

# An Introduction to Abstract Algebra with Notes to the Future Teacher Complete Solutions

## Chapter 1 \_\_\_\_\_

### Section 1.1

1.
  - i. The answer is yes because any nonempty set of positive integers has a smallest member by the Well-Ordering Principle. The smallest member is 1 because we can write 1 as  $1 = 139 - 397 - 102 - 541$ .
  - ii. No. If  $\frac{m}{n}$  is in the set, then  $\frac{m}{2n}$  is also in the set. So there is no smallest member. The Well-Ordering Principle does not apply because the set in question is not a subset of the integers.
2. Let  $P(n)$  be the statement that  $1 + 3 + \dots + (2n - 1) = n^2$ . Then  $P(1)$  is the statement that  $1 = 1^2$ , which is true. Now suppose that  $P(n)$  is true. We prove that  $P(n + 1)$  is true, namely, that  $1 + 3 + \dots + (2n - 1) + (2n + 1) = (n + 1)^2$ . By our induction hypothesis, we can substitute  $n^2$  for  $1 + 3 + \dots + (2n - 1)$ . So we are left to prove that  $n^2 + (2n + 1) = (n + 1)^2$ , which is clearly true.
3. Let  $n = 1$ . Then  $\frac{1 - r^{n+1}}{1 - r} = \frac{1 - r^2}{1 - r} = \frac{(1 - r)(1 + r)}{1 - r} = (1 + r)$  since  $r \neq 1$ . Assume  $1 + r + r^2 + \dots + r^n = \frac{1 - r^{n+1}}{1 - r}$ . Then  $1 + r + r^2 + \dots + r^n + r^{n+1} = \frac{1 - r^{n+1}}{1 - r} + r^{n+1} = \frac{1 - r^{n+1}}{1 - r} + \frac{(1 - r)r^{n+1}}{1 - r} = \frac{1 - r^{n+1} + r^{n+1} - r^{n+2}}{1 - r} = \frac{1 - r^{n+2}}{1 - r}$ .
4. Let  $n = 1$ . Then  $n^3 + 2n = 3$ , which is a multiple of 3. Assume  $n^3 + 2n$  is a multiple of 3. We must show that  $(n + 1)^3 + 2(n + 1)$  is a multiple of 3. Now  $(n + 1)^3 + 2(n + 1) = n^3 + 3n^2 + 3n + 1 + 2n + 2$ , which equals  $(n^3 + 2n) + 3n^2 + 3n + 3$ . Since  $(n^3 + 2n)$  is a multiple of three, and  $3n^2 + 3n + 3 = 3(n^2 + n + 1)$ ,  $(n + 1)^3 + 2(n + 1)$  is a multiple of 3.
5. If there is one person in the room, there are 0 handshakes. Assume that if  $n$  people are in the room, there are  $\frac{n(n-1)}{2}$  handshakes. If an  $(n + 1)$ th person enters the room then  $n$  more handshakes will occur, making the total  $\frac{n(n-1)}{2} + n$ . Now  $\frac{n(n-1)}{2} + n = \frac{n(n-1)}{2} + \frac{2n}{2} = \frac{n^2 - n + 2n}{2} = \frac{n^2 + n}{2} = \frac{n(n+1)}{2}$ .

# Introduction To Abstract Algebra Nicodemi Solutions

**Roman Wölfel**



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