

Roll No.

Total No. of Questions : 9]
(2033)

[Total No. of Printed Pages : 4

UG (CBCS) IIIrd Year Annual Examination

3295

B.Sc. PHYSICS

(Elements of Modern Physics)

(DSE-1A)

Paper : PHYS 301 TH

Time : 3 Hours]

[Maximum Marks : 50

Note :- Attempt *five* questions in all, selecting *one* question each from Sections–B, C, D and E. Question No. 1 (Section–A) is compulsory.

Section–A

(Compulsory Question)

1. (i) Why is observation of Compton Effect difficult with visible light ?
- (ii) Why is the wave nature of matter not apparent in our daily observation ?

CA–495

(1)

Turn Over

- (iii) What is the importance of normalising a wave function ?
- (iv) What are Eigen values and Eigen function ?
- (v) Why is that electrons cannot be inside the nucleus ?
- (vi) Differentiate between artificial and natural radioactivity.
- (vii) Write a short note on 'Thermal Neutrons'. $2 \times 7 = 14$

Section-B

2. (i) Describe the Einstein's theory of photo-electric effect. How does it explain the laws of photoelectric emission ?
- (ii) Describe Davisson-Germer experiment for the diffraction of electrons. What role did it play in the verification of de-Broglie hypothesis ? 5,4
3. (i) Explain the various reasons for the acceptance of the Rutherford nuclear atom model.
- (ii) Describe Bohr's postulates and derive the formula for Balmer series of hydrogen lines. Calculate the radius of first Bohr orbit. 5,4

Section-C

4. (i) Explain uncertainty principle in Quantum mechanics and by using it calculate binding energy of electron in hydrogen atom.
- (ii) A proton and deuteron have the same kinetic energy. Which one of them will have longer wavelength ? 5,4
5. (i) Derive time dependent Schrödinger equation and from it obtain the time independent Schrödinger equation.
- (ii) Explain expectation value of an operator and the need to define it. 5,4

Section-D

6. (i) What do you mean by a particle in a box ? Obtain expression for energy levels and normalised wave functions for a particle in a box.
- (ii) Calculate the zero point energy of a simple harmonic oscillator. 5,4
7. (i) Derive the semi-empirical mass formula of liquid drop model.
- (ii) What are nuclear forces ? In what respects do they differ from electrostatic and gravitational forces ? 5,4

Section-E

8. (i) What is natural radio-activity ? Explain the terms Half-life and Mean-life and derive a relation for them.
- (ii) Give the origin of neutrino and antineutrino. 5,4
9. (i) What are the different types of nuclear reactions ? Discuss with examples and derive an expression for the Q-value of the reaction.
- (ii) Discuss the role of cadmium control rods in a nuclear reactor. 6,3

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UG (CBCS) IIIrd Year (Annual) Examination

3229

B.Sc. PHYSICS

(Nuclear and Particle Physics)

(DSE-1B)

Paper : PHYS 304 TH

Time : 3 Hours]

[Maximum Marks : 70

Note :- Attempt *five* questions in all, selecting *one* question from each Section. Question No. 1 is compulsory.

Section-A

(Compulsory Question)

1. (i) Magnetic moment of neutron is :
- (a) Positive (b) Negative
- (c) Zero (d) Infinite
- (ii) Which has the highest penetrating power ?
- (a) α particles
- (b) β particles
- (c) γ rays
- (d) All have the same penetrating power

CH-29

(1)

Turn Over

- (iii) The decay constant of the end product of natural radioactive series is :
- (a) Zero (b) One
(c) Infinite (d) π
- (iv) A meson is a bound state of :
- (a) 3 quarks
(b) 2 quarks
(c) 1 quark and 1 anti-quark
(d) 3 anti-quarks
- (v) The values of Baryon number, Lepton number, Iso-spin, Strangeness number of neutron are :
- (a) 1, 0, $\frac{1}{2}$, 0
(b) 1, 1, $\frac{1}{2}$, 0
(c) 0, 1, $\frac{1}{2}$, 1
(d) 1, 0, 0, 1
- (vi) Nuclear forces are saturated forces. Explain.
- (vii) What are Thermal Neutrons ?
- (viii) What are the processes by which a γ -ray may lose its energy ?
- (ix) What are Cerenkov radiations ?
- (x) What is a Cyclotron ? How does it differ from a betatron ?
- (xi) Give an example of each : Fermion, Boson, Baryon, Lepton.

11×2=22

Section-B

2. (a) Why electron cannot be a constituent part of the nucleus ? Explain in detail.
- (b) What is Binding Energy (BE) per nucleon ? What inferences can be drawn from BE. per nucleon curve ?
- (c) Assuming that average mass of a nucleon is 1.67×10^{-27} kg and radius of a nucleus to be given $R = R_0 A^{1/3}$, calculate the density of the nucleus ($R_0 = 1.5 \times 10^{-15}$ m). 6,3,3
3. Describe the nuclear shell model. Show how 'magic numbers' are obtained in nuclear shell model. Describe limitations of nuclear shell model. 12

Section-C

4. Discuss Gamow's theory of α -decay and derive the expression for transmission coefficient for α -decay. 12
5. (a) Derive the expression for half life and mean life time of radioactive substance. What is the relation between these two ?
- (b) Explain neutrino hypothesis of β -decay.
- (c) Explain inverse β -decay. 6,3,3

Section-D

6. (a) What is Compton Effect ? Derive an expression for the change in wavelength of a scattered photon.
- (b) Why a photon cannot transfer its entire energy to the electron in Compton process ?
- (c) Explain why visible light cannot demonstrate Compton effect ? 6,3,3
7. Describe the construction and working of Geiger-Muller (GM) counter. What do you mean by dead time and recovery time of GM counter ? Explain the differences between GM counter and proportional counter. 12

Section-E

8. What are Quarks ? Discuss qualitative aspects of quark model. On the basis of quark model discuss quark content of mesons and baryons. 12
9. (a) For each of the following decays state the conservation law that forbids it :
- (i) $n \rightarrow p + e^-$
- (ii) $n \rightarrow p + \gamma$
- (iii) $n \rightarrow \pi^+ + e^-$
- (b) Write a short note on composition of cosmic rays.
- (c) Write a short note on variation of cosmic rays intensity with latitude and altitude. 6,3,3

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UG (CBCS) IInd Year Annual Examination

3106

B.Sc. PHYSICS

(Waves and Optics)

(DSC ID)/Core

Paper : PHYS 202 TH

Time : 3 Hours]

[Maximum Marks : 50

Note :- Attempt *five* questions in all, selecting *one* question each from Sections-B, C, D and E. Q. No. 1 (Section-A) is compulsory. Use of Non-programmable calculator is allowed.

Section-A

(Compulsory Question)

1. (i) The oscillations of a simple pendulum are generally :

(a) Resonant

(b) Undamped

(c) Damped

(d) Forced

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(1)

Turn Over

(ii) The resonant frequency of an electric circuit is given by :

(a) $\frac{\sqrt{LC}}{2\pi}$

(b) $\frac{2\pi}{\sqrt{LC}}$

(c) $\frac{1}{2\pi\sqrt{LC}}$

(d) $2\pi\sqrt{LC}$

(iii) What is the difference between free and forced oscillations ?

(iv) Two pendulums are coupled by a rigid rod instead of a spring. What is the number of degrees of freedom of the system ?

(v) What does coupling mean in Physics ?

(vi) When a drop of oil is spread on the surface of water, it displays beautiful colours in day light because of :

(a) Dispersion of light

(b) Polarization of light

(c) Interference of light

(d) Reflection of light

(vii) What is plane polarized light ?

2×7=14

Section-B

(a) Derive expressions for kinetic and potential energy of a simple harmonic oscillator. Show that its total energy is conserved.

- (b) The displacement of a moving particle at any time t is given by :

$$x = a \cos \omega t + b \sin \omega t$$

Show that the motion is simple harmonic. 5,4

3. (a) Write the differential equation for damped electric oscillator and find its solution when the oscillator is lightly damped.

- (b) Define quality factor and derive its expression for an electric oscillator. 5,4

Section-C

4. (a) Discuss the inductive coupling of the electric oscillator. Obtain the expression for the normal modes of frequencies.

- (b) Differentiate between in-phase and out of phase modes of vibrations for coupled system. 5,4

5. (a) Derive an expression for average power in a forced mechanical oscillator.

- (b) Discuss the variation of average power with frequency of the driving force and hence define resonance bandwidth of forced oscillator. 5,4

Section-D

6. (a) State the principles of Huygen's wave theory.

- (b) Describe an experimental arrangement for producing Newton's rings by reflected light. Prove that the diameters of dark rings are proportional to the square roots of natural numbers.

3,6

7. (a) Describe Fresnel's biprism method for producing interference fringes. How can it be used to determine the wavelength of light ?
- (b) A Fresnel's biprism is used to form interference fringes. Find the fringe width of sodium light ($\lambda = 5890\text{\AA}$), when the distance between the source and the prism is 18 cm and that between the prism and screen is 81 cm, given $d = 0.033$ cm. 6,3

Section-E

8. (a) What is Zone Plate ? Derive an expression for its focal length. Show that a zone plate has multiple foci and it behaves like a convergent lens.
- (b) Calculate the radius of the 3rd half-period zone of a zone plate of focal length 1.5 m, illuminated by a light of wavelength 593 nm. 6,3
9. (a) What is Brewster's law ? Show that when a ray is incident at the Brewster's angle, the reflected rays are at right angles.
- (b) Explain the following terms :
- (i) Double refraction
 - (ii) Positive and negative crystals 5,4

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UG (CBCS) IInd Year Annual Examination

3105

B.Sc. PHYSICS

(Statistical and Thermal Physics)

(DSC 1C)/Core

Paper : PHYS 201 TH

Time : 3 Hours]

[Maximum Marks : 50

Note :- Attempt *five* questions in all, selecting *one* question each from Sections-B, C, D and E and seven sub-questions from Section-A. Question No. 1 is compulsory.

Section-A

(Compulsory Question)

1. Attempt all the seven sub-questions :

- (a) What is the probability of a random event, an event and an impossible event ?
- (b) What is phase space and what is a small volume element in it ?

(c) What are Fermions ? State the statistics followed by them.

(d) State Kelvin-Planck statement of second law of thermodynamics.

(e) The thermodynamic probability of a system in perfect order is :

(i) 1

(ii) 0

(iii) -1

(iv) ∞

(f) Define temperature of Inversion.

(g) For indistinguishable particles, the number of microstates is the number of macrostates.

(i) Equal to

(ii) More than

(iii) Less than

2×7=14

Section-B

2. Derive an expression for the probability of a microstate corresponding to the distribution of N distinguishable particles in K compartments of unequal sizes which are further divided into cells of equal a priori probability. 9
3. (a) Explain macrostate, microstate and thermodynamic probability of microstate. Obtain relationship between thermodynamic probability and the probability of a microstate.
- (b) Differentiate between static and dynamic system. 7,2

Section-C

4. (a) Obtain basic equation for distribution law in all the three statistics.
- (b) Derive Maxwell-Boltzmann relation :
- $$n_i = g_i / e^{\alpha + \beta u_i}$$
- where symbols have their usual meaning. 4,5
5. What is Bose-Einstein statistics ? What are its assumptions ? Derive its distribution law. 9

Section-D

6. A thermocouple acts like a reversible heat engine. Obtain expression for Thermoelectric e.m.f., Peltier coefficient and Thomson coefficient. 9
7. (a) Give the statistical definition of entropy. Show that the process of diffusion of one gas into another is accompanied by increase in entropy.
- (b) Entropy is the measure of disorder. Comment. 6,3

Section-E

8. What are thermodynamic potentials and their significance ? Obtain thermodynamic relations from U, F, H and G. 9
9. (a) A wire is stretched adiabatically. Show that the change in temperature is given by :

$$\Delta T = -(\ln \eta \Delta F) / C_p$$

where T , η , l and ΔF are temperature, coefficient of linear expansion, length of wire and change in force respectively.

- (b) Calculate the pressure under which water will boil at 125°C , if the change in specific volume is 1.676 m^3 . Given the latent heat of steam = $22.68 \times 10^5 \text{ J/kg}$. 6,3

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UG (CBCS) Annual Ist Year Examination

3008

B.Sc. PHYSICS

(Electricity, Magnetism and EMT)

(Core)

PHYS 102 TH

Time : 3 Hours]

[Maximum Marks : 50

Note :- Attempt *five* questions in all, selecting *one* question from each Section B, C, D and E and *seven* sub-questions from Section A. Question No. 1 (Section A) is compulsory.

Section-A

(Compulsory Question)

1. (i) What is a solenoidal vector field ?
- (ii) Why do two electric field lines not cross each other ?
- (iii) Give one example when Ohm's law fails.

CA-208

(1)

Turn Over

- (iv) State Ampere's circuital law.
- (v) Define Dielectric constant.
- (vi) Magnetic behaviour of a magnetic substance decreases with increase in temperature. Why?
- (vii) Why is steel used for making permanent magnets?
- (viii) What is skin depth? What is its value for a perfect conductor?
- (ix) What is meant by Poynting vector? What does it represent? 2×7=14

Section-B

- 2. (a) State and prove Stokes' theorem.
- (b) Show that the vector field $\vec{A} = 6xy\hat{i} + (3x^2 - 3y^2)\hat{j}$ is an irrotational field. 5,4
- 3. (a) What is Gauss theorem for electric flux? Apply it to find the expression for electric field due to an infinite line of charge.
- (b) If $V = 3x^2y - y^3z^2$ be the electric potential at a point (x, y, z) , then find the electric field at point $(1, 1, 1)$. 5,4

Section-C

4. (a) Using Ampere's circuital law, find the expression for the magnetic field inside a long current carrying solenoid.
- (b) A solenoid has a length of 20 cm, diameter of 10 cm and total number of turns 1000 of the wire. Find the magnetic field at the mid-point inside it. 5,4
5. (a) Find the expression for the capacitance of a parallel plate capacitor having a dielectric slab between its plates.
- (b) Show that $\vec{D} = \epsilon_0 \vec{E} + \vec{P}$; where \vec{D} is the electric displacement vector, \vec{P} is the polarization vector and \vec{E} is the reduced electric field in a polarized dielectric substance. 5,4

Section-D

6. (a) Find the expression for the energy stored in a dielectric medium.
- (b) Establish the relation $\nabla \cdot \vec{D} = \rho_{\text{free}}$; where ρ_{free} is the free charge density and \vec{D} is the electric displacement vector. 5,4

7. (a) What is Ferromagnetism ? Explain Domain theory of ferromagnetism.
- (b) Explain retenticity, coercivity and hysteresis in case of a ferromagnetic substance placed in a magnetising field of changing strength.

5,4

Section-E

8. Find the electromagnetic wave equations in a medium having finite permeability and permittivity but with conductivity $\sigma = 0$ and then find the expressions for the speed of e.m. waves in this medium and refractive index of a non-magnetic medium.
9. Find the expressions for reflection and transmission coefficients for electromagnetic waves at a boundary of two dielectric media for normal incidence.

9

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UG (CBCS) Ist Year Annual Examination

3007

B.Sc. PHYSICS

(Mechanics)

(Core)

PHYS-101

Time : 3 Hours]

[Maximum Marks : 50

Note :- Attempt *five* questions in all, selecting *one* question each from Sections B, C, D and E respectively. Question No. 1 (Section A) is compulsory.

Section-A

(Compulsory Question)

1. (i) What are the dimensions of solid angle ? What is its unit ?
- (ii) What is a conservative force ? How is it related to the potential energy ?
- (iii) Is the earth an inertial frame of reference ?
- (iv) What is the difference between weak forces and electromagnetic forces ?

CA-207

(1)

Turn Over

(v) Why length contraction is not observed in daily life ?

(vi) What is the difference between elastic and inelastic collisions ?

(vii) What are the findings of Michelson-Morley experiment ? 2×7=14

Section-B

2. (a) Find the solution of differential equation :

$$4 \frac{d^2 y}{dx^2} - 8 \frac{dy}{dx} + 3y = 0$$

(b) Starting from the expression for the velocity :

$$\vec{V} = \dot{r} \hat{e}_r + r \dot{\theta} \hat{e}_\theta + r \dot{\Phi} \sin \theta \hat{e}_\phi$$

Obtain an expression for the acceleration in spherical polar co-ordinates. 4,5

3. (a) Show that homogeneity of time and Newton's second law of motion result in the law of conservation of energy.

(b) Show that the force \vec{F} acting on a particle in rotating frame is given by :

$$\vec{F}_R = \vec{F}_s - m \vec{\omega} \times (\vec{\omega} \times \vec{r}) - 2m \vec{\omega} \times \vec{v}_R$$

4,5

Section-C

4. (a) The path of a particle moving under the action of force is given by $r = a \cos \theta$. Calculate corresponding force law.
- (b) What is Central Force ? Set up a differential equation of motion under central force and solve it. 4,5
5. (a) Using Kepler's laws, show that the force between the Sun and the planet obeys inverse square law.
- (b) Derive the relation for total energy and effective potential energy of the reduced mass moving under the effect of central force. 4,5

Section-D

6. Prove that the differential scattering cross-section for Rutherford scattering of α -particles by a Nucleus is inversely proportional to square of the energy of the incident α -particle. 9
7. (a) Prove that the kinetic energy of the system in lab system is always greater than the kinetic energy in C.M. system provided the collision is elastic.

- (b) Show that in C.M. system, the magnitude of the velocities remains unaltered in an elastic collision.

4,5

Section-E

8. (a) Derive Lorentz space time transformation equations for two inertial frames.

- (b) A meter rod is moving along its length with a velocity of $0.6c$. Calculate its length as it appears to :

(i) An observer on the earth

(ii) Moving with the rod itself

6,3

9. (a) Derive the relation, $E = mc^2$. Show that if $v \ll c$, it reduces to non-relativistic

K.E. $\left(\frac{1}{2}mv^2\right)$ expression.

- (b) Prove the laws of relativistic addition of velocities. Hence, prove that no material body can move with a velocity greater than that of light.

4,5

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**UG (CBCS) IIIrd Year (Annual)
Examination**

2526

B.Sc. PHYSICS

(Elements of Modern Physics)

(DSE-1A)

Paper : PHYS 301 TH

Time : 3 Hours]

[Maximum Marks : 50

Note :- Attempt *five* questions in all, selecting *one* question from each Sections-B, C, D and E. Question No. 1 (Section-A) is compulsory.

Section-A

(Compulsory Question)

1. (a) Explain dual nature of material particles.
- (b) Write drawbacks of Rutherford's model of atom.
- (c) What are Eigenvalues and Eigenfunctions ?

CH-356

- (d) For $n = 1$, find the energy of an electron in a box of length 1 \AA .
- (e) Find the relation between Electron-volt and Atomic Mass Unit.
- (f) Define the main two units to measure the intensity of radioactivity.
- (g) What is γ -rays Emission ? 2 each

Section-B

2. (a) What is Compton Effect ? Derive an expression for the wavelength of scattered photon in Compton effect. 4
- (b) Also calculate the expression for the kinetic energy of the recoil electron. 3
- (c) Why is observation of the Compton shift difficult with visible light ? 2
3. (a) Describe Davisson and Germer experiment for the diffraction of electrons. What role did it play in the verification of de-Broglie hypothesis ? 6
- (b) What is de-Broglie wavelength of an electron which has been accelerated from rest through a potential difference of 100V . 3

Section-C

4. (a) Explain Uncertainty Principle. How did Heisenberg show $\Delta x \cdot \Delta p \geq \hbar/2$? Using this principle, calculate the binding energy of an electron in hydrogen atom. 6
- (b) An electron has a speed of 500 ms^{-1} correct up to 0.01% with what minimum accuracy can you locate the position of this electron. 3
5. (a) Derive the Schrödinger equation for a free particle in one dimension. 5
- (b) Derive an expression for the expectation value of momentum and energy operators. 4

Section-D

6. A particle of mass m and total energy E moves from the region of zero potential to the region of constant potential V_0 . Given that $E > V_0$, derive expressions for reflection coefficient R and transmission coefficient T . Prove that $R + T = 1$. 9
7. Discuss the semi-empirical mass formula of liquid drop model. 9

Section-E

8. (a) What do you understand by Half-Life and Mean Life of a radioactive substance ? 6
- (b) The half-life of radon is 3.8 days. After how many days, one per cent of radon will be left behind ? 3
9. Discuss the following terms :
- (a) Nuclear Fuel
 - (b) Moderators
 - (c) Control Rods
 - (d) Coolant 2,3,2,2

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**UG (CBCS) 1st Year (Suppl.) Examination
2008**

B.Sc. PHYSICS
(Electricity, Magnetism and EMT)
(Core)
Paper : PHYS-102

Time : 3 Hours]

[Maximum Marks : 50

Note :- Attempt *five* questions in all, choosing *one* question from each Section B, C, D and E and *seven* sub-questions from Section A. Q. No. 1 (Section-A) is compulsory.

Section-A

(Compulsory Question)

1. (i) What is an irrotational vector field ?

- (ii) What is the electric flux through a spherical surface of area 2 m^2 having $+4\mu\text{c}$ and $-4\mu\text{c}$ charges inside it ?

- (iii) What is invariance of charge ?
- (iv) What is the relation between curl of magnetic field \vec{B} and current density \vec{J} ?
- (v) Define electric susceptibility.
- (vi) What are ferrites ?
- (vii) Why is soft iron used for making an electromagnet ?
- (viii) Show that skin depth of a good conductor is independent of its permittivity.
- (ix) Define Poynting vector. What are its units ? $2 \times 7 = 14$

Section-B

- 2. (a) State and prove Gauss-Divergence theorem.
- (b) Find the value of constant 'b' so that the vector field $\vec{A} = x^2 \hat{i} + (y - 2xy) \hat{j} + (x + bz) \hat{k}$ is solenoidal. 5,4
- 3. (a) What is Gauss theorem for electric flux ? Apply it to find the expression for electric field due to a plan charged sheet.
- (b) Show that electric field is negative gradient of electric potential. 5,4

Section-C

4. (a) What is Hall effect ? Find the expression for Hall constant.
- (b) Show that $\vec{\nabla} \cdot \vec{B} = 0$; where \vec{B} is the magnetic field. 5,4
5. (a) Define surface current density. Using the surface current density, find the expression for the charge in magnetic field from one side of a current sheet to its other side.
- (b) Define vector potential and find its expression. 5,4

Section-D

6. (a) What is Atomic Polarizability ? Find its expression.
- (b) Show that $k = 1 + \chi_e$; where k is the dielectric constant, χ_e is the electric susceptibility of a dielectric substance. 5,4

7. (a) What is Diamagnetism ? Explain diamagnetism with orbital motion of electrons.

(b) Show that $\vec{\nabla} \times \vec{H} = \vec{J}_{\text{free}}$; where \vec{J}_{free} is the free current density and \vec{H} is the magnetic field intensity.

5,4

Section-E

8. State and prove Poynting theorem.

9

9. Derive electromagnetic wave equations in a conductor and find their solutions.

9