

Solutions to Abstract Algebra (Dummit and Foote 3e)

Chapter 1 : Group Theory

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This work was done as an undergraduate student: if you really don't understand something in one of these proofs, it is very possible that it doesn't make sense because it's wrong. Any questions or corrections can be directed to jason.rosendale@gmail.com.

Exercise 1.1.1

(a) is not associative: $3 - (2 - 1) \neq (3 - 2) - 1$. (b),(c),and (d) can be shown to be associative by grinding out the algebra and showing that $a * (b * c) = (a * b) * c$. (e) is not associative, as can be shown by letting $a = b = c = 2$.

Exercise 1.1.2

(a) and (e) can be shown to not be commutative by letting $a = 1, b = 2$. (b),(c) and (d) can be shown to be commutative by grinding out the algebra.

Exercise 1.1.3

$$\begin{aligned}\overline{a+b+c} &= \overline{a+b+c} \quad \text{def. of modular addition} \\ &= \overline{a+b+c} \quad \text{def. of modular addition}\end{aligned}$$

Exercise 1.1.4

$$\begin{aligned}\overline{ab \cdot c} &= \overline{a \cdot b \cdot c} \quad \text{def. of modular multiplication} \\ &= \overline{a \cdot bc} \quad \text{def. of modular multiplication}\end{aligned}$$

Exercise 1.1.5

To be a group, each element a would need a multiplicative inverse b such that $ab = 1$; but \mathbb{Q} has no such inverse.

Exercise 1.1.6

(b) is not closed: $1/14 + 1/14 = 1/7$. (c) is not closed: $2/3 + 2/3 = 4/3$. (d) is not closed: $2 + (-3/2) = 1/2$. (f) is not closed: $1/2 + 1/3 = 5/6$. (a) and (e) are groups under addition.

Exercise 1.1.7

That $x * y$ is well-defined follows directly from the fact that $+, \cdot$, and the greatest integer function are well defined on \mathbb{R} . To prove that G is a group: G has an identity element ($0 \in G$ and $0 * x = x * 0 = x - [x] = 0$), each

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Table of Contents Dummit Foote Abstract Algebra Solutions

1. Understanding the eBook Dummit Foote Abstract Algebra Solutions
 - The Rise of Digital Reading Dummit Foote Abstract Algebra Solutions
 - Advantages of eBooks Over Traditional Books
2. Identifying Dummit Foote Abstract Algebra Solutions
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Dummit Foote Abstract Algebra Solutions
 - User-Friendly Interface
4. Exploring eBook Recommendations from Dummit Foote Abstract Algebra Solutions
 - Personalized Recommendations
 - Dummit Foote Abstract Algebra Solutions User Reviews and Ratings
 - Dummit Foote Abstract Algebra Solutions and Bestseller Lists
5. Accessing Dummit Foote Abstract Algebra Solutions Free and Paid eBooks
 - Dummit Foote Abstract Algebra Solutions Public Domain eBooks
 - Dummit Foote Abstract Algebra Solutions eBook Subscription Services
 - Dummit Foote Abstract Algebra Solutions Budget-Friendly Options

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 - ePub, PDF, MOBI, and More
 - Dummit Foote Abstract Algebra Solutions Compatibility with Devices
 - Dummit Foote Abstract Algebra Solutions Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Dummit Foote Abstract Algebra Solutions
 - Highlighting and Note-Taking Dummit Foote Abstract Algebra Solutions
 - Interactive Elements Dummit Foote Abstract Algebra Solutions
8. Staying Engaged with Dummit Foote Abstract Algebra Solutions
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Dummit Foote Abstract Algebra Solutions
9. Balancing eBooks and Physical Books Dummit Foote Abstract Algebra Solutions
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Dummit Foote Abstract Algebra Solutions
10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
11. Cultivating a Reading Routine Dummit Foote Abstract Algebra Solutions
 - Setting Reading Goals Dummit Foote Abstract Algebra Solutions
 - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Dummit Foote Abstract Algebra Solutions
 - Fact-Checking eBook Content of Dummit Foote Abstract Algebra Solutions
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
14. Embracing eBook Trends
 - Integration of Multimedia Elements

- Interactive and Gamified eBooks

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