



# Punjab Technical University

Maximum Marks: 90

Time: 90Mins.

### Important Instructions

- Fill all the information in various columns, in Capital letters, with blue/black point pen for attempting the questions
- Use of calculators is not allowed.
- Make attempt by writing the answer in capital Letters in the box against each question number.
- All questions are compulsory. Each Question has only one right answer. No Negative marking for wrong answers.
- Questions attempted with two or more options/answers will not be evaluated.

Stream (Engg/Arch/Pharm/Mgmt/App. Sci/life Sci/Humanities): APPLIED SCIENCES

Discipline / Branch: PHYSICS

Name: .....

Father's name:

Q. 1 A sphere of radius  $a$  is centered at a point  $(x_1, y_1, z_1)$ , the algebraic equation for the sphere is

- (a)  $(x - x_1)^2 + (y - y_1)^2 + (z - z_1)^2 = a^2$
- (b)  $(x + x_1)^2 + (y + y_1)^2 + (z + z_1)^2 = a^2$
- (c)  $x_1^2 + y_1^2 + z_1^2 = a^2$
- (d)  $(x - x_1)^2 + (y - y_1)^2 + (z - z_1)^2 = 0$

Q. 2 If  $A$  is a diagonal matrix, with all diagonal elements different, and  $A$  and  $B$  commute, then

- (a)  $B$  can be diagonal or non diagonal matrix
- (b)  $B$  can be any diagonal matrix
- (c)  $B$  is a non diagonal matrix
- (d)  $B$  can only be a unit matrix

Q. 3 For a homogeneous second order differential equation, given as  $y'' + P(x)y' + Q(x)y = 0$ , the point  $x_0$  is called a singular point, if

- (a) Both  $P(x)$  and  $Q(x)$  diverge as

- (b) Either  $P(x)$  or  $Q(x)$  diverges as  $x \rightarrow x_0$
- (c) Both  $P(x)$  and  $Q(x)$  remain finite as  $x \rightarrow x_0$
- (d) Either  $P(x)$  or  $Q(x)$  remains finite as  $x \rightarrow x_0$

Q. 4 The Fourier Transform of a function  $f(t)$  is given as

- (a)  $g(w) = \frac{1}{2\pi} \int_{-\infty}^{+\infty} f(t)e^{-iwt} dt$
- (b)  $g(w) = \frac{1}{\sqrt{2\pi}} \int_0^{+\infty} f(t)e^{-iwt} dt$
- (c)  $g(w) = \frac{1}{2\pi} \int_{-\infty}^{+\infty} f(t)e^{iwt} dt$
- (d)  $g(w) = \frac{1}{2\pi} \int_0^{+\infty} f(t)e^{iwt} dt$

Q. 5 The covariance of two random variables  $X$  and  $Y$  is defined as

- (a)  $cov(X, Y) = (X - \bar{X})(Y - \bar{Y})$
- (b)  $cov(X, Y) = (X + \bar{X})(Y + \bar{Y})$
- (c)  $cov(X, Y) = (X + \bar{X})(Y - \bar{Y})$
- (d)  $cov(X, Y) =$

Q. 6 Which of the following is correct?

- (a) If the multiplication is commutative, the group is called abelian
- (b) Two groups are isomorphic, if their elements can be put into one-to-one correspondence
- (c) If a discrete group possesses  $n$  elements, its order is  $n-1$
- (d) Two groups are homomorphic, if their elements can be put into many-to-one correspondence

Q. 7 The values of  $p$  and  $q$  for which,

$$\sum_{n=2}^{\infty} \frac{1}{n^{p(\ln n)^q}}$$
 converge are,

- (a)  $p > 1, q = 0$
- (b)  $p > 1, \text{all } q$
- (c)  $p < 1, q = 0$
- (d)  $p < 1, q < 1$

Q. 8 For a complex function, a regular point of  $f(z)$  is a point in which

- (a)  $f(z)$  is analytic
- (b)  $f(z)$  fails to be analytic
- (c)  $f(z)$  is zero
- (d)  $f(z)$  is one

Q. 9 A block with mass  $M$  and contact area  $A$  slides down an inclined plane with friction, covering a distance  $L$  in time  $T$ . How much time does it take another block with the same mass and composition, but contact area  $2A$ , to slide down the same length?

- (a)  $T^2$
- (b)  $T$
- (c)  $\sqrt{T}$
- (d)  $T^3$

Q. 10 The conditions for an observable  $Q$  to be constant of motion is

- (a)  $[H, Q] = 0$
- (b)  $[H, Q] = 0$
- (c)  $[H, Q] < 0$
- (d)  $[H, Q] > 0$

Q. 11 For a rigid rotator, the rotational eigen energies are proportional to

- (a)  $l^2 \hbar^2$
- (b)  $\hbar^2 / (l(l+1))$
- (c)  $\hbar^2 / l^2$
- (d)  $l(l+1) \hbar^2$

Q. 12 The selection rules for electric dipole transitions are

- (a)  $\Delta l = 0, \Delta m = 0$
- (b)  $\Delta l = \pm 1, \Delta m = 0, \pm 1$
- (c)  $\Delta l = \pm 2, \Delta m = \pm 1$
- (d)  $\Delta l = \pm 2, \Delta m = 0, \pm 1$

Q. 13 Which of the following is true?

(a) The energy level spectrum of an atom consists of discrete positive energies corresponding to bound states and a continuum of negative energies corresponding to unbound states.

(b) The energy level spectrum of an atom consists of continuum of negative energies corresponding to bound states and a continuum of positive energies corresponding to unbound states.

(c) The energy level spectrum of an atom consists of discrete negative energies corresponding to bound states and a continuum of positive energies corresponding to unbound states.

(d) The energy level spectrum of an atom consists of discrete negative energies corresponding to bound states and discrete positive energies corresponding to unbound states.

Q. 14 When the two particles A and B undergo a change of their internal quantum state during the collision, the process is known as

- (a) elastic collision
- (b) inelastic collision
- (c) classical collision
- (d) may be elastic or inelastic collision

Q. 15 In a Ruby laser, the output is spiked due to

- (a) flash lamp
- (b) chromium ions
- (c) the laser being a three level laser
- (d) all of above

Q. 16 The Doppler broadening of spectral lines is

- (a) proportional to temperature

Created with

- (a) proportional to the frequency
- (c) inversely proportional to square root of atomic weight

(d) proportional to atomic number

Q. 17 The pure rotational spectrum falls in

- (a) Visible region
- (b) Extreme IR or microwave region
- (c) radio frequency region
- (d) UV region

Q. 18 The principal series

- (a) can be observed only in emission spectrum
- (b) can be observed only in absorption spectrum
- (c) can be observed in emission as well as in absorption spectrum
- (d) cannot be observed.

Q. 19 In the Zeeman spectrum of a spectral line consisting of 6 equidistant components, the upper state term is  $P_{3/2}^2$ , the lower state term

- (a)  $D_{3/2}^2$
- (b)  $P_{3/2}^2$
- (c)  $S_{1/2}^2$
- (d)  $P_{1/2}^2$

Q. 20 Which of the following is true?

- (a) The hyperfine structure effects give rise to splittings of electronic energy levels, while the isotope effects do not give rise to splittings
- (b) The hyperfine structure effects do not give rise to splittings of electronic energy levels, while the isotope effects give rise to splittings
- (c) Both, hyperfine structure effects and isotope effects give rise to splittings of electronic energy levels
- (d) None of the above

Q. 21 The Lagrange's equations are given as

- (a)  $\frac{d}{dt} \frac{\partial L}{\partial \dot{q}_j} + \frac{\partial L}{\partial q_j} = 0$
- (b)  $\frac{d}{dt} \frac{\partial L}{\partial q_j} - \frac{\partial L}{\partial \dot{q}_j} = 0$
- (c)  $\frac{d}{dt} \frac{\partial L}{\partial q_j} + \frac{\partial L}{\partial \dot{q}_j} = 0$
- (d)  $\frac{d}{dt} \left( \frac{\partial L}{\partial \dot{q}_j} \right) - \frac{\partial L}{\partial q_j} = 0$

Q. 22 If the Lagrangian of a

system does not contain a given coordinate  $q_j$ , then the coordinate is said to be a

- (a) generalized coordinate
- (b) non cyclic coordinate
- (c) cyclic coordinate
- (d) special coordinate

Q. 23 The number of degrees of freedom possessed by a rigid body is

- (a) 6
- (b) 3
- (c) 1
- (d) •

Q. 24 For a canonical transformation  $(q, p) \rightarrow (Q, P)$

- (a)  $pdq - PdQ$  is an exact differential
- (b)  $pdq + PdQ$  is an exact differential
- (c)  $pdQ - Pdq$  is an exact differential
- (d)  $pdQ + Pdq$  is an exact differential

Q. 25 Which of the following is true?

- (a) Linear momentum and angular momentum are both polar vectors.
- (b) Linear momentum and angular momentum are both axial vectors.
- (c) Linear momentum is a polar vector and angular momentum is an axial vector.
- (d) Linear momentum is an axial vector and angular momentum is a polar vector.

Q. 26 The expression for the conserved angular momentum in a central force problem is,

- (a)  $L = mr^2\dot{\theta}$
- (b)  $L = \frac{m}{r^2\dot{\theta}}$
- (c)  $L = mr\dot{\theta}$
- (d)  $L = 2mr^2\dot{\theta}$

Q. 27 The Poisson bracket of any two constants of the motion

- (a) is always zero
- (b) is a constant of motion
- (c) is never constant
- (d) may or may not be constant

Q. 28 The electric field variation for a spherically symmetric charge distribution of radius  $R$ , for the cases  $r < R$  and  $r > R$ , is given as

- (a)  $E \text{ constant}, E \propto 1/r$
- (b)  $E \propto r, E \propto 1/r^2$
- (c)  $E \propto 1/r^2, E \propto r$

(d)  $E \propto 1/r$ ,  $E$  constant

- Q. 29 An excess charge is placed on a conductor. Then, at equilibrium, the charge is located on the surface and
- (a) Both the surface and the interior points have same uniform potential
  - (b) Potential inside is zero throughout and has a uniform value on the surface
  - (c) Potential inside has a uniform value throughout and a different uniform value on the surface
  - (d) Potential inside has a uniform value and is zero on the surface

Q. 30 The power flux information of the electromagnetic wave is given by the

- (a) Pauli matrix
- (b) poynting vector
- (c) Levi-Civita tensor
- (c) field tensor

Q. 31 When em wave propagates through a dielectric medium, then

- (a) the electric and magnetic fields oscillate in phase and with same frequency
- (b) the electric and magnetic fields oscillate in phase, but not with same frequency
- (c) magnetic field oscillates with a phase lag relative to the electric field
- (d) electric field oscillates with a phase lag relative to the magnetic field

Q. 32 For the em wave emitted by an electric dipole

- (a) power radiated is directly proportional to the second power of frequency and maximum radiation is emitted orthogonal to the dipole
- (b) power radiated is directly proportional to the second power of frequency and minimum radiation is emitted orthogonal to the dipole
- (c) power radiated is directly proportional to the fourth power of frequency and maximum radiation is emitted orthogonal to the dipole
- (d) power radiated is directly proportional to the fourth power of frequency and minimum radiation is emitted orthogonal to the dipole

Q. 33 For a sinusoidally varying

input voltage of frequency  $\omega$ , the ratio of conduction current density to displacement current density is proportional to

- (a)  $\frac{\omega\epsilon}{\omega\sigma}$
- (b)  $\frac{\sigma}{\omega\epsilon}$
- (c)  $\frac{\epsilon}{\omega\sigma}$
- (d)  $\sqrt{\omega\epsilon\sigma}$

Q. 34 Faraday's law of electromagnetic induction may be expressed as

- (a)  $\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$
- (b)  $\nabla \times \mathbf{B} = \frac{\partial \mathbf{E}}{\partial t}$
- (c)  $\nabla \cdot \mathbf{E} = \frac{\partial \mathbf{B}}{\partial t}$
- (d)  $\nabla \cdot \mathbf{B} = \frac{\partial \mathbf{E}}{\partial t}$

Q. 35 On a conductor of non uniform curvature, the charge

- (a) has the greatest concentration on the parts of least curvature.
- (b) has the greatest concentration on the parts of greatest curvature.
- (c) is distributed uniformly on the whole surface
- (d) is distributed uniformly over its volume.

Q. 36 Which of the following statement is correct for the series combination of two capacitors with unequal capacitances?

- (a) Less charge is stored on a series capacitor, than on either one of them with the same voltage
- (b) More charge is stored on a series capacitor, than on either one of them with the same voltage
- (c) The charge stored on a series capacitor is double than on either one of them with the same voltage
- (d) The charge stored on a series capacitor is half than on either one of them with the same voltage

Q. 37 When resistance of  $2 \cdot$  is connected across the terminals of a battery, the current is 0.5A. When the resistance across the terminal is  $5 \cdot$ , the current is 0.25A. The emf of the battery is

- (a) 0.5V

- (b) 1.0V
- (c) 1.5V
- (d) 5.0V

Q. 38 For an extrinsic semiconductor,

- (a) the fermi level lies just above the valence band for  $p$  type, and just below the conduction band for  $n$  type.
- (b) the fermi level lies just above the valence band for  $n$  type, and just below the conduction band for  $p$  type.
- (c) the fermi level lies midway in the energy gap
- (d) the fermi level lies within the conduction band

Q. 39 In the Bode plot of an operation amplifier, a roll off rate of 20 dB/decade at high frequencies is equivalent to

- (a) 3 dB/octave
- (b) 2 dB/octave
- (c) 6 dB/octave
- (d) 9 dB/octave

Q. 40 An electronic circuit is unstable, if its transfer function in  $s$ -domain has

- (a) a positive real pole
- (b) a negative real pole
- (c) a pole at the origin
- (d) no zeros

Q. 41 The informational content of the signal represents

- (a) only one-third of the AM wave power at full modulation
- (b) only one-fourth of the AM wave power at full modulation
- (c) only one-half of the AM wave power at full modulation
- (d) only two-third of the AM wave power at full modulation

Q. 42 The amplifier band width is defined as difference between two frequencies at which the power is

- (a)  $\frac{1}{4}$  of mid frequency power
- (b) 33% of mid frequency power
- (c) half of mid frequency power
- (d) 67% of mid frequency power

Q. 43 The resistance-transistor logic (RTL) family of gates replaces the diodes of the diode-transistor logic (DTL)

family with the

- (a) base-emitter junctions of transistor
- (b) base-collector junctions of transistor
- (c) emitter-collector junctions of transistor
- (d) any of the above

Q. 44 The field-effect transistor (FET) differs from a bipolar transistor, as

- (a) FET has a very low input resistant
- (b) FET has a very high input resistant
- (c) FET suffers more random variation of current
- (d) FET is useful with very high input signal

Q. 45 The input impedance of the base of an emitter-follower is usually

- (a) low
- (b) high
- (c) open
- (d) shorted to ground

Q. 46 Only one IC is active at a time to avoid a bus conflict caused by two ICs writing different data to the same bus, is ensured by

- (a) control bus
- (b) control instructions
- (c) address decoder
- (d) CPU

Q. 47 In a light dependent resistor (LDR), the resistance

- (a) increases linearly with increase in the intensity of light
- (b) decreases linearly with increase in the intensity of light
- (c) increases non-linearly with increase in the intensity of light
- (d) decreases non-linearly with increase in the intensity of light

Q. 48 According to the method of least squares, the best fitting curve has the property that

- (a)  $\sum_{i=1}^n [y_i - f(x_i)]^2 = \text{aminimum}$
- (b)  $\sum_{i=1}^n [y_i - f(x_i)] = \text{aminimum}$
- (c)  $\sum_{i=1}^n [y_i - f(x_i)]^{1/2} = \text{aminimum}$
- (d)  $\sum_{i=1}^n [y_i - f(x_i)]^{3/2} = \text{aminimum}$

where,  $y$  is dependent and  $x$  is independent variable, while  $f(x)$  is the best fitting curve.

Q. 49 The theorem of equipartition of energy states the molecules in thermal equilibrium have same average energy associated with each independent degree of freedom and is

- (a)  $kT^2/2$  per molecule
- (b)  $kT/2$  per molecule
- (c)  $kT$  per mole
- (d)  $kT^2$  per mole

Q. 50 At standard atmospheric pressure, liquid nitrogen has a temperature of

- (a) 0 K
- (b) 270 K
- (c) 77 K
- (d) 373 K

Q. 51 Dulong and Petit law says that the specific heat per mole of a solid at constant volume is given as

- (a)  $3kT$
- (b)  $3RT$
- (c)  $3R$
- (d)  $3K$

Q. 52 Heat convection is

- (a) heat transfer by means of molecular agitation without any motion of material as a whole
- (b) heat transfer by mass motion of a fluid such as air or water when the heated fluid is caused to move away from the source of heat
- (c) heat transfer by the emission of electromagnetic waves which carry energy away from the emitting object
- (d) all of above

Q. 53 The Gibbs function for a system is given as  $G = H - TS$ , where  $H$  is enthalpy.  $T$  is temperature and  $S$  is the entropy of the system. In the case of a reversible, isothermal, isobaric process

- (a)  $G = \text{constant}$
- (b)  $G > 0$  and changes with  $T$
- (c)  $G < 0$  and changes with  $S$
- (d)  $G$  changes with both  $T$  and  $S$

Q. 54 The second law of thermodynamics says that in any cyclic process, the entropy

- (a) will always increase
- (b) will always decrease
- (c) will always remain same

(d) will either increase or remain the same.

Q. 55 In an adiabatic process, the

- (a) heat is gained by the system
- (b) heat is lost by the system
- (c) heat is neither gained nor lost by the system
- (d) heat may be gained or lost by the system

Q. 56 The Fermi - Dirac distribution function is given as

- (a)  $f(E) = \frac{1}{e^{(E-E_F)/kT} + 1}$
- (b)  $f(E) = \frac{1}{Ae^{E_F/kT} - 1}$
- (c)  $f(E) = \frac{1}{e^{(E-E_F)/kT} - 1}$
- (d)  $f(E) = \frac{1}{Ae^{E_F/kT} + 1}$

Q. 57 For non-constant pressure, the work done is given as the area under

- (a) pressure-volume curve
- (b) pressure-temperature curve
- (c) temperature-volume curve
- (d) any of (a) and (b)

Q. 58 With regards to bond energy, which of the following is arranged in correct order

- (a) diamond > Fe > water > Ar
- (b) diamond > water > Fe > Ar
- (c) Fe > water > diamond > Ar
- (d) water > diamond > Ar > Fe

Q. 59 The directional nature of covalent bonds is responsible for

- (a) the high tensile strength of the covalently bonded solids
- (b) low density of the covalently bonded solids
- (c) ductility of the covalently bonded solids
- (d) high refractive index of the covalently bonded solids

Q. 60 A triclinic crystal is represented by

- (a)  $a \neq b \neq c, \alpha \neq \beta \neq \gamma : 90^\circ$
- (b)  $a = b \neq c, \alpha = \gamma = 90^\circ, \beta \neq 90^\circ$
- (c)  $a = b = c, \alpha = \gamma = \beta = 90^\circ$
- (d)  $a \neq b = c, \alpha = \gamma = \beta = 90^\circ$

Q. 61 The crystal lattice of diamond is

- (a) bcc with basis
- (b) bcc with basis

(c) fcc with basis at 000 and

$\frac{111}{222}$  positions

(d) fcc with basis at 000 and

$\frac{111}{444}$  positions

Q. 62 Which of the following is not true?

(a) The single crystals are characterized by having anisotropic properties

(b) A polycrystalline solid is usually isotropic

(c) Single crystals can be grown in the lab

(d) A polycrystalline substance has a very long range order

Q. 63 In the rotating crystal method for determination of crystal structure,

(a) the sample is taken in the powdered form and a polychromatic X-ray beam is used

(b) the sample is taken in the powdered form and a monochromatic X-ray beam is used

(c) the sample is a single crystal and a polychromatic X-ray beam is used

(d) the sample is a single crystal and a monochromatic X-ray beam is used

Q. 64 The high value of the elastic constant of a solid implies that

(a) the solid has high elasticity

(b) the solid is very stiff

(c) the solid has high yield strength

(d) the solid has high ductility

Q. 65 The resistivity of a metal increases with the temperature, primarily due to

(a) increase in the charge carrier concentration

(b) increase in the relaxation time of the free electrons

(c) decrease in the charge carrier concentration

(d) decrease in the relaxation time of the free electrons

Q. 66 The Hall coefficient for a semiconductor, increases with

(a) an increase in the applied current and applied magnetic field

(b) decrease in the applied current and

applied magnetic field

(c) decrease in the charge carrier concentration

(d) increase in the width of the crystal

Q. 67 A crystal shows

piezoelectricity only if

(a) it possesses a center of inversion symmetry

(b) it does not possess a center of inversion symmetry

(c) it possesses a diad rotational symmetry axis

(d) it does not possess a diad rotational symmetry axis

Q. 68 The dipolar polarizability of a dielectric

(a) is independent of the temperature

(b) is inversely proportional to the temperature

(c) is directly proportional to the strength of the applied electric field

(d) is inversely proportional to the strength of the applied electric field

Q. 69 The magnetic susceptibility of a ferromagnetic material is

(a) large and negative

(b) small and negative

(c) large and positive

(d) small and positive

Q. 70 Ferromagnetic materials

respond mechanically to an impressed magnetic field, changing length slightly in the direction of the applied field.

This property is known as

(a) magnetocontraction

(b) magnetostriction

(c) transducerism

(d) length contraction

Q. 71 According to Wein's displacement formula, the wavelength of the peak of the radiation curve is inversely proportional to

(a) the second power of the temperature

(b) the fourth power of the temperature

(c) the temperature

(d) the square root of the temperature

Q. 72 The famous Franck-Hertz

Experiment

confirmed

(a) the dual nature

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(b) that the atomic energy levels are quantized

(c) the hyperfine structure

(d) the existence of a band gap in insulators

Q. 73 The position and momentum of a microscopic particle cannot be simultaneously measured with arbitrarily high precision, due to

(a) the inaccuracy of measurement instruments,

(b) the quality of experimental methods

(c) the wave properties inherent in the quantum mechanical description of nature.

(d) all of above

Q. 74 The group velocity of a wave packet representing a particle is

(a) same as the velocity of the particle

(b) greater than the velocity of the particle

(c) smaller than the velocity of the particle

(d) greater than the speed of the light

Q. 75 The normalized wave function for a particle in a rigid box is given as

(a)  $\psi(x) = \sqrt{\frac{2}{x}} \sin \frac{n\pi a}{x}$

(b)  $\psi(x) = \sqrt{\frac{2}{a}} \sin \frac{n\pi a}{x}$

(c)  $\psi(x) = \sqrt{\frac{2}{x}} \sin \frac{n\pi x}{a}$

(d)  $\psi(x) = \sqrt{\frac{2}{a}} \sin \frac{n\pi x}{a}$

Q. 76 For a bounded particle, which of the following is true?

(a) the energy is a continuous function of frequency.

(b) the rest mass energy is zero.

(c) the energy states are discrete.

(d) the uncertainty principle is not valid.

Q. 77 A photon recoils back after striking an electron at rest. The shift in wavelength is

(a) 0.0048nm

(b) 0.024 nm

(c) zero

(d) infinite

Q. 78 For an electron of mass  $9.1 \times 10^{-31} \text{ Kg}$  in an infinite well of 2cm

width, the value of  $n$  for which the electron energy is 1 eV, is

(a) 300

(b) 3000

(c)  $3 \times 10^5$

(d)  $3 \times 10^7$

Q. 79 For purely orbital angular momentum, the Lande'  $g$  factor is

(a) 2

(b) 1

(c) 0

(d) 3/2

Q. 80 The shift of the first rotational Raman line from the exciting line is equal to

(a) 6B

(b) 12B

(c) 4B

(d) 8B

Q. 81 Which of the following is wrong?

(a) The quantum no.  $m_l$  determines the space orientation of orbital angular momentum vector

(b) Total energy of the atom does not depend on  $m_l$ .

(c) Eigenfunctions are degenerate w.r.t.  $m_l$ .

(d) The z component of angular momentum is  $L_z = m_l(m_l + 1)\hbar$

Q. 82  $\text{Bi}^{210}$  has a half life of 5 days. The time taken for  $1/8^{\text{th}}$  of a sample to decay is

(a) 20 days

(b) 15 days

(c) 10 days

(d) 5 days

Q. 83 A single fission event can yield

(a) over 20 times the energy of the neutron which triggered it

(b) over 2000 times the energy of the neutron which triggered it

(c) over 200 thousand times the energy of the neutron which triggered it

(d) over 200 million times the energy of the neutron which triggered it

Q. 84 Neutron inverse process of



- (a) pair production
- (b) photoelectric effect
- (c) photo-disintegration
- (d) beta decay

Q. 85 Which of following is the correct daughter nucleus associated with beta decay of  ${}^{184}_{72}\text{Hf}$ ?

- (a)  ${}^{183}_{72}\text{Hf}$
- (b)  ${}^{183}_{73}\text{Ta}$
- (c)  ${}^{184}_{73}\text{Ta}$
- (d) none of above

Q. 86 The quark content of the the neutral pion  $\pi^0$  is

- (a)  $u\bar{u}$  or  $d\bar{d}$
- (b)  $u\bar{s}$
- (c)  $u\bar{d}$
- (d)  $s\bar{u}$

Q. 87 The weak interactions are mediated by

- (a) the photon
- (b) the massless vector bosons
- (c) the massive vector bosons
- (d) the gluons

Q. 88 Helicity of a particle is

- (a) its spin at rest
- (b) its spin measured in the direction of motion
- (c) defined only for a massless particle
- (d) not a measurable quantity

Q. 89 Parity is violated in

- (a) strong interactions
- (b) gravitational interactions
- (c) electromagnetic interactions
- (d) weak interactions

Q. 90 According to the shell model of nuclear structure

- (a) Each nucleon exists in quantized energy states
- (b) There are fewer collisions between the nucleons
- (c) none of (a) and (b) is true
- (d) both (a) and (b) are true