ENTRANCE EXAMINATION FOR ADMISSION, MAY 2010.

M.Tech. (GREEN ENERGY TECHNOLOGY)

COURSE CODE : 307

Register Number : [ ]

Signature of the Invigilator
(with date)

COURSE CODE : 307

Time : 2 Hours Max : 400 Marks

Instructions to Candidates :

1. Write your Register Number within the box provided on the top of this page and fill in the page 1 of the answer sheet using pen.
2. Do not write your name anywhere in this booklet or answer sheet. Violation of this entails disqualification.
3. Read each question carefully and shade the relevant answer (A) or (B) or (C) or (D) in the relevant box of the ANSWER SHEET using HB pencil.
4. Avoid blind guessing. A wrong answer will fetch you –1 mark and the correct answer will fetch 4 marks.
5. Do not write anything in the question paper. Use the white sheets attached at the end for rough works.
6. Do not open the question paper until the start signal is given.
7. Do not attempt to answer after stop signal is given. Any such attempt will disqualify your candidature.
8. On stop signal, keep the question paper and the answer sheet on your table and wait for the invigilator to collect them.
9. Use of Calculators, Tables, etc. are prohibited.

1. When one operates with d^2/dx^2 on the function $8\sin(2x)$, one finds that
   (A) the function is an eigen function with the eigen value -32
   (B) the function is an eigen function with the eigen value 4
   (C) the function is an eigen function with the eigen value -4
   (D) the function is not an eigen function

2. The reason for normalizing a wave function Ψ is
   (A) to guarantee that Ψ is square-integrable
   (B) to make $\Psi^* \Psi$ equal to the probability distribution of the particle
   (C) to make Ψ an eigenfunction of the Hamiltonian operator
   (D) to make Ψ display the proper symmetry characteristics

3. The integral $\int \sin(x) \cos(x)\, dx$ in the interval $-a$ to $+a$
   (A) is zero for any value of a and cos(x) is antisymmetric in this range
   (B) is not zero except for certain values of a and cos(x) is symmetric in this range
   (C) is zero for any value of a and cos(x) is symmetric in this range
   (D) is zero for any value of a and sin(x) is symmetric in this range

4. The energy gap between the n and n+1 level in the particle in a sphere
   (A) increase with increasing in n
   (B) decrease with increasing in n
   (C) independent of the value of n
   (D) goes to negative

5. The energy of the particle in a box is independent of
   (A) length of the box
   (B) potential energy barrier of the box
   (C) mass of the particle
   (D) width of the box

6. The energy of hydrogen atom is a function of
   (A) primary quantum number n
   (B) azimuthal quantum number l
   (C) magnetic quantum number m
   (D) all of the above

7. The equation $(x^2/a^2) - (y^2/b^2) = 1$ describes a
   (A) straight line (B) circle (C) parabola (D) hyperbola

8. If three Persons A, B and C toss a coin in the same order repeatedly till somebody gets a head, what is the probability of A getting the head?

(A) 1/7 (B) 2/7 (C) 3/7 (D) 4/7

9. In the differential equation $3(d^2y/dx^2) + (dy/dx)^3 = x$, the degree and order is

(A) 3, 3 (B) 1, 2 (C) 2, 1 (D) 3, 2

10. The translational analogue of force in rotational motion is

(A) Moment of Inertia (B) Angular momentum

(C) Angular velocity (D) Torque

11. Zero point energy is zero in

(A) particle in a box (B) particle in a ring

(C) particle in a sphere (D) harmonic oscillator

12. Bohr's atomic model does not agree with

(A) Line spectra of hydrogen atom (B) Heisenberg's principle

(C) Plank's theory (D) Pauli's principle

13. Which of the following set of quantum numbers is possible?

(A) n=2, l=1, m=0, s=+1/2 (B) n=2, l=0, m=0, s=+1/2

(C) n=2, l=1, m=0, s=0 (D) n=2, l=1, m=-2, s= +1/2

14. Mathematically, Heisenberg's uncertainly principle can best be represented by

(A) $\Delta x \geq \Delta px/4\pi h$ (B) $\Delta x \times \Delta px \geq h/\pi$

(C) $\Delta x \times \Delta px \geq h/4\pi$ (D) $\Delta x \times h \geq \Delta px/4\pi$

15. The correct Schrodinger's equation for an electron with total energy E and potential energy is

(A) $\partial^2\Psi/\partial x^2 + \partial^2\Psi/\partial y^2 + \partial^2\Psi/\partial z^2 + E = V - (8\pi^2 m/h^2)\Psi$

(B) $\partial^2\Psi/\partial x^2 + \partial^2\Psi/\partial y^2 + \partial^2\Psi/\partial z^2 + 8\pi^2 m/h^2(E-V)\Psi = 0$

(C) $\partial^2\Psi/\partial x^2 + \partial^2\Psi/\partial y^2 + \partial^2\Psi/\partial z^2 + 8\pi^2/n^2h^2(E-V)\Psi = 0$

(D) $\partial^2\Psi/\partial x^2 + \partial^2\Psi/\partial y^2 + \partial^2\Psi/\partial z^2 + 8\pi^2 m/h^2 = (E-V)$

16. Identify combination of metals which form alloys readily

(A) sodium-potassium
(B) beryllium-tungsten
(C) rubidium-caesium
(D) tin-lead

17. Identify the alloy among the following which is super conducting at 24 K

(A) niobium-titanium
(B) nickel-aluminium
(C) copper-gold
(D) niobium-germanium

18. Solids where there is only moderate difference in energy between valence band and conduction band are known as

(A) transistors
(B) conductors
(C) semiconductors
(D) rectifiers

19. Which of the following transformation is feasible to isolate the metal from its oxide?

(A) $2HgO + heat \rightarrow 2Hg + O_2$
(B) $2Fe_2O_3 + heat \rightarrow 4Fe + 3O_2$
(C) $2CaO + heat \rightarrow 2Ca + O_2$
(D) $2MgO + heat \rightarrow 2Mg + O_2$

20. Which one of the following is the molecular formula of Kaolinite clay?

(A) $Na[AlSi_3O_8]$
(B) $Ca[Al_2Si_2O_8]$
(C) $Al_2(OH)_4[Si_2O_5]$
(D) $Ba[Al_2Si_2O_8]$

21. Heating sulfur monochloride S_2Cl_2 with ammonium chloride yields a bright orange solid **A** which is insoluble in water. When **A** can be reduced with metallic potassium to yield a salt **B**. This salt obeys Huckel's rule of aromaticity. **A** can be oxidized with chorine to form stable trichloride **C**. **A**, **B** and **C** respectively are

(A) S_4N_4, S_3N_3K, $S_3N_3Cl_3$
(B) S_3N_2, S_3N_2K, $S_2N_2Cl_3$
(C) $S_{11}N_3$, S_4N_2K, $S_4N_3Cl_3$
(D) S_5N_6, S_4N_6K, $S_4N_5Cl_3$

22. This element which occurs in group 10 shows d^{10} configuration. It is used extensively as a catalyst in hydrogenation and coupling reactions. It can be oxidized to the dication, which is paramagnetic. The metal is

(A) Nickel
(B) Palladium
(C) Platinum
(D) Gold

23. Which one of the following compounds is planar at room temperature?

(A) $N(CH_3)_3$ (B) $N(SiH_3)_3$ (C) $P(CH_3)_3$ (D) $P(Cl)_3$

24. The crystal field stabilization energy (CFSE) for low spin cobalt(III) complex is

(A) $2.4\,\Delta_o - 3p$ (B) $2.4\,\Delta_o - 2p$

(C) $2.4\,\Delta_o - p$ (D) $2.4\,\Delta_o$

25. The oxygen molecule in its ground state is

(A) diamagnetic (B) paramagnetic

(C) ferromagnetic (D) antiferromagnetic

26. Which of the following is an inert gas?

(A) Nitrogen (B) Oxygen (C) Chlorine (D) Argon

27. Which one of the following isotopes is radio active?

(A) ^{13}C (B) ^{14}C (C) ^{1}H (D) ^{2}H

28. Solubility of common salt (NaCl) in water is

(A) exothermic

(B) endothermic

(C) depends on the amount of NaCl dissolved

(D) no change in heat

29. Which one of the following will be close to ideal gas behavior?

(A) Carbon dioxide, CO_2 (B) Dinitrogen gas, N_2

(C) Helium gas, He (D) Dioxygen gas, O_2

30. Which one of the following combination gives buffer solution?

(A) NaCl + HCl (B) NaOH + NaCl

(C) $CH_3COOH + CH_3COONa$ (D) $BaCl_2 + HCl$

31. The second law of thermodynamics can be represented as

(A) $ds \geq \frac{dq}{T}$ (B) $ds \leq \frac{dq}{T}$ (C) $ds = \frac{dq}{T}$ (D) $ds = 0$

32. At triple point of water, the number of degrees of freedom for the system is

(A) zero (B) one (C) two (D) three

33. Hydrolysis of an ester in excess acid is an example of

(A) First order kinetics (B) Zero order kinetics

(C) Second order kinetics (D) Half order kinetics

34. The empirical formula for Arrhenius theory can be written as

(A) $A = ke^{-Ea/RT}$ (B) $k = Ae^{-Ea/RT}$ (C) $A = ke^{+Ea/RT}$ (D) $k = Ae^{+Ea/RT}$

35. The half-life of a first order chemical reaction

(A) is independent of initial concentrations of reactants

(B) is directly proportional to initial concentration of reactants

(C) is inversely proportional to initial concentration of reactants

(D) is directly proportional to square root of initial concentration of reactants

36. A photochemical reaction

(A) is initiated by the excitation of at least one reactant to its electronic excited state

(B) is initiated by the excitation of at least one reactant to its vibrational excited state

(C) is initiated by the excitation of at least one reactant to its excited rotational state

(D) is initiated due to increase in kinetic energy of at least one reactant

37. The instrument used to identify the crystal structure of a material is

(A) Scanning Electron Microscope (B) X-ray diffractometer

(C) Transmission Electron Microscope (D) Fluorescence spectroscopy

38. Which of the following is bio-mass source(s)?

(1) Gobar gas; (2) Coal; (3) Wood; (4) Nuclear energy

(A) (1,2,3) (B) (1,2,4) (C) (2,3,4) (D) (1,3,4)

39. Which of the following produces least pollution when burnt?

(A) Petrol (B) Diesel (C) Coal (D) Hydrogen

40. Efficiency of solar cooker can be increased by placing a

(A) plane mirror (B) convex mirror

(C) concave lens (D) convex lens

41. The element which is used in making a solar cell is

(A) silicon (B) titanium

(C) magnesium (D) cerium

42. Floating generators are used in coastal areas of sea to harness

(A) depth energy (B) wave energy

(C) hydel energy (D) energy from surface wind

43. The molten material mixed with gases in the mantle of the earth is called

(A) core (B) lava (C) geyser (D) magma

44. Very rough terrain or nearby large obstacles near a wind mill may create

(A) smooth air (B) turbulence

(C) damage blade (D) pollution

45. The best place for a wind turbine is

(A) valleys (B) forest

(C) foot hills (D) near sea shore

46. Major drawback of wind power is

(A) variability (B) meltdowns

(C) pollution (D) cluttered scenery

47. What is the line of latitude 23.5 degrees north of the equator called?

(A) Tropic of Cancer (B) Tropic of Capricorn

(C) Temperate (D) Equatorial

48. The best way to determine the wind conditions at a site is by measuring the wind speed. What duration of time would be at least required?

(A) At least a day
(B) At least a month
(C) At least a year
(D) At least three years

49. Match the element and its oxidation state

A.	Phosphorus in phosphorus pentachloride	E.	+3
B.	Chromium in potassium dichromate	F.	+4
C.	Boron in boric acid	G.	+5
D.	Lead in lead tetra-acetate	H.	+6

(A) A = G; B = H; C = E; D = F
(B) A = H; B = G; C = F; D = E
(C) A = F; B = G; C = H; D = E
(D) A = G; B = F; C = H; D = E

50. Match the ionic compounds with the geometry around the metal

A.	ammonium zirconium heptafluoride	E.	tetrahedral
B.	wurzite	F.	trigonal prism
C.	zinc blende	G.	octahedral
D.	rutile	H.	cubic

(A) A = G; B = H; C = E; D = F
(B) A = H; B = G; C = F; D = E
(C) A = F; B = E; C = H; D = G
(D) A = G; B = F; C = H; D = E

51. Match the standard electron potential (at 25 °C; volts) with the reduction of metal salts.

A.	$Ni^{2+} + 2e \rightarrow Ni$	E.	– 1.18
B.	$Fe^{3+} + e \rightarrow Fe^{2+}$	F.	– 0.25
C.	$Mn^{2+} + 2e \rightarrow Mn$	G.	+ 0.35
D.	$Cu^{2+} + 2e \rightarrow Cu$	H.	+ 0.77

(A) A = F; B = H; C = E; D = G
(B) A = H; B = G; C = F; D = E
(C) A = F; B = E; C = H; D = G
(D) A = G; B = F; C = H; D = E

52. Which of the following compounds or mixture is readily soluble in toluene at 25 °C?

A. $KMnO_4$; B. Equimolar mixture of $KMnO_4$ and 18-crown-6; C. *tetra-n*-butylammonium bromide; D. barium hydroxide

(A) A and D (B) B and C (C) D alone (D) A alone

53. Arrange the following bases according to their strength

A. *n*-BuLi; B. $Al(OH)_3$; C. NaOH; D. Cyclohexanol

(A) B > C > A > D (B) D > C > A > B

(C) A > B > D > C (D) A > C > B > D

54. Match the following hydrides with the reaction that they are used for as reagents

A.	calcium hydride	E.	for ionic hydrogenation of double bonds
B.	sodium borohydride	F.	for dehydration of solvents
C.	sodium hydride	G.	for reduction of an aldehyde to alcohol
D.	triethylsilylhydride	H.	as a strong base

(A) A = G; B = H; C = E; D = F (B) A = F; B = G; C = H; D = E

(C) A = H; B = E; C = F; D = G (D) A = G; B = F; C = H; D = E

55. Match the following compounds with the symmetry element

A.	sulphur tetrafluoride	E.	C_{4v}
B.	pentafluorotellurate(IV) anion	F.	C_{2h}
C.	tetrachloroiodate(III) anion	G.	C_{2v}
D.	*E*-1,2-dichloroethylene	H.	D_{4h}

(A) A = G; B = H; C = E; D = F (B) A = F; B = G; C = H; D = E

(C) A = H; B = E; C = F; D = G (D) A = G; B = E; C = H; D = F

56. Match the following compounds with moles of water of hydration

A.	$FeSiF_6$	E.	$5H_2O$
B.	Na_4XeO_6	F.	$6H_2O$
C.	Na_2SO_4	G.	$8H_2O$
D.	$CuSO_4$	H.	$12H_2O$

(A) A = G; B = H; C = E; D = F (B) A = F; B = G; C = H; D = E

(C) A = H; B = E; C = F; D = G (D) A = G; B = E; C = H; D = F

57. Identify Lewis acids among the following compounds

A. SiO_2; B. CaO; C. AsH_3; D. GaH_3

(A) C only (B) A only (C) B and C (D) D only

58. Match the coordination complexes with their property

A.	bis(benzoylacetonato)beryllium	E.	square planar complex
B.	tris(trimethylphosphinesulfide)copper(I) perchlorate	F.	trigonal bipyramidal
C.	cis-diaminedichloroplatinum(II)	G.	coordination umber of metal is 3
D.	Iron(0) pentacarbonyl	H.	can exist as enantiomers and they are resolvable

(A) A = G; B = H; C = E; D = F (B) A = F; B = G; C = H; D = E

(C) A = H; B = G; C = E; D = F (D) A = G; B = E; C = H; D = F

59. The electron in a hydrogen atom makes a transition from an excited state to the ground state. Which of the following statements is true?

(A) Its kinetic energy increases and its potential and total energy decreases

(B) Its kinetic energy decreases, potential energy increases and its total energy remains the same

(C) Its kinetic energy and total energy decreases and its potential energy increases

(D) Its kinetic, potential and total energy decreases

60. Which of the following is not a mode of radioactive decay?

(A) Position emission (B) Electron capture

(C) Fusion (D) Alpha decay

61. A piece of copper and another of germanium are cooled from room temperature to 77K. The resistance of

(A) each of these decreases

(B) copper strip increases and that of germanium decreases

(C) copper strip decreases and that of germanium increases

(D) each of these increases

62. The P^{-n} function has a thickness of the order of

(A) 1 cm (B) 1 mm (C) 10^{-6} m (D) 10^{-12} cm

63. If [A,B] = C then [A, f(B)]=?

(A) $c\frac{df(B)}{dB}$ (B) $\frac{1}{c}\frac{df(B)}{dB}$ (C) $c\frac{df(A)}{dA}$ (D) $\frac{df(B)}{dB}$

64. Spin-orbit coupling results in

(A) Bohr model (B) Land shift

(C) Fine structure (D) Hyperfine structure

65. A particle is confined to a region 0<x<L in are dimension. If the particle is in the first excited state, then the probability of finding the particle is maximum at

(A) x = L/6 (B) x = L/2

(C) x = L/3 (D) x = L/4 and 3L/4

66. Which of the following quantity has the same dimensions as the latent heat?

(A) Work per unit mass (B) Specific heat per unit mass

(C) Force per unit velocity (D) Acceleration per unit displacement

67. An electron propagating along the x axis passes through a slit of width $\Delta y > 1$ nm. The uncertainty in the y-component of its velocity after passing through the slit is

(A) 7.322×10^5 m/s (B) 1.166×10^5 m/s

(C) 3.346×10^5 m/s (D) 2.326×10^5 m/s

68. A particle of energy E is incident on a potential barrier of height Vo and width b. Then

(A) the reflection coefficient for E<Vo tends to be unity as b tends to be infinity

(B) the reflection coefficient is zero for some specific values of E>Vo

(C) the transmission coefficient is always zero for E<Vo

(D) the transmission coefficient is zero for some specific values of E>Vo

69. The value of sin 330° is

(A) −1/2 (B) 1/2 (C) 1/4 (D) −1/4

70. The solutions of $10x^2-27x+5=0$ are

(A) $\frac{-1}{5}, \frac{5}{2}$ (B) $\frac{-5}{2}, \frac{1}{5}$ (C) $\frac{-5}{2}, \frac{-1}{5}$ (D) $\frac{5}{2}, \frac{1}{5}$

71. Following equation represent $x^2+4y^2+116x+2y+4xy+259=0$

(A) circle (B) straight line (C) parabola (D) ellipse

72. The value of the integral $\int 6^x dx$ is

(A) $\frac{6^x}{\log_e 6}$ (B) $\frac{6^{x-1}}{\log_e 12}$ (C) $\frac{12^x}{\log_e 3}$ (D) $\frac{-6^{x/2}}{\log_e 6}$

73. The value of $\int_0^\infty x^{-1/2}\, dx$ is

(A) ∞ (B) $-\infty$ (C) 0 (D) 1

74. Which of the following is a scalar?

(A) Displacement (B) Kinetic energy

(C) Couple (D) Momentum

75. The magnitudes of vectors **A**, **B** and **C** are 12, 5 and 13 units respectively and $\mathbf{A} + \mathbf{B} = \mathbf{C}$. The angle between vectors **A** and **B** is

(A) 0 (B) π (C) $\pi/2$ (D) $\pi/4$

76. When milk is churned, cream separate out because of the

(A) cohesive force (B) gravitational force

(C) frictional force (D) centrifugal force

77. Thermodynamic potential which is minimum for system at equilibrium at constant entropy and pressure is

(A) Internal Energy (B) Enthalpy

(C) Helmholtz free energy (D) Gibb's free energy

78. Some materials such as camphor does not have a liquid phase at ambient pressure why?

(A) Triple point pressure is greater than ambient pressure

(B) Triple point pressure is less than ambient pressure

(C) Critical point pressure is greater than ambient pressure

(D) Critical point pressure is less than ambient pressure

79. Thermal energy shared by each degree of freedom of a system obeying equipartition theorem is

(A) KT (B) 2 KT (C) 1/2 KT (D) 3/2 KT

80. Maximum number of phases that can coexist for a K-component system is

(A) K (B) K+2 (C) K-2 (D) K+1

81. In Vander Walls equation of state, the constant correction to pressure is proportional to

(A) N^2 (B) N (C) 1/N (D) $1/N^2$

82. Pressure exerted by a photon gas is related to energy density u as

(A) 1/2 u (B) 2/3 u (C) 3/5 u (D) 1/3 u

83. Lattice specific heat of solids at low temperatures varies with temperature as

(A) T (B) T^2 (C) T^3 (D) $\bar{e}^{\theta/T}$

84. Which of the following thermodynamic variables are discontinuous across a first order phase transit?

(A) Volume (B) A Gibb's free energy

(C) Specific heat (D) Bulk modular

85. When the temperature of a blackbody is doubled the total power radiated increases by

(A) 2 times (B) 4 times (C) 16 times (D) 32 times

86. Entropy in a free expansion of a gas

(A) increases

(B) decreases

(C) remains same

(D) increases initially and then decreases

87. Number of atoms per unit cell of Face Centered Cubic (FCC) structure is

(A) 2 (B) 4 (C) 1 (D) 3

88. Which of the following structure is a close packed structure?

(A) FCC (B) Hexagonal

(C) BCC (D) Orthorhombic

89. Number of point group operations in three dimensional crystal structures

(A) 17 (B) 5 (C) 32 (D) 230

90. (hkl) corresponding to first peak in 2θ versus intensity of XRD pattern of BCC structure is

(A) 111 (B) 110 (C) 100 (D) 200

91. Which of the following structures have smallest packing fraction?

(A) Hexagonal close packed (B) BCC

(C) SC (D) Diamond

92. Molecular process associated with infrared region are

(A) Change of orientation (B) Change of electron distribution

(C) Change of configuration (D) Change of nuclear spin

93. Among CH, CF, CCl, and CBr series, which group gives lowest frequency in Fourier Transform infrared (FT-IR) spectra?

(A) CH (B) CF (C) CCl (D) CBr

94. The photoelectron spectroscopy resulting from the core electrons requires excitation source of

(A) UV (B) X-ray

(C) Either UV or X-ray (D) Microwave

95. The appropriate order of magnitude of electronic, molecular and rotational is

(A) $\Delta\varepsilon_{elec} \times 10^6 \approx \Delta\varepsilon_{vib} \times 10^3 \approx \Delta\varepsilon_{rot}$

(B) $\Delta\varepsilon_{elec} = \Delta\varepsilon_{vib} \approx \Delta\varepsilon_{rot} \times 10^2$

(C) $\Delta\varepsilon_{elec} \approx \Delta\varepsilon_{vib} \times 10^3 \approx \Delta\varepsilon_{rot} \times 10^6$

(D) $\Delta\varepsilon_{elec} \approx (\Delta\varepsilon_{vib} \times 10^3)^{-1} \approx (\Delta\varepsilon_{rot} \times 10^6)^{-1}$

96. Nuclei with both p and n even have spin equal to

(A) integral (B) half-integral

(C) zero (D) all are correct

97. The Raman shift of the first stokes or antistokes from the exciting line is

(A) $6B\ cm^{-1}$ (B) $4B\ cm^{-1}$ (C) $2B\ cm^{-1}$ (D) $8B\ cm^{-1}$

98. Larmor frequency is given by

(A) $\frac{\text{(Magnetic moment) (Applied field strength along z – axis)}}{\text{Angular momentum}}$

(B) $\frac{\text{(Angular momentum) (Applied field strength along z – axis)}}{\text{Magnetic moment}}$

(C) $\frac{\text{(Applied field strength along z – axis)}}{\text{(Angular momentum) (Magnetic moment)}}$

(D) $\frac{\text{(Angular momentum)}}{\text{(Magnetic moment) (Applied field strength along z – axis)}}$

99. A sequence of atoms having the same number of extra nuclear electrons are known as

(A) Ionization sequence (B) Zeeman sequence

(C) Spin-relativity sequence (D) Isoelectronic sequence

100. Spectroscopy based on the deviation of distribution of the positive charge in the nucleus from spherical symmetry is

(A) Nuclear Magnetic Resonance

(B) Mass Spectrometry

(C) Nuclear quadrupole Resonance

(D) Mossbauer spectroscopy
