A R-12 plant has to produce 10 tons of refrigeration. The condenser and evaporator temperatures are 40ºC and -10ºC respectively. Determine

a) Refrigerant flow rate
b) Volume flow rate of the compressor
c) Operating pressure ratio
d) Power required to drive the compressor
e) Flash gas percentage after throttling
f) COP

Q1: A refrigeration unit is to be designed for a meat market using R-22 to maintain meat at 0.0°C while operating in an environment at 30.0°C. The refrigerant enters the condenser as a saturated vapor and exits as a saturated liquid. Determine the coefficient of performance (COP) for this refrigerator, using

(a) A reversed Carnot cycle operating between these temperature limits.

(b) An isentropic, vapor-compression refrigeration cycle with an adiabatic throttling valve installed between the high-pressure condenser and the low-pressure evaporator

(c) Draw the h-s diagram of the cycle

Q2: A commercial refrigerator with refrigerant-134a as the working fluid is used to keep the refrigerated space at −30°C by rejecting its waste heat to cooling water that enters the condenser at 18°C at a rate of 0.25 kg/s and leaves at 26°C. The refrigerant enters the condenser at 1.2 MPa and 65°C and leaves at 42°C. The inlet state of the compressor is 60 kPa and −34°C and the compressor is estimated to gain a net heat of 450 W from the surroundings.

Determine

(a) the quality of the refrigerant at the evaporator inlet

(b) the refrigeration load

(c) the COP of the refrigerator, and

(d) the theoretical maximum refrigeration load for the same power input to the compressor.

Q3: A vapor compression plant uses R134a and has a suction saturation temperature of -5^{o}C with a condenser saturation temperature of 45^{o}C. The vapor is dry saturated entering the compressor after evaporator and there is no subcooling of vapor at the exit of condenser. The compression is carried out isentropically in two stages and a flash chamber is employed at intermediate stage with a saturation temperature of 15^{o}C. Calculate

(a) the amount of vapor bled off at the flash chamber

(b) state of the vapor at the inlet of second stage compressor

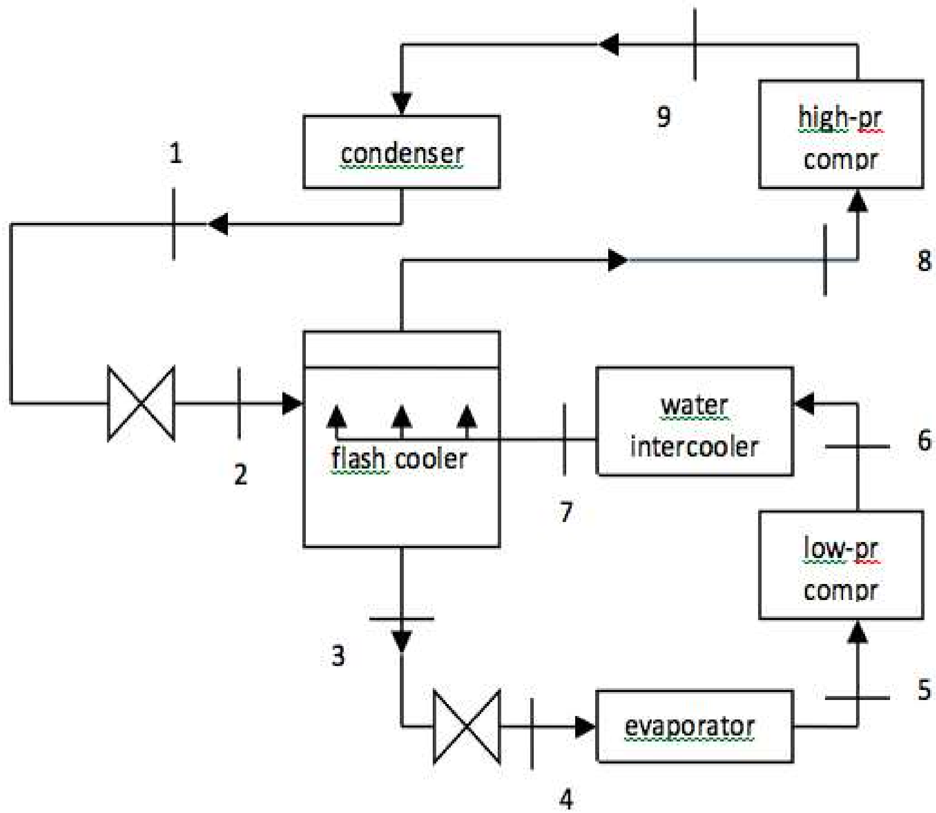
(c) refrigeration effect per unit total mass of the refrigerant

(d) the work done and COP

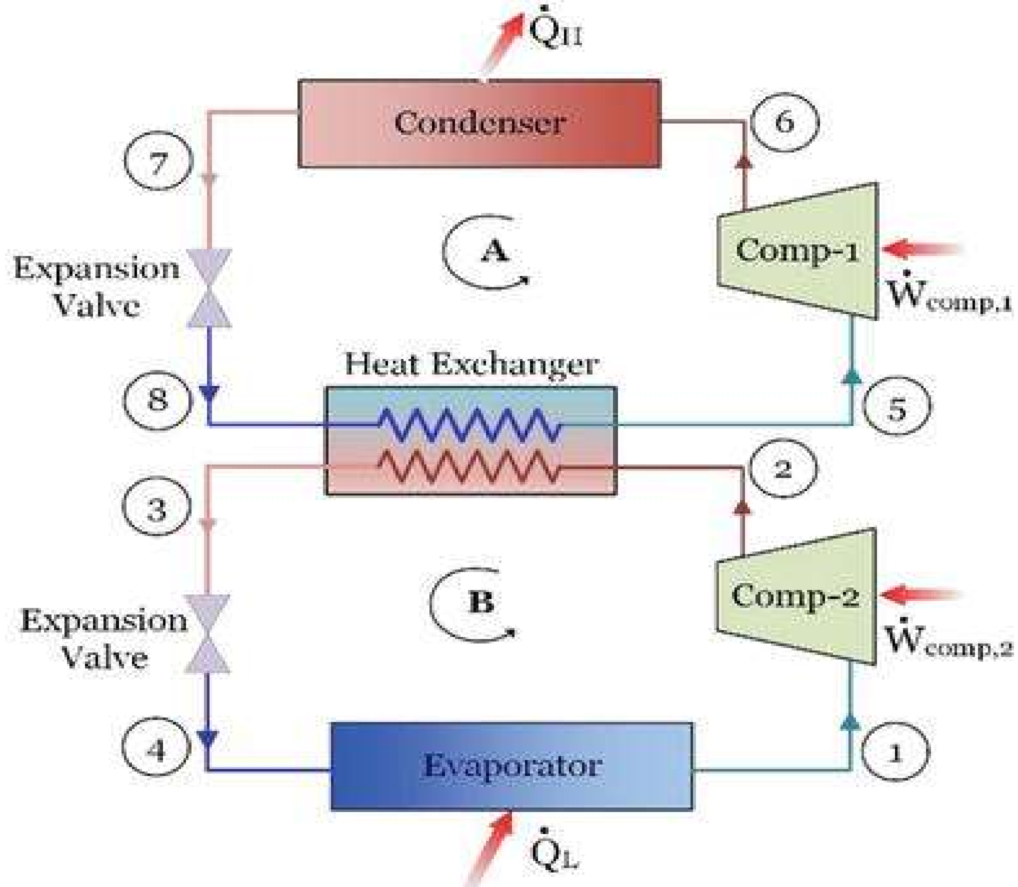
(e) draw the p-h and p-v diagram

Q4: Draw the p-v, h-s and T-s diagram for the following VCR cycle configurations

(a)

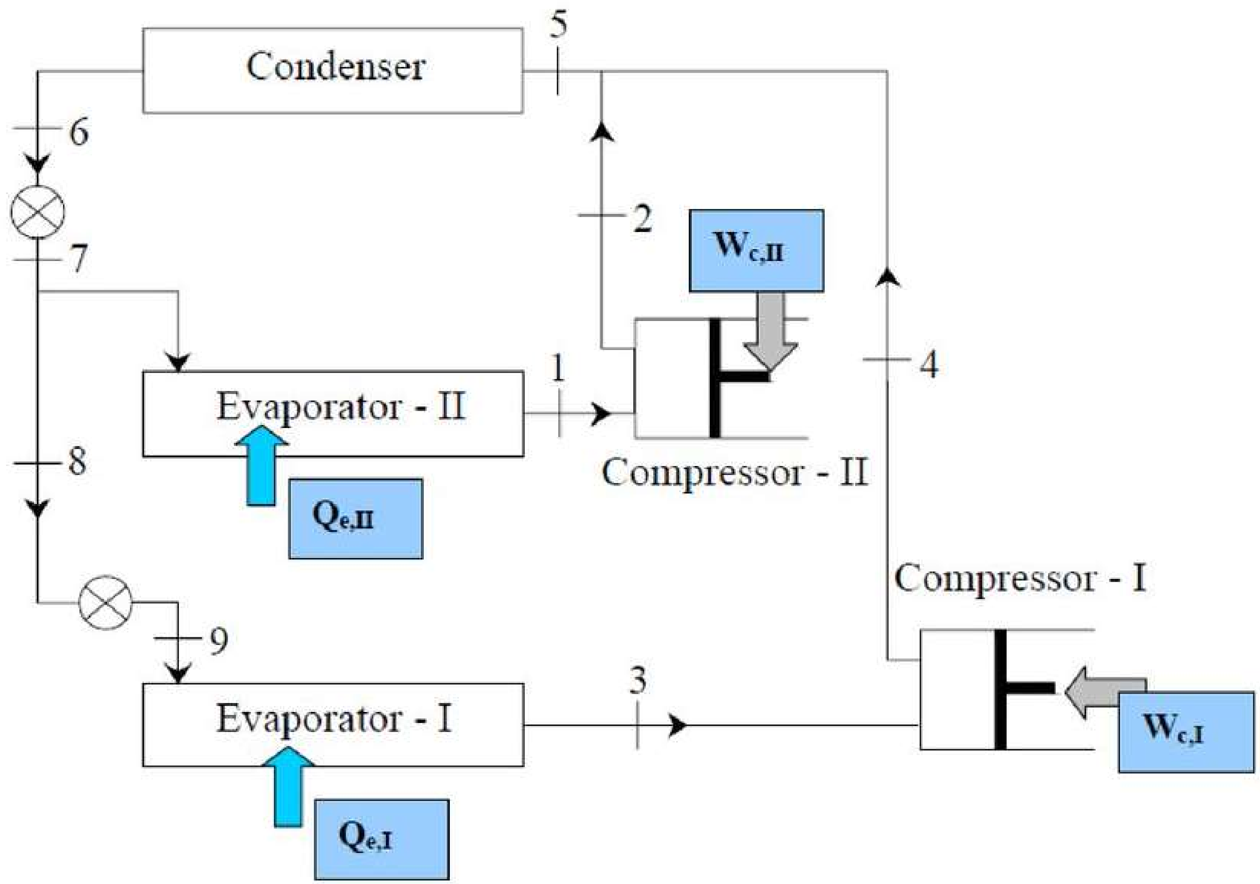


(b)



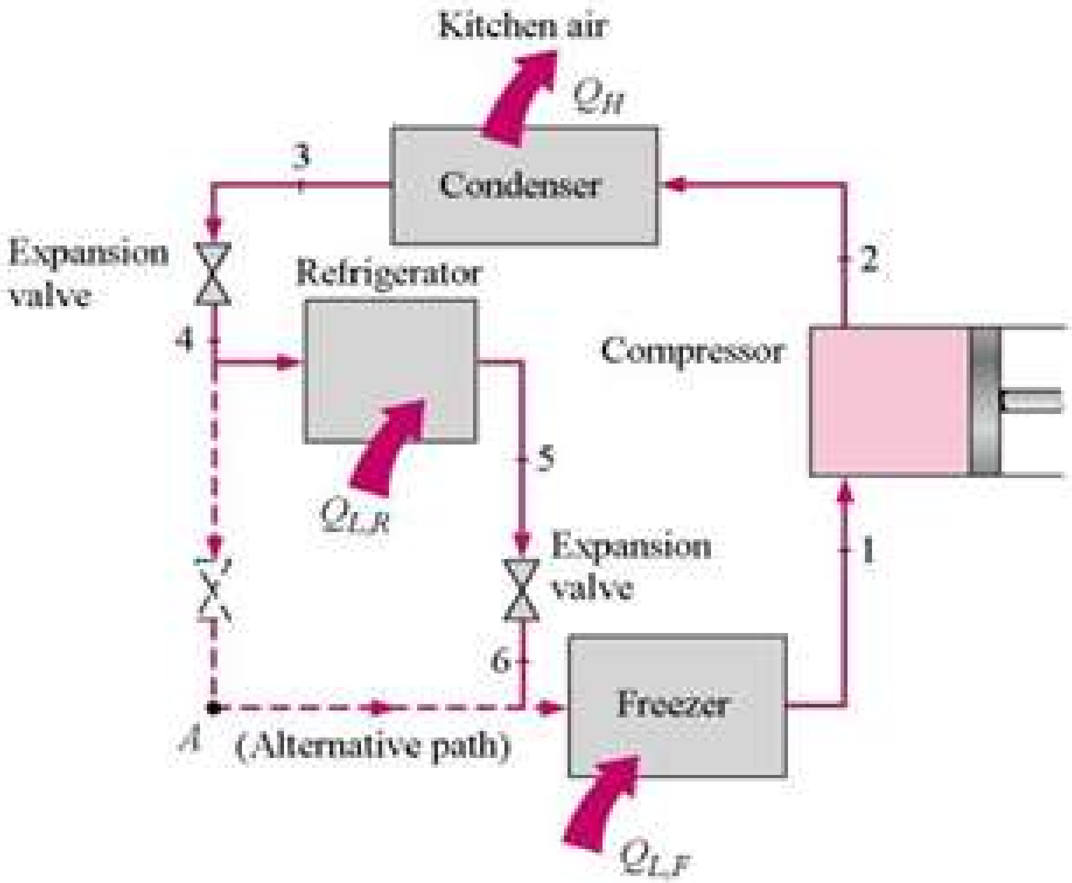
$\dot{Q}_H$
Condenser
6
7
A
Comp-1
$\dot{W}_{comp,1}$
Expansion Valve
Heat Exchanger
8
5
2
3
B
Comp-2
$\dot{W}_{comp,2}$
Expansion Valve
4
Evaporator
1
$\dot{Q}_L$

(c)



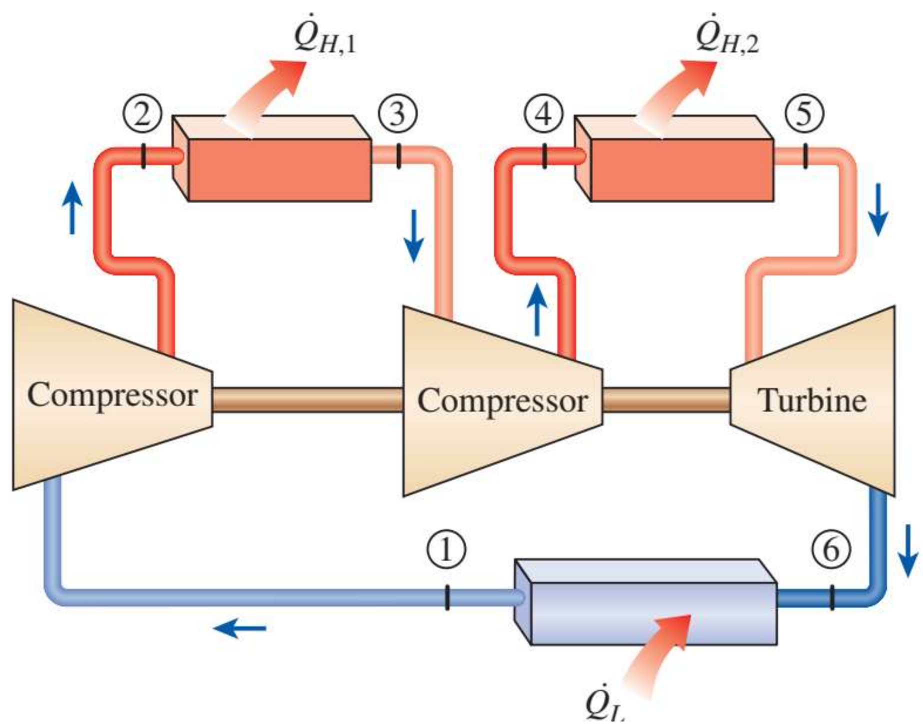
Condenser
5
6
7
2
$W_{c,II}$
4
1
Evaporator - II
Compressor - II
8
$Q_{e,II}$
Compressor - I
9
3
Evaporator - I
$W_{c,I}$
$Q_{e,I}$

(d)


Kitchen air
Q_H
3
Condenser
Expansion valve
Refrigerator
2
4
Compressor
5
$Q_{L,R}$
Expansion valve
1
6
Freezer
A
(Alternative path)
$Q_{L,F}$

Q5: Show that how the throttling process is considered as isenthalpic process with heat transfer possibilities. Draw the T-P curve for constant enthalpy and indicate the reduction of temperature during throttling process.

An ideal gas refrigeration system with two stages of compression with intercooling as shown in Figure operates with air entering the first compressor at 90 kPa and -24°C. Each compression stage has a pressure ratio of 3, and the two intercoolers can cool the air to 5°C. Calculate the coefficient of performance of this system and the rate at which air must be circulated through this system to service a 45,000 kJ/h cooling load.



Consider a room that contains air at 1 atm, 35°C, and 40 percent relative humidity. Using the psychrometric chart, determine (a) the specific humidity, (b) the enthalpy, (c) the wet-bulb temperature, (d) the dew-point temperature, and (e) the specific volume of the air.

An air-conditioning system is to take in outdoor air at 10°C and 30 percent relative humidity at a steady rate of 45 m3/min and to condition it to 25°C and 60 percent relative humidity. The outdoor air is first heated to 22°C in the heating section and then humidified by the injection of hot steam in the humidifying section. Assuming the entire process takes place at a pressure of 100 kPa, determine

(a) the rate of heat supply in the heating section and (b) the mass flow rate of the steam required in the humidifying section.

Air enters a window air conditioner at 1 atm, 30°C, and 80 percent relative humidity at a rate of 10 m3/min, and it leaves as saturated air at 14°C. Part of the moisture in the air that condenses during the process is also removed at 14°C. Determine the rates of heat and moisture removal from the air.

Saturated air leaving the cooling section of an air-conditioning system at 14°C at a rate of 50 m3/min is mixed adiabatically with the outside air at 32°C and 60 percent relative humidity at a rate of 20 m3/min. Assuming that the mixing process occurs at a pressure of 1 atm, determine the specific humidity, the relative humidity, the dry-bulb temperature, and the volume flow rate of the mixture.