Nalanda Open University
Annual Examination – 2020
B.Sc. Physics (Honours), Part-I
Paper-I

Time: 3.00 Hrs. **Full Marks: 80**

*Answer any **Five** questions, selecting at least one from each group. All questions carry equal marks.*

Group - A

1. Derive Rutherford scattering formula for the differential scattering cross-section for particles in the inverse square law of free field.

2. Derive the expression for force experienced by a particle in a rotating frame of reference and hence explain the Centrifugal force and the coriolis force.

3. Define divergence and curl of a vector. Write their expressions in the Cartesian and the spherical polar coordinates..

4. Explain the variafional principle of least action. On its basis derive langrage's equation of motion.

5. State the Keeper's laws of planetary motion. On the basis of inverse square law of gravitation deduce these laws.

Group - B

6. Deduce the equation of variation of mass of a particle with its velocity and hence show that $E = mc^2$.

7. On the basis of the special theory of relativity discuss (i) Length Contraction and (ii) Time dilation.

8. With help of neat diagram, give the theory of Michelson-Morley experiment. Explain the result of the experiment.

Group - C

9. What are Ultrasonic waves? Give a brief account of their production and uses in practical life.

10. Obtain the differential equation of damped Vibration in one dimention and discuss its solution.

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Nalanda Open University
Annual Examination – 2020
B.Sc. Physics (Honours), Part-I
Paper-II

Time: 3.00 Hrs.   **Full Marks: 80**

*Answer any **Five** questions, selecting at least **Two** from each group. All questions carry equal marks.*

Group - A

1. State the principle applied by planck for the energy of an oscillator. Derive planck's radiation formula and give its application.

2. State the principle of equipartition of energy and derive the result that the mean energy of system of gases in 1/2kT per degree of freedom.

3. Deduce an expression for steady state temperature distribution along a uniform metal rod heated at one end.

4. Derive the expression for mean free path λ of gas molecules on the basis of kinetic theory of gases. How is this quantity experimentally determined.

5. Give the Einstein theory of Brownian motion.

Group – B

6. Derive Maxwell's thermodynamic relations. Apply them to explain at least two thermodynamical problems.

7. State and explain Joule-Thomson effect. What is the Third law of thermodynamics.

8. Derive the expression for efficiency of Carnot's engine using the laws of thermodynamics. Define Carnot refrigerator.

9. Derive clausins-clapeyron equation of 1st order phase transition and explain triple point.

10. Write brief notes on any two of the following:-
    - (a) Thermodynamic scale
    - (b) Chemical potential
    - (c) Reversible & irreversible process
    - (d) Debye theory in short.

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Time: 3.00 Hrs.   **Full Marks: 80**

*Answer any **Five** questions. All questions carry equal marks.*

1. Explain the terms: generalized coordinates, degrees of freedom, constraints, difference between holonomic and non-holonomic corotraints.

2. Derive relativistic mass energy relation, $E = mc^2$.

3. Derive Vander Wall's equation of state for real gases. Evaluate 'a' & 'b' in terms of P_c, V_c and T_c.

4. Obtain the expression for depression of a Cantilever when a force W is applied at its free end.

5. Set up the Lagrangian for a one dimensional harmonic oscillator and obtain the Lagrange's equation & motion.

6. Derive Planck's law of radiation. Show that Wein's displacement law may be derived from Planck's law of radiation.

7. A suspended solid cylinder is fixed at one end and the other end is twisted. Give the theory of torsion and derive expression for its time period.

8. State and explain the 1st law of thermodynamics and hence obtain expression for (Cp-Cv).

9. Evaluate the Fourier coefficients in the solution for motion of a plucked string.

10. Write note on any two of the following:

    (a) Ultrasonic   (b) Entropy (c) Clausius-Clapeyror equation   (d) Definitions of Y, K, η & σ.

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Nalanda Open University
Annual Examination – 2020
B.Sc. Physics (Honours), Part-II
Paper-III (Optics & Electromagnetic Theory)

Time: 3.00 Hrs.   **Full Marks: 80**

*Answer any **Three** questions from group 'A' and **Two** Questions from group 'B'.*
All questions carry equal marks.

Group - A

1. What is Brewster's law? Show that when a ray is incident at the Brewster's angle, the reflected ray is perpendicular to the refracted ray.

2. Describe the construction of a Babinet's compensator, How is it superior than a quarter wave plate?

3. What is a zone plate? Show that it has multilple focii. Compare the zone plate with convex lens.

4. What do you understand by resolving power of an optical instrument? Deduce an expression for resolving power of a microscope.

5. What is the basic principle of a laser? Discuss the construction and working of a Ruby Laser.

6. Explain the formation of fringes in Feby-Perot interferometer. How would you use it for measurement of wavelength of light.

Group - B

7. Show that in case of total internal reflection a phase difference is introduced between the $\vec{E}$ vector in the plane of incidence and that in the plane perpendicular to it.

8. Deduce the laws of reflection and the laws of refracting of e.m. wave.

9. What are Poynting vector and Poynting theorem? Deduce Poynting theorem.

10. Write notes on any two of the following :-

    (a) Pressure of radiation   (b) Einstein's 'A' & 'B' coefficients

    (c) Dispersion is gases   (d) Scattering of e.m. waves.

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Nalanda Open University
Annual Examination – 2020
B.Sc. Physics (Honours), Part-II
Paper-IV (Electrostatics, Magnetism current Electricity and Modern Physics)

Time: 3.00 Hrs.   Full Marks: 80

*Answer any **five** questions. All questions carry equal marks.*

1. Investigate the growth of current is an LCR circuit subjected to a steady e.m.f.

2. Describe a Geiger Muller Counter and explain its working together with that of a dekatron.

3. Define a quadrupole. Calculate the field and potential at a point far away from a linear quadrupole.

4. Sate and explain compton effect. How do you experimentally find the change in wavelength by compton effect.

5. Describe weiss theory of ferromagnetism. Discuss the temperature dependence of spontaneous magnetisation.

6. Obtain the resonance frequency of parallel resonance circuit. Discuss the sharpness of resonance of the circuit.

7. Define π and σ and making use of the thermodynamic laws derive the relations

   (a) $\pi = T \dfrac{dE}{dT}$ (b) $\sigma = -T \dfrac{d^2 E}{dT^2}$

8. Describe the millikan's oil drop experiment to find the charge on an electron.

9. Give the principle and working of De Sauty's bridge using necessary diagram.

10. What is Einstein's quantum hypothesis and write down photo electric equation. Calculate the work function of sodium light in electron volt. Given that the threshold wavelength is $68004\text{A}°$ and $h = 6.625 \times 10^{-34}$ Js^{-1}.

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Nalanda Open University
Annual Examination – 2020
B.Sc. Physics (Subsidiary), Part-II
Paper-II

Time: 3.00 Hrs.   **Full Marks: 80**

*Answer any **five** questions. All questions carry equal marks.*

1. What is photoelectric effect? Derive Einstein's photoelectric equation.

2. Define electric Intensity $\vec{E}$, electric polarisation $\vec{P}$ and electric displacement $\vec{D}$ and establish a relation between them.

3. State Brewster's law. How will you change unpolarised light into plane polarised light by reflection? What is double refraction.

4. Explain Seeback effect, Peltier effect and Thomson effect. Define Peltier Coefficient and derive its expression. What is Thomson's coefficient.

5. Distinguish between Dia, para and ferro magnetism. Give Langevin's theory of para magnetism.

6. What is LASER? Discuss the construction and working of Ruby Laser.

7. Describe the millikan's Oil Drop method of measurement of charge on an electron using neat diagram and derive the necessary formula.

8. Discuss the growth of charge in a d.c. circuit having resistance, inductance & capacitance.

9. Give the theory of Newton's ring and show how can it be used to find λ of sodium light.

10. Give an account of Borh's theory of hydrogen atom.

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Time: 3.00 Hrs.   **Full Marks: 80**

Answer any five questions. All questions carry equal marks.

1. Discuss the solution of Laplace's equation $\nabla^2\phi = o$ in spherical polar coordinals.

2. State and prove Laurent's theorem.

3. (a) Using the method of separation of Variables solve the differential equation $\dfrac{du}{dx} = 2\dfrac{du}{dt} + u$ where $u = u(x,t)$

    (b) What is Dirac delta function? Show that $x\delta(x) = o$

4. State and prove Cauchy's Residue theorem.

5. Describe the equation of motion of a symmetric top. Discuss the special case of a sleeping top.

6. Write the Lagrangian of motion of a double pendulum and deduce the frequency of its motion.

7. What are Poisson's brackets? State and prove none of its properties.

8. Explain canonical transformation. Prove that the transformations $P = \dfrac{1}{2}(p^2 + q^2)$, $Q = \tan^{-1}(\dfrac{1}{2})$ are canonical.

9. Apply action-angle variables method to find time period of small oscillation of a simple pendulum.

10. Write notes on any Two of the following :-

    (a) M.I. of rigid body.
    (b) Hamilton's equation of motion
    (c) D Alembert's principle
    (d) Principle of least action.

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Nalanda Open University
Annual Examination – 2020
B.Sc. Physics (Honours), Part-III
Paper-VI (Quantum Mechanics and Statistical Mechanics)

Time: 3.00 Hrs.   **Full Marks: 80**

Answer any five questions. All questions carry equal marks.

1. Derive Schrodinger equation in both the time independent and time dependent cases. What are stationary states?

2. Define angular momentum in quantum mechanics. Show that the components of angular momentum commute with L^2, whereas they do not commute with each other.

3. Write uncertainty principle for three sets of canonical variables. Derive Heisenberg's uncertainty relation for the position and momentum variables.

4. What are symmetric and anti-symmetric wave functions? Discuss the symmetry of a wave function in detail.

5. Write down the Schrodinger equation for one dimensional potential barrier of height Vo and with 'a'. Calculate the transmission probability when the energy E>Vo. E represents the energy of the particle.

6. State and prove Liouiville's theorem.

7. Deduce Planck's radiation formula on the basis of Bose-Einstein statistics.

8. Establish the Fermi-Dirac distribution formula and hence obtain an expression for Fermi energy.

9. Find the relation between pressure and temperature of vapour treated as a gas during liquid-vapour transition.

10. Define ensemble and distinguish between three different types of ensembles.

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Nalanda Open University
Annual Examination – 2020
B.Sc. Physics (Honours), Part-III
Paper-VII (Classical Electrodynamics, Plasma Physics, Physics of Atoms, Molecules and Nuclei)

Time: 3.00 Hrs.   **Full Marks: 80**

Answer any five questions. All questions carry equal marks.

1. Explain electromagnetic field tensor. Find all the sixteen components of it in terms of the electric and magnetic fields.

2. Write Maxwell's field equations and discuss their covariance under Lorentz transformations.

3. What is Lienard Wiechert potential? On its basis, obtain electric and magnetic field intensity due to a uniformly moving charge.

4. Give the theory of rotational spectra of diatomic molecules treated as a non-rigid rotator.

5. Discuss the micropic and macroscopic properties of plasma. Explain quasineutrality of plasma, Debye Shielding and Debye length.

6. Give the construction of He-Ne laser and the theory of its working. What is an optically pumped laser?

7. Distinguish between normal and anomalous Zeeman effects. How are they explained theoretically?

8. Give the theory of shell model of nucleus and on its basis explain the angular momentum of the ground state of the nucleus.

9. What do you mean by NMR spectroscopy? Describe with diagram the continuous wave NMR spectrometer.

10. Discuss angular momentum, magnetic moment and electric quadruple moment associated with an atomic nucleus.

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Time: 3.00 Hrs.   **Full Marks: 80**

Answer any five questions. All questions carry equal marks.

1. What is space lattice? Describe various types of lattices in the cubic system. Show that for a simple cubic lattice, $d_{100} : d_{110} : d_{111} = \sqrt{6} : \sqrt{3} : \sqrt{2}$.

2. Explain Hall effect. Define Hall Coefficient and give its importance. How are they determined in the laboratory?

3. Discuss Van-der-valls binding. Obtain expression for the total potential energy of pairs of atoms in the crystal on the basis of this theory.

4. Explain energy band. On the basis of energy bands of solids, distinguish between a metal, a semiconductor and an insulator.

5. Explain Drude-Lorentz theory. Derive Wiedmann-Franzrelation between thermal and electrical conductisties on the basis of this theory.

6. State and explain Thevenin's theorem. Give an example and show how this theorem helps in circuit analysis.

7. What is photodiode? Discuss its working, characteristics and uses.

8. What is filter circuit? Give their classification and describe elementary filter theory.

9. Explain the principle of frequency modulation. Define frequency deviation and modulation index for a frequency modulated carrier.

10. What is an amplifier? Giving a neat circuit diagram discuss the working of a R.C. coupled amplifier. Explain voltage gain.

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