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## PHYS 1110 Worksheet: Engines

1. A heat engine absorbs heat  $Q_h$  from a body at high temperature  $T_h$  (say, burning fuel), uses it to do work  $W$  (say, by expanding gas pushing against a piston), and expels residual heat  $Q_c$  to the environment at lower temperature  $T_c$  (say, in exhaust gases) so that it can start over again.
  - A. What is the relationship between  $Q_h$ ,  $Q_c$ , and  $W$ ?
  - B. What is the entropy change of the hot body in one cycle?
  - C. What is the entropy change of the engine in one cycle?
  - D. What is the entropy change of the environment in one cycle?
2. An engine burns fuel at a rate of 1.0 kilowatt and does work at a rate of 200 watts.
  - A. How much heat does the engine expel to the surroundings?
  - B. What is the efficiency of the engine?
3. A refrigerator absorbs heat  $Q_c$  from its interior at temperature  $T_c$  (say, by putting it in thermal contact with a colder working fluid) applies work  $W$  to transfer the heat elsewhere (say, by compressing the working fluid to raise its temperature), and transfers heat  $Q_h$  to the environment at higher temperature  $T_h$ .
  - A. What is the relationship between  $Q_h$ ,  $Q_c$ , and  $W$ ?
  - B. What is the entropy change of the interior in one cycle?
  - C. What is the entropy change of the engine in one cycle?
  - D. What is the entropy change of the environment in one cycle?