fringes is finite (small)
4. Fringe width is equal for each fringe.	Fringe width of primary and secondary maxima are different.

3. Secondary wavelets can superpose to produce disturbances.

Secondary wavelets as well as primary wavefronts move with c (speed of light).

Diffraction from a single slit

Fig.

Fig. 3.29 Single slit diffraction

Path difference = BC = AB sin θ

= d sin θ

For minima

d sin $\theta = n\lambda$

$\sin\theta = \frac{x_n}{D}$. Thus $\frac{dx_n}{D} = n\lambda$

$x_n = \frac{n\lambda D}{d}$ for nth minima.

Note D = f (of focussing lens)

Fringe with $\beta_{primary} = \frac{2\lambda D}{d}$

Angular fringe width $\beta_{primary} = \frac{2\lambda}{d}$ (radian)

$= \frac{2\lambda}{d} \times \frac{180}{\pi}$ (degrees)

Angular fringe width $\beta_{secondary} = \frac{\lambda}{d}$ (radian)

$= \frac{\lambda}{d} \times \frac{180}{\pi}$ (degree)

If $\beta = \frac{\pi d \sin\theta}{\lambda}$ then $I = \frac{I_0 \sin^2\beta}{\beta^2}$

If aperture is circular then sin $\theta = \frac{1.22\lambda}{r}$ where r is radius of aperture.

Radius of first dark ring $R = \frac{1.22\lambda D}{r}$

$= \frac{1.22\lambda f}{r}$.

Polarisation

If plane of vibration is fixed then light will travel in a single direction. Such a state is called "plane polarised light."

In the fig. 3.30 electric field varies along y-axis and magnetic field along z-axis, wave travels x-axis, plane of polarisation is y – z.

If $E_v = E_o \sin(\omega x - kx)$ is the electric field along y-axis and $B_z - B_o \sin(\omega t - kx)$ is the magnetic field along z-axis then wave progresses in x-direction.

Only transverse waves can be polarised, longitudinal waves cannot be polarised. Plane polarised light can be achieved using

(a) Reflection

(b) Refraction

Fig.

Fig. 3.30 Plane polarised light

Brewester's Law

If light is incident on the interface of two media such that the angle between reflected and refracted radiations is 90° then reflected rays are completely polarised. Angle of incidence is called "angle of polarization" (θ_p).

Then $\mu = \tan \theta_p$

Malus Law

When the plane of polarisation is rotated by an angle θ then intensity of emergent light is given by $I = I_o \cos^2 \theta$. I_o is intensity of incident polarised light. In birefracting analysis there are two rays – ordinary and extraordinary. The extraordinary ray does not follow law of refraction. If the velocity of extraordinary ray is greater than that of ordinary ray such crystals are called negative crystals. Examples of negative crystal are Iceland spar, foruma line, sappire, ruby, emerald and appetite. If the ordinary ray has higher velocity than such crystals are called positive crystals. Examples of positive crystals are quartz, iron oxide.

polarised wave front results, it could be elliptically.

SPECTRUM OF LIGHT AND PHOTOMETRY

Concepts and equations

Spectrum

A collection of dispersed light giving its wavelength composition is called a "spectrum." For example, hydrogen spectrum has Lyman series, Balmer series, Paschen series, Brackett series, P-fund series etc. and when a white light is incident on a prism a spectrum of different colours form red to violet is observed.

Pure and Impure Spectrum

If each colour gives its sharp impression in the spectrum, then a well defined line spectrum is obtained. Such a spectrum is called pure spectrum. To achieve pure spectrum — (i) The beam of light incident on the dispersing element (prism or diffraction grating) should be parallel or collimated. (ii) The dispersed light should be focussed in such a way that all the rays of a particular wavelength are collected at a place.

N.B. A spectrum will satisfy the above requirements.

If the slit is wide, different points of the slit produce separate spectra which overlap each other. Thus colour impression gets diffused due to overlap resulting into an impure spectrum.

Kinds of Spectra

Broadly speaking we can divide the spectrum into two types — emission spectrum and absorption spectrum.

be obtained from the emission spectrum. Emission spectrum may be of three types:

Continuous Spectrum

If the source is a hot solid such as bulb filament or liquid, the spectrum is continuous. Light emitted by a bulb, candle or red hot iron has continuously varying wavelengths. Even X-ray spectrum is continuous.

Line Spectrum

When substances in its atomic state (gaseous or vapour state) de-excite, they produce bright colour lines. For example when common salt is thrown in a campfire, only a few colours appear in the form of isolated sharp parallel lines. Each lien is the image of spectrograph slit deviated through an angle that depends upon the wavelength. A spectrum of this sort is called a line spectrum. For example sodium gives D_1 and D_2 doublet (589 and 589.6 nm). Hydrogen spectrum is well studied and so on.

Band Spectrum

The molecular energy levels are generally grouped into several bunches, each bunch widely separated from the other but levels in a bunch are close to each other. The wavelengths emitted by such molecules are also grouped. Each group retains its identity (is separated from the other). The wavelengths in a group being close to each other and appear as continuous. The spectrum looks like a band of colours.

Absorption Spectrum

When white light having all the wavelengths is passed through an

wavelengths appear on an otherwise bright continuous coloured background. Such a spectrum is called absorption spectrum. It is of two types line absorption spectrum and band absorption spectrum. When sunlight is dispersed certain sharply defined dark lines are seen. These lines are called Fraunhoffer lines. Fig. 3.31(a) and Fig. 3.31(b) illustrates emission and absorption process.

Fig.

Fig. 3.31

Speed of Light using Fizeau Method

$c = \frac{2Dn\omega}{\pi} = 4\ Dnf$ where D is distance from the rotating wheel of the mirror ω is angular speed of rotation of the wheel when image is completely unseen for the first time and n is number of teeth in the wheel or number of rotations per second, $\omega = 2\pi f$ where f is linear frequency.

Foucault's Method to find Speed of Light

$c = \frac{4R^2\omega a}{S(R + b)}$ where R is the radius of concave mirror, a is distance between lens and source, b is distance between plane mirror and lens and S is shift in image.

speed of rotation and D is the distance travelled by light on reflections from polygonal mirror. f = $\frac{\omega}{2\pi}$ is the linear frequency.

Fresnel Distance

$Z_f = \frac{a^2}{\lambda}$ where a is slit width. Z_f describes the distance travelled by a beam without appreciable broadening of the beam.

Lambert's Cosine Law

The surfaces which radiate according to the Lambert's Cosine Law are called perfectly diffused. $I = I_\theta \cos \theta$.

Luminous Flux

Radiation emitted by a source has components corresponding to a wide range of wavelengths. Different component wavelengths have different energies and different brightness. The luminous flux is a quantity directly representing the total brightness producing capacity of the source. Its unit is lumen. Luminous flux of a source of $\frac{1}{685}$ W emitting monochromatic light of wavelength 555 nm is called 1 lumen. That is, a 1 watt source emitting a

$$= \frac{\text{Total luminous flux}}{\text{Total radiant flux}}$$

$$= \frac{\text{Luminous flux emitted}}{\text{Power input to the source}}$$

Luminous Intensity or Illuminating Power (I)

Luminous flux per unit solid angle is defined as luminous intensity. Its unit is candela (cd).

$I = \frac{dF}{d\Omega} = \frac{F}{4\pi}$ where F is luminous flux and Ω is solid angle.

1 Candela is the luminous intensity of a black body of surface area $\frac{1}{60}$ cm^2 placed at the freezing temperature of platinum at a pressure of 101.325 N m^{-2}.

Illuminance (E) is the luminous flux incident per unit area $\frac{dF}{dA}$ units lumen m^{-2} or Lux. CGS unit is Phot.

Law of Photometry

A photometer is used to compare intensities of two sources $\frac{I_1}{I_2} = \left(\frac{d_1}{d_2}\right)^2$ where d_1 and d_2 are distances of the source from photometer.

1. What is optics?
   (a) the scientific study of light and vision
   (b) the scientific study of sound
   (c) the scientific study of time
   (d) the scientific study of fluids

2. Which of the following forms of electromagnetic (EM) energy has the longest wavelength?
   (a) microwaves
   (b) radiowaves
   (c) infrared waves
   (d) visible light

3. Which of the following form of EM energy has the highest frequency?
   (a) x-rays
   (b) gamma rays
   (c) ultraviolet waves
   (d) infra-red waves

4. In comparison to the other forms of EM radiation, radiowaves have the
   (a) highest energy and highest frequency
   (b) lowest energy and lowest frequency
   (c) lowest energy and highest frequency
   (d) highest energy and lowest frequency

5. Which form of electromagnetic radiation is used in RADAR?
   (a) long wavelength ultraviolet waves
   (b) short wavelength microwaves
   (c) short wavelength infrared waves
   (d) long wavelength radio waves

6. Infrared radiation is also known as
   (a) radio signals
   (b) heat radiation
   (c) magnetic resonance waves
   (d) RADAR

7. Which scientist made the first successful terrestrial measurement of the speed of light?
   (a) Isaac Newton
   (b) Ole Romer
   (c) Armand Fizeace
   (d) Albert Michelson

8. Which branch of medicine deals with the anatomy, physiology and diseases of the eye?
   (a) Ophthalmology
   (b) Cardiology
   (c) Radiology
   (d) Andrology

9. Which law states that the angle of incidence equals the angle of reflection?
   (a) law of refraction
   (b) law of reflection
   (c) Snell's, law
   (d) none of the above

10. Which Muslim scientist gave the first clear description and correct analysis of pinhole camera in the Book of Optics (Kitab al-Manazir) in 1021 AD?
   (a) Ibn al-Haytham (Alhazen)
   (b) Ibn Ishaq al-Kindi (Alkindus)
   (c) Nasir al-Din al-Tusi
   (d) Ibn Musa al-Khwarizmi

11. Which Muslim scientist is regarded as "father of optics"?
   (a) Ibn al-Haytham
   (b) Ibn Ishaq al-Kindi

(a) plano-convex lens
(b) concave lens
(c) spherical mirrors
(d) plane mirrors

13. Which of the following is used for the failure of a lens to form a sharp and distinct image?
(a) distortion
(b) astigmation
(c) chromatic aberration
(d) spherical aberration

14. Power of lens is measured in
(a) cm (b) cm^{-1}
(c) dioptress (d) meters

15. A double convex air bubble in water acts as
(a) converging lens
(b) diverging lens
(c) plane slab
(d) none of the above

16. The blurring of the image due to dispersion in lens is called
(a) spherical aberration
(b) chromatic aberration
(c) astigmation
(d) curvature of image field

17. Electromagnetic wave theory was proposed by
(a) Maxwell (b) Hertz
(c) Fizeace (d) Huygen

18. Which of the following properties exhibits that light waves are transverse in nature?
(a) interference (b) diffraction
(c) polarization (d) refraction

20. Huygen's wave theory fails to explain
(a) diffraction
(b) polarization
(c) interference
(d) refection

21. The light speed is vacuum depends on
(a) frequency
(b) amplitude
(c) wavelength
(d) none of the above

22. The minimum angle of incidence for which total internal reflection can occur is called the
(a) critical angle
(b) acute angle
(c) obtuse angle
(d) right angle

23. Which of the following are electromagnetic waves?
(a) x-rays
(b) microwaves
(c) light
(d) all of the above

24. What are SI units of Plank's constant?
(a) J.s. (b) W.s.
(c) N.s. (d) J.m.

25. Which law states that the ratio of the angles θ_a and θ_b is equal to the inverse ratio of the two indexes of refraction?
(a) Snell's law
(b) Ohm's law
(c) Newton's law
(d) Kirchoff's law

(c) reflection
(d) echo

27. The band of colours is called
    (a) spectrum
    (b) prism
    (c) medley
    (d) LASER

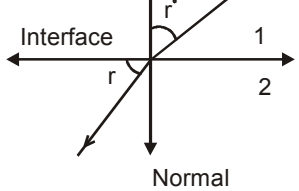
28. Who set forwarded the corpuscular theory of light?
    (a) Newton
    (b) Huygen
    (c) Hertz
    (d) Einstein

29. Newton's corpuscular theory failure to explain which phenomenon of light?
    (a) diffraction
    (b) interference
    (c) polarization
    (d) all of the above

30. In water drops, rainbows are formed by
    (a) refraction
    (b) reflection
    (c) dispersion
    (d) all of the above

31. Rebounding of light from a polished surface like a mirror is termed as
    (a) reflection
    (b) refraction
    (c) dispersion
    (d) interference

32. Reflection from a rough surface (such as a wall) is called
    (a) refraction (b) dispersion
    (c) diffusion (d) interference



    (a) reflection (b) refraction
    (c) dispersion (d) diffusion

34. Splitting of complex light into its constituent colours is called
    (a) reflection (b) refraction
    (c) dispersion (d) diffusion

35. Which of the following are defects in human eye?
    (a) Myopia (short sightedness)
    (b) Hypermetropia (long sightedness)
    (c) Presbyopia
    (d) all of the above

36. Which law states that when a perfect polarizer is placed in a polarized light beam, the intensity I, of the light passes through is given by $I = I_0 \text{Cos}^2 \phi_0$?
    (a) Mauls' law
    (b) Hooke's law
    (c) Bragg's law
    (d) Dalton's law

37. Which law states that the maximum polarization of a light ray may be achieved by letting the ray fall on a surface of a transparent medium such that the refracted ray makes an angle of 90° with the reflected ray?
    (a) Mauls' law
    (b) Bragg's law
    (c) Brewster's law
    (d) Lenz's law

39. When we look at the day time sky, the light that we see is sunlight that has been absorbed and then re-radiated in different directions. This process is called ————

(a) scattering (b) diffusion
(c) mirage (d) rainbow

40. Clouds are white because they efficiently scatter sunlight of all ————.

(a) colours
(b) wavelengths
(c) frequencies
(d) phases

41. Which principle assumes that every point of a wavefront may be considered the source of secondary wavelets that spread out in all directions with a speed equal to the speed of propagation of the wave?

(a) Huggen's principle
(b) Archimedes' principle
(c) Relativity principle
(d) Landauer's principle

42. Huygens' concept of secondary wave is used to

(a) determine the velocity of light
(b) locate the wavefront
(c) explain polarization
(d) find the power of a lens

43. What is defined as the ratio of image height to the object height?

(a) lateral magnification
(b) angular magnification
(c) both of the above
(d) none of the above

(c) Brewster's law
(d) Hooke's law

45. Which instrument measures the magnification of a telescope?

(a) Lactometer
(b) Dynamometer
(c) Wattmeter
(d) Ammeter

46. Which of the following are defects in lenses?

(a) chromatic aberration
(b) spherical aberration
(c) astigmatism
(d) all of the above

47. Which principle states that the path taken by a ray of light between any two points in a system is always the path that takes the least time (or the shortest optical path)?

(a) Fermat's principle (principle of least time)
(b) Huygens' principle
(c) Archimedes' principle
(d) Landauer's principle

48. Which term is used for human eye defect "near sightedness"?

(a) Myopia
(b) Presbyopia
(c) Hypermetropia
(d) Cataract

49. Which of the following are optical telescopes?

(a) refracting telescope (reflectors)
(b) refracting telescopes (refractors)
(c) catadioptric telescopes
(d) all of the above

(c) concave mirror
(d) any one of the above

51. Which property of light waves does not vary with the medium?
(a) frequency
(b) velocity
(c) wavelength
(d) amplitude

51. Which is the complementary colour of orange?
(a) blue (b) yellow
(c) violet (d) indigo

53. Electromagnetic waves are produced by
(a) charge at rest
(b) accelerated charge
(c) heating a conductor
(d) none of the above

54. Wavelength of a LASER can be used as a standard of
(a) angle
(b) time
(c) length
(d) temperature

55. Which of the following waves cannot be polarised?
(a) x-ryas
(b) radio waves
(c) ultraviolet rays
(d) sound waves

56. Dispersive power of a prism depends upon the wavelength of the light used and is
(a) more for large wavelengths
(b) less for large wavelengths
(c) more for small wavelengths
(d) less for small wavelengths

fields only
(d) none of the above

58. Two lenses of focal lengths f_1 and f_2 are separated by a distance d. What is the condition that the condition be achromatic?
(a) $f_1 + f_2 = 2d$
(b) $f_1 - f_2 = 2d$
(c) $f_1 f_2 = d$
(d) $f_1 f_2 = 2d$

59. The inability of rays of different colours to converge a single point after refraction through a convex lens a called
(a) coma
(b) spherical aberration
(c) distortion
(d) chromatic aberration

60. The power of lens in dioptress (D) is
(a) its focal length in meters
(b) the reciprocal of its focal length in meters'
(c) the reciprocal of length in meters
(d) the focal length in centimeters

61. What is a "zoom lens"?
(a) a lens having a fixed focal length
(b) a lens having variable focal length
(c) a lens used in telescopes
(d) none of these

62. Two convex lenses of focal length f used in combination become telescopic when the distance between them is
(a) f (b) 2f
(c) 4f (d) 4/2

64. The variation of focal length of a lens when we pass from the central portion to periphery is called
(a) coma
(b) astigmatism
(c) spherical aberration
(d) chromatic aberration

65. The defect in image due to oblique centric rays falling on the lens is called
(a) coma
(b) spherical aberration
(c) astigmatism
(d) curvature of image field

66. Which of the following defects is removed by Huygen's eye-piece?
(a) astigmatism
(b) chromatic aberration
(c) spherical aberration
(d) both a and b

67. On which property of lens, longitudinal chromatic aberration depends upon?
(a) resolving power
(b) dispersive power
(c) magnifying power
(d) none of these

68. Which of the following be used for reducing mechanical aberration in optical instruments?
(a) plane mirrors
(b) spherical mirrors
(c) concave lenses
(d) plano-convex lenses

(c) achromatic aberration
(d) none of these

70. The ability of a convex lens to produce convergence in a parallel beam is called its
(a) magnification
(b) focal length
(c) power
(d) strength

71. Image formed by a concave lens is
(a) real
(b) magnified
(c) virtual
(d) none of the above

72. Two thin lenses in contact, produce a combined power of +10 dioptress. When they are 0.25 m apart the power reduced to +6 dioptress. The power of the lens in dioptress are
(a) 1 and 9 (b) scach
(c) 4 and 6 (d) 2 and 8

73. On which of the following the object size as perceived by eye depends upon?
(a) actual size of the object
(b) aperture of the pupil
(c) object distance from the eye
(d) size of the image formed on the retina

74. Why an eye is not able to see objects closer than 25 cm?
(a) focal length of the eye is 25 cm
(b) distance of retina from eye-lens is 25 cm
(c) eye is not able to decrease the focal length beyond a limit
(d) none of these

retina is x. For a normal eye, the maximum focal length the eye-lens is

(a) = x (b) < x

(c) > x (d) = 2x

77. The intensity produced by a long cylindrical light source at a small distance r from the source is proportional to

(a) $\frac{1}{r}$ (b) $\frac{1}{r^2}$

(c) $\frac{1}{r^3}$ (d) none of these

78. As the wavelength is increased from violet to red, the luminosity

(a) continuously increases

(b) continuously decreases

(c) increases then decreases

(d) decreases then increases

79. Why danger signals are made red?

(a) our eyes are more sensitive to red colour

(b)the red colour has minimum scattering

(c) the red colour has maximum scattering

(d) none of the above

80. What is the cause of mirage in desert areas?

(a) the refractive index of atmosphere increases with height

(b) the refractive index of atmosphere decreases with height

(c) the refractive index of atmosphere remains constant

(d) scattering

(d) their refractive indices are same

82. What is the relation between energy E and momentum p of a photon?

(a) E = pc (b) $E = \frac{p}{c}$

(c) p = Ec (d) $E = \frac{p^2}{c}$

83. What is the total energy density of an electromagnetic wave in vacuum?

(a) $e_0 \frac{E^2}{3}$ (b) $e_0 E^2$

(c) $\frac{\in_0 E^2}{2}$ (d) $\frac{E^2}{\in_0}$

84. All particles of a wavefront vibrate

(a) in same phase

(b) in opposite phase

(c) up and down

(d) left and right

85. What is the unit of poynting vector?

(a) watt (b) joule

(c) $\frac{watt}{m^2}$ (d) $\frac{joule}{m^2}$

86. When a light ray enters form air into water then its wavelength

(a) increases

(b) decreases

(c) becomes infinity

(d) remains constant

87. Which phenomenon verifies the transverse nature of light waves?

(a) reflection

(b) refraction

(c) polarization

(d) interference

89. What would be the colour of sky in the absence of atmosphere?
(a) blue (b) indigo
(c) red (d) black

90. For total internal reflection, the light ray enters
(a) form rearer to denser medium
(b) from denser to rearer medium
(c) medium of same refractive index
(d) none of the above

91. Why a diamond shines so brightly? Due to
(a) scattering of light
(b) refraction of light
(c) dispersion of light
(d) total internal reflection of light

92. Which of the following colours scatters minimum?
(a) blue (b) violet
(c) yellow (d) red

93. The sun appears elliptical before sunset due to
(a) reflection
(b) refraction
(c) scattering
(d) total internal reflection

94. Sunlight can undergo internal reflection if it enters from
(a) glass to air
(b) air to glass
(c) air to water
(d) water to glass

95. The refractive index of diamond is 2. What will be the velocity (in cm/sec) in diamond?
(a) 3×10^{10}

appears bent because of
(a) reflection of water surface
(b) diffraction at water surface
(c) refraction at water surface
(d) water is a fluid

97. A red flower when viewed through blue light, appear
(a) red (b) black
(c) blue (d) violet

98. Which of the following is a correct statement?
(a) light exhibits wave nature in propagation and particle nature in mutual interaction with matter
(b) wave theory is valid for long wavelength region and quantum theory is valid for short wavelength region
(c) the main cause of microwaves being unfit for vision is the particle nature of EM waves
(d) all of the above

99. Which of the following are examples of images?
(a) your reflection in the bathroom mirror
(b) view of the moon through a telescope
(c) the patterns seen in kaleidoscope
(d) all of the above

100. The Ramsden eyepiece consist of
(a) two plano-convex lens with same focal length
(b) two sets of doublets
(c) an achromatic doublet
(d) none of the above

(c) an achromatic doublet
(d) none of these

102. Kellner or Achromat eye-piece consists of
(a) two plano-convex lens with same focal length
(b) two sets of doublets
(c) an achromatic doublet
(d) none of these

103. Photometers are used to measure
(a) illuminance
(b) irradiance
(c) fluorescence
(d) all of the above

104. Which of the following factors determines the resolving power of an instrument?
(a) magnification
(b) focal length of objective
(c) diameter of objective
(d) none of the above

105. A biprism consists of
(a) two parallel glass plates
(b) two acute angled prisms
(c) two obtuse angled prisms
(d) none of the above

106. The branch of optics deals with the nature and propagation of light is called
(a) geometric optics
(b) physical optics
(c) quantum optics
(d) none of these

107. When the frequency of an EM wave and ultrasonic wave are same then
(a) their wavelengths should be same

108. Which of the following is not EM in nature?
(a) x-rays
(b) γ-rays
(c) cathode rays
(d) infra-red rays

109. Which of the following is an important property of EM waves?
(a) electric and magnetic fields are in same phase
(b) electric and magnetic fields are out of phase
(c) both the fields are sometimes in phase and sometimes out of phase
(d) all of the above

110. Which of the following colour of light passes through glass with minimum speed?
(a) red (b) green
(c) yellow (d) violet

111. Colour of light is determined by its
(a) amplitude
(b) velocity in air
(c) wavelength
(d) state of polarization

112. The linear distance between succession points having same phase in a wave disturbance is called
(a) frequency
(b) amplitude
(c) phase difference
(d) wavelength

113. Which of the following phenomenon can not be explained by Newton's corpuscular theory?
(a) reflection

colour of a star?

(a) weight
(b) distance
(c) size
(d) temperature

115. Which phenomenon is responsible for formation of shadows?
(a) interference of light
(b) diffraction of light
(c) polarization of light
(d) propagation of light

116. What happens in the phenomenon of interference?
(a) annihilation of light
(b) re-distribution of light
(c) local addition of intensity
(d) none of these

117. Monochromatic light passing through a thick prism is
(a) polarised
(b) dispersed
(c) diffracted
(d) deviated

118. Which of the following is used as a remedy for defect of hypermetropia?
(a) convex lens
(b) concave lens
(c) cylindrical lens
(d) bifocal length lens

119. Which lens is used for curing colour blindness?
(a) contact lens
(b) cylindrical lens
(c) bifocal length lens
(d) none of the above

(d) astigmatism

121. A light ray is reflected from a denser medium. What is phase and path difference?

(a) 0, 0 (b) $\pi, \frac{\lambda}{2}$

(c) π, λ (d) $\frac{\pi}{2}, \frac{\lambda}{2}$

122. Least distance of distinct vision
(a) decreases with increase in age of a person
(b) increases with increase in age of a person
(c) varies with the age of a person
(d) does not vary with age of a person

123. Short sightedness in the eye occurs due to the
(a) contraction of eyeball
(b) increase in focal length of eye-lens
(c) reduction in focal length of eye-lens
(d) reduction in distance between retina and eye-lens

124. A youngman wearing glasses does not require bifocals because he
(a) is farsighted
(b) has the ability to accommodate
(c) is short sighted
(d) does not suffer form coma

125. What is the magnifying power of a convex lens of focal length 5 cm?
(a) 3 (b) 5
(c) 6 (d) 20

(c) appear slightly raised
(d) none of the above

127. The critical angle will be maximum when light travels from
(a) glass to air
(b) water to air
(c) glass to water
(d) water to glass

128. The variation of focal length when we pass from the central position to the periphery is called
(a) coma
(b) chromatic aberration
(c) spherical aberration
(d) astigmatism

129. Two lenses of focal length of are combined. The resultant focal length is
(a) f (b) 2f
(c) $\frac{f}{2}$ (d) zero

130. When a light ray enters a glass slab form air
(a) its frequency increases
(b) its wavelength increases
(c) its wavelength decreases
(d) neither frequency nor wavelength change

131. Which property of light waves does not vary with the medium?
(a) velocity
(b) frequency
(c) amplitude
(d) wavelength

132. Which are the types of wavefronts?
(a) spherical (b) planar
(c) cylindrical (d) all of the above

(d) elliptically

134. Dichorism means selective absorption of
(a) dispersed light
(b) scattered light
(c) unpolarised light
(d) one of the polarised components

135. To which interference antinodal curves correspond to
(a) constructive
(b) destructive
(c) neither constructive nor destructive
(d) both constructive and destructive

136. When exposed to sunlight, thin films of oil on water often exhibit brilliant colours due to the phenomenon of
(a) dispersion
(b) diffraction
(c) interference
(d) acceleration

137. Optically active substances are those which
(a) produce polarised light
(b) rotate plane of polarisation of polarised light
(c) produce double refraction
(d) none of the above

138. Light transmitted by Nicole prisms is
(a) unpolarised
(b) circularly polarised
(c) plane polarised
(d) elliptically polarised

139. Which is the light-sensitive tissue in the human eye?
(a) retina (b) pupil
(c) iris (d) cornea

(c) iris (d) cornea

141. Eye colour is the colour of
(a) iris (b) retina
(c) cornea (d) pupil

142. Which part is a hole located in the centre of the eye that allows light to enter the retina?
(a) iris (b) pupil
(c) cornea (d) fovea

143. Which is a transparent front part of the eye that covers the pupil, iris and anterior chamber?
(a) cornea (b) fovea
(c) sclera (d) choroid

144. What is the refractive power of cornea in humans?
(a) 13 dioptress
(b) 23 aioptress
(c) 33 disptress
(d) 43 dioptres

145. Which is a health care profession concerned with eyes as well as vision, visual system and vision information processing in humans?
(a) optometry
(b) ophthalmology
(c) telemetry
(d) psychology

146. Which is the branch of medicine that deals with the anatomy, physiology and diseases of the eye?
(a) ophthalmology
(b) psychology
(c) andrology
(d) gynecology

fringe
(c) remains unchanged
(d) none of the above

148. The central ring is bright in case of Newton rings produced by
(a) reflection
(b) wedges
(c) transmission
(d) none of these

149. The phenomenon of interference is explained by
(a) complex effect
(b) Newton's ring
(c) Raman's spectra
(d) emission spectra

150. A chromatic fringe can be obtained with
(a) white light
(b) coherent light
(c) incoherent light
(d) invisible light

151. Which is not an example of interference by division of wavefront
(a) Lylod's mirror
(b) Newton's rings
(c) Fresnel Bi-prism
(d) Young's slit

152. Which of the following devices can be used to observe interference?
(a) biprism
(b) prism
(c) spectrometer
(d) photometer

(c) scattering
(d) dispersion

154. Soap film exhibit brilliant colours in sunlight due to
(a) dispersion of light
(b) scattering of light
(c) interference of light
(d) diffraction of light

155. Which of the following phenomenon is not an interference phenonmeon?
(a) metallic surface when heated displays colours
(b) soap bubbles in sunlight show colours
(c) sky seems blue at noon but red at dawn and at evening
(d) oil spread on water surface exposed to sunlight

156. A fringe is a path of
(a) constant amplitude
(b) constant phase
(c) same wavelength
(d) none of these

157. Which method produces Newton's rings?
(a) division of wavefront
(b) division of amplitude
(c) addition of amplitude
(d) none of the above

158. Due to which phenomenon, an air bubble in water shines?
(a) dispersion
(b) reflection
(c) diffraction
(d) total internal reflection

160. Fresnel diffraction is
(a) a far field phenomenon
(b) a near field phenomenon
(c) both of the above
(d) none of the above

161. The spectrum obtained with a grating is called
(a) grating spectrum
(b) impure spectrum
(c) anomalous spectrum
(d) normal spectrum

162. Rising and setting sun appears to be reddish due to
(a) refraction of light rays
(b) scattering of light rays
(c) less temperature at sunset and sunrise
(d) interference of light rays

163. The dispersive power of a grating is
(a) light used
(b) separation of lines
(c) frequency of light used
(d) independent of wavelength

164. In a diffraction pattern, the width of any fringe is
(a) directly proportional to slit width
(b) inversely proportional to slit width
(c) independent of slit width
(d) none of the above

165. With which factor, dispersive power of a grating increases?
(a) order of spectrum
(b) number of lines per centimeter
(c) order and number of lines per centimeter
(d) all of the above

particles
(d) all of the above

167. Which of the following device produces plane polarised light?
(a) prism
(b) bi-prism
(c) Nicole prism
(d) none of the above

168. The vibrations of an unpolarised light can take place
(a) in all planes
(b) in one plane
(c) in no plane
(d) all are false

169. Light waves can be polarised because they
(a) are transverse in nature
(b) can be reflected
(c) have short wavelength
(d) have high frequencies

170. A plane of polarisation is one in which
(a) vibrations take place
(b) no vibrations take place
(c) longitudinal vibrations take place
(d) transverse vibrations take place

171. Light produced by a single Nicole is
(a) unpolarised
(b) plane polarised
(c) circulatory polarised
(d) elliptically polarised

172. Light waves can be polarised because they
(a) have short wavelengths
(b) have high frequencies
(c) can be reflected
(d) are transverse

(d) photons

174. In photometry what is the total luminous flux incident on the surface, per unit area?
(a) illuminance
(b) fluorescence
(c) luminance
(d) incandescence

175. What is the emission of light by a substance that has observed light or others electromagnetic radiation of a different wavelength?
(a) fluorescence
(b) illuminance
(c) luminance
(d) incandescence

176. What is the photometric measure of luminous intensity per unit area of light travelling in a given direction?
(a) luminance
(b) illuminance
(c) fluorescence
(d) irridiance

177. Candela per square meter (cd/m^2) is the SI unit for
(a) luminance
(b) irradiance
(c) illuminance
(d) fluorescence

178. In optics, which subfield studies the measurement of electromagnetic radiation, including visible light?
(a) radiometry
(b) photometry
(c) telemetry
(d) chronometry

(c) fluorescence
(d) irradiance

180. What is the radiometry term for the power of electromagnetic radiation per unit area at a surface?
(a) fluorescence
(b) luminance
(c) irradiance
(d) incandescence

181. What is the SI unit of irradiance or radiant emittance or radiant existence?
(a) w/m (b) w/m^2
(c) w/m^3 (d) w/m

182. Irradiance due to solar radiation is also called
(a) insulation
(b) isolation
(c) declamation
(d) insolation

183. What is the SI unit of spectral irradiance?
(a) w/m (b) w/m^2
(c) w/m^3 (d) w/cm

184. What is the SI derived unit of illuminnace?
(a) lux or lumens/m^2
(b) candela
(c) phot
(d) candela/cm

185. Which device is used for measuring illuminance in work environments?
(a) luxmeter
(b) photometer
(c) ammeter
(d) wattmeter

(d) mercury vapour lamp

187. For what the wavelength of LASER light can be used as a standard?
(a) time
(b) length
(c) weight
(d) temperature

188. A monochromatic light beam when passed through a prism is
(a) diffracted
(b) deviated
(c) polarised
(d) dispersed

189. Raman effect is due to
(a) coherent scattering
(b) incoherent scattering
(c) no scattering
(d) refraction

190. Which principle does not hold in non linear optics?
(a) Superposition principle
(b) Huygenes' principle
(c) energy conservation principle
(d) none of the above

191. On what principle, interferometers are based on?
(a) diffraction
(b) superposition
(c) interference
(d) scattering

192. Michelson's interferometer can be used to measure
(a) intensity of light
(b) amplitude of disturbance
(c) wavelength of light
(d) none of these

(d) none of these

194. The phenomenon of rotating the plane of vibration of polarised light is called
(a) polarisation
(b) optical cavity
(c) refraction
(d) reflection

195. Lenses of what diameter are usually not practical?
(a) less than 1 m
(b) larger than 1 m
(c) larger than 5 m
(d) larger than 10 m

196. Monochromatic light is a single _____
(a) frequency
(b) length
(c) amplitude
(d) pitch

197. Which type of microscope was the first to be developed?
(a) optical microscope
(b) digital microscope
(c) electron microscope
(d) none of these

198. Who is generally credited with the invention of first optical microscope?
(a) Hans Lippershery
(b) Giovanni Faber
(c) Galilee Galilei
(d) Isaac Newton

199. Which of the following structural components microscope is called "Ocular"?
(a) eyepiece (b) objective
(c) frame (d) diaphragm

(b) Robert Hooke
(c) Auton van Luuwenbhock
(d) Isaac Newton

201. In which country both microscope and telescope were invented?
(a) Italy
(b) England
(c) India
(d) Netherlands

202. Which type of telescope works on shorter wavelengths than ultraviolet light?
(a) ultraviolet telescope
(b) x-ray telescope
(c) infrared telescope
(d) submillimeter telescope

203. Which Italian inventor is credited with describing and sketching the first ideas for contact lens in 1508?
(a) Galileo Galilei
(b) Leonardo da Vinci
(c) Roger Bacon
(d) Hans Lippershey

204. Which eye problem can be rectified by using divergent lens?
(a) Myopia (Near-sightedness)
(b) Hyperopia (For sightedness)
(c) Presbyopia
(d) Astigmatism

205. What is the type of corrective lens used to correct or enhance the vision in only one eye?
(a) axicon
(b) monocle
(c) zoom lens
(d) camera lens

207. Which dimensionless number is a quantitative measure of lens speed?
(a) A-number
(b) F-number
(c) Avogadro's number
(d) none of these

208. Which phenomenon is an interference pattern caused by the reflection of light between a spherical surface and an adjacent flat surface?
(a) Newton's rings
(b) Diamond rings
(c) Engagement rings
(d) Uranus rings

209. Which of the following is a technique for recording and reproducing an image of an object through the use of interference effects?
(a) photography
(b) tomography
(c) holography
(d) cartography

210. How many colours comprise white light?
(a) infinite (b) one
(c) three (d) seven

211. For which colour is the fringe width minimum?
(a) red (b) green
(c) violet (d) yellow

212. On which parameter intensity of light depends on?
(a) frequency
(b) wavelength
(c) amplitude
(d) velocity
(d) total internal reflection

214. What is the path difference between the waves reaching the central fringe and bright fringe in Young's double slit experiment?
(a) zero (b) 3π
(c) 2π (d) 4π

215. Which are different types of emission spectrum?
(a) continuous spectrum
(b) line spectrum
(c) band spectrum
(d) all of the above

216. Which parameter determines the brightness of a light source sensed by an eye?
(a) light energy entering the eye
(b) wavelength of light
(c) total radiant flux entering the eye
(d) total luminous flux entering the eye

217. A photographic plate records sufficiently intense image when exposed with a 10 W source for 12 sec. How much time will be required with 12 W source?
(a) 8 sec (b) 9 sec
(c) 10 sec (d) 11 sec

218. Inverse square law for illuminance is valid for
(a) isotropic point source
(b) cylindrical source
(c) search light
(d) all types of sources

(c) half the original value
(d) one quarter of the original value

220. What is the unit of luminous efficiency of electric bulb?
(a) watt
(b) lux
(c) lumen
(d) lumen/watt

221. Candela is a unit of
(a) acoustic intensity
(b) electric intensity
(c) luminous intensity
(d) magnetic intensity

222. If the distance of a surface from light source is doubled, then the illuminance will become?
(a) 1/2 times (b) 2 times
(c) $\frac{1}{4}$ times (d) 4 times

223. As the wavelength is increased from violet to red, the luminosity
(a) increases continuously
(b) decreases continuously
(c) first increases then decreases
(d) first decreases then increases

224. Which of the following is the method used to measure the light speed in laboratory?
(a) Fizeau method
(b) Roemer Method
(c) Michelson method
(d) Foucault's method

(a) 20 lux (b) 40 lux
(c) 60 lux (d) 80 lux

226. Which instrument measures properties of light over a specific portion of the electromagnetic spectrum?
(a) Photometer
(b) Spectrometer
(c) Ammeter
(d) Lactometer

227. Persistence of vision is the phenomenon of the eye by which an afterimage is thought to persist for approximately one twenty-fifth of a second on the
(a) retina (b) heart
(c) mind (d) liver

228. Modern theoretical film runs at how many frames per second?
(a) 8 (b) 16
(c) 24 (d) 32

229. What is an elementary particle, the basic unit of light and all other forms of electromagnetic radiation?
(a) Phonon (b) Photon
(c) Neutron (d) Proton

230. Which portion of light has a wavelength in a range from 400 to 780 nm, with a frequency range of 405 to 790 Hz?
(a) infrared light
(b) visible light
(c) ultra-violet light
(d) none of the above

13. c 14. c 15. b 16. b
17. a 18. b 19. c 20. a
21. d 22. a 23. d 24. a
25. a 26. b 27. a 28. a
29. d 30. d 31. a 32. c
33. b 34. c 35. d 36. a
37. c 38. b 39. a 40. b
41. a 42. b 43. a 44. b
45. b 46. d 47. a 48. a
49. d 50. c 51. a 52. a
53. b 54. b 55. d 56. c
57. b 58. d 59. d 60. b
61. b 62. b 63. d 64. b
65. d 66. d 67. b 68. d
69. c 70. c 71. c 72. d
73. d 74. c 75. b 76. a
77. a 78. c 79. b 80. a
81. d 82. a 83. b 84. a
85. c 86. b 87. c 88. a
89. d 90. b 91. d 92. d
93. b 94. a 95. c 96. c
97. c 98. d 99. d 100. a
101. b 102. c 103. d 104. a
105. a 106. c 107. c 108. c
109. a 110. d 111. c 112. d
137. b 138. c 139. a 140. c
141. a 142. b 143. a 144. d
145. a 146. a 147. c 148. c
149. b 150. d 151. c 152. b
153. d 154. c 155. c 156. b
157. b 158. b 159. a 160. b
161. d 162. b 163. d 164. c
165. c 166. c 167. b 168. a
169. b 170. b 171. c 172. c
173. b 174. c 175. a 176. a
177. a 178. a 179. b 180. c
181. b 182. d 183. c 184. a
185. a 186. b 187. b 188. d
189. b 190. a 191. c 192. c
193. b 194. b 195. b 196. a
197. a 198. a 199. a 200. c
201. d 202. b 203. b 204. a
205. b 206. c 207. b 208. a
209. c 210. d 211. c 212. c
213. c 214. d 215. d 216. d
217. c 218. d 219. d 220. d
221. c 222. c 223. c 224. d
225. c 226. b 227. a 228. c
229. b 230. b