



PUNJAB TECHNICAL UNIVERSITY JALANDHAR

Max. Marks: 90

Time: 90 Mins.

Entrance Test for Enrollment in Ph.D. Programme

Important Instructions

- Fill all the information in various columns, in capital letters, with blue/black ball point pen.
- Use of calculators is not allowed. Use Blue/Black ball point pen for attempting the questions.
- All questions are compulsory. No negative marking for wrong answers.
- To attempt a question, make a tick mark (✓) at the right option/answer.
- Each question has only one right answer.
- Questions attempted with two or more options/answers will not be evaluated.

Subject (Engg./Arch./Pharm./Mgmt./Sciences) APPLIED SCIENCE

Discipline / Branch PHYSICS

Name

Father's Name

Roll No. Date : 10-07-2010

Signature of Candidate

Signature of Invigilator

Q.1 If $x = \sin t$ & $y = \tan t$, then y in terms of x is:

- (a) $\frac{x}{1-x^2}$
- (b) $\frac{\sqrt{1-x^2}}{x}$
- (c) $\frac{x}{\sqrt{1-x^2}}$
- (d) $\frac{1-x^2}{x}$

Q.2 Four equal circles are inscribed in a square of side 'a' touching each other and the sides of square. Ratio of the area of the four circles to the area of the square is:

- (a) $\frac{2}{\pi}$
- (b) $\frac{4}{\pi^2}$
- (c) $\frac{\pi}{4}$
- (d) $\frac{\pi^2}{16}$

Q.3 Determine the value of b for which the sequence

$-a, \frac{-a}{b}, \frac{a}{b}, a$ is an arithmetic progression

(where $a \neq 0$).

- (a) -3
- (b) -2
- (c) 2
- (d) 3

Q.4 A battery is replaced by two identical batteries connected in parallel. The combination can deliver

- (a) the same maximum voltage and the same maximum current
- (b) the same maximum voltage and a lower maximum current
- (c) the same maximum voltage and a higher maximum current
- (d) a higher maximum voltage and a lower maximum current

Q.5 When an object moves at high velocity in a fluid the drag force on it is given by $F = Kv^2A$, where v is the object's velocity and A its area. What sort of quantity is K ?

- (a) mass
- (b) acceleration
- (c) length
- (d) density

Q.6 The moon orbits the earth at a distance of 400,000 km with a period of 2.4×10^6 s. What is its acceleration towards the earth?

- (a) $2.7 \times 10^{-3} \text{ ms}^{-2}$
- (b) $2.7 \times 10^{-6} \text{ ms}^{-2}$
- (c) 10 ms^{-2}
- (d) $6.6 \times 10^3 \text{ ms}^{-2}$

Q.7 Evaluation of $(0.09)^{\frac{3}{2}}$ gives

- (a) 0.00027
- (b) $\sqrt{0.027}$
- (c) 0.027
- (d) $\sqrt{0.27}$

Q.8 In quantum mechanics the de Broglie wavelength of an object depends on its momentum according to $\lambda = \frac{h}{p}$ where h is

Planck's constant. Protons of charge e and mass m are accelerated from rest through a potential V. What is their de Broglie wavelength?

- (a) $\frac{2h}{\sqrt{meV}}$
 (b) $\frac{h}{\sqrt{2meV}}$
 (c) $\frac{h}{\sqrt{meV}}$
 (d) $\frac{h}{eV}$

Q.9 An alien civilization is in the business of building custom solar systems. Their basic model has five planets in circular orbits at distances D that are perfect square multiples of a basic length, so that they are in the ratio 1:4:9:16:25. For this model the year lengths Y of the planets are in ratios 1:8:27:64:125. How are D and Y related? { where k is some constant }

- (a) $\frac{Y}{D} = k$
 (b) $D = k\sqrt{Y}$
 (c) $Y = kD\sqrt{D}$
 (d) $\frac{Y^3}{D^2} = k$

Q.10 When a metal bar is cooled it contracts. Which of the following is true?

- (a) The density and mass increase.
 (b) The density increases and the mass remains constant.
 (c) The density and mass are unchanged.
 (d) The mass remains constant and the density decreases.

Q.11 A hot air balloon is descending at a steady speed of $11ms^{-1}$. The pilot drops a sandbag, which takes 7s to fall to the ground. What was the height of the balloon when the sandbag was released?

- (a) 168m
 (b) 245m
 (c) 322m
 (d) 528m

Q.12 A symmetric seesaw is 3m long from end to end. If a girl of mass 20 kg sits on one end, how far away from her should a boy of mass 30 kg sit to balance the seesaw?

- (a) $0.5m$
 (b) $1.0m$
 (c) $2.0m$
 (d) $2.5m$

Q.13 The universe contains about 400 billion galaxies (where 1 billion equals 10^9). Our galaxy contains about 250 billion stars. The mass of our sun is about $2 \times 10^{30} kg$. It is estimated that dark matter out-masses stars by about 20:1. The estimated total mass of the universe is:

- (a) $4 \cdot 2 \times 10^{36} kg$
 (b) $9 \cdot 5 \times 10^{51} kg$
 (c) $2 \cdot 0 \times 10^{53} kg$
 (d) $4 \cdot 2 \times 10^{54} kg$

Q.14 A physics lecture theatre is situated 3m east and 4m above reception. Calculate the minimum energy a 60 kg receptionist would have to expend to reach the lecture theatre.

- (a) 1800 J
 (b) 2400 J
 (c) 3000 J
 (d) 4200 J

Q.15 A train 110m long is running with a speed of $60kmh^{-1}$. In what time will it pass a man who is running at $6kmh^{-1}$ in the direction opposite to that in which the train is going?

- (a) 5 sec
 (b) 6 sec
 (c) 7 sec
 (d) 10 sec

Q.16 Tickets numbered 1 to 20 are mixed up and then a ticket is drawn at random. What is the probability that the ticket drawn has a number which is a multiple of 3 or 5?

- (a) $\frac{1}{2}$
 (b) 5
 (c) $\frac{8}{15}$
 (d) $\frac{9}{20}$

Q.17 A spring that obeys Hooke's law has a spring constant k. Two such springs are linked to form a spring of twice the length. What is the spring constant of this new longer spring?

- (a) $\frac{k}{2}$
 (b) $\frac{k}{\sqrt{2}}$
 (c) $\frac{\sqrt{2}}{k}$
 (d) $2k$

Q.18 Two resistors R_1 & R_2 are in parallel with a potential difference V across them. The total power dissipated in this circuit is

(a) $V^2 \left(\frac{1}{R_1} + \frac{1}{R_2} \right)$

(b) $\frac{V^2}{R_1 + R_2}$

(c) $\frac{V^2}{\left(\frac{1}{R_1} + \frac{1}{R_2} \right)}$

(d) $V^2(R_1 + R_2)$

Q.19 A lump of ice attached to a small weight (to keep the ice at the bottom) is put in a test tube filled with water. Tube is slightly tilted and is heated near the upper level of water. Select the **correct** statement.

- (a) Ice will melt & water will boil simultaneously
- (b) First the ice will melt and only then water at the top will boil
- (c) Ice will not melt for sometime but the water at the top will boil
- (d) Ice will melt first and then whole mass of water will boil.

Q.20 A bus is moving from south to north with a uniform speed on a smooth road. The velocity vector at the point of contact between tyres and the road will be

- (a) North to south
- (b) south to north
- (c) at 45° with north to south
- (d) at 45° with south to north

Q.21 Founder director of Tata Institute of Fundamental Research (TIFR) institute is

- (a) C. V. Raman
- (b) H J Bhabha
- (c) K. S. Krishnan
- (d) Vikram Sarabhai

Q.22 Physical Research Laboratory (PRL) is located at

- (a) Ahmedabad
- (b) Chennai
- (c) Kolkata
- (d) Mumbai

Q.23 Winners of the Noble prize in Physics in 2009 are

- (a) Charles K. Kao & Willard S. Boyle
- (b) Charles K. Kao & George E. Smith
- (c) Willard S. Boyle & George E. Smith
- (d) Charles K. Kao, Willard S. Boyle & George E. Smith

Q.24 Journal of Science education RESONANCE is published from

- (a) Allahabad
- (b) Bangalore
- (c) Kolkata
- (d) New Delhi

Q.25 The mode of the following terms 0, 1, 6, 7, 2, 3, 7, 6, 6, 2, 6, 0, 5, 6, 0 is

- (a) 5
- (b) 4
- (c) 6
- (d) 2

Q.26 If the speed of light were $\frac{2}{3}$ of its present value,

then energy released in a given atomic explosion will decrease by a factor of :

- (a) $\frac{2}{3}$
- (b) $\frac{5}{9}$
- (c) $\frac{4}{9}$
- (d) $\frac{\sqrt{5}}{9}$

Q.27 Slow neutrons are incident on a sample of uranium containing both ${}_{92}U^{235}$ & ${}_{92}U^{238}$ isotopes. Then

- (a) Both isotopes will undergo fission and break up
- (b) Only ${}_{92}U^{235}$ atoms undergo fission
- (c) Only ${}_{92}U^{238}$ atoms undergo fission
- (d) None of the isotopes will undergo fission

Q.28 Parity is not conserved in

- (a) α - decay
- (b) β -decay
- (c) γ -decay
- (d) None of the above

Q.29 Neutron has

- (a) Positive magnetic moment
- (b) Negative magnetic moment
- (c) Sometimes positive and sometimes negative magnetic moment
- (d) No magnetic moment

Q.30 The number of normal modes in a bent H_2O molecule is

- (a) 3
- (b) 6
- (c) 4
- (d) 9

Q.31 The characteristic impedance of a dielectric medium to electromagnetic waves is

- (a) $(\mu\epsilon)^{\frac{1}{2}}$
- (b) $\left(\frac{\mu}{\epsilon} \right)^{\frac{1}{2}}$
- (c) $\left(\frac{\epsilon}{\mu} \right)^{\frac{1}{2}}$
- (d) $\mu\epsilon$

- Q.32 Hyperons are the particles, which are
 (a) Heavier than proton
 (b) Of same mass as that of proton
 (c) Lighter than proton
 (d) None of the above
- Q.33 The decay $\Lambda^0 \rightarrow p + \pi^-$
 (a) Is not possible
 (b) Is a strong decay
 (c) Is a weak decay
 (d) Is electromagnetic decay process
- Q.34 In the decay $p \rightarrow \pi^0 + e^+$
 (a) Strangeness is not conserved
 (b) Charge is not conserved
 (c) Baryon number is not conserved
 (d) Lepton number is not conserved
- Q.35 If the doping level of a crystal diode is increased, then the breakdown voltage
 (a) Remains same
 (b) Increases
 (c) Decreases
 (d) None of the above
- Q.36 Which filter circuit results in best voltage regulation?
 (a) Choke input
 (b) Capacitor input
 (c) Resistance input
 (d) None of the above
- Q.37 In which mode, the voltage gain of transistor is maximum?
 (a) Common base
 (b) Common collector
 (c) Common emitter
 (d) a & b
- Q.38 The phase difference between input and output voltage signals in common base arrangement is
 (a) 180°
 (b) 90°
 (c) 270°
 (d) 0°
- Q.39 If a wavefunction ψ satisfies the condition $\iiint \psi^* \psi dV = 1$ then ψ is said to be
 (a) normalized
 (b) orthonormal
 (c) orthogonal
 (d) none of the above
- Q.40 1dB corresponds to _____ change in power level. {Given $\log_{10}(1.50) = 0.176$, $\log_{10}(1.35) = 0.130$, $\log_{10}(1.26) = 0.100$, $\log_{10}(1.22) = 0.086$ }
 (a) 50%
 (b) 35%
 (c) 26%
 (d) 22%
- Q.41 An important limitation of a crystal oscillator is
 (a) Its low output
 (b) Its high Q
 (c) Less availability of quartz crystal
 (d) Its high output
- Q.42 One condition for oscillation is
 (a) A phase shift around the feedback loop of 180°
 (b) A gain around the feedback loop of one third
 (c) A phase shift around the feed back loop of 0°
 (d) The gain around the feedback loop of less than one
- Q.43 Consider the Boolean expression $Y = \overline{AB} + \overline{A}B$: If $A = 1$ & $B = 1$; then Y is equal to
 (a) 1
 (b) 0
 (c) Either 0 or 1
 (d) Neither 0 nor 1
- Q.44 Digital circuit can be made by repeated use of
 (a) OR gates
 (b) NOT gates
 (c) NAND gates
 (d) None of the above
- Q.45 The binary number 10101 is equivalent to decimal number
 (a) 19
 (b) 12
 (c) 27
 (d) 21
- Q.46 If M_A and ρ are the atomic weight and density of a metal respectively, and N_A is the Avogadro's number, then the number of atoms present in unit volume is calculated using the relation
 (a) $\frac{M_A}{\rho N_A}$
 (b) $\frac{\rho N_A}{M_A}$
 (c) $\frac{\rho M_A}{N_A}$
 (d) $\frac{N_A}{\rho M_A}$
- Q.47 The maximum number of electrons in a subshell with orbital quantum number l is
 (a) $(2l + 1)$
 (b) $(2l - 1)$
 (c) $2(2l + 1)$
 (d) $2(2l - 1)$

Q.48 If f_1 & f_2 are the frequencies of the electron in the first and second orbits of hydrogen atom

respectively, then $\left(\frac{f_1}{f_2}\right)$ is

- (a) 8
- (b) 2
- (c) 4
- (d) 1

Q.49 Which of the following relation gives the potential energy of a diatomic molecule

- (a) $-\frac{a}{r^m} + \frac{b}{r^n}$
- (b) $\frac{a}{r^m} + \frac{b}{r^n}$
- (c) $ar^m + br^n$
- (d) $ar^m - br^n$

Q.50 The effective mass of a photon of wavelength λ is

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

Q.51 If σ and E are the electric conductivity and applied field respectively in a current carrying conductor, then the heat developed per unit volume per second is

- (a) σE^2
- (b) $\sigma^2 E$
- (c) $\frac{\sigma}{E}$
- (d) $\frac{E^2}{\sigma}$

Q.52 If $\Psi_{(1,1,1)}$ & $\Psi_{(1,1,2)}$ are the wavefunctions of the electrons in the two energy states (1,1,1) and (1,1,2) respectively in a cubical box of

side a , then $\frac{\Psi_{(1,1,1)}}{\Psi_{(1,1,2)}} = ?$

- (a) $\frac{\sin\left(\frac{\pi z}{a}\right)}{\sin\left(\frac{2\pi z}{a}\right)}$
- (b) $\frac{\sin\left(\frac{2\pi z}{a}\right)}{\sin\left(\frac{\pi z}{a}\right)}$
- (c) $\frac{\sin\left(\frac{\pi z}{a}\right)}{\sin\left(\frac{\pi y}{a}\right)}$
- (d) $\frac{\sin\left(\frac{2\pi y}{a}\right)}{\sin\left(\frac{2\pi z}{a}\right)}$

Q.53 If both ends of a string of length l are fixed, then the wavelengths of the wave that can be propagated through it are (where n is an integer)

- (a) $\frac{2l}{n}$
- (b) $\frac{n}{2l}$
- (c) $\frac{l}{n}$
- (d) $\frac{n}{l}$

Q.54 Electronic spectra of a diatomic molecule lie in the

- (a) Microwave region only
- (b) Visible and ultraviolet region
- (c) Infrared region only
- (d) Visible region only

Q.55 The favourable condition both for superconductivity and high resistance is

- (a) a weak electron – phonon interaction
- (b) a strong electron – phonon interaction
- (c) a weak phonon – phonon interaction
- (d) none of these

Q.56 The anomalous Zeeman effect can be explained when

- (a) relatively weak external magnetic field and no electron spin are considered.
- (b) relatively weak external magnetic field and electron spin are considered.
- (c) a relatively strong external magnetic field and electron spin are considered.
- (d) relatively strong external magnetic field and no electron spin are considered.

Q.57 When a monoatomic gas atom is placed in a uniform electric field E, then the displacement of the nucleus is proportional to

- (a) E^2
- (b) E
- (c) E^3
- (d) Independent of E

Q.58 A vector field \vec{A} is conservative. It can always be written as

- (a) $\vec{A} = \nabla \cdot \phi$
- (b) $\vec{A} = \nabla \times \phi$
- (c) $\vec{A} = \nabla \phi$
- (d) $\vec{A} = \nabla^2 \phi$

Q.59 Two particles, each of mass 1g, moving with velocity $0.6c$ in opposite directions collide and come to rest. If no heat is lost by annihilation, what is the total increase in rest mass

- (a) $0.5g$
- (b) 1g
- (c) 2g
- (d) more than 2g

Q.60 Two bodies of same momentum have different masses. Then

- (a) The total mass energy will be greater of lighter body
- (b) The total mass energy will be greater of heavier body
- (c) The total mass energy will be same for both the bodies.
- (d) none of these

Q.61 The Poisson brackets of all the constants of motion with Hamiltonian H must be equal to

- (a) unity
- (b) zero
- (c) $\frac{h}{2\pi}$
- (d) none of these

Q.62 The Lagrangian for a particle moving under a central force is

- (a) $\frac{1}{2}m(\dot{r}^2 + r^2\dot{\theta}^2) + \frac{k}{r}$
- (b) $\frac{1}{2}m(\dot{r}^2 + r^2\dot{\theta}^2) - \frac{k}{r}$
- (c) $-\frac{1}{2}m(\dot{r}^2 + r^2\dot{\theta}^2) + \frac{k}{r}$
- (d) $\frac{1}{2}m(\dot{r}^2 - r^2\dot{\theta}^2) + \frac{k}{r}$

Q.63 Spherical aberration can be removed by using

- (a) Convex lens
- (b) Concave lens
- (c) Plano convex lenses
- (d) Cylindrical lenses

Q.64 Number of cardinal points in a lens system is

- (a) 2
- (b) 4
- (c) 6
- (d) 8

Q.65 The focal length of objective of telescope is 60cm. To obtain a magnification of 20, the focal length of the eyepiece should be

- (a) 2cm
- (b) 3cm
- (c) 4cm
- (d) 5cm

Q.66 The velocity of light in diamond, glass and water decreases in the following order

- (a) Water>glass>diamond
- (b) Diamond>glass>water
- (c) Diamond>water>glass
- (d) Water>diamond>glass

Q.67 White light is used to illuminate the two slits in a Young's double slit experiment. The separation between the slits is b and the screen distance is d ($d \gg b$). At a point on the screen directly in front of one of the slits, certain wavelengths are missing. Some of the missing wavelengths are:

- (a) $\lambda = \frac{b^2}{d}$
- (b) $\lambda = \frac{2b^2}{d}$
- (c) $\lambda = \frac{d^2}{3b}$
- (d) $\lambda = \frac{2b^2}{3d}$

Q.68 The condition for observing Fraunhofer diffraction from single slit is that the light wavefront incident on the slit should be

- (a) Spherical
- (b) Cylindrical
- (c) Plane
- (d) Elliptical

- Q.69 A hollow metallic sphere filled with water is hung from a support by a long thread. A small hole is made at the bottom of the sphere and it is oscillated. How will the time period of oscillations be affected as water slowly flows out of the hole?
- The time period will remain unchanged as water is flowing out
 - The time period will keep increasing until the sphere is empty
 - The time period will keep decreasing until the sphere is empty
 - The time period will increase at first, then decrease until the sphere is empty; finally the period will be the same as that when the sphere was full of water

- Q.70 When stationary waves are produced, which physical characteristic out of pressure and density will change at antinodes?
- Pressure
 - No change of pressure or density
 - Density
 - Pressure as well as density

- Q.71 Lissajous figures are useful in comparing
- Frequency
 - Loudness
 - Quality
 - Intensity

- Q.72 At any point in the electromagnetic cavity, resonator energy stored per unit volume of the field (U) is given by:

- $U = \frac{1}{2} \epsilon_0 E^2$
- $U = \frac{1}{2} \frac{B^2}{\mu_0}$
- $U = \frac{1}{2} \epsilon_0 E^2 - \frac{1}{2} \frac{B^2}{\mu_0}$
- $U = \frac{1}{2} \epsilon_0 E^2 + \frac{1}{2} \frac{B^2}{\mu_0}$

- Q.73 The eigenvalues of the matrix $A = \begin{bmatrix} 0 & i \\ i & 0 \end{bmatrix}$ are

- real and distinct
- complex and distinct
- complex and coinciding
- real and coinciding

- Q.74 $\sigma_i (i = 1, 2, 3)$ represent the Pauli spin matrices. Which one of the following is **not** true?

- $\sigma_i \sigma_j + \sigma_j \sigma_i = 2\delta_{ij}$
- $Tr(\sigma_i) = 0$
- The eigenvalues of σ_i are ± 1
- $\det(\sigma_i) = 1$

- Q.75 Which one of the following functions represents the bound state eigenfunction of the operator $\left(-\frac{d^2}{dx^2}\right)$ in the region $0 \leq x \leq \infty$; with the eigenvalue -9 ?

- $A_0 e^{3x}$
- $A_0 \cosh 3x$
- $A_0 e^{-3x}$
- $A_0 \sinh 3x$

- Q.76 Identify which one is a first order phase transition?

- Solid to liquid transition at its melting point
- He (I) to He (II) at $2.18K$
- Ferromagnetic to paramagnetic transition in the absence of a magnetic field
- Superconductor to normal metal transition in the absence of a magnetic field

- Q.77 The separation between the first Stokes line and the incident radiation line in the rotational Raman spectrum in terms of rotational constant,

$$B = \frac{h^2}{8\pi^2 I}, \text{ where } h \text{ is Planck's constant and}$$

I is moment of inertia, is

- $2B$
- $4B$
- $6B$
- $12B$

- Q.78 In a cubic crystal, atoms of mass M_1 lie on one set of planes and atoms of mass M_2 lie on the planes interleaved between those of the first set. If C is the force constant between nearest neighbour planes, the frequencies of the lattice vibrations for the optical phonon branch and the acoustic phonon branch at $k_{\max} = \pm \frac{\pi}{a}$ are respectively,

given by

- $\sqrt{\frac{C}{M_1}}, \sqrt{\frac{2C}{M_2}}$
- $\sqrt{\frac{C}{M_1}}, \sqrt{\frac{C}{M_2}}$
- $\sqrt{\frac{2C}{M_1}}, \sqrt{\frac{2C}{M_2}}$
- $\sqrt{\frac{2C}{M_2}}, \sqrt{\frac{2C}{M_1}}$

Q.79 Consider a nucleus with N neutrons and Z protons. If m_p & m_n and BE represent the mass of the proton, the mass of the neutron and the binding energy of the nucleus respectively and c is the velocity of light in free space, the mass of the nucleus is given by

- (a) $Nm_n + Zm_p$
- (b) $Nm_p + Zm_n$
- (c) $Nm_n + Zm_p + \frac{BE}{c^2}$
- (d) $Nm_p + Zm_n + \frac{BE}{c^2}$

Q.80 Mark the correct statement.

- (a) Energy levels of H atom, particle in a box and of harmonic oscillator depend in the same way on the principal quantum number n .
- (b) Energy levels of a one dimensional harmonic oscillator are expressed as $\left(n + \frac{1}{2}\right)$ with $n = 1, 2, 3, \dots$.
- (c) Uncertainty principle has bearing on the zero point energy.
- (d) Uncertainty principle has no bearing on the zero point energy.

Q.81 Mark the correct statement

- (a) Fermions have half integral spin and obey the exclusion principle
- (b) Fermions have half integral spin and do not obey the exclusion principle
- (c) Fermions have integral spin and obey the exclusion principle
- (d) Fermions have integral spin and do not obey the exclusion principle

Q.82 Fermi energy of free electron gas in some metal is 5.0 eV . The average energy of these electrons in it at 0K is

- (a) 5.0 eV
- (b) 3.33 eV
- (c) 3.0 eV
- (d) 2.5 eV

Q.83 A relativistic particle of the rest mass m_0 is moving with a speed v . The value v at which kinetic energy is equal to its rest mass energy is

- (a) $v = \frac{c}{2}$
- (b) $v = \frac{c}{4}$
- (c) $v = \frac{c}{\sqrt{2}}$
- (d) $v = \frac{\sqrt{3}c}{2}$

Q.84 The function $v(x, y) = 3x^2y - y^3$ is

- (a) harmonic
- (b) not harmonic
- (c) analytic
- (d) both a and c

Q.85 The function $f(z) = \frac{\sin z}{z^4}$ has

- (a) a pole of zero order at $z = 1$
- (b) a pole of order 3 at $z = 0$
- (c) a pole of order 3 at $z = 1$
- (d) a pole of order 2 at $z = 0$

Q.86 For liquefying any gas, its temperature must be

- (a) more than the critical temperature
- (b) less than the critical temperature
- (c) equal to the critical temperature
- (d) none of the above

Q.87 Gibb's Rule for a heterogeneous system of chemically non-interacting components is

- (a) $F = C - P + 2$
- (b) $F = C + P - 2$
- (c) $F = C - P$
- (d) $F = C - P + 1$

Q.88 The width of the energy gap of a superconductor is maximum at

- (a) T_c
- (b) 0 K
- (c) $\frac{T_c}{2}$
- (d) $\frac{T_c}{3}$

Q.89 Laser light is considered to be coherent because it consists of

- (a) many wavelengths
- (b) uncoordinated wavelengths
- (c) coordinated wavelengths
- (d) divergent waves

Q.90 The order of the pumping power necessary to achieve the population inversion in a Ruby laser is

- (a) 10^7 W/m^2
- (b) 10^2 W/m^2
- (c) 10^{10} W/m^2
- (d) 10^{16} W/m^2