

3e

Physics Galaxy

Volume I

Mechanics

Ashish Arora

Mentor & Founder

PHYSICSGALAXY.COM

World's largest encyclopedia of online video courses on High School Students preparing for

JEE Main * JEE Advanced * NEET * KVPY * NSEP/INPhO/IPhO



G K Publications (P) Ltd

First Edition : December, 2000

Second Edition : May, 2016

Revised Edition : March, 2023

Title : Physics Galaxy : Vol.1 - Mechanics 3rd edition

Language : English

Author's Name : Ashish Arora

Copyright © : 2023 Ashish Arora

No part of this book may be reproduced in a retrieval system or transmitted, in any form or by any means, electronics, mechanical, photocopying, recording, scanning and or without the written permission of the Author/Publisher.

Typeset & Published by :

Career Launcher Infrastructure (P) Ltd.

A-45, Mohan Cooperative Industrial Area, Near Mohan Estate Metro Station, New Delhi - 110044

Marketed by :

G.K. Publications (P) Ltd.

Plot No. 9A, Sector-27A, Mathura Road, Faridabad, Haryana-121003

ISBN : 978-93-94168-51-0

Printer's Details: Printed in India, New Delhi.

For product information :

Visit www.gkpublications.com or email to gkp@gkpublications.com

Dedicated

to

My Parents, Son, Daughter

and

My beloved wife

In his teaching career since 1992 Ashish Arora personally mentored more than 10000 IITians and students who reached global heights in various career and profession chosen. It is his helping attitude toward students with which all his students remember him in life for his contribution in their success and keep connections with him live. Below is the list of some of the successful students in International Olympiad personally taught by him.

NAVNEET LOIWAL	<i>International GOLD Medal in IPhO-2000 at LONDON</i> , Also secured AIR-4 in IIT JEE 2000 PROUD FOR INDIA : Navneet Loiwal was the first Indian Student who won first International GOLD Medal for our country in International Physics Olympiad.
DUNGRA RAM CHOUDHARY	AIR-1 in IIT JEE 2002
HARSHIT CHOPRA	<i>National Gold Medal in INPhO-2002</i> and got AIR-2 in IIT JEE-2002
KUNTAL LOYA	A Girl Student got position AIR-8 in IIT JEE 2002
LUV KUMAR	<i>National Gold Medal in INPhO-2003</i> and got AIR-3 in IIT JEE-2003
RAJHANS SAMDANI	<i>National Gold Medal in INPhO-2003</i> and got AIR-5 in IIT JEE-2003
SHANTANU BHARDWAJ	<i>International SILVER Medal in IPhO-2002 at INDONESIA</i>
SHALEEN HARLALKA	<i>International GOLD Medal in IPhO-2003 at CHINA</i> and got AIR-46 in IIT JEE-2003
TARUN GUPTA	<i>National GOLD Medal in INPhO-2005</i>
APEKSHA KHANDELWAL	<i>National GOLD Medal in INPhO-2005</i>
ABHINAV SINHA	<i>Hon'ble Mension Award in APhO-2006 at KAZAKHSTAN</i>
RAMAN SHARMA	<i>International GOLD Medal in IPhO-2007 at IRAN</i> and got AIR-20 in IIT JEE-2007
PRATYUSH PANDEY	<i>International SILVER Medal in IPhO-2007 at IRAN</i> and got AIR-85 in IIT JEE-2007
GARVIT JUNI WAL	<i>International GOLD Medal in IPhO-2008 at VIETNAM</i> and got AIR-10 in IIT JEE-2008
ANKIT PARASHAR	<i>National GOLD Medal in INPhO-2008</i>
HEMANT NOVAL	<i>National GOLD Medal in INPhO-2008</i> and got AIR-25 in IIT JEE-2008
ABHISHEK MITRUKA	<i>National GOLD Medal in INPhO-2009</i>
SARTHAK KALANI	<i>National GOLD Medal in INPhO-2009</i>
ASTHA AGARWAL	<i>International SILVER Medal in IJSO-2009 at AZERBAIJAN</i>
RAHUL GURNANI	<i>International SILVER Medal in IJSO-2009 at AZERBAIJAN</i>
AYUSH SINGHAL	<i>International SILVER Medal in IJSO-2009 at AZERBAIJAN</i>
MEHUL KUMAR	<i>International SILVER Medal in IPhO-2010 at CROATIA</i> and got AIR-19 in IIT JEE-2010
ABHIROOP BHATNAGAR	<i>National GOLD Medal in INPhO-2010</i>
AYUSH SHARMA	<i>International Double GOLD Medal in IJSO-2010 at NIGERIA</i>
AASTHA AGRAWAL	<i>Hon'ble Mension Award in APhO-2011 at ISRAEL</i> and got AIR-93 in IIT JEE 2011
ABHISHEK BANSAL	<i>National GOLD Medal in INPhO-2011</i>
SAMYAK DAGA	<i>National GOLD Medal in INPhO-2011</i>
SHREY GOYAL	<i>National GOLD Medal in INPhO-2012</i> and secured AIR-24 in IIT JEE 2012
RAHUL GURNANI	<i>National GOLD Medal in INPhO-2012</i>
JASPREET SINGH JHEETA	<i>National GOLD Medal in INPhO-2012</i>
DIVYANSHU MUND	<i>National GOLD Medal in INPhO-2012</i>
SHESHANSH AGARWAL	<i>International SILVER Medal in IAO-2012 at KOREA</i>
SWATI GUPTA	<i>International SILVER Medal in IJSO-2012 at IRAN</i>
PRATYUSH RAJPUT	<i>International SILVER Medal in IJSO-2012 at IRAN</i>
SHESHANSH AGARWAL	<i>International BRONZE Medal in IOAA-2013 at GREECE</i>
SHESHANSH AGARWAL	<i>International GOLD Medal in IOAA-2014 at ROMANIA</i>
SHESHANSH AGARWAL	<i>International SILVER Medal in IPhO-2015 at INDIA</i> and secured AIR-58 in JEE(Advanced)-2015
VIDUSHI VARSHNEY	<i>International SILVER Medal in IJSO-2015 at SOUTH KOREA</i>
AMAN BANSAL	AIR-1 in JEE Advanced 2016
KUNAL GOYAL	AIR-3 in JEE Advanced 2016
GOURAV DIDWANIA	AIR-9 in JEE Advanced 2016
DIVYANSH GARG	<i>International SILVER Medal in IPhO-2016 at SWITZERLAND</i>
NALIN KHANDELWAL	AIR-1 in NEET 2019
MRIDUL AGARWAL	AIR-1 in JEE Advanced 2021

ABOUT THE AUTHOR



The complexities of Physics have given nightmares to many, but the homegrown genius of Jaipur- Ashish Arora has helped millions of students to live their dreams by decoding it.

Newton Law of Gravitation and Faraday's Magnetic induction force apply perfectly well with this unassuming genius. A Pied Piper of students, his webportal <https://www.physicsgalaxy.com>, The world's largest encyclopedia of video lectures on high school Physics possesses strong gravitational pull and magnetic attraction for students who want to make it big in life.

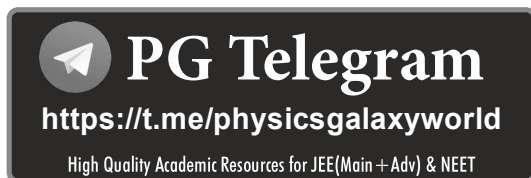
Ashish Arora, gifted with rare ability to train masterminds, has mentored over 10,000 IITians and Medicos in his past over three decades of teaching sojourn including lots of students made it to Top 100 in IIT-JEE/JEE(Advance) including multiple times AIR-1 and many in Top-10. Apart from that, he has also groomed hundreds of students for cracking International Physics Olympiad. No wonder his student Navneet Loibal brought laurel to the country by becoming the first Indian to win a Gold medal at the 2000 - International Physics Olympiad in London (UK).

His special ability to simplify the toughest of the Physics theorems and applications rates him as one among the best Physics teachers in the world. With this, Arora simply defies the logic that perfection comes with age. Even at 18 when he started teaching Physics while pursuing engineering, he was as engaging as he is now. Experience, besides graying his hair, has just widened his horizon.

Now after encountering all tribes of students - some brilliant and some not-so-intelligent - this celebrated teacher has embarked upon a noble mission to make the entire galaxy of Physics inform of his webportal PHYSICSGALAXY.COM to serve and help global students in the subject. Today students from 183 countries are connected with this webportal. On any topic of physics students can post their queries in INTERACT tab of the webportal on which many global experts with Ashish Arora reply to several queries posted online by students.

Dedicated to global students of middle and high school level, his website www.physicsgalaxy.com also has teaching sessions dubbed in American accent and subtitles in 87 languages. For students in India preparing for JEE & NEET, his online courses will be available soon on PHYSICSGALAXY.COM.

Subscribe to



Courses on Mobile App

- Complete JEE & NEET Concept Videos on Physics
- Complete Pre-Foundation Physics for Class 6-7-8
- Complete Foundation Physics for Class 9-10
- Complete NCERT Class 11 & 12 Physics Solutions
- Complete JEE Main 2002-2020 Video Solutions (Online & Offline)
- 700+ Advance Illustration Videos for JEE Advanced
- Tips & Tricks Guidance Videos for Competitive Exams
- Revision Checklist Videos for JEE Main & NEET
- Exam Memory Maps Videos for JEE Main & NEET

and much more...

FOREWORD

It has been a pleasure for me to follow the progress Er. Ashish Arora has made in teaching and professional career. In the last about three decades he has actively contributed in developing several new techniques for teaching & learning of Physics and driven important contribution to Science domain through nurturing young students and budding scientists. Physics Galaxy is one such example of numerous efforts he has undertaken.

The third edition of Physics Galaxy provides a good coverage of various topics of Mechanics, Thermodynamics and Waves, Optics & Modern Physics and Electricity & Magnetism through dedicated volumes and many new questions included. It would be an important resource for students appearing in competitive examination for seeking admission in engineering and medical streams.

The structure of book is logical and the presentation is innovative. Importantly the book covers some of the concepts on the basis of realistic experiments and examples. The book has been written in an informal style to help students learn faster and more interactively with better diagrams and visual appeal of the content. Each chapter has variety of theoretical and numerical problems to test the knowledge acquired by students. The book also includes solution to all practice exercises with several new illustrations and problems for deeper learning.

I am sure the book will widen the horizons of knowledge in Physics and will be found very useful by the students for developing in-depth understanding of the subject.

Date : March 06, 2023

Prof. Sandeep Sancheti

Ph. D. (U.K.), B.Tech. FIETE, FIE (I), SMIEEE

Vice-Chancellor (Provost) Marwadi University, Rajkot
Member Executive Council, Association of Commonwealth Universities, London
Former President, AIU, New Delhi
Former Vice-Chancellor, SRMIST, Chennai
Former President, Manipal University, Jaipur
Former-Director NIT Surathkal, NIT New Delhi, NIT Trichy,
NIT Calicut, SPA Delhi; Former-Mentor Director NIT Goa,
NIT Sikkim, NIT Puducherry
Former-Member JEE Apex Board (JAB), MHRD, GoI
Former-Chairman, Central Counselling Board (CCB), AIEEE, MHRD, GoI
Former-Chairman, Direct Admission of Students Abroad (DASA), MHRD, GoI

PREFACE

For a science student, Physics is the most important subject, unlike to other subjects it requires logical reasoning and high imagination of brain. Without improving the level of physics it is very difficult to achieve a goal in the present age of competitions. To score better, one does not require hard working at least in physics. It just requires a simple understanding and approach to think a physical situation. Actually physics is the surrounding of our everyday life. All the six parts of general physics-Mechanics, Heat, Sound, Light, Electromagnetism and Modern Physics are the constituents of our surroundings. If you wish to make the concepts of physics strong, you should try to understand core concepts of physics in practical approach rather than theoretical. Whenever you try to solve a physics problem, first create a hypothetical approach rather than theoretical. Whenever you try to solve a physics problem, first create a hypothetical world in your imagination about the problem and try to think psychologically, what the next step should be, the best answer would be given by your brain psychology. For making physics strong in all respects and you should try to merge and understand all the concepts with the brain psychologically.

The book PHYSICS GALAXY is designed in a totally different and friendly approach to develop the physics concepts psychologically. The book is presented in four volumes, which covers almost all the core branches of general physics. First volume covers Mechanics. It is the most important part of physics. The things you will learn in this book will form a major foundation for understanding of other sections of physics as mechanics is used in all other branches of physics as a core fundamental. In this book every part of mechanics is explained in a simple and interactive experimental way. The book is divided in seven major chapters, covering the complete kinematics and dynamics of bodies with both translational and rotational motion then gravitation and complete fluid statics and dynamics is covered with several applications.

The best way of understanding physics is the experiments and this methodology I am using in my lectures and I found that it helps students a lot in concept visualization. In this book I have tried to translate the things as I used in lectures. After every important section there are several solved examples included with simple and interactive explanations. It might help a student in a way that the student does not require to consult any thing with the teacher. Everything is self explanatory and in simple language.

One important factor in preparation of physics I wish to highlight that most of the student after reading the theory of a concept start working out the numerical problems. This is not the efficient way of developing concepts in brain. To get the maximum benefit of the book students should read carefully the whole chapter at least three or four times with all the illustrative examples and with more stress on some illustrative examples included in the chapter. Practice exercises included after every theory section in each chapter is for the purpose of in-depth understanding of the applications of concepts covered. Illustrative examples are explaining some theoretical concept in the form of an example. After a thorough reading of the chapter students can start thinking on discussion questions and start working on numerical problems.

Exercises given at the end of each chapter are for circulation of all the concepts in mind. There are two sections, first is the discussion questions, which are theoretical and help in understanding the concepts at root level. Second section is of conceptual MCQs which helps in enhancing the theoretical thinking of students and building logical skills in the chapter. Third section of numerical MCQs helps in the developing scientific and analytical application of concepts. Fourth section of advance MCQs with one or more options correct type questions is for developing advance and comprehensive thoughts. Last section is the Unsolved Numerical Problems which includes some simple problems and some tough problems which require the building fundamentals of physics from basics to advance level problems which are useful in preparation of NSEP, INPhO or IPhO.

In this third edition of the book I have included many new questions and solutions in different exercises at practice, conceptual, numerical and advance MCQs to support students who are dependent on their self study and not getting access to teachers for their preparation.

This book has taken a shape just because of motivational inspiration by my mother in 1997 when I just thought to write something for my students. She always motivated and was on my side whenever I thought to develop some new learning methodology for my students.

I don't have words for my best friend my wife Anuja for always being together with me to complete this book in the unique style and format.

I would like to pay my gratitude to Sh. Dayashankar Prajapati in assisting me to complete the task in Design Labs of PHYSICSGALAXY.COM and presenting the book in totally new format of third edition.

At last but the most important person, my father who has devoted his valuable time in finally presenting the book in such a format and a simple language, thanks is a very small word for his dedication in building the base structure of this book.

In this third edition I have tried my best to make this book error free but owing to the nature of work, inadvertently, there is possibility of errors left untouched. I shall be grateful to the readers, if they point out me regarding errors and oblige me by giving their valuable and constructive suggestions via emails for further improvement of the book.

Date : March 06, 2023

Ashish Arora

PHYSICSGALAXY.COM

B-80, Model Town, Malviya Nagar, Jaipur-302017

e-mails: ashisharora@physicsgalaxy.com

ashash12345@gmail.com

CONTENTS

Chapter 1

Kinematics

1-78

1.1 Speed	2
1.2 Average Velocity	2
1.3 Instantaneous Velocity	2
1.4 Variation in Instantaneous Velocity	5
1.5 Acceleration	6
1.6 Speed Equations	7
1.7 Uniformly Accelerated Motion	8
1.8 Free Fall	11
1.9 Graphical Interpretation of Motion	15
1.9.1 Displacement Versus Time Graphs	15
1.9.2 Velocity Versus Time Graphs	16
1.10 Motion with Time and Displacement Dependence	19
1.11 Relative Motion	22
1.11.1 River Flow Cases	23
1.11.2 Rainfall Cases	24
1.12 Motion in Two Dimensions	28
1.12.1 Acceleration in Two Dimensional Motion	29
1.12.2 Trajectory of a Particle in Two Dimension	29
1.13 Projectile Motion	32
1.13.1 Projectile Motion on Inclined Plane	37
1.13.2 Use of Co-ordinate Geometry For Projectile Problems	39
1.14 Simple Constraint Motion of Bodies and Particles in Two Dimensions	40
1.14.1 Pulley and Wedge Constraints	43
1.14.2 Step Pulley Constraints	45
1.14.3 Wedge Constraints	49
DISCUSSION QUESTION	52
CONCEPTUAL MCQS SINGLE OPTION CORRECT	54
NUMERICAL MCQS SINGLE OPTIONS CORRECT	58
ADVANCE MCQS WITH ONE OR MORE OPTIONS CORRECT	69
UNSOLVED NUMERICAL PROBLEMS FOR PREPARATION OF NSEP, INPHO & IPHO	71

Chapter 2

Forces and Newton's Laws of Motion

79-148

2.1 Force and Superposition	80
2.2 Newton's First Law	81
2.3 Newton's Second Law	81
2.4 Newton's Third Law	82
2.5 Using Newton's Laws	83
2.5.1 External and Internal Forces	83
2.5.2 Normal Contact Force	83
2.5.3 Tension in a String	84
2.5.4 Application of Forces in Newton's Second Law	85
2.6 Static Equilibrium	90
2.6.1 Torque	92
2.7 Pseudo Force	96
2.7.1 Inertial and Non-inertial Reference Frames	96
2.7.2 Requirement of Pseudo Force	97
2.7.3 Concept of a Weighing Machine	99
2.7.4 Concept of a Spring Balance	99

2.8 Friction	103
2.8.1 Pulling on a Rough Surface is Always Easier Than Pushing	104
2.8.2 Friction Between Pulley and String	108
2.8.3 Conditions for Sliding	110
2.9 Spring Force	114
2.9.1 Force Constant of a Spring	114
2.10 Breaking of Supports	118
DISCUSSION QUESTION	121
CONCEPTUAL MCQS SINGLE OPTION CORRECT	123
NUMERICAL MCQS SINGLE OPTIONS CORRECT	126
ADVANCE MCQS WITH ONE OR MORE OPTIONS CORRECT	136
UNSOLVED NUMERICAL PROBLEMS FOR PREPARATION OF NSEP, INPHO & IPHO	139

Chapter 3

Work, Energy and Power

149-218

3.1 Work	150
3.1.1 Positive and Negative Work	151
3.2 Work Done by a Variable Force	151
3.2.1 Graphical Analysis of Work Done by a Force	152
3.3 The Work-Energy Theorem	154
3.4 Power	157
3.5 Circular Motion	160
3.5.1 Angular Coordinate, Velocity and Acceleration	160
3.5.2 Kinematics of Circular Motion	162
3.6 Tangential and Normal Acceleration	162
3.6.1 Centripetal Acceleration	163
3.6.2 Normal Acceleration in a General Two Dimension Motion	163
3.6.3 Force Required For Circular Motion	164
3.6.4 Concept of Centrifugal Force	165
3.7 Vertical Circular Motion of a Pendulum Bob	168
3.7.1 Projection Cases	169
3.7.2 Motion of a Body Outside a Spherical Surface	170
3.8 Horizontal Circular Motion	174
3.8.1 Banking of Tracks	174
3.9 Potential Energy & Conservative Force Fields	179
3.9.1 Relation in Force and Potential Energy	179
3.9.2 Conservative Force in a three dimensional force field	180
3.9.3 Work done in conservative and non-conservative force fields	180
3.9.4 State of Equilibrium and Potential Energy	181
3.9.5 Unstable Equilibrium	181
3.9.6 Stable Equilibrium	181
3.9.7 Neutral Equilibrium	182
DISCUSSION QUESTION	190
CONCEPTUAL MCQS SINGLE OPTION CORRECT	192
NUMERICAL MCQS SINGLE OPTIONS CORRECT	197
ADVANCE MCQS WITH ONE OR MORE OPTIONS CORRECT	208
UNSOLVED NUMERICAL PROBLEMS FOR PREPARATION OF NSEP, INPHO & IPHO	211

Chapter 4

Linear Momentum and its Conservation

219-286

4.1 Centre of Mass and Centre of Gravity	220
4.2 Localization of Centre of Mass	221

4.3 Centre of Mass of a Two Body System	222
4.4 Centre of Mass of a Multiple Object System	222
4.4.1 Displacement of Center of Mass of a System of Particles	223
4.5 Continuous Object System	226
4.5.1 Centre of Mass of a Semicircular Ring	227
4.5.2 Centre of Mass of a Semicircular Disc	227
4.5.3 Centre of Mass of a Solid Hemisphere	228
4.5.4 Centre of Mass of a Hollow Hemisphere	228
4.5.5 Centre of Mass of a Solid Cone	229
4.5.6 Centre of Mass of a Hollow Cone	229
4.6 Centre of Mass and Conservation of Momentum	234
4.7 Impulse and Momentum Conservation	240
4.8 Cases of Mass Variation	242
4.9 Collisions	245
4.9.1 Elastic Collision	246
4.9.2 Partial Elastic and Inelastic Head-on Collision	247
4.9.3 Two Dimensional Collisions	248
4.9.4 Impact Parameter	250
4.9.5 Super Elastic Collision	250
DISCUSSION QUESTION	256
CONCEPTUAL MCQS SINGLE OPTION CORRECT	258
NUMERICAL MCQS SINGLE OPTIONS CORRECT	262
ADVANCE MCQS WITH ONE OR MORE OPTIONS CORRECT	271
UNSOLVED NUMERICAL PROBLEMS FOR PREPARATION OF NSEP, INPHO & IPHO	274

Chapter 5

Rigid Bodies and Rotational Motion

287-354

5.1 Rotational Kinematics	288
5.2 Moment of Inertia	288
5.2.1 Moment of Inertia of a Rigid Body in Rotational Motion	289
5.2.2 Moment of Inertia of Different Objects	289
5.2.3 Moment of Inertia About a General Axis of Rotation	293
5.2.4 Application of Axes Theorems	294
5.2.5 Mass Distribution and Moment of Inertia	295
5.2.6 Radius of Gyration	298
5.3 Torque and Newton's Second Law	299
5.4 The Kinetic Energy of Rotation	302
5.5 Angular Momentum and its Conservation	305
5.5.1 Angular Momentum of Point Objects	305
5.5.2 Angular Momentum of a Rigid Body in Rotation	305
5.5.3 Conservation of Angular Momentum	307
5.6 Rigid Body Rotation About a Moving Axis	312
5.6.1 Energy of a Body in Simultaneous Translation and Rotational Motion	312
5.7 Rolling Friction	314
5.8 Rolling with Slipping	320
5.9 Rotational Collision and Angular Momentum	324
5.10 Work and Power in Rotational Motion	327
DISCUSSION QUESTION	329
CONCEPTUAL MCQS SINGLE OPTION CORRECT	331
NUMERICAL MCQS SINGLE OPTIONS CORRECT	335
ADVANCE MCQS WITH ONE OR MORE OPTIONS CORRECT	345
UNSOLVED NUMERICAL PROBLEMS FOR PREPARATION OF NSEP, INPHO & IPHO	347

6.1 Newton's Law of Universal Gravitation	356
6.2 Gravitational and Inertial Mass	359
6.3 Gravitational Field	360
6.3.1 Strength of Gravitational Field	360
6.3.2 Gravitational Field Strength of a Point Mass	360
6.3.3 Gravitational Field Strength due to a Ring	360
6.3.4 Gravitational Field Strength due to a Rod	362
6.3.5 Gravitational Field due to a Circular Arc	363
6.3.6 Gravitational Field Strength due to a Sphere	363
6.3.7 Gravitational Field Strength due to a Long Thread	364
6.3.8 Gravitational Field Strength Due to a Long Solid Cylinder	365
6.4 Gravitational Lines of Forces	369
6.5 Gravitational Field Strength of Earth	370
6.5.1 Value of g on Earth's Surface	370
6.5.2 Value of g at a Height h Above the Earth's Surface	371
6.5.3 Value of g at a Depth h Below the Earth's Surface	371
6.5.4 Effect of Earth's Rotation on Value of g	371
6.5.5 Effect of Shape of Earth on Value of g	372
6.6 Gravitational Potential Energy	374
6.6.1 Interaction Energy	374
6.6.2 Interaction Energy of a System of Particles	375
6.6.3 Self Energy	376
6.7 Gravitational Potential	378
6.7.1 Gravitational Potential due to a Point Mass	378
6.7.2 Gravitational Potential due to a Ring	378
6.7.3 Work done in Displacement of a Body in Gravitational Field	379
6.7.4 Relation in Gravitational field and Gravitational Potential	379
6.7.5 Gravitational Potential due to a Sphere	379
6.8 Gravitational Potential Energy of a Body on Earth	381
6.8.1 On Earth's Surface	381
6.8.2 Above the Surface of Earth	381
6.8.3 Inside the Earth's Core	381
6.9 Satellite and Planetary Motion	386
6.9.1 Motion of a Satellite in a Circular Orbit	386
6.9.2 Energies of a Satellite in a Circular Orbit	387
6.10 Motion of a Satellite in Elliptical Path	391
6.11 Satellite Motion and Angular Momentum Conservation	392
6.12 Kepler's Laws of Planetary Motion	392
6.12.1 Kepler's First Law [The Law of Orbits]	392
6.12.2 Kepler's Second Law [The Law of Areas]	393
6.12.3 Kepler's Third Law [The Law of Periods]	393
6.13 Projection of Satellites and Spaceships From Earth	400
6.14 Escaping From a Satellite	401
6.15 Communication Satellites	404
6.15.1 Geostationary Satellite and Parking Orbit	404
6.15.2 Broadcasting Region of a Satellite	405
DISCUSSION QUESTION	408
CONCEPTUAL MCQS SINGLE OPTION CORRECT	410
NUMERICAL MCQS SINGLE OPTIONS CORRECT	414
ADVANCE MCQS WITH ONE OR MORE OPTIONS CORRECT	420
UNSOLVED NUMERICAL PROBLEMS FOR PREPARATION OF NSEP, INPHO & IPHO	422

7.1	<i>The Concept of Pressure</i>	431
7.2	<i>Pressure Distribution in a Static Fluid</i>	432
7.2.1	<i>Force on Side Wall of a Vessel</i>	433
7.2.2	<i>Average Pressure on Side Wall</i>	434
7.2.3	<i>Torque on the Side Wall due to Fluid Pressure</i>	434
7.2.4	<i>Force on the Side Walls of a Random Shaped Vessel</i>	434
7.3	<i>Archimedes Principle</i>	434
7.4	<i>Pascal's Principle</i>	440
7.4.1	<i>Pressure at the Different Levels of a Liquid</i>	441
7.4.2	<i>The Hydraulic Lift</i>	441
7.5	<i>Pressure Distribution in an Accelerated Frame</i>	442
7.5.1	<i>Pressure Distribution in a Closed Accelerated Container</i>	443
7.6	<i>Fluid Dynamics</i>	448
7.6.1	<i>Representation of Streamlines</i>	448
7.6.2	<i>Laminar Versus Turbulent Flow</i>	448
7.6.3	<i>Equation of Continuity</i>	449
7.7	<i>Bernoulli's Theorem</i>	450
7.8	<i>Numerical Applications of Bernoulli's Theorem</i>	451
7.8.1	<i>Pitot Tube</i>	451
7.8.2	<i>Venturimeter</i>	452
7.8.3	<i>Torecelli's Theorem</i>	452
7.8.4	<i>Freely Falling Liquid</i>	453
7.8.5	<i>Force of Reaction due to Ejection of Water</i>	453
	<i>Discussion Question</i>	461
	<i>Conceptual MCQs Single Option Correct</i>	463
	<i>Numerical MCQs Single Options Correct</i>	465
	<i>Advance MCQs with One or More Options Correct</i>	470
	<i>Unsolved Numerical Problems for Preparation of NSEP, INPhO & IPhO</i>	473

ANSWERS & SOLUTIONS

Chapter 1	Kinematics	483 - 523
Chapter 2	Forces and Newton's Laws of Motion	524 - 550
Chapter 3	Work, Energy and Power	551 - 580
Chapter 4	Linear Momentum and its Conservation	581 - 605
Chapter 5	Rigid Bodies and Rotational Motion	606 - 630
Chapter 6	Gravitation	631 - 649
Chapter 7	Fluid Mechanics	650 - 662

