REFRIGERATORS AND HEAT PUMPS

It is the reverse of a heat engine

Working substance extracts heat (Q_2) from the cold reservoir kept at temperature T_1.

After doing some external work on the working substance the heat **Q_1** is liberated to the hot reservoir at temperature T_1.

A heat pump is the same as a refrigerator

The working substance undergoes the following steps

(a) sudden expansion of the gas from high to low pressure which cools it and converts it into a vapour-liquid mixture.

(b) absorption by the cold fluid of heat from the region to be cooled converting it into vapour

(c) heating up of the vapour due to external work done on the system, and

(d) release of heat by the vapour to the surroundings, bringing it to the initial state and completing the cycle.

Coefficient of performance

The coefficient of performance (α) of a refrigerator is given by

$$\alpha = \frac{Q_2}{W}$$

By energy conservation, the heat released to the hot reservoir is $Q_1 = W + Q_2$

$$W = Q_1 - Q_2$$

$$\alpha = \frac{Q_2}{Q_1 - Q_2}$$

In a heat engine, heat cannot be fully converted to work; likewise a refrigerator cannot work without some external work done on the system