ADVANCED LEVEL PHYSICAL CHEMISTRY PROBLEMS

CHAPTER 4: COLLIGATIVE PROPERTIES

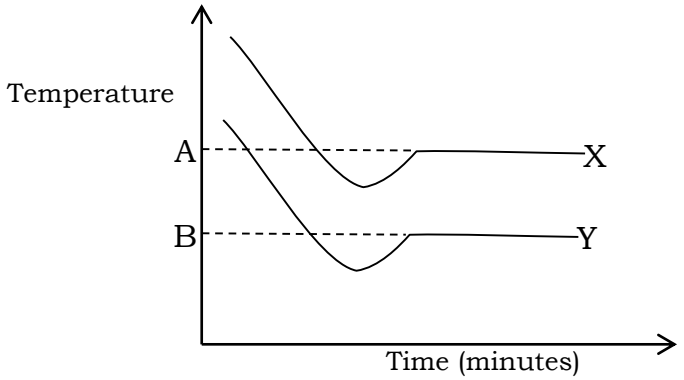
1. (a) One of the limitations of the method of determining the relative molecular mass by freezing point method is that the solute should not associate or dissociate in the solution.
   (i) State three other limitations of determining the molecular mass by freezing point method
   (ii) Explain how association of a solute in solution affects the molecular mass determined by freezing point method
   (b) A solution containing 0.142g of naphthalene in 20.25g of benzene caused a lowering of freezing point of 0.284°C. Calculate the molecular mass of naphthalene. (K_f of benzene is $5.12°Cmol^{-1}kg^{-1}$)

2. (a) The osmotic pressure of a solution containing $4.00gdm^{-3}$ of PVC in dioxane is $65Nm^{-2}$ at 20°C. Calculate the number of PVC monomers
   (b) A solution containing 28.145g of R in 250g of water froze at -3.490°C. determine the molecular mass of R

3. (a) Explain why a solution containing 2.5g of glucose ($C_6H_{12}O_6$), in 100g of ethanol boils at 83°C at 760mmHg yet pure ethanol boils at 78°C at the same pressure.
   (b) Using the data in (a), calculate the molar boiling point constant of ethanol.

4. (a) Define a colligative property.
   (b) A solution contains 1.80g of naphthalene in 3.0g of camphor
   (i) Calculate the melting point of the solution (molecular mass of naphthalene =128, melting point of pure camphor =177°C, K_f for camphor =40°C per mol per 100g.)
   (ii) State whether your answer in (b)(i) significantly affected if the pressure of the system was lowered. Give a reason.

5. The cooling curves of a solution containing 1.2g of sulphur in 20.0g of carbon disulphide and that of pure carbon disulphide are shown



(a) (i) Identify the curves X and Y
(ii) State what points A and B represent

(b) Calculate the relative formula mass of sulphur in carbon disulphide (the freezing point depression constant for carbon disulphide is 6.10°Cmol^{-1}kg^{-1} and the freezing point depression of carbon disulphide is 1.43°C)

(c) (i) Comment on your result in (b) above
(ii) Deduce and draw the molecular structure of sulphur in carbon disulphide.

6. (a) The osmotic pressure of a solution containing 4g per liter of a polymer is 65Nm^{-2} at 298K. calculate the molecular mass of the polymer

(b) The osmotic of pressure of a solution containing 2gdm^{-3} of nylon at 25°C was 0.155mmHg. calculate the molecular mass of nylon (R=0.0821atml^{-1}°Cmol^{-1})

7. (a) (i) Describe how the molecular mass of a substance can be determined using the freezing point depression method.
(ii) Explain why the method you have described above is not suitable for determining the molecular mass of a polymer

(b) Calculate the freezing point of a given solution containing 4.2g of ethane-1,2-diol (molecular 62) in 30g water. (K_f of water is 18.6°Cmol^{-1}per 100g).

(c) The osmotic pressure of various concentrations of solute X in methyl benzene at 25°C are given in the table below

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

(i) Plot a graph of osmotic pressure against concentration
(ii) Use your graph to determine the molecular mass of X

8. (a) Define the term freezing point constant of a substance

(b) A solution contains 1.54g of naphthalene ($C_{10}H_8$) in 18g of camphor freezes at 148.3°C. calculate the freezing point constant of camphor (the freezing point of camphor is 175°C)

9. (a) What is meant by the term boiling constant of a liquid

(b) Describe an experiment that can be used to determine the relative molecular mass of a compound by the method of elevation of boiling point of a liquid. Draw a labelled diagram of apparatus.

(c) Explain why the method you have described is not suitable for determining the relative molecular mass of ethanoic acid in aqueous solution.

(d) A solution of 2.8g of cadmium iodide (CdI_2) in 20g of water boiled at 100.2°C at normal pressure. Calculate the relative molecular mass of cadmium iodide and comment in your result. ($Cd = 112; I = 127$)

10. (a) Explain what is meant by
(i) Osmosis
(ii) Osmotic pressure

(b) State the significance of osmosis

(c) Describe a method which can be used to measure the osmotic pressure of a solution

(d) State the conditions under which solutions do not obey the laws of osmotic pressure

(e) The osmotic pressure of a solution containing 1.24% of a polymer is 3.1×10^{-3} atm at 25°C. Determine the relative molecular mass of the polymer. (take $R = 0.0821 atmol^{-1}°Cl^{-1}$)

11. The osmotic pressure of a solution containing 1.4g of a polymer X in 100cm^3 of a solution is 1200Nm^{-2} at 25°C.

(a) Calculate the relative molecular mass of X

(b) Determine the number of monomer units in X (the molecular of the monomer is 28)

(c) Determine the freezing point depression for a solution containing 0.025g of sodium chloride in 200g of water (given that the K_f of water is 1.86 °Cmol^{-1}kg^{-1} Na=23, Cl=35.5)

(d) 1.445g of a compound Y was dissolved in 80g of ethanol. The boiling point of the solution was 78.97°C while that of pure ethanol is 78.8°C. calculate the molecular mass of Y in ethanol (K_b of ethanol is 1.15 °Cmol^{-1}kg^{-1})

12. (a) (i) What is a colligative property?

(ii) State four colligative properties of solution

(b) (i) Describe how the molecular mass of a substance can be determined using the method of freezing point depression

(ii) State two limitations of this method

(c) Calculate the boiling point of an aqueous solution of urea ($CO(NH_2)_2$) of concentration 12.0gdm^{-3} at a pressure of 101.325kPa (the boiling point elevation constant of water is 0.52 °Cmol^{-1}kg^{-1})

(d) (i) Explain the term mole fraction

(ii) Calculate the mole fraction of sodium chloride in an aqueous solution of 10g of sodium chloride per 100g of water

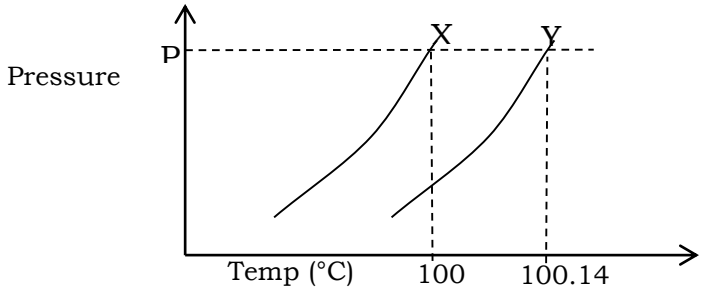
13. (a) An aqueous solution containing 7.2g of a non-cyclic compound Q in 250g of water freezes at -0.744°C. determine the molecular mass of Q. (the K_f of water is 1.86 °Cmol^{-1}kg^{-1})

(b) The boiling point of a solution containing 2.8g of a compound Z in 20g of water is 100.2°C at standard pressure.

(i) Explain how the solute affects the boiling point of water

(ii) Calculate the relative molecular mass of Z

14. 5.5g of a non-volatile substance B was dissolved in 125g of a solute. The vapour pressure curve of the solution and the pure solvent at constant pressure P are shown



(a) Identify the curve for the solution and the solvent

(b) Calculate the molecular mass of B (boiling point elevation constant for the solvent, K_b, is 0.52 °Cmol^{-1}kg^{-1})

(c) State two limitations of your calculations

15. (a) A solution contains 30g of ethane-1,2-diol and 40g of water.

(i) Calculate the boiling point of the solution (K_b for water is 0.52°Cmol^{-1}kg^{-1})

(ii) State ay assumption made in the calculations

(b) (i) A solution containing 4.50g of a solute B dissolved in 125g of water freezes at -0.372°C. Calculate the formula mass of B (the K_f of water is 1.86°Cmol^{-1}kg^{-1})

(ii) How would you expect the molecular mass of B to change if it ionized in water?

(c) A solution containing X g of cane sugar (relative formula mass 342) in 105g of water at 101.3kPa boiled at 100.06°C. determine X

16. (a) State Raoult's law.

(b) The lowering of vapour pressure of a solution of 108.2g of a substance X in 1kg of water at 20°C is 24.790kPa. The vapour pressure of water at 20°C is 2.338kPa. Calculate the relative molecular mass of X

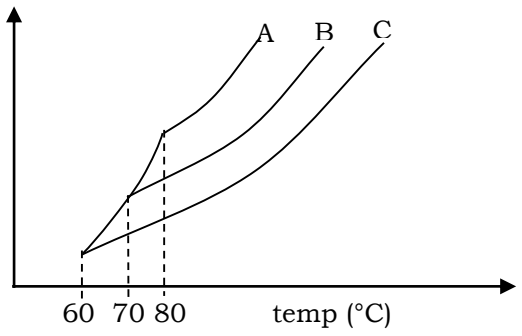
(c) The boiling point of ethanol is 78°C and its molar elevation constant is 1.15Kmol^{-1}. A solution of 0.56g of camphor in 16g of ethanol had a boiling point of 78.278°C. Calculate the relative molecular mass of camphor

17. (a) A solution of 0.142g of naphthalene in 20.25g of benzene causes a lowering of freezing of 0.284K. The molar depression constant of benzene is 5.12Kmol^{-1}kg^{-1}. Determine the molecular mass of naphthalene.

(b) The melting point of camphor is 177.5°C while that of a mixture containing 5g of substance Y of molecular mass 128 and 10g of camphor is 147°C. What is the molecular mass of camphor?

(c) The melting point of a mixture of acetanilide and 10g of camphor is 148.5°C. What is the relative molecular mass of acetanilide?

18. (a) 0.5g of Q was dissolved in 20g of naphthalene to form a solution X. another 0.25g of solute Q was dissolved in 20g of naphthalene to form a solution Y. the graph below shows how the vapour pressure of a solution X, Y and that of pure naphthalene varies with temperature.



(i) State what curves A, B, and C represent

(ii) State the freezing point of naphthalene

(iii) Calculate the relative molecular mass of Q. (K_f of naphthalene is 70°Cmol^{-1}kg^{-1})

19. (a) Define osmotic pressure

(b) The osmotic pressure of solution at 25°C for various concentrations of naphthalene and methylbenzene is given below.

Concentration (gdm^{-3})	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0
Osmotic pressure (kPa)	10.0	20.0	28.0	37.0	46.0	56.0	74.0	92.0

Plot a graph of osmotic pressure against concentration and use it calculate the relative formula mass of naphthalene

(c) Explain the following observations

(i) 0.1 mole of sodium chloride depresses the melting point of a given mass of water twice as much as 0.1 mole of glucose

(ii) 0.1 mole of aluminium chloride depressed the freezing point of a given mass of benzene half as much as does 0.1 mole of naphthalene.

20. (a) (i) What is meant by the term colligative property

(ii) State the assumptions made

(b) (i) Describe how the molecular mass of a non-volatile solute can be determined by elevation of boiling point method

(ii) The boiling point of a solvent A is 69.0°C. When 2g of solid X was dissolved in 40g of A the boiling was 71.4°C. calculate the molecular mass of X (boiling point elevation constant for the solvent is 3.2 per 1000g of the solvent)

(c) EXPERIMENT I; a mixture of 2g of camphor and 0.22 g of an organic compound Q of molecular mass 206 was found to have a melting point of 166.2°C

EXPERIMENT II; The following results of melting point were obtained when 1 g of camphor and solid P were mixed

Mass od P(g)	0.00	0.03	0.05	0.07	0.09	0.11
M.P(°C)	189.0	181.8	175.0	168.1	160.1	154.0

(i) Calculate the cryoscopic constant for camphor

(ii) Plot a graph of depression of freezing point against mass of P and use it to determine the RMM of P

21. (a) In order to determine the molecular mass of a compound T, 8.0g of T was dissolved in 250g of water. The solution froze at -0.331°C. if the freezing point of water is 0°C. Determine the molecular mass of the compound. (K_f of water s 1.86°Cmol^{-1}kg^{-1})

(b) When 15g of glucose ($C_6H_{12}O_6$) was dissolved in 50g of a solvent of molecular mass 200, the freezing point was depressed by 8.0°C. Determine the freezing point constant for the solvent

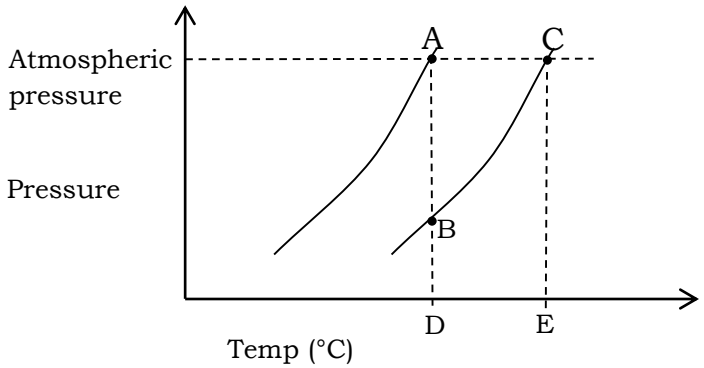
(c) When 5g of sulphur were dissolved in 63cm^3 of carbon disulphide, the vapour pressure recorded was 52340Pa. (the vapour pressure f carbon disulphide at this temperature is 53330Pa and its density is 1.27gcm^3)

(i) Determine the molecular mass of sulphur

(ii) What is molecular formula of sulphur in carbon disulphide

22. (a) A substance was dissolved in a solvent Z. the graph below shows how the vapour pressure of the solution and that of pure Z vary with temperature

c



State what points A to E and lines AB and AC represent

(b) A solution was prepared by dissolving 7.5g of propane-1,2,3-triol ($C_3H_8O_3$) in 200g of water at 25°C. Calculate the boiling point of the solution at atmospheric pressure. (K_f of water is 0.52°Cmol^{-1}kg^{-1})

23. A solution containing 20g of a polymer X in 1litre of a solvent exerts an osmotic pressure of 1.4mmHg at 25°C.

(a) Explain the term osmotic pressure

(b) Determine the molecular mass of X

(c) The formula of the monomer of X is $CH_2 = CHCN$. Determine the number of monomers units in X

(d) Explain why freezing point depression method is not suitable for determining the molecular mass of a polymer

24. (a) The osmotic pressure of a solution containing 1.40g of Y per 100cm^3 of solution is 1200Nm^{-2} at 25°C.

(i) Calculate the relative molecular mass of Y

(ii) Determine the number of monomer units in Y (RFM of the monomer is 28)

(b) (i) The vapour pressure of a solvent at 25°C is 3.15×10^3Nm^{-2}. Calculate the vapour pressure of a solution containing 6.0g of urea ($CO(NH_2)_2$) in 100g of water at the same temperature.

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

25. (a) A solution of 3.1g of sucrose, $C_{12}H_{22}O_{11}$, in 100g of water froze at a temperature of -0.2.4°C. If a solution containing 27.3gdm^{-3} of W freezes at -0.282°C. Calculate the molecular mass of W.

(b) Calculate the freezing point of a solution of 28.0g of ethanamide CH_3CONH_2 in 500g water. (the cryoscopic constant for 100g of water is 18.6°C)

26. (a) The vapour pressure of water at 94200Nm^{-2}. The vapour pressure of a 1% solution of sucrose is 94150Nm^{-2}. Calculate the molecular mass f sucrose

(b) The vapour pressure of water at 20°C is 3.14Nm^{-2}. Determine the vapour pressure of a solution of 2.5g of a solute of molecular mass 180 in 50g of water at this temperature.

(c) The vapour pressure of water at 50°C is 12333Pa. at this temperature, a solution of 9.14g of urea in 150g of water has a vapour pressure of 12108Pa. determine the RFM of urea.

27. (a) Find the lowering in vapour pressure if 2.8g of naphthalene, $C_{10}H_8$ dissolves in 250g of butyric acid, $C_4H_8O_2$, at 20°C. The vapour pressure of butyric acid at this temperature is 0.112kPa.

(b) When 3.4g of naphthalene was dissolved in 200g of butyric acid at 50°C, the vapour pressure lowering caused was 8.649Pa. Determine the molecular mass of naphthalene. The vapour pressure of butyric acid at 50°C.

28. (a) When 7.6g of camphor, $C_{10}H_{16}O$, was dissolved in 400g of propanone at 0°C, and its vapour pressure was lowered by 68.08Nm^{-2}. Determine the vapour pressure of pure propanone at this temperature.

(b) Determine the lowering of vapour pressure at 0°C when 20.8g of camphor dissolve in 500g of propanone whose vapour pressure at this temperature is 9.39kNm^{-2}.

(c) Calculate the vapour pressure of a solution made by dissolving 15.2g of camphor in 480g of propanone at 0°C. the vapour pressure of pure propanone at this temperature is 9390Pa.

29. (a) 10.5g of a compound R was dissolved in 500g of propanone at 25°C and the vapour pressure of the resulting solution was 30354.8Nm^{-2}. Determine the molecular mass of R. (the vapour pressure of pure propanone at this temperature is 30.6kPa).

(b) At 25°C, the vapour pressure of propanone is 30600Nm^{-2}. If 3.8g of a compound Y in 250g of propanone decrease the vapour pressure of propanone by 88.74Pa, calculate the molecular mass of Y.

30. (a) When 4.5g of urea, $CO(NH_2)_2$, were dissolved in 250g of water, the boiling point of the resultant solution was 100.154°C. Determine the boiling point elevation constant for water.

(b) Determine the boiling point of a solution made by dissolving 6.0g of urea in 400g of water. (the boiling point elevation for water is 0.512°Cmol^{-1}kg^{-1})

(c) What is the elevation in boiling point when 10.2g of urea are dissolved in 500g of water? (boiling point elevation for water is 5.12°Cmol^{-1}per 100g)

(d) Determine the relative molecular mass of a compound X if a solution containing 5.8g of X in 480g of water boils at 100.103°C. (the boiling point elevation for water is 0.512°Cmol^{-1}kg^{-1})

(e) Calculate the mass of urea that should be dissolved in 200g of water so that the boiling point of the solution is 100.128°C. (the boiling point elevation for water is $0.512°Cmol^{-1}kg^{-1}$)

31. (a) When 4.2g of urea was dissolved in 200g of ethanol, the boiling point of the resultant solution was 79.017°C. if the boiling point of pure ethanol is 78.6°C. Determine the boiling point elevation constant for ethanol.

(b) Determine the boiling point of a solution made by dissolving 3.8g of urea in 250g of water. (the boiling point of pure ethanol and its boiling point elevation constant are 78.6° and $1.19°Cmol^{-1}kg^{-1}$)

(c) What is the elevation in boiling point when 5.4g of urea is dissolved 400g of ethanol? (the boiling point elevation constant for ethanol is $1.19°Cmol^{-1}kg^{-1}$)

(d) Determine the relative molecular mass of compound K if a solution containing 6.8g of K in 450g of ethanol boils at 79°C. (the boiling point elevation for ethanol $1.19°Cmol^{-1}kg^{-1}$)

(e) What mass of urea should be dissolved in 480g of ethanol to increase its boiling point to 78.89°C? (the boiling point elevation constant for ethanol is $1.19°Cmol^{-1}kg^{-1}$)

32. The table below shows how the elevation of the boiling point of benzene, ΔT, varies with concentration of a substance M at 25°

Concentration (gl^{-1})	6.4	9.0	12.8	16.0	20.0	24.0
ΔT, (°C)	0.133	0.186	0.265	0.331	0.414	0.497

(a) Plot a graph of elevation in boiling point, ΔT, against concentration.

(b) Use your graph to find the relative molecular mass of M. (the boiling point elevation constant for benzene is $2.65°Cmol^{-1}kg^{-1}$)

33. The table below shows the boiling point of different solution of naphthalene in ethanol at different concentrations at 25°C.

Concentration (gl^{-1})	5.4	8.6	10.8	12.8	20.6	30.2
Boiling point (°C)	78.85	78.88	78.90	78.92	78.99	79.08

(a) Plot a graph of boiling point elevation against concentration

(b) Use your graph to determine the boiling point elevation for ethanol (the boiling point of pure ethanol is 78.8°C)

34. The table below shows how the boiling point of butanone varies with the amount of substance Q dissolved in it at 25°C.

Concentration (gl^{-1})	0.0	4.0	8.0	10.0	14.0	16.0
Boiling point (°C)	80	80.06	80.15	80.18	80.21	80.24

(a) Plot a graph of boiling elevation against concentration

(b) Determine the molecular mass of Q. (boiling point elevation for butanone is $2.28°Cmol^{-1}kg^{-1}$)

35. The table below shows how the boiling point elevation of cyclohexane changes with increase in the amount of camphor dissolved in it.

Concentration (gl^{-1})	7.0	10.0	15.0	18.0	20.0	28.0
ΔT, (°C)	0.13	0.18	0.27	0.33	0.36	0.51

(a) Plot a graph of boiling point elevation against concentration

(b) Using your graph, determine the boiling point elevation constant for cyclohexane (molecular mass of camphor is 152)

36. When a substance W was dissolved in acetone, the boiling points of the different solutions of different concentrations were noted as shown.

Concentration (gl^{-1})	6.4	9.1	11.9	14.6	18.2	22.8
Boiling point (°C)	56.17	56.20	56.23	56.26	56.30	56.35

(a) Plot a graph of boiling point elevation against concentration

(b) Using your graph, determine the molecular mass of W. (the boiling point of acetone is 56.1 and its boiling point elevation constant is 1.67°Cmol^{-1} per 1000g)

37. The table below shows the freezing points of a solution of glucose ($C_6H_{12}O_6$) in water at different concentrations.

Concentration (gl^{-1})	5.9	9.7	15.0	19.4	24.2	30.0
Freezing point (°C)	-0.061	-0.100	-0.155	-0.200	-0.250	-0.310

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

(b) Using your graph, determine the freezing point depression constant (K_f) for water. (C=12, H=1, O=16)

38. The table below shows the freezing point of water when different amounts of substance P are added.

Concentration (gl^{-1})	10.30	15.80	20.31	25.80	31.40	34.94
Freezing point (°C)	-0.056	-0.086	-0.110	-0.140	-0.170	-0.190

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

(b) Use your K_f value above (in number 37) and your graph above to determine the molecular mass of P.

39. The table below shows how the osmotic pressure of a solution varies with the amount of polymer R

Concentration (gl^{-1})	1.40	4.20	8.40	12.60	15.40	17.50
Osmotic pressure (Nm^{-2})	49.6	148.7	297.3	446.0	545.1	619.4

(a) Plot a graph of osmotic pressure against concentration

(b) Using your graph, determine the molecular mass of the polymer

(c) The molecular mass of the monomer of R is 28. Determine the number of monomer units

40. The table below shows how the osmotic pressure of a solution varies with the amount of polymer Y

Concentration (gl^{-1})	1.25	4.40	6.25	10.65	12.50	15.65
Osmotic pressure (Nm^{-2})	48.7	171.3	243.7	414.2	487.4	609.2

(a) Plot a graph of osmotic pressure against concentration

(b) Using your graph, determine the molecular mass of the polymer

(c) Given that the number of monomer units in Y are 2235, determine the molecular mass of the monomer of Y

41. Vinyl chloride polymerises according to the equation

$$nCH_2 = CHCl \longrightarrow -(CH_2CHCl)_n -$$

Use the table to determine the value of n

Concentration (gl^{-1})	1.25	4.40	6.25	10.65	12.50	15.65
Osmotic pressure (Nm^{-2})	48.7	171.3	243.7	414.2	487.4	609.2

(a) Plot a graph of osmotic pressure against concentration
(b) Using your graph, determine the value of n

43. (a). 2.0g of phosphorus raises the boiling point of 37.4g of carbon disulphide by 1.003°C whereas 4.65g of sulphur raises the boiling point of 100g of carbon disulphide by 0.42°C. Calculate the
(i). Boiling point constant of carbon disulphide
(ii). Molar mass of phosphorus in carbon disulphide
(b) Determine the molecular formula of phosphorus.

44. (a). State one colligative property other than depression of freezing point or elevation of boiling point of a solvent.
(b) Ethane-1,2-diol is used as an antifreeze for water in car radiators. Calculate the mass of ethane-1,2-diol that should be added to 1 kg of water to prevent it from freezing at -10°C. (freezing point depression constant for water is1.86°Ckgmol^{-1})

45. (a). Describe an experiment that can be carried out to determine the relative molecular mass of benzoic acid in benzene by depression of freezing point method.
(b) State four limitations of the depression of freezing point as a method for determination of molecular mass of a substance
(c) A solution containing 0.368g of methanoic acid in 50g of benzene froze at 5.093°C. Calculate the molecular mass of methanoic acid. (the freezing point f benzene is 5.533°C; the freezing point constant of benzene is 5.5°Cmol^{-1}kg^{-1})
(d) Comment on your answer in (c). (the molecular mass of methanoic acid is 46)

46. (a). 0.128g of naphthalene in dissolved in 10g of camphor lowered the melting point of the latter by 4°C. calculate the relative molecular mass of naphthalene (the cryoscopic constant of camphor is 40°Cmol^{-1}kg^{-1})
(b). What would be the freezing point of a solution containing 9 g of glucose ($C_6H_{12}O_6$) in 500g if water. (freezing point constant for water is 1.86°Cmol^{-1}kg^{-1})
(c). Solution of 2.0g of a polymer in 1 litre of water has an osmotic pressure of 273Nm^{-2} at 0°C. calculate the relative molecular mass of the polymer (R=8.31)
(d). A solution containing 1.2g of ethanoic acid in 80g of water freezes at -0.46°C. what is the relative molecular mas of the acid
(e). 0.48g of a substance X dissolved in 50g of benzene caused a freezing point depression of 0.44°C. Calculate the relative molecular mass of X. (K_f for benzene is 5.5°Cmol^{-1}kg^{-1})
(f). Calculate the temperature at which a solution of 3.33g of ethane-1,2-diol in 14 g of water begin to freeze (K_f for water is 1.86°Cmol^{-1}kg^{-1})

(g). Liquid camphor freezes at 175°C. A solution of 1.54g of naphthalene ($C_{10}H_8$) in 18g of camphor freezes at 148.3°C. Calculate the freezing point constant for camphor.

(h). Calculate the mas of water in which 10g of glucose ($C_6H_{12}O_6$) should be dissolved to obtain a solution freezing at -0.35°C.

(i). The freezing point of a sample of pure benzene was found to be 5.481°C. A solution of 0.31g of naphthalene ($C_{10}H_8$) in 25g of this benzene began to freeze at 4.971°C. A solution of 0.305 g of benzoic acid in 25g of the same solvent began to freeze at 5.226°C. Calculate the molar freezing point depression constant for 100g of benzene and hence calculate the relative molecular mass of benzoic acid in benzene solution ($C = 12;\ H = 1$)

47. (a). 2.0g of phosphorus raise the boiling point of 37.4g of carbon disulphide by 1.003°C. what is the molecular formula of phosphorus in carbon disulphide. What reasons can you suggest for this result (K_b for carbon disulphide is 2.35°C for 1 mole in 1000g)

(b). The boiling point of ethanol is 78°C. Calculate the boiling point of a solution containing 2.7g of ethanamide (CH_3CONH_2) in 75g of ethanol (K_b for 1000g of ethanol = 1.15°Cmol^{-1})

(c). The vapour pressure of pure water at 25°C is 3167 Pa. The vapour pressure of a solution of 4 g of a sugar in 100g of water at the same temperature is 3154.5 Pa. what is the relative molecular mass of the sugar.

(d). The vapour pressure of carbon disulphide at a certain temperature is 5333 Pa. At the same temperature, a solution of 5 g of sulphur in 63cm^3 of carbon disulphide has a vapour pressure of 52230 Pa. the density of carbon disulphide is 1.27gcm^{-3}. Find the

(i). Relative molecular mass of sulphur

(ii). Molecular formula of sulphur in carbon disulphide

(e). Calculate the vapour pressure of a 3% solution of camphor ($C_{10}H_{16}O$) in ethoxyethane ($C_4H_{10}O$) if the vapour pressure of pure ethoxyethane at the same temperature is 32760Pa.

(f). A solution of 42 g of mannitol in 1dm^3 of water has an osmotic pressure of 5.624×10^5Pa at 20°C. Calculate the relative molecular mass of mannitol.

(g). Calculate the pressure that would prevent the passage of water molecules through a semipermeable membrane from water into a 2% solution of sucrose ($C_{12}H_{22}O_{11}$) at 12°C.

(h). At 25°C, the osmotic pressure of a solution containing 1.35g of a protein per 100cm^3 of solution was found to be 1216Pa. Calculate the relative molecular mass of the protein.

(i). Calculate the temperature at which an aqueous solution of 10g of glucose in 500cm^3 have an osmotic pressure of 264700Pa.

(j). An aqueous solution of 5.2g of ethanamide (C_2H_5NO) per dm^3 froze at -0.164°C. Calculate the. ($C = 12; H = 1; N = 14; O = 16$)

(i). The freezing point of a 1% glucose solution

(ii). The osmotic pressure at 20°C of a 1% solution of glucose $C_6H_{12}O_6$.

(k). The osmotic pressure of an aqueous solution of a non-electrolyte containing 8.15g in 1.5dm^3 of solution is 70930Pa at 25°C. Calculate the freezing point of the solution.

48. (a). Describe an experiment to determine the relative molecular mass of benzoic acid in benzene by the elevation of boiling point of the solvent.

(b). The following data was obtained in an investigation into the molecular state of ethanoic acid in in benzene.

- Freezing point of benzene = 5.533°C.
- Freezing point of a solution of 0.289g ethanoic acid in 100g benzene = 5.386°C
- Freezing point of a solution of 0.784g tetrachloromethane in 43.0 g benzene = 4.930°C.

(i). Calculate the freezing point constant for benzene

(ii). Calculate the formula mass of ethanoic acid in benzene

(iii). Write the molecular formula and hence the structure of ethanoic acid in benzene

(c). The vapour pressure of an organic pressure of an organic liquid X at 20°C is 58670Pa and that of a solution of 9.00g methyl octadecanoate in 100g of the same liquid is 57400Pa at 20°C. Calculate the relative molecular mass of X. given that the molecular mass of methyl octadecanoate is 298

49. (a).

