Reduce to normal form whenever possible. Make sure you indicate which rules you are using - each reduction step must be justified. For each example, use (and document) both normal-order and by-value (i.e., \( \beta \) and \( \beta_v \)) rules. This will require you to read ahead in the lecture - Slide 37. Compare the amount of computation required by the methods you use.

1. \((\lambda x.\lambda y.z(yyx))w((\lambda x.xz)w)\).
2. \((\lambda x.x + x + x)((\lambda x.x)a)\).
3. \((\lambda x.\text{plus } x x)((\lambda y.\text{times } y y)(\text{plus } 5 5))\), where \( \text{plus} \), \( \text{times} \) and 5 are the usual functions and constants.
4. \((\lambda g.\text{plus}(g\text{ times } (g\text{ plus } 5)))((\lambda f.\lambda x.f\ x\ x)\).