## *For JEE Physics PYQ Plus Reviewer/ YouTuber*

*I am happy to connect with you.*

Even great things need to be shared! I'm glad to hear that you want to spread the word about the book to your audience. I firmly believe that only a genuine and honest review makes an impact. That's why I encourage you to go through Volume 3 on Electricity and Magnetism. If you don't have a copy, feel free to reach out — I'd be happy to send one to you.

The following will help you understand and review the book — so your audience can make an informed decision.

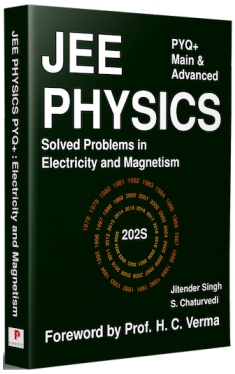
### *Four Volumes*

The book is carefully designed to help school students prepare for JEE. Dividing the book into four volumes and aligning PYQs with the four volumes of NCERT serves this purpose. Imagine a student practicing PYQs right after reading a chapter from NCERT—just like an exercise at the end of a chapter. This book complements the textbook — NCERT or HC Verma. I believe PYQs should be practiced alongside the school syllabus, not after finishing it.

1. Mechanics
2. Fluids, Waves, & Thermodynamics
3. Electricity and Magnetism
4. Optics and Modern Physics

### *Following Examples are from Volume 3*

The examples that follow are from the third volume, Electricity and Magnetism (Green color book). I encourage you to keep this book with you as you read on. I am doing the same while writing this. Let's begin with the cover page.

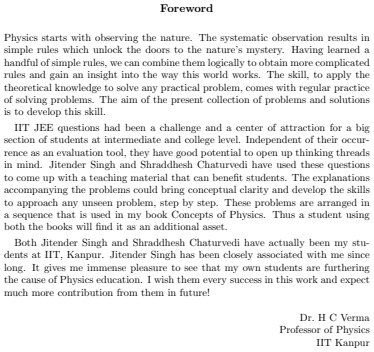



### *Book Cover*

The Plus symbol in PYQ+ indicates that this book is more than just a collection of PYQs. Mains & Advanced indicates that it includes all PYQs from both JEE Mains and JEE Advanced. When I say all, I mean:

- IIT JEE (Advanced) from 1978 onward
- AIEEE from 2002 to 2012
- JEE Mains (CBSE) from 2013 to 2017 and
- JEE Mains (NTA) from 2018 onward.

The book is authored by Jitender Singh and S. Chaturvedi, both of whom cleared JEE in 1995 and joined the Five-Year Integrated Programme in Physics at IIT Kanpur. The book also features a foreword by Prof. H.C. Verma.



**Foreword**

Physics starts with observing the nature. The systematic observation results in simple rules which unlock the doors to the nature's mystery. Having learned a handful of simple rules, we can combine them logically to obtain more complicated rules and gain an insight into the way this world works. The skill, to apply the theoretical knowledge to solve any practical problem, comes with regular practice of solving problems. The aim of the present collection of problems and solutions is to develop this skill.

IIT JEE questions had been a challenge and a center of attraction for a big section of students at intermediate and college level. Independent of their occurrence as an evaluation tool, they have good potential to open up thinking threads in mind. Jitender Singh and Shraddhesh Chaturvedi have used these questions to come up with a teaching material that can benefit students. The explanations accompanying the problems could bring conceptual clarity and develop the skills to approach any unseen problem, step by step. These problems are arranged in a sequence that is used in my book Concepts of Physics. Thus a student using both the books will find it as an additional asset.

Both Jitender Singh and Shraddhesh Chaturvedi have actually been my students at IIT, Kanpur. Jitender Singh has been closely associated with me since long. It gives me immense pleasure to see that my own students are furthering the cause of Physics education. I wish them every success in this work and expect much more contribution from them in future!

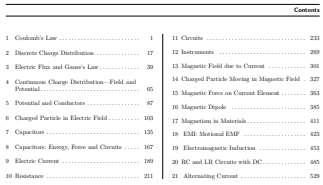
Dr. H C Verma
Professor of Physics
IIT Kanpur

## *Read Me First!*

The book has a Read Me First page explaining how to use it effectively. (The following text is mostly an extension of Read Me First!).

## *Content Page*

The Electricity and Magnetism book contains 21 chapters—starting with Coulomb's Law and ending with Alternating Current. The book includes 1,700 problems, averaging 75 problems per chapter.



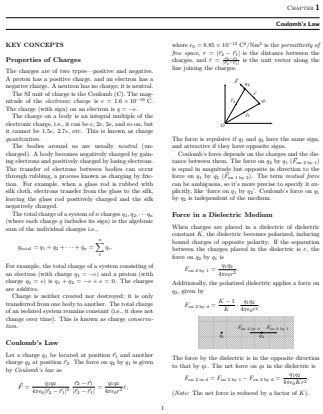
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## *Chapter*

Each chapter is structured into four parts:

1. Key Concepts
2. Problems
3. Answers and
4. Solutions.



Chapter 1

**Coulomb's Law**

**KEY CONCEPTS**

**Properties of Charges**

The charges are of two types—positive and negative. A proton has a positive charge, and an electron has a negative charge. A neutron has no charge; it is neutral.

The SI unit of charge is the Coulomb (C). The magnitude of the *electronic charge* is $e = 1.6 \times 10^{-19}$ C. The charge (with sign) on an electron is $q = -e$.

The charge on a body is an integral multiple of the electronic charge, i.e., it can be $e$, $2e$, $3e$, and so on, but it cannot be $1.5e$, $2.7e$, etc. This is known as charge quantization.

The bodies around us are usually *neutral* (uncharged). A body becomes negatively charged by gaining electrons and positively charged by losing electrons. The transfer of electrons between bodies can occur through rubbing, a process known as charging by friction. For example, when a glass rod is rubbed with silk cloth, electrons transfer from the glass to the silk, leaving the glass rod positively charged and the silk negatively charged.

The total charge of a system of $n$ charges $q_1, q_2, \cdots q_n$ (where each charge $q$ includes its sign) is the algebraic sum of the individual charges i.e.,

$$q_{\text{total}} = q_1 + q_2 + \cdots + q_n = \sum_{i=1}^{n} q_i.$$

For example, the total charge of a system consisting of an electron (with charge $q_1 = -e$) and a proton (with charge $q_2 = e$) is $q_1 + q_2 = -e + e = 0$. The charges are additive.

Charge is neither created nor destroyed; it is only transferred from one body to another. The total charge of an isolated system remains constant (i.e., it does not change over time). This is known as charge *conservation*.

**Coulomb's Law**

Let a charge $q_1$ be located at position $\vec{r}_1$ and another charge $q_2$ at position $\vec{r}_2$. The force on $q_2$ by $q_1$ is given by *Coulomb's law* as

$$\vec{F} = \frac{q_1 q_2}{4\pi\epsilon_0|\vec{r}_2 - \vec{r}_1|^2}\frac{\vec{r}_2 - \vec{r}_1}{|\vec{r}_2 - \vec{r}_1|} = \frac{q_1 q_2}{4\pi\epsilon_0 r^2}\hat{r},$$

where $\epsilon_0 = 8.85 \times 10^{-12}$ C$^2$/Nm$^2$ is the *permittivity of free space*, $r = |\vec{r}_2 - \vec{r}_1|$ is the distance between the charges, and $\hat{r} = \frac{\vec{r}_2 - \vec{r}_1}{|\vec{r}_2 - \vec{r}_1|}$ is the unit vector along the line joining the charges.

The force is repulsive if $q_1$ and $q_2$ have the same sign, and attractive if they have opposite signs.

Coulomb's force depends on the charges and the distance between them. The force on $q_2$ by $q_1$ ($\vec{F}_{on\ 2\ by\ 1}$) is equal in magnitude but opposite in direction to the force on $q_1$ by $q_2$ ($\vec{F}_{on\ 1\ by\ 2}$). The term *mutual force* can be ambiguous, so it's more precise to specify it explicitly, like 'force on $q_1$ by $q_2$'. Coulomb's force on $q_1$ by $q_2$ is independent of the medium.

**Force in a Dielectric Medium**

When charges are placed in a dielectric of dielectric constant $K$, the dielectric becomes polarized, inducing bound charges of opposite polarity. If the separation between the charges placed in the dielectric is $r$, the force on $q_2$ by $q_1$ is

$$\vec{F}_{on\ 2\ by\ 1} = \frac{q_1 q_2}{4\pi\epsilon_0 r^2}\hat{r}.$$

Additionally, the polarized dielectric applies a force on $q_2$, given by

$$\vec{F}_{on\ 2\ by\ d} = \frac{K-1}{K}\cdot\frac{q_1 q_2}{4\pi\epsilon_0 r^2}\hat{r}$$

The force by the dielectric is in the opposite direction to that by $q_1$. The net force on $q_2$ in the dielectric is

$$\vec{F}_{on\ 2\ in\ d} = \vec{F}_{on\ 2\ by\ 1} - \vec{F}_{on\ 2\ by\ d} = \frac{q_1 q_2}{4\pi\epsilon_0 K r^2}\hat{r}.$$

(*Note:* The net force is reduced by a factor of $K$).

1

## *Problems*

The problems are divided into multiple sections, each containing problems related to a particular concept or situation. Within each section, problems are arranged in increasing order of difficulty, irrespective of the year and exam in which they were asked. The goal is to progressively develop problem-solving skills rather than simply following a chronological order.

### *Ordering of Problems*

For example, on Page 3 in the section Three or More Charges in a Plane:

Problem 20 is from JEE Mains 2022 (2022 m)

Problem 21 is from JEE Mains 2023 (2023 m)

Problem 22 is from JEE Mains 2009 (2009 m)

Problem 23 is from IIT JEE 1992 (1992)

Problem 24 is from JEE Mains 2004 (2004 m)

Problem 25 is from JEE Advanced 2014 (2014)

At first glance, a beginner might see this as unordered. However, an experienced educator will recognize that this follows a logical progression, gradually increasing in difficulty to help students strengthen their problem-solving skills step by step. Arranging problems in this manner requires careful analysis, while simply listing them year-wise is easy but less effective for learning.

### *Important (or ⋆) Problems*

The problem 26 on page 4 has a star (⋆) after number 26. The starred problems are important PYQs. A problem is important because it is

1. Fundamental—a direct application of a basic law or
2. Foundational—the basis for more complex problems or
3. A well-known result—recognized in higher-level physics.

My deep understanding of physics helped me identify these problems. By adding a simple star next to a problem number, I guide students on where to focus more.

### *Difficult (or † or ‡) Problems*

Problem 31 on the same page has a dagger symbol (†) next to it, indicating that it is difficult. A problem is considered difficult if it (1) involves multiple concepts, (2) requires lateral thinking, or (3) needs advanced mathematics. This marking helps students recognize challenging problems and reassures them that it's okay if they don't solve them on the first attempt.

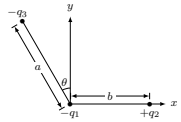
### *Miscellaneous Section*

On Page 4, Problems 33, 34, and 35 belong to the Miscellaneous section, which includes problems based on multiple concepts.

**Three or More Charges in a Plane**

**20**. Three point charges of magnitude 5 μC, 0.16 μC and 0.3 μC are located at the vertices A, B, C of a right-angled triangle whose sides are AB = 3 cm, BC = $3\sqrt{2}$ cm and CA = 3 cm and point A is the right angle corner. Charge at point A experiences ..... N of electrostatic force due to the other two charges. (2022 m)

**21**. Three charges $-q_1$, $+q_2$ and $-q_3$ are placed as shown in the figure. The $x$-component of the force on $-q_1$ is proportional to (2003 m)




(A) $\frac{q_2}{b^2} - \frac{q_3}{a^2}\cos\theta$ (B) $\frac{q_2}{b^2} + \frac{q_3}{a^2}\sin\theta$
(C) $\frac{q_2}{b^2} + \frac{q_3}{a^2}\cos\theta$ (D) $\frac{q_2}{b^2} - \frac{q_3}{a^2}\sin\theta$

**22**. Two charges, each equal to $Q$, are placed at the opposite corners of a square. Two more charges, each equal to $q$, are placed at the other two corners. If the net electrostatic force on $Q$ is zero, then $Q/q$ is equal to (2009 m)

(A) $-2\sqrt{2}$ (B) $-1$ (C) 1 (D) $-1/\sqrt{2}$

**23**. Five point charges, each of value $+q$ coulomb, are placed on five vertices of a regular hexagon of side $a$ metre. The magnitude of the force on the point charge of value $-q$ coulomb placed at the centre of the hexagon is ..... newton. (1992)

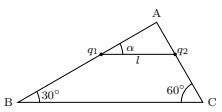



**26**.⋆ Two equal positive point charges are separated by a distance $2a$. The distance of a point from the centre of the line joining two charges on the equatorial line (perpendicular bisector) at which force experienced by a test charge $q_0$ becomes maximum is $a/\sqrt{\alpha}$. The value of $\alpha$ is ..... (2023 m)

**31**.† Three particles, each of mass 1 g and carrying a charge $q$, are suspended from a common point by insulated massless strings, each 100 cm long. If the particles are in equilibrium and are located at the corners of an equilateral triangle of side length 3 cm, calculate the charge $q$ on each particle. [Take $g = 10\ \mathrm{m/s^2}$] (1988)

**Miscellaneous**

**33**. A rigid insulated wire frame in the form of a right-angled triangle ABC, is set in a vertical plane as shown in the figure. Two beads of equal masses $m$ each and carrying charges $q_1$ and $q_2$ are connected by a cord of length $l$ and can slide without friction on the wires. Considering the case when the beads are stationary determine, (1978)



## *Exercise Section*

On Page 5, there are two exercise sections:

Exercise (Revision): Contains PYQs that are small variants of other PYQs already included in previous sections.

Exercise (Challenge): Problems 40 to 46 are challenging questions selected from advanced physics books like Irodov, Griffiths, and Purcell & Morin. These problems serve two key purposes:

1. Provide high-quality practice – They introduce students to top-tier problems within the JEE syllabus, helping them stay focused without needing multiple books.
2. Strengthen problem-solving skills – These problems push students to think critically and refine their approach. Solutions are intentionally not provided, encouraging students to struggle, analyze, and learn.

## *Answers*

The Problems are followed by Answers, so students can verify their answers.

Some answers include a See Solution, encouraging students to check the solution even if they got the correct answer. These solutions contain something extra—an alternate method, an explanatory note, an extension of the problem, or a warning. For Example:

Solution 11 on Page (9): The first sentence states, "This problem from JEE Mains 2024 is likely to cause confusion." This acts as a warning, helping students avoid common pitfalls. The book directly addresses ambiguous or incorrect JEE problems instead of justifying them with incorrect reasoning.

Solution 14 on Page (10): A Note and Exercise at the end extends the problem beyond simply finding the solution.

## *Solutions*

By now, you must have had a glimpse of the solutions. We made efforts to come up with correct, clear, and better solutions. The solutions are detailed for a reason—if a student struggles with a problem, it indicates a gap in conceptual understanding or problem-solving

**Exercise (Revision)**

**36.** Two identical charged metallic spheres A and B when placed at certain distance in air repel each other with a force $F$. Another identical uncharged sphere C is first placed in contact with A and then in contact with B and finally placed at midpoint between spheres A and B. The force experienced by sphere C will be (2022 m)
(A) $3F/2$ (B) $3F/4$ (C) $F$ (D) $2F$

**Exercise (Challenge)**

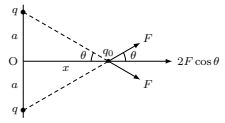
**40.** Three charged particles are in equilibrium under their electrostatic forces only. Which of the following statement(s) is (are) correct? [One or more option(s) correct]
(A) The charges must be kept in a line.
(B) All the charges cannot have the same polarity.
(C) All the charges cannot have the same magnitude.
(D) The equilibrium is unstable.

**ANSWERS**

1. A
2. B
3. B
4. A, C
5. A, C, D
6. A
7. See solution.
8. B
9. A
10. C
11. D. See solution.
12. A
13. 300
14. B. See solution.

**26.** The resultant force on the charge $q_0$ due to other two charges is

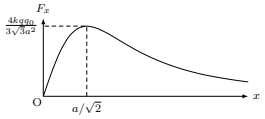
$$F_x = 2F\cos\theta = 2kqq_0\frac{x}{(x^2+a^2)^{3/2}}.$$




The resultant force attain its maxima at $\mathrm{d}F_x/\mathrm{d}x = 0$ i.e.,

$$2kqq_0\frac{a^2-2x^2}{(a^2+x^2)^{5/2}} = 0.$$

Solve to get $x = a/\sqrt{2}$.




*Note:* The force on $q_0$ is along the $x$-axis. It is zero at the origin O and it is also zero at infinity i.e., $F_x \to 0$ as $x \to \infty$. It attains maxima at a point between O and infinity.

If charge $q_0$ is far away from the origin (i.e., $x \gg a$) then $F_x \approx \frac{k(2q)q_0}{x^2}$. The effect of two charges ($q$ and $q$ placed near O) at a distance far away from them is the same as that of a single charge $2q$ placed at O.

We encourage you to analyse the situation if two charges are $q$ and $-q$.

skills. Our detailed solutions help bridge this gap and add value to learning. To see this in action, check the solution for problem 26 on page (13).

Every word has a purpose, every line adds value.

IF I DON'T EXPLAIN THIS CLEARLY, you might think that some problems don't have solutions. For example, solution 36 on page (13) only includes a hint referring to another problem. This is because it belongs to the Exercise (Revision) section and is a small variation of problem 8, which already has a detailed solution. Repeating the same solution would only add bulk to the book without providing additional value.

### *Seamless Transition*

Numbering $1 \cdots N$

Did you find the transition from problem to answer to solution seamless? It is because of a simple numbering scheme, numbering from 1 to $N$. Answers and solutions are given within the same chapter, so students do not need to flip through half the book searching for them. The book design is structured to enhance usability.

### *Elegance*

TEX for typography, maths and graphics

Additionally, the typography, mathematical equations, and graphics are accomplished using TeX (Donald Knuth's typesetting system) for appealing results.

### *More...*

The above examples are from chapter 1. Beyond Chapter 1, there are many more examples:

- Solution 42 on Page (205): highlights the practical relevance of the problem in rural areas, where two bulbs are often connected in series to a 440 V supply.

  Connect with real life

- Solution 22 on Page 223: Provides a detailed solution clarifying an important concept overlooked by problem setters.

  Mistakes happen—even problem setters aren't immune.

- Solution 28 on Page 235: Guides students on how to handle these situations.
- Solution 5 in Chapter 21 on Page 545: Includes an alternate solution (Aliter).

  Alternate solutions

## *Paper Quality and Binding*

Quality matters

The book is printed on high-quality 70 gsm paper, meeting industry standards.

The book has strong section-sewn binding. Open page 559, and you'll see the threads in the middle. The pages stay intact even when fully opened. Try it yourself—while the paper might tear, it won't come loose.

## *Final Thoughts*

This book has evolved over 12 years, making it different from other PYQ books. One major distinction is that this book has authors—real people with deep expertise in physics. Other PYQ books are compiled by editorial committees with no single author responsible for their content.

Thanks for reading! Wishing you the best for your review. Feel free to reach out anytime if you need more information.

Jitender Singh