February 2013 Paper- III

1 The eigenvalues of (2×2) matrix
$$\begin{bmatrix} 2 & 3 \\ 1 & 0 \end{bmatrix}$$
are :
(a) 0,2   (b) 1, 3

(c) 3, −1   (d) 1 + i, 1 − i

2 The asymptotic behaviors of the curve $y = e^{-x^2} \sin x$ is :
(a) oscillatory   (b) goes to zero

(c) not defined   (d) goes to unity

3 Five boys and three girls are to stand in a line for a photograph, in such a way that no two girls are adjacent. Number of ways in which this can be done is :
(a) 720   (b) 360

(c) 14400   (d) 11600

4 The room temperature measured by different instruments gave the following results :
$$37°C, 70°F, 311°K, 35°C$$
The average temperature would be :
(a) 113°K   (b) 37°C

(c) 35°C   (d) 70.5°F

5 $\lim_{x \to 0} x^x$ is :
(a) 0   (b) 1

(c) i   (d) ∞

6 The particular integral of the inhomogeneous linear differential equation :
$$\frac{dy}{dx} - y = x$$
is given by :
(a) e^x (b) $x\, e^x$

(c) $-x - 1$ (d) $x + 1$

7 Masses m and 3m are attached to the two ends of a spring of spring constant k. What is the period of oscillation?

(a) $4\pi\sqrt{\dfrac{m}{k}}$ (b) $2\pi\sqrt{\dfrac{k}{m}}$

(c) $2\pi\sqrt{\dfrac{m}{2k}}$ (d) $\pi\sqrt{\dfrac{3m}{k}}$

8 The mutual potential energy v of two particles depends on their mutual distance r as follows :
$$v = \frac{a}{r^2} - \frac{b}{r}$$
where a and b are positive constants. For what separation r are the particles in static equilibrium ?
(a) r = a + b   (b) r = ab/a + b

(c) r = 2a/b   (d) $r^2 = a^2 + b^2$

9 The captain of a boat becalmed in the equatorial doldrum moves the anchor vertically upwards with velocity v. Will the boat start moving ? Which way ?
(a) Yes, northwards   (b) Yes, eastwards

(c) Yes, westwards   (d) no.

10 An empty cylindrical can and a can tightly packed with wheat flour, both start rolling down on inclined plane at the same instant. Which can reaches the bottom first?
(a) Empty can

(b) Filled can

(c) Both arrive at the same time

(d) Sizes of the cans must be known to answer this question

11 For attractive inverse square forces the shape of the orbit will be :
(a) Elliptic   (b) Parabolic

(c) Hyperbolic   (d) All of the above

12 A cork is submerged in a pail of water by a spring attached to the bottom of the pail. The pail is held by a child in an elevator. During the initial acceleration as the elevator travels to the next lower floor, the length of the spring will :
(a) increase

(b) decrease

(c) remain the same

(d) any one of the above depending on the spring constant

13 In free space, an infinite grounded conducting plane is placed in xy plane. The force experienced by a point charge q at a point $(0,0,d)$ $d > 0$ is................
(a) $\bar{0}$

(b) $\dfrac{1}{4\pi\epsilon_0}\dfrac{q^2}{d^2}\hat{z}$

(c) $\dfrac{1}{16\pi\epsilon_0}\dfrac{q^2}{d^2}\hat{z}$

(d) $\dfrac{-1}{16\pi\epsilon_0}\dfrac{q^2}{d^2}\hat{z}$

14 The dimensions of a quantity $\epsilon_0\,E^2$ are................
(a) MLT^{-2} (b) $ML^2\,T^{-2}$

(c) $ML^{-1}\,T^{-2}$ (d) $ML^{-2}\,T^2$

15 The direction of propagation of electromagnetic wave is given by...............
(a) $\bar{E}$ (b) $\bar{B}$

(c) $\bar{E}\times\bar{B}$ (d) $\bar{B}\times\bar{E}$

16 Electric field at large distance r, from the electric quadrupole is proportional to
(a) r^{-2} (b) r^{-3}

(c) r^{-4} (d) r^3

17 An electron enters a uniform magnetic field region with its velocity perpendicular to the direction of the field. In the field region, the trajectory of the electron is.....................
(a) linear   (b) circular

(c) parabolic   (d) hyperbolic

18 An infinitely long straight wire is carrying current I. The magnetic field at a distance r from it is..........
(a) $\dfrac{\mu_0 I}{r}$ (b) $\dfrac{\mu_0 I}{\pi r}$

(c) $\dfrac{\mu_0 I}{2\pi r}$ (d) $\dfrac{\mu_0 I}{\pi r^2}$

19 The parity of wave function ψ is associated with which of the following transformation ?
(a) Space inversion

(b) Space rotation

(c) Space translation

(d) Space exchange of two particles

20 The energy levels of the deuterium atom are given in terms of the principal quantum number n and a positive constant A by the expression :
(a) $A(n + 1/2)$ (b) $A\left(-\dfrac{1}{4}+\dfrac{1}{n^2}\right)$

(c) $-A/n^2$ (d) An^2

21 A one-dimensional harmonic oscillator is perturbed by a perturbation potential αx^3. The ground state energy of the oscillator to a first order perturbation is :
(a) $\dfrac{\hbar\omega}{2}$ (b) $\dfrac{\hbar\omega}{2}+\alpha$

(c) $\frac{3}{2}\hbar\omega + \alpha$

(d) $\frac{\hbar\omega}{2} + \alpha^3$

22 The configuration of three electrons 1s2p3p has which of the following as the value of its maximum possible total angular momentum quantum number ?

(a) $\frac{7}{2}$

(b) $\frac{5}{2}$

(c) 3

(d) $\frac{3}{2}$

23 A freely moving electron is localized in space to within Δx at x_0, its wave function can be described by a wave packet :

$$\psi(x, t) = \int_{-\infty}^{\infty} e^{i(kx - wt)} f(k) dk,$$

where $f(k)$ is peaked around a central value k_0. Which of the following is most nearly the width of the peak in k ?

(a) $\Delta k = \frac{1}{x_0}$

(b) $\Delta k = \frac{1}{\Delta x}$

(c) $\Delta k = \frac{\Delta x}{x_0^2}$

(d) $\Delta k = (\Delta x) \frac{k_0}{x_0}$

24 ψ_1 and ψ_2 are two orthonormal wave functions for an electron. Which of the following can describe a state of two electrons ?

(a) $\psi_1(x_1)\psi_2(x_2)$

(b) $\frac{[\psi_1(x_1) + \psi_2(x_2)]}{\sqrt{2}}$

(c) $\frac{1}{\sqrt{2}}\{\psi_1(x_1)\psi_2(x_2) + \psi_1$

(d) $\frac{1}{\sqrt{2}}\{\psi_1(x_1)\psi_2(x_2) - \psi_1(x_2)\psi_2(x_1)\}$

25 Consider distributing 2 identical particles over 3 energy levels. Treating the particles as indistinguishable Fermi-Dirac particles, the

number of ways of distributing is :

(a) 9

(b) 6

(c) 3

(d) 2^3

26 The energy density of the photon gas maintained at a temperature ' T ' is proportional to T^n, where ' n ' is :

(a) 1

(b) 2

(c) 3

(d) 4

27 The average value $\bar{v}$ (non-relativistic) of the velocity of a gas of molecules maintained at a temperature ' T ' is given by :

(a) $\frac{1}{2}k_B T$

(b) zero

(c) $\frac{3}{2}k_B T$

(d) $\frac{k_B T}{m}$

28 In the canonical ensembles the system :

(a) is not maintained at a fixed temperature

(b) can exchange energy with the surroundings

(c) can exchange the number of particles with the surroundings

(d) is completely isolated from the surroundings

29 The entropy of the universe in a reversible process is :

(a) is constant

(b) is increasing

(c) is decreasing

(d) becomes infinite

30 For a system in thermodynamic equilibrium the following must be necessarily constant throughout the system :

(a) Temperature and pressure

(b) Temperature and not pressure

(c) Pressure and chemical potential

(d) Temperature, pressure, chemical potential

31 Noise voltage varies in a resistor as :

(a) $4kTR_B$

(b) $\sqrt{4kTR_B}$

(c) $\sqrt{2eI_P B}$

(d) $\sqrt{2eI_P B \cdot R}$

32 G.M. counter is used for the detection of :

(a) only alpha particles

(b) only beta particles

(c) only gamma radiation

(d) alpha, beta and gamma radiations

33 In a photomultiplier if each stage emits 4 secondaries per primary and there are ten stages the gain is of the order of :

(a) 4^{10}

(b) 10^4

(c) 40

(d) $\dfrac{10\,!}{4!}$

34 A thin and hollow electrode is tapered and open at the end. The electrode is filled with an electrolyte. The electrode is put in an electrolyte bath. The tip will have :

(a) A very high resistance only

(b) A very low resistance only

(c) A high resistance with capacitance

(d) A low resistance with capacitance

35 Best vacuum that can be obtained with a rotary pump is :

(a) 10^{-3} Torr

(b) 10 Torr

(c) 10^{-6} Torr

(d) 10^{-10} Torr
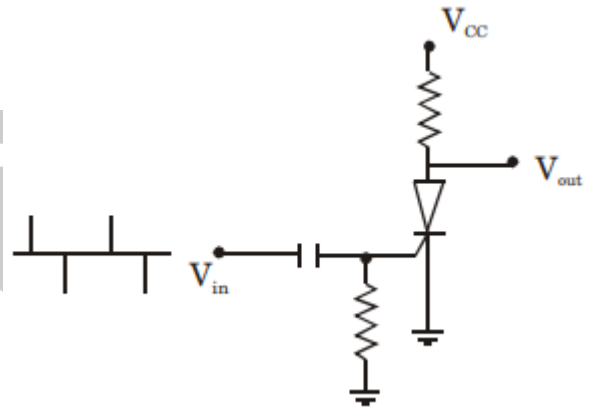
36 Precise value of $e/\hbar$ can be obtained by :

(a) Millikan's oil drop method
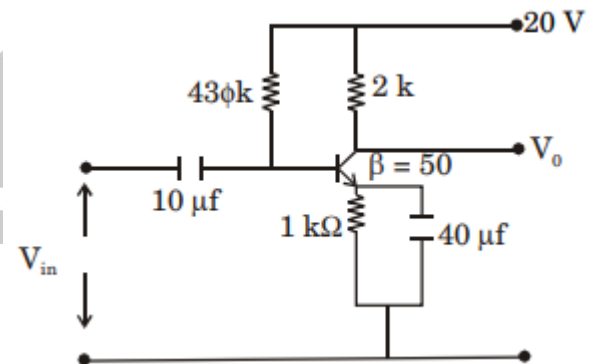
(b) Compton effect

(c) Michelson interferometer

(d) Superconducting quantum interference device

37 What is the output for the following circuit?

(a) Square wave

(b) Triangular wave

(c) Sawtooth

(d) Sine wave

38 Find out the value of I_B and V_C in the following circuit :

(a) 43μA and 11.4 V

(b) 50μA and 10 V

(c) 40μA and 16 V

(d) 45μA and 11 V

39 In which of the following ADC the speed of conversion is maximum :

(a) Successive-approximation ADC

(b) Counter-type ADC

(c) Dual-slope type ADC

(d) Parallel-comparator ADC

40 Which of the following interrupts is un-maskable interrupt?
(a) RST 5.5   (b) RST7.5
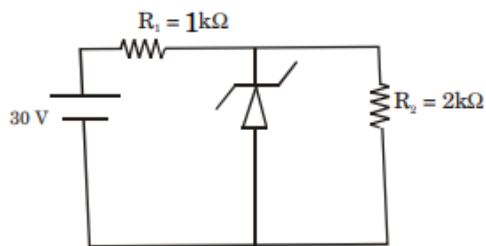
(c) TRAP   (d) INTR 1

41 To send digital data over telephone lines, the modulation technique used is :
(a) AM   (b) FM

(c) FSK   (d) Z-modulation

42 In the given circuit the current through resistor $R_2 (2k\Omega)$ is :
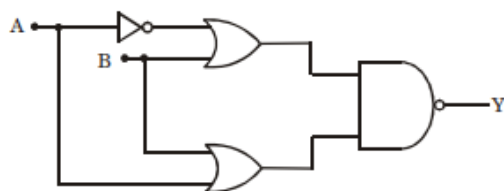

(a) 2 mA   (b) 15 mA

(c) 10 mA   (d) 6 mA

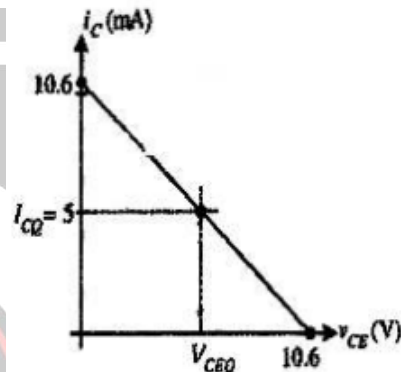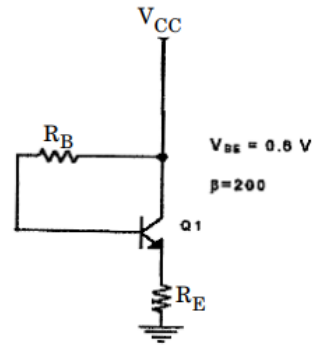43 In the given digital logic circuit, A and B form the inputs. The output Y is :

(a) $Y = \bar{A}$ (b) $Y = A\bar{B}$

(c) $Y = A \oplus B$ (d) $Y = \bar{B}$

44 Find the values of V_{CC}, R_B and R_E in the following circuit :

(a) $\begin{aligned} &V_{CC} = 10\ V, R_B = 200k\Omega \\ &R_E = 1k\Omega \end{aligned}$

(b) $\begin{aligned} &V_{CC} = 10.6\ V, R_B = 200\Omega \\ &R_E = 1k\Omega \end{aligned}$

(c) $\begin{aligned} &V_{CC} = 10.6\ V, R_B = 200k\Omega \\ &R_E = 1k\Omega \end{aligned}$

(d) $\begin{aligned} &V_{CC} = 10\ V, R_E = 1k\Omega \\ &R_B = 200k\Omega \end{aligned}$

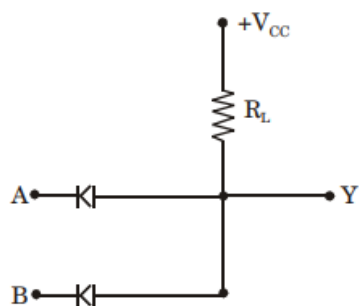45 In op-amp zero crossing detector :
(a) output of comparator is zero

(b) $-V_{CC} = 0$

(c) Reference voltage is zero

(d) $+V_{CC} = 0$

46 The following circuit acts as :

(a) AND   (b) OR

(c) NOT   (d) NAND

47 Consider a planar ion CO_3^{2-}. How many normal modes of vibration this ion will exhibit ?

(a) 6   (b) 7

(c) 4   (d) 12

48 For 1 s and 2 s states of the hydrogen atom, the all points is space at which the corresponding wave functions vanish is :

1s	2s
(a) ∞	$r = 2a_0$ and ∞
(b) 0	$r = a_0, \infty$
(c) $r = a_0$	∞
(d) ∞	0

49 Give functional form of the variation of the potential energy with the separation r between a neutral atom and an ion :

(a) $\dfrac{-1}{r}$ (b) $\dfrac{1}{r^{12}} - \dfrac{1}{r^6}$

(c) $\dfrac{-1}{r^2}$ (d) $\dfrac{-1}{r^3}$

50 A molecule can be infrared active provided a mode of vibration produces :

(a) a change in magnetic dipole moment

(b) a change in polarizability

(c) a change in electric dipole moment

(d) a change in quadrupole moment

51 A light source of wavelength 4358 Å is used to irradiate an organic liquid giving 3 Raman lines at 4400,4419 and 4447Å. The 'Raman Shift' of 4447Å line will be :

(a) 219 cm^{-1} (b) 316.8 cm^{-1}

(c) 345.2 cm^{-1} (d) 459.2 cm^{-1}

52 Distance between two protons in a hydrogen molecule is :

(a) 1 nm   (b) 0.1 nm

(c) 0.01 nm   (d) 0.001 nm

53 State the quantum numbers for the ground state of neutral boron (atomic number 5).

(a) $^2P_{1/2}$ (b) $^1S_0$

(c) $^2S_0$ (d) $^3D_{1/2}$

54 Give the formula and the numerical value in meters, for the radius of the first Bohr orbit in hydrogen atom :

(a) $\dfrac{\hbar}{mc} = 3.8 \times 10^{-13}$ meters

(b) $\dfrac{\hbar}{mc} = 1.4 \times 10^{-15}$ meters

(c) $\dfrac{\hbar^2}{me^2} = 5.3 \times 10^{-11}$ meters

(d) $\dfrac{\hbar}{p} = 2 \times 10^{-17}$ meters

55 Alpha particles and protons of the same kinetic energy are passed through a gold foil. What is the ratio of their Coulomb scattering intensity?

(a) 2   (b) 3

(c) 3/2   (d) 4

56 What is the ground state binding energy of an atom consisting of an electron and a positron bound to each other by their Coulomb interaction?

(a) 13.6Ev   (b) 6.8Ev

(c) 8eV   (d) 20.2eV

57 If the first reflection from an f_{cc} crystal has a Bragg angle θ of 21.5°, the second reflection will have an angle θ of :

(a) 18.5°   (b) 25.0°

(c) 31.0°   (d) 47.13°

58 One of the following is a non-polar molecule :

(a) HCl   (b) CO_2

(c) H_2O (d) HF

59 A rare earth ion has a ground state described by a basic level $^5I_8$. The maximum value of the orbital angular momentum L according to Hund rules is :

(a) 3   (b) 4

(c) 5   (d) 6

60 For Al, critical magnetic field at absolute zero is 105 gauss. The stabilization energy density of the superconducting Al wire in erg/cm^3 is :

(a) 530.00   (b) 320.00

(c) 439.00   (d) 100.00

61 In a semiconductor the effective mass of a hole near the top of valence band is :

(a) positive   (b) negative

(c) zero   (d) pure imaginary

62 The plot of the energy momentum relation for free electrons has the shape of :

(a) A rectangular hyperbola

(b) An ellipse

(c) A circle

(d) A parabola

63 The magnetization of inside a type I superconductor at temperatures T below the critical temperature T_c behaves :

(a) linearly as a function of the applied field H, upto the critical field H_C

(b) is a non-zero constant as a function of H, upto the critical field H_C

(c) is identically zero upto the critical field H_C

(d) shows parabolic behavior upto H_C and shows a gap above H_C

64 In an experiment of photoelectric effect, monochromatic X-rays are incident on the surface of a metal. Some of the resulting photoemitted electrons do not lose energy in escaping the surface and they leave the metal surface with a certain kinetic energy. If φ is the workfunction of the metal, hv the photon energy and E is the binding energy (depth below the Fermi level from which the electron originates), the kinetic energy of the electron will be :

(a) K.E. $= hv + E - \phi$ (b) K.E. $= hv - E + \phi$

(c) K.E. $= hv - E - \phi$ (d) K.E. $= hv + E + \phi$

65 When a beam of electron is reflected from a solid Aluminum surface, it is found that the electrons lose energy in discrete amounts of 15, 31 and 46 eV. Assuming the ideal electron gas model to be valid, the losses must be due to :

(a) plasma oscillations

(b) valence electron excitations

(c) core electron excitations

(d) generation of photoelectrons

66 Which of the following is not true in connection with the nuclear force ?
(a) Nuclear force is short-ranged

(b) Nuclear force is charge independent

(c) Nuclear force is spin-dependent

(d) The proton-proton force is stronger than the neutron-neutron force

67 The ratio of sizes (radii) of $^{208}_{82}$ Pb and $^{26}_{12}$Mg is approximately.
(a) 2   (b) 4

(c) 8   (d) 7

68 Which of the following is not a doubly magic nucleus ?
(a) $^{16}_{8}$O   (b) $^{40}_{20}$Ca

(c) $^{208}_{82}$ Pb   (d) $^{238}_{92}$U

69 A nucleus with mass number 204 decays by α-emission. The Q-value of the reaction is 5.26MeV. The kinetic energy of the α-particle is :
(a) 5.26MeV   (b) 2.63MeV

(c)$5.26 \times \dfrac{200}{204}$ MeV   (d) $5.26 \times \dfrac{4}{204}$ MeV

70 Which of the following is violated by a β-decay phenomenon?
(a) Energy conservation

(b) Momentum conservation

(c) Angular momentum conservation

(d) Parity conservation

71 The nuclear fission due to an absorption of a slow neutron is an example of :
(a) Compound nuclear reaction

(b) Direct reaction

(c) Neutron scattering reaction

(d) Quantum mechanical tunneling

72 Which of the following reactions is allowed one?
(a) $P + P \rightarrow k^+ + \Sigma^+$

(b) $P + P \rightarrow k^+ + P + \Lambda^0$

(c) $\pi^- + P \rightarrow \Sigma^+ + K^0$

(d) $\pi^- + P \rightarrow \pi^0 + \Lambda^0$

73 The quark structure of π^+ is :
(a) uu   (b) $\bar{u}$d

(c) dd   (d)

74 The symmetry term in the semiempirical mass formula is due to :
(a) non-equality of proton number Z and neutron number N

(b) non-spherical shape of nuclei

(c) charge-independence of nuclear force

(d) non-zero value of quadrupole moment of nuclei

75 α-particles of energy 5 MeV passing through an ionisation chamber completely lose their energy. Assuming that 35eV of energy is required to produce one ion pair, find the height of the output pulse, if the capacity of the system is 10μμf.
(a) 2.85×10^{-3} volts   (b) 3.2×10^{-3} volts

(c) 2.24×10^{-3} volts   (d) 3.4×10^{-3} volts .

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