No.7/2/2016-MPSC(DR)

MANIPUR PUBLIC SERVICE COMMISSION

Advt. No.2of 2016
Imphal, dated 29.08.2016

Applications are invited for recruitment to following posts of Scientific Assistant (SA) in Forensic Science Laboratory, Police Department, Manipur.

Sl. No.	Name of Post	Scale of pay	Class/ Group	No. of post	Gen
1	**Scientific Assistant (Mobile Forensic Unit)**	PB-2, 9,300-34,800/- + Rs. 4,300 (GP)	Group -B	02	02
2	**Scientific Assistant (Ballistics)**	PB-2, 9,300-34,800/- + Rs. 4,300 (GP)	Group -B	03	03
3	**Scientific Assistant (Biology)**	PB-2, 9,300-34,800/- + Rs. 4,300 (GP)	Group -B	02	02
4	**Scientific Assistant (Chemistry)**	PB-2, 9,300-34,800/- + Rs. 4,300 (GP)	Group -B	01	01
5	**Scientific Assistant (Documents)**	PB-2, 9,300-34,800/- + Rs. 4,300 (GP)	Group -B	02	02
6	**Scientific Assistant (Toxicology)**	PB-2, 9,300-34,800/- + Rs. 4,300 (GP)	Group -B	02	02
			Total	**12**	**12**

2. **Centre of Examination**: Imphal

3. **Eligibility Conditions:**

(i) The candidate must be a citizen of India.
(ii) The candidate must be able to speak Manipuri or any of the Tribal Dialect of Manipur.
(iii) The candidate must be a permanent resident of Manipur provided that a candidate whose parent or any of his/her ancestors in his/her direct lineage are permanent resident of the State, with proper documentary proof like enrolment in the electoral roll and birth certificate will also be eligible.

4. **Age Limit: 38** years as on **1st July, 2016** (upper age limit is relaxable for Government Servants appointed under the Government of Manipur to the extent of the period of continuous services put in the post/ service and by 5 years for SC/ST candidates and by 3 years for OBC candidates and a Government servant who belongs to SC/ST will get the relaxation admissible to a Government servant in addition to the relaxation admissible to SC/ST candidates)

5. **Educational Qualifications**:

Sl. No.	Name of post	
1	**Scientific Assistant (Mobile forensic unit)**	**Essential:** M.Sc. in Forensic Science (with Physics/Chemistry/ Zoology/Biochemistry/Biotechnology in Bachelor degree)/Physics/ Chemistry/ Zoology/ Microbiology/ Biophysics/Physical Anthropology/ Biochemistry/ Biotechnology/MCA (With Physics as one of the subjects in Bachelor degree)/M.Sc. IT (With Physics as one of the subjects in Bachelor Degree) from a recognised university/Institute.
2	**Scientific Assistant (Ballistics)**	**Essential:** M.Sc. in Physics or Forensic Science (with Physics in bachelor's degree) from a recognised university. **Desirable:** Previous experience in a Forensic Science Lab. recognised by State / Central Government.
3	**Scientific Assistant (Biology)**	**Essential:** M.Sc. in Zoology/Life Science (Zoology stream) Biochemistry/Forensic Science/Physical Anthropology /Microbiology/ Biotechnology (with Zoology in Bachelor's Degree) from a recognised university **Desirable:** Previous experience in a Forensic Science Lab. recognised by State / Central Government.

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4	**Scientific Assistant** (Chemistry)	**Essential:** M.Sc. in Chemistry/Biochemistry/Forensic Science (with Chemistry in Bachelor's Degree) from a recognised university. **Desirable:** Previous experience in a Forensic Science Lab. recognised by State / Central Government.
5	**Scientific Assistant** (Documents)	**Essential:** M.Sc. in Physics/Forensic Science (with Physics in bachelor's degree) from a recognised university. **Desirable:** Previous experience in a Forensic Science Lab. recognised by State / Central Government.
6	**Scientific Assistant** (Toxicology)	**Essential:** M.Sc. in Chemistry/Biochemistry/Forensic Science (with Chemistry in bachelor's degree) from a recognised university. **Desirable:** Previous experience in a Forensic Science Lab. recognised by State / Central Government.

IMPORTANT NOTE: Candidates may submit only one application for all posts for which he/she is eligible as per the above requirement. However, he/she has to indicate the name of the post in order of preference in the relevant column of the application form.

6. STARTING AND CLOSING DATE FOR SUBMISSION OF ONLINE APPLICATION:

The online application should be submitted through www.empsconline.gov.in **w.e.f. 12.09.2016** and up to midnight of **22.09.2016** after which the link will be disabled. Submission of application by any other mode will not be entertained.

7. **MODE OF SUBMITTING APPLICATIONS:**

Before applying for the post, candidates should register as per "**ONE TIME REGISTRATION**" scheme through the official website of Manipur Public Service Commission www.empsconline.gov.in. Candidates need to upload and fill all details before applying for any post. Once, the ONE TIME REGISTATION is completed, candidates need to fill up and complete his/her PROFILE by submitting all the relevant details as indicated below: -

1. Upload Passport size Photograph, signature and proof of age etc.
2. Add personal details.
3. Add Parents details.
4. Add Educational Qualification details.
5. Add Language and Nature of disability in case of DAPs.
6. Add Experience.

Once the above mentioned processes are completed, only then the candidate can apply for the post. Candidates are responsible to ensure correctness of the personal information and secrecy of password and they shall remember the user ID and the mobile number for further communication. Applications submitted in deviation of the instructions for the purpose will be summarily rejected. Documents in support of qualification, experience, age, community etc. have to be produced as and when called for by the Commission. If any variance is found in the documents submitted online and physical documents, the application will be summarily rejected.

8. FEE: Candidates are required to pay a fee of Rs. 300/- for GEN/OBC, Rs.150/- for SC/ST by using net banking, Visa/Master Card/Debit Card through the **www.empsconline.gov.in** portal. No fee is payable for DAP (Differently Abled Persons).

NOTE 1: Candidate should note that payment of examination fee can be made only through online mode as mentioned above. Payment of fee through any other mode is neither valid nor acceptable. Applications submitted without prescribed fee/mode shall be summarily rejected.

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NOTE 2: Fee once paid shall not be refunded under any circumstances nor can the fee be held in reserve for any other examination or selection.

NOTE 3: For the Applicants in whose case payment details have not been received from the bank, will be treated as fictitious payment cases and their application will be rejected in the first instance. A list of such applicants shall be available on the Commission website within 3(three) days after the last date of submission of online application.

In case of any problem being faced in the processing of the online application, drop a mail at empsconlineissues@gmail.com along with your phone number and problem being faced from your register user mail ID.

9. All candidates in service other than casual or muster roll will be required to state in the application Form that they have informed in writing their employer/ controlling authority that they are applying for the examination. In case the employer or the controlling authority withholds permission to the candidate for appearing in the examination, such application will be rejected.

10. The eligible candidates shall be issued an **e-Admission Certificate**. The e-Admission Certificate will be made available in the MPSC Website (www.empsconline.gov.in) for downloading by the candidates from **25.09.2016.** No Admission Certificate will be issued from MPSC Office or sent by post.

11. No candidate will be admitted to the Examination unless he/she holds an **e-Admission Certificate** issued by the Commission for the purpose.

12. The decision of the Commission as to the eligibility or otherwise of a candidate for admission to the Examination shall be final. If on verification at any time before or after the Written Examination and Interview, it is found that a candidate does not fulfil any of the eligibility conditions, his/her candidature for the Examination will be cancelled by the Commission.

13. **Withdrawal of applications**: - No request for withdrawal of candidature received from a candidate after he/she has submitted the application will be entertained under any circumstances.

14. **Mobile Phone Banned**:

(a) Mobile phones, Pager or any electronic communication devices are not allowed inside the premises where the examination is being conducted. Any infringement of these instructions shall entail disciplinary action including ban from future examinations.

(b) Candidates are advised in their own interest not to bring any of the banned items including mobile phones/pagers etc. to the venue of examination as arrangement for safe-keeping of the same cannot be assured. Commission will not be responsible for any loss in this regard.

15. The written examination will be held on **2nd October, 2016.**

The Scheme of Examination and syllabus are given at **Annexure-I & II.**

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(Shyam Lal Poonia)
Secretary,
Manipur Public Service Commission

Copy to: -

1. Secretary to the Governor of Manipur.
2. Secretary to the Chief Minister, Manipur.
3. PS to Chairman, MPSC.
4. Additional Chief Secretary (Home), Government of Manipur
5. The Commissioner(DP), Government of Manipur.
6. Director, FSL, Pangei, Manipur.
7. The Director(DIPR), Manipur. He is requested to cause wide circulation of the Notification for benefit of the candidates.
8. Director, Doordarshan Kendra, Imphal. He/she is requested to display on TV for information to the candidates

9. The News Editor (Apptt. & Employment), AIR, Imphal. He is requested to announce it over Radio in all dialects as News Item.
10. The Additional Secretary/Deputy Secretary/Under Secretary/L.R. & R.O./Exam. Officer/Registrar/Section Officers, MPSC.
11. The News Editor-in-Chief, ISTV, Imphal, Manipur. He is requested to display on TV screen for information to candidate.
12. Official Website of MPSC (www.mpscmanipur.gov.in and www.empsconline.gov.in)
13. Notice Board.
14. Guard File, MPSC, Imphal.

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ANNEXURE-I

SCHEME OF EXAMINATION FOR RECRUITMENT OF SCIENTIFIC ASSISTANT (SA) IN FORENSIC SCIENCE LABORATORY, POLICE DEPARTMENT, MANIPUR

There shall be a Written Examination (MCQ Type) comprising of two papers of graduation standard as per the details given below:

Paper	Subject	No. of Questions	Marks	Duration
Paper-I	General Studies	100	100	1 ½ hours
Paper-II	Optional Paper	100	150	1 ½ hours
		Total	**250**	
		Personality Test	**50**	
		Grand Total	**300**	

Note: The number of candidates to be called for Interview is about 2 times of the vacancies for each post and the minimum qualifying marks is 40% in each paper.

List of Optional Paper:
(Candidates are to choose any one from the following five subjects)

1. Chemistry
2. Computer Science
3. Forensic Science
4. Physics
5. Zoology

ANNEXURE-II

SYLLABUS

Paper-I (General Studies)

i. General English: Grammatical Knowledge
ii. Current Affairs: National & International events
iii. General Science covering general appreciation and matters of everyday observation & experience.
iv. Forensic Science
v. General Mental Ability.

Paper-II (Optional subject)

Chemistry

Section-A
(Inorganic Chemistry)

1.1 **Atomic structure** : · Schrodinger wave equation, significance of · 2 · and · quantum numbers and their significance, radial and angular probability, shapes of orbitals, relative energies of atomic orbitals as a function of atomic number. Electronic configurations of elements; Aufbau principle, Hund's multiplicity rule, Pauli exclusion principle.

1.2 **Chemical periodicity** : Periodic classification of elements, salient characteristics of s,p,d and f block elements. Periodic trends of atomic radii, ionic radii, ionisation potential, electron affinity and electronegativity in the periodic table.

1.3 **Chemical bonding** : Types of bonding, overlap of atomic orbitals, sigma and pi bonds, hydrogen and metallic bonds. Shapes of molecules, bond order, bond length, V.S.E.P.R. theory and bond angles. The concept of hybridization and shapes of molecules and ions.

1.4 **Oxidation states and oxidation number** : Oxidation and reduction, oxidation numbers, common redox reactions, ionic equations. Balancing of equations for oxidation and reduction reactions.

1.5 **Acids and bases** : Bronsted and Lewis theories of acids and bases. Hard and soft acids and bases. HSAB principle, relative strengths of acids and bases and the effect of substituents and solvents on their strength.

1.6 **Chemistry of elements** :

(i) **Hydrogen**: Its unique position in the periodic table, isotopes, ortho and para hydrogen, industrial production, heavy water.

(ii) **Chemistry of s and p block elements** : electronic configuration, general characteristics properties, inert pair effect, allotropy and catenation. Special emphasis on solutions of alkali and alkaline earth metals in liquid ammonia. Preparation, properties and structures of boric acid, borates, boron nitrides, borohydride (diborane), carboranes, oxides and oxyacids of nitrogen, phosphorous, sulphur and chlorine; interhalogen compounds, polyhalide ions, pseudohalogens, fluorocarbons and basic properties of halogens. Chemical reactivity of noble gases, preparation, structure and bonding of noble gas compounds.

(iii) **Chemistry of d block elements**: Transition metals including lanthanides, general characteristic properties, oxidation states, magnetic behaviour, colour. First row transition metals and general properties of their compounds (oxides, halides and sulphides); lanthanide contraction.

1.7 **Extraction of metals** : Principles of extraction of metals as illustrated by sodium, magnesium, aluminium, iron, nickel, copper, silver and gold.

1.8 **Nuclear Chemistry** : Nuclear reactions; mass defect and binding energy, nuclear fission and fusion. Nuclear reactors; radioisotopes and their applications.

1.9 **Coordination compounds** : Nomenclature, isomerism and theories of coordination compounds and their role in nature and medicine.

1.10 **Pollution and its control** : Air pollution, types of air pollutants; control of air and water pollution; radioactive pollution.

Section-B
(Organic Chemistry)

2.1 **Bonding and shapes of organic molecules** : Electronegativity, electron displacements-inductive, mesomeric and hyperconjugative effects; bond polarity and bond polarizability, dipole moments of organic molecules; hydrogen bond; effects of solvent and structure on dissociation constants of acids and bases; bond formation, fission of covalent bonds : homolysis and heterolysis; reaction intermediates-carbocations, carbanions, free radicals and carbenes; generation, geometry and stability; nucleophiles and electrophiles.

2.2 **Chemistry of aliphatic compounds**: Nomenclature; alkenes-synthesis, reactions (free radical halogenation) -- reactivity and selectivity, sulphonation-detergents; cycloalkanes-Baeyer's strain theory; alkenes and alkynes-synthesis, electrohilic addition reactions, Markownikov's rule, peroxide effects, 1- 3-dipolar addtion; nucleophilic addition to electron-deficient alkenes; polymerisation; relative acidity; synthesis and reactions of

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alkyl halides, alkanols, alkanals, alkanones, alkanoic acids, esters, amides, nitriles, amines, acid anhydrides, a, ß-unsaturated ketones, ethers and nitro compounds.

2.3 **Stereochemistry of carbon compounds** : Elements of symmetry, chiral and achiral compounds. Fischer projection formulae; optical isomerism of lactic and tartaric acids, enantiomerism and diastereoisomerism; configuration (relative and absolute); conformations of alkanes upto four carbons, cyclohexane and dimethylcyclo-hexanes-their potential energy. **D, L**-and **R, S**-notations of compounds containing chiral centres; projection formulae-Fischer, Newman and sawhorse-of compounds containing two adjacent chiral centres; meso and dl-isomers, erythro and threo isomers; racemization and resolution; examples of homotopic, enantiotopic and diasteretopic atoms and groups in organic compounds, geometrical isomers; **E** and **Z** notations. Stereochemistry of SN1, SN2, E1 and E2 reactions.

2.4 **Organometallic compounds** : Preparation and synthetic uses of Grignard reagents, alkyl lithium compounds.

2.5 **Active methylene compounds** : Diethyl malonate, ethyl acetoacetate, ethyl cyanoacetate-applications in organic synthesis; tautomerism (keto-enol).

2.6 **Chemistry of aromatic compounds** : Aromaticity; Huckel's rule; electrophilic aromatic substitution-nitration, sulphonation, halogenation (nuclear and side chain), Friedel-Crafts alkylation and acylation, substituents effect; chemistry and reactivity of aromatic halides, phenols, nitro-, diazo, diazonium and sulphonic acid derivatives, benzyne reactions.

2.7 **Chemistry of biomolecules :** (i) **Carobhydrates** : Classification, reactions, structure of glucose, D, L-configuration, osazone formation; fructose and sucrose; step-up step-down of aldoses and ketoses, and ther interconversions, (ii) **Amino acdis** : Essential amino acids; zwitterions, isoelectric point, polypeptides; proteins; methods of synthesis of -amino acids. (iii) Elementary idea of oils, fats, soaps and detergents.

2.8 **Basic principles and applications** of UV, visible, IR and NMR spectroscopy of simple organic molecules.

Section-C
(Physical Chemistry)

3.1 **Gaseous state** : Deviation of real gases from the equation of state for an ideal gas, van der Waals and Virial equation of state, critical phenomena, principle of corresponding states, equation for reduced state. Liquification of gases, distribution of molecular speed, collisions between molecules in a gas; mean free path, speicific heat of gases

3.2 **Thermodynamics** : (i) **First law and its applications**: Thermodynamic systems, states and processes, work, heat and internal energy, zeroth law of thermodynamics,

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various types of work done on a system in reversible and irreversible processes. Calorimetry and thermochemistry, enthalpy and enthalpy changes in various physical and chemical processes, Joule-Thomson effect, inversion temperautre. Heat capacities and temperature dependence of enthalpy and energy changes.

(ii) **Second law and its applications** : Spontaneity of a process, entropy and entropy changes in various processes, free energy functions, criteria for equilibrium, relation between equilibrium constant and thermodynamic quantities.

3.3 **Phase rule and its applications** : Equilibrium bewteen liquid, solid and vapours of a pure substance, Clausius-Clapeyron equation and its applications. Number of components, phases and degrees of freedom; phase rule and its applications; simple systems with one (water and sulphur) and two components (lead-silver, salt hydrates). Distribution law, its modifications, limitations and applications.

3.4 **Solutions** : Solubility and its temperature dependence, partially miscible liquids, upper and lower critical solution temperatres, vapour pressures of liquids over their mixtures, Raoult's and Henry's laws, fractional and steam distillations.

3.5 **Colligative Properties** : Dilute solutions and colligative properties, determination of molecular weights using colligative properties.

3.6 **Electrochemistry** : Ions in solutions, ionic equilibria, dissociation constants of acids and bases, hydrolysis, pH and buffers, theory of indicators and acid-base titrations. Conductivity of ionic solutions, its variation with concentration, Ostwald's dilution law, Kohlrausch law and its application. Transport number and its determination. Faraday's laws of electrolysis, galvanic cells and measurements of their e.m.f., cell reactions, standard cell, standard reduction potential, Nernst equation, relation between thermodynamic quantities and cell e.m.f., fuel cells, potentiometric titrations.

3.7 **Chemical kinetics** : Rate of chemical reaction and its dependence on concentrations of the reactants, rate constant and order of reaction and their experimental determination; differential and integral rate equations for first and second order reaction, half-life periods; temperature dependence of rate constant and Arrhenius parameters; elementary ideas regarding collision and transition state theory.

3.8 **Photochemistry** : Absorption of light, laws of photochemistry, quantum yield, the excited state and its decay by radiative, nonradiative and chemical pathways; simple photochemical reactions.

3.9 **Catalysis :** Homogeneous and heterogeneous catalysis and their characteristics, mechanism of heterogeneous catalysis; enzyme catalysed reactions (Michaelis-Menten mechanism).

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3.10 **Colloids** : The colloidal state, preparation and purification of colloids and their characteristics properties; lyophilic and lyophobic colloids and coagulation; protection of colloids; gels, emulsions, surfactants and micelles.

COMPUTER SCIENCE

PART-A

1. **Formal Languages and Automata Theory**

Finite state machines, push down automata, Finite automata, context free language, context sensitive language, Turing machine, Decision question and undecided problems.

2. **Computer Organisation**

Functional components, CPU design, Memory organization and I/O organization.

3. **Operating Systems.**

Process management, Memory management, File management I/O management.

4. **Software Engineering**

Life cycle model, function oriented design, object oriented design, User interface design, coding and Testing, software requirement, project management, software reliability and Maintenance.

PART-B

1. **Date Structures**

Continuous and Non-continuous data structures, Dynamic storage allocations, File organization techniques.

2. **Principle of Programming Languages.**

Various programming paradigms Syntax, Semantics, Block structure, Scooping, Binding, Object oriented programming, Functional programming, Logic and concurrent programming.

3. **Database Management**

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Concept, Data independence, Different models, Storage organization, query languages, Normal forms, Decomposition, Security, concurrency, Recovery.

4. **Data communication and computer Networks**

Basics of digital communication, Network architecture, physical layer, Medium access protocols, Data-link layer,

FORENSIC SCIENCE

Section-A

UNIT I
Forensic Science - Definition - Development of Forensic Science in India and other countries - Organisation and functions of Forensic Laboratory.

UNIT II
Physical evidences - Their classification and significance - Locard's principle of exchange - Class and individual characteristics.

UNIT III
Crime Scene examination - Documentation of crime scene- Recognition, Collection, Preservation and transportation of physical evidence for laboratory examination.

UNIT IV
Fundamentals of photography - Crime scene photography - Micro and Macro photography - colour Photography.

UNIT V
Foot and tyre impressions - Walking pattern - Recording and Examination of foot prints and tyre prints.

UNIT VI
Finger prints - Fundamental principles - Finger print patterns - Classification of finger prints - Methods of development of latent finger prints.

UNIT VII
Tool marks - Identification - Restoration of filed off/erased marks - Detection of counterfeit coins and currency.

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UNIT VIII
Fire arms - Bullet and cartridge case identication - Pellets and wads - Range of firing.

UNIT IX
Fire and arson - Natural fires - Arson - Accelerants - Combustible properties of flammable substances.

UNIT X
Explosives - Classification of explosive substances - Combustion, detonation and explosion - Effects of explosions- Military and Industrial explosives - Improvised explosive devices - explosive residues examination.

Section-B

UNIT I
Questioned Documents Identification of handwriting, typewriter and forged signatures - Erasures and alterations on documents and their detection

UNIT II
Broken glass - Glass fractures - Direction of force - backward fragmentation - Comparison of glass fragments.

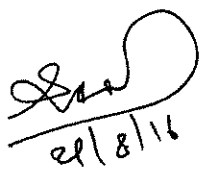
UNIT III
Forensic Examination of Soil, paint, fibres, hair, bones, teeth and skull.

UNIT IV
Toxicology - Classification and mode of action of poisons - Narcotic drgus -Alcoholic beverages - Isolation and Identification of poisons, drugs and alcohol.

UNIT V
Examination of biological fluids - Blood, Seminal and Saliva stands - Forensic characterisation of the above stains - Stain pattens of blood - Fundamentals of DNA typing.

UNIT VI
Motor Vehicle accidents - Hit and run - Skid marks - Speed of the vehicle at the time of accident - Broken head light and its significance.

UNIT VII
Theory and practice of polygraph and voice identification.



UNIT VIII
Microscopy - Compound, Stereo, comparison and polarising microscopes-transmission and canning electron microscope.

UNIT IX
Instrumental methods for organic analysis-Principles of Chromatography, spectrophotometry and mass spectrometry.

UNIT X
Instrumental methods for inorganic analysis - principles of emission and atomic absorption spectra - x-ray diffraction - Neutron activation analysis.

Network layer, Transport layer and Application layer.

Physics

1. **Mechanics and Waves**

Dimensional analysis. Newton's laws of motion and applications, variable mass systems, projectiles. Rotational dynamics-kinetic energy, angular momentum, theorems of moment of intertia and calculations in simple cases. Conservative forces, frictional forces. Gravitaional potential and intensity due to spherical objects. Central forces, Kepler's problem, escape velocity and artificial satellites (including GPS). Streamline motion, viscosity, Poiseuille's equation. Applications of Bernoulli's equation and Stokes' law.

Special relativity and Lorentz transformation-length contraction, time dilation, mass-energy relation.

Simple harmonic motion, Lissajous figures. Damped oscillation, forced oscillation and resonance. Beats, Phase and group velocities. Stationary waves, vibration of strings and air columns, longitudinal waves in solids. Doppler effect. Ultrasonics and applications.

2. **Geometrical and Physical Optics.**

Laws of reflection and refraction from Fermat's principle. Matrix method in paraxial optics-thin lens formula, nodal planes, system of two thin lenses. Chromatic and spherical aberrations. Simple optical instruments-magnifier, eyepieces, telescopes and microscopes.

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Huygens' principle-reflection and refraction of waves. Interference of light-Young's experiment, Newton's rings, interference by thin films, Michelson interferometer. Fraunhofer diffraction-single slit, double slit, diffraction grating, resolving power. Fresnel diffraction-half-period zones and zone plate. Production and detection of linearly, circularly and elliptically polarised light. Double refraction, quarter-waves plates and half-wave plates. Polarizing sheets. Optical activity and applications. Rayleigh scattering and applications.

Elements of fibre optics-attenuation; pulse dispersion in step index and parabolic index fibres; material dispersion. Lasers, characteristics of laser light-spatial and temporal coherence. Focussing of laser beams and applciations.

3. **Heat and Thermodynamics**

Thermal equilibrium and temperature. The zeroth law of thermodynamics. Heat and the first law of thermodynamics. Efficiency of Carnot engines. Entropy and the second law of thermodynamics. Kinetic theory and the equation of state of an ideal gas. Mean free path, distribution of molecular speeds and energies. Trasport phenomena. Andrew's experiements-van der Waals equation and applications. Joule-Kelvin effect and applications. Brownian motion. Thermodynamic potentials-Maxwell relations. Phase transitions. Kirchhoff's laws. Black-body radiation-Stefan-Boltzmann law, spectral radiancy, Wien displacement law, application to the cosmic microwave background radiation, Planck radiation law.

4. **Electricity and Magnetism**

Electric charge, Coulomb's law, electric field, Gauss' law. Electric potential, van de Graff accelerator. Capacitors, dielectrics and polarization. Ohm's law, Kirchhoff's first and second rules, resistors in series and parallel, applications to two-loop circuits. Magnietic field-Gauss'law for magnetism, atomic and nuclear magnetism, magnetic susceptibility, classification of magnetic materials. Cirulating charges, cyclotron, synchrotron. Hall effect. Biot-Savart law, Ampere's law, Faraday's law of induction., Lenz's law. Inductance. Alternating current circuits-RC, LR, single-loop LRC circuits, impedance, resonance, power in AC circuits. Displacement current, Maxwell's equations (MKS units), electromagnetic waves, energy transport and Poynting vector.

5. **Atomic and Nuclear Physics**

Photoelectric effect, Einstein's photon theory. Bohr's theory of hydrogen atom. Stern-Gerlach experiment, quantisation of angular momentum, electron spin. Pauli exclusion principle and applications. Zeeman effect. X-ray spectrum, Bragg's law, Bohr's theory of the Mosley plot. Compton effect, Compton wavelength. Wave nature of matter, de Broglie wavelength, wave-particle duality. Heisenberg's uncertainty relationships. Schroedinger's equation-eigenvalues and eigenfunctions of (i) particle in a box, (ii) simple harmonic

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oscillator and (iii) hydrogen atom. Potential step and barrier penetration. Natural and artificial radioactivity. Binding energy of nuclei, nuclear fission and fusion. Classification of elementary particles and their interactions.

6. **Electronics**

Diodes in half-waves and full-wave rectification, qualitative ideas of semiconductors, p type and n type semiconductors, junction diode, Zener diode, transistors, binary numbers, Logic gates and truth tables, Elements of microprocessors and computers.

ZOOLOGY

I. **Cell structure and function:**

(a) Prokaryote and eukaryote.

(b) Structure of animal cell, structure and functions of cell organelles.

(c) Cell cycle-mitosis, meiosis.

(d) Structure and contents of nucleus including nuclear membrane, structure of chromosome and gene, chemistry of genetic components.

(e) Mendel's laws of inheritance, linkage and genetic recombination; cytoplasmic inheritance.

(f) Function of gene: replication, transcription and translation; mutations (spontaneous and artificial); Recombinant DNA: principle and application.

(g) sex determination in Drosophila and man; sex linkage in man.

II. **Systematics:**

(a) Classification of non-chordates (up to sub-classes) and chordates (up to orders) giving general features and evolutionary relationship of the following phyla:

Protozoa, Porifera, Coelenterata, Platyhelminthes, Nemathelminthes, Annelida, Arthropoda, Mollusca, Echinodermata, Minor Phyla (Bryozoa, Phoronida and Chaetognatha) and Hemichordata.

(b) Structure reproduction and life history of the following types:

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Amoeba, Monocystis, Plasmodium, Paramaecium, Sycon, Hydra, Obelia, Fasciola, Taenia, Ascaris, Neanthes, Pheretima, Hirudinia, Palaemon, Buthus, Periplaneta, Lamellidens, Pila, Asterias and Balanoglossus.

(c) Classification of chordates (up to orders), giving general features and evolutionary relationship of the following:

Protochordata; Agnatha; Gnathostomata-Pisces, Amphibia, Reptilia, Aves and Mammalia.

(d) Comparative functional anatomy of the following based on type animals (Scoliodon, Rana, Calotes, Columba and Oryctolagus): integrument and its derivatives, endoskeleton, digestive system, respiratory system, circulatory system including heart and aortic arches, urinogenital system; brain and sense organs (eye and ear); endocrine glands and other hormone producing structures, (Pituitary, thyroid, parathyroid, adrenal, pancreas, gonads) their function.

III. **Vertebrate Physiology and Biochemistry:**

(a) Chemical composition of protoplasm; nature and function of enzymes; vitamins, their sources and role; colloids and hydrogen ion concentration; biological oxidation, electron transport and role of ATP, energetics, glycolysis, citric acid cycle; vertebrate hormones: their type, sources and functions; pheromones and their role.

(b) Neuron and nerve impulse-conduction and transmission across synapses; neurotrasmitters and their role, including acetyl cholinesterase activity.

(c) Homeostasis; osmoregulation; active transport and ion pump.

(d) Composition of carbohydrates, fats, lipids and proteins; steroids.

IV. **Embryology:**

(a) Gametogenesis, fertilization, cleavage; gastrulation in frog and chick

(b) Metamorphosis in frog and retrogressive metamorphosis in ascidian; extra-embryonic membranes in chick and mammal; placentation in mammals; Biogenetic law.

V. **Evolution:**

(a) Origin of life; principles, theories and evidences of evolution; species concept.

(b) Zoogeographical realms, insular fauna; geological eras.

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(c) Evolution of man; evolutionary status of man.

VI. **Ecology, Wildlife and Ethology:**

(a) Abiotic and biotic factors; concept of ecosystem, food chain and energy flow; adaptation of aquatic, terrestrial and aerial fauna; intra-and inter-specific animal relationships; environmental pollution: Types, sources, causes, control and prevention.

(b) Wildlife of India; endangered species of India; sanctuaries and national parks of India.

(c) Biological rhythms.

VII. **Economic Zoology:**

(a) Beneficial and harmful insects including insect vectors of human diseases.

(b) Industrial fish, prawn and molluscs of India.

(c) Non-poisonous and poisonous snakes of India.

(d) Venomous animals-centipede, wasp, honey bee.

(e) Diseases caused by aberrant chromosomes/genes in man; genetic counselling; DNA as a tool for forensic investigation.

29/8/16