

## Topics since Exam 2

1.  $p$ -groups
  - (a) Have “big centers” ( $N \cap Z(P) \neq 1$  for any  $N \triangleleft P$ )
  - (b) Normalizers grow ( $N_P(H) > H$ )
2. Symmetric group  $S_n$ 
  - (a) Conjugation in  $S_n$ .
  - (b) Cycle structure vs 1-line notation
3. Alternating groups
  - (a) Even permutations vs odd permutations
  - (b) Oriented graph proof that even/odd is well-defined
  - (c) Simplicity of  $A_n$ ; proof technique to show  $A_5$  is simple.
4. New groups from old
  - (a) Direct products – internal, external, and the relation between the two.
  - (b) application: minimal normal subgroups
  - (c) application: Fundamental Theorem of Abelian Groups
  - (d) Semidirect products – internal, external, and the relation between the two.
  - (e) Semidirect product decomposition examples:  $A_4$ ,  $S_n$ ,  $D_{2n}$ .