NOTES ON ORDINALS

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0. There is a class of objects called ordinals, of which the first few are
$$0, 1, 2, \dots, \omega, \omega+1, \omega+2, \dots, 2\omega, \dots, \omega^2, \dots, \omega^\omega, \dots$$
1. There are too many ordinals for the class of ordinals to be a set; it is "roughly the same size" as the class of *all* sets.
2. Algebraic operations with ordinals (e.g. ω^2) must be treated with caution. For example, $1+\omega = \omega \neq \omega + 1$. The reason for this phenomenon is actually quite easy to understand, but I shall not go into it here.
3. There is a linear order relation on ordinals. In other words, for any pair of ordinals α and β precisely one of the alternatives $\alpha < \beta$, $\alpha = \beta$ and $\alpha > \beta$ is true.
4. The ordinals are well-ordered by this relation — any nonempty collection S of ordinals has a least element α, so $\alpha \in S$ and $\alpha \leq \beta$ for any $\beta \in S$.
5. For any ordinal κ, the collection $S(\kappa)$ of ordinals $\alpha < \kappa$ is a set.
6. For any set X there is an ordinal κ and a bijection $S(\kappa)@>>>X$, so $X = \{x_\alpha \mid \alpha < \kappa\}$ say.
7. For any set X there is an ordinal λ so large that there is no injective map $S(\lambda)@>>>X$.
8. An ordinal α is a successor ordinal iff $\alpha = \beta + 1$ for some β iff there is no ordinal γ with $\beta < \gamma < \alpha$. A limit ordinal is an ordinal (such as ω) which is not a successor.
9. Transfinite induction over ordinals is valid. Suppose we have a statement $P(\alpha)$ about ordinals α, and we can show that $P(\alpha)$ is true whenever $P(\beta)$ is true for all $\beta < \alpha$. Then $P(\alpha)$ is true for all α. Indeed, consider the collection S of ordinals for which P is false. If S were nonempty, it would have a least element α. This would mean that $P(\beta)$ holds for all $\beta < \alpha$, leading swiftly to a contradiction.
10. Transfinite recursion is valid. We can define a function f of ordinals by specifying $f(\alpha)$ in terms of the values $f(\beta)$ for $\beta < \alpha$.