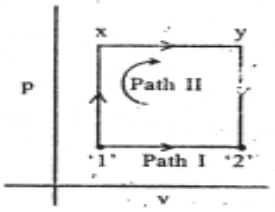
PHYSICS

1. A telescope of aperture 0.05 m views a wire gauge from a distance of 50 m by using illuminating light of wavelength 500 nm. The smallest structure in the wire-gauge which it can clearly shows is
   a) 6.1×10^{-4}m b) 1.2×10^{-7}m
   c) 1.0×10^{-3}m d) 5.0×10^{-2}m
2. The product of the lateral and angular magnifications of a lens system of the first focal length f_1 and second focal length f_2 is given by
   a) $+f_1/f_2$ b) $-f_1/f_2$
   c) $+f_1 f_2$ d) $-f_1 f_2$
3. The spherical aberration may be reduced by using a crossed lens. If the refractive index of the lens material is 1.5, the lens should have the radii of curvature R_1 and R_2 such that R_1/R_2 should be
   a) +6 b) –6
   c) –1/6 d) +1/6
4. In a diffraction grating experiment, the grating has 10^5 rulings. Then, in the λ =5000 Å region of the spectrum and in the second order, the grating can resolve two lines with a wavelength difference o
   a) 2.5 Å b) 0.25 Å
   c) 0.025 Å d) 25 Å
5. Which of the following can b diffracted?
   1. Radio wave
   2. Sound waves
   3. Microwaves 4. X-rays
   Select the orrect answer using the codes given below :
   a) 2 onl b) 2 and 4
) 1 and 3 d) 1, 2, 3 and 4
6. A quarter wave plate is designed for a wavelength of 600 nm. The difference in refractive indices for the electric components along the fast and the slow axes is 0.2. The geometrical thickness of the plate will be
   a) 120 nm b) 750 nm
   c) 1200 nm d) 3000 nm
7. Consider two light waves represented by two matually perpendicular electric field vectors : $E_x = A_x \cos(\omega_x t + \varphi_x)$ and $E_y = A_y \sin(\omega_y t + \varphi_y)$.
   a) $A_X = A_y, \varphi_X = \pi/2, \varphi_y = \pi$
   b) $\varphi_X = \varpi_y, \varphi_X = \pi/2, \varphi_y = \pi$
   c) $A_X \neq A_y, \omega_X = \omega_y, \varphi_y = 0$
   d) $A_X = A_y, \omega_X = \omega_y, \varphi_X \neq \varphi_y$
8. For a particular medium, θ_C is the critical angle for total internal reflection and θ_B is the Brewste angle for the same medium. Then which one of the follow ng relationships will hold?
   a) $\sin\theta_C = \cot\theta_B$
   b) $\cos\theta_C = \tan\theta_B$
   c) $\tan\theta_C = i\theta_B$
   d) $\cot\theta_C = \cos\theta$
9. A 10 W las r beam (λ_0=0.6μm) is launch d on a lens of focal length 10 cm. The diameter of the aser beam is 4 mm. The area of the ocussed spot is approximately given by
   a) 2.25×10^{-10} cm2
   b) 2.25×10^{-6} cm2
   c) 2.25×10^{-8} m2
   d) 3×10^{-9} m2
10. Which of the following can be called a set of a low power laser and a high power laser, respectively?
    a) He-Ne laser and a GaAs diode laser
    b) Q-switched laser and mode locked laser
    c) He-Ne laser and a CO_2 laser
    d) Ruby laser and a Nd : YAG laser
11. A Carnot refrigerator operates between 0°C and 27.3°C. What is its coefficient of performance?
    a) 10 b) 27.3
    c) 0.91 d) 9.1
12. A carnot engine has an efficiency of 1/6. On reducing the sink temperature by 65°C, the efficiency becomes 1/3. what is the source temperature?
    a) 265K b) 350K
    c) 390K d) 400K
13. When a system is held at constant temperature and pressure in a state of equilibrium, then it attains a minimum value of
    a) Internal energy
    b) Enthalpy
    c) Helmholtz energy
    d) Gibb's free energy
14. Consider he following statements:
    When a compressed real gas is allowed to p ss through a narrow h le, the temperature
    1. always falls.
    2. falls for some gases.
    3. rises for some gases.
    Which of the statements given above is/are correct?
    a) 1 only b) 2 only
    c) 3 only d) 2 and 3
15. Consider the following statements:
    A gas can be liquefied by increasing the pressure
    1. above the critical pressure only.
    2. only when the temperature of the enclosed gas is below the critical temperature.
    3. only when the volume of the enclosed gas is below the critical volume.
    Which of the statements given above is/are correct?
    a) 1 and 2 b) 2 only
    c) 3 only d) 2 and 3
16. 

    One mole of an ideal gas goes from state 1 to state 2 following two different paths-1-2 (Path I) and 1-x-v-2 (Path II). The change in entropy along path II:
    a) Is less than the change in entropy along the path I

b) Is twice the change in entropy along the path I

c) Equals the change in entropy along the path I

d) Is thrice the change in entropy along the path I

17.

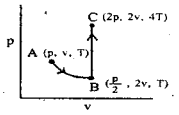


Figure 1 (Path I)

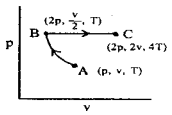


Figure 2 (Path II)

One mole of an ideal gas is taken from an initial state (p,v,T) to a final state (2p, 2v, 4T) by two different paths as shown in the figures 1 and 2 given above. If the changes in internal energy between the final and the initial states of the gas along the paths I and II are denoted by ΔU_I and ΔU_{II} respectively, then

a) $\Delta U_I = \Delta U_{II}$ b) $\Delta U_I > \Delta U_{II}$

c) $\Delta U_I < \Delta U_{II}$

d) $\Delta U_I = 0.66\ \Delta U_{II}$

18. Consider the following statements about the features of Brownian motion :

1. The motion of the particles increases with increase of temperature.
2. The motion of the particles is affected by the movement of the vessel containing the gas.
3. Lower the viscosity of the liquid the faster is the motion of the particles.

Which of the statements given above are correct

a) 1, 2 and 3 b) 1 and 2

c) 1 and 3 d) 2 and 3

19. Average energy of Planck's oscillators is given by

a) kT b) $\frac{3kT}{2}$

c) $\frac{h\upsilon}{\exp(h\upsilon/kT) - 1}$ d) $\frac{kT}{2}$

20. The transport phenomenon in gases is related to which of the following?

1. Viscosity
2. Surface tension
3. Conduction 4. Radiation
5. Diffusion

Select the correct answer using the codes given below:

a) 1, 3 and 5 b) 1, 4 and 5

c) 2, 3 and 4 d) 2, 3 and 5

21. Match List-I (Scientists) with List-II (Results) and select the correct answer using the codes given below the lists:

	List I (Scientists)		*List II (Results)*
A.	Kirchoff	1.	Equation agrees with the energy distribution curves for shorter wavelength when $\lambda T < 1$.
B.	Rayleigh Jeans	2.	Equation agrees with the energy distribution curves for all wavelengths.
C.	Planck	3.	When an atom is properly excited, it emit light of definite wavelength which is the characteristic of the atom.
D.	Wien	4.	Equation agrees with the energy distribution curves for longer wavelength when $\lambda T > 1$

Codes :

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

22. Match List I (Physical Variables) with List II (Expressions) and select the correct answer using the codes given below the lists (n=number of gas molecules present per unit volume, k=Boltzmann constant, T=absolute temperature, m=mass of the particle) :

	List I (Physical Variables)		*List II (Expressions)*
A.	Most probable	1.	nkT
B.	Energy per degree of freedom	2.	$\sqrt{(3kT/m)}$
C.	Pressue	3.	$\sqrt{(2kT/m)}$
D.	R.M.S. velocity	4.	kT/2

Codes :

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

23. At very low temperatures the heat capacity of crystals is given by $C=aT^3$, where a is a constant. In this temperature range the entropy S of a crystal as a function of temperature T is equal to

a) $aT^4/4$ b) $aT^3/3$

c) $aT^2/2$ d) $3aT^2$

24. Assuming the spectral distribution of thermal radiation energy to obey Wien's formula $u(\omega,T) = A\omega^3 e^{-a\omega/T}$, where A and a are constants, the most probable radiation frequency ω for a temperature T is

a) 2T/a b) 2a/T

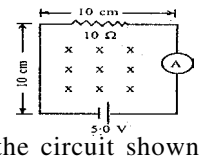
c) 3T/a d) 3a/T

25. A sphere of radius R carries charge density ρ proportional to the square of the distance from the center such that $\rho = AR^2$, where A is a positive constant. At a distance R/2 from the center, the magnitude of the electric field is

a) $A/4\ \varepsilon_0$ b) $AR^3/40\ \varepsilon_0$

c) $AR^3/24\ \varepsilon_0$ d) $AR^3/5\ \varepsilon_0$

26.



In the circuit shown above, x indicates a uniform magnetic field, which is directed into the page and decreasing in magnitude at the rate of 150 tesla/second. The ammeter reads

a) 0.65 A b) 0.15 A

c) 0.50 A d) 0.35 A

27. An electron of change e is going around an orbit of radius R metre in a hydrogen atom with velocity V m/s. The magnetic flux density associated with its centre is

a) $\mu_0 e v/4\ \pi R^2$ b) $\mu_0 e v/2R$

c) $\mu_0 e v R$ d) $\mu_0 e v/R^2$

28. Two condensers of capacity 0.3 μF and 0.6 μF respectively are connected in series. The combination is connected across a source of potential difference of 6 volts. The ratio of energy stored by the first to that by the second condenser will be
a) 1/2 b) 2
c) 1/4 d) 4

29. Consider the following :
1. $\oint E.ds = 0$ 2. $\oint E.dl = 0$
3. $\oint E.dl = -d/dt\ (\int B.ds)$
where E = electrical field
B = magnetic field
Which of the above equations predict(s) the electric field E to be zero?
a) 1 only b) 1 and 2
c) 1, 2 and 3
d) none of the above

30. In N-type germanium the mobility of electrons in 3900 $cm^2/V.s$ and their conductivity is 5 mho/cm. If the hole concentration is negligible then impurity concentration will be (charge of electron = 1.6×10^{-19} C)
a) 8×10^{15} per cm^3
b) 8×10^{-15} per cm^3
c) 9×10^{-15} per cm^3
d) 8×10^{13} per cm^3

31. The correct expression for the de-Broglie wavelength λ of a particle (E is the kinetic energy) i
a) $\lambda = \frac{hc}{\sqrt{(E + 2m_0c^2}}$
b) $\lambda = \frac{h}{\sqrt{E(E\ m_0c^2}}$
c) $= \frac{hc}{\sqrt{E(E + 2m_0c^2}}$
d) $\lambda = \frac{hc}{\sqrt{(E + m_0c^2}}$

32. Match List I (Expression for Current) with List II (rms Value of Current) and select the correct answer using the codes given below the lists:

	List I (Expression for Current)	List II (rms Value of Current)
A.	$I = I_0 \sin \omega t \cos \omega t$	1. I_0
B.	$I = I_0 \sin\left[\omega t + \frac{\pi}{3}\right]$	2. $I_0/\sqrt{2}$
C.	$I = I_0 (\sin \omega t + \cos \omega t)$	3.
D.	$I = I_0 (3^{j\omega t} + e^{-j\omega t})$	4. $I_o/(\sqrt{2})$

Codes :

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

33. You are given a dilute gas of diatomic molecules say of Nitrogen. At a temperature T of the order of room temperature or more, the average energy per molecule is (k is Boltzmann's constant)
a) 3 kT/2 b) kT
c) kT/2 d) 5 kT/2

34. For an ideal gas the product of pressure (P) and volume (V) equals X times the total kinetic energy of the molecules of the gas, where X is
a) 1/3 b) 1/2
c) 2/3 d) 1

35. A wire of resistance R ohm carrying a current I ampere is maintained at a constant temperature T.K. The rate of entropy increase of the resistance is
a) 0 b) $I^2 R/T$
c) $I^2 R/2T$ d) $2 I^2 R/T$

36. Match List I (Series Spectra of Hydrogen) with List II (Region in Which the Series Lies) and select the correct answer using the codes given below the lists:

	List I (Series Spectra of Hydrogen)	*List II (Region in of which the Series Lies)*
A.	Lyman	1. Visible
B.	Blamer	2. Infra red
C.	Paschen	3. Ultra violet
D.	Brackett	4. X-ray
		5. γ -ray

Codes :

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

37. In a straight coaxial cable, the central conductor and the outer one carry equal currents in opposite directions. The magnetic field will be zero
a) inside the inner conductor
b) inside the outer conductor
c) in between the two conductors
d) outside the cable

38. First order phase transition is an
a) isothermal and isochoric process
b) isothermal and adiabatic process
c) adiabatic process
d) isothermal and isobaric process

39. Laminations are used to build magnetic circuits operating under acconditions to reduce
a) Hysteresis loss
b) Eddy current loss
c) Both hysteresis and eddy current losses
d) Joule loss

40. Stack Pointer (SP) always holds the addiess of the
a) top of the stack
b) bottom of the stack
c) main programme
d) subroutine

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

	List I	*List II*
A.	Voltage stabilizing circuit	1. Holes becomes minority charge carriers
B.	N-type semi-conductor	2. Wide depletion layer
C.	Avalanche break down	3. Holes become majority charge carriers
D.	P-type semi-conductor	4. Reverse biased P-N diode

Codes :

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

Directions: The following 8 (Eight) items consist of two statements : one labelled as the 'Assertion (A)' and the other as 'Reason (R)'. You are to examine these two statements carefully and select the answers to these items using the codes given below:

Codes :

a) Both A and R are individually true and R is the correct explanation iof A

b) Both A and R are individually true but R is not the correct explanation of A

c) A is true but R is false

d) A is false but R is true

42. **Assertion(A)** : Photoelectric effect takes place only with a bound electron.
Reason(R) : The photon cannot transfer all its energy and momentum to the electron.

43. **Assertion(A)** : Beta-ray energy spectrum is continuous.
Reason(R) : Parity is not conserved.

44. **Assertion(A)** : When Newton's rings are formed by sodium light, the clarity of rings diminishes gradually as one moves outwards from the central spot and after a while the clarity improves again.
Reason(R) : This is because sodium light is a mixture of lights of two wavelengths $\lambda_1 = 5890$ Å, $\lambda_2 = 5896$ Å.

45. **Assertion(A)** : $\psi(x) = A\cos(\pi x/L)$ does not represent the wave function of a particle trapped ina box.
Reason(R) : This is not a mathematically possible solution of the Schrodinger equation.

46. **Assertion(A)** : A junction diode acts like an open switch after it is turned on and like a closed switch before it is turned on.
Reason(R) : A junction diode does have a measurable forward resistance, and a high but not infinite reverse resistance.

47. **Assertion(A)** :Width of resonance for a forced oscillator is independent of the magnitude of the damping force.
Reason(R) : Damping force decreases the frequency of the oscillator.

48. **Assertion(A)** : When a neutron and a proton combine to form a deuteron, a γ-ray of energy 2.2 MeV is given off.
Reason(R) : Mass of a deuteron is less than the proton and a neutron and the mass difference appears in the form of γ-ray energy.

49. **Assertion(A)** : An electric field with components $E_x = Ax - Bz$, $E_y = Ay + Bz$ and $E_z = B(y-x)$ where A and B are constants has $\nabla . E = 0$
Reason(R) : The divergence of the electric field is zero when there is no free charge in the space.

50. The total electrostatic energy of the 8 charges, q each at the corners of a cube of side L, is

a) $8(q^2/4\pi\varepsilon_0)/L$

b) $8(q^2/4\pi\varepsilon_0)(3+3/\sqrt{2}+1\sqrt{3})/L$

c) $8(q^2/4\pi\varepsilon_0)(3+1\sqrt{3})/L$

d) $4(q^2/4\pi\varepsilon_0)(3+3\sqrt{2})$

51. A sphere of radius 2R has a uniform charge density ρ. The difference in the electrostatic potential at r = R and r = 0 from the centre, is

a) $-\rho R^2/\varepsilon_0$ b) $-2\rho R^2/\varepsilon_0$

c) $-\rho/(6\varepsilon_0 R)$ d) $-\rho R^2/6\varepsilon_0$

52. A long cylindrical conductor parallel to Z-axis and of radius R, carries a uniform current density $\bar{J} = J_0\bar{k}$, $\bar{k}$ = unit vector in the Z-direction .The magnetic field B at a radial distance r from the axis, r < R, is

a) $\mu_0 J_0 r/2$ b) $\mu_0 J_0 r$

c) $\mu_0 J_0$ d) $\pi\mu_0 J_0 r/2$

53. A copper strip 2.0 cm wide and 1.0 mm thick is placed in a magnetic field with B=1.5 wb/m^2 (The number of free electrons per unit volume of copper is 8.4×10^{28} m^{-3} and charge of electron is 1.6×10^{-19}C). If a current of 200 A is set up in the strip, what Hall potential difference appears across the strip?

a) 11 μV b) 22 μV

c) 33 μV d) 4 μV

54. The mass of a proton is 1836 times that of an electron. An electron and a proton are projected into a uniform electric field ina direction at right angles to the direction of field with the same kinetic energy, then

a) the electron trajectory will be less curved than proton trajectory

b) the proton trajectory will be less curved than electron trajectory

c) both the trajectories will be equally curved

d) both the trajectories will be straight

55. Which of the following are true regarding forces between nucleons inside the nucleus :

1. attractive in nature
2. electrical in nature
3. extremely short range
4. strongest forces in nature

Which of the above are correct?

a) 1, 2 and 4 b) 2 and 3

c) 1, 3 and 4 d) 3 and 4

56. Match List I (Elementary Particles) with List II (Average Lifetime in Seconds) and select the correct answer using the codes given below the lists :

	List I (Elementary Particles)	*List II (Average Life-time in seconds*
A.	Muon (μ^-)	1. 1×10^3
B.	Pion (μ^+)	2. 2.2×10^{-6}
C.	K Meson (K^+)	3. 2.6×10^{-8}
D.	Neutron (n^o)	4. 1.2×10^{-3}

Codes :

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

57. The selection rule for transition between various energy level of the atom is given by (l is orbital angular momentum and j is the total angular momentum) :

a) $\Delta l = \pm 1$ $\Delta j = 0$
b) $\Delta l = \pm 1$ $\Delta j = 0$ or ± 1
c) $\Delta l = 0$ $\Delta j = \pm 1$
d) $\Delta l = 0$ or ± 1 $\Delta j = 0$ or ± 1

58. The lowest energy possible for a particle in a potential box is 2 eV. The next highest energy the particle can have is

a) 4 eV b) 8 eV
c) 16 eV d) 32 eV

59. In photoelectric effect with incoming radiation of frequency γ_0 with $h\gamma_0 = 8$ eV, electrons of energy 3 eV are emitted from a metal surface. The energy of the electrons emitted from this surface when radiation with frequency 1.2 γ_0 is incident, is

a) 4.2 eV b) 5.2 eV
c) 3.6 eV d) 4.6 eV

60. consider the following statements about quantization of angular momentum :

1. The total angular momentum of an electron in a hydrogen atom is quantized
2. The total angular momentum as well as all its three components are quantized
3. Only one of the component of the angular momentum is quantized

Which of the statemen s given above is/are correc ?

a) 1 and 2 b) 1 only
c) 1 and 3 d) 3 only

61. The inter pla nar separation in a crystal is d. If the incoming electr ns have a momentum p=h/d h being the Planck's constant, and the momentum makes an angle θ with the reflecting planes, the constructive interference is observed at θ equal to

a) $\pi/6$ b) $\pi/4$
c) $\pi/8$ d) $\pi/3$

62. Which one of the followings is accompained by the characteristic X-rays emission?

a) α-particle emission
b) electron emission
c) positron emission
d) k-electron capture

63. In compton scattering, an incoming photon of wavelength $\lambda^0 = h/2mc$ (h = Planck's constant, m = mass of electron, c = speed of light) is scattered by an electron at rest. If the photon is scattered backwards at angle of 180°, the momentum of the corresponding scattered electron is

a) $\frac{5}{3}mc$ b) $\frac{12}{5}mc$
c) $\frac{8}{5}mc$ d) $\frac{3}{5}mc$

64. The Zeeman effect in the presence of a magnetic field B leads to a splitting in the ground stat energies of the hydrogen atom with an energy separation of

a) $2e^2 \hbar B/m$ b) $4e \hbar B/m$
c) $2e \hbar B/m$ d) e B/m

65. Consider the following s atements about de-Brog ie Wa es :

1. The group velocity of these waves i equal to $d\omega/dk$
2. The hase velocity of these wa es s equal to ω/k
3. T e phase velocity of these waves is equal to c^2/v, v is the velocity of the particle and c is the velocity of light

a) 1 and 2 b) 2 and 3
c) 1 and 3 d) 1, 2 and 3

66. For a particle described by the wave function $\psi = A(x+iy)e^{-r^2}$ where $r^2 = x^2 + y^2 + x^2$, the z-component of the angular momentum is ($\hbar = h/2\pi$, h = Planck's constant)

a) 0 b) $\hbar$
c) $2\hbar$ d) $\hbar^2$

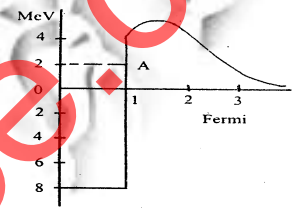
67. An electron and a proton each having an enery 5 eV are incident on a barrier of 10 eV high and 1 Å wide. The correct statement is

a) The electron will have greater transmission probability
b) The proton will have greater transmission probability
c) Both electron and proton will have equal transmission probabilities
d) Neither electrons nor protons can cross the barrier

68. For a radioactive nucleus, the mean life is T. If the number of decays per unit time is n at t = 0, the number of decays between times 0 and t, is

a) $nT\,e^{-t/T}$ b) $n(1-e^{-t/T})$
c) $nT\,(1-e^{-t/T})$ d) $n\,e^{-t/T}$

69. The figure given her shows the potential well diagram for a pr ton in a nucleus. Kineti and potential energies of th proto in level A shown in the figure respectively are



a) 10 MeV, –2 MeV
b) 10 MeV, –8 MeV
c) 2 MeV, –8 MeV
d) 2 MeV, –2 MeV

70. The redius of a molecule is r. Its collision cross-section is equal to

a) πr^2 b) $2\pi r^2$
c) $3\pi r^2$ d) $4\pi r^2$

71. Which one of the following groups of particles is a Boson group?

a) Photon, muon, pion, proton
b) Photon, pion, graviton, kaon
c) Pion, neutron, graviton, photon
d) Electron, muon, neutrino, proton

72. During execution, OP code of an instruction is stored in the

a) general purpose register
b) accumulator register
c) instruction register
d) temporary register

73. Consider the following statements regarding the magnitude of barrier potential of a PN junction :

1. It is independent of temperature
2. It depends on difference between Fermi levels on two sides of junction
3. It depends on forbidden energy gap on two types of semiconductors

4. It depends on impurity concentration in P and N type semiconductors

Which of the statements given above is/are correct?

a) 1, 2 and 3 b) 1 and 3
c) 1 and 2 d) 2, 3 and 4

74. The voltage across a diode in a full-wave rectifier having input voltage of peak value V_m, during its non-conducting period is

a) 0 b) $-V_m$
c) $-2V_m$ d) $-4V_m$

75. The programming language used for a microprocessor is knokwn as

a) FORTRAN language
b) Assembly language
c) COBOL
d) C++

76. The electrical conductivity of a semiconductor increases when em radiation of wavelength shorter than 2480 nm is incident on it. The band gap for the semiconductor is (Planck's constant = 6.6×10^{-34} Joule second and 1 eV = 1.6×10^{-19}) approximately

a) 0.9 eV b) 0.7 eV
c) 0.5 eV d) 0.3 eV

77. A mass m is at a long distance from the earth where it can barely feel the gravity of the earth. It starts moving towards the earth under the force of gravity. Its velocity at the instant it reaches the earth (assume there are no other bodies) is

a) 1.12 ms^{-1}
b) 1.12×10^{2} ms^{-1}
c) 1.12×10^{4} ms^{-1}
d) 1.12×10^{5} ms^{-1}

78. Two inertial frames A and B are moving with a relative speed of $\frac{c\sqrt{7}}{4}$. If a rod of length L be placed at an angle of 45° with respect to the direction of motion in the frame A, it will seem to have a length in the other frame B equal to

a) 0.95 L b) 0.88 L
c) 0.75 L d) 0.68 L

79. A space ship is approaching a source of light with a speed equal to 0.5 c (c is the speed of light). Light coming from the source of light as seen by a person in the space ship travels with speed equal to

a) 0.5 c b) c
c) 1.5 c d) 2.0 c

80. A photographic plate shows a track of a cosmic ray particle placed in a magnetic field that its energy is 870 MeV and the momentum is 720 MeV/c. The mass of this particle is, approximately

a) 1600 MeV/c^2 b) 850 MeV/c^2
c) 490 MeV/c^2 d) 270 MeV/c^2

81. A particle of mass m at rest decays into a particle of mass m/2 and a photon. The energy of the photon (c is the speed of light) is

a) $\frac{3}{8}mc^2$ b) $\frac{3}{4}mc^2$
c) $\frac{1}{4}mc^2$ d) $\frac{1}{2}mc^2$

82. Match List I (Body Rolling on a Surface Without Slipping) with List II (Ratio of Translational Energy to Rotational Energy) and select the correct answer using the codes given below the lists :

	List I (Body Rolling on a Surface without Slipping)	*List II (Ratio of Trans-lational Energy to Rotational Energy)*
A.	Circular ring	1. 1/2
B.	Circular disc	2. 1
C.	Solid sphere	3. 3/2
D.	Spherical shell	4. 2
		5. 5/2

Codes :

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

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

	List I	List II
A.	Phase difference between acceleration and displacement in case of a particle executing SHM	1. 0
B.	Phase difference between any two points on a wave front	2. $\pi/2$
C.	Phase difference between emf and current in an AC circuit containing pure inductance	3. π
D.	Phase-difference between electric and magnetic fields in a plane sinusoidal electromagnetic wave propagating along positive direction of x-axis	4. 2π

Codes :

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

84. Two projectiles are thrown with velocities v_1 and v_2 at angles θ_1 and θ_2 respectively with respect to earth's surface such that $v_1 \sin\theta_1 = v_2 \sin\theta_2$.

Consider the following statements:

1. The range for each of the projectiles is equal.
2. Both of them attain the same height.
3. Both of them remain in air for the same time interval.

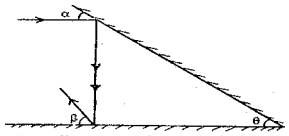
Which of the statements given above are correct?

a) 1 and 2 b) 2 and 3
c) 1 and 3 d) 1, 2 and 3

85. Consider the formation of Newton's rings by monochromatic light of wavelength 6000 Å. The point of contact is perfect and dark. If we slowly raise the lens vertically above the plate, the central spot becomes bright. The distance by which the lens has been raised is

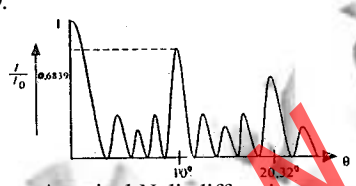
a) 1500 Å b) 3000 Å
c) 6000 Å d) 9000 Å

86. A prism of angle 6 degree made from a crown glass of refractive index 1.5 is placed in contact with another prism, made of flint glass of refractive index 1.6 A ray of light passes normally through the two prisms without a deviation. Thus the angle of flint glass prism is
a) 5.0 degree b) 5.5 degree
c) 6.6 degree d) 7.2 degree

87. 

The figure given above shows two successive reflections from two mirros inclined to each other at an angle θ. The net deviation after two successive deviations depends on:
a) α and θ b) β and θ
c) α and β d) θ only

88. The electric field components of a plane electromagnetic wave are $E_x = 2E_0 \cos(\omega t - kz)$; $E_y = E_0 \sin(\omega t - kz)$
The state of polarization of the wave will be
a) Circular b) Plane
c) Elliptical d) Unpolarized

89. 

A typical N slit diffraction grating intensity distribution is shown in the figure above. Assume $\lambda = 6 \times 10^{-5}$ cm. The value of N is given by
a) 4 b) 5
c) 6 d) 7

90. According to Fermat's principle, the path of light between two points has to be
a) Minimum b) Maximum
c) Minimum or maximum or stationary
d) Minimum or stationary

91. A zone plate is made by arranging that the radii of the circles which define the zones are the same as the radii of Newton's rings formed between a plane surface and the surface having radius of curvature R. The principal focal length of the zone plate is
a) R b) R/2
c) 2R d) $\sqrt{R}$

92. If there are two plano-convex lenses of focal lengths f1 and f2 respectively, then the minimization will occur for spherical as well as chromatic aberration provided (f_1/f_2) is equal to
a) 1 b) 2
c) 3 d) 4

93. The focal length of a convex lens of refractive index 3/2 is 10 cm in air. Its focal length in water having refractive index 4/3 is
a) 40 cm b) 11.25 cm
c) 9 cm d) 20 cm

94. Perfectly circular fringes are observed in a Michelson interferometer. Which combination of the following settings gives a correct description of the experiment?
1. Mirrors are parallel
2. Mirrors are perpendicular
3. Fringes of equal thickness are formed
4. Fringes of equal inclination are formed.
Select the correct answer using the codes given below :
a) 1 and 3 b) 1 and 4
c) 2 and 3 d) 2 and 4

95. The interference pattern is obtained using a yellow light of wavelength 6000 Å, in which 20 equally spaced fringes occupy 2.0 cm on the screen. On replacing the yellow source by another monochromatic source but making no other changes it is noticed that 30 fringes occupy 2.4 cm on the screen. What is the wavelength of the second source?
a) 4500 Å b) 4800 Å
c) 5000 Å d) 5400 Å

96. A projectile of mass m is fired with speed v at an angle α with the horizontal. Its range on the ground is R. Another identical projectile when fired with the same speed and at the same angle, breaks into two equal parts (by mass) when at the highest position. One part falls vertically below. The other part will fall at a distance (from the firing point) equal to
a) R b) 2R
c) 3R/2 d) R/2

97. A body is released from a point at a distance r from the centre of earth. Its velocity at the time of striking the earth (R is the radius of earth and r > R) will be
a) $(2Rg)^{1/2}$
b) (Rg)
c) $[\{2g(r-R)R\}/r]^{1/2}$
d) $[2grR/(r-R)]^{1/2}$

98. A body moving with uniform acceleration, accelerates for first ten seconds and then retards at double the value of the acceleration uniformly for the next five seconds. The body will have the same velocity.
1. at the end of 4th and 13th seconds
2. at the end of 9th and 12th seconds
3. at the end of 8th and 11th seconds
Which of the above are correct?
a) 1 and 2 b) 1 and 3
c) 1, 2 and 3 d) 2 and 3

99. A bullet loses half of its velocity after penetrating 30 cm into a target. It would come to rest after covering an additional distance equal to
a) 10 cm b) 20 cm
c) 30 cm d) 40 cm

100. A uniform solid cylinder of mass 2 kg and radius 0.20 m rolls without slipping on a flat surface. If the total energy of the cylinder be 12 J, its rotational kinetic energy will be
a) 8 J b) 6 J
c) 4 J d) 3 J

101. Two paper screens A and B are separated by 150 m. A bullet pierces A and then B. The hole in B is 15 cm below the hole in A. If the bullet is travelling horizontally at the time of hitting A, then the velocity of the bullet at A is (g =

$10\ m/s^2$)

a) $100\sqrt{3}$ m/s b) $200\sqrt{3}$ m/s

c) $300\sqrt{3}$ m/s d) $500\sqrt{3}$ m/s

102. A rectangular piece of dimension *l*xb is cut out of central portion of a uniform circular disc of mass m and radius r. The moment of inertia of the remaining piece about an axis perpendicular to the plane of the disc and passing through its centre is

a) $m\left[r^2 - \frac{\ell b}{6\pi\pi^2}(\ell^2 + b^2)\right]$

b) $\frac{m}{2}\left[r^2 - \frac{\ell b}{6\pi\pi^2}(\ell^2 + b^2)\right]$

c) $\frac{m}{2}\left[r^2 - \frac{\ell^2 + b^2}{6}\right]$

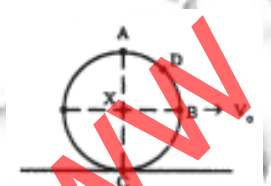
d) not determinable as mass of the rectangular piece is not given

103. If the change in the value of acceleration due to gravity at a height h above the surface of earth is the same as that at a depth d below the surface of earth (both h and d being much smaller than the earth's radius), then

a) $d = \sqrt{2}\,h$ b) $d = h/2$

c) $d = 2h$ d) $d = \sqrt{3}\,h$

104.



A bicycle wheel is rolling without slipping on a level road. It has a linear velocity v_o. For this to happen, the velocity of

1. A is $2\,v_o$
2. B is greater than that of X
3. C is zero
4. A, B and D are equal to v_o

Which of the above statements is/are correct?

a) 4 only b) 1, 2 and 3

c) 3 and 4 d) 2 and 4

105. In the case of anomalous dispersion, the group velocity is

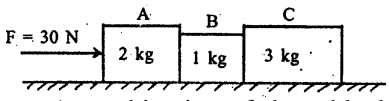
a) equal to the phase velocity

b) less than the phase velocity

c) greater than the phase velocity

d) lower than the phase velocity for media having higher values of acoustic impedance and vice-versa

106.



A combination of three blocks shown in the figure given above is pushed by a horizontal force of 30 N on a frictionless surface. Which of the following are correct?

1. Force exerted by A on B is 5 N
2. Force exerted by A on B is 20 N
3. Force exerted by A on B is 15 N
4. Force exerted by A on B is 10 N

Select the correct answer using the codes given below :

a) 1 and 4 b) 2 and 3

c) 3 and 4 d) 2 and 3

107. The change in mass when 1 gm of copper is heated from 20°C to 320°C (Given that the specific heat of copper is 0.40 J/g K) is

a) 1.33×10^{-18} kg b) 1.33×10^{-15} kg

c) 1.33×10^{-12} kg d) Zero

108. Water is flowing in a pipe of radius r and length L under a pressure difference maintained at the two ends. If the flow rate has to be maintained the same for another pipe of radius 2r, then the length of the pipe is

a) 2L b) 4L

c) 8L d) 16L

109. If the angular frequency of vibration ω of a damped S.H. vibrator is given by

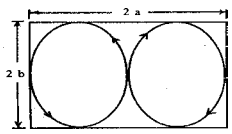
$$\omega_o^2 - \omega^2 = 10^{-6}\,\omega_o^2$$

where ω_0 is the angular frequency of its vibration when there is not damping, the Q-factor will be equal to

a) 500 b) 1,000

c) 5,000 d) 10,000

110.



A particle subjected to two simple harmonic motions along the x-axis and y-axis respectively describes the Lissajous figures as shown in the diagram. If ω_x and ω_y be the angular frequencies of these vibrations and δ be the phase difference between them, then

a) $\omega_x/\omega_y = 2$ and $\delta = 0$

b) $\omega_x/\omega_y = 2$ and $\delta = \pi/2$

c) $\omega_x/\omega_y = 2$ and $\delta = 0$

d) $\omega_x/\omega_y = 2$ and $\delta = \pi/2$

111. The vibration of a string can be described by the equation

$y = (0.75\ cm)\{\cos\{2\pi/5\ cm^{-1})x\}\sin\{(60\ \pi\ s^{-1})t\}$

The speed of the waves travelling in the string is

a) 24 π cm/s b) 0.3 π cm/s

c) 450 π cm/s d) 150 π cm/s

112. A plane wave travelling with a velocity c_1 in a medium of density ρ_1 is incident normally on an interface with another medium of density ρ_2 in which the wave velocity is c_2. If the fraction of energy transmitted by

$$\frac{4\rho_1\rho_2 c_1 c_2}{(\rho_1 c_1 + \rho_2 c_2)^2}$$

the fraction of energy reflected is equal to (Assuming no absorption)

a) $\frac{\rho_1 c_1 - \rho_2 c_2}{(\rho_1 c_1 + \rho_2 c_2)}$

b) $\frac{\rho_1 c_1 - \rho_2 c_2}{(\rho_1 c_1 + \rho_2 c_2)^2}$

c) $\frac{(\rho_1 c_1 - \rho_2 c_2)^2}{\rho_1 c_1 + \rho_2 c_2}$

d) $\left[\frac{(\rho_1 c_1 - \rho_2 c_2)}{\rho_1 c_1 + \rho_2 c_2}\right]^2$

113. A fire alarm sounds with a frequency of 480 Hz. Two fire engines dash to the site to extinguish the fire from opposite directions. One travels with a speed of 33 m/s and the other with 27.5 m/s. If the velocity of sound in air be 330 m/s. If the velcoity of sound in air be 330 m/s, the

difference between the frequencies of the sirens as heard by the drivers of the two fire engines will be

a) 8 Hz b) 12 Hz
c) 16 Hz d) 24 Hz

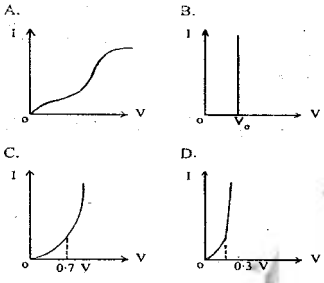
114. A satellite is in elliptical orbit about the earth (radius = 6400 km). At perigee it has an altitude of 1100 km and at the apogee its altitude is 4100 km. The major axis of the orbit is

a) 5200 km b) 10400
c) 11600 d) 18000

115. Pure silicon at 300 K has equal electron (n_e) and hole (n_h) concentration of 1.5×10^{16} m^{-3}. Doping by indium increases n_h to 4.5 to 4.5×10^{22} m^{-3}. The n_e in the doped silicon is

a) 9×10^{5} m^{-3} b) 5×10^{9} m^{-3}
c) 9×10^{-5} m^{-3} d) 5×10^{-9} m^{-3}

116. Match the following figures drawn for I-V characteristics with their corresponding devices and select the correct answer using the codes given below the lists :



List I (Figure)	*List II (Name of the Device)*
A.	1. Diode valve
B.	2. Silicon diode
C.	3. Germanium diode
D.	4. Ideal diode

Codes :

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

117. Match List I (Gate) with List II (Minimum Number of NAND Gates Required to Obtain the Gate) and select the correct answer using the codes given below the lists :

List I (Gate)	*List II (Minimum Number of NANDGates Required to Obtain the Gate)*
A. OR	1. one
B. AND	2. two
C. XOR	3. three
D. NOT	4. six
	5. nine

Codes :

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

118. The electric and magnetic fields in the space are

$\bar{A} = A_0 \bar{i} \cos(\omega t - kz)$,

$\bar{B} = B_0 \bar{j} \cos(\omega t - kz)$, $\bar{i}$, $\bar{j}$ being unit vectors in x and y directions respectively. The Poynting vector in this region is

a) $(A_0 \bar{i} + B_0 \bar{j})\mu_0$

b) $A_0 B_0 \bar{k} + \cos^2(\omega t - kz)/\mu_0$

c) $(A_0 \bar{i} + B_0^2 \bar{j})\mu_0 \cos^2(\omega t - kz)$

d) $\bar{A} = A_0 \bar{i} \cos(\omega t - kz)$,

119. A square loop wire with side ℓ in the xy plane, with its sides parallel to the x and y axes, carries a current i in the clockwise direction. With a constant magnetic field B in the x direction the torque acting on the loop is ($\bar{j}$, $\bar{k}$ are unit vectors in the y and z directions respectively)

a) $i\ell^2 B \bar{j}$ b) $i^2 \ell B \bar{j}$
c) $i\ell B \bar{k}$ d) $i\ell^2 B \bar{k}$

120. An AC circuit using an inductor and a capacitor in series has a maximum current. If the inductance L = 0.5 H and capacitance C = 8 μF, then the angular frequency of AC voltage will be

a) 500 b) 5×10^5
c) 4000 d) 5000

ANSWERS

1.	(A)	2.	(D)	3.	(C)	4.	(C)
5.	(D)	6.	(B)	7.	(B)	8.	(A)
9.	(D)	10.	(C)	11.	(A)	12.	(C)
13.	(D)	14.	(D)	15.	(B)	16.	(C)
17.	(A)	18.	(C)	19.	(C)	20.	(A)
21.	(B)	22.	(A)	23.	(B)	24.	(C)
25.	(C)	26.	(A)	27.	(B)	28.	(B)
29.	(A)	30.	(A)	31.	(C)	32.	(A)
33.	(D)	34.	(C)	35.	(B)	36.	(A)
37.	(D)	38.	(D)	39.	(C)	40.	(A)
41.	(C)	42.	(C)	43.	(B)	44.	(D)
45.	(A)	46.	(D)	47.	(D)	48.	(A)
49.	(D)	50.	(B)	51.	(D)	52.	(A)
53.	(A)	54.	(B)	55.	(C)	56.	(B)
57.	(D)	58.	(B)	59.	(D)	60.	(C)
61.	(A)	62.	(D)	63.	(B)	64.	(D)
65.	(D)	66.	(B)	67.	(A)	68.	(B)
69.	(C)	70.	(D)	71.	(B)	72.	(C)
73.	(D)	74.	(C)	75.	(B)	76.	(C)
77.	(C)	78.	(B)	79.	(B)	80.	(D)
81.	(D)	82.	(B)	83.	(D)	84.	(B)
85.	(A)	86.	(A)	87.	(D)	88.	(C)
89.	(B)	90.	(C)	91.	(A)	92.	(C)
93.	(A)	94.	(D)	95.	(B)	96.	(C)
97.	(C)	98.	(B)	99.	(A)	100.	(C)
101.	(D)	102.	(B)	103.	(C)	104.	(B)
105.	(C)	106.	(D)	107.	(A)	108.	(D)
109.	(A)	110.	(D)	111.	(D)	112.	(D)
113.	(A)	114.	(A)	115.	(B)	116.	(B)
117.	(B)	118.	(B)	119.	(D)	120.	(A)

(Contd.. from Page No.....55)

109. $K^2 = 10^{-6}$ $W_0^2 \Rightarrow K = 10^{-3}$ W0

$Q = \frac{W_0}{2K} = 500$

112. R+T=1

113. $\Delta\nu^1 = \frac{V\nu^1}{C}$

115. $n_e n_h = n_i^2$

118. $S = E \times H$

119. $\tau = MxB = iAxB = il^2 \beta \hat{K}$

120. $\omega = \frac{1}{\sqrt{LC}}$

SOME EXPLANATIONS

1. $d\theta = \frac{x}{R} = \frac{1.22\lambda}{a} \Rightarrow x = \frac{1.22\lambda.}{a} = 1.22x500x10^{-9}\ x50/0.05 = 6.1x10^{-4}$ m.

2. Newton's formula $x_1 x_2 = -f_1 f_2$

3. $R_1 / R_2 = -1/6$ (B.S. Aggarwal)

4. $\frac{\lambda}{d\lambda} = nN \Rightarrow d\lambda = \frac{\lambda}{nN}\frac{500x10^{-4}}{2x10^{5}} = 0.025A$

9. $\text{Area} = \pi\left(\frac{\lambda f}{a}\right)^2, a = \text{radius}, = 3.14\left(\frac{0.6x10^{-6}\,x0.1}{2x10^{-3}}\right) = 3x10^{-9}\ m^2$

16. Entropy is state fn, does not depend on path
17. Internal energy is state function, does not depend on path.

63. $\lambda_0 = \frac{h}{2mc},\ \lambda^1 = \lambda_0 + \frac{2h}{m_0 c},\ (\theta = 180)$ By compton scattering formula

$\lambda^1 = \frac{h}{2m_0 c} + \frac{2h}{m_0 c} = \frac{5h}{2m_0 c}$

$P_0 = 2mc\left(P = \frac{h}{\lambda}\right),\ P^1 = \frac{2mc}{5},\ \Delta P = P_0 + P_1 = \frac{12}{5}mc$ (as cattered at 180)

so momentum of electron is $= \frac{12}{5}mc$

67. $T = e^{-2\beta d},\ \beta = \sqrt{\frac{2m(V-E)}{\hbar^2}}$ since E, V & D is same so transmision probability of electron will be more t an proton.

70. Collison cross section = πd^2 (d = 2R diameter of molecule).

77. Velocity of particle when i r ach on earth is equal to escape velocity.
79. Velocity of light is constant in all frame of reference.

80. $E = \frac{B^2 q^2 r^2}{2m},\ P = Bqr$ so $m = \frac{P^2}{2E}$

89. Nth slit diffr ction, there are N-2 2ndry diffraction maxima between two prime maxima N – 2 = 3 ⇒ N = 5

95. $\beta = \frac{x}{n}, \beta = \frac{n\lambda\lambda}{d}, \Rightarrow \beta \propto \alpha,$ so $\lambda^1 = \frac{\lambda\beta^1}{\beta} = 4800\ A^0$

97. Change in potential energy = change in kinetic energy

$\frac{GMm}{r} - \left(\frac{-GMm}{R}\right) = \frac{1}{2}mV^2 \Rightarrow 2GM\left(\frac{1}{R} - \frac{1}{r}\right)$

$\Rightarrow V = \sqrt{\frac{2g(r-R)R}{r}}$

101. Vertical distance = 15cm, Horizontal distance = 150cm.

Timeof flight, $\frac{1}{2}gt^2 = 0.15,\ t \Rightarrow t = (0.3/g)^{1/2}$ &$vt = 150 \Rightarrow v\ x(.3/g)^{1/2} = 150$

$\Rightarrow v = 500\sqrt{3}$

114. $a(1-e) = 1100km,\ a(1+e) = 4100km \Rightarrow 2a = 5200km$

6. $t = \frac{\lambda}{4(\mu_e - \mu_o)}$

23. $S = \int \frac{aT^3}{T}dT = \frac{aT^3}{3}$

11. $\beta = \frac{T_2}{T_1 - T_2}$

30. $\sigma = \mu_e\, en_e$

33. Average nergy per molecule

$= \frac{f}{2}KT$ (f = degree of freedom)

N_2 = diatomic molecule

$= \frac{5}{2}KT$

34. $PV = \frac{2}{3}NE \qquad X = \frac{2}{3}$

35. $\Delta S = I^2\frac{R}{T}$

51. Potential inside the sphere

$V = \frac{\rho}{6\varepsilon}(3R^2 - r^2)$ (B.S.Aggarwal)

$V_1 = \frac{\rho}{6\varepsilon}(3R^2 - R^2),\ V_2 \frac{\rho}{6\varepsilon}(3R^2)$

$\Delta V = \frac{-\rho R^2}{6\varepsilon}$

52. ByAmpere is law

$\int B.dl = \mu o I$

$B.2\pi r = \mu_o J_o \pi r^2$

$B = \frac{\mu_o J_o r}{2}$

53. $V_H = \frac{IH}{neb} = 1\,l\mu V$

76. $Eg = \frac{hc}{\lambda}$

86. $(\mu - 1)\,A = (\mu^1 - 1)A^1$

91. for zone plate

$f = \frac{r^2}{n\lambda},$ in newton ring

$r^2 = n\lambda R$

$f = \frac{n\lambda R}{n\lambda} = R$