MODULE - 1

for

PHYSICS LECTURERS

2016-17

MICRO LEVEL UNDERSTANDING OF PHYSICS IN MACROSCOPIC VIEW

स्वाध्यायान्मा प्रमदः

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Module- 1

Contents

ABOUT THE MODULES.....

The series of Six Modules of physics at the Higher Secondary Stage has been developed with a view that the school education is crucial and challenging as it is a transition from general science to discipline-based curriculum. The recommendations of National Curriculum Framework-2005 have been followed, keeping the disciplinary approach with rigour and depth, appropriate to the comprehension level of learners.

It is expected that, these six modules will help teachers teaching XI and XIIth classes will develop an interest in the learners to study Physics as a discipline and inculcate in learners the abilities, useful concepts of Physics in real-life situations for making learning of Physics relevant, meaningful and interesting. The learner is expected to realize and appreciate the interface of Physics with other disciplines.

RATIONALE

Physics is being offered as an elective subject at the higher secondary stage of school education. At this stage, the students take up Physics, as a discipline, To achieve the primary aim of the Curriculum - to create interest in the learmer, to pursue their future careers in basic sciences- physics. This demands sufficient conceptual background of Physics which would eventually make them competent to meet the challenges of academic and professional courses after the higher secondary stage.

The six modules is an effort in reforming and updating the Physics curriculum based on the feedback received from the teachers during earlier INSET programmes organised by SCERT time to time. The educational and curricular concerns and issues provided in the National Curriculum Framework-2005, is addressed to a greater extent.

SALIENT FEATURES

• Emphasis on basic conceptual understanding of content.

• Promoting process-skills, problem-solving abilities and applications of Physics concepts/content, useful in real-life situations for making Physics learning more relevant, meaningful and interesting.

• Emphasis on Numerical analysis.

• Emphasis on Technical Educational Movie – Analysis from Physics and scientific approach

• Emphasis on Physics-related technological/industrial aspects to cope up with changing demand of society committed to the use of Physics, technology and informatics.

• Providing logical sequencing of the concepts and their linkages for better learning and matching the concepts/content with comprehension level of the learners.

• Reducing the curriculum load by eliminating overlapping of concepts/content within the discipline of Physics or with other disciplines; reducing the descriptive portion and providing suitable formulation/depth of treatment appropriate to the comprehension level of learners, making room for contemporary core - topics and emerging curricular areas in Physics.

• The content are so sequenced as to provide different dimensions of Physics as a discipline. Each Module has been arranged with a topic, content related practical work (one core experiment, two activities to be evaluated)

• There is an imperative need for evaluating the learners through Continuous and Comprehensive Evaluation of various concepts covered in a Unit.

With this background, the Physics curriculum at the higher secondary stageattempts to:

• Strengthen the concepts developed at the secondary stage to provide firm ground work and foundation for further learning Physics at the tertiary level more effectively and learning the relationship with daily-life situations;

• Develop conceptual competence in the learners and make them realize and appreciate the interface of Physics with other disciplines;

• Expose the learners to different processes used in Physics-related industrial and technological applications;

• Develop process-skills and experimental, observational, manipulative, decision- making and investigatory skills in the learners;

• Promote problem-solving abilities and creative thinking to develop interest in the learners in the study of Physics as a discipline;

• Understand the relationship between nature and matter on scientific basis, develop positive scientific attitude, and appreciate the contribution of Physics towards the improvement of quality of life and human welfare;

• Physics teaching-learning at the higher secondary stage enables the learners to comprehend the contemporary knowledge and develop aesthetic sensibilities and process skills. The experimental skills and process-skills developed together with conceptual Physics knowledge prepare the learners for more meaningful learning experiences and contribute to the significant improvement of quality of life. The learners would also appreciate the role and impact of Physics and technology, and their linkages with overall national development.

PGT-PHYSICS	
S. No.	**TITLE**
Module-1	**Micro Level Understanding of Physics in Macroscopic View** Free Body Diagram and Resolution of Vector Electrostatic Properties of Dielectrics/Conductors Potentiometer Open Ended Questions Marking Scheme and Question Paper
Module-2	**Physics of Spherical and Circular Surfaces** Rolling Friction Concept of COG and COM Experiment to find Focal Length of Mirror Experiment to find Focal Length of a Convex Lens Open Ended Questions Marking Scheme and Question Paper.

Module-3	**Study of Interaction among Particles and Waves** Superposition of Waves Magnetism in Action Fun with Pendulum Open Ended Questions Marking Scheme and Question Paper
Module-4	**Energy Transport with and without Molecules** Heat Transfer Thermodynamics Communication Systems Resonance of Air Columns Use of Media in Enhancing Physics Teaching-Learning Strategies Learning Outcome - How Teachers can Educate their Students on the Science of 'Interstellar' Marking Scheme and Question Paper
Module-5	**Study and Application of Matter and Electricity** Fluids in Motion and Energy Conservation Electrical Capacitance Sonometer (Experiment) Use of Media in Enhancing Physics Teaching Marking Scheme and Question Paper
Module-6	**Particle Motion to Wave Motion** Projectile Motion Qualitative Analysis of Wave Optics Capillary Rise Method Use of Media in Enhancing Physics Teaching-Learning Strategies Marking Scheme and Question Paper

Abstract of the six Modules

Module: 1 – Micro Level Understanding of Physics in Macroscopic View

Mathematics as a field influences Physics to a greater extent. On the contrary, one can also say that Physics adds meaning to Mathematics. This module requires a greater mathematical strength to understand and impart in a classroom situation. It covers the free body diagram where many forces are involved, resolution of vectors-force, indication of electric field in dielectric and conductors. These topics demand utmost dedication and will to learn and apply in the situations that evolve in due course. Activity on potentiometer is taken for in depth study with hands-on-tools to overrule the practical problems faced in the laboratory. This segment will enhance your skills in the experimentation and thereby the theory also will get strengthened. Applications and computational skills for problem solving have been stressed in the question papers now-a-days. Rather than solving a single question with values if one can generalize the problem the student can in fact do a lot of numerical questions and will enhance his confidence in Physics. This will also encourage the student to take up Physics as a subject in higher classes. You also stand out to gain a greater insight into physics by learning to analyse and interpret the data.

Happy using the module and Learning the content the way it is said.

Module 2 – Physics of Spherical and Circular Surfaces

This module attempts to help teachers to integrate scientific practices into the learning of Physics. A sound knowledge and understanding of the core observations, concepts and quantitative theoretical structures that constitute our contemporary understanding of the concept is aimed at here. This module emphasize on problem solving skills with nuances and generalization. Care has been taken to cover all areas in the numerical practice across the modules. Here an introduction to magnetic effect of current, Ampers' circuital law, its application are discussed in detail besides the most important aspect of transportation - rolling motion. The simple way by which Rolling can be introduced within the limitations of CBSE Board Syllabus is followed. The activities of optics and optical benches are taken from the practical side as many students fail to make an image without Parallax. The methods that will be shown hands-on will facilitate the teacher and in-turn he student in their care.*Happy using the module and Learning the content the way it is said.*

Module 3 – Study of Interaction among Particles and Waves

Magnetism and Waves are two topics that fail to induce any interest in the student because of the way it is introduced. So a lucid style and a comparative approach on the interaction of waves is done efficiently. Numerical questions are open ended and are to be solved with care such that a similar twisted questions are done with ease. The numerical session in groups will enhance the teaching ability as the teachers in the group may provide multiple approach to the same query or situation. In a way one may also understand the defect in our organs like the eye and ear.

A normal ear retains the sound for about 1/10 of a second.

A human eye can observe an event if 24 frames are shown per second.

A simple experiment which may provide a lot of scope for the guided projects is a Simple pendulum. This is dealt with in detail so that the many students can be given one aspect of the experiment for the investigatory project.

Happy using the module and Learning the content the way it is said.

Module 4 – Energy Transport with and without Molecules

A great philosopher has said "Change is a constant in life". Keeping these words in mind, we as teachers keep learning and implementing in the classes the best of the teaching practices and the simplified ways and means to understand any topic. The topics of Heat and Thermodynamics, Communication systems and some experiments on Resonance are on the neglected list over a period of time. The student tries to do the minimum work on these areas and the absence of intent hinders the learning process. The fundamental aspects of the topics transfer of Heat and Thermodynamics is dealt with in a manner that will ease the difficulty in learning. The degrees of freedom in different molecular formation can be done with ease with idea incorporated here. The experiment on the Resonance tube apparatus is taken for a complete demonstration and this will ease the difficulty in performing them in the school. The content of the chapter – Communication Systems is available in plenty. But how to make the student to understand the same is a difficult task which was expressed by the teachers in the previous INSET programme. The content may look the same way as the rest but as you attend the session you may feel the way the content be used for the student to score full marks allotted for the chapter. Following a regular pattern may make a boredom. To avoid there should be certain traits we need to imbibe as teachers from time to time. For the first time incorporating Movie Session for learning new traits to be used in class, learn the scientific ways of improving Observation and Interpretation skills and the way technological tools can be used in the teacher training programme is done. The movie that is to be shown here partly is to bring certain changes in your classroom so that the good traits from the reel world is a reality and helps the student community. The attempt by SCERT in providing Freedom for the content developers in bringing necessary variations in

the regular topics that has been provided will make this module a unique one.

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Module 5 – Study and Application of Matter and Electricity

Time and again there has been a difficulty felt in the classroom in dealing with some interesting but felt hard topics in the class XI and XII Physics syllabus. Some of these areas include Bernoulli's theorem and Capacitance. They play a great role in the scoring pattern of the student and to a greater extent induce interest in our subject. An attempt is made here to simplify and apply to a greater extent in the classroom. Why a ball spinned around rises up in the sky when the student is playing cricket is an unanswered question in his mind. The module here with you is an answer to bring the spinning ball into the classroom. Various other examples like the quantifying the volume of water that is being received from a canal outside Delhi will bring reality to classrooms. The capacitors as a energy storage device and their combinations in various circuits have revolutionised the field of communication. Unless and until the student is informed of the daily use of capacitors while doing the topic of Electrostatics - Capacitance it is difficult to make them mentally prepared for conceptualisation. The numerical questions given as practice questions are to prepare the student through the teachers for the board examination. In the practical part there is apprehension in the handling of Sonometer. This induced us to build a session on Sonometer. The session will be hands-on on the stage with the recording of results highlighting the intricacies of the practical handling of Sonometer. One may understand that simple recording is not doing experiment but to understand the nuances of the topic is of prime focus. Following a regular pattern in the teaching –learning process may make a boredom. To avoid there should be certain traits we need to imbibe as teachers from time to time. For the first time incorporating Movie Session for learning new traits to be used in class, learn the scientific ways of improving Observation and Interpretation skills and the way technological tools can be used in the teacher training programme is done. The movie that is to be shown here partly is to bring certain changes in your classroom so that the good traits from the reel world is a reality and helps the student community. The attempt by SCERT in providing Freedom for the content developers in bringing necessary variations in the regular topics that has been provided will make this module a unique one.

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Module 6 – Particle Motion to Wave Motion

To take interest, identify, acknowledge ,unfolding curiosities ,seeking for explanations and reasons is the real fun of Science. Bringing down the observations to find theoretical justification and explanations to the observations makes the difficult part of the subject. Perception is the key reference of interpreting the world around . Inculcating the ability of qualitative understanding and idea is another bless that the students deserve to be served. Throwing a ball while playing a simple game makes it move along a curved path that most people know, the purpose is to create fascination and curiosity of the level that the child feels to interrogate every specification that the child observes and seeks for a theory that supports the same. The projectile motion faces lack of connect of how the various parameters like horizontal range , maximum height serves to make student's life easy.The topic aims to extend and connect the theoretical findings with its applications in the real world to enable students to appreciate the value of the various derivations ,their findings and understanding from the same. To make someone realize the existence of something for which first hand experience is difficult to attain is a task,which if accomplished is a real achievement.Wave optics being one of the most mind opening experience to realize the possibilities of what you observe in nature, the qualitative description of the same has been taken up in the module.The purpose stays as basic as to widen the vision and possibilities that a student can incorporate to extract understanding and knowledge from nature.For the things there in books and theories are hard to experience and trust in real life , experiencing that perception being existing for real people gives a better

idea of authentic existence of the same . Movies based on Scientific ideology to avail critical thinking to the learners , so as to go down the the line to the thought process of the person who had thought about this edge of the Scientific development and progress is another concern of the module.

Happy using the module and Learning the content the way it is said.

PHYSICS (Code No. 042)

Senior Secondary stage of school education is a stage of transition from general education to discipline-based focus on curriculum. The present updated syllabus keeps in view the rigour and depth of disciplinary approach as well as the comprehension level of learners. Due care has also been taken that the syllabus is comparable to the international standards. Salient features of the syllabus include:

Emphasis on basic conceptual understanding of the content.

Emphasis on use of SI units, symbols, nomenclature of physicsl quantities and formulations as per international standards.

Providing logical sequencing of units of the subject matter and proper placement of concepts with their linkage for better learning.

Reducing the curriculum load by eliminating overlapping of concepts/content within the discipline and other disciplines.

Promotion of process-skills, problem-solving abilities and applications of Physics concepts.

Besides, the syllabus also attempts to

strengthen the concepts developed at the secondary stage to provide firm foundation for further learning in the subject.

expose the learners to different processes used in Physics-related industrial and technological applications.

develop process-skills and expperimental, observational, manipulative, decision making and investigatory skills in the learners.

promote problem solving abilities and creative thinking in learners.

develop conceptual competence in the learners and make them realize and appreciate the interface of Physics with other discipline.

PHYSICS (Code No. 042)

COURSE STRUCTURE

Class XI (Theory) (2016-17)

Time: 3 hrs. Max Marks: 70

		No. of Periods	Marks
Unit-I	**Physical World and Measurement**	10	23
	Chapter-1: Physical World		
	Chapter-2: Units and Measurements		
Unit-II	**Kinematics**	24	
	Chapter-3: Motion in a Straight Line		
	Chapter-4: Motion in a Plane		
Unit-III	**Laws of Motion**	14	
	Chapter-5: Laws of Motion		
Unit-IV	**Work, Energy and Power**	12	17
	Chapter-6: Work, Energy and Power		
Unit-V	**Motion of System of Particles and Rigid Body**	18	
	Chapter-7: System of Particles and Rotational Motion		
Unit-VI	**Gravitation**	12	
	Chapter-8: Gravitation		
Unit-VII	**Properties of Bulk Matter**	24	20
	Chapter-9: Mechanical Properties of Solids		
	Chapter-10: Mechanical Properties of Fluids		
	Chapter-11: Thermal Properties of Matter		
Unit-VIII	**Thermodynamics**	12	
	Chapter-12: Thermodynamics		
Unit-IX	**Behaviour of Perfect Gases and Kinetic Theory of Gases**	08	
	Chapter-13: Kinetic Theory		
Unit-X	**Oscillations and Waves**	26	10
	Chapter-14: Oscillations		
	Chapter-15: Waves		
Total		160	70

Unit 1: Physical World and Measurement 10 Periods

Chapter-1: Physical World

Physics-scope and excitement; nature of physics, technology and society.

Chapter-2: Units and Measurements

Need for measurement: Units of measurement; systems of units; SI units, fundamental and derived units. Length, mass and time measurements; accuracy and precision of measuring instruments; errors in measurements; significant figures.

Dimensions of physical quantities; dimensional analysis and its applications.

Unit II: Kinematics 24 Periods

Chapter-3: Motion in a Straight line

Frame of reference, Motion in a straight line: Position-time graph, speed and velocity.

Elementary concepts of differentiation and integration for describing motion, uniform and non-uniform motion, average speed and instantaneous velocity, uniformly accelerated motion, velocity- time and position-time graphs.

Relations for uniformly accelerated motion (graphical treatment).

Chapter-4: Motion in a Plane

Scalar and vector quantities; position and displacement vectors; general vectors and their notations; equality of vectors; multiplication of vectors by a real number; addition and subtraction of vectors; relative velocity; Unit vector; resolution of a vector in a plane, rectangular components, scalar and vector product of vectors.

Motion in a plane, cases of uniform velocity and uniform acceleration-projectile motion, uniform circular motion.

Unit III: Laws of Motion

Chapter-5: Laws of Motion

Intuitive concept of force; Intertia; Newton's first law of motion; momentum and Newton's second law of motion; impulse; Newton's third law of motion.

Law of coservation of linear mometum and its applications.

Equilibrium of concurrent forces; Static and kinetic friction; Laws of friction; rolling friction;

lubrication.

Dynamics of uniform circular motion; Centripetal force, examples of circular motion (vehicle on a level circular road, vehicle on a banked road).

Unit IV: Work, Energy and Power

Chapter-6: Work, Energy and Power

Work done by a constant force and a variable force; kinetic energy; work-energy theorem; power.

Notion of potential energy; potential energy of a spring; conservative forces: concervation of mechanical energy (kinetic and potential energies); non-conservative forces: motion in a vertical circle; elastic and inelastic collisions in one and two dimensions.

Unit V: Motion of System of Particles and Rigid Body

Chapter-7: System of Particies and Rotational Motion

Centre of mass of a two-particle system; momentum conservation and centre of mass motion.

Centre of mass of rigid body; centre of mass of a uniform rod.

Moment of a force; torque; angularmomentum; law of conservation of angular momentum and its applications.

Equilibrium of right bodies; rigid body rotation and equations of rotational motion; comparison of linear and rotationl motions.

Moment of inertia; radius of gyration; values of moments of inertia for simple geometrical objects (no derivation). Statement of parallel and prependicular axes theorems and their applications.

Unit VI: Gravitation

Kelper's laws of planetary motion, universal law of gravitation.

Acceleration due to gravity and its variation with altitude and depth.

Unit VII: Properties of Bulk Matter

Chapter-9: Mechanical Properties of Solids

Elastic behaviour; Stress-strain relationship; Hooke's law; Young's modulus; bulk modulus; shear modulus of rigidity; Poisson's ratio; elastic energy.

Chapter-10: Mechanical Properties of Fluids

Pressure due to fluid colomn; Pascal's law and its applications (hydraulic lift and hydraulic brakes); effect of gravity on fluid pressure.

Viscosity; Strokes' law; terminal velocity; streamline and turbulent flow; critical velocity; Bernoulli's theorem and its application.

Surface energy and surface tension; angle of contact; excess of pressure across a curved surface; application of surface tension ideas to drop, bubbles and capilary rise.

Chapter-11: Thermal Properties of Matter

Heat; temperature; thermal expansion; thermal expansion of solids, liquids and gases; anomalous expansions of water; specific heat capacity.

Heat transfer-conduction, convection and radiation; thermal conductivity; qualitative ideas of Blacbody radiation; Wein's displacement Law; Stefan's law; Green house effect.

Unit VIII: Thermodynamics

Chapter-12: Thermodynamics

Thermal equilibrum and definition of temperature (zeroth law of thermodynamics); heat, work and internal energy. First law of thermodynamics; isothemal and adiabatic processes.

Second law of thermodynamics: reverible and irreversible processes; Heat engine and refrigetor.

Unit IX: Behaviour Of Perfect Gases and Kinetic Theory of Gasses

Chapter-13: Kinetic Theory

Equation of state of a perfect gas; work done in compressing a gas.

Kinetic theory of gases- aasumptions, concept of pressure. Kinetic interpreation of temperature; rms speed of gas molecules; degrees of freedom, law of equi-partition of energy (statement only) and application to specific heat capacities of gases; concept of mean free path, Avogadro's number.

Unit X: Oscillations and Waves

Chapter-14: Oscillations

Periodic motion- time period, frequency, displacemnents as a function of time, periodis functions.

Simple harmonic motion (S.H.M) and its equation; phase; oscillations of loaded spring-restoring force and force constant; energy in S.H.M Kinetic and potential energies; simple pendulum derivation of expression for its time period.

Free, forced and damped oscillations (qualitative ideas only), resonance.

Chapter-15: Waves

Wave motion: Transverse and longitudinal waves, speed of wave motion, displacement relkation for a progressiuve wave, principal of superposition of waves, reflection of waves, standing waves in string and organ pipes, fundamental mode and harmonics, Beats, Doppler effect.

PRACTICALS

The record, to be submitted by the students, at the time of their annual examination, has to include:

Record at least 15 Experiments [with a minimum of 6 from each section], to be performed by the students.

Record of at least 5 Activities [with a minimum of 2 each from section A and section B], to be demonstrated

by the teachers.

Report of the project to be carried out by the students.

EVALUATION SCHEME

Time Allowed: Three hours **Max. Marks: 30**

Two experiments one from each section	8+8 Marks
Practical record (experiment and activities)	6 Marks
Investigatory Project	3 Marks
Viva on experiments, activities and project	5 Marks
Total	**30 Marks**

SECTION-A

Experiments

1. To measure diameter of a small spherical/cylindrical body and to measure internal diameter and depth of a given beaker/calorimeter using Vernier Callipers and hence find its volume.
2. To measure diameter of a given wire and thickness of a given sheet using screw gauge.
3. To determine volume of an irregular lamina using screw gauge.
4. To determine radius of curvature of a given spherical surface by a spherometer.
5. To determine the mass of two different objects using a beam balance.
6. To find the weight of a given body using parallelogram law of vectors.
7. Using a simple pendulum, plot its $L\text{-}T^2$ graph and use it to find the effective length of second's pendulum.
8. To study variation of time period of a simple pendulum of a given length by taking bobs of same size but different masses and interpret the result.
9. To study the relationship between force of limiting friction and normal reaction and to find the co-efficient of friction between a block and a horizontal surface.
10. To find the downward force, along an inclined plane, acting on a roller due to gravitational pull of the earth and study its relationship with the angle of inclination θ by plotting graph between force and sinθ.

Activities

(for the purpose of demonstration only)

1. To make a paper scale of given last count, e.q. , 0.2cm, 0.5 cm.

2. To determine mass of a given body using a metre scale by principle of moments.

3. To plot a graph for a given set of data, with proper choice of scales and error bars.

4. To measure the forces of limiting friction for rolling of a roller on a horizontal plane.

5. To study the variation in range of projectile with angle of projection.

6. To study the conservation of energy of a ball rolling down on an inclined plane (using a double inclined plane)

To study dissipation of energy of a simple pendulum by plotting a graph between square of amplitude and time.

SECTION-B

Experiments

1. To determine Young's modulus of elasticity of the material of a given wire.

2. To find the forces constant of a helical spring by plotting a graph between load and extension.

3. To study the variation in volume with pressure for sample of air at constant temperature by plotting graphs between P and 1/V.

4. To determine the surface tension of water by capilary rise method.

5. To determine the cofficient of viscosity of a given viscous liquid by measuring terminal velocity of a given sphericalbody.

6. To study the relationship between the temperature of a hot body and time by plotting a cooling curve.

7. To determine specific heat capacity of a given solid by method of mixtures.

8. To study the relation between frequency and lenght of a given wire under constant tension using sonometer.

9. To study the relation between the lenght of given wire and tension for constant frequency using sonometer.

10. To find the speed of sound in air at room temperature using a resonance tube by two resonance positions.

Activities

(for the purpose of demonstration only)

1. To observe change of state and plot a cooling curve for molten wax.

2. To observe and explain the effect of heating on a bi-metallic strip.

3. To note the change in level of liquid in a container on heating and interpret the observations.

4. To study the effect of detergent on surface tension of water by observing capillary rise.

5. To study the factors affecting the rate of loss of heat of a liquid.

6. To study the effect of load on depression of a suitably clamped metre scale loaded at (i) its end (ii) in the middle.

7. To observe the decrease in presure with increase in velocity of a fluid.

Practical Examination for Visually Impaired Students

Class XI

Note: Same Evaluation scheme and general guidelines for visually impaired students as given for Class XII may be followed.

A. Items for identification/Familiarity of the apparatus for assessment in practicals(All experiments)

Spherical ball, Cylindrical objects, vemier calipers, beaker, calorimeter, screw guage, wire, Beam balance, spring balance, weight box, gram and milligram weights, forceps, Parallelogram law of vectors apparatus, pulleys and pans used in the same 'weights' used, Bob and string used in a simple pendulum, meter scale, split cork, suspension arrangement, stop clock/stop watch, Helical spring, suspension arrangement used, weights, arrangement used for measuring extension, Sonometer, Wedges, pan and pulley used in it, 'weights' Tuning Fork, Meter scale, Beam balance, Weight box, gram and miligram weights, forceps, Resonance Tube, Tunning Fork, Meter scale, Flask/Beaker used for adding water.

B. List of Practicals

1. To measure diameter of a small spherical/cylindrical body using vernier calipers.

2. To measure the internal diameter and depth of a given beaker/calorimeter using vernier calipers and hence find its volume.

3. To measure diameter of given wire using screw gauge.

4. To measure thickness of a given sheet using screw gauge.

5. To determine the mass of a given object using a beam balance.

6. To find the weight of given body using the parallelogram law of vectors.
7. Using a simple pendulum plot L-T and L-T2 graphs. Hence find the effective length of second's pendulum using appropriate length values.

8. To find the force constant of given helical spring by plotting a graph between load and extension.

9. (i) To study the relation between frequency and lenght of a given wire and tension, for constant frequency, using a sonometer.

(ii) To study the relation between the length of a given wire and tension =, for constant frequency =, using a sonometer.

10. To find the speed of sound in air, at room temperature, using a resonance tube, by observing the two resonance positions.

Note: The above practicals may be carried out in an experiential manner rather than recording observations.

Prescribe Books:

1. Physics Part-1, Textbook for Class XI, Published by NCERT

2. Physics Part-II, Textbook for Class XI, Published by NCERT

3. The list of other related books and manuals brought out by NCERT (consider multimedia also).

PHYSICS (Code No. 042)
QUESTION PAPER DESIGN
CLASS - XI (2016-17)

Time 3 Hours **Max. Marks: 70**

S. No.	Typology of Questions	Very Short Answer (VSA) (1 mark)	Short Answer-I (SA-I) (2 marks)	Short Answer -II (SA-II) (3 marks)	Value based question (4 marks)	Long Answer (LA) (5 marks)	Total Marks	% Weightage
1.	**Remembering- (Knowledge based** Simple recall questions, to know specific facts, terms, concepts, principles, or theories, identify, define, or recite information)	2	1	1	-	-	7	10%
2	**Understanding- (Comprehension -**to be familiar with meaning and to understand conceptually, interpret, compare, contrast, explain, paraphrase information)	-	2	4	-	1	21	30%
3	**Application -** (Use abstract - information in concrete situation, to apply knowledge to new situations, Use given content to interpret a situation, provide an example, or solve a problem)	-	2	4	-	1	21	30%
4	**Higher Order Thinking Skills - (Analysis & Synthesis-** Classify, compare, contrast, or differentiate between different pieces of information, Organize and/or integrate unique pieces of information from a variety of sources)	2	-	1	-	1	10	14%
5	**Evaluation -** (Appraise, judge, and/or justify the value or worth of a decision or outcome, or to predict outcomes based on values)	1	-	2	1	-	11	16%
	TOTAL	**5x1=5**	**5x2=10**	**12x3=36**	**1x4=4**	**3x5=15**	**70(26)**	**100%**

Question Wise Break Up

Type of Question	Mark per Question	Total No. of Questions	Total Marks
VSA	1	5	05
SA-I	2	5	10
SA-II	3	12	36
VBQ	4	1	04
LA	5	3	15
Total		**26**	**70**

1. Internal Choice: *There is no overall choice in the paper. However, there is an internal choice in one question of 2 marks weightage, one question of 3 marks weightage and all the three questions of 5 marks weightage.*

2. *The above template is only a sample. Suitable internal variations may be made for generating similar templates keeping the overall weightage to different form of questions and typology of questions same.*

CLASS XII (2016-17)
(THEORY)

Time: 3 hrs. Max Marks: 70

		No. of Periods	Marks
Unit-I	**Electrostatics**	22	15
	Chapter-1: Electric Charges and Fields		
	Chapter-2: Electrostatic Potential and Capacitance		
Unit-II	**Current Electricity**	20	
	Chapter-3: Current Electricity		
Unit-III	**Magnetic Effects of Current and Magnetism**	22	16
	Chapter-4: Moving Charges and Magnetism		
	Chapter-5: Magnetism and Matter		
Unit-IV	**Electromagnetic Induction and Alternating Currents**	20	
	Chapter-6: Electromagnetic Induction		
	Chapter-7: Alternating Current		
Unit-V	**Electromagnetic Waves**	04	17
	Chapter-8: Electromagnetic Waves		
Unit-VI	**Optics**	25	
	Chapter-9: Ray Optics and Optical Instruments		
	Chapter-10: Wave Optics		
Unit-VII	**Dual Nature of Radiation and Matter**	08	10
	Chapter-11: Dual Nature of Radiation and Matter		
Unit-VIII	**Atoms and Nuclei**	14	
	Chapter-12: Atoms		
	Chapter-13: Nuclei		
Unit-IX	**Electronic Devices**	15	12
	Chapter-14: Semiconductor Electronics: Materials, Devices and Simple Circuits		
Unit-X	**Communication Systems**	10	
	Chapter-15: Communication Systems		
Total		160	70

Unit1: Electrostatics

Chapter-1: Electric Charges and Fields

Electric Charges; Conservation of charge; Coulomb's law-force between two point charges; forces betweenmultiple charges; superposition principle and continuous charge distribution.

Electric field, electric field due to a point charge, electric field lines, electric dipole, electric field due to a dipole , torque on a dipole in uniform electric field.

Electric flux, statement of Gauss's theorem and its applications to field due to infinitely long straight wire, uniformly charged infinite plane sheet and uniformly charged thin spherical shell (field inside and outside).

Chapter-2: Electrostatic Potential and Capacitance

Electric potential; potential difference; electric potential due to a point charge, a dipole and system of charges; equipotential surfaces; electrical potential energy of a system of two point charges and of electric dipole in an electrostatic field.

Conductors and insulators: free charges and bound charges inside a aconductor Dielectrics and electric polarisation; capacitors and capacitance; combination of capacitors in series and in parallel; capacitance of a parallel plate capacitor with and without dielectric medium between the plates; energy stored in a capacitor.

Unit II: Current Electricity

Chapter-3: Current Electricity

Electric current: flow of electric charges in a metallic conductor; drift velocity; mobility and their relation with electric current; Ohm's law; electrical resistance; V-I characteristics (linear and non-linear), electrical energy and power; electrical resistivity and conductivity; carbon resistors; colour code for carbon resistors; series and parallel combinations of resistors; temperature dependence of resistence.

Internal resistance of a cell; potential difference and emf of a cell; combination of cell in series and in parallel; Kirchhoff's laws and simple applications; Wheatstone bridge, metre bridge.

Potentiometer- principle and its applications to measure potential difference and for comparing EMF of two cells; measurement of internal resistance of a cell.

Unit III: Magnetic Effects of Current and Magnetism

Chapter-4: Moving Charges and Magetism

Concept of magnetic field, Oersted's experiment.

Biot-Savart law and its application to current carrying circular loop.

Ampere's law and its applications to infinitely long straight wire. Straight and toroidal solenoids (only qualitative treatment); force on a moving charge in uniform magnetic and electric fields; Cyclotron.

Force on a current-carrying conductor in a uniform magnetic field; force between two parallel current-carrying conductors-definition of ampere, torque experienced by a current loop in uniform magnetic field; moving coil galvanometer-its current sensitivity and conversion to ammeter and voltmeter.

Chapter-5: Magnetism and Matter

Current loop as a magnetic dipole and its magnetic dipole moment; magnetic dipole moment of a revolving electron; magnetic field intensity due to a magnetic dipole (bar magnet) along its axis and perpendicular to its axis; torque on a magnetic dipole (bar magnet) in a uniform magnetic field; bar magnet as an equivalent solenoid; magnetic field lines; earth's magnetic field and magnetic elements.

Para-, dia- and ferro- magnetic substances, with examples. electromagnets and factors affecting their strengths; permanent magnets.

Unit IV: Electromagnetic Induction and Alternating Currents

Chapter-6: Electromagnetic Induction

Electromagnetic induction; Faraday's laws, induced EMF and current; Lenz's Law, Eddy currnents.

Self and mutual induction.

Chapter-7: Alternating Current

Alternating currents, peak and RMS value of alternating current/voltage; reactance and impedance; LC oscillations (qualitative treatment only); LCR series circuit; resonance; power in AC circuits, power factor; wattless current.

AC generator and transformer.

Unit V: Electromagnetic waves

Chapter-8: Electromagnetic Waves

Basic idea of displacement current, Electromagnetic waves, their characteristics, their Transverse nature (qualitative ideas only).

Electromagnetic spectrum (radio waves, microwaves, infrared, visible, ulltraviolet, X-rays, gamma rays)

including elementary facts about their uses.

Unit VI: Optics

Chapter-9: Ray Optics and Optical Instruments

Ray Optics: Reflection of light; spherical mirrors; mirror formula; reflection of light; total internal reflection and its applications; optical; fibers; reflection at spherical surfaces; lenses; thin lens formula; lensmaker's formula; magnification, power of a lens; combination of thin lenses in contact; refraction and dispersion of light through a prism.

Scattering of light- blue colour of sky and raddish appearance of the sun at sunrise and sunset.

Optical instruments: Microscopes and astronomical telescopes (reflecting and refracting) and their magnifying powers.

Chapter-10: Wave Optics

Wave Optics: Wave front and Huygen's principle; reflection and refraction of plane wave at a plane surface using wave fronts. Proof of laws of reflection and refrection using Huygen's principle. Interference; Young's double sit experiment and expression for fringe width, coherent sources and sustained interference of light; diffraction due to a single slit; width of central maximum; resolving power of microscope and astronomical telescope, polarisation; plane polarised light; Brewster's law; uses of plane polarised light and Polaroids.

Unit VII: Dual Nature of Radiation and Matter

Chapter-11: Dual Nature of Radiation and Matter

Dual nature of radiation; Photoelectric effect; Hertz and Lenard's observations; Einstein's photoelectric equation-partcle nature of light.

Matter waves-wave nature of particles; de-Broglie relation; Davisson-Germer experiment (experimental details should be omitted; only conclusion should be explained).

Unit VIII: Atoms and Nuclei

Chapter-12: Atoms

Alpha-particle scatting experiments; Rutherford;s model of atom; Bohr model, energy levels, hydrogen spectrum.

Chapter-13: Nuclei

Composition and size of nucless; Radioactivity; alpha, beta and gamma particles/rays and their properties; radioactiv decay law.

Mass-energy relation; mass defect; binding energy per nucleon and its variation with mass number; nuclear fission; nuclear fusion.

Unit IX: Electronic Devices

Chapter-14: Semiconductors Electronics: Materials, Devices and Simple Circuits

Energy bands in conductors; semiconductors and insulators (qualitative ideas only)

Semiconductor diode-I-V characteristics of a transistor and transistor as an amplifier (common emitter configuration); basic idea of analog and digital; signals Logic gates (OR,AND, NOT, NAND and NOR).

Unit X: Communication System

Chapter-15: Communication Systems

Elements of a communication system (block diagram only); bandwidth of signals (speech, TV and digital

data); bandwidth of transmission medium. Propagation of electromagenetic waves in the atmosphere, sky and space wave propagation, satellite communication. Need for modulation, apmlitude modulation.

PRACTICALS

The record to be submitted by the students at the time of their annual examination has to include:

Record of at least 15 Experiments [with a minimum of 6 from each section], to be performed by the students.

Record ao at least 5 Activities [with a minimum of 2 each from section A and section B], to be demonstrated by the teachers.

The Report of the project to be carried out by the students.

Evaluation Scheme

Time Allowed: Three hours **Max. Marks: 30**

Two experiments one from each section	8+8 Marks
Practical record [experiments and activities]	6 Marks
Investigatory Project	3 Marks
Viva on experiments, activities and project	5 Marks
Total	**30 marks**

SECTION-A

Experiments

1. To determine resistance per cm of a given wire by plotting a graph for potential difference versus current.
2. To find resistance of a given wire using metre bridge and hence determine the resistivity (specific resistance) of its material.
3. To verify the laws of combination (series) of resistances using a metre bridge.
4. To verify the laws of combination (parallel) of resistances using a metre bridge.
5. To compare the EMF of two given primary cells using potentiometer.
6. To determine the internal resistance of given primary cell using potentiometer.
7. To determine resistance of a galvanometer by half-deflection method and to find its figure of merit.
8. To convert the given galvanometer (of known resistance and figure of merit) into a voltmeter of desired range and to verify the same.
9. To convert the given galvanometer (of known resistance and figure of merit) into an ammeter of desired range and to verify the same.
10. To find the frequency of AC mains with a sonometer.

Activities

(For the purpose of demonstration only)

1. To measure the resistance and impedance of an inductor with or without iron core.
2. To measure resistance, voltage (AC/DC), current (AC) and check continuity of a given circuit using multimeter.
3. To assemble a household circuit comprising three bulbs, three (on/off) switches, a fuse and a power source.
4. To assemble the components of a given electrical circuit.
5. To study the variation in potential drop with length of a wire for a steady current.
6. To draw the diagram of a given open circuit comprising at least a battery, resistor/rheostat, key, ammeter and voltmeter. Mark the components that are not connected in proper order and correct the circuit and also the circuit diagram.

SECTION-B

Experiments

1. To find the value of *v* for different values of *u* in case of a concave mirror and to find the focal length.

2. To find the focal length of a convex mirror, using a convex lens.

3. To find the focal lenghth of a convex lens by plottinf graphs between u and v or between 1/u and 1/v.

4. To find the focal length of a concave lens, using a convex lens.

5. To determine angle of minimum deviation for a given prism by plotting a graph betwwen angle of incidence and angle of deviation.

6. To determine refractive index of a glass slab using a travelling microscope.

7. To find refractive index of a liquid by using convex lens and plane mirror.

8. To draw the I-V characteristic curve for p-n junction in forward bias and reverse bias.

9. To draw the characteristic curve of a zener diode and to determine its reverse break down voltage.

10. To study the characteristic of a common-emitter npn or pnp transistor a nd to find out the values of current and votage gains.

Activities

(*For the purpose of demonstration only)*

1. To identify a diode, an LED, a transistor, an IC, a resistor and a capacitor from a mixed collection odf such items.

2. Use of multimeter to (i) identify base of transistor, (ii) distinguish between npn and pnp type transistors, (iii) see the unidirectional flow of current in case of a diode and an LED, (iv) check wether a given electronic component (e.q. diode, transistor or IC) is in working order.

3. To study effect of intensity of light (by varying distance of the source) on an LDR.

4. To observe refraction and laterral deviation of a beam of light incident obliquely on a glass slab.

5. To observe polarization of light using two Polaroids.

6. To observe diffraction of light due to thin slit.

7. To study the nature and size of the image formed by a (i) convex lens, (ii) concave mirror, on a screen by using a candle and a screen (for different distances of the candle from the lens/mirror).

8. To obtain a lens combination with the specified focal length by using two lenses from the given set of lenses.

Suggested Investigatoy Projects

1. To study various factors on which the internal resistance/EMF of a cell depends.

2. To study the variations in current flowing in a circuit containing an LDR because of a variation in

(a) the power of the incandescent lamp, used to 'illuminate' the LDR (keeping all the lamps at a fixed distance).

(b) the distance of a incandescent lamp (of fixed power) used to 'illuminate' the LDR.

3. To find the refractive indics of (a) water (b) oil (transparent) using a plane mirror, an equi convex lens (made from a glass of known refractive index) and an adjustable object needle.

4. To design an appropriate logic gate combination for a given truth table.

5. To investigate the relation betweenthe ratio of (i) output and input voltage and (ii) number of turns in the secondary coil and primary coil of a self designed transformer.

6. To investigate the dependence of the angle of deviation on the angle of incidence using a hollow prism filled one by one, with different transparent fluids.

7. To estimate the charge induced on each one of the two identical styrofoam (or pith) balls suspended in a

vertical plane by making use of Coulomb's law.

8. To set up a common base transistor circuit and to study its input and output characteristic and to calculate its current gain.

9. To study the factor on which the self inductance of a coil depends by observing the effect of this coil, when put in series with a resistor/(bulb) in a circuit fed by A.C source of adjustable frequency.

10. To construct a switch using a transistor and to draw the graph between the input and output voltage and make the cut-off, saturation and active regions.

11. To study the earth's magnetic field using a target galvanometer.

Practical Examination for Visually Impaired Students of Classes XI and XII
Evaluation Scheme

Time Allowed: Two hours **Max. Marks: 30**

Identification/Familiarity with the apparatus	5 marks
Written test (based on given/prescribed practicals)	10 marks
Practical Record	5 marks
Viva	10 marks
Total	**30 marks**

General Guidelines

- The practical examination will be of two hour duration.
- A separate list of ten experiments is included here.
- The written examination in practicals for these students will be conducted at the time of practical examination of all other students.
- The written test will be of 30 minutes duration.
- The question paper given to the students should be legibly typed. It should contain a total of 15 practical skill based very short answer type questions. A student would be required to answer any 10 questions.
- A writer may be allowed to such students as per CBSE examination rules.
- All questions included in the question papers should be related to the listed practicals. Every question should require about two minutes to be answered.
- These students are also required to maintain a practical file. A student is expected to record at least five of the listed experiments as per the specific instructions for each subject. These practicals should be duly checked and signed by the internal examiner.
- The format of writing any experiment in the practical file should include aim, apparatus required, simple theory, procedure, related practical skills, precautions etc.
- Questions may be generated jointly by the external/internal examiners and used for assessment.
- The viva questions may include questions based on basic theory/principle/concept, apparatus/ materials/chemicals required, procedure, precautions, sources of error etc.

Class XII

A. Items for Identification/familiarity with the appartus for assessment in practicals (All experiments)

Meter scale, general shape of the voltmeter/ammeter, battery/power supply, connecting wires, standard resistances, connecting wires, voltmeter/ammeter, meter bridge, screw gauge, jockey Galvanometer, Resistance Box, standard Resistance, connecting wires, Potentiometer, jockey, Galvanometer, Lechlanche cell, Daniell cell (simple distinction between the two vis-a-vis their outer (glass and copper) containers), rhestat connecting wires, Galvanometer, resistance box, Plug-in and tapping keys, connecting wires battery/power supply, Diode, Transistor, IC, Resistor (Wire-wound or carbons one with two wires connected to two ends), capacitors (one or two types), Inductors, Simple electric, electronic bell, battery/power supply, Plug-in and tapping keys, Convex lens, concave lens, convex mirror, concave mirror, Core/hollow wooden cylinder, insulated wire, ferromagnetic rod, Transformer core, insulated wire.

B. List of Practicals

1. To determine the resistance per cm of a given wire by plotting a graph between voltage and currnent.

2. To verify the laws of combination (series/parallel combination) of resistances by ohm's law.

3. To find the resistance of a given wire using a meter bridge and hence determine the specific resistance (resistivity) of its material.

4. To compare the e.m.f of two given primary cells using a potentiometer.

5. To determine the resistance of galvanometer by half deflection method.

6. To identify a

(i) a convex lens and a concave lens.

(ii) a convex mirror and concave mirror and to estimate the likely difference between the power of two given convex/concave lenses.

9. To design an inductor coil and to know the effect of

(i) change in the number of turns.

(ii) introduction of ferromagnetic material as its core material on the inductance of the coil.

10. To design a (i) step up (ii) step down transformer on a given core and know the relation between its input and output voltages.

Note: The above practicals may be carried out in an experiential manner rather than recording observations.

Prescribed Books:

1. Physics, Class XI, Part-I and II, Published by NCERT.

2. Physics, Class XII, Part-I and II, Published by NCERT.

3. The list of other related books and manuals brought out by NCERT (consider multimedis also).

PHYSICS (Code No. 042)
QUESTION PAPER DESIGN
CLASS - XII (2016-17)

Time 3 Hours | Max. Marks: 70

S. No.	Typology of Questions	Very Short Answer (VSA) (1 mark)	Short Answer-I (SA-I) (2 marks)	Short Answer -II (SA-II) (3 marks)	Value based question (4 marks)	Long Answer (LA) (5 marks)	Total Marks	% Weightage
1.	**Remembering - (Knowledge based** Simple recall questions, to know specific facts, terms, concepts, principles, or theories, Identify, define, or recite, information)	2	1	1	-	-	7	10%
2	**Understanding - (Comprehension** -to be familiar with meaning and to understand conceptually, interpret, compare, contrast, explain, paraphrase information)	-	2	4	-	1	21	30%
3	**Application** - (Use abstract information in concrete situation, to apply knowledge to new situations, Use given content to interpret a situation, provide an example, or solve a problem)	-	2	4	-	1	21	30%
4	**Higher Order Thinking Skills - (Analysis & Synthesis-** Classify, compare, contrast, or differentiate between different pieces of information, Organize and/or integrate unique pieces of information from a variety of sources)	2	-	1	-	1	10	14%
5	**Evaluation** - (Appraise, judge, and/or justify the value or worth of a decision or outcome, or to predict outcomes based on values)	1	-	2	1	-	11	16%
	TOTAL	**5x1=5**	**5x2=10**	**12x3=36**	**1x4=4**	**3x5=15**	**70(26)**	**100%**

QUESTION WISE BREAK UP

Type of Question	Mark per Question	Total No. of Questions	Total Marks
VSA	1	5	05
SA-I	2	5	10
SA-II	3	12	36
VBQ	4	1	04
LA	5	3	15
Total		**26**	**70**

1. *Internal Choice: There is no overall choice in the paper. However, there is an internal choice in one question of 2 marks weightage, one question of 3 marks weightage and all the three questions of 5 marks weightage.*
2. *The above template is only a sample. Suitable internal variations may be made for generating similar templates keeping the overall weightage to different form of questions and typology of questions same.*

FREE BODY DIAGRAM AND RESOLUTION OF VECTORS

Introduction

To understand the motion of various objects, we need to organize the forces that are acting on it. The

easiest way to do this is by using a free body diagram. A free body diagram is a simple sketch of the object showing all the forces acting on the given object. Once the forces are indicated, there is a need to resolve them (find their components) so that the motion in a particular direction can be defined. The equation of the forces (causes) in any direction can in-turn define the motion.

Free body diagrams, often abbreviated "fbd" are a tool for solving problems with multiple forces acting on a single body. The methods developed here can also be used for the summation of force fields. The purpose of a free body diagram is to reduce the complexity of the situation and aid in easy analysis. The diagram is used as a starting point to develop a mathematical model of the forces acting on an object.

Learning Outcome:

The learner attains the art of

i) Identifying the forces.

ii) Purpose of the force.

iii) Helping or opposing nature of the forces.

iv) Sense of direction of forces and

v) Finding the resultant effect of the forces.

vi) Writing an equation to define the motion in a particular direction.

Process of Drawing FBD:

To draw a proper free body diagram, you must follow the steps:

1. Draw a quick sketch of an object. Often a simple box will do.(Consider an object at an instant).

2. Place a dot at the centre of the object. We basically treat this as the spot that all the forces are thought to act upon. It is the centre of mass of the object or makes us to treat the mass as point object.

3. For every force acting on that object, draw a vector that shows the size and direction of the force. Each vector must start from the dot and point outwards.

4. Label each vector based on the nature of the force. Do not include numbers.

5. Indicate the tensional force due to strings connecting the Objects. Remember each string is to have different tension and the tension will always act outward from the object under consideration.

6. Repeat these steps for all the Objects given in the situation.

Common Features in FBD

Free body diagrams must show a wide variety of forces acting on an object. The common forces acting on objects are:

F g = force due to gravity

F a = applied force

F f = force due to friction

T or F T = force of tension

N or F N = normal force

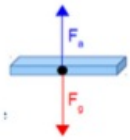
Using these forces we find the net force F net what may act along a particular direction.

Activity I: Book held by a person.

The dot at the centre indicates the Centre of Mass. There are two forces acting on this book. They are

the force of gravity F g pulling it down and

the force applied F a by the person - pushing up.



Observation of Motion

Since the book is just held in the hand, (no acceleration)the two forces acting on it must be equal and opposite - the length of the arrows are kept same to indicate their equal values.

Activity II:A mass on a table.

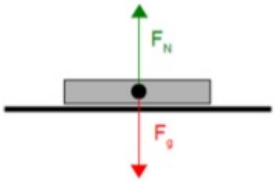
At the Centre of Mass the forces acting are,

the force due to gravity (F g) pulling the mass down and

the Normal Reaction force F N acting upward

Observation of Motion

Force due to gravity (Fg) pulls the mass down, but the table top is strong enough to uphold the mass exerting an upward force perpendicular to the surface called as normal force(F N).



The force due to gravity and the normal force must be equal and so the object stays at rest.

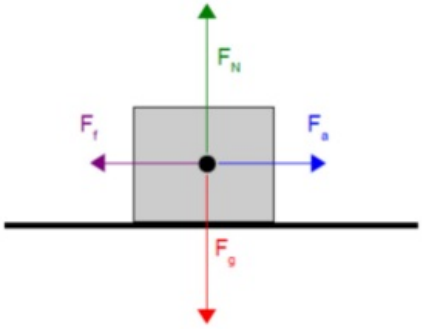
Activity3:

You are trying to pull a heavy box across the floor. It's causing you some trouble because the

floor is not very smooth.

● Force due to gravity and normal force exist. (F g and F n)

● You are trying to pull it sideways by exerting a force. (F a)

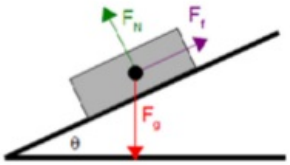


● Force due to friction should be accounted. (Force is shown at centre due to Symmetr y)

● Force due to friction (F f)always opposes the motion of an object. It is tangential to the surface on which the object is placed and will be dependent on the nature of the surface.

● The normal force and force due to gravity are still equal. If the applied force and force due to friction are also equal to each other, then the object is moving at a constant velocity which includes not moving at all v = 0 m/s. Acceleration will be zero.

Activity 4:
A sled is sliding down a sloped hill.
In contrast to the other activities, there is a slope and no applied force



Notice that...

● F g still points straight down.

● F N points upwards at an angle, since it has to be perpendicular to the surface of the slope.

● F f points back up the hill, since friction will try to slow down the sled.

It is essential to resolve the force of gravity to find

i) F g Sinθ acts down the plane and

ii) F g Cosθ acts to oppose the Normal force

As F g Sinθ exceeds the F f the mass will slide down.

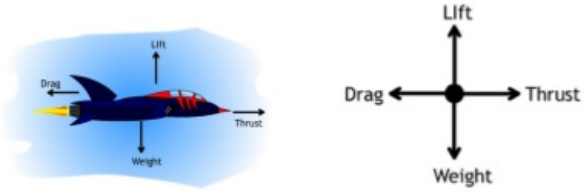
Otherwise there will be two possibilities:

i) F f will be equal to F g Sinθ (Remember Static friction is self-adjusting) and

ii) Force has to be applied to move the object up. In this case remember to check the direction of frictional force.**(Will be downward).**

Activities /Examples

A free body diagram of a flying jet might look as below:



Weight

Weight is a term to describe the pull of gravity. If a physicist had defined the terms we use everyday in our conversations with each other, then instead of “weighing 120 pounds” at the doctor’s office, the doctor would instead “measure the pull of gravity as a 120 pound force.” 4If a body has mass then is has weight when it is near the surface of the Earth. Weight alwayspulls down towards the center of the Earth.

Drawing the weight's force on an free body diagram.

On a free body diagram, "fbd," weight, "mg," is ALWAYS drawn pulling towards the ground. The direction the body is moving and the other forces acting on the body do not change weight's direction on a free body diagram.

Weight is defined as the mass of a body times the pull of gravity. Mathematically it is written as

W=mg

Where “W” is the weight measured in Newtons [N.] Always use a Capital “N.” [The letter you write must look like the accepted capital “N.” That means it cannot look like a lower case “n” that is written bigger.] "m" is the mass in kilograms. "g" is the acceleration due to gravity. On the Earth's surface this is 9.80 m/s^2.

In order to have the weight force on a free body diagram, the body must have mass and it need to be on a very near a large body such as a planet, exerting gravitational force.

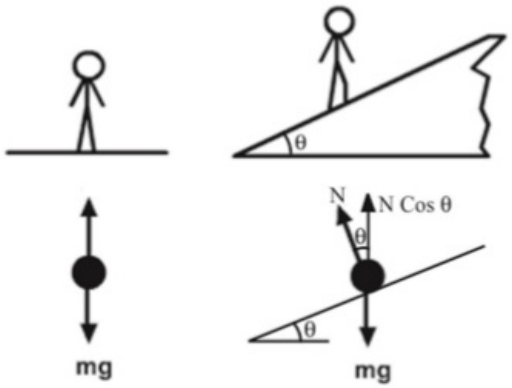
Normal Force

The normal force is a force that is:

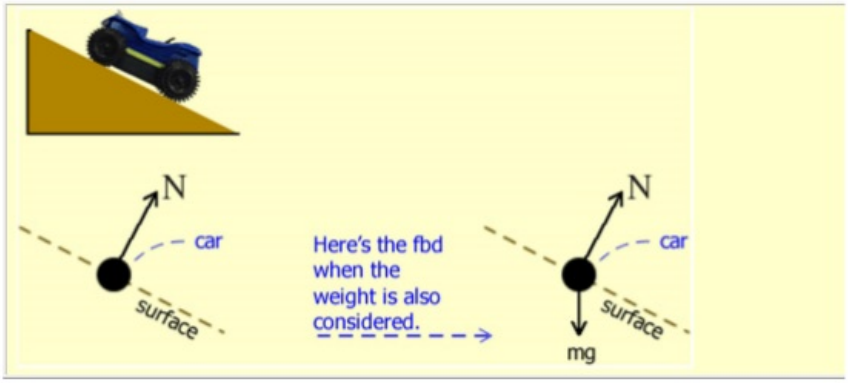
1. perpendicular to the surface of contact,
2. a reaction force to presence of other forces.

The normal force keeps two surfaces from sinking into each other.
N is the symbol for the normal force.

Currently you are sitting down or standing. The ground experiences a force pulling you down. The normal force is perpendicular to the surface and is a reaction to the force(s) holding you down. If you are standing on an incline, the normal force would be the reaction force keeping you from sinking into the incline and it would be perpendicular to the incline's surface.



If you were to lean on a wall, it is the normal force that keeps you from puncturing the wall. In order to have normal force, you must have a contact surface touching something. For example, your shoe on the floor. The floor exerts a normal force upwards against the shoe while the show exerts a normal force down against the floor.



Friction

There are many types of frictional forces. Irrespective of the magnitude of the frictional force, they all point in the opposite direction of motion, (or the intended motion if there were no friction,) and parallel to the surfaces of contact.

We are going to focus in friction due to contact between two surfaces. This frictional force's magnitude is a percentage of the normal force pressing the two surfaces together.

$$F = \mu N$$

$F \rightarrow$ is the frictional force's magnitude

$N \rightarrow$ is the normal force's magnitude

$\mu \rightarrow$ is the "coefficient of firction"

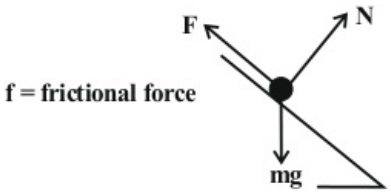
The "coefficient of friction" is the percentage of the normal force. It is found through experimentation and depends on the nature of the materials in contact. **Just because there is a normal force does not mean that there has to be a frictional force.** If you were standing on a the slickest ice in the world, a normal force would be keeping your from sinking into the ice but the frictional force of the "slickest" ice in the world might have no measurable value. Below is a table of examples frictional coefficients.

Top material	Bottom material	Static coefficient	Kinetic coefficient
ice	ice	0.02	- - -
wood	on dry wood	0.3	0.2
iron	on clean iron	1.1	0.15
iron	on clean, dry, oak	- - -	0.49
graphite	on steel		0.1
skin	on clean glass	0.9 – 1	- - -
Rubber tire	on asphalt	0.7	0.45
Sources: http://hyperphysics.phy-astr.gsu.edu/Hbase/Mechanics/frictire.html http://physics.info/friction http://www.engineershandbook.com/Tables/frictioncoefficients.htm			

Notice: Some coefficients are greater than one. In the table above you can see two types of frictional forces exist between the surfaces, static and kinetic friction. Static friction means the two surfaces in contact are not sliding across each other. Kinetic friction means the two surfaces are sliding across each other.

The girl that is standing up in the middle of the playground slide, (right side,) is experiencing static friction between her shoes and the slide because these two surfaces are not moving relative to each other. The girl that is moving down the slide, (left side,) is experiencing kinetic friction between her pants and the slide. This is because the pants are moving relative to the slide's surface.

In both cases the friction opposes the direction of motion (or the intended direction without friction) and is parallel to surface. The free body for each girl would look like the one below. The other forces have been dimmed to highlight the frictional force (View with reference to the figures shown before).



There are six basic principles of friction due to contact between surfaces.

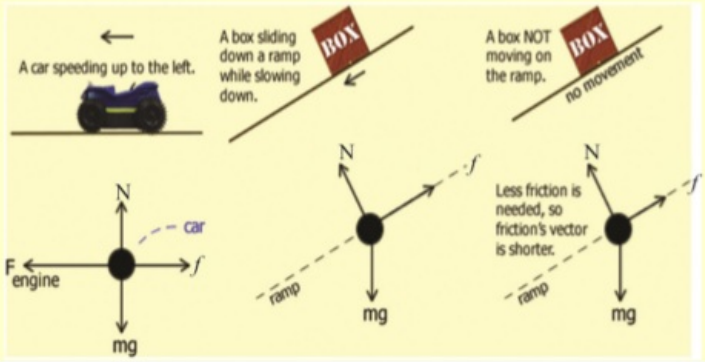
It is worthy to recall,

i. Friction acts parallel to the surfaces that are in contact and in the direction opposite to the motion of the object or to any force tending to produce such motion.
ii. Friction depends on the nature of the materials in contact and the smoothness of their surfaces.
iii. Sliding friction is less than starting friction. Sliding and starting friction are called kinetic and static friction respectively.
iv. Kinetic friction is practically independent of speed.
v. Friction is practically independent of the area of contact.

vi. Friction is directly proportional to the force pressing the surfaces together. The reaction force to pressing the surface is the NORMAL force.

Drawing the frictional force on a free body diagram.

Notice that the frictional force's vector is (1) parallel to the force, (2) opposite the direction of motion -or intended motion.

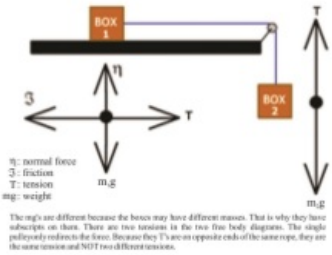


Tension

Tension exists in any body that is pulled by two opposing forces. Typically we talk about ropes and chains as being in tension but any body can be in put in tension. Tension is a pair of equal and opposite forces.

In the drawing above the two 20 N forces represent the tension in the rope. The forces are equal in magnitude and pulling in opposite directions. A taut rope provides its own action reaction pair. The tension in the rope is said to be "20 N." In the picture below, the girls' arms are in tension.

One of the clever features of tension and ropes has to do with corners and a single pulley. If the rope passes around a single pulley then the direction of the tension is redirected. Assuming the pulley is frictionless (as are all of our pulleys) then the tension's magnitude will remained unchanged. The symbol for tension is "**T**." There is not a formula for tension. Tension's value has to be either known in the problem or calculated from the other forces.



In order to have a tension your must have a rope or chain. You can also have a tension when any object is being stretched. Like the arms of the girls in the photo above.

Net Force

The "net" of anything is what is left over after everything is added and subtracted.

When a body is changing velocity the net force is not zero. This is because Newton's 2nd law says an unbalanced force is visually demonstrated by a body changing its velocity. The "unbalanced" force described earlier is actually known to physicists as the "net force." Below is an example showing you what this looks like as well as the various free body diagrams. The net force is represented as $\mathbf{F_{NET}}$.

The vector that represents the net force does not touch the body. This is because the "net force" is not a force that acts on the body. It is the mathematical result of adding up all the other forces. That is why it is called "net."

Note in the animation above how when the opposite force vectors are the same length the net force is zero and the body moves with a constant velocity.[Examples "C" and "D."] When the force in one direction are bigger than the forces in the other directions, this is shown on the free body by having one arrow is longer than the other. When this happens the net force is not zero and the body accelerates or decelerates. [Examples "A" and "B."]

The math used to model the situation is derived directly from the the free body diagram.

PRACTICE QUESTIONS:

1. If the applied force on a 5 kg mass is 10 Newton when placed on a surface having coefficient of friction 0.1, what will be the acceleration? If the coefficient of friction becomes 0.5 will there be any change? Give reason.

2. Two masses 5 Kg and 10 Kg are connected by a mass-less, inextensible string and the 5 kg is applied a pulling force of 25N, find the acceleration of the masses and Tension in the wire.

3. Two masses 5 kg and 10 kg are placed in contact and a force of 100N is applied on the 10Kg. What will be the force at the contact between them? Will your answer change as the force is applied on 5 Kg.

FREE BODIES QUIZ:

1. A box is sliding across a floor while experiencing a frictional force between the box and floor. The box is sliding from left to right. What direction is the force due to friction pointing?

A. →

B. ←

2. A box slides across a rough floor at a constant velocity. What forces act on the box? (The term "rough" is geek-speak implying that friction is present.)

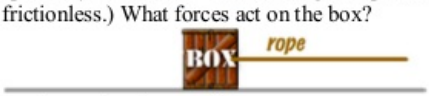
A. friction, gravity

B. friction, tension, gravity

C. friction, normal force, gravity

D. friction, normal force, net force

3. A box slides across a perfectly smooth floor at a constant velocity. (The phrase "perfectly smooth" or "smooth" is geek-speak for meaning that the surface is frictionless.) What forces act on the box?



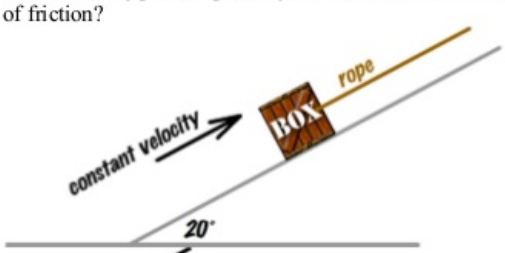
A. tension, gravity

B. tension, gravity, normal froce

C. tension, gravity, normal force, friction

D. gravity, normal force, friction

4. A box is being pulled up a rought incline at a constant velocity. What is the direction of friction?



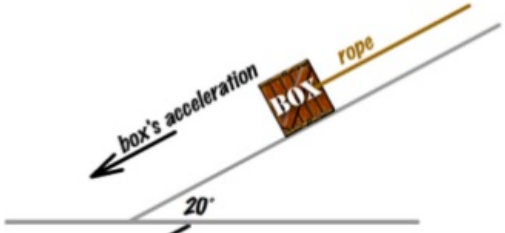
A. ↙

B. ↓

C. ↗

D. ↑

5. What is the direction of the tension force from the attached rope?



A.

B.

C.

D.

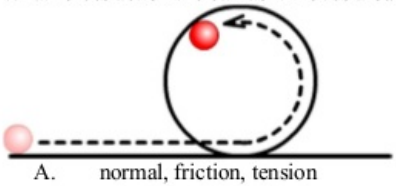
6. What is the direction of the frictional force acting on the box?

A.

B.

C.

7. What forces act on the ball as it moves around the smooth surfaced loop?



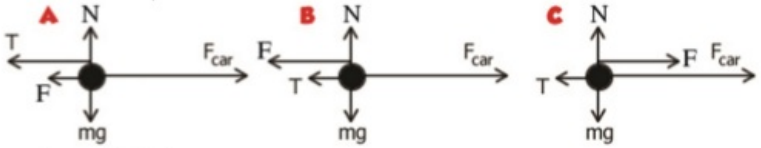
A. normal, friction, tension

B. normal, friction

C. normal, gravity, tension

D. normal, gravity

8. A car is traveling down a level road to the the right. The car's engine exerts 5000 N of force. It is dragging a sled behind it by a thick cable. The tension in the cable is 1000N. Friction acting on the car has a magnitude of 2000N. Which freebody diagram is scaled correctly?



A. fbd "A"

B. fbd "B"

C. fbd "C"

Conclusive Remarks:
There is an attempt to bring in an orderly approach to the formation of equation in deciding the motion of objects. The learner is expected to mark the forces in the way it has to be at the centre of mass and this will bring clarity in the thought process. The direction of friction and its value is stressed upon so that motion along the slide can be expressed.

ELECTROSTATIC PROPERTIES OF DIELECTRICS/CONDUCTORS

Introduction:

Many materials are used by everyone in every walk of life. A clear understanding of their properties will open up a lot of applications. In this topic we are focusing+ on the polarisation of the material in an electric field and there by understand the properties. One may not be surprised if the understanding leads to a single parameter being different in them. Based on the influence of the external electric field how the polarisation happens in a conductor and dielectric one may understand the difference in the behaviour of the materials at microscopic level.

Learning Outcome:

1. Understands the influence of external field

2. Appreciates the alignment that happens as free charges or as dipoles

3. Understands the intrinsic and extrinsic factors and parameters.

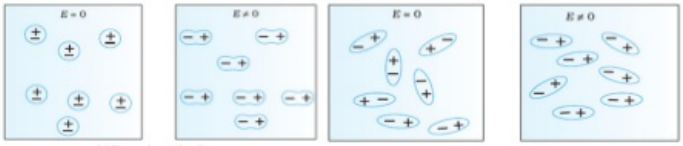
4. Acknowledges the difference in the properties with the dielectric constant

5. Registers that dielectric constant is that parameter which unifies them.

Understanding the Material- Dielectric

(A) Dielectric

Materials can be classified into Conductors and Dielectrics based on their behaviour in an electric field. Polar and Non-polar molecules are shown below:

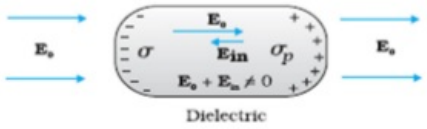


When a dielectric is placed in an electric field, under the influence of electric field,

i) New creation of dipoles take place
ii) Alignment of the dipoles in the line of the field happens.

In the case of polar dielectrics, creation will be less, alignment will be more. But in the case of non-polar dielectrics, the alignment will happen with sufficient dipoles being formed.

As the alignment takes place a reverse electric field will be created. This field E_{in} will be opposite to the external field applied and the net field is $E_m = E_o - E_{in}$



Since the field in a medium is inversely proportional to the relative permittivity of the medium the net field will be$E_m = E_{in}/\varepsilon_r$ Therefore, the induced field will be

$E_{in} = E_o - E_m$ implying $(\sigma_{in}/\varepsilon_o) = (\sigma_o/\varepsilon_o) - (\sigma_m/\varepsilon_o\varepsilon_r)$

Which means $q_{in} = q - q/\varepsilon_r = q(1-1/\varepsilon_r)$.

This formation of the dipoles, net induced charge and alignment polarises the dielectric and so the process is called as Polarisation. The polarisation is expressed in terms of Polarisation density (P), Atomic Polarisability (α)and Susceptibility(χ).

Polarisation density is the dipole moment created in the dielectric per unit Volume. P = Np/V where p is the dipole moment and N is the number of dipoles available.

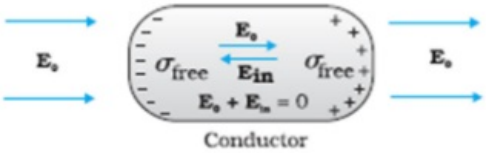
Polarisability is the dipole moment created per unit electric field.

Susceptibility is a material character and is a measure of the readiness of the material in undergoing polarisation. It is the Polarisation density formed per unit influencing electric field.

Understanding the Material- Conductors

(B) Conductors

When a conductor is introduced in to the region of Electric field between two plates having equal and opposite charges, the free electrons align and create an opposing electric field E_m.



This field was observed to be equal in strength to the external field. So the net field inside the conductor becomes zero.

1. Also the conductors have infinite relative permittivity ε_r making the induced charge equal to the charge on the plates between which it is placed.
   Thusa conductor does not have any electric field inside $E_m = E_c = 0$

2. As the electric field is zero, the flux and thereby the charge inside the conductor will be zero.

Thus charges reside only on the surface of the conductor.

3. If the surface is not equi-potential then the charges will be in motion disturbing their static nature and in violation of the Law of Conservation of energy.

Thus the surface of any conductor is an equi-potential surface.

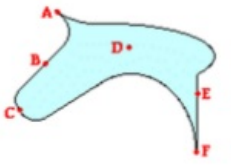
4. For any equi-potential surface, the field lines will be perpendicular to the surface.

Thus any conductor to have normal field lines from its surface.

5. Charge density is the charge per unit area.

Thus the charge density will be more in sharp regions of a conductor (area ofcross-section will be less).

Activity:



Use your understanding to answer the following questions.

1. Describe the electric field strength at the six labeled locations of the irregularly shaped charged object at the right. Use the phrases "zero," "relatively weak," "moderate," and relatively strong" as your descriptions.

Answers: Electric field E at

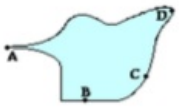
A, and F are relatively strong since they're the most sharp locations on the conductor's surface.

B, and E are relatively weak since they're at the least curved (most flat) locations on the conductor's surface.

C is of moderate strength since it is at a location with some curvature but not large.

D is 0 since it is at a location under the surface of the conductor; electric fields are zero inside of conductors.

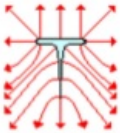
2. A diagram of an irregularly shaped charged conductor is shown at the right. Four locations along the surface are labeled - A, B, C, and D. Rank these locations in increasing order of the strength of their electric field, beginning with the smallest electric field.



Answer: **B < C < D < A**

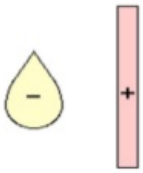
For conducting surfaces, electric fields are strongest at locations where the curvature is the greatest. A projection (such as at point A) is the extreme case of lots of curvature. A flat section of a surface (such as point B) is on the opposite extreme with with no curvature. So point B is listed first and point A is listed last. Since point D is on a section of the surface which curves more than point C's section, the ordering of the final two locations is point C < point D.

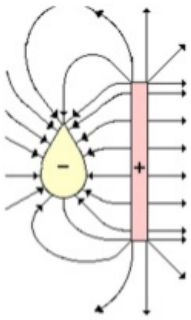
3. Consider the diagram of the thumbtack shown at the right. Suppose that the thumbtack becomes positively charged. Draw the electric field lines surrounding the thumbtack.



- The electric field lines should be directed from the positively charged thumbtack to the extremities of the page. Each field line MUST have an arrowhead on it to indicate such directions.
- All electric field lines should be perpendicular to the surface of the thumbtack at the locations where the lines and the thumbtack meet.
- There should be more lines concentrated at the pointed extremity of the thumbtack and the two sharply curved sections and fewer lines along the flatter sections of the thumbtack.

4. Diagram the electric field lines for the following configuration of two objects. Place arrows on your field lines.





- The field lines should be directed from + to - or from the edge of the page to the - or from + to the edge of the page. Each field line MUST have an arrowhead on it to indicate such directions.
- At the surface of either object, the field lines should be directed perpendicular to the surface.
- There should be more lines at the sharply curved and pointed surfaces of the objects and less lines at the flatter sections.

Answer:

An *uncoiled* paper clip becomes an object with a blunt edge with extreme curvature at its tip. This extreme curvature creates strong electric fields around its surface. The strength of the electric field is great enough to ionize the air between the paper clip and the Van de Graaff dome. This provides a conducting path from the dome to the clip. Charge that normally accumulates on the dome now flows through the ionized air and is grounded through the demonstrator. Rather than experiencing a sudden discharge of large quantities of charge, there is a gradual non-harmful (so he claims) flow of charge off the dome.

Practice Questions

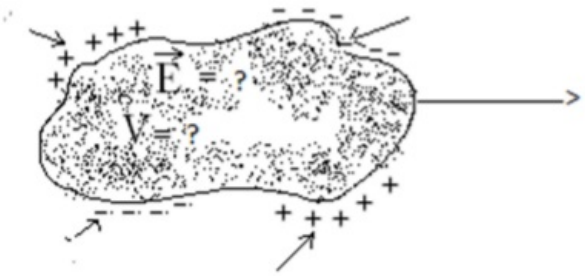
1. What is the similarity in the process in the Conductors and Dielectrics when placed in an external field?

2. What is the range of value of dielectric constant of materials?

3. Are all materials dielectrics/conductors at some stage? Justify.

4. What will happen if the field is non-uniform?

5. In the following figure, identify the direction of electric field? Also expressthe value of E and V.



Conclusive Remarks:

Study of the properties is to understand the material in a better manner. This understanding helps the mankind in enhancing the Capacitance of a Capacitor. This application is not clearly understood by the student leading to an aversion. The teacher is to make this realisation possible by discussing this topic along with Parallel Plate Capacitor. The relation for the induced chargas derived here will make the student to appreciably use the material of his/her choice.

POTENTIOMETER

Introduction

Potentiometers are variable resistors. It has three leads with one of them attached tothe wiper. The resistance changes when the wiper is adjusted from one of the outsideleads (where the connection is made) to the central (wiper) lead. As the resistanceincreases, the amount of current in the circuit decreases.

There are many types of potentiometers, some with two terminals (rheostats) and others withthree terminals. **Potentiometers are used in real life to change the brightness of lights; adjustthe volume of audio devices, like stereos and boom boxes; and control the speed ofappliances, such as mixers, blenders, and drills. Potentiometers are rarely used to directlycontrol significant amounts of power (more than a watt or so). Instead they are used toadjust the level of analog signals (for example volume controls on audio equipment),and as control inputs for electronic circuits.**

Learning Outcomes

Learn the concept of electromotive force in cells.

Able to construct circuits based on circuit diagrams.

Develops understanding of the principle of Potentiometer.

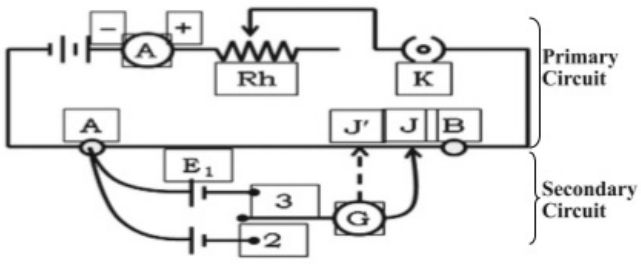
Differentiates between emf and terminal voltage.

Understand the consequences of the use of improper potentials.

PRINCIPLE

The fall of potential across any portion of the potentiometer wire is directly proportional tothe length of that portion provided the wire is of uniform cross–sectional area and a constantcurrent is flowing through it.

How and Why ?



Understands to use sources of appropriate voltage in primary and secondary circuits.

PRINCIPLE

The fall of potential across any portion of the potentiometer wire is directly proportional to the length of that portion provided the wire is of uniform cross–sectional area and a constantcurrent is flowing through it.

How and Why ?

Always

Using the Primary Circuit

i) Find the current through the potentiometer wire. $I = \frac{E}{R_{AB} + R_s}$

ii) Find potential difference across the potentiometer wire. $V_{AB} = IR_{AB} = \frac{ER_{AB}}{(R_{AB} + R_s)}$

(iii) Find potential gradient V_g = V/L where L is the length of the potentiometer wire.

$$Vg = \frac{V_{AB}}{AB} = \frac{E}{(R_{AB} + Rs)} \frac{R_{AB}}{AB}$$

For Comparison of emf of 2 cells,

Balancing length for E_1 will satisfy

$E_1 = V_g \times l_1$

Balancing length for E_2 will satisfy

$E_2 = V_g \times l_2$

Therefore, $E_1/E_2 = l_1/l_2$

For Internal resistance of the cell,

Using secondary circuit, $E_1 - I_1 r_1 - I_1 R = 0$ where $I_1 R = V_1$

$$\therefore E_1 - \frac{V_1}{R} r_1 - V_1 = 0 \text{ implying } \frac{E_1}{V_1} = 1 + \frac{r_1}{R}$$

Using $\therefore \frac{E_1}{V_1} = \frac{l_1}{l_2}$ we have $\frac{r_1}{R} = \frac{l_1}{l_2} - 1 \Rightarrow r_1 = R\left(\frac{l_1 - l_2}{l_1}\right)$

Advantage of the potentiometers is that since it makes use of a balance or null condition, no current flows and hence no power is consumed in the circuit containing the unknown emf when the instrument is balanced.

Activity 1

Observation/ As Practical,

If the length of the wire is increased/ decreased – Identify the change in

- Resistance of the wire increases/ Decreased ,
- Current drawn increases/ Decreased
- Potential across AB increase/decrease
- Potential gradient increase/decrease
- Balancing length increase/decrease
- Balancing point shifts to the right/left

Activity 2

Observation/ As Practical,

If the emf in the primary circuit is increased -

- Potential across AB increases
- Potential gradient increases
- Balancing length decreases
- Balancing point shifts to the left of A

Activity 3

Observation/ As Practical,

If the emf E_1 in the Secondary circuit is increased-

If it is less than the emfE in primary circuit -

- Current drawn decreases
- Potential across AB decreases
- Potential gradient decreases
- Balancing length increases
- Balancing point shifts to the right

If it is greater than the emfE in primary circuit –

- No Opposite deflection at the edges
- Draws current from the source in the Primary circuit

Activity 4

Observation/ As Practical,

When opposite deflection is non-existing/absent–CHECK FOR

Possibility I: Emf of cells in the secondary circuit may be higher. They will be drawing current from the source cell in the Primary circuit

Possibility II: Cells in the secondary circuit are connected with their negative terminals to the positive terminal of the source in the Primary circuit

Activity 5

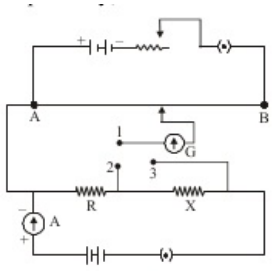
Observation/ As Practical,

When the internal resistance is very low–

- The difference between the balancing length in the case of with shunt and without shunt will be very small.

Practice Questions /Problems:

1. A potential circuit is set up as shown in figure. The potential gradient, across the potentiometer wire, is K volt/cm and the ammeter, preset in the circuit, reads 1.0 A when two way key is switched off. Find the magnitudes of the resistors R and X, in ohms if the balancing lengths when the key between the terminals (i) 1 and 2 (ii) 1 and 3, are found to be at lengths l 1 cm and l 2 cm respectively. the, are then, equal respectively, to



2. A wire of length 400 cm, resistance 2 Ω is connected to a source of potential 5 Volt along with a series resistance 3 Ω. Find the potential gradient. Also find the emf that can be balanced at a length of 150 cm.

3. A potentiometer with a cell of 2.0 V and internal resistance 0.40 Ω maintaining a potential drop across a resistive wire AB. A standard cell which maintains a constant emf of 1.02 V (for very moderate currents upto a few mA) gives a balance point at 67.3 cm length of the wire. To ensure very low currents drawn

from the standard cell, a very high resistance of 600 kΩ is put in series with it, which is shorted close to the balance point. The standard cell is then replaced by a cell of unknown emf e and the balance point found similarly, turns out to be at 82.3 cm length of the wire.

(a) What is the value e?

(b) What purpose does the high resistance of 600 k Ω have?

(c) Is the balance point affected by this high resistance?

(d) Is the balance point affected by the internal resistance of the driver cell?

(e) Would the method work in the above situation if the driver cell of the

potentiometer had an emf of 1.0V instead of 2.0V?

(f) Would the circuit work well for determining an extremely small emf, say of the order of a few mV

(such as the typical emf of a thermo-couple)? If not, how will you modify the circuit?

Conclusive Remarks:

Demonstration experiment discussed here is expected to remove the phobia with regard to potentiometers. The experiment can be performed with any cell that is available in the lab and the students can be given the freedom to experiment with varying parameters and record their observations. This attempt may help the learner in having a good grasp of the intricacies involved in the experiments with potentiometer.

OPEN ENDED QUESTIONS

Introduction

This open ended questions are framed such that the teacher can bring in the changes in various parameters (as asked) involved and study how the changes affect the outcome of the other related parameters. The intrinsic parameters are to be understood to solve these questions. With change in value of these parameters multiple conclusion can be drawn. This will reflect up on the conceptual understanding of the learner which is expected to enhance the Teaching – Learning process in the Classroom Situation.

Learning Outcome

1. Tries to understand the given situation at micro-level.

2. Picturises the situation for all the objects involved.

3. Tries to relate with Physics in the given situation.

4. Recalls the mathematical tools

5. Applies the mathematical tools to the given situation.

6. Critically analyses the steps involved to simplify the steps wherever possible.

7. Understands the Physics through the thought that evolves in the group.

8. Appreciates the quick processing ability of the learner in the group and tries to imbibe such abilities.

9. Tries to develop the thought process that can be built up on in his/her lecture to benefit the learner.

10. Learns to appreciate the grasp, scientific approach, logical thinking and feedback of the Learner.

Mode of Activity:

Teachers will be grouped in 6 or 7 members and will be assigned to do atleast 3 questions out of the six in a time of One hour. The same will be presented by the Team leader and the queries that evolve will be answered. The teacher facilitator will move among the groups to just give a helping hand without opening

the complete answer. The facilitator is to finally make the teacher learner to grasp, think, execute, perform the task and enhance his skills for delivery in the classroom.

Problem 1

False balance – Principle of moments

A false balance with unequal arms is given. Using the same how will you find the correct mass of the given object?

Problem 2

Approach to a SHM – Spring in different form

A spring of force constant K is attached to a mass M and allowed to oscillate. Will it be a S.H.M? Why? If another Spring of equal constant K is attached in (a) Series and

(b) Parallel how will the Time period change? If another spring of same constant K is attached with previous two such that the three are in 90 o with each other what will be the equivalent spring constant? If the angle changes to 120 o will your answer change?

Problem 3

Circular Motion – Non-uniform

A car is moving in a circular track of radius r such that the kinetic energy associated is E=α s 2 with α is a constant.

What kind of circular motion is this? Give reason.

Find the acceleration?

Is the acceleration simply radial? If so why? If not, Why?

Will there be work done in this motion?

Does the radial acceleration contribute for the same?

Problem 4

Ring of positive charge and electron

A ring of positive charge with charge density λ is given.

What will be the electric field i) at its centre and ii) at a point distance x along its axis. If an electron is allowed to approach the centre along its axis from a large distance what will be your observation? Depict the nature of motion performed. Will a proton follow the same? Is so, how? If not, Why? Does the value of x in comparison with the radius r of the ring play a role in your decision of the nature of the motion?

Problem 5

Find the equivalent capacitance between M and N and the charge on each plate of area A kept equidistant (d) from their neighbours in the arrangements given below.

Problem 6

Spherical Shell in a Shell

Two concentric spherical shells A and B of radius r 1 and r 2 (>r 1)are charged such that

q 1 and q 2 are the charges on their surfaces.

Find the potential difference between A and B.

If additional charges are added to the i) inner and ii) outer sphere will the answer

change?

After charging A, if uncharged B is grounded,

What will be the charge on the inner surface of B?

After charging B, if uncharged A is grounded,

What will be the charge on A?

Hint/Steps to solve the Problems

Teachers are requested to try solving the questions with all variables possible before seeing

the steps in the group to share their experiences in solving a Question.

1. It is a beam balance. The arms are unequal.

Without weight in both the pans, Keeping the weight to be measured in one arm and the stone weight in the other and interchanging the stone and the weight, Apply Principle of moments.

2. Check for the restoring forces and their direction. Try to resolve the length and force to get the equivalent restoring force and the equivalent spring constant.

3. Always identify the motion to be uniform or not. Distance never decreases. Find both the tangential and radial acceleration. Add them using law of vector addition.

4. Recall that a ring of positive charge will result in a field along the outward drawn normal. So an electron will be pulled towards the centre of the ring. Check whether this force is proportional to the distance from the centre to identify a S.H.M.

5. Identify the nearby plates having difference in potential and draw equivalent circuit of capacitances.

6. Recall that

i) Potential on the surface of any sphere is the sum of the potential on it due to the charge in each of the spheres.

ii) Potential at any point inside a hollow sphere due to the charges on its surface is the potential on its surface.

iii) For all points outside a sphere, charges on its surface behave as if they are at its surface.

Conclusive REMARKS

The attempt through these questions is to enhance the teaching process. The teacher is expected to incorporate the methods learned in solving the numerical questions during routine lecture and thereby make learning an enjoyable and a complete process. The joy of getting a correct answer to the questions by any student is unquestionably good.

SET-1

Series SSO

कोड नं.
Code No. **55/1/MT**

रोल नं.
Roll No.

परीक्षार्थी कोड को उत्तर-पुस्तिका के मुख-पृष्ठ पर अवश्य लिखें ।

Candidates must write the Code on the title page of the answer-book.

- कृपया जाँच कर लें कि इस प्रश्न-पत्र में मुद्रित पृष्ठ **19** हैं ।
- प्रश्न-पत्र में दाहिने हाथ की ओर दिए गए कोड नम्बर को छात्र उत्तर-पुस्तिका के मुख-पृष्ठ पर लिखें ।
- कृपया जाँच कर लें कि इस प्रश्न-पत्र में **26** प्रश्न हैं ।
- **कृपया प्रश्न का उत्तर लिखना शुरू करने से पहले, प्रश्न का क्रमांक अवश्य लिखें ।**
- इस प्रश्न-पत्र को पढ़ने के लिए 15 मिनट का समय दिया गया है । प्रश्न-पत्र का वितरण पूर्वाह्न में 10.15 बजे किया जाएगा । 10.15 बजे से 10.30 बजे तक छात्र केवल प्रश्न-पत्र को पढ़ेंगे और इस अवधि के दौरान वे उत्तर-पुस्तिका पर कोई उत्तर नहीं लिखेंगे ।
- Please check that this question paper contains **19** printed pages.
- Code number given on the right hand side of the question paper should be written on the title page of the answer-book by the candidate.
- Please check that this question paper contains **26** questions.
- **Please write down the Serial Number of the question before attempting it.**
- 15 minute time has been allotted to read this question paper. The question paper will be distributed at 10.15 a.m. From 10.15 a.m. to 10.30 a.m., the students will read the question paper only and will not write any answer on the answer-book during this period.

भौतिक विज्ञान (सैद्धान्तिक)

PHYSICS (Theory)

निर्धारित समय : 3 घण्टे *अधिकतम अंक : 70*

Time allowed : 3 hours *Maximum Marks : 70*

General Instructions :

(i) ***All*** *questions are compulsory. There are* ***26*** *questions in all.*

(ii) *This question paper has* ***five*** *sections : Section A, Section B, Section C, Section D and Section E.*

(iii) *Section A contains* ***five*** *questions of* ***one*** *mark each, Section B contains* ***five*** *questions of* ***two*** *marks each, Section C contains* ***twelve*** *questions of* ***three*** *marks each, Section D contains one value based question of* ***four*** *marks and Section E contains* ***three*** *questions of* ***five*** *marks each.*

(iv) *There is no overall choice. However, an internal choice has been provided in one question of two marks, one question of three marks and all the three questions of five marks weightage. You have to attempt only one of the choices in such questions.*

(v) *You may use the following values of physical constants wherever necessary :*

$c = 3 \times 10^{8}$ m/s

$h = 6{\cdot}63 \times 10^{-34}$ Js

$e = 1{\cdot}6 \times 10^{-19}$ C

$\mu_o = 4\pi \times 10^{-7}$ T m A^{-1}

$\varepsilon_o = 8{\cdot}854 \times 10^{-12}$ C^2 N^{-1} m^{-2}

$\frac{1}{4\pi\varepsilon_o} = 9 \times 10^{9}$ N m^2 C^{-2}

$m_e = 9{\cdot}1 \times 10^{-31}$ kg

Mass of neutron = $1{\cdot}675 \times 10^{-27}$ kg

Mass of proton = $1{\cdot}673 \times 10^{-27}$ kg

Avogadro's number = $6{\cdot}023 \times 10^{23}$ per gram mole

Boltzmann constant = $1{\cdot}38 \times 10^{-23}$ JK^{-1}

सामान्य निर्देश :

(i) ***सभी** प्रश्न अनिवार्य हैं । इस प्रश्न-पत्र में कुल **26** प्रश्न हैं ।*

(ii) *इस प्रश्न-पत्र के **5** भाग हैं : खण्ड अ, खण्ड ब, खण्ड स, खण्ड द और खण्ड य ।*

(iii) *खण्ड अ में **5** प्रश्न हैं, प्रत्येक का **1** अंक है । खण्ड ब में **5** प्रश्न हैं, प्रत्येक के **2** अंक हैं । खण्ड स में **12** प्रश्न हैं, प्रत्येक के **3** अंक हैं । खण्ड द में **4** अंक का एक मूल्याधारित प्रश्न है और खण्ड य में **3** प्रश्न हैं, प्रत्येक के **5** अंक हैं ।*

(iv) *प्रश्न-पत्र में समग्र पर कोई विकल्प नहीं है । तथापि, दो अंकों वाले एक प्रश्न में, तीन अंकों वाले एक प्रश्न में और पाँच अंकों वाले तीनों प्रश्नों में आन्तरिक चयन प्रदान किया गया है । ऐसे प्रश्नों में आपको दिए गए चयन में से केवल एक प्रश्न ही करना है ।*

(v) *जहाँ आवश्यक हो आप निम्नलिखित भौतिक नियतांकों के मानों का उपयोग कर सकते हैं :*

$c = 3 \times 10^8$ m/s

$h = 6{\cdot}63 \times 10^{-34}$ Js

$e = 1{\cdot}6 \times 10^{-19}$ C

$\mu_o = 4\pi \times 10^{-7}$ T m A^{-1}

$\varepsilon_o = 8{\cdot}854 \times 10^{-12}$ C^2 N^{-1} m^{-2}

$\frac{1}{4\pi\varepsilon_o} = 9 \times 10^9$ N m^2 C^{-2}

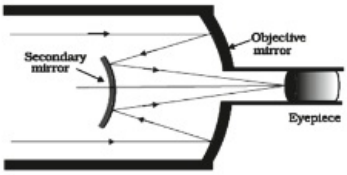
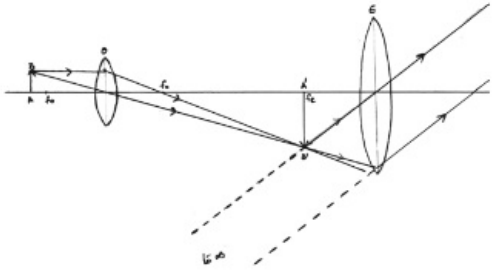
$m_e = 9{\cdot}1 \times 10^{-31}$ kg

न्यूट्रॉन का द्रव्यमान = $1{\cdot}675 \times 10^{-27}$ kg

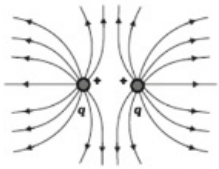
प्रोटॉन का द्रव्यमान = $1{\cdot}673 \times 10^{-27}$ kg

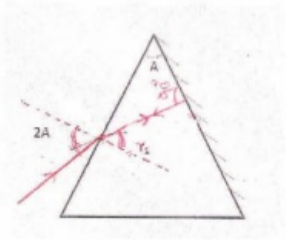
आवोगाद्रो संख्या = $6{\cdot}023 \times 10^{23}$ प्रति ग्राम मोल

बोल्ट्ज़मान नियतांक = $1{\cdot}38 \times 10^{-23}$ JK^{-1}

	a) Better Light gathering power and higher resolving power	1 + 1	
	b) 	1	
	Magnifying power of the telescope is the ratio of the angle subtended at the eye by the final image to the angle subtended by the object at the lens or the eye. [Also accept if the student just writes $m = \frac{f_o}{f_e}$]	1	
	1) Larger objective size 2) No spherical aberration, 3) No chromatic aberration, 4) More light gathering power 5) Mounting and polishing is easier 6) More economical [any two points]	½ + ½	
	OR		5
	(a) Diagram 2 (b) Minimum separation 1½ Relation with resolving power ½ Factors by which resolving power can be increased 1		
	(a) 	2	

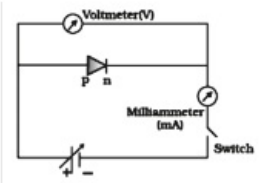
MARKING SCHEME
SET 55/1/MT

Q. No.	Expected Answer / Value Points	Marks	Total Marks
	Section A		
Set1,Q1 Set2,Q5 Set3,Q4	 [Award ½ mark if the student just writes that the field lines radiate outwards from a positive charge]	1	1
Set1,Q2 Set2,Q4 Set3,Q5	Convex lens OR Converging lens	1	1
Set1,Q3 Set2,Q2 Set3,Q1	A current is said to be wattless if the average power consumed over one complete cycle is zero. ***Alternatively,*** In a a.c. circuit containing pure inductor or pure capacitor the phase difference between voltage and current is $\pi/2$. Hence $\cos\phi = 0$ and no power is dissipated even though a current is flowing in the circuit. This current is referred as wattless current. ***Alternatively,*** The component of the current perpendicular to the applied voltage ($I_v \sin\phi$) does not contribute power in an LCR circuit. Hence it is referred as wattless current.	1	1
Set1,Q4 Set2,Q3 Set3,Q2	Repeaters are used to increase/extend the range of a communication system.	1	1
Set1,Q5 Set2,Q1 Set3,Q3	B has higher resistivity. ***Alternatively,*** B	1	1
	Section B		
Set1,Q6 Set2,Q8 Set3,Q9	Formula ½ Ratio of the de-Broglie wavelengths 1 ½ De-Broglie wavelength $\lambda = \frac{h}{\sqrt{2mqV}}$ Ratio of de-Broglie wavelengths of deuterons and $\propto$ - particle $= \frac{\lambda_D}{\lambda_\propto} = \frac{\sqrt{2m_\propto q_\propto V}}{\sqrt{2m_d q_d V}}$ $= \frac{\sqrt{2\times 4m_p \times 2qV}}{\sqrt{2\times 2m_p \times q\times V}}$ $= 2$	½ ½ ½ ½	2

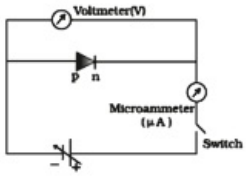
Set1,Q7 Set2,Q9 Set3,Q10	Identifying the transitions ½ + ½ Calculating the ratio of shortest wavelengths 1 Lyman series - C and E Blamer Series – B and D Ratio of the shortest wavelength $\frac{\lambda_L}{\lambda_B} = \frac{3}{10} = 0.3$ ***Alternatively*** Ratio of the shortest wavelength $\frac{\lambda_L}{\lambda_B} = \frac{{n_1}^2}{{n_2}^2} = \frac{1}{4}$ [Note: The student may write that Lyman and Balmer series are defined for the hydrogen atom and the given energy level values do not correspond to hydrogen. Hence one cannot identify the Lyman and Balmer series in the given case. Full credit may be given for this type of answer]	½ ½ 1	2
Set1,Q8 Set2,Q10 Set3,Q7	Determining the value of modulation Index 1 Value of μ when amplitude is zero ½ Reason for $\mu < 1$ ½ $A_c + A_m = 10\ V$ $A_c - A_m = 2\ V$ On solving we get Modulation Index $\mu = \frac{A_m}{A_c} = \frac{4}{6} = \frac{2}{3}$ If the value of minimum amplitude $A_c - A_m = 0,\ A_c = A_m = 5V$ Then $\mu = \frac{A_m}{A_c} = 1$ μ is kept less than one to avoid distortion.	½ ½ ½ ½	2
Set1,Q9 Set2,Q6 Set3,Q8	Diagram 1 Relation between refractive index and angle of the prism 1  A= $r_1 + r_2$ (Here r_2=0)	1	

	$A = r_1$ Refractive index of the material is $\mu = \frac{\sin i}{\sin r} = \frac{\sin 2A}{\sin A}$ $(= 2\cos A)$	½ ½	2
	OR Image for the first lens ½ Formula for the second lens and substituting correct values ½ Calculating the distance between initial and final positions of the image 1		
	For convex lens u = - 40 cm , f = + 30 cm $\therefore \frac{1}{30} = \frac{1}{v} - \frac{1}{-40}$	½	
	$\therefore$v = 120 cm		
	On introducing concave lens of focal length f = −50 cm f = -50 cm , u= +(120-20) cm = +100 cm	½	
	$\therefore \frac{1}{-50} = \frac{1}{v} - \frac{1}{100}$ $\therefore \frac{1}{v} = \frac{1}{100} - \frac{1}{50} = -\frac{1}{100}$	½	
	$\therefore v = -100$ cm Change in the position of the image = 200 cm to the left of its original position.	½	2
Set1,Q10 Set2,Q7 Set3,Q6	Calculation of potential gradient 1 Calculation of unknown resistance R 1 Current through the wire $I = \frac{E}{R+r}$ $= \frac{2}{R+15}$	½	
	$\therefore$ Potential gradient = $\left(\frac{2}{R+15}\right) \times \frac{15}{100}$	½	
	Now E_2= Potential drop across 30 cm $\therefore 75 \times 10^{-3} = \left(\frac{2}{R+15}\right) \times 0.15 \times 30$	½	
	$\therefore R = 105\ \Omega$	½	2

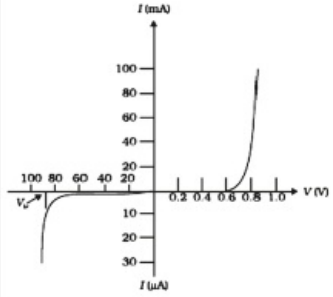
Section C			
Set1,Q11 Set2,Q20 Set3,Q17	Formulae 1 Calculating energy loss 1 ½ Source of energy loss ½ We have, energy stored = $\frac{1}{2}\frac{Q}{C^2}$ and Equivalent Capacitance = $C_1 + C_2$ =(600+300) pF Charge on the capacitor = Q = $600 \times 200 \times 10^{-12}$ $= 12 \times 10^{-8}$ C Initial Energy = $\frac{1}{2}\frac{Q^2}{C} = \frac{1}{2}\frac{Q^2}{600\times10^{-12}}$ Final Energy = $\frac{1}{2}\frac{Q^2}{900\times10^{-12}}$ Loss in energy = $\frac{1}{2}\frac{144\times10^{-16}}{10^{-12}}\left[\frac{1}{600}-\frac{1}{900}\right]$ $= 4\times10^{-6}$ J The source of energy loss is the energy converted into heat due to sharing of charge between the two capacitors. (Also accept: heat produced) [Alternatively: Also accept if the student calculates directly.]	½ ½ ½ ½ ½ ½	3
Set1,Q12 Set2,Q21 Set3,Q18	Production of i) microwaves ½ ii) infrared waves ½ Two uses of each wave (½+½) × 2 i) Microwaves are produced by special vacuum tubes called Klystrons / Magnetrons / Gun diodes / Point contact diodes. (<u>any one</u>) ½ Uses: Radar system, Ovens, Communication <u>(any two)</u> ½ + ½ ii) Infrared waves are produced by vibration of atoms and hot bodies. ½ Uses: Physical therapy, remote switches in household electronic systems, detectors in earth satellites <u>(any two)</u> ½ + ½		3
Set1,Q13 Set2,Q22 Set3,Q19	Drawing circuit diagrams of a p - n junction diode in i) forward bias ½ ii) reverse bias ½ Drawing the characteristic curves ½ + ½ Describing the terms minority carrier injection and break down voltage ½ + ½		



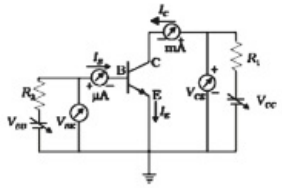
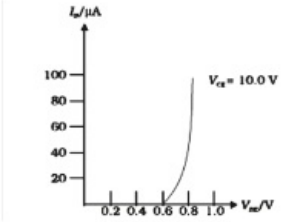
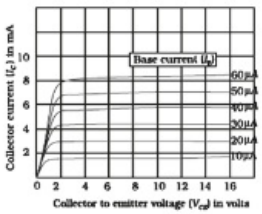
a) Forward bias

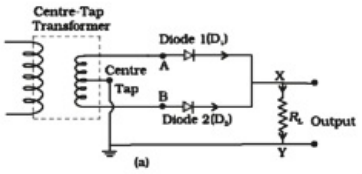
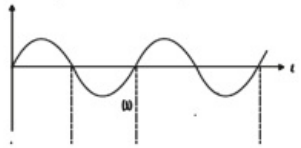
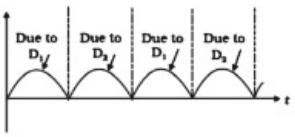


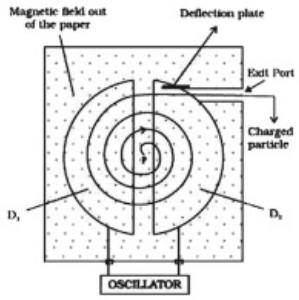
b) Reverse bias

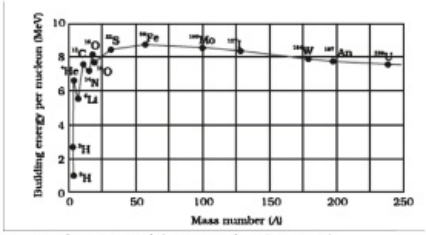
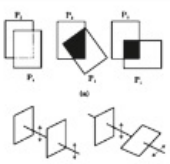


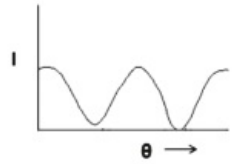
	(i) During forward bias majority carriers (electrons) enter from n to p side which are actually minority carriers in p. This is called minority carrier injection. ***Alternatively*** Majority carriers holes enter from p side and enter into n side	½	
	(ii) At very high reverse bias voltage, the current suddenly increases. This voltage is called breakdown voltage. ***Alternatively*** It is the critical voltage in reverse bias at which current is independent of applied voltage.	½	3
Set1,Q14 Set2,Q11 Set3,Q20	(a) Description of elementary process 1 Equation for V_{max}^2 1 (b) Expression for Planck's constant ½ Expression for work function ½		

	(a) According to Einstein, packets of energy called photons, which are absorbed completely by electrons. This absorbed energy is used to eject the electron and also provide kinetic energy to the emitted electron. (b) i) $\frac{1}{2} m V_{max}^2 = h\nu - \phi_0$ $\therefore V_{max}^2 = \left(\frac{2h}{m}\right)\nu - \left(\frac{2\phi_0}{m}\right)$ Slope $= \frac{2h}{m} = \frac{l}{n}$ $\therefore h = \frac{m\,l}{2\,n}$ Intercept $= \frac{2\,\phi_0}{m} = l$ $\therefore \phi_0 = \frac{ml}{2}$	1 ½ ½ ½ ½	3
Set1,Q15 Set2,Q12 Set3,Q13	Drawing circuit diagram 1 Explanation of input / output characteristics 1 Drawing graphs showing input / output characteristics 1  For input charateristics, Keep V_{CE} as fixed value Study the dependence of I_B on V_{BE} For output charateristics, Keep I_B as constant Study the dependence of I_C on V_{CE} (Any one)   (i) Input characteristics (ii) Output charcteristics (Any one of the above two curves)	1 1 1	3

	OR Drawing circuit diagram 1 Principle ½ Working ½ Input and output waveform ½ Role of capacitor ½  Principle: When the diode is forward biased, it conducts and when it is reverse biased, it does not conduct. Working: Secondary of the transformer has a center tap. The two diodesconduct during alternate half cycles but the current, in the load, flows in the same direction during both the half cycles. Input Waveform  Output Waveform  Role of capacitor is to smoothen the output. (also accept any other answer)	1 ½ ½ ½ ½	3
Set1,Q16 Set2,Q13 Set3,Q14	Diagram 1 Explanation of working principle 1 Obtaining the mathematical expression 1		

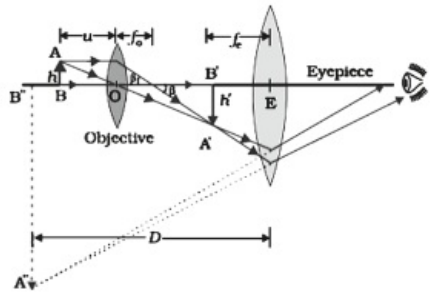
	 A charged particle can be accelerated to very high energy by subjecting it to an oscillating electric field applied between the dees. When the charged particle is subjected to a uniform magnetic field, it moves in a circular path. Both the fields are perpendicular to each other. The time for one revolution of the charged particle is independent of its speed or radius of its orbit. $Bqv = \frac{mv^2}{r}$ $v = \frac{Bqr}{m}$ $\because T = \frac{2\pi r}{v}$ $\therefore T = \frac{2\pi m}{Bq}$	1 1 ½ ½	3
Set1,Q17 Set2,Q16 Set3,Q15	Expression for resultant intensity 1 Finding intensity at the given point on the screen 2 Resultant Intensity $I = 4I_o cos^2\left(\frac{\phi}{2}\right)$ ***Alternatively :*** $I_R = I_o + I_o + 2I_o\, cos\phi$ When the path difference is λ , phase difference is 2π $\therefore\ I_R = I_o + I_o + 2I_o$ $= 4I_o = K$ If path difference is $\frac{\lambda}{4}$, phase difference is $\frac{\pi}{2}$ $\therefore\ I_R = I_o + I_o + 0$ $= 2I_o = \frac{K}{2}$	1 ½ ½ ½ ½	3
Set1,Q18 Set2,Q17 Set3,Q16	Writing three factors 1 ½ Explanation to overcome these factors 1 ½ Three factors that prevent us from sending the signals directly are: (i) Size of antenna (ii) Power radiated by the antenna	½ ½	

	(iii) Intermixing of signals To overcome these factors (i) Size of antenna should be comparable to wavelength (around $\lambda/4$). (ii) Power depends inversely on λ^2 - Power radiated increases with decrease of wavelength. (iii) Message signal should be used to modulate a high frequency carrier wave so that a band of frequencies can be alloted to each message signal.	½ ½ ½ ½	3
Set1,Q19 Set2,Q18 Set3,Q21	(a) Binding Energy/nucleon graph 1 ½ Property ½ (b) Finding Atomic number and Mass number of A 1 (a)  Nuclear forces are short ranged / saturated (any one) (b) ${}_{70}A^{180} \xrightarrow{\propto} {}_{68}A_1^{176} \xrightarrow{\beta^-} {}_{69}A_2^{176} \xrightarrow{\gamma} {}_{69}A_3^{176}$ Mass number of A is 180 Atomic number of A is 70 ***Alternatively*** ${}_{72}A^{180} \xrightarrow{\propto} {}_{70}A_1^{176} \xrightarrow{\beta^+} {}_{69}A_2^{176} \xrightarrow{\gamma} {}_{69}A_3^{176}$ Mass number of A is 180 Atomic number of A is 72	1½ ½ ½ ½	3
Set1,Q20 Set2,Q19 Set3,Q22	Diagram ½ Explanation 1 Graph ½ Understanding graph using Malus' law 1  	½	

	When light from an ordinary source passes through a polaroid sheet P_1, its intensity is reduced by half. When the second polaroid (identical to the first one) is rotated with respect to the first one, the intensity of the light transmitted by the second polaroid varies from zero to maximum.  According to Mauls's law when the angle between the two polaroids is θ , the intensity of the transmitted light by the second polaroid is given by the relation $I = I_o cos^2\theta$ As θ keep on changes, intensity of the transmitted light by the second polaroid changes.	½ 1 1	3
Set1,Q21 Set2,Q14 Set3,Q11	(a) Calculation of current 1 (b) Voltage across resistor and capacitor ½ + ½ Paradox and its resolution ½ + ½ (a) Current in the circuit $I = \frac{V}{\sqrt{R^2 + \left(\frac{1}{C\omega}\right)^2}}$ $I = \frac{220}{\sqrt{100^2 + \left(\frac{1}{\frac{100}{\pi} \times 10^{-6} \times 2\pi \times 50}\right)^2}}$ $= \frac{2.2}{\sqrt{2}}$ A = 1.55 A (b) Voltage across the resistor = 100×1.55 V $= 155$ volt Voltage across the capacitor = 100×1.55 V $= 155$ volt Yes The sum of the two voltages is greater than 220 V but the voltage across the resistor and the capacitor are not in phase.	½ ½ ½ ½ ½	3
Set1,Q22 Set2,Q15 Set3,Q12	Explanation of drift of electrons 1 Definition ½ Showing $\vec{j} = \sigma \vec{E}$ 1 ½		

	When metal conductor is subjected to a certain potential the electron get accelerated due to electric field. Each electron experiences acceleration for an average time, τ, called the relaxation time. It then undergoes a collision and its velocity again becomes random. The average(drift) velocity of all the electrons contributes to the flow of current. The average velocity of electrons, acquired through their acceleration for a time τ is called drift velocity. $v_d = \frac{eE}{m}\tau$ Current density $j = \frac{I}{A}$ $= \frac{neAv_d}{A}$ $= ne\left\{\frac{eE}{m}\tau\right\}$ $= \left(\frac{ne^2\tau}{m}\right)E$ $\therefore \vec{j} = \sigma \vec{E}$	1 ½ ½ ½ ½	3
	Section D		
Set1,Q23 Set2,Q23 Set3,Q23	The qualities displayed by Deepika, Ruchika and the teacher 2 Principle of galvanometer 1 Shape of the magnets and why is it so designed 1 a) The values displayed by Deepika and Ruchika are their inquisitiveness for practical knowledge. The teacher displayed concern for the students. b) Principle: When a current passes through a coil, placed in a uniform magnetic field, it experiences a torque. c) The pole pieces of the magnet are given a concave shape. This is done to produce a radial magnetic field.	1 1 1 ½ ½	4
	Section E		
Set1,Q24 Set2,Q25 Set3,Q26	Flux through the flat faces 1 ½ Flux through the curved surface 1 Net flux 1 The charge inside the cylinder 1 ½ (i) Flux = $\int \vec{E}.\overrightarrow{ds}$ Flux through the flat surface on the: i. right side = $E_o.\pi r^2$ (outwards) ii. left side = $E_o.\pi r^2$ (outwards)	½ ½ ½	

	(ii) Flux through the curved surface = 0 [As electric field and area vector are perpendicular to each other]	½ ½	
	Net outward flux $= \pi r^2 E_o + \pi r^2 E_o + 0 = 2\pi r^2 E_o$	1	
	Charge inside the cylinder = Net flux × ε_o $= (2 \pi r^2 E_o) \times \varepsilon_o$ $= 2 \pi \varepsilon_o r^2 E_o$	½ ½ ½	5
	OR Electric field outside the plates ½ + ½ Electric field between the plates ½ Capacitance Expression 1 ½ Effect on electric field on introducing the dielectric 1 Effect on Capacitance with dielectric 1		
	(a) Calculation of electric field (i) Electric field outside the plates: $\frac{\sigma}{2\varepsilon_0} + \frac{(-\sigma)}{2\varepsilon_0} = 0$ on both the sides of the capacitor.	½ + ½	
	(ii) Electric fields between the two plates due to the left plate = $\frac{\sigma}{2\varepsilon_0}$ towards right due to the right plate = $\frac{\sigma}{2\varepsilon_0}$ towards right ∴ Net Electric field = $\frac{\sigma}{\varepsilon_0}$ (towards right)	½	
	Capacitance , C = $\frac{Q}{V}$	½	
	$= \frac{Q}{Ed} = \frac{\sigma A}{(\frac{\sigma d}{\varepsilon_0})}$	½	
	$= \varepsilon_0 A/d$	½	
	(b) (i) When a dielectric slab is introduced, the Electric field decreases to $\frac{E}{K} = \frac{\sigma}{K\varepsilon_0}$ where K is the dielectric constant. This is because of the (oppositely directed) field due to the polarized dielectric.	1	
	(ii) Capacitance with dielectric increases by a factor K because the electric field (and hence p.d.) decreases by a factor K.	1	5
Set1,Q25 Set2,Q26 Set3,Q24	(a) Main considerations 1 + 1 (b) Ray diagram 1 Magnifying Power 1 (c) Advantages (any two) ½ + ½		

	[Also accept if the student draws the following diagram]  		
	(b) S = Size of image of a point object in the image plane = $\nu\left(\frac{1.22\,\lambda}{d}\right)$ Minimum separation between two distinctly seen points in the object plane = $\frac{S}{Magnifying\ Power}$	½	
	$= \frac{S}{\left(\frac{\nu}{f}\right)} = \frac{1.22\,f\,\lambda}{D}$ [Also give this mark if the student writes (i)Minimum separation = $\frac{1.22\,f\,\lambda}{D}$ Or (ii)Minimum separation equals the separation at which their images are just resolved Or (iii) Minimum separation corresponds to'limit of resolution'.]	1	
	Resolving power $= \frac{1}{d} = \frac{2\mu\sin\theta}{1.22\,\lambda}$ [Also accept: Resolving power $\propto \frac{1}{(\text{minimum seperation})}$] Resolving power can be increased by (i) increasing the aperture of the objective (ii) using a medium with higher refractive index (iii) by decreasing the wavelength of the light used for illuminating the object [Any two]	½ 1	5
Set1,Q26 Set2,Q24 Set3,Q25	(a) Meaning of mutual inductance 1 (b) Expression for the mutual inductance of the arrangement 2 (c) Expression for the emf induced 2 (a) Consider two long co-axial solenoids. When a varying current flows through one coil, an induced emf is set up in the second coil due to the variation in the magnetic field associated with the second coil. This phenomena is known as mutual induction	1	

(b) Flux (φ_1) associated with S_1 when I_2 current flows through S_2 ½

$N_1\phi_1 = M_{12}I_2$ -----(1)

The magnetic field due to the current I_2 in S_2 is $\mu_o n_2 I_2$ ½

$\therefore\ N_1\phi_1 = (n_1 l)(\pi {r_1}^2)(\mu_o n_2 I_2)$

$= \mu_o n_1 n_2 \pi {r_1}^2\, l I_2$ ----(2) 1

From (1) and (2), we get

$$M_{12} = \mu_o n_1 n_2 \pi {r_1}^2\, l$$

(c) Induced emf in coil C_1 due to the change in current through C_2 ½

We have $N_1\phi_1 = MI_2$

For varying currents, ½

$$N_1\left(\frac{d\phi_1}{dt}\right) = M\left(\frac{dI_2}{dt}\right)$$ ½

$\therefore$ $$-\varepsilon_1 = M\left(\frac{dI_2}{dt}\right)$$ ½

or $$\varepsilon_1 = -M\left(\frac{dI_2}{dt}\right)$$

5

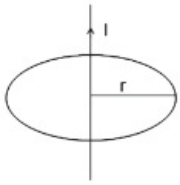
OR

(a) Statement of Ampere's circuital law	1
Derivation of magnetic field B	2
(b) Magnetic field inside the thick wire	1
outside the wire	½
Graph	½

(a) Ampere's Circuital law states that the line integral of the magnetic field, over a closed loop is equal to μ_o times the total current passing through the surface enclosed by the loop. 1

Alternatively, $\oint \vec{B}.\,\vec{dl} = \mu_o I$

Let an infinite straight wire carry a current I. We consider a circle of radius r, centered on the wire, and having its plane perpendicular to the wire.



½

By right hand rule, the magnetic field is tangential at every point of this circular loop.

General Instructions :

(i) ***All*** *questions are compulsory. There are* ***26*** *questions in all.*

(ii) *This question paper has* ***five*** *sections : Section A, Section B, Section C, Section D and Section E.*

(iii) *Section A contains* ***five*** *questions of* ***one*** *mark each, Section B contains* ***five*** *questions of* ***two*** *marks each, Section C contains* ***twelve*** *questions of* ***three*** *marks each, Section D contains one value based question of* ***four*** *marks and Section E contains* ***three*** *questions of* ***five*** *marks each.*

(iv) *There is no overall choice. However, an internal choice has been provided in one question of two marks, one question of three marks and all the three questions of five marks weightage. You have to attempt only one of the choices in such questions.*

(v) *You may use the following values of physical constants wherever necessary :*

$c = 3 \times 10^{8}$ m/s

$h = 6{\cdot}63 \times 10^{-34}$ Js

$e = 1{\cdot}6 \times 10^{-19}$ C

$\mu_o = 4\pi \times 10^{-7}$ T m A^{-1}

$\varepsilon_o = 8{\cdot}854 \times 10^{-12}$ C^2 N^{-1} m^{-2}

$\frac{1}{4\pi\varepsilon_o} = 9 \times 10^{9}$ N m^2 C^{-2}

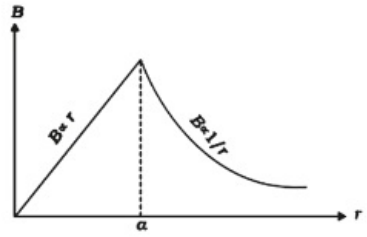
$m_e = 9{\cdot}1 \times 10^{-31}$ kg

Mass of neutron = $1{\cdot}675 \times 10^{-27}$ kg

Mass of proton = $1{\cdot}673 \times 10^{-27}$ kg

Avogadro's number = $6{\cdot}023 \times 10^{23}$ per gram mole

Boltzmann constant = $1{\cdot}38 \times 10^{-23}$ JK^{-1}

	∴ By Ampere's circuital law, $\oint \vec{B}.\vec{dl} = B.2\pi r = \mu_0 I$ $\therefore B = \frac{\mu_0 I}{2\pi r}$ (b) For r < a, we have $B.2\pi r = \mu_o I_{enclosed}$ $= \mu_o \left(\frac{\pi r^2}{\pi a^2}\right) I$ $= \frac{\mu_o r^2}{a^2} I$ $\therefore B = \frac{\mu_o}{2\pi} \frac{I}{a^2} r$ For r > a $B.2\pi r = \mu_0 I$ $or\ B = \frac{\mu_0 I}{2\pi r}$  	1 ½ ½ ½ ½ ½	5

NOTES

Document Outline