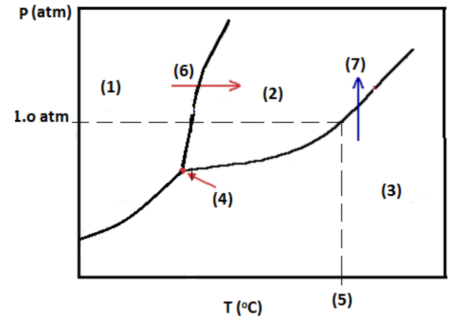
Model Answer of Model A

Answer the following questions (each with 5 marks)



1) The front graph represents the phase diagram of a matter

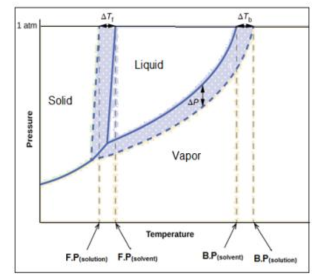
- Write down the names of **6 points only.** Each point with (0.5 mark)

(1) Solid (2) Liquid (3) Gas (4) Triple point (5) Boiling point
(6) Melting process (7) Condensation process

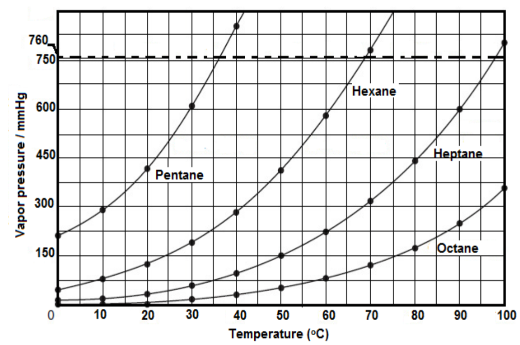
(0.5 mark) How many states at any solid lines in this diagram? 2 states

- **In the same graph,** *Could you please* draw the phase diagram of a solution containing a liquid mixed with a nonvolatile solute.

(1.5 mark)



2) Based on the following graph,



- The most volatile solvent is pentane
- Boiling point of hexane is around 68 °C **(0.5 mark for each)**
- Intermolecular forces in ocatne stronger than that in heptane.
- Calculate the total vapor pressure of an ideal solution made from mixing 2 moles of hexane with 2 moles of pentane at 30 °C.

Hexane = A, pentane = B,

$P_t = X_A P^o_A + X_B P^o_B$ **(2 marks)**

Since, P^o_A = 190 mmHg, P^o_B = 600 mmHg

$X_A = n_A/(n_A+n_B) = 2/(2+2) = ½$, $X_B = n_B/(n_A+n_B) = 2/(2+2) = ½$

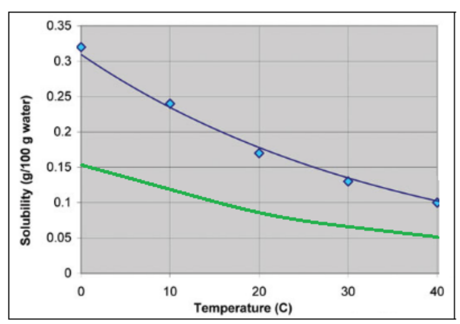
So, $P_t = 0.5 \times 190 + 0.5 \times 600 = 395$ mmHg

- If 0.2 mole of a nonvolatile non-electrolyte was added to 200 g heptane, what will be the elevation in its B.P (K_b of heptane = 3.43 °C mol^{-1} kg). $\Delta T_b = K_b \cdot m$ K_b = 3.43 °C mol^{-1} kg **(2 marks)**

since m is molality = n_{solute} / mass of solvent(Kg) = 0.2 / 0.2 = 1 mole/kg solvent

So elevation in boiling point, ΔT_b = 3.43 x 1 = 3.43 °C

3) **Based on the solubility curve of a certain gas in water <u>at 1.0 atm</u>.**



- In one sentence, describe why it behaves like this.

The solubility of gas in liquid solution decreases with the temperature, this is because as the temperature increases, the kinetic energy of gas molecules increases, thus they will have the ability to escape from the sc **(1 mark)**

- Predict the solubility of that gas in water at 40 °C when the pressure is lowered to its half.

m = k .P, since m is the solubility, K = Henry's constant x, P = pressure.
It can be written as: $m_1/m_2 = P_1/P_2$ since P_1 = 1.0 atm, P_2 = 0.5 atm.
m_1 at 40 °C = 0.1 g/100 g water, , m_2 at 40 °C = ??? so, m_2 = (0.5 x 0.1)/ 1.0 = 0.05 g/100 g water **(2 marks)**

- ***In the same graph,*** *please* draw a new solubility curve for this gas at this new pressure.

Since the solubility is directly proportional to the pressure, the new curve (at 0.5 atm) will be under the original curve at the graph.

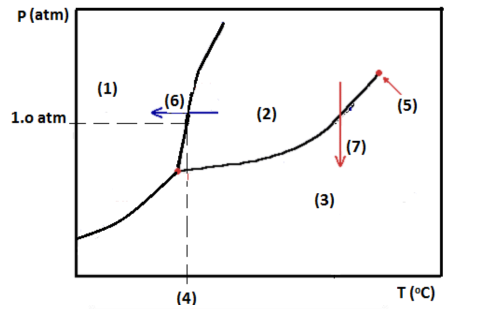
(2 marks)

Benha University- Faculty of Engineering – Shubra
Mid term exam in Engineering chemistry

Department of mathematics & engineering physics
Preparatory year, first term 2019

Model Answer of Model B

Answer the following questions (each with 5 marks)



1) The front figure represents the phase diagram of a solvent

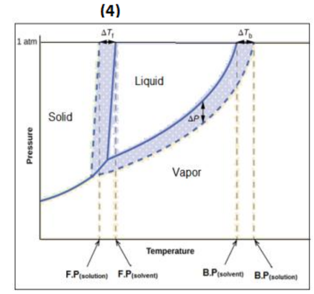
- Write down the names of **6 points only.** Each point with (0.5 mark)

(1) Solid (2) Liquid (3) Gas (4) Freezing point (5) Critical point
(6) Freezing process (7) Evaporation process

- How many states at any region in this diagram? One state **(0.5 mark)**

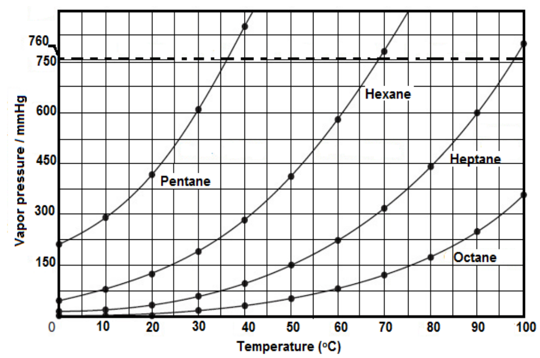
- **In the same graph**, *Could you please* draw the phase diagram of a solution containing this solvent mixed with a nonvolatile solute.

(1.5 mark)



2) Based on the following graph,

- The strongest intermolecular force is in octane
- P^o of heptane at 75 °C is 375 mm Hg **(0.5 mark for each)**
- Boiling point of hexane larger than that of pentane



- Calculate the total vapor pressure of an ideal solution made from mixing 2 moles of heptane with 2 moles of octane at 60 °C.

Heptane = A, octane = B,

$Pt = X_A P^o_A + X_B P^o_B$ **(2 marks)**

Since, P^o_A = 225 mmHg, P^o_B = 75 mmHg

$X_A = n_A/(n_A+n_B) = 2/(2+2) = ½$, $X_B = n_B/(n_A+n_B) = 2/(2+2) = ½$

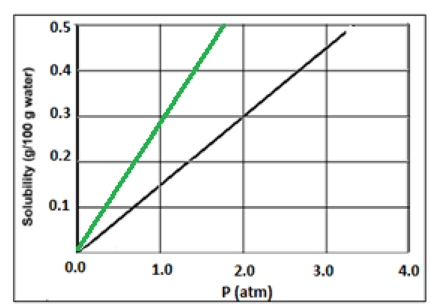
So, Pt = 0.5 x 225 + 0.5 x 75 = 150 mmHg

- If 0.5 mole of a nonvolatile non-electrolyte was added to 100 g heptane, what will be the elevation in its boiling point (K_b of heptane = 3.43 °C mol^{-1} kg). $\Delta T_b = K_b \cdot m$ K_b = 3.43 °C mol^{-1} kg **(2 marks)**

since m is molality = n_{solute} / mass of solvent(Kg) = 0.5 / 0.1 = 5 mole / kg solvent

So elevation in boiling point, ΔT_b = 3.43 x 5 = 17.15 °C

3) Based on the solubility curve of a certain gas in water <u>at 30 °C</u>.



- Give two limitations of the law controlling the following behavior.

Solubility is directly proportional to pressure of gas **(1 mark)**
Limitation: P is not high, T is not too low

- Predict the solubility of that gas in water at 30 °C when the pressure is increased from 2.0 atm to 4.0 atm.

m = k .P, since m is the solubility, K = Henry's constant x, P = pressure.
It can be written as: $m_1/m_2 = P_1/P_2$ since P_1 = 2.0 atm, P_2 = 4 atm.
m_1 at 2.0 at = 0.3 g/100 g water, , m_2 at 4.0 atm = ??? so, m_2 = (4.0 x 0.3)/ 2.0 = 0.6 g/100 g water **(2 marks)**

In the same graph, *please* draw a new line of solubility at 20 °C. Since the solubility is inversely proportional to the temperature, the new curve (at 20 °C) will be above the original curve at the graph.

(2 marks)