b. a resonance effect produced by the ultrasonic wave

c. an interference effect produced by the ultrasonic wave

d. a diffraction effect produced by the ultrasonic wave

27. A quartz crystal is capable of generating ultrasonic waves of frequency

   a. varying directly with the length of the crystal along the optic axis

   b. varying inversely with the length of crystal along the optic axis

   c. varying directly with the thickness of the crystal along the electrical axis

   d. varying inversely with the thickness the crystal along the electrical axis

28. The Clausius-Clapeyron equation indicates that the increase of pressure increases the melting point

   a. in the case of all substances

   b. in the case of substances which expand on solidification

   c. in the case of substances which contact on solidification

   d. in the case of substances which neither expand nor contract on solidification

29. The entropy of a thermodynamic system increases, when the system is made use of to convert

   a. heat into work at a constant temperature

   b. heat into work in a cyclic operation

   c. work into heat in a cyclic operation

   d. work into heat at a constant temperature

30. Consider the following statements regarding the transition of a system from one thermodynamic state to another:

   1. The heat absorbed by it along any reversible path is independent of the path

   2. The change of entropy of the system in a reversible process is independent of the path

   3. The change of entropy of the system in a irreversible process is also impendent of the path.

   Of these statements

   a. 1 and 2 are correct

   b. 2 and 3 are correct

   c. 2 alone is correct

   d. 1 alone is correct

31. The entropy of a gaseous system decreases, when the gas expands

a. freely, with doing any work

b. by seepage, without any change in volume

c. by doing work, isothermally

d. by doing work, adiabatically

32. Match List I with List II and select the correct answer using the codes given below the list:

List I
A. Absolute zero
B. Triple point
C. Critical temperature
D. Adiabatic work

List II
1. Gaseous state
2. Entropy of the universe
3. Third lad of thermodynamics
4. Sublimation
5. First law of thermodynamics

	A	B	C	D
a.	5	3	1	3
b.	3	4	1	5
c.	3	1	4	2
d.	5	4	2	1

33. A given mass of a gas at $27^{\circ}C$ is suddenly compressed until its volume is reduced to $\frac{1}{4}$ of its value. If the initial pressure is equal to atmospheric pressure and the value of $\gamma = 1.5$, then the final pressure is given by

   a. 2 atm

   b. 4 atm

   c. 8 atm

   d. 16 atm

34. The temperature-entropy diagrams of two engines A and B working between the same temperature T_1 and T_2 of the source and the sink respectively are shown in the given figures:

The efficiency of A

   a. is less than that of B

   b. is equal to that of B

   c. is greater than that of B

   d. and B cannot be compared on the basis of data given in the diagrams

35. When the temperature of a gas is increased at constant pressure, the potential energy of molecules

a. increases but their kinetic energy decreases

b. decreases but their kinetic energy increases

c. as well as their kinetic energy decrease

d. as well as their kinetic energy increase

36. The phenomenon of viscosity in gases is associated with momentum transport from 'high velocity' region to 'low velocity' region. The mean square velocity of those molecules which participate in the transfer of momentum across a hypothetical layer of the gas is given by

a. $2 kT/m$

b. $8 kT/\pi m$

c. $3 kT/m$

d. $4 kT/m$

37. The vessel containing a gas has a small hole in it causing the gas to leak. When the temperature is increased from 400 K to 900 K, the rate of leakage of the gas will

a. remain the same

b. increase by a factor 2.25

c. increase by a factor 1.5

d. decrease by a factor 0.44

38. Match List I with List II and select the correct answer, using the codes given below the list:

List I

A. $T_{inversion}$

B. T_{Boyle}

C. $T_{Critical}$

List II

1. $8a/27bR$

2. $2a/Rb$

3. a/Rb

4. $4a/Rb$

Codes:

	A	B	C
a.	2	3	1
b.	1	3	2
c.	3	4	1
d.	2	4	1

39. Planck's law for the distribution of energy in the spectrum of black body radiation goes over to Wien's law in the short wavelength region because of the fact that both these laws

a. assume continuous variation of energy

b. assume discontinuous variation of energy

c. use of same expression for different modes of vibration

d. lead to very small values for the probability factor

40. If a black body radiation in a spherical cavity of volume V satisfies the relation, PV^η = constant during a quasistatic isentropic process, then the numerical value of η should be

a. $7/5$

b. $5/3$

c. $4/3$

d. $3/2$

41. Consider the following statements regarding Brownian motion:

1. Mean displacement of a particle is proportional to time.

2. Mean square displacement of a particle is proportional to time.

3. Mean square displacement of a particle is proportional to the square of time.

4. Mean square displacement of a particle is proportional to the absolute temperature.

Of these statements

a. 1 alone is correct

b. 2 and 4 are correct

c. 3 and 4 are correct

d. 1 and 4 are correct

42. 'Critical temperature' is defined as the

a. lowest temperature at which the gas can be liquefied at constant pressure

b. lowest temperature at which the gas can be liquefied by increase of pressure alone

c. highest temperature at which the gas can be liquefied by increase of pressure alone

d. highest temperature at which the gas can be liquefied at constant pressure

43. Denoting temperature, entropy and internal energy by T. S and u respectively and their initial and final values by subscripts i and - f respectively, the Joule-Thomson expansion of an ideal gas can be expressed as

a. $u_f \neq u_i,\ T_f = T_i,\ S_f = S_i$

b. $u_f = u_i,\ T_f = T_i,\ S_f = S_i$

c. $u_f = u_i,\ T_f = T_i,\ S_f = S_i$

d. $u_f = u_i,\ T_f = T_i,\ S_f = S_i$

44. According to Einstein's equation for Brownian motion the mean value of squared displacement $\vec{x}^2$ per unit time interval depends upon temperature T,

coefficient of viscosity is η and radius of particles r. x^2 will be large if

a. T is large, r and η small
b. η is large, r and T small
c. r is large, η and T small
d. η and T are large, r is small

45 The points of unit angular magnification in a lens assembly are
a. principal points
b. focal points
c. nodal points
d. conjugate points

46 A glass container ($\mu = 1.65$) is filled with a liquid of reflective index 1.46. When light is incident normally on the surface, the amount of light transmitted through the container is
a. 100%
b. 88%
c. 44%
d. 36%

47 When a ray of light of frequency 6×10^{14} Hz travels from water of reflective index 4/3 to glass of reflective index 8/5, its
a. frequency decreases by a factor of 5/3
b. speed decreases by a factor of 5/6
c. wavelength increases by a factor of 6/5
d. speed increases by a factor of 6/5

48 Match List I with List II and select the correct answer using the codes given below the lists:
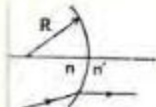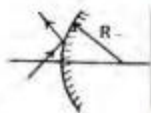
List I
(Ray diagram)

A.
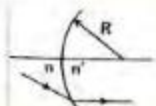
B.

C.

D.

List II
(Formula matrix)

1. $\begin{pmatrix} 1 & 0 \\ \dfrac{2}{|R|} & 1 \end{pmatrix}$

2. $\begin{pmatrix} 1 & 0 \\ -\dfrac{2}{|R|} & 1 \end{pmatrix}$

3. $\begin{pmatrix} 1 & 0 \\ \dfrac{n-n'}{|R|n} & \dfrac{n}{n'} \end{pmatrix}$

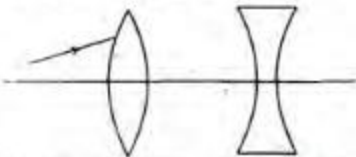4. $\begin{pmatrix} 1 & 0 \\ \dfrac{n'-n}{|R|n'} & \dfrac{n}{n'} \end{pmatrix}$

5. $\begin{pmatrix} 1 & 0 \\ \dfrac{n-n'}{|R|n} & \dfrac{n}{n'} \end{pmatrix}$ |R| is positive in all the above matrices

Code:

	A	B	C	D
a.	1	2	3	4
b.	3	4	1	2
c.	5	3	2	1
d.	3	4	2	1

49 A ray of light is incident from the left on a system of two lenses of focal lengths 30 cm and -10 cm separated by a distance of 10 cm as shown in the given figure

If the medium is taken as air, then the emergent ray can be traced by taking the system matrix as

a. $\begin{pmatrix} 1 & \dfrac{1}{10} \\ 0 & 1 \end{pmatrix}\begin{pmatrix} 1 & 0 \\ 10 & 1 \end{pmatrix}\begin{pmatrix} 1 & -\dfrac{1}{30} \\ 0 & 1 \end{pmatrix}$

b. $\begin{pmatrix} 1 & -\dfrac{1}{30} \\ 0 & 1 \end{pmatrix}\begin{pmatrix} 1 & 0 \\ 10 & 1 \end{pmatrix}\begin{pmatrix} 1 & \dfrac{1}{10} \\ 0 & 1 \end{pmatrix}$

c. $\begin{pmatrix} 1 & 0 \\ 10 & 1 \end{pmatrix}\begin{pmatrix} 1 & -\frac{1}{30} \\ 0 & 1 \end{pmatrix}\begin{pmatrix} 1 & \frac{1}{10} \\ 0 & 1 \end{pmatrix}$

d. $\begin{pmatrix} 1 & -\frac{1}{30} \\ 0 & 1 \end{pmatrix}\begin{pmatrix} 1 & \frac{1}{10} \\ 0 & 1 \end{pmatrix}\begin{pmatrix} 1 & 0 \\ 10 & 1 \end{pmatrix}$

50. Two lenses of focal lengths 10 and 20 cm and dispersive power 0.015 and 0.027 respectively will act as an achromatic doublet if they are separated by
    a. 5.5 cm
    b. 10.5 cm
    c. 13.5 cm
    d. 18.5 cm

51. A parallel beam of white light is allowed to fall axially on the slit of a spectrometer. A thin air film between parallel glass plates is placed in front of the slit. There are 250 fringes between 4000 A^0 and 6500 A^0. The order of the bright fringe corresponding to 6500 A^0 is
    a. 200
    b. 250
    c. 400
    d. 500

52. Match List I with List II and select the correct answer using the codes given below the list:
    List I
    (Defects)
    A. Spherical aberration
    B. Coma
    C. Distortion
    D. Chromatic aberration
    List II
    (Characteristics)
    1. Heterochromatic on and off axis
    2. Monochromatic on and off axis
    3. Monochromatic off axis only
    Codes:

	A	B	C	D
a.	1	2	3	3
b.	2	3	3	1
c.	3	2	3	1
d.	2	1	3	3

53. An astronomical telescope has an objective of focal length 80 cm and gives 8 x angular magnification. The focal length of they eye piece is
    a. 6.0 cm
    b. 8.0 cm
    c. 10.0 cm
    d. 12.0 cm

54. Match List I with List II and select the correct answer using the codes given below the lists:
    List I
    A. Newton's rings
    B. Interference from a wedge shaped film
    C. Fabry-Perot interferometer
    D. Interference by a dielectric film with a point source
    List II
    1. Non-localized fringes
    2. Haidinger fringes
    3. Fringes of equal thickness
    4. Localized fringes of equal thickness
    Codes:

	A	B	C	D
a.	1	2	3	4
b.	2	3	4	1
c.	3	4	1	2
d.	3	4	2	1

55. Consider the following statements:
    In Fraunhofer diffraction with a circular aperture we obtain
    1. a circular diffracted image of the aperture which is called Airy disc
    2. the Airy disc which is surrounded with circular dark and bright fringes
    3. Airy disc which is a circular dark spot.
    Of these statements
    a. 1, 2 and 3 are correct
    b. 2 and 3 are correct
    c. 1 and 2 are correct
    d. 1 and 3 are correct

56. An interference filter designed to isolate the wavelength 5461 A^0 with a material of refractive index 1.5 should have a thickness of
    a. 90 A^0
    b. 180 A^0
    c. 360 A^0
    d. 546 A^0

57. A laser beam passes normally through a diffraction grating which has its grating spaces vertical. Then the pattern seen on a screen behind the grating will be
   a. ____
    b. ⊚ ⊚ ⊚ ⊚ ⊚
    c. ‧ ‧ ‧ ‧ ‧|
    d. | | | | |

58. A mixture of unpolarized and circularly polarized light is passed through a quarter wave plate and then through an analyzer. As the analyzer is rotated
    a. there will be no variation in intensity

b. there are maximum and minima in intensity with $I_{min} = 0$

c. there are maxima and minima in intensity with $I_{min} \neq 0$

d. the result depends on the orientation of the quarter wave plate

59. A Raman frequency shift of 3000 cm^{-1} was observed for a substance. The substance will show infrared absorption at

a. 0.3μ

b. 3μ

c. 30μ

d. $300 A^0$

60. The given figure illustrates the passage of the ordinary and extraordinary wave fronts O and E through a uniaxial crystal. The figure represents crystal orientation with its
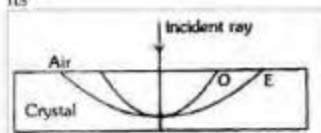
a. optic axis in the plane of incidence and parallel to the crystal surface

b. optic axis perpendicular to the plane of incidence and parallel to the crystal surface

c. optic axis in the plane of incidence and perpendicular to the crystal surface

d. optic axis perpendicular to the plane of incidence and perpendicular to the crystal surface

61. An incident light is viewed through a rotating nicol prism. Match List I with List II and select the correct answer using the codes given below the lists.

List I

(Polarisation of light incident on rotating nicol prism)

A. Circularly polarised

B. Elliptically polarised

C. Mixture of plane polarised and unpolarised light

D. Plane polarised light

E. Unpolarised light

List II

(Intensity of light as observed through rotating nicol prism)

1. Intensity changes and vanishes

2. Intensity changes but is never completely extinguished

3. Intensity does not change

Codes:

	A	B	C	D	E
a.	2	3	1	2	3
b.	1	1	2	3	3
c.	3	2	2	1	3
d.	3	2	1	3	1

62. Holograms can be constructed

a. and viewed by white light

b. by lasers but viewed by white light

c. by monochromatic light and viewed by lasers

d. by white light and viewed by lasers

63. In He-Ne laser the most favourable ratio of Helium to Neon for satisfactory laser action is

a. 1:4

b. 4:1

c. 1:7

d. 7:1

64. A charged body has an electric flux (ϕ) associated with it. The body is now placed inside a metallic container. The electric flux ϕ_1 outside the container will be

a. $\phi_1 = 0$

b. $0 < \phi_1 < \phi$

c. $\phi_1 = \phi$

d. $\phi_1 > \phi$

65. The electric field at 20 cm from the centre of a uniformly charged dielectric sphere of radius 10 cm is E. Then, at a distance 5 cm from the centre it will be

a. 16 E

b. 4 E

c. 2 E

d. zero

66. Consider the following conclusions regarding the components of an electric field at a certain point is space given by $E_x = -K_y, E_y = K_x, E_z = 0$

1. The field is conservative

2. The field is non conservative

3. The lines of force are straight lines

4. The lines of forces are circles

Of these conclusions

a. 2 and 4 are valid

b. 1 and 3 are valid

c. 1 and 4 are valid

d. 2 and 3 are valid

67. The electric field at a point due to an electric dipole is perpendicular to the dipole axis, if the angle between the dipole axis and the line joining the point with the centre of the dipole is

a. $\tan^{-1}\left(\frac{1}{\sqrt{2}}\right)$

b. $\tan^{-1}(1)$

c. $\tan^{-1}(\sqrt{2})$

d. $\tan^{-1}(\sqrt{3})$

68. The force of attraction between two coaxial electric dipoles with moments P_1 and P_2, whose centres are r meters apart, varies with distance r, as

a. r^{-1}

b. r^{-2}

c. r^{-3}

d. r^{-4}

69. A charge q is placed at a distance $d/2$ above the centre of a horizontal square surface of side d. The flux of electric field through the square surface will be

a. $2q/\varepsilon_0$

b. q/ε_0

c. $q/2\varepsilon_0$

d. $q/6\varepsilon_0$

70. A capacitor of capacitance 1 μF is charged by connecting it to a battery of emf 10 V. The capacitor is then disconnected and reconnected to the battery with the polarity reserved. The heat developed in the connecting wires will be equal to

a. 0.5×10^{-4} J

b. 1.0×10^{-4} J

c. 2.0×10^{-4} J

d. 2.5×10^{-4} J

71. When a current of 2 A flows in a battery from negative to positive terminal, the p.d across it is 12 V. If a current of 3 A flowing in the opposite direction procedures a p.d. of 15 V, the emf of the battery is

a. 12.6 V

b. 13.2 V

c. 13.5 V

d. 14.0 V

72. An ammeter can read currents upto 2 A. If its coil has resistance of 25Ω and takes 1mA for full-scale deflection, the resistance of the shunt used should be

a. 1.5×10^{-2} Ω

b. 1.25×10^{-2} Ω

c. 1.0×10^{-2} Ω

d. 1.25×10^{-3} Ω

73. The horizontal component of the earth's magnetic field at a place is 3×10^{-4} T and the dip is $\tan^{-1}(4/3)$. A metal rod of length 0.25 m placed in the north-south position is moved at a constant steed of 10 cm/s towards the east. The emf induced in the rod will be

a. zero

b. 1 μV

c. 5 μV

d. 10 μV

74. A coil, a capacitor and an AC source of rms voltage 24 V are connected in series. By varying the frequency of the source, a maximum rms current of 6 A is observed. If this coil is connected to a battery of emf 12 V and internal resistance 4Ω, the current through it will be

a. 2.4 A

b. 1.8 A

c. 1.5 A

d. 1.2 A

75. Which one of the following statements is correct?

a. Voltage across L and C in series are 180^0 out of phase, while for L and C in parallel the currents are 180^0 out of phase

b. An inductor is used in series for effective filtering of low frequency ac.

c. In circuit used for transporting electric power, a high power factor implies power losses in transmission

d. Power factor can often be improved by the used of higher resistance in circuit

76. A current of 12A is passed along the length of a silver strip 1 cm wide and 0.1 mm thick. A transverse magnetic field of 1.6 T is applied. Assuming the number of atoms per unit volume of silver to be 6×10^{28} per m^3, the 'Hall emf' produced will be

a. 2.0×10^{-6} V

b. 2.0×10^{-5} V

c. 1.5×10^{-4} V

d. 3.2×10^{-4} V

77. When a current carrying thin rectangular copper shed is placed in a magnetic field such that the direction of current and magnetic field are perpendicular to each other, voltage developed across the sheet will be

a. in the direction of the current

b. in the direction of the magnetic field

c. in the plane containing the directions of current and the magnetic field

d. in the direction perpendicular to both the direction of current and magnetic field

78. If the temperature of the cold inaction of a thermocouple is increased, then the
   a. temperature of inversion is increased
   b. temperature of inversion is lowered
   c. temperature of inversion does not change
   d. neutral temperature changes accordingly

79. The smallest temperature difference that can be detected with a thermocouple of thermo e.m.f. 30 μV per degree and a galvanometer of 50 Ω resistance, capable of detecting current as low as 3×10^{-7} A, is
   a. 0.5^0
   b. 1.0^0
   c. 1.5^0
   d. 2.0^0

80. The energy density of an e.m wave given by
   $E = (50 \text{ N/C}) \sin (\omega t - kx)$ will be nearly
   a. 10^{-8} Jm^{-3}
   b. 10^{-7} Jm^{-3}
   c. 10^{-6} Jm^{-3}
   d. 10^{-5} Jm^{-3}

81. The frequency of a cyclotron oscillator is 10^7 Hz. The cyclotron is accelerating protons ($m_p = 1.67 \times 10^{-}$ kg). If the radius of the dees of the cyclotron be 0.6 m, the kinetic energy of the proton beam produced by the accelerator will be nearly
   a. 1.2×10^{-13} J
   b. 1.2×10^{-12} J
   c. 2.4×10^{-12} J
   d. 4.8×10^{-12} J

82. The electric field between the plates of a velocity selector in a Bainbridge mass spectrometer is 120000 volt/m and the magnetic induction in both magnetic fields is 0.6 Web/m^2. A stream of singly charged ions moves in a circular path of 7.25 cm radius in the magnetic field. Given that 1 amu 1.66×10^{-27} kg, the mass number of the isotope is
   a. 22
   b. 13
   c. 11
   d. 9

83. The cathode ray particles originate in a discharge tube from the
   a. cathode
   b. anode
   c. source of high voltage
   d. residual gas

84. Match List I with List II and select the correct answer using the codes given below the lists:
   List I
   (Experiments)
   A. de Brogue wavelength
   B. Discrete atomic energy level
   C. Localization of nuclear charge
   D. Measurement of e/m
   List II
   (Scientists)
   1. Rutherford
   2. Franck-Hertz
   3. Bohr
   4. J.J. Thomson
   5. Davisson-Germer
   Codes:

	A	B	C	D
a.	5	2	1	4
b.	3	2	1	5
c.	5	3	2	4
d.	4	2	3	5

85. The angular momentum of the α-particles which are scattered through large angles by the heavier nuclei, is conserved because of the
   a. nature of the repulsive forces
   b. conservation of linear momentum
   c. conservation of kinetic energy
   d. conservation of total energy

86. For hydrogen atom, the difference between any two consecutive energy levels (where 'n' is the principal quantum number)
   a. is always the same
   b. decreases inversely with n
   c. decreases inversely with n^2
   d. decreases inversely with n^3

87. Light coming from the discharge tube filled with hydrogen falls on the cathode of the photoelectric cell. The work function of the surface of cathode is 4 eV. Which one of the following values of the anode voltage (in V) with respect to the cathode will make the photocurrent zero?
   a. -4
   b. -6
   c. -8
   d. -10

88. When a certain metallic surface is irradiated with monochromatic light of wavelength λ, the stopping potential for photoelectric current is 3 V_0. When the

same surface is irradiated with light of wavelength 2λ, the stopping potential is V_0. The threshold wavelength for the given surface is

a. 4λ
b. 6λ
c. 8λ
d. $4\lambda/3$

89. The change in wavelength in Compton effect is
   a. independent of the frequency of incident radiation
   b. dependent on the frequency of incident radiation
   c. dependent on the nature of the scattering material
   d. dependent on the intensity of incident radiation

90. Consider the following statements regarding radioactive element emitting a β-particle:
   1. The atomic number of the element increases by one unit.
   2. The atomic number of the element decreases by one unit.
   3. The mass number of the element decreases by one unit.
   4. The mass number of the element remains the same.
   Of these statements
   a. 1 and 2 are correct
   b. 2 and 3 are correct
   c. 1 and 4 are correct
   d. 3 and 4 are correct

91. An artificial radioactive decay series begins with unstable $_{94}Pu^{241}$. The stable nuclide obtained after eight α-decays and five β-decays is
   a. $_{80}Hg^{201}$
   b. $_{81}Tl^{205}$
   c. $_{82}Pb^{209}$
   d. $_{83}Bi^{209}$

92. An X-ray tube is operating at 15 KV. The lower limit of the wavelength of X-rays produced is
   a. 0.82×10^{-7} m
   b. 0.82×10^{-8} m
   c. 0.82×10^{-10} m
   d. 0.82×10^{-13} m

93. An average nucleus consists of
   a. neutrons, protons and electrons with the nuclear force $f(r) \sim \dfrac{1}{r^2}$

b. neutrons and protons with nuclear force $f(r) \sim \dfrac{1}{r^2}$

c. neutrons, protons and electrons with nuclear force $f(r) \sim \dfrac{1}{r^n}$, $n > 2$

d. neutrons and protons with nuclear force $f(r)$, $n > 2$

94. One of the probable fission reactions of Pu^{239} is

$_{94}Pu^{239} + _0n^1 \rightarrow _{z_1}X^{A_1} + _{z_2}X^{A_2} + 3 _0n^1$

Which one of the following statements is correct?
   a. $Z_1 + Z_2 = 94$ and $A_1 + A_2 = 240$
   b. $Z_1 + Z_2 = 91$ and $A_1 + A_2 = 240$
   c. $Z_1 + Z_2 = 94$ and $A_1 + A_2 = 237$
   d. $Z_1 + Z_2 = 91$ and $A_1 + A_2 = 237$

95. In Carbon-Nitrogen cycle of nuclear fusion, the sequence in which C_6^{12} gets converted is
   a. $N_8^{13}, C_6^{13}, O_8^{15}, N_7^{14}, N_7^{15}$
   b. $N_7^{15}, O_8^{15}, N_7^{14}, C_6^{13}, N_7^{13}$
   c. $N_7^{13}, C_6^{13}, N_7^{14}, O_8^{15}, N_7^{15}$
   d. $N_7^{13}, N_7^{14}, O_8^{15}, N_7^{15}, C_6^{13}$

96. The energy released in the fusion of six deuterium atoms is 42 MeV. (Abundance of deuterium is 0.0156%). If all the deuterium atoms from a lake containing 10^{10} molecules of water are used up in fusion, the amount of energy released will be
   a. $14 \times 0.0156 \times 10^{10}$ MeV
   b. $7 \times 1.56 \times 10^{10}$ MeV
   c. $14 \times 1.56 \times 10^{10}$ MeV
   d. $7 \times 0.0156 \times 10^{10}$ MeV

97. The magnitude of the DeBroglie wavelength (λ) of electron (e), proton (p), neutron (n) and x particle (α) all having the same energy of 1 MeV, in the increasing order will follow the sequence
   a. $\lambda_e, \lambda_p, \lambda_n, \lambda_\alpha$
   b. $\lambda_\alpha, \lambda_n, \lambda_p, \lambda_e$
   c. $\lambda_n, \lambda_\alpha, \lambda_p, \lambda_e$
   d. $\lambda_p, \lambda_e, \lambda_n, \lambda_\alpha$

98. Which one of the following processes is an example of weak decay?
   a. $\pi^0 \rightarrow \gamma + e^+ + e^-$
   b. $\pi^0 \rightarrow \gamma + \gamma$
   c. $n \rightarrow p + e^- + \bar{\nu}_e$
   d. $\gamma \rightarrow e^+ + e^-$

99. A triode valve having a plate resistance of 25 kΩ is used in an oscillator with a load resistance of 50 kΩ. If the gain of the oscillator is 20, then the amplification factor of the valve is
   a. 40/3
   b. 20
   c. 30
   d. 50

100. The depletion layer in a p-n junction diode consists of layers of
   a. positively charged donors on the p-side and negatively charged acceptors on the n-side
   b. negatively, charged donors on the p-side and positively charged acceptors on the n-side
   c. positively charged donors on the n-side and negatively charged acceptors on the p-side
   d. negatively charged donors on the π-side and positively charged acceptors on the p-side

101. Match List I with List II and select the correct answer using the codes given below the lists:

List I
A. Plate resistance
B. Amplification factor
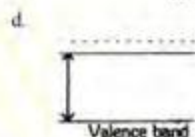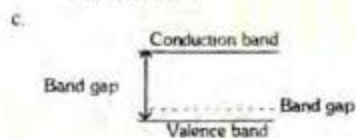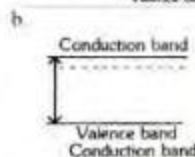C. Trans-conductance
D. Cutoff voltage

List II

1. $\left(\dfrac{\partial l_p}{\partial v_s}\right)_{v_s}$ = Const

2. $-\dfrac{v_p}{\mu}$

3. $\left(\dfrac{\partial v_p}{\partial l_p}\right)_{v_s}$ = Const

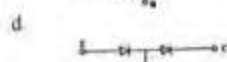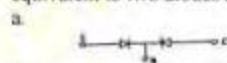4. $-\left(\dfrac{\partial v_p}{\partial l_p}\right)_{v_s}$ = Const

Codes:

	A	B	C	D
a.	1	2	3	4
b.	3	2	4	1
c.	4	3	1	2
d.	3	4	1	2

102. Which one of the following diagrams correctly represents the energy levels in the p-type semi-conductor?
   a.

b.


c.

d.

103. A npn transistor can be considered to be equivalent to two diodes as shown in
   a.
   b.
   c.
   d.

104. Which one of the following is true for the mid-frequency voltage gain A_{vm} and the phase difference ϕ between output and input signals in RC coupled CE transistor amplifier?
   a. A_{vm} is highest and ϕ is 90°
   b. A_{vm} is lowest and ϕ is 180°
   c. A_{vm} is highest and ϕ is zero
   d. A_{vm} is highest and ϕ is 180°

105. Which one of the following circuits is to be selected for doubling the input voltage?
   a.
   b.
   c.
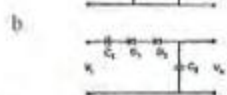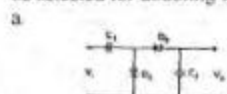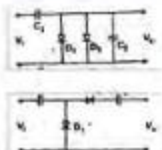
d.

106. The Truth table for two input NAND Gate is given by

a.

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

b.

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

c.

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

d.

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

107. Match List I with List II and select the correct answer using the codes given below the lists:

List I
(gates with inputs X and Y)
A. OR
B. AND
C. NOR
D. Exclusive OR
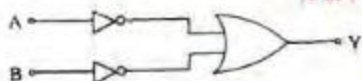
List II
(Outputs)
1. $(X+Y)(\overline{XY})$
2. $X+Y$
3. XY
4. $\overline{X+Y}$

Codes:

	A	B	C	D
a.	2	3	4	1
b.	4	2	1	3
c.	2	4	1	3
d.	4	3	2	1

108. The output Y from the following logic gate circuit

will be
a. $\overline{A}+\overline{B}$
b. A.B
c. $\overline{A.B}$
d. $\overline{A+B}$

109. **Assertion (A):** The work done in bringing a body down from the top to the base along a frictionless inclined plane is the same as the work done in bringing it down along the vertical side.
Reason (R): The gravitational force on the body along the inclined plane is the same as that along the vertical side.
a. Both A and R are true and R is the correct explanation of A
b. Both A and R are true but R is not a correct explanation of A
c. A is true, but R is false
d. A is false, but R is true

110. **Assertion (A):** The pressure exerted by a gas is the same and independent of the 'size' of the molecules.
Reason (R): Molecular collisions will invariably change the velocities of individual molecules but the number of molecules having any particular velocity will remain unaltered.
a. Both A and R are true and R is the correct explanation of A
b. Both A and R are true but R is not a correct explanation of A
c. A is true, but R is false
d. A is false, but R is true

111. **Assertion (A):** A vibrating tuning fork sounds louder when its stem is put against a desk top
Reason (R): When a wave reaches another denser medium, part of the wave is reflected.
a. Both A and R are true and R is the correct explanation of A
b. Both A and R are true but R is not a correct explanation of A
c. A is true, but R is false
d. A is false, but R is true

112. **Assertion (A):** Raman spectrum of a liquid contains lines whose wavelengths are longer and shorter than the incident radiation.

Reason (R): If a photon strikes an atom or a molecule in a liquid, which is in the excited state, the photon gains energy.

a. Both A and R are true and R is the correct explanation of A
b. Both A and R are true but R is not a correct explanation of A
c. A is true, but R is false
d. A is false, but R is true

113. Assertion (A): During a quasi-static isothermal compression of copper work done exceeds the heat liberated.

Reason (R): The internal energy of a thermodynamic system depends on volume besides temperature when the atoms of the system are held together by strong forces.

a. Both A and R are true and R is the correct explanation of A
b. Both A and R are true but R is not a correct explanation of A
c. A is true, but R is false
d. A is false, but R is true

114. Assertion (A): Dielectric breakdown occurs under the influence of an intense light beam.

Reason (R): Electromagnetic radiation exerts pressure.

a. Both A and R are true and R is the correct explanation of A
b. Both A and R are true but R is not a correct explanation of A
c. A is true, but R is false
d. A is false, but R is true

115. Assertion (A): Fragments produced in the fission of U^{235} are β active.

Reason (R): The fragments have abnormally high proton to neutron ratio.

a. Both A and R are true and R is the correct explanation of A
b. Both A and R are true but R is not a correct explanation of A
c. A is true, but R is false
d. A is false, but R is true

116. Assertion (A): The magnetic flux through a closed surface is zero.

Reason (R): Gauss' law applies in the case of electric flux only.

a. Both A and R are true and R is the correct explanation of A
b. Both A and R are true but R is not a correct explanation of A
c. A is true, but R is false
d. A is false, but R is true

117. Assertion (A): In a stationary wave there is no transfer of energy.

Reason (R): The ratio of kinetic energy to potential energy is a constant independent of the position.

a. Both A and R are true and R is the correct explanation of A
b. Both A and R are true but R is not a correct explanation of A
c. A is true, but R is false
d. A is false, but R is true

118. Assertion (A): A changing electric-field produces a magnetic field.

Reason (R): A changing magnetic-field produces an electric field.

a. Both A and R are true and R is the correct explanation of A
b. Both A and R are true but R is not a correct explanation of A
c. A is true, but R is false
d. A is false, but R is true

119. Assertion (A): Isotopes of an element can be separated using a mass-spectrometer.

Reason (R): Separation of isotopes is possible because of the difference in electron numbers of isotopes.

a. Both A and R are true and R is the correct explanation of A
b. Both A and R are true but R is not a correct explanation of A
c. A is true, but R is false
d. A is false, but R is true

120. Assertion (A): Electron capture occurs more often than positron emission in heavy elements.

Reason (R): Heavy elements exhibit radioactivity.

a. Both A and R are true and R is the correct explanation of A
b. Both A and R are true but R is not a correct explanation of A
c. A is true, but R is false
d. A is false, but R is true

PHYSICS

1. If the Earth is considered as a sphere of radius 'r' and density 'ρ', the gravitational intensity at the surface is given by $g = kr\rho$ where k is a constant. Then the dimensions of k are
   a. MLT^{-2}
   b. $ML^{-1}T^{-1}$
   c. $ML^{-3}T^{2}$
   d. $M^{-1}L^{3}T^{-2}$

2. If the resultant of two forces $(F_1 + F_2)$ and $(F_1 - F_2)$ is $\sqrt{\left(F_1^2 + F_2^2\right)}$, then the angle between these forces is
   a. $\cos^{-1}\left\{-\dfrac{F_1^2 - F_2^2}{F_1^2 + F_2^2}\right\}$
   b. $\cos^{-1}\left\{\dfrac{F_1^2 + F_2^2}{F_1^2 - F_2^2}\right\}$
   c. $\cos^{-1}\left\{-\dfrac{F_1^2 + F_2^2}{2\left(F_1^2 - F_2^2\right)}\right\}$
   d. $\cos^{-1}\left\{-\dfrac{2\left(F_1^2 - F_2^2\right)}{F_1^2 + F_2^2}\right\}$

3. A particle moves uniformly with the speed v along the parabolic path $y = kx^2$. Taking k as a positive constant, acceleration of the particle at $x = 0$ is given by
   a. $2kv^2$
   b. kv^2
   c. $\dfrac{kv^2}{2}$
   d. $2kv$

4. If a ball is dropped from rest, it bounces from the floor repeatedly. The coefficient of restitution is 0.5 and the speed just before the first bounce is 5 m/s. The total time taken by the ball to come to rest is
   a. 2 s
   b. 1 s
   c. 0.5 s
   d. 0.25 s

5. A weight, W is suspended from the midpoint of a rope, whose ends are at the same level. In order to make the rope perfectly horizontal, the force applied to each of its ends must be

a. less than W
b. equal to W
c. equal to 2 W
d. infinitely large

6. The mass of a rocket is M and the total mass of the rocket and the fuel is M_0. The average exhaust velocity of gases ejected from rocket motors is u and the final velocity attained by the rocket after using up all fuel is v. The final velocity v is proportional to
   a. $\log\left(\dfrac{M_0}{M}\right)$
   b. $\left(\dfrac{Mu}{M_0}\right)$
   c. $(M_0 - M)$
   d. $(M_0 - M)^{-1}$

7. Four spheres each of diameter 2a and mass m are placed with their centres on the four corners of a square of side b. The moment of inertia of the system about any side of the square will be
   a. $\dfrac{8}{5}ma^2 + 4mb^2$
   b. $\dfrac{8}{5}ma^2 + 16mb^2$
   c. $\dfrac{8}{5}ma^2 + 2mb^2$
   d. $\dfrac{16}{5}ma^2 + 8mb^2$

8. A 10^4 kg rocket standing on its launch pad can expel exhaust gas at the speed of 2×10^3 m/s. Just to lift the rocket from the ground the exhaust gas must be rejected at
   a. 4.9 kgs^{-1}
   b. 49 kgs^{-1}
   c. 490 kgs^{-1}
   d. 980 kgs^{-1}

9. Which one of the following gives the force required to accelerate a car of mass 200 kg from rest to 30 m/s in 12 sec if the frictional force between the tyres and the ground is 0.2 Newton per kg?
   a. 5400 N
   b. 5000 N
   c. 4600 N

d. 400 N

10. Let Rs and Rm be the distances of the geostationary satellite and moon from the centre of the earth. The Rm/Rs is approximately
    a. $(29)^{1/7}$
    b. $(29)^{2/3}$
    c. 29
    d. $(29)^{1/2}$

11. A satellite is moving in a circular orbit round the earth with a diameter of the orbit 2R. At a certain point a rocket fixed to the satellite is fired such that it increases the velocity of the satellite tangentially. The resulting orbit of the satellite would be
    a. same as before
    b. circular orbit with diameter greater than 2R
    c. elliptical orbit with minor axis 2R
    d. elliptical orbit with major axis 2R

12. If u is the velocity of a particle and c the velocity of light, its relativistic mass m will exceed its rest mass m_o by 4% when the ratio u/c is
    a. 0.4
    b. 0.3
    c. 0.2
    d. 0.1

13. A 2 kg stone is tried at the end of wire of length 2m and whirled in a vertical circle. When the stone is at the lowest point on the circle, the tension in the wire is 101 N. The velocity of the stone at that point is
    a. 8 m/s
    b. 9 m/s
    c. 10 m/s
    d. 11 m/s

14. A particle of mass m is moving under the force $\vec{F}$. If $|\vec{F}|$ is constant, then the possible path of the particle can never
    a. rectilinear
    b. circular
    c. parabolic
    d. elliptical

15. Moderation or slowing down of neutrons is achieved by collision of neutrons with moderator atoms such as deuterium atom. Assuming deuterium atoms to be at rest initially and the collisions as central and elastic, the fractional change in velocity of neutron due to a single collision is approximately
    a. 1/3
    b. 2/3

c. 3/3
d. 4/3

16. A tennis ball receives a top spin when struck by a racket and describes a curve trajectory. The top spin implies that the rotatory motion of the top surface of the ball is in the direction of the translatory motion of the ball. Which one of the following statements is the best description of the trajectory?
    a. Pressure on the top surface is lower; trajectory rises
    b. Pressure on the top surface is lower; trajectory dips
    c. Pressure on the top surface is hither; trajectory rises
    d. Pressure on the top surface is higher; trajectory dips

17. Gun shots are made by pouring down molten lead through a sleeve from the top of a tower. The molten liquid while descending breaks into spherical droplets due to
    a. terminal velocity
    b. friction between droplets
    c. viscosity
    d. surface tension

18. A soap bubble of radius r is placed on another soap bubble of radius R (R ? r). Then radius of curvature R_f of the soap film separating the two bubbles is given by
    a. $\dfrac{Rr}{R-r}$
    b. R-r
    c. R+r
    d. $\sqrt{R^2+r^2}$

19. Two spherical metal balls (of the same material) with radii 0.2 cm and 0.3 cm are falling through a fluid at constant speeds. If the velocity of the 1st ball (radius = 0.2 cm) is 4 cm/sec. What is that of the other ball?
    a. 6 cm/s
    b. 8 cm/s
    c. 9 cm/s
    d. 12 cm/s

20. Match List I with List II and select the correct answer using the codes given below the lists:
    List I
    (Types of waves)
    A. Longitudinal progressive waves
    B. Transverse progressive waves
    C. Longitudinal stationary waves

D. Transverse stationary waves

List II

(Phenomenon)

1. Vibrations of the stretched wire of sonometer
2. Vibrations of the air column of Resonance Apparatus
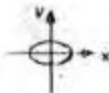3. Ripples formed on water surface
4. Tuning fork vibrating in air

	A	B	C	D
a.	4	3	2	1
b.	1	2	3	4
c.	2	1	4	3
d.	4	3	1	2

21. A particle is moving under the action of two simple harmonic forces. The forces are of equal magnitude and phase difference is $(\pi/2)$. The path taken by the particle would be represented by
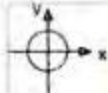
a.
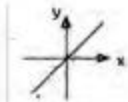
b.

c.

d.

22. In the case of beats, the amplitude varies at a frequency equal to
   a. average frequency of the two interfering sound waves
   b. twice the frequency difference of the two interfering sound waves
   c. the frequency difference of the two interfering sound waves
   d. half the frequency difference of the two interfering sound waves

23. Given that in Doppler effect, v is the velocity of sound in air, v_s and v_0 are velocities of the source and the observer, n the frequency of sound, match List I with

list II and choose the correct answer using the codes given below the lists:

List I

A. Source moving away from observer at rest
B. Source at rest and the observer moving away from the source
C. Source at rest and observer moving towards the source
D. Source moving towards the observer at rest

List II

1. $n' = n\left(\dfrac{v}{v - v_s}\right)$

2. $n' = n\left(\dfrac{v}{v + v_s}\right)$

3. $n' = n\left(\dfrac{v - v_0}{v}\right)$

4. $n' = n\left(\dfrac{v + v_0}{v}\right)$

	A	B	C	D
a.	2	3	4	1
b.	4	3	2	1
c.	3	2	4	1
d.	2	1	3	4

24. A rocket, moving away from earth with a speed of 0.01 C, gives a signal of frequency 33.33 MHz, where C is the velocity of electromagnetic waves. The apparent frequency observed on earth is
   a. 32.67 MHz
   b. 33.00 MHz
   c. 33.67 MHz
   d. 34.00 MHz

25. A wire under tension vibrates with a fundamental frequency of 460 Hz. If the length of the wire is halved, radius made twice and is made to vibrate under one-fourth the tension, then the fundamental frequency will now be equal to
   a. 920 Hz
   b. 460 Hz
   c. 230 Hz
   d. 115 Hz

26. Pattern of maximum and minimum intensity distribution of light observed when a monochromatic light passes through a liquid traversed by ultrasonic wave is
   a. a standing wave pattern produced by the ultrasonic wave