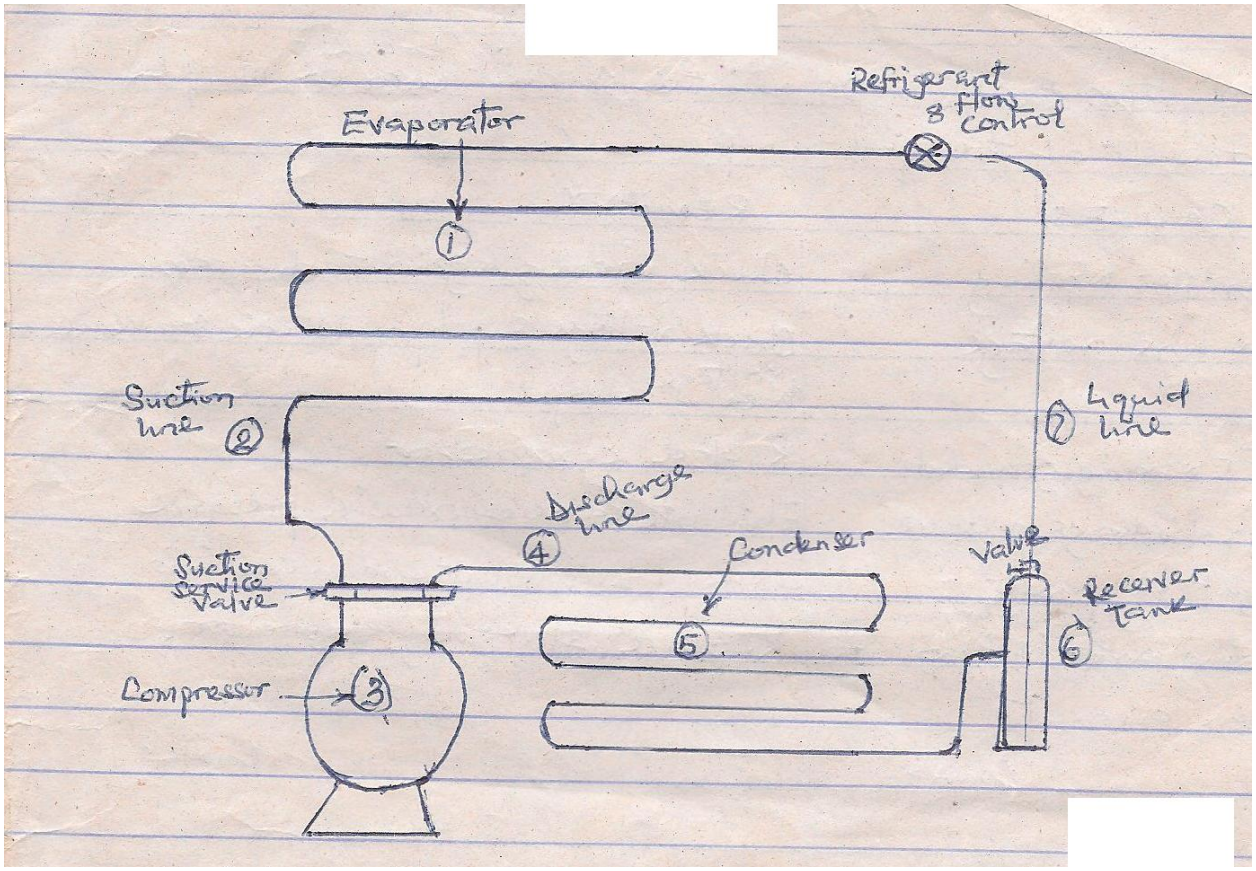
NATIONAL BUSINESS AND TECHNICAL EXAMINATIONS BOARD (NABTEB)
REFRIGERATION AND AIR-CONDITIONING
MAY/JUNE 2008 MODEL QUESTIONS AND ANSWERS

QUESTIONS

1) Explain with a well labeled drawing the mode of a vapour compression system.

ANSWERS



Vapour Compressor System
The principal parts of the system are stated in the diagram above. The evaporator is the heat transfer surface through which heat can pass from the refrigerated space or products into the vaporizing refrigerant which is then conveyed to the compressor via the suction line. The compressor's function is to remove the vapour from the evaporator, raise its temperature and pressure to a point such that the vapour can be condensed with normally available condensing media. A hot gas or discharge line delivers the high temperature, high pressure to the condenser. The condenser is responsible for converting the vapour to liquid delivering it via the liquid line to the control. The control meters the proper amount of refrigerant to the evaporator. The refrigerant circulation through the system is done by the compressor.

QUESTION

2) A cold room unit trips on overload. The overload was changed with a new one, yet the unit will not work but trips off the circuit breaker. What would be the probable cause and solution to this problem.

ANSWER

2. A system that trips off the circuit breaker may be as a result of the following:

	CAUSES	**REMEDY**
1.	Improper Wiring	Check wiring against diagram
2.	Low line voltage	Check voltage supply and locate source of voltage drop.
3.	Stator Winding Ground	Replace Compressor.
4.	High Discharge Pressure	Eliminate cause of excessive pressure
5.	Tight Compressor	Check oil level, correct binding condition.
6.	Starting Capacitor with Open circuit.	Replace starting capacitor.

QUESTION

3(a) Define and state Boyles law.
(b) A gas having an initial volume of $1.5m^3$ at a temperature of 280k is heated under constant pressure until its volume increases to $2.5m^3$. Determine the final temperature of the gas in Kelvin.

ANSWER

3(a) Boyles law states that the volume of a fixed mass of gas varies inversely as the pressure provided the temperature is kept constant.
$P_1V_1 = P_2V_2$

(b) Given values
$V_1 = 1.5m_3$
$T_1 = 280k$
$V_2 = 2.5m_3$
$T_2 = ?$

Formular = $\frac{V_1}{T_1} = V_2$ or $V_1T_2 = V_2T_1$

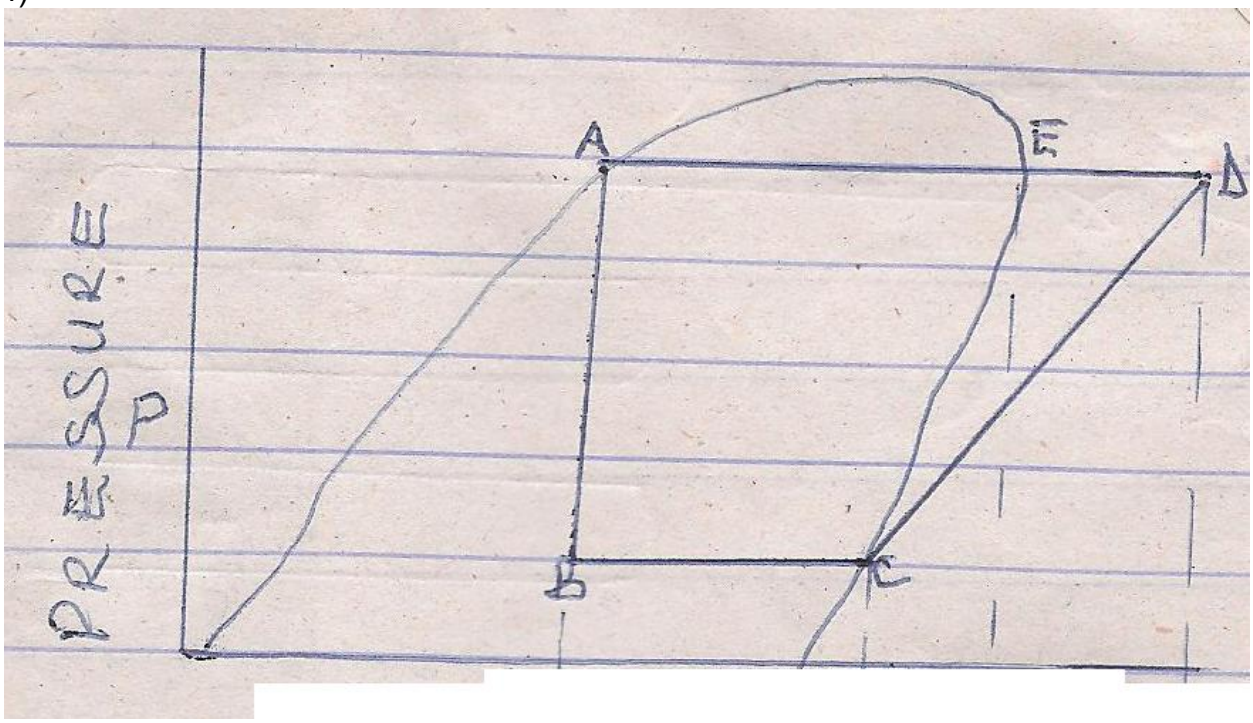
Therefore, $T_2 = \frac{V_2T_1}{V_1}$

$T_2 = \frac{2.5m^3 \times 2.80k}{1.5m^3}$

= 466.7k

QUESTION

4)

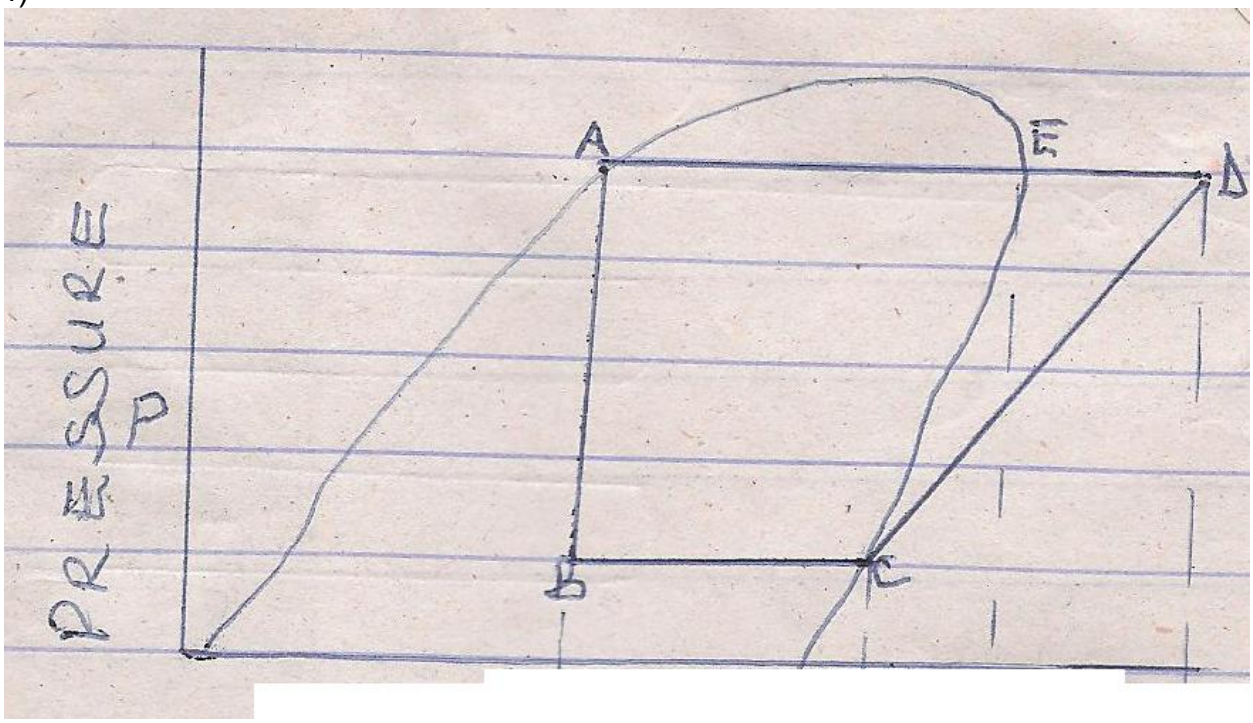


From the pressure/enthalpy chart shown above, state how the following values can be computed.

i. Net refrigerating effect.
ii. Heat of compression.
iii. Heat of condensation
iv. Co-efficient of performance.

ANSWER

4)



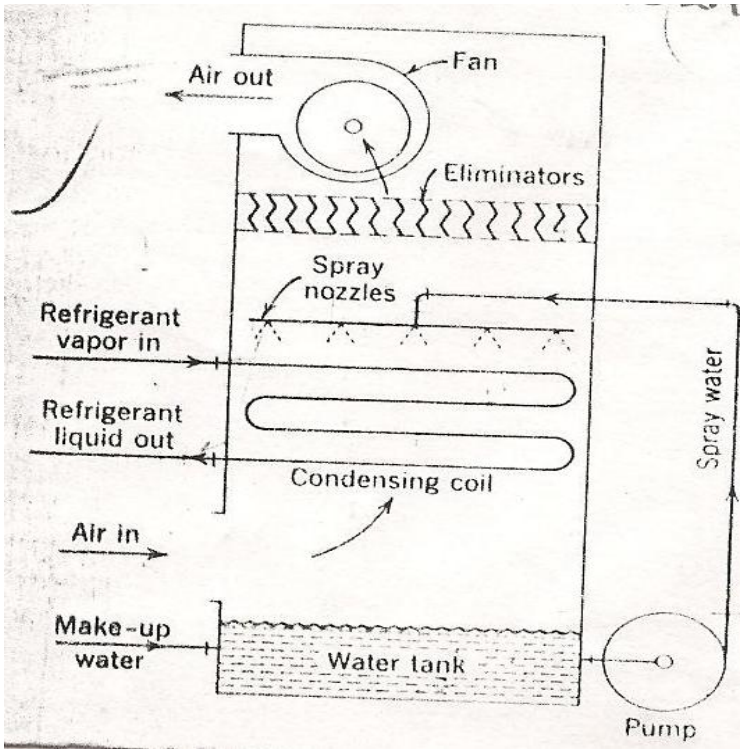
i. Net Refrigerating Effect
ii. H.b.c Head of Compression
iii. Heat of Condensation
H
E N T H A L P Y
iv. Co-efficient of performance = Net refrigerating effect / Heat of Compression.

QUESTION

5) Draw and explain the operation of evaporative condenser

ANSWER

5)



An evaporative condenser is essentially a water conservation device and is in effect a condenser and a cooling tower combined in a single unit and shown in the diagram below.

The water pumped from the sump up to the spray header, sprays down over the refrigerant coils and returns to the sump. The air is drown in from the outside at the bottom of the condenser by action of the blower and is discharged back to the outside at the top of the condenser. In some cases, both pump and blower are driven by the same motor but in some separate motors are employed. The eliminators installed in the air stream above the spray header are to prevent entrained water from being carried over to the blower. The fundamental proves is evaporative cooling.

QUESTION

6) Describe properties of refrigerant and explain why each point raised is important.

ANSWER

A) It should be chemically inert to the extent that it is:

i. Non Flammable;
ii. Non explosive;
iii. Non toxic;
iv. It should not react unfavourably with the lubricating oil or any material normally used in the construction of refrigerating system. Since all fluids are toxic in the sense that they will cause suffocation when in concentration large enough to preclude sufficient oxygen to sustain life, toxicity is a relative term which becomes meaningful only when the degree of concentration and the time of exposure required to produce harmful effects are specified. The toxicity of most commonly used refrigerants has been tested and are separated into six groups according to their degree of toxicity.

With regards to flammability and explosiveness, most of the refrigerants in common use are entirely non-flammable and non explosive. Notable exceptions are ammonia and the straight hydrocarbons. Ammonia is slightly flammable and explosive when mixed in exact proportions with air. On the other hand, straight hydrocarbons are highly flammable and explosive and their use are limited to special applications.

B. Economic Considerations:

It is desirable that the refrigerant have physical and thermal characteristics which will result in minimum power requirements per unit of refrigerating capacity i.e. a high co-efficient of performance.

1) A high latent heat value is desirable in that the mass-flow rate per unit of capacity is less.
2) Accompanied a low specific volume in the vapour state, the efficiency and capacity of the compressor are greatly increased.