1. $\boxed{N = 7}$

2. $\{1, 2, 3, 4, 6\}$. $\boxed{5}$

3. four distinct primes: $2 \times 3 \times 5 \times 7 = \boxed{210}$

4. $\boxed{3}$

5. $\boxed{105}$

6. There is an important method for counting factors/divisors. The method is as follows:
   a) *write the number in prime factorization.* $2 \cdot 3 \cdot 3 \cdot 5 \cdot 5 = 2 \cdot 3^2 \cdot 5^2$
   b) *write down each of the exponents on the prime factors.* 1, 2, 2.
   c) *add 1 to each exponent value.* $1 + 1, 2 + 1, 2 + 1 = 2, 3, 3$.
   d) *multiply the values together.* $2 \times 3 \times 3 = \boxed{18}$

7. $\boxed{5}$

8. $8^2 = 4^3 = \boxed{64}$

9. $\boxed{2013}$

10. Let's continue the pattern until we find a repetition.

$$1, 9, 8, 9, 2, 8, 6, 8, 8, 4, 2, 8, 6, 8, 8, \ldots$$

So we've found a pattern. After the first 4 numbers (1, 9, 8, 9), there is a pattern of 6 digits (2, 8, 6, 8, 8, 4) that will continue repeating forever. To find the 2011th number in the pattern, we need to first subtract 4: $2011 - 4 = 2007$. So after the first 4 digits, we need to find the 2007th digit in the repeating part. So we divide 2007 by 6, which is 334 remainder 3. So the pattern will continue 334 times, and then the remainder 3 tells us that the 2007th digit will be the 3rd in the pattern. The pattern is 2, 8, 6, 8, 8, 4, and the third number in this pattern is $\boxed{6}$