LECTURE NOTES

ON

REFRIGERATION & A/C

CE C471 / ME C461 / ME F461

INTRODUCTION

BY

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OBJECTIVES

1. INTRODUCTION
2. GAS (AIR)CYCLE REFRIGERATION
3. VAPOUR COMPRESSION REFRIGERATION SYSTEM
4. MULTI- PRESSURE SYSTEM
5. REFRIGERENTS
6. REFRIGERENT SYSTEM COMPONENTS
7. VAPOUR ABSORPTION REFRIGERATION SYSTEM
8. AIR CONDITIONING UNITS
9. PSYCHROMETRY OF AIR CONDITIONING PROCESS
10. HEATING & COOLING LOAD CALCULATIONS
11. DESIGN OF AIR CONDITIONING SYSTEM
12. DESIGN OF AIR DISTRIBUTION SYSTEM(DUCTS)
13. APPLICATION OF A/C SYSTEM

EVALUATION SCHEME

EC No.	Evaluation components	Nature of components	Duration	Weighatge	Date & time	Venue
1	Test-1	Closed book	50 minutes	25%	02-10-2013 W5	To be announced later
2	Quiz-1	Closed book	20-25 minutes	08%	23-10-2013 W5	
3	Test-2	Open book	50 minutes	20%	06-11-2013 W5	
4	Quiz-2	Closed book	20-25 minutes	07%	20 - 11-2013	
5	Compre	Closed book	3 Hours	40%	05-01-2014 (A N)	

INTRODUCTION

TWO CATEGORIES OF THERMAL PLANTS[DEVICES]

WORK PRODUCING	WORK CONSUMING
HEAT ENGINE (I.C ENGINE, GAS TURBINE STEAM TURBINE)	HEAT PUMPS REFRIGERATORS, COMPRESSORS PUMPS

DEFINITION

- **REFRIGERATION** is the cooling of air/liquids, thus providing lower temperatures to preserve food, cool beverages, make ice and for many other applications.
- **AIR CONDITIONING** :SIMULTANIUS CONTROL OF TEMPERATURE, HUMIDITY, CLEANLINESS AND AIR MOTION.

DEFINITION

REFRIGERATION- PRODUCTION OF COOL CONFINEMENT WITH RESPECT TO SURROUNDINGS.

ARTIFICIAL WITHDRAWAL OF HEAT, PRODUCING A TEMPERATURE LOWER THAN THAT WHICH WOULD EXIST.

SCIENCE OF PROVIDING & MAINTAINING TEMPERATURES BELOW THAT OF SURROUNDINGS.

REFRIGERATION MACHINERY WHICH DOES HEATING IS CALLED A HEAT PUMP.

REFRIGERATION- PUMPING OF HEAT OUT OF THE SYSTEMS

HEAT PUMP – PUMPING OF HEAT FROM THE SURROUNDINGS INTO THE SYSTEMS

DIFFERENCE BETWEEN REFRGERATION & HEAT PUMP

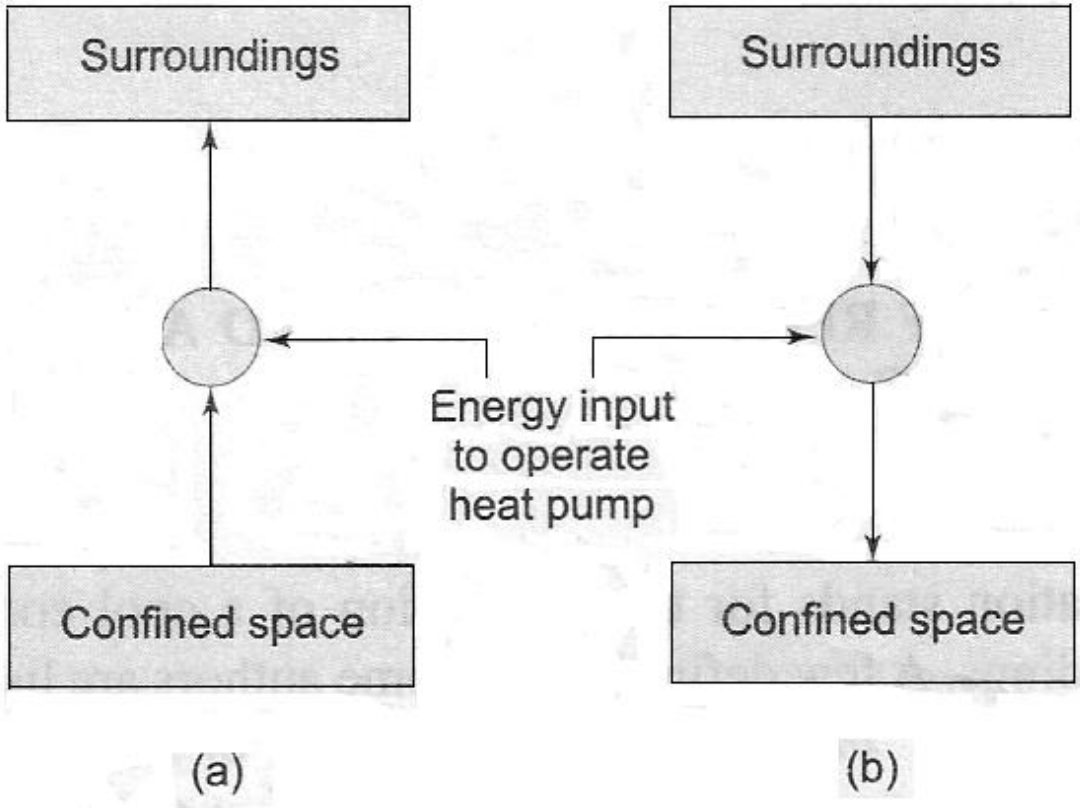


Fig. *Schematic representation of (a) refrigeration system and (b) heat pump*

REFRIGERATION

- **REFRIGERATION** is the process of removing heat from a place where it is not wanted and transferring that heat to a place where it makes little difference.

- In the average household, the room temperature from summer to winter is normally between 70^0F and 90^0F.
- The temperature inside the refrigerator fresh food section should be about 35^0F

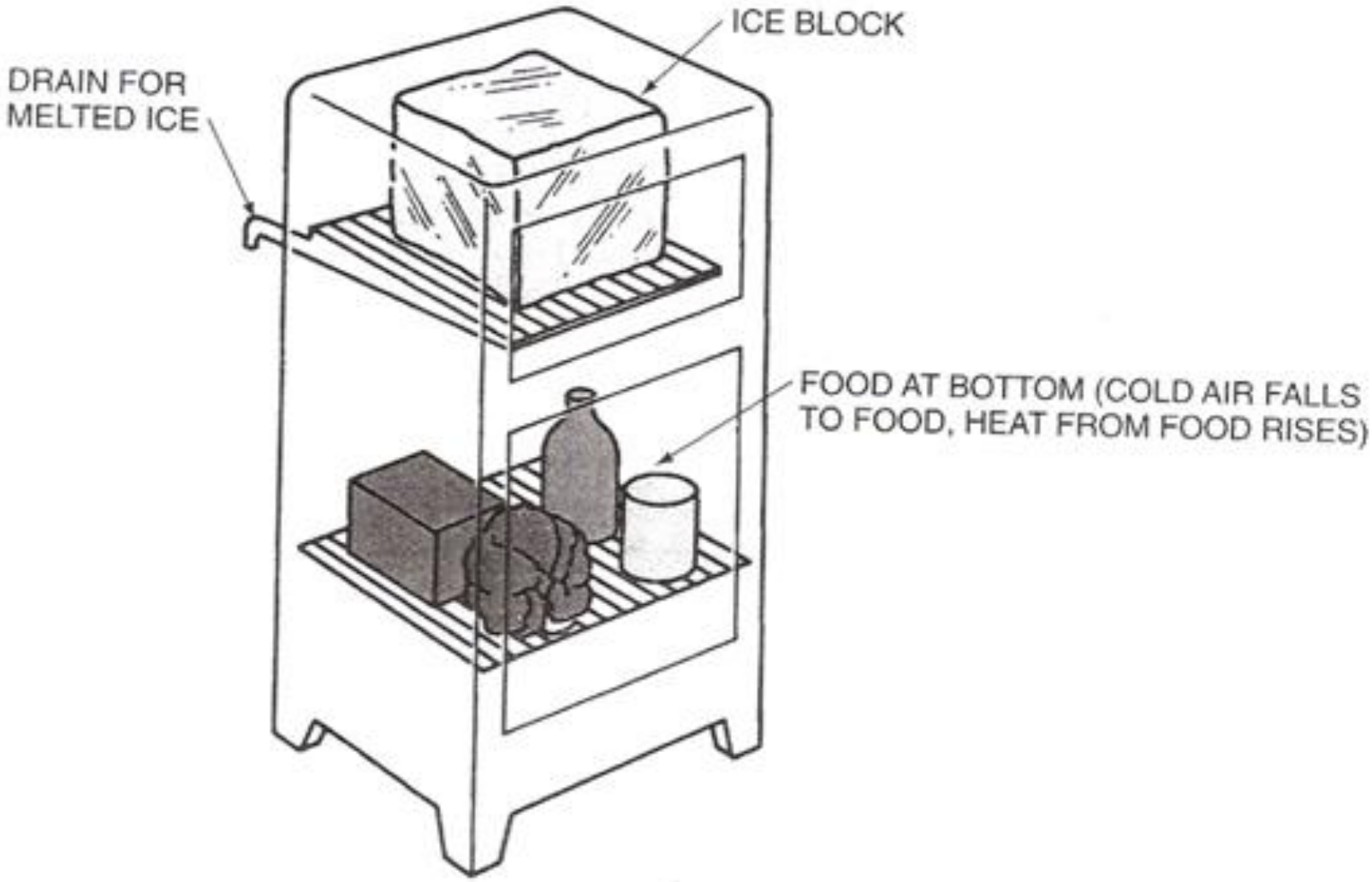


Figure Ice boxes were made of wood at first, then metal. The boxes were insulated with cork. If a cooling unit were placed where the ice is, this would be a refrigerator.

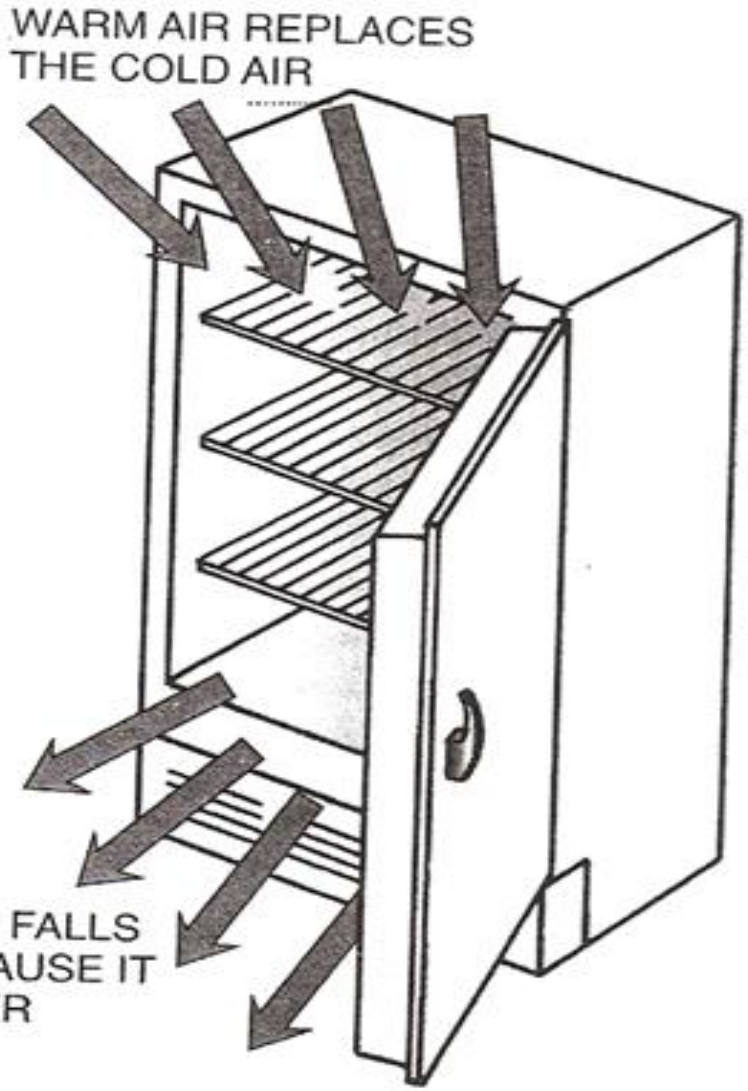


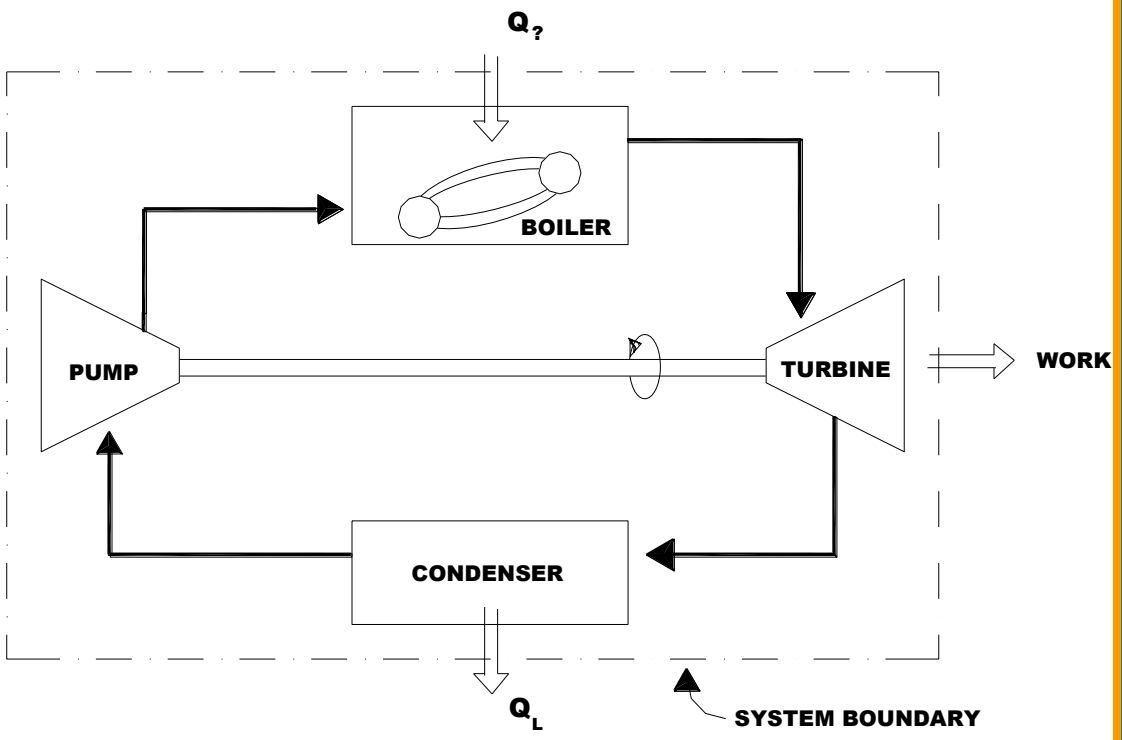
Figure The colder air falls out of the refrigerator because it is heavier. It is replaced with warmer air from the top. This warm air is a heat leakage.

STANDARD RATING OF A REFRIGERATION MACHINE

- The rating of a refrigeration machine is obtained by refrigerating effect or the amount of heat extracted in a given time from a body or space.
- One tonne of refrigeration is defined as the refrigerating effect (amount of heat extracted) produced by melting 1 tonne of ice from and at 0^0C in 24 hours.
- We know that latent heat of fusion of ice = 336 kJ/kg.
- Refrigerating effect of this heat in terms of tonne in 24 hours is rated as
- tonne of refrigeration
  - 1T.R = 336x 1000/ 24 = 14000kJ/hr.
  - = 210kJ/min. = 3.85 kJ/se

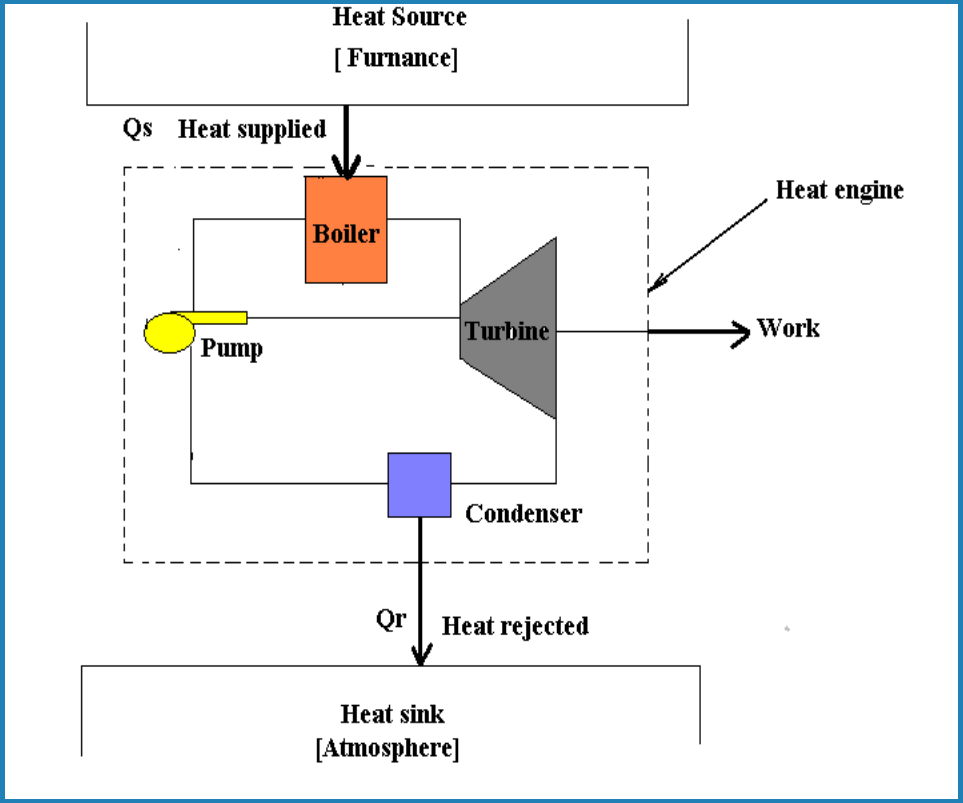
- **REFRIGERATION EQUIPMENT SMALLER IN SIZE AS COMPARED TO WORK PRODUCING PLANTS**
- **CENTRAL A/C - CONSUMES 2000 TO 5000 kW**
- **WINDOW A/C CONSUMES 2.5 kW**
- **DOMESTIC REFRIGERATOR – CONSUMES 250 W**

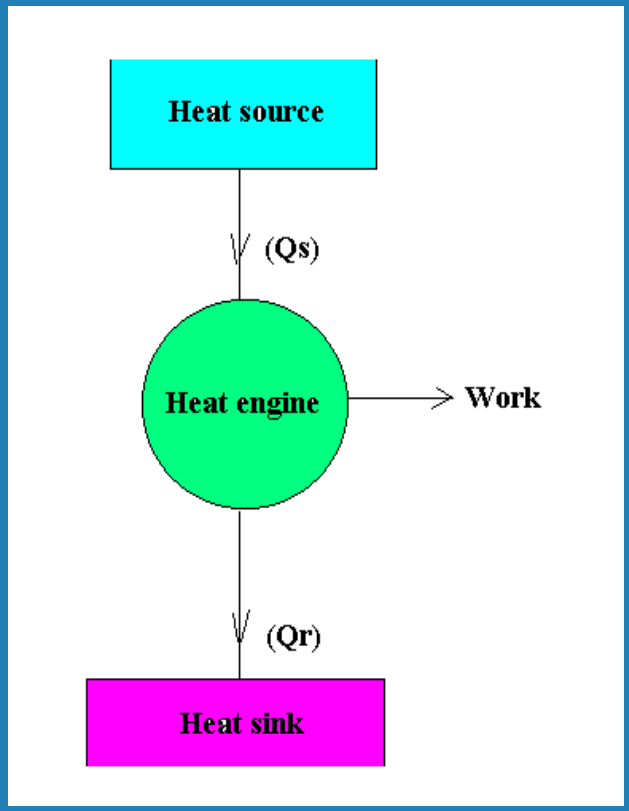
HEAT ENGINE



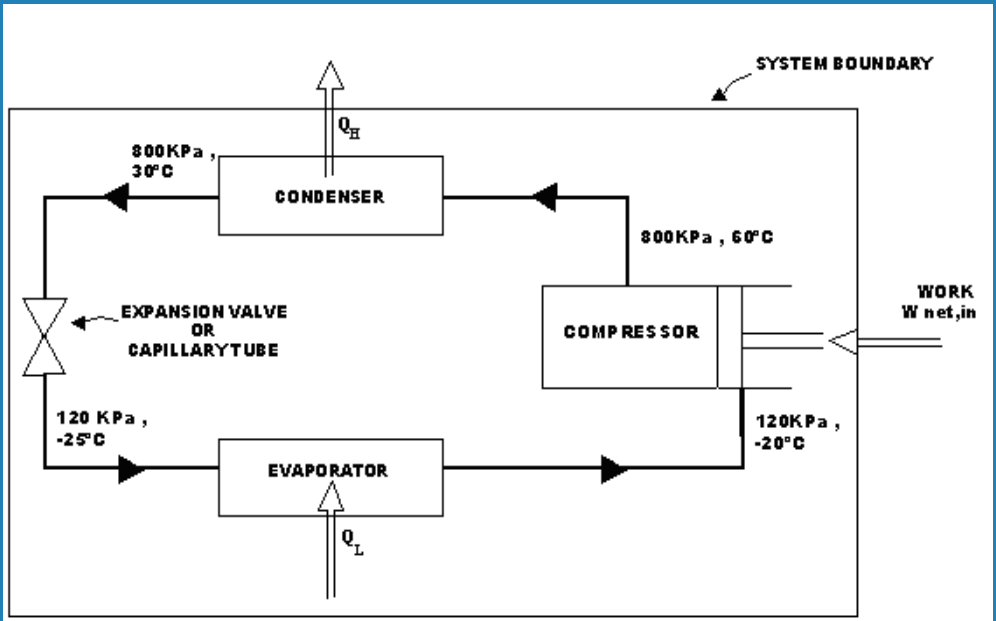
A HEAT ENGINE INVOLVING STEADY-STATE, STEADY FLOW PROCESSES.

HEAT ENGINE

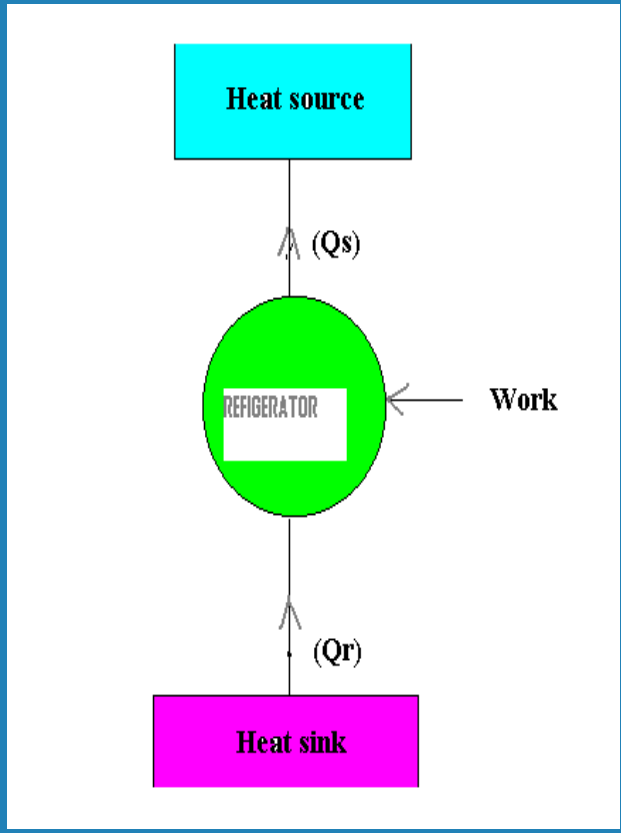

Heat Source
[Furnance]
Qs Heat supplied
Boiler
Heat engine
Pump
Turbine
Work
Condenser
Qr Heat rejected
Heat sink
[Atmosphere]


Heat source
(Qs)
Heat engine
Work
(Qr)
Heat sink

HEAT PUMP & REFRIGERATOR



A SIMPLE REFRIGERATION CYCLE.



COEFFICIENT OF PERFORMANCE

- **Performance of the refrigerator is determined by using co- efficient of performance which is defined as**

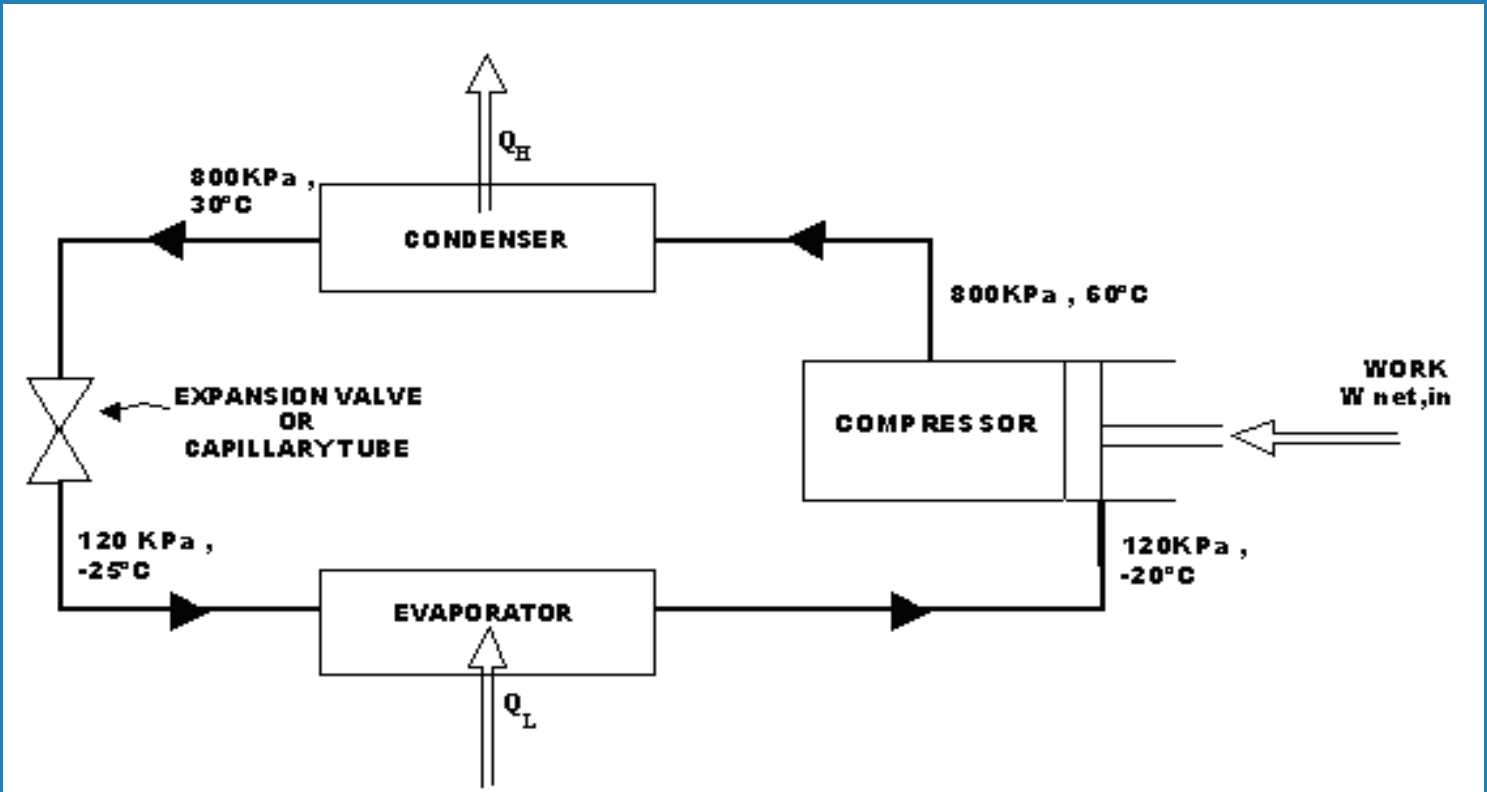
$$COP_R = \frac{\text{desired output}}{\text{required input}}$$

From the conservation of energy principle;

$$W_{net,\,in} = Q_H - Q_L$$

$$COP_R = \frac{Q_L}{Q_H - Q_L}$$

A simple refrigeration cycle



A SIMPLE REFRIGERATION CYCLE.

COP OF HEAT PUMP

$$COP_{HP} = \frac{\text{desired output}}{\text{required input}}$$

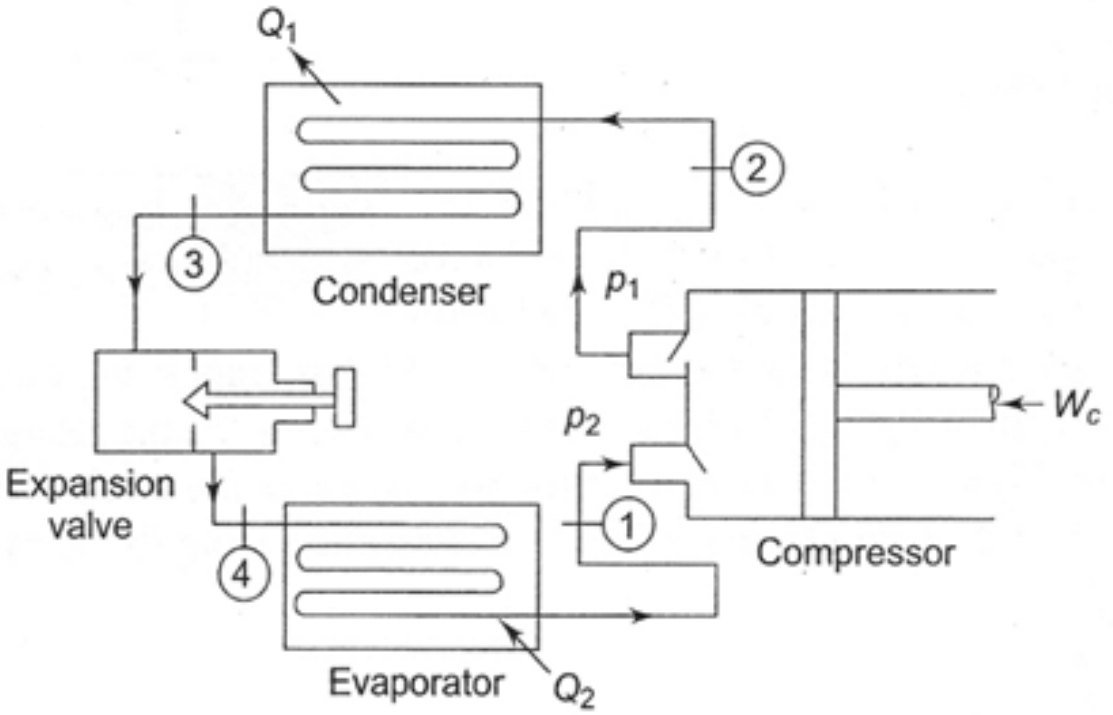
$$= \frac{Q_H}{W_{net,\,in}}$$

For fixed values of QL and QH, from the definition of COPR and COP HP, we can write

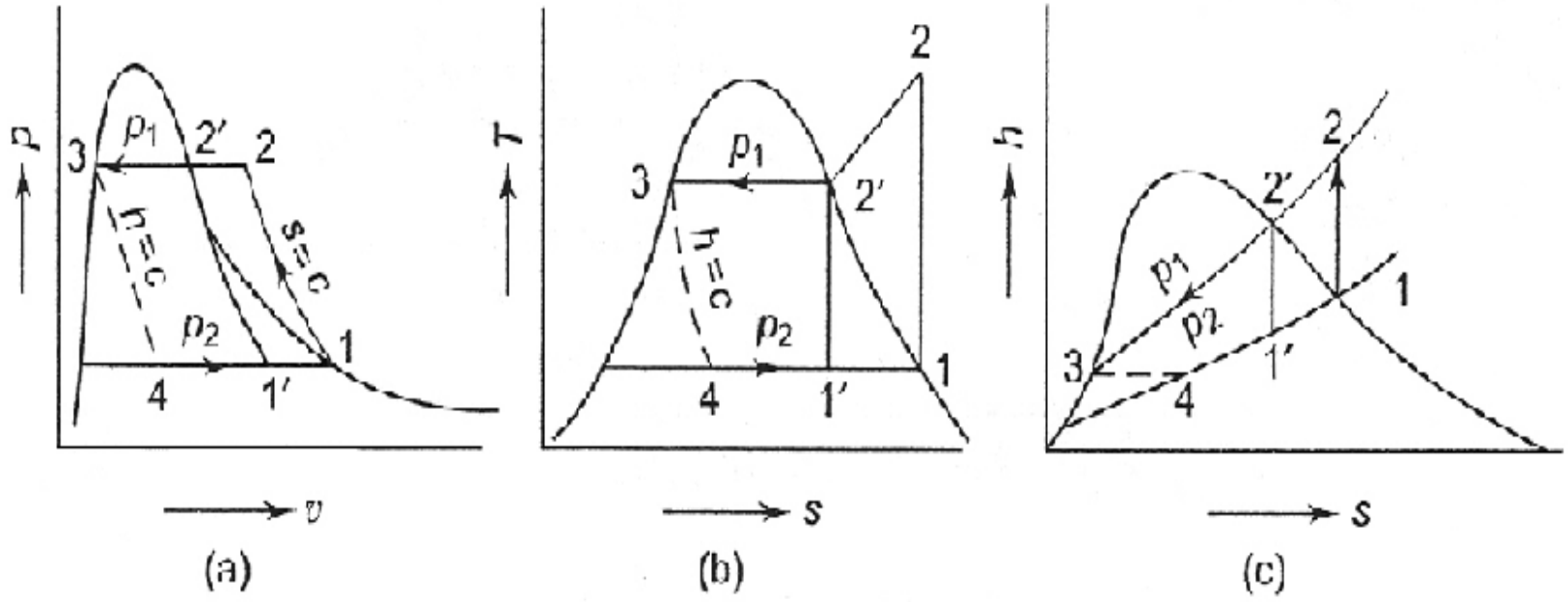
$$COP_{HP} = \frac{Q_H}{Q_H - Q_L}$$

$$COP_{HP} = COP_R + 1$$

VAPOUR COMPRESSION REFRIGERATION SYSTEM

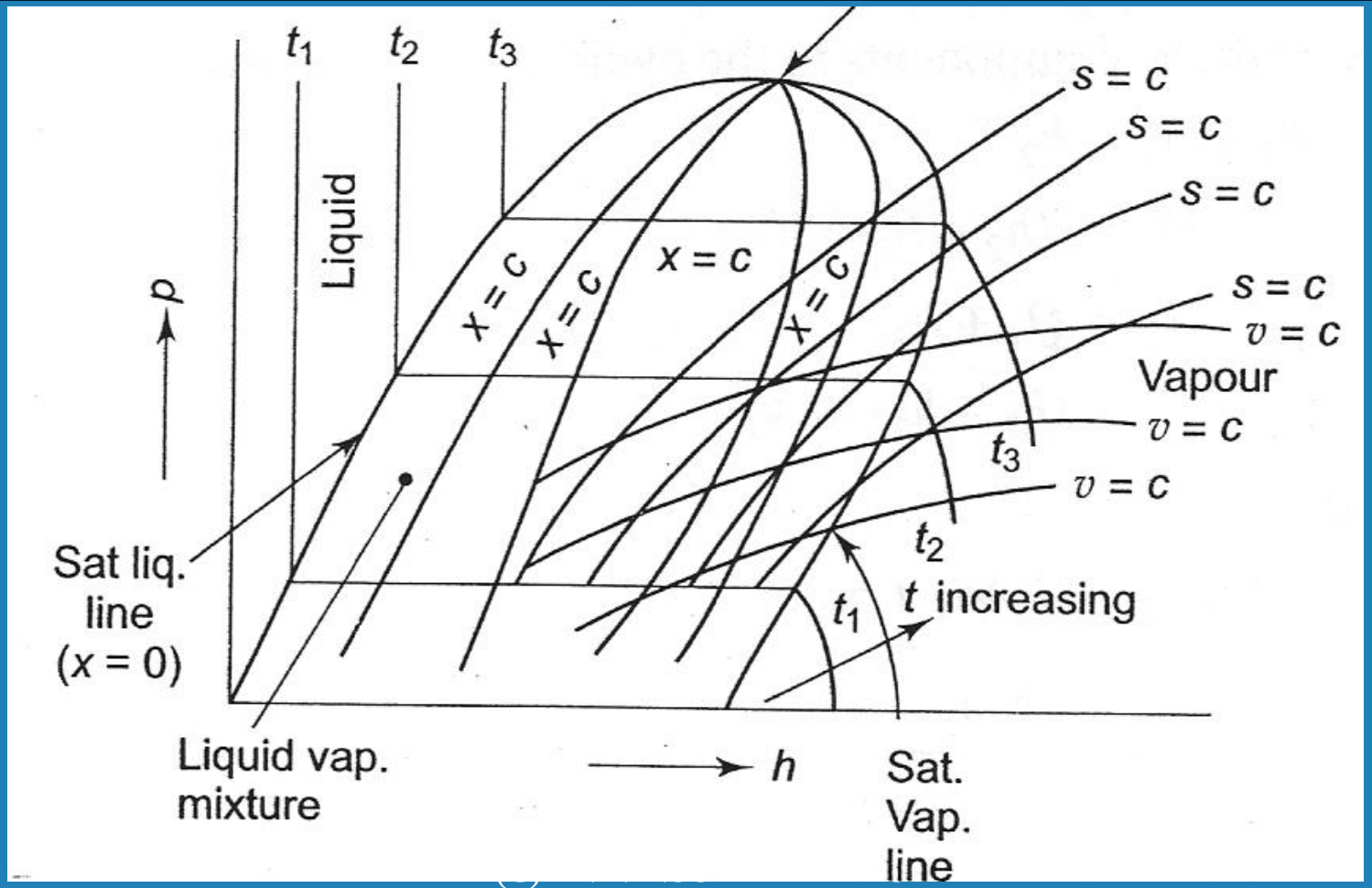


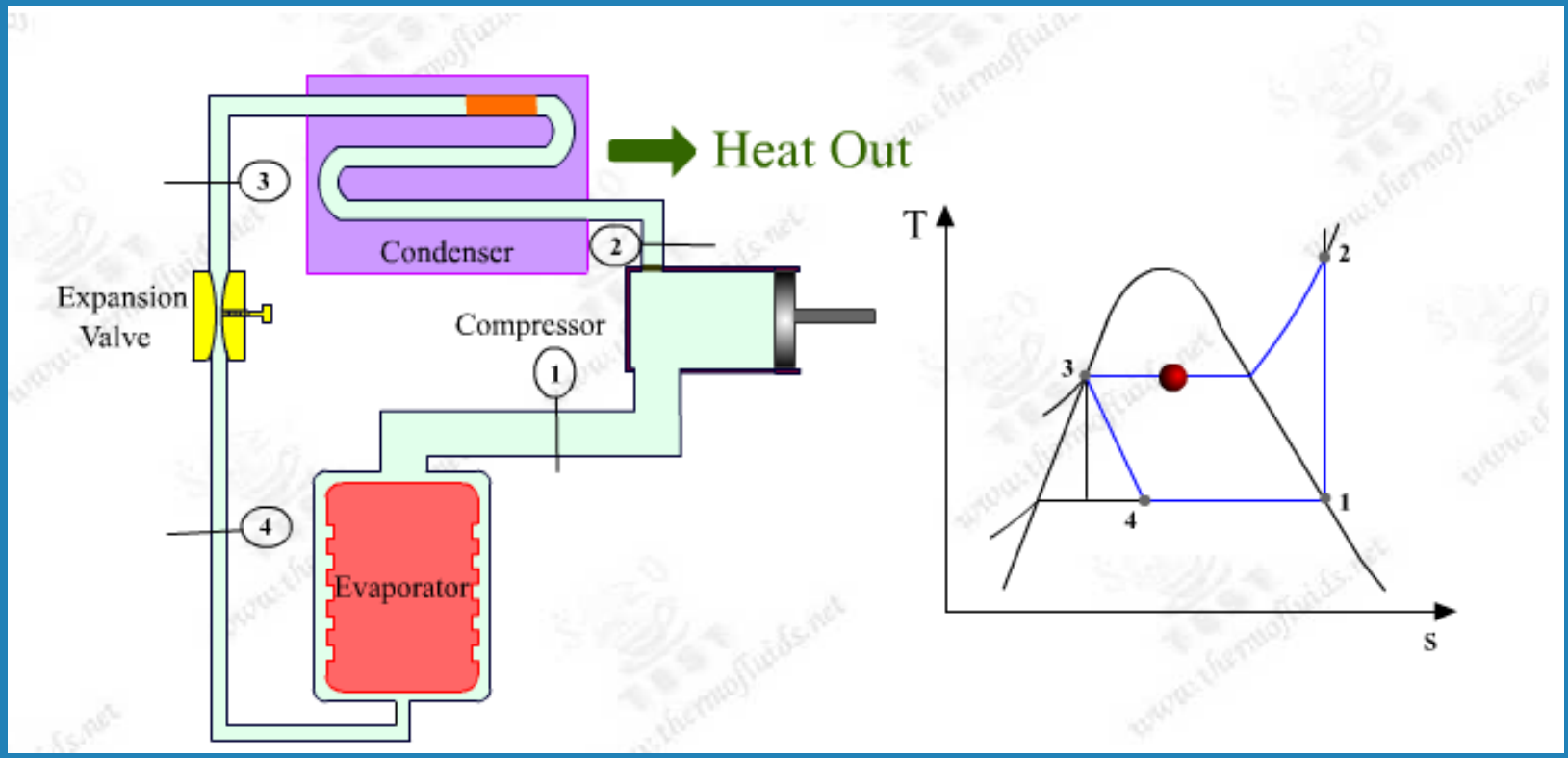
Vapour Compression Refrigeration Plant-flow Diagram



Vapour Compression Refrigeration Cycle-Property Diagrams

P-H CHART


t_1
t_2
t_3
Liquid
$x = c$
$x = c$
$x = c$
$x = c$
$s = c$
$s = c$
$s = c$
$s = c$
$v = c$
Vapour
$v = c$
$v = c$
t_3
t_2
t_1
t increasing
p
Sat liq. line ($x = 0$)
Liquid vap. mixture
h
Sat. Vap. line


Heat Out
Condenser
Expansion
Valve
Compressor
Evaporator
3
2
1
4
T
S