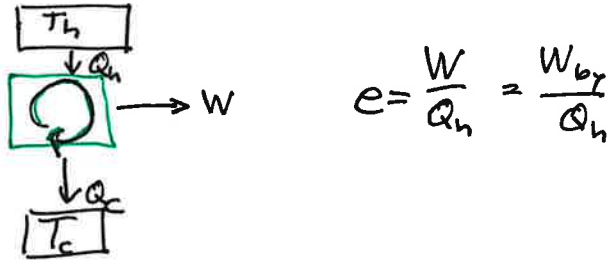## SUMMARY FOR TEST 4

- Heat Engines & Refrigerators

$$e = \frac{W}{Q_h} = \frac{W_{by}}{Q_h}$$

- Thermodynamic Potentials $\quad U, F, H, G$

  - thermodynamic identities:
    derive $dF = \ldots$ etc.
    & Maxwell relations

  - derive $G = \mu N$ etc.

  - $dS_{tot} \geq 0 \quad \xrightarrow{\text{derive}} \quad dG \leq 0 \longrightarrow G$ minimum etc.

  - apply H, S, G etc. using table

- Phase Transitions
  - apply G minimum to examples like diamond
    & water, liquid, steam

    $p(T), \ p(V), \quad G(p), G(T)$
    including derive Clausius Clapeyron $\quad$ also $\quad p(T), p(V), S(T), G(p)$
  - van der Waals model:
    $\longrightarrow p_c, T_c, V_c \ \& \ p(t,v)$

NOT: phase transitions of mixtures $G(x) \& T(x)$