

# GRIFFITHS ELECTRODYNAMICS SOLUTIONS

## KALMAN KNIZHNIK

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### Problem 2.1

a) Twelve equal charges,  $q$  are situated at the corners of a regular 12-sided polygon (for instance, one on each numeral of a clock face.) What is the net force on a test charge  $Q$  at the center?

The force on  $Q$  must be 0 by symmetry. The  $x$ ,  $y$ , and  $z$  components of the fields due to each charge cancel, so the force vanishes.

b) Suppose one of the 12  $q$ 's is removed (the one at "6 o'clock"). What is the force on  $Q$ ? Explain your reasoning carefully.

Now it is like 10 of the charges cancel, the only one that doesn't cancel being the one directly opposite the missing charge. Thus, the force is

$$F = \frac{1}{4\pi\epsilon_0} \frac{qQ}{r^2} \quad \square \quad (1)$$

pointing in the direction of the missing charge. Here,  $r$  is the distance from the center to each charge.

c) Now 13 equal charges,  $q$ , are placed at the corners of a regular 13-sided polygon. What is the force on a test charge  $Q$  at the center.

Again, by symmetry, the answer is still 0.

d) If one of the 13  $q$ 's is removed, what is the force on  $Q$ ? Explain your reasoning.

The same answer as in part b, equation 1, and for the same reason.

### Problem 2.2

a) Find the electric field (magnitude and direction) a distance  $z$  above the midpoint between two equal charges,  $q$ , a distance  $d$  apart. Check that your result is consistent with what you'd expect when  $z \gg d$ .

The force would not have components in the  $y$  or  $x$  direction, if we put the charges in the  $x - z$  plane, there is no  $y$ -component of the field at the point in question, and the  $x$ -components cancel. The  $z$ -component of the field is

$$\mathbf{E} = \frac{1}{4\pi\epsilon_0} \frac{2q}{z^2 + (d/2)^2} \sin(\theta) \hat{\mathbf{z}} = \frac{1}{4\pi\epsilon_0} \frac{2qz}{(z^2 + (d/2)^2)^{3/2}} \hat{\mathbf{z}} \quad \square \quad (2)$$

where the factor of 2 comes from adding up the two charges. When  $z \gg d$ , the electric field becomes

$$\mathbf{E} = \frac{1}{4\pi\epsilon_0} \frac{2q}{z^2} \hat{\mathbf{z}} \quad (3)$$

which is what you would expect, since the system acts like a point charge of charge  $2q$ .

b) Repeat part (a), only this time make the right hand charge  $-q$  instead of  $+q$ .

Now the  $z$ -components cancel and the  $x$ -components don't. Mathematically, this means replacing  $\sin(\theta)$  with  $\cos(\theta)$ .

$$\mathbf{E} = \frac{1}{4\pi\epsilon_0} \frac{2q}{z^2 + (d/2)^2} \cos(\theta) \hat{\mathbf{x}} = \frac{1}{4\pi\epsilon_0} \frac{qd}{(z^2 + (d/2)^2)^{3/2}} \hat{\mathbf{x}} \quad \square \quad (4)$$

where the 2 has canceled out with the  $d/2$  that comes from the cosine. If  $z \gg d$ , then from far away it looks like a dipole, and the field reduces to that of a dipole:

$$\mathbf{E} = \frac{1}{4\pi\epsilon_0} \frac{qd}{z^3} \hat{\mathbf{x}} \quad (5)$$

# Manual Solution For Electrodynamic

**Mike Jess**



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of the book is obtained from the following principles Base the theory on the concept of force and mutual interaction Connect the theory to experiments and observations accessible to the student Treat the electric magnetic and inductive phenomena cohesively with respect to force energy dipoles and material Present electrodynamics using the same principles as in the preceding mechanics course Aim at explaining that theory of relativity is based on the magnetic effect Introduce field theory after the basic phenomena have been explored in terms of force Although electrodynamics is described in this book from its 1st principles prior knowledge of about one semester of university studies in mathematics and physics is required including vector algebra integral and differential calculus as well as a course in mechanics treating Newton's laws and the energy principle The target groups are physics and engineering students as well as professionals in the field such as high school teachers and employees in the telecom industry Chemistry and computer science students may also benefit from the book

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electrodynamics textbook for undergraduate physics and engineering students in their second or third years who are studying intermediate or advanced level electrodynamics and who want to learn techniques for scientific computing at the same time This book will also appeal to computer science students who want to see how their computer programming skills may be applied to science particularly to physics without needing too much background physics knowledge Key features Major concepts in classical electrodynamics are introduced cohesively through computational and mathematical treatments Computational examples in Python programming language guide students on how to simulate and visualize electrodynamic principles and phenomena for themselves     Engineering Electrodynamics Janusz Turowski, Marek Turowski, 2017-12-19

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web maharani jindan kaur was the last queen of the sikh empire from 1843 until 1846 she was the youngest wife of the first maharaja of the sikh empire ranjit singh and the mother of the last maharaja duleep singh

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web oct 10 2013 above jind kaur below 2nd from bottom painting by amrita shergill 3rd from bottom sketch of rani sada kaur by kehar singh punjab s women have always been considered among the most beautiful in the land during the mughal days they were sought after by the kings and nobles to embellish their harems

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web punjabi sikhs are primarily found in the indian state of punjab the only sikh majority administrative division on earth punjabi sikhs make up roughly 60 percent of the state s population 6 many have ancestry from the greater punjab region an area that was partitioned between india and pakistan in 1947

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web rani jindan played a conspicuous role in the punjab politics after her son s elevation to the throne of lahore kingdom the british entered into a treaty known as the treaty of bhyrowal with the lahore kingdom in december 1846 which made the

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web sikhs legacy of the punjab 1 was a temporary exhibit at the smithsonian institution s national museum of natural history that highlights the art culture and history of the sikh people it was dedicated and opened to the public on july 24 2004 and is a part of the broader smithsonian sikh heritage project which was launched in 2000 it

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web punjab history and culture the word punjab is made up of two persian words panj and aab panj means five and aab means water this name was probably given to this land possibly in an era when this region came into close contact with persia the punjab was known as land of five rivers because of the five rivers that ran through it

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web from 1843 until 1846 maharani jind kaur was regent of the sikh empire rani jindan was well known for her beauty vigor and resolve however her celebrity stems primarily from the fear she instilled in the british in india who referred to

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web september 19 2018 sikh arts heritage by vidya pradhan even the most casual student of indian history knows of maharaja ranjit singh the leader of the sikh empire who famously united warring confederacies misls and

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web india sikhism punjab diversity the origins of the sikhs a religious group initially formed as a sect within the larger hindu community lie in the punjab in the 15th century the sikh founder guru nanak 1469 1539 was roughly a contemporary of the founder of mughal fortunes in india bābur and belonged to the khatri community of

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web rani jindan in punjabi the sikhs of the punjab sep 24 2022 in a revised edition of his original book j s grewal brings the history of the sikhs from its beginnings in the time of guru nanak the founder of sikhism right up to the present day against the background of the history of the punjab the volume surveys the changing pattern of

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web in 1873 captain speedy recruited 110 sikhs from the patiala ludhiana and ferozepur districts of punjab for service in perak in malaysia this band was known as the perak armed police the success of these early recruits prompted the british to recruit more sikhs and by 1888 under one captain walker the group had grown and came to be known as

**jind kaur wikipedia** - Oct 23 2023

web maharani jind kaur c 1817 1 august 1863 was regent of the sikh empire from 1843 until 29 march 1847 after the sikh empire was dissolved on 29 march 1847 the sikhs claimed her as the maharani and successor of maharaja duleep singh however on the same day the british took full control and refused to accept the claims