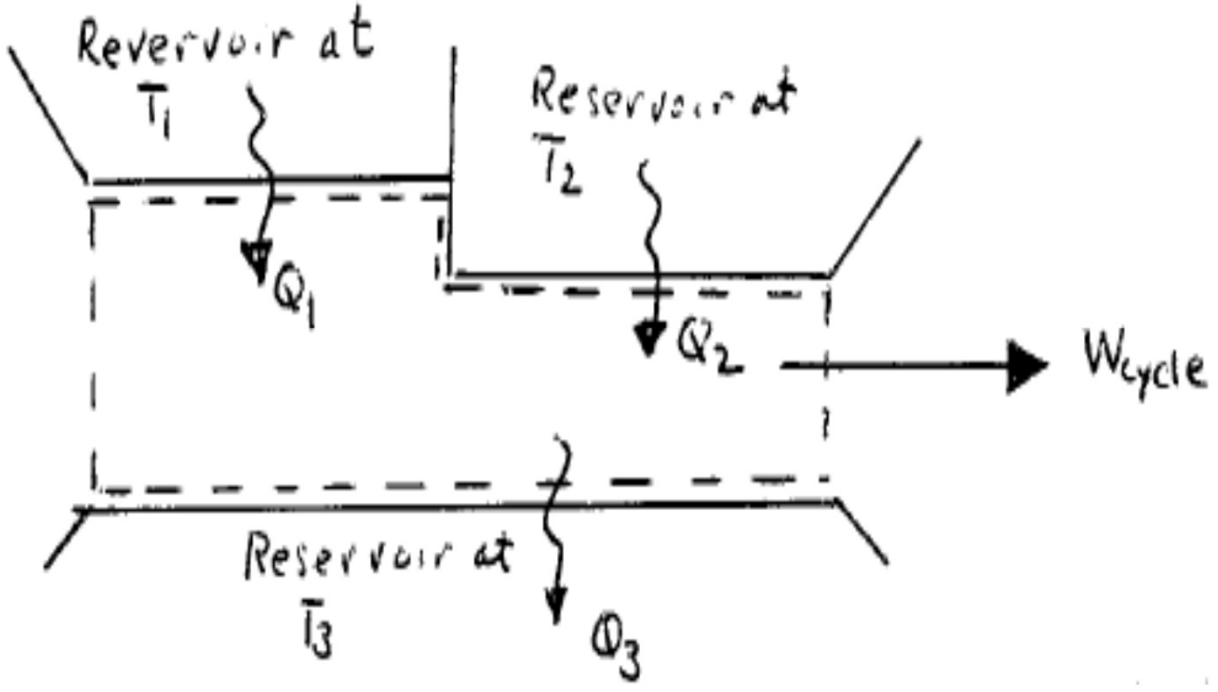
Statement

- A reversible power cycle receives energy Q_1 and Q_2 from hot reservoirs at temperature T_1 and T_2 respectively, and discharges energy Q_3 to a cold reservoir at temperature T_3

(a)Obtain an expression for the thermal efficiency in terms of the ratios $T_1/T_3, T_2/T_3, q=Q_2/Q_1$

(b)Discuss the results of part(a) in each of these limits: limit$q\rightarrow 0$, limit $q\rightarrow\infty$ limit$T_1\rightarrow\infty$

Figure


Reservoir at
T_1
Reservoir at
T_2
Q_1
Q_2
W_{cycle}
Reservoir at
T_3
Q_3

Solution

- Part (a)

By using energy balance equation for cycle

$W_{cycle}=Q_1+Q_2-Q_3$

$Q_1/T_1+Q_2/T_2-Q_3/T_3=-\sigma_{cycle}$

$Q_3=(T_3/T_1)*Q_1+(T_3/T_2)*Q_2$

The thermal efficiency can be expressed as

$\eta=W_{cycle}/(Q_1+Q_2)= (Q_1+Q_2-Q_3)/(Q_1+Q_2)$

$\eta=1-Q_3/(Q_1+Q_2)$

$\eta=1-[T_3/T_1*Q_1+ T_3/T_2*Q_2]/(Q_1+Q_2)$

$\eta=1-1/(T_1/T_3)[1/(1+q)]- 1/(T_2/T_3)[q/(1+q)]$

- Part(b)

$\lim_{q \to 0} \eta = 1 - 1/(T_1/T_3) = 1 - (T_3/T_1)$

$\lim_{q \to \infty} \eta = 1 - 1/(T_2/T_3) = 1 - (T_3/T_2)$

$\lim_{T1 \to \infty} \eta = 1 - 1/(T_2/T_3)[q/(1+q)]$

$= 1 - (T_3/T_2)[q/(1+q)]$