Efficiency of a Heat Engine (SwiftStudy Printable)

Key Formulas

$$\eta = 1 - \frac{T_c}{T_h}$$

η	efficiency	[no units]
T_c	cold temperature	K
T_h	hot temperature	K

$$\eta = \frac{W_{out}}{Q_{in}}$$

η	efficiency	[no units]
W_{out}	work done	Joules (J)
Q_{in}	heat energy used	Joules (J)

$$T_K = T_C + 273.15$$

T_C	Celsius temperature	°C
T_K	Kelvin temperature	K

Tips to Remember

- Though efficiency has no units, it is typically expressed as a percent rather than a pure decimal. Thus, if η = 0.4, it would typically be written as 40%.
- If the percent efficiency is given as part of a problem, be sure to convert it to a decimal. For example, if the efficiency is given to be 34%, use 0.34 for η in your calculations.
- Make sure your temperatures are in Kelvins before using them in the first equation (the one with cold and hot temperatures). If you get a really strange answer, e.g., more than 100%, this is one of the first things to check.
- While the second equation (based on the output work) can apply to any heat engine, the first (with the cold and hot temperatures) applies specifically to **ideal** heat engines. This equation reflects the fact that even if you had no losses due to friction, etc., you still couldn't get 100% efficiency because of the Second Law of Thermodynamics. That is, turning heat energy into useful work would make the universe more orderly—exactly what the Second Law says can't happen.