C.S.E.

PHYSICS – 2005

(PRELIMINARY)

Time Allowed : Two Hours *Maximum Marks : 300*

1. The coefficient of thermal conductivity of a gas is proportional to

   (a) T^2 (b) T (c) $1/T$ (d) $\sqrt{T}$

2. If the mean kinetic energy of a smoke particle executing Brownian motion in air is E_{smoke} and the mean kinetic energy of an air moleculr is E_{air}, then which one of the following is correct ?

   (a) $E_{smoke} > E_{air}$ (b) $E_{smoke} = E_{air}$

   (c) $E_{smoke} < E_{air}$

   (d) No relation between E_{smoke} and E_{air} can be established

3. The equation of state of a gas is given as $P(V - b) = nRT$ where b is a constant, n is the number of moles and R is the universal gas constant. When 2 moles of this gas undergo reversible isothermal expansion from volume V to volume 2V, what is the work done by the gas ?

   (a) $2RT \ln[(V-b)/(2V-b)]$

   (b) $2RT \ln[(2V-b)/(V-b)]$

   (c) $2RT \ln[(V-b)/(2V)]$

   (d) $2RT \ln[(2V)/(V-b)]$

4. Consider the following statements :

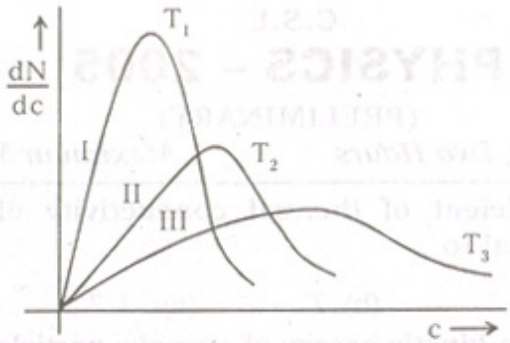
   Some of the important results of Andrews' experiment are that

   1. there exists a temperature called critical temperature, above which a gas cannot be liquified however great the applied pressure is.
   2. oxygen, nitrogen and hydrogen are permanent gases and they cannot be liquefied.

   Which of the statements given above is/are correct ?

   (a) 1 only (b) 2 only

   (c) Both 1 and 2 (d) Neither 1 nor 2

5. 

The plots of Maxwell's distribution function $\left(\frac{dN}{dc}\right)$ versus speed (c) for a given sample of a gas at three different temperatures T_1, T_2 and T_3 respetively are shown in the above diagram. If the areas on the c-axis under three curves I, II and III be denoted by A_I, A_{II} and A_{III} respectively, then which one of the following is correct ?

(a) $A_I > A_{II} > A_{III}$ (b) $A_I = A_{II} = A_{III}$
(c) $A_I < A_{II} < A_{III}$ (d) $A_{II} < A_I < A_{III}$

6. A quarter wave plate is placed over a shiny coin. A plane polariser is placed on top of the quarter wave plate such that the transmission axis of the polariser is at 45° to the fast axis of the quarter wave plate. How does the shiny coin appear now ?

(a) Dark (b) Shiny as before
(c) Shinier than before (d) Coloured

7. What is the ground state energy of positronium ? (The ground state energy of hydrogen is –13.6 eV)

(a) –3.4 eV (b) –6.8 eV
(c) –13.6 eV (d) –27.2 eV

8. Match List I (Different Types of Laser) with List II (Active Medium) and select the correct answer using the code given below :

List I	List II
A. Ruby Laser	1. Liquid laser
B. He-Ne Laser	2. Solid state laser
C. Dye Laser	3. Gas laser

D. Injection Laser 4. Junction semiconductor laser

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

9. A soap film of thickness d and refractive index μ is illuminated by white light incident at an angle i. The light refracted at an angle θ is examined by a spectroscope, and two consecutive bright bands are seen corresponding to wavelengths λ_1 and λ_2. The path difference $2\mu d\cos\theta$ is given by

(a) $(\lambda_1 - \lambda_2)/(\lambda_1\lambda_2)$ (b) $(\lambda_1 + \lambda_2)/(\lambda_1\lambda_2)$

(c) $(\lambda_1\lambda_2)/(\lambda_1 + \lambda_2)$ (d) $(\lambda_1\lambda_2)/(\lambda_1 - \lambda_2)$

10. In a differaction grating, slit width is *e* and ruling separation is *d* . If second-order spectrum is to be avoided, one should choose

(a) $e = d/2$ (b) $e = 2d$

(c) $e = \sqrt{2}d$ (d) $e = d$

11. A differaction grating has N lines and grating element is (e+d). For wave-length λ, what is the maximum resolving power possible ?

(a) $N(e+d)/\lambda$ (b) $(e+d)/(N\lambda)$

(c) $(e+d)N^2/\lambda$ (d) $(e+d-\lambda)^2N/\lambda^2$

12. The core of an optical fibre has refractive index 1.6 and its cladding has refractive index 1.5. What is the approximate numerical aperture of the optical fibre ?

(a) 0.31 (b) 0.56 (c) 0.68 (d) 0.88

13. Match List I (Phase Difference between Two Similar Superimposed Waves having Mutually Perpendicular States of Polarisation and Propogating through the Same Axis) with List II (Result) and select the correct answer using the code given below the lists :

List – I	List – II
A. $\theta = 0$	1. Linearly polarised light
B. $\theta = \pi/2$	2. Left circularly polarised light
C. $\theta = 2\pi/3$	3. Right circularly polarised light
D. $\theta = 3\pi/2$	4. Elleptically polarised light

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

14. Match List I (Optical Instrument) with List I (Characteristics of the Instrument) and select the correc answer using the code given below the lists :

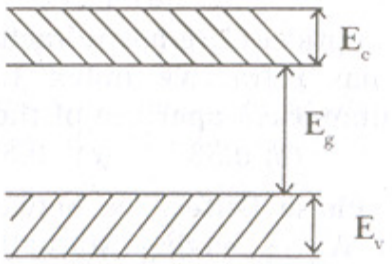
List - I	List - II
A. Huygens eye-piece	1. Analysis of elliptically polarised light
B. Optical fibre	2. Chromatic and spherical aberrations are reduced to a minimum
C. Babinet's compensator	3. Production of circularly polarised ligh
D. Quarter wave plate	4. Refractive index is maximum at the axis & decreases towards the peripher

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

15. If the ratio of the concentration of electrons to that o holes in a semiconductor is 7/5 and the ratio of the currents is 7/4, then what is the ratio of their drif velocities ?

(a) 4/7 (b) 5/8 (c) 4/5 (d) 5/4

16.



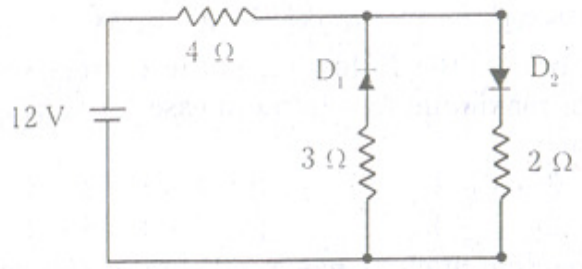
In the figure above, E_c, E_g and E_v represent the conduction bendwidth, the band gap and the valence bandwidth of a semiconductor respectively. If the lattice constant of this semiconductor is decreased, then which one of the following is correct ?

(a) E_c, E_v and E_g increase (b) E_c, E_v and E_g decrease

(c) E_c and E_v increase but E_g decreases

(d) E_c and E_v decrease but E_g increases

17.



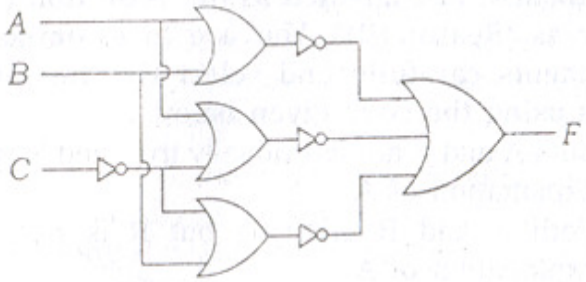
The circuit given above has two oppositely connected ideal diodes in parallel. What is the current flowing in the circuit ?

(a) 1.33 A (b) 1.71 A (c) 2.00 A (d) 2.31 A

18. A Zener diode has a breakdown voltage of 9.1 V with a maximum power dissipation of 364 mW. What is the maximum current that the diode can withstand ?

(a) 0.04 A (b) 0.4 A (c) 4.0 A (d) 40 A

19.



Which one of the following gives the output F for the logic diagram shown above ?

(a) $\bar{A}\bar{B} + \bar{A}C + \bar{B}C$ (b) $A\overline{B} + A\overline{\bar{C}} + B\overline{\bar{C}}$

(c) $(\overline{A+B})+(\overline{B+C})+(\overline{C+A})$ (d) $(A+B+\bar{C})$

20. The number of bits that a digital computer can process in parallel at a time is called

(a) Byte (b) Binary digit

(c) Word length (d) PACE

21. If the memory chip size is 256×1 bits, what is the number of chips required to make up 1 kbyte of memory ?

(a) 32 chips (b) 64 chips

(c) 128 chips (d) 256 chips

22. Given below are four type of read only memories used in microcomputers :

1. EPROM 2. PROM 3. ROM 4. EAROM

Which one of the following is the correct sequence in terms of maximum to minimum ease for storing program in them ?

(a) 2 – 3 – 1 – 4 (b) 4 – 1 – 2 – 3

(c) 3 – 2 – 1 – 4 (d) 4 – 1 – 3 – 2

23. A radioactive nucleus has a half-life of 100 years. If the number of nuclei at t=0 is N_0, what will be the number of nuclei which have decayed in 300 years ?

(a) $7N_0/8$ (b) $N_0/2$ (c) $3N_0/4$ (d) $N_0/8$

24. A beam of atoms splits into 4 components in the Stern-Gerlach experiment with a weak magnetic field. What is the total angular momentum quantum number j for these atoms ?

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

Directions : The following six (6) 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 code given below :

(a) Both A and R are individually true, and R is the correct explanation of A

(b) Both A and R are 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

25. Assertion (A) : Energy is released when two light elements combine to form a heavier element.

Reason (R) : Binding energy per nucleon decreases with mass number in the region of large mass numbers.

26. Assertion (A) : A disc rolls down on inclined plane faster than a ring of same outer radius, material and thickness.

Reason (R) : Radius of gyration of disc is greater than that of ring.

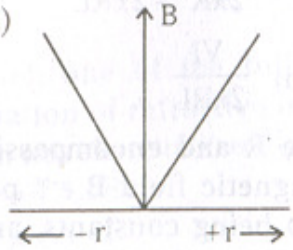
27. Assertion (A) : The energy eigenvalue of the lowest energy state of a simple harmonic oscillator is called zero-point energy.
Reason (R) : Energy of this state is zero.

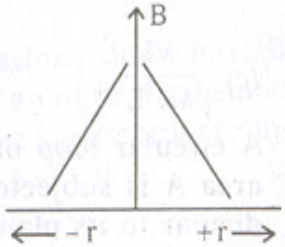
28. Assertion (A) : In quantum mechanics, a particle with total energy E can tunnel through a potential barrier of height V_0 greater than E, which is classically impermentrable due to kinetic energy becoming negative inside the barrier.
Reason (R) : Wave particle duality in quantum mechanics allows the particle to have negative kinetic energy.

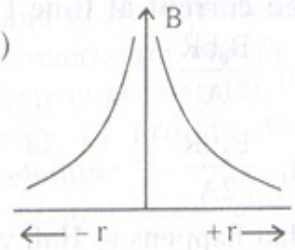
29. Assertion (A) : It is possible to obtain Newton's rings with transmitted light.
Reason (R) : Phase change of π is introduced in any one beam of the transmitted light.

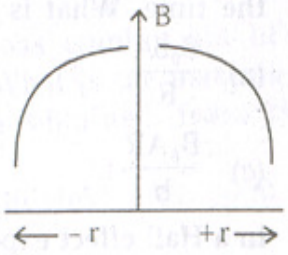
30. Assertion (A) : In almost all measuring optical instruments, Ramsden eyepiece is used.
Reason (R) : A cross wire or a scale can be fitted at the position of the image formed by the objective.

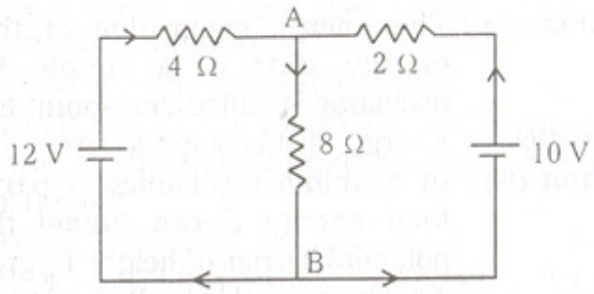
31. Which one of the following graphs represents the variation of magnetic flux density (B) with distance (r) from a long straight conductor carrying current ?

(a)


(b)


(c)


(d)


32. 

What is the value of current passing through the brance AB in the electric circuit given above ?

(a) 8/7 A (b) 2/3 A
(c) 3/2 A (d) 3/7 A

33. If the value of van der Waals constant *b* for a real gas is 32 cm^3/mole, than what is the approximate volume of one molecule of the gas ? (Avogadro constant = 6.02×10^{23})

(a) 5.2×10^{-23} cm^3 (b) 3.9×10^{-23} cm^3
(c) 2.6×10^{-23} cm^3 (d) 1.3×10^{-23} cm^3

34. Black-body radiation behaves like a perfect gas of adiabatic exponent (γ) equal to

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

35. What is the Poynting vector at the surface of a long cylindrical wire of radius *R*, length *L* carrying a current *I*, when its ends are kept at a potential difference of *V*?

(a) zero (b) $\frac{VI}{2\pi R^2 + 2\pi RL}$

(c) $\frac{VI}{\pi R^2 L}$ (d) $\frac{VI}{2\pi RL}$

36. A circular loop of resistance R and encompassing an area A is subjected to a magnetic field B_0e^{-bt} perpendicular to its plane, B_0 and b being constants, and t is the time. What is the induced current at time t = 0 ?

(a) $\frac{B_0bA}{R}$ (b) $\frac{B_0bR}{A}$

(c) $\frac{B_0AR}{b}$ (d) $\frac{B_0bR}{2A}$

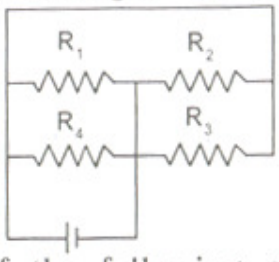
37. In a Hall effect experiment, what happens to Hall voltage

if the applied magnetic field is doubled, keeping the Ohmic current density unchanged ?

(a) It increases 4 times (b) It becomes half

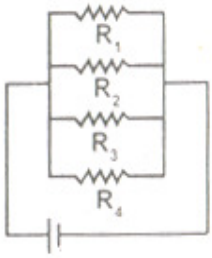
(c) It remains unchanged (d) It increases 2 times

38.

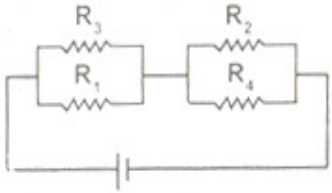


Which one of the following circuits is electrically equivalent to the circuit above ?

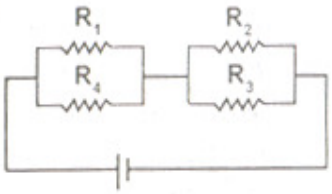
(a)



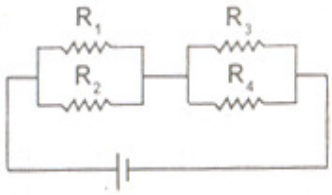
(b)



(c)



(d)



39. Which one of the following relations describes the variation of refractive index (μ) of an optical substance with wavelength (λ) of light ? (Neglect higher order terms)

(a) $\mu = A + B\lambda^2$ (b) $\mu = A + B\lambda^{-1}$

(c) $\mu = A + B\lambda^{-2}$ (d) $\mu = A + B\lambda$

(A and B are Cauchy constants)

40. The maximum energy of deuterons coming out of a cyclotron accelerator is 20 MeV. What is the maximum energy of protons that can be obtained from the accelerator ?

(a) 10 MeV (b) 20 MeV (c) 30 MeV (d) 40 MeV

41. The frequency of the radiation emitted by a hydrogen atom for the transition between n=2 and n=1 states is ν_0. What is the frequency of the radiation emitted by the hydrogen atom for transition between n=4 and n=1 states ?
(a) $3\nu_0/2$ (b) $2\nu_0$ (c) $4\nu_0$ (d) $5\nu_0/4$

42. For what value of g is the function x+gy , an eigenfunction of L_z with eigenvalue $-\hbar$, where $\hbar = h/2\pi$, h being the Planck's constant ?
(a) g = 1 (b) g = –1
(c) g = i (d) g = –i

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

List I	List II
A. Goudsmit and Uhlenbeck	1. Antisymmetric state
B. Moseley's plot	2. Space quantization
C. Pauli exclusion principle	3. Bohr's theory
D. Stern-Gerlach	4. Electron spin

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

44. A μ-meson which is about 200 times as heavy as an electron is captured by a proton to form a hydrogen-like atom. What is the radius of the first Bohr orbit ? (The radius of first Bohr orbit for normal hydrogen atom is 0.5 Å)
(a) 100 Å (b) 0.25 Å
(c) 0.025 Å (d) 0.0025 Å

45. Consider the following statements :
The continuous X-ray spectrum is the result of
1. inverse photo-electric emmission.
2. decrease in the kinetic energy of the incident electrons on the target atom.
3. annihilation of the mass of the incident electron.
Which of the statements given above are correct ?
(a) 1, 2 and 3 (b) 1 and 2
(c) 2 and 3 (d) 1 and 3

46. In the Bragg scattering of a beam of electrons each of mass m and velocity v by a nickel crystal, the first maximum is observed at $\theta=30^\circ$ (θ being the angle the beam makes with the crystal plane). What is the inter-planar distance d for the crystal ?

(a) $\frac{h}{mv}$ (b) $\frac{2h}{mv}$ (c) $\frac{h}{2mv}$ (d) $\frac{mv}{h}$

47. A thermal neutron of rest mass m_o has kinetic energy given by 3kT/2, where k is the Boltzmann constant and T is the room temperature. What is the de Broglie wavelength associated with such a neutron ?

(a) $h/\sqrt{3m_okT}$ (b) $3hkT/(2\sqrt{m_o})$

(c) $2h/(3kT\sqrt{m_o})$ (d) $2h/\sqrt{3m_okT}$

48. A particle of rest mass (10m)/3 decays at rest into two mesons of mass m each. What is the velocity of each meson in terms of the velocity of light c ?

(a) 3c/10 (b) 3c/5 (c) 2c/5 (d) 4c/5

49. A cube has density ρ_o when at rest. What is the density of the cube when it moves with velocity v (close to c) parallel to one of its sides ?

(a) $\rho_o(1-v^2/c^2)^{1/2}$ (b) $\rho_o(1-v^2/c^2)^{-1/2}$

(c) $\rho_o(1-v^2/c^2)^{-1}$ (d) $\rho_o(1-v^2/c^2)$

50. Which one of the following represents relativistic Second Law of motion with rest mass m_o and speed v ?

(a) $F = m_0\frac{dv}{dt}(1-v^2/c^2)^{3/2}$ (b) $F = m_0\frac{dv}{dt}(1-v^2/c^2)^{3/2}$

(c) $F = m_0\frac{dv}{dt}(1-v^2/c^2)^{1/2}$ (d) $F = m_0\frac{dv}{dt}(1-v^2/c^2)$

51. A source of sound approaches an observer and then recedes from it. Ratio of frequencies of sound as the source approaches and as the source recedes is 6 : 5. What is the speed at which the source is moving ? (Velocity of sound =330 ms^{-1})

(a) 24 ms^{-1} (b) 27 ms^{-1} (c) 30 ms^{-1} (d) 33 ms^{-1}

52.

A light ray is travelling through a ring of an optical fibre which is made of four different glasses (shown above) but each part has the same geometrical thickness. If their refractive indices are (i) 1.51, (ii) 1.52, (iii) 1.53, (iv) 1.54 respectively, light ray will take the maximum time in crossing which part ?

(a) Part No. 1 (b) Part No. 2
(c) Part No. 3 (d) Part No. 4

53. A convex lens of optical glass (μ=1.42) is immersed in a liquid (μ=1.49) inside a glass cell. How does the lens-liquid combination act ?

(a) As a converging lens (b) As a diverging lens
(c) As a plano-parallel plate
(d) As a plano-convex lens

54. Let F_R and F_V be the focal lengths corresponding to red and violet colours repectively for a combination of lenses. For removal of chromatic aberration, which one of the following conditions holds good ?

(a) $(F_R/F_V)=1$ (b) $(F_R/F_V)=2$
(c) $(F_R/F_V)>1$, but not equal to 2 (d) $(F_R/F_V)<1$

55. If the refractive index of the material of a prism is cot (A/2) and vertex angle of the prism is A, what is the angle of minimum deviation ?

(a) $\pi-2A$ (b) $\pi-A$
(c) $(\pi/2)-2A$ (d) $(\pi/2)-A$

56. Light takes 4.5×10^{-10}s to travel 10 cm in a transparent medium. What is the optical path length covered by it?

(a) 11.5 cm (b) 13.5 cm
(c) 15.5 cm (d) 17.5 cm

57. Which one of the following statements is correct ?

A zone plate is used as a convex lens to focus light of wavelength λ. The focal lenght is

(a) independent of λ in the visible region
(b) proportional to λ in the visible region
(c) inversely proportional to λ and is more for violet rays than for red rays
(d) proportional to $\lambda^{-1/2}$ and is more for violet rays than for red rays

58. A circularly polarised beam of light passes through a quarter wave plate. The emerging beam is

(a) plane polarised (b) circularly polarised
(c) elliptically polarised (d) partially polarised

59. When an unpolarised light beam passes through a double refracting medium, it splits up into two beams called ordinary ray and extraordinary ray.
Consider the following statements :

1. Intensities of the both rays are equal.
2. Refractive index of the ordinary ray ramains constant.
3. Refractive index of the extraordinary ray does not remain constant.
4. Both the rays are unpolarised.

Which of the statements given above are correct ?

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

60. Which one of the following statements is correct ?
Optically active substances are responsible for

(a) the rotation of the plane of polarisation of polarised light
(b) producing polarised light
(c) producing bifringence
(d) converting ordinary light into polarised light

61. Two light waves having their intensities in the ratio 16 : 9 interfere to produce interference pattern. What is the ratio of maximum intensity to minimum intensity in this pattern ?

(a) 4 : 3 (b) 25 : 7
(c) 625 : 49 (d) 49 : 1

62. For the X-ray spectrum due to transition between n=2 and n=1 states, for large nuclear charge Ze, we have frequencies ν_0, ν_1, ν_2 for $Z_0=Z_0$; $Z_1=Z_0+1$, $Z_2=Z_0+2$ respectively. Moseley's law implies which one of the following equations ?

(a) $\nu_1=(\nu_0+\nu_2)/2$ (b) $\nu_1=(\nu_0\nu_2)^{1/2}$

(c) $\nu_1^{1/2}=(\nu_0^{1/2}+\nu_2^{1/2})/2$ (d) $\nu_1=(\nu_0\nu_2)/(\nu_0+\nu_2)$

63. Consider the following statements :

In order that measurable properties (such as energy, linear momentum, etc.) of a quantum mechanical system be physically acceptable, it is essential that

1. the corresponding eigenfunction $\psi(x)$ and its derivative $\frac{d\psi(x)}{dx}$ must be finite for all values of x.
2. $\psi(x)$ & $\frac{d\psi(x)}{dx}$ must be single valued for all values of x.
3. $\psi(x)$ & $\frac{d\psi(x)}{dx}$ must be continuous for all values of x.

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

64. A particle constrained to move along the x-axis is described by the wave function

$\psi(x)=2x$; $0<x<1$

$=0$; elsewhere

What is the probability of finding the particle within the interval (0,0.4) ?

(a) 0.85 (b) 0.085

(c) 0.0085 (d) 0.00085

65. For a particle of mass *m* in a one-dimensional box of length *l*, what is the average of momentum p_x for the ground state ?

(a) 0 (b) $h/(2l)$ (c) h/l (d) $h/(2\pi l)$

66. The eigenfunctions of hydrogen atom contain which of the following ?

1. Legendre polynomials 2. Laguerre polynomials
3. Hermite polynomials

Select the correct answer using the code given below :

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

67. If n represents the number of eigenstates of a hydrogen atom, then its discrete energy levels are proportional to
(a) n (b) n^2 (c) $1/n$ (d) $1/n^2$

68. A particle of mass m and energy E is incident on a potential step of height V_0 (at x=0). If $E<V_0$, the wave function of the particle for x>0 will be of the form
(a) e^{ikx} (b) zero
(c) e^{-kx} (d) $Ae^{ikx}+Be^{-ikx}$

69. The radius of Ge nucleus is measued to be twice the radius of $^{9}Be_{4}$ nucleus. How many nucleons ate there in the Ge nucleus ?
(a) 72 (b) 96 (c) 120 (d) 144

70. The binding energy per nucleon is largest for
(a) ^{56}Fe (b) ^{16}O (c) ^{4}He (d) ^{208}Pb

71. For the neutron decay process, n→p+e+(y), where e is an electron, the particle (y) is a
(a) neutrino (b) photon
(c) pion (d) anti-neutrino

72. Which one of the following elementary paricles is called Baryon ?
(a) Electron (b) μ-Meson
(c) π-Meson (d) Neutron

73. If a solid state power supply having voltage regulation 25% has full-load voltage of 20V, what will be its no-load voltage ?
(a) 20 V (b) 25 V (c) 40 V (d) 50 V

74. A power supply P_1 delivers 20 V d.c. with a ripple of 1.0 V r.m.s. while the power supply P_2 delivers 50 V d.c. with a ripple of 2.0 mV r.m.s. Which one of the following is correct ?
(a) P_1 performs better than P_2
(b) P_2 performs better than P_1

(c) Both P_1 and P_2 perform equally and similarly
(d) Comparison between P_1 and P_2 is not possible

75. Moment of inertia of a uniform disc of mass m about an axis x=a is mk^2, where k is the radius of gyration. What is its moment of inertia about an axis x=a+b ?

(a) $mk^2+m(a+b)^2$ (b) $mk^2+m\frac{(a+b)^2}{2}$

(c) $mk^2+m\frac{b^2}{2}$ (d) mk^2+mb^2

76. A body of mass M moves under the action of a central force with potential $V(R) = AR^3$ (A>0). For what kinetic energy will the orbit be a circle of radius r about the origin ?

(a) $3AMr^3/2$ (b) $3AMr/2$
(c) $3AMr^4/2$ (d) $3AMr^2$

77. A block B is resting on a horizontal plate in the x-y plane and the coefficient of friction between the block and the plate is μ. The plate begins to move in the x-direction & its velocity is $v=bt^2$, *t* being time and *b* being a constant. At what time will the block start sliding on the plate ?

(a) $\frac{\mu b}{g}$ (b) $\frac{\mu gb}{2}$ (c) $\frac{\mu g}{b}$ (d) $\frac{\mu g}{2b}$

78. A gun shoots three times as high when its angle of elevation is α as when it is β. What is the ratio of the horizontal distances travelled respectively in the two cases ?

(a) 1 : 3 (b) 1 : 1
(c) 2 : 1 (d) 3.5 : 1

79. If the radius of earth were to decrease by 1%, what would be the approximate change in acceleration due to gravity ?

(a) Decrease by 2% (b) Increase by 2%
(c) Decrease by 1% (d) Increase by 1%

80. Which one of the following statements is correct ?

(a) Gravitational force has an inverse-square dependence on distance, whereas electromagnetic, weak and strong forces are the short range forces

(b) Gravitational and electromagnetic forces have the inverse-square dependence on distance, whereas weak and strong forces are the short range forces

(c) Gravitational, electromagnetic and weak forces have the inverse-square dependence on distance, whereas strong force is the short range force

(d) Gravitational, electromagnetic, weak and strong force have the inverse-square dependence on distance

81. If two bodies of mass M and 4M are attached to the two ends of a spring of spring constant s, what is the period of oscillation ?

(a) $4\pi\sqrt{M/(5s)}$ (b) $4\pi\sqrt{5s/M}$

(c) $2\pi\sqrt{5M/s}$ (d) $2\pi\sqrt{5M/(2s)}$

82. After cutting off a circular portion of radius R/2 from the centre of a uniform circular disc of radius R, the moment of inertia about an axis passing through its centre & perpendicular to its plane becomes I. What is the moment of inertia of the original disc about the same axis ?

(a) 2I (b) 4I (c) (8/7)I (d) (16/15)I

83. A projectile is projected with a speed u making an angle 2θ with the horizontal. What is the speed when its direction of motion makes an angle θ with the horizontal?

(a) $(u\cos 2\theta)/2$ (b) $u\cos$

(c) $u(2\cos\theta - \sec\theta)$ (d) $u(\cos\theta - \sec\theta)$

84. Which one of the following statements is correct ?
Binding energy of a nucleus is maximum when it contains

(a) even number of protons and even number of neutrons

(b) odd number of protons and odd number of neutrons

(c) odd number of protons and even number of neutrons

(d) even number of protons and odd number of neutrons

85. A uniform spring of spring constant k is cut into two pieces whose lengths are in the ratio 1 : 2. What is the ratio of frequencies of oscillations in the vertical direction when mass m each is suspended from the smaller and the larger pieces of the spring ?

(a) $1/\sqrt{2}$ (b) $\sqrt{2}$ (c) 1/2 (d) 2

86. A mass m attached to a spring is oscillating in water. If

the spring constant is k and restoring force is $R\dot{\psi}$, which one of the following is correct ?

(a) $m\psi = R\psi + k\psi$ (b) $m\psi = R\psi - k\psi$

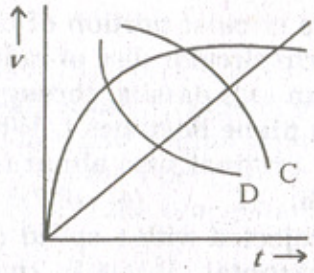
(c) $m\psi = -R\psi + k\psi$ (d) $m\psi = -R\psi + k\psi$

87. A unit mass at position vector $\vec{r} = (3\hat{i} + 4\hat{j})$ is moving with a velocity $\vec{v} = (5\hat{i} - 6\hat{j})$. What is the angular momentum of the body about the origin ?

(a) 2 units along z-axis (b) 38 units along x-axis

(c) 38 units along y-axis (d) 38 units along z-axis

88.



For a spherical ball dropped in a long column of a viscous liquid, the speed (v) of the ball as a function of time (t) may be best represented by which one of the curves shown above in the graph ?

(a) A (b) B (c) C (d) D

89. A cube at rest has a side of length $\sqrt{5}$ m. What is the approximate volume of the cube, when it moves with a velocity of 2×10^8 ms^{-1} parallel to one of its sides ?

(a) 13.9 m^3 (b) 11.2 m^3 (c) 8.3 m^3 (d) 6.7 m^3

90. Two simple harmonic motions of same frequency but having a phase difference of π travel at right angles. When superimposed, what will be the nature of the resultant motion ?

(a) A sine curve (b) A circle

(c) An ellipse (d) A straight line

91. A spring oscillating in water is acted upon by an external force $B\cos\omega t$. With the passage of time, the frequency

of the spring tends to be

(a) greater then ω (b) less than ω

(c) equal to ω (d) decreasing exponentially

92. Reference frame A is moving with a velocity V_A with respect to earth and reference frame B is moving with a velocity V_B with respect to reference frame A. If M_A & M_B are the masses of a body in A and B respectively & c is the speed of light, then what is the value of M_A/M_B?

(a) $\sqrt{1 - V_B^2/c^2}$ (b) $\left[1 - \frac{(V_A - V_B)^2}{c^2}\right]^{-1/2}$

(c) $\sqrt{1 - (V_A - V_B)^2/c^2}$ (d) $(1 - V_B^2/c^2)^{-1/2}$

93. On the *T-S* diagram, an isotherm is a straight line parallel to the entropy axis. What does the area under the isotherm indicate ?

(a) The work done by the system

(b) The change in internal energy of the system

(c) The heat exchanged during the process

(d) The work done on the system

94. A heat engine converts a given quantity of heat into work with maximum efficiency during which one of the following processes ?

(a) Isobaric process (b) Isochoric process

(c) Isentropic process (d) Isothermal process

95. When a wire is heated to a sufficiently high temperature, it is found to emit electrons. The emitted electrons present in the interspace follow which one of the following distributions ?

(a) Maxwellian distribution (b) Boltzmann distribution

(c) Lorentzian distribution (d) Exponential distribution

96. Consider the following statements in respect of van der Waals equation/van der Waals forces :

1. The values of a and b in van der Waals equation do not vary with temperature.
2. van der Waals forces are much weaker than those arising from valence bonds and are inversely proportional to the seventh power of the distance

between atoms or molecules.

Which of the statements given above is/are correct ?

(a) 1 only (b) 2 only

(c) Both 1 and 2 (d) Neither 1 nor 2

97. **On the inversion curve, the Joule-Thomson coefficient is**

(a) positive (b) zero

(c) negative (d) infinite

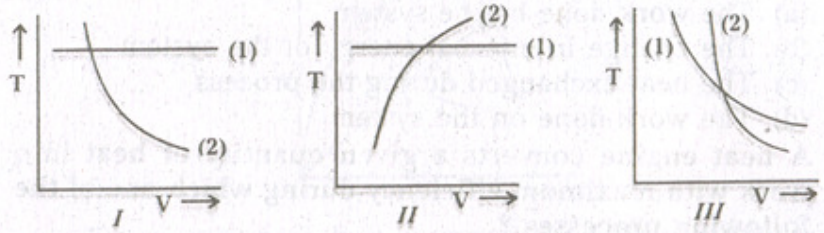
98. **For a particle of mass m in a one-dimesional potential $V(x) = (1/2)\,kx^2 + ax$ what is the ground state energy ?**

$\{\hbar = h/2\pi$ and $\omega = (k/m)^{1/2}\}$

(a) $\hbar\omega/2$ (b) $(\hbar\omega/2) + ak$

(c) $(\hbar\omega/2) + \frac{a^2}{2k}$ (d) $(\hbar\omega/2) - \frac{a^2}{2k}$

99.

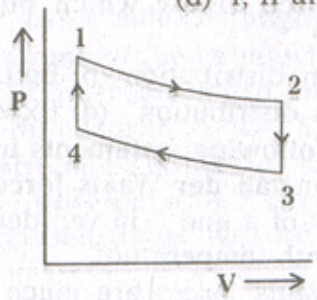


If (1) represents isothermal and (2) represents adiabatic, which of the graphs given above in respect of an ideal gas are correct ?

(a) I and II (b) II and III

(c) I and III (d) I, II and III

100.



An ideal gas completes a cycle consisting of two isotherms and two isochors as shown in the above figure. Which one of the following is correct ?

(a) In the processes 1-2 and 2-3, entropy increases
(b) In the processes 3-4 and 4-1, entropy increases
(c) In the processes 1-2 anbd 4-1, entropy increases
(d) In the processes 2-3 and 3-4, entropy increases

101. What is the minimum attainable pressure of an ideal gas in the process given by $T=a+bV^2$, where a, b are constants & V is the volume of one mole of ideal gas?

(a) $\sqrt{ab}$ (b) $R\sqrt{ab}$ (c) $2R\sqrt{ab}$ (d) $\sqrt{a/b}$

(R is the universal gas constant)

102. How many degrees of freedom will the gas molecules have under standard condition if ρ is the density and P is the pressure of the gas, and V is the velocity of sound propagating through it ?

(a) $2[(\rho V^2 / P)-1]$ (b) $2[(\rho V^2 / P)-1]^{-1}$
(c) $[(\rho V^2 / P)-1]$ (d) $[(\rho V^2 / P)-1]^{-1}$

103. What is the quantity of heat required to raise the temperature of one gram molecule through one degree for a monatomic gas at constant volume ?

(a) 0.5 R (b) 1.0 R (c) 1.5 R (d) 2.5 R

104. van der Walls equation predicts that the critical coefficient of a gas $\left(\frac{RT_c}{P_cV_c}\right)$ has the value

(a) 8/3 (b) 2 (c) 4/3 (d) 3/8

105. If the most probable speed of a gas molecule of mass m is $(2kT/m)^{1/2}$, where k is Boltzmann constant and T is the absolute temperature, then what will be the most probable value of kinetic energy of the gas molecule ?

(a) kT (b) 2kT (c) 3kT/2 (d) kT/2

106. What is the relationship between pressure (p) and energy density (μ) due to diffuse radiation ?

(a) $p = \mu/3$ (b) $p = \mu$
(c) $p = 2\mu/3$ (d) $p = \mu/4$

107. If heat Q is added reversibly to a system at temperature T and heat Q' is taken away from it reversibly at temperature T', then which one of the following is correct?

(a) $\frac{Q}{T}-\frac{Q'}{T'}=0$ (b) $\frac{Q}{T}-\frac{Q'}{T'}>0$

(c) $\frac{Q}{T}-\frac{Q}{T'}<0$

(d) $\frac{Q}{T}-\frac{Q'}{T'}$ = change in internal energy of the system

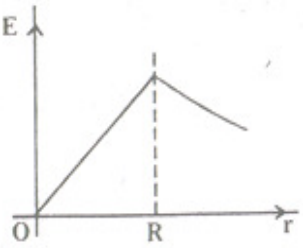
108. What is the approximate peak value of an alternating current producing four times the heat produced per second by a steady currect of 2.0 A in a resistor ?
(a) 2.8 A (b) 4.0 A (c) 5.6 A (d) 8.0 A

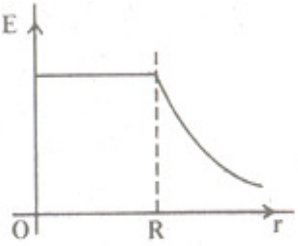
109. Which one of the following statements is correct ?
If in the Wheatstone bridge, the battery and galvanometer are interchanged, the condition for balance
(a) is not disturbed (b) is disturbed
(c) depends on internal resistance of the battery
(d) depends on the values of resistances in the bridge

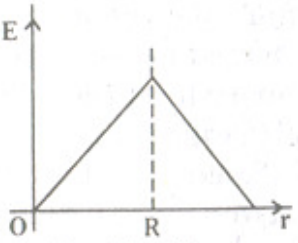
110. Consider a rhombus ABCD with $\angle B=120°$. A charge q placed at corner A produces field E and potential V at the corner D. If we now add charges –2q and +q at the corners B and C respectively, what will be the magnitudes of the field and potential at D respectively?
(a) E and 0 (b) 0 and V
(c) $\sqrt{2}E$ and $V/2$ (d) $E/\sqrt{2}$ and $V/\sqrt{2}$

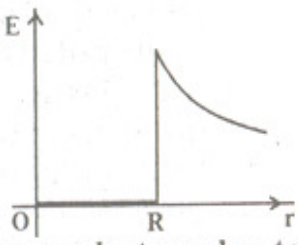
111. A loop of diameter d is rotated in a uniform electric field until the position of maximum electric flux is found. The flux in this position is measured to be ϕ. What is the electric field strength ?
(a) $\frac{4\phi}{\pi d^2}$ (b) $\frac{2\phi}{\pi d^2}$ (c) $\frac{\phi}{\pi d^2}$ (d) $\frac{\pi\phi d^2}{4}$

112. Charge is distributed uniformly throghout a long non-conducting cylinder of radius R. Which one of the following graphs best represents the magnitude of the resulting electric field E as a function of r, the distance from the axis of the cylinder ?

(a) 

(b) 

(c) 

(d) 

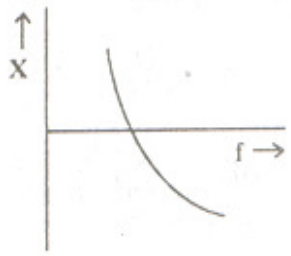
113. What is the kinetic energy gained by an electron due to acceleration through a potential difference of 1 V ?
(a) 1 eV (b) 1 joule (c) 5 Nm (d) 10 Nm

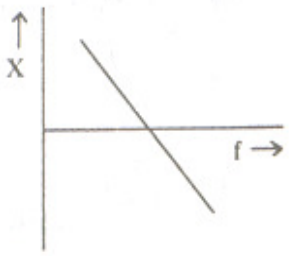
114. In a series resonant circuit, L = 1H, C = 0.25μf and the quality factor is 100. What is the range of FWHM (Full width at Half Maximum) of the resonant circuit ?
(a) (1990-2010) rad/s (b) (1980-2020) rad/s
(c) (1995-2005) rad/s (d) (1900-2100) rad/s

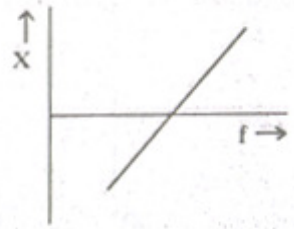
115. Dielectric constant of mica is 6. What is the velocity of light in this medium approximately ?
(a) 1.2×10^7 m/s (b) 5.0×10^7 m/s
(c) 1.2×10^8 m/s (d) 3.0×10^8 m/s

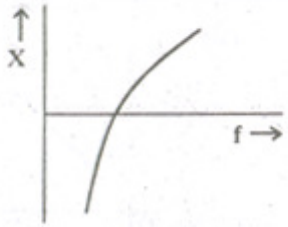
116. Which one of the following statements is correct ?
A material while superconducting behaves like
(a) a diamagnet (b) a paramagnet
(c) a ferromagnet (d) an antiferromagnet

117. In an a.c. circuit with the combination of L and C, which one of the following represents the variation of frequency (f) with reactance (X) ?

(a) 

(b) 

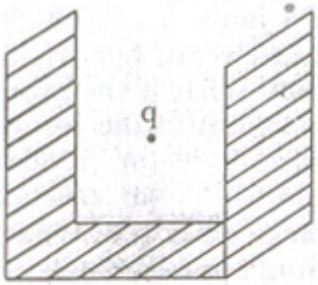
(c) 

(d) 

118. Two parallel plate capacitors of capitances C and 2C are connected in parallel & charged to a potential difference V. The battery is then disconnected & the region between the plates of the capacitor of capacitance C is completely filled with a material of dielectric constant K. What is the potential difference across the capacitors now ?

(a) (3V)/(K+2) (b) (2V)/(K+3)

(c) KV (d) V/K

119. 

A charge q is placed symmetrically with respect to three faces of equal area as shown in the figure given above. What is the total electric flux through the faces ?

(a) q/ε_0 (b) $q/(2\varepsilon_0)$

(c) $q/(3\varepsilon_0)$ (d) zero

120. A conducting spherical shell having inner radius a and outer radius b carries a net charge Q. If a point charge q is placed at the centre of this shell, what is the surface charge density on the outer surface ?

(a) $\frac{Q-q}{4\pi b^2}$ (b) $\frac{Q}{4\pi b^2}$

(c) $\frac{Q}{4\pi b^2}$ (d) $\frac{Q+q}{4\pi(b^2-q^2)}$