COLLIGATIVE PROPERTIES

1. (a) (i) Explain what is meant by the term colligative property of a solution.

   (ii) Give four examples of these properties in (a) (i) above.

   (b) (i) The vapour pressure of a solvent at 25°C is $3.15X10^3$ Nm^{-2}. Calculate the vapour pressure of a solution of 6.0 g urea, $CO(NH_2)_2$ in 100 g of water at the same temperature.

   (ii) The vapour pressure of a solution of 29.0 g of a substance **X** in 100 g of water at 50°C is $1.12 X 10^4$ Pa. if at the same temperature, the vapour pressure of water alone was $1.22 x 10^4$ Pa, Calculate the molecular mass of **X.**

2. The lowering of the vapor pressure of a solution containing 108.2 g of a non volatile solute **K** in 1000 g of water at 10°C is 24.79 Nm^{-2}. The vapor pressure of pure water is 2.338 KNm^{-2}. Calculate the R.F.M of **K**.

3. A solvent **Q** of molecular mass 62 has a vapour pressure of $1.0 x 10^4$ Nm^{-2} at 0°C. 23.4 g of a non volatile solute of molecular mass of 270 was added to 100 g of **Q** at 0°C. Calculate the vapour pressure of the solution.

4. When 18.04 g of sugar dissolve in 100 g of water, the vapour pressure of water lowered from 17.535 mmHg to 17.226mmHg. Calculate the molar mass of the sugar.

5. Calculate the expected vapour pressure at 25°C for a solution prepared by dissolving 158 g of a common table sugar, sucrose of molar mass 342.3 g in 643.5 cm^3 of water at 25°C. (density of water =0.9971 gcm^{-3}, vapour pressure of water =23.76 Pa)

6. The vapour pressure of pure ether is 32670 Nm^{-2}. Calculate the vapour pressure of camphor ($C_{10}H_6O$) in ether ($C_4H_{10}O$).

7. The vapour pressure of carbon disulphide at certain temperature is 53330 Nm^{-2}. At the same temperature 5 g of sulphur in 63cm^3 of carbon disulphide has a vapour pressure of 52320 Nm^{-2}, if the density of carbon disulphide is 1.27 gcm^{-3}. Calculate ;

   (i) RMM of sulphur.

   (ii) The molecular formular of sulphur in carbon disulphide.

8. A solution of 100 g of solute in 1dm^3 of water has a vapour pressure of 2.27 x 10^{-3} Nm^{-2} at 20°C. The vapour pressure of water at 20°C is 2.34 x 10^{-3} Nm^{-2}. Calculate the molecular mass of the solute.
9. The vapour pressure of benzene is 9.97 x10^{-3} at 20°C. What is the vapour pressure of the solution of 12.8 g of naphthalene, $C_{10}H_8$ in 100 g of benzene?
10. The vapour pressure of water at 25°C is 316 Pa. The vapour pressure of a solution containing 4 g of sugar in 100 g water at 50°C. The lowering of vapour pressure produced in 5mmHg. Calculate the molecular mass of urea. The vapour pressure of water at 50°C is 92mmHg.
11. The vapour pressure of ether (molar mass =74) is 442 mmHg at 293K. If 3 g of a compound A are dissolved in 50 g of ether at this temperature, the vapour pressure fails to 426 mmHg. Calculate the molecular mass of A. Assume that the solution of A in ether is very dilute.
12. (a) With the aid of a diagram, describe an experiment you can carry out to determine the formular mass of a substance using the method of freezing point depression.

    (b) (i) A solution of 3.7 g of sucrose $C_{12}H_{22}O_{11}$ in 100 g of water freezes at -0.204°C. If a solution containing 27.3 g per dm^3 of W freezes at -0.282°C, Calculate the molar mass of W.

    (ii) Calculate the freezing point of a solution of 28.0 g of ethanamide, CH3CONH2 in 500 g of water. The cryoscopic constant for 100 g of water is 18.6 °C.

    (c) 2.15 g of calcium nitrate dissolved in 100 g of water freezes at -0.62°C. Calculate the apparent degree of dissociation of the salt. Freezing constant for 1000 g of solvent 1.86°C.

    (d) Give one advantage of freezing point point depression for the determination of molecular masses over the boiling point elevation method.

    (e) Barium hydroxide has an apparent degree of ionization of 0.92. Calculate the freezing point of a solution 0f 2.5 g of barium hydroxide in 1.00dm^3.

13. (a) A n aqueous solution containing 9.0 g of glucose ($C_6H_{12}O_6$) in 250 cm^3 of water freezes at the same temperature as an aqueous solution containing 1.46 g of sodium chloride in 250 cm^3 of water.

(i) Explain what is meant by the term **Freezing point depression constant**.

(ii) Calculate the relative molecular mass of sodium chloride in water.

(iii) State any two assumptions made in a (ii) above.

(b) Compare your results in a (ii) above with the theoretical R.F.M of sodium chloride. Explain the differences between the two values.

14. Define the term freezing point constant.

b) When 1.2 g of sulphur was dissolved in 20 g of carbon disulphide the solution froze at 1.43^0C lower than the freezing point carbon disulphide. (K_f =6.10˚$Cmol^{-1}kg^{-1}$)

I. Calculate the relative formular mass of sulphur in carbon disulphide.

II. Deduce the molecular formular of carbon disulphide and and comment on your results.

c) On the same axes draw the cooling curve of carbon disulphide and for solution of sulphur in carbon disulphide.

15. a) State three limitations of the cryoscopic method of determining molar mass of solute.

b) The freezing point of solution containing 4.2 g mannitol dissolved in 50g of naphthalene was found to be 77.03^0C. Calculate the molar mass of mannitol. (K_f of naphthalene =6.87^0C) and the freezing point of pure naphthalene was found to be 80.2 ^{0}C.

c) State how the molar mass of manifold would be affected if association occurs in naphthalene. Give a reason for your answer.

16. (a) Define the terms.

(i) Colligative property

(ii) Osmotic pressure

b) Describe how the RMM of neoprene can be determined by using the osmotic pressure

c) State the;

(i) Laws of osmotic pressure

(ii) Conditions under which the laws are invalid.

d) The osmotic pressure of a 2.16% solution neoprene rubber is 0.45mmHg at 23^0C.

(i) Calculate the RMM of neoprene rubber.

(ii) Determine the number of monomers units in neoprene is 2-chlorobuta-1, 3-diene.

(e) Explain why osmotic pressure method was preferred over the freezing point method for determining the molecular mass of neoprene rubber.

17. The osmotic pressure of solution containing 4.0g of a substance Y per liter is $5.62 \times 10^5 Nm^2$ at 25^0C . Calculate the RMM of Y.

18. The osmotic pressure of an aqueous solution containing 1.24% polystyrene was 2.356×10^{-2} mmHg at 25^0C, Calculate the

(i) RMM of polystyrene.

(ii) Number of monomer units in polystyrene

19. Water boils at $100s^0$C at a pressure of 760mmHg.

(a) When atmospheric pressure reduced to 660mmHg water boils at 96^0C . Explain why the boiling reduced.

(b) When 0.76g of potassium chloride in 100 g of water, the solution boils at 100.11^0C at a pressure of 760mmHg.

(i) Explain why the boiling point changes on adding KCL for water.

(ii) Calculate the molar boiling point constant k_b for water.

c) When amino benzene (phenyl amine) or aniline and water are mixed to form two layers at 760mmHg the mixture boils at 97^0C . Explain why aniline reduces the boiling point of water.

20. (a) 30g of organic compound Y depressed the freezing point of 50 g of water by -6.2^0C. Calculate the RMM of Y. (freezing point depression for water is 1.86^0C mol).

(b) When the experiment was repeated using benzene instead of water a much higher value of molecular mass was obtained. Explain the observation.

21. The osmotic pressure of various concentrations of solute **X** in methyl benzene are given in the table below.

Concentration/ gdm^{-3}	1.0	2.0	3.0	4.0	5.0	6.0
Osmotic pressure/Nm^{-2}	23	37	53	75	92	109

(a) Plot a graph of osmotic pressure against concentration.

(b) Use the graph you have drawn to determine the molar mass of **X**.

22. The osmotic pressure of solutions of different concentrations measured at 298K for polymer is given in the table below.

Osmotic pressure / Pa	Concentration / gdm^{-3}
118	2.0
480	6.0
1000	10.0
1680	14.0

(a) Plot a graph of osmotic pressure against concentration,

(b) Use the graph to determine the molar mass of the polymer.

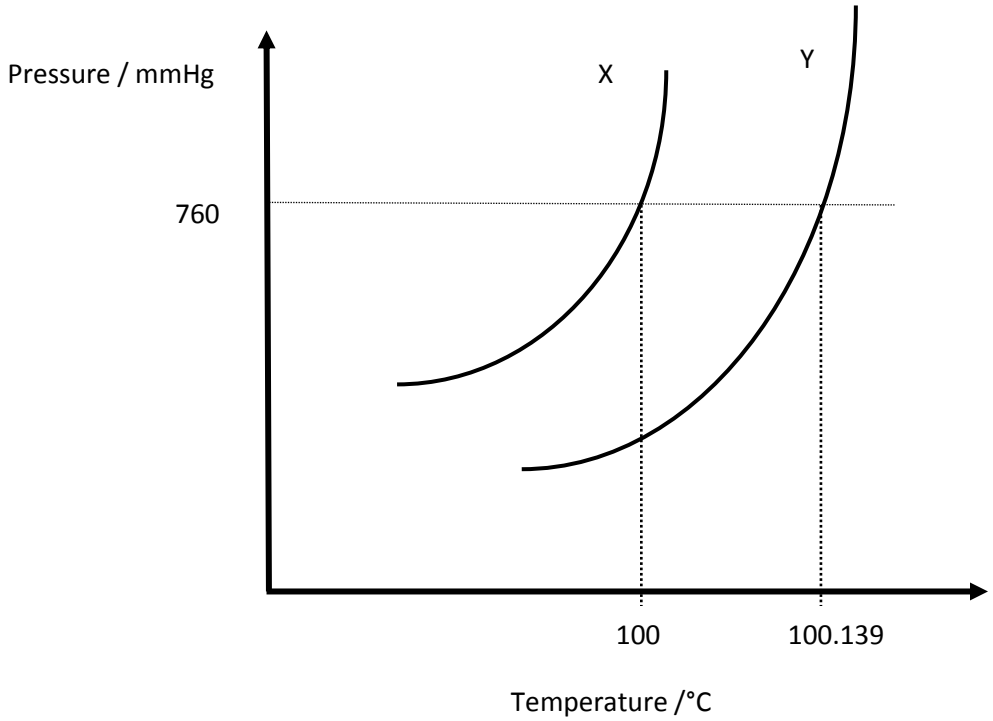
23. The freezing point of various concentration of a non volatile solute **K** in water at 1atm is given in the table below.

Concn./ gdm^{-3}	0	20	40	60	80	100	120	140
Freezing point/°C	0	-0.11	-0.22	-0.32	-0.43	-0.54	-0.65	-0.76

(a) Plot a graph of freezing point depression against concentration.

(b) Use the graph you have drawn to determine the RMM of **K** given K_f of water is $1.86°Cmol^{-1}Kg^{-1}$.

24. 5.5 g of a non volatile substance **B** dissolved in 125 g of solvent. The vapour pressure of the solution and pure solvent at constant pressure P are shown below.

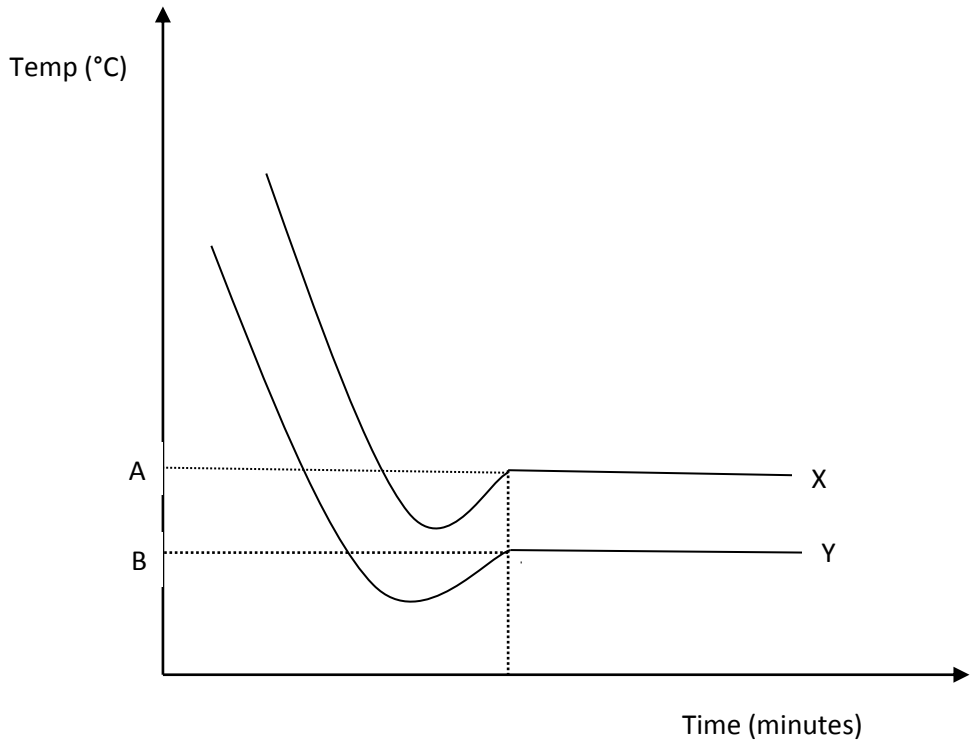


(a) Identify the curve for the solution.

(b) Calculate the molecular mass of **B. (Boiling point elevation constant for the solvent, Kb =0.52 $°Cmol^{-1}Kg^{-1}$**)

(c) State two limitations of your calculation in (b)

25. The cooling curve of a solution containing 1.2 g of sulphur in 200 g of carbon disulphide and pure carbon disulphide as shown below as shown below.



(a) (i) Identify curves X and Y

State what is represented by points A and B.

(b) (i) Calculate the RMM of sulphur in carbon disulphide. (The freezing point depression constant for carbon disulphide is 6.10 °C$mol^{-1}Kg^{-1}$ and freezing point depression of carbon disulphide was 1.43°C)

Comment on your answer.

Deduce and draw the structure of sulphur in carbon disulphide.