Practical Test

Deriving a Solubility Curve

Writing time: 45 minutes

Student's Name: _____

Teacher: _____

Structure of booklet

Section	Number of Questions	Number of questions to be answered	Marks
Short Answer	6	6	43
		Total:	**43**

Directions to students

Materials

- Students **are permitted** to bring into the examination room: pens/pencils, highlighters, erasers, sharpeners, rulers, and an approved scientific calculator.

- Students are **NOT permitted** to bring into the examination room: white out liquid/tape, phones or electronic devices, including smart watches.
- Students are provided with the following: Question and answer book of **6** pages and VCAA Data booklet.

The task

- Please ensure that you write your name and teacher's name on this booklet. This paper consists of short answer questions.

- There are a total of **43** marks available.

- Be sure to include states with all chemical equations.

- All numerical answers need to be quoted to the correct number of significant figures.

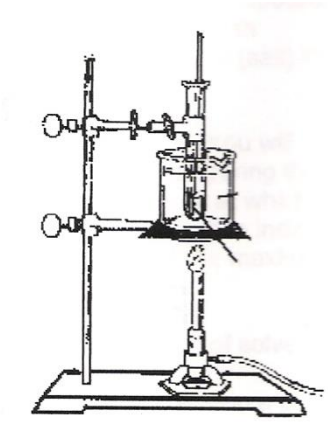
1) Below is the procedure of a practical investigation to determine the solubility curve of KNO_3.

Procedure

1. Number four test tubes and place them into a test tube rack.
2. Using a balance to measure the KNO_3, prepare the test tubes as indicated below:

Test tube	grams of KNO_3	Volume of H_2O (mL)
1	2.00	5
2	4.00	5
3	6.00	5
4	8.00	5

3. Fill a 400 ml beaker about ¾ full of tap water. This will be used as a hot water bath.
4. Place the test tube 1 in the water bath and heat the water to 90 °C
5. Stir the KNO_3-mixture with a glass stirring rod until the KNO_3 is completely dissolved.
6. One lab partner repeats step 4 for next test tube. The other lab partner holds test tube 1 with thermometer up to the light and at the first sign of crystallisation record the temperature. Record the data in a table and partners swap roles.
7. Repeat steps 4 and 6 for the remaining test tubes. Partners should now change roles, one will do step 5 and the other step 6. Record all temperatures in the data table.

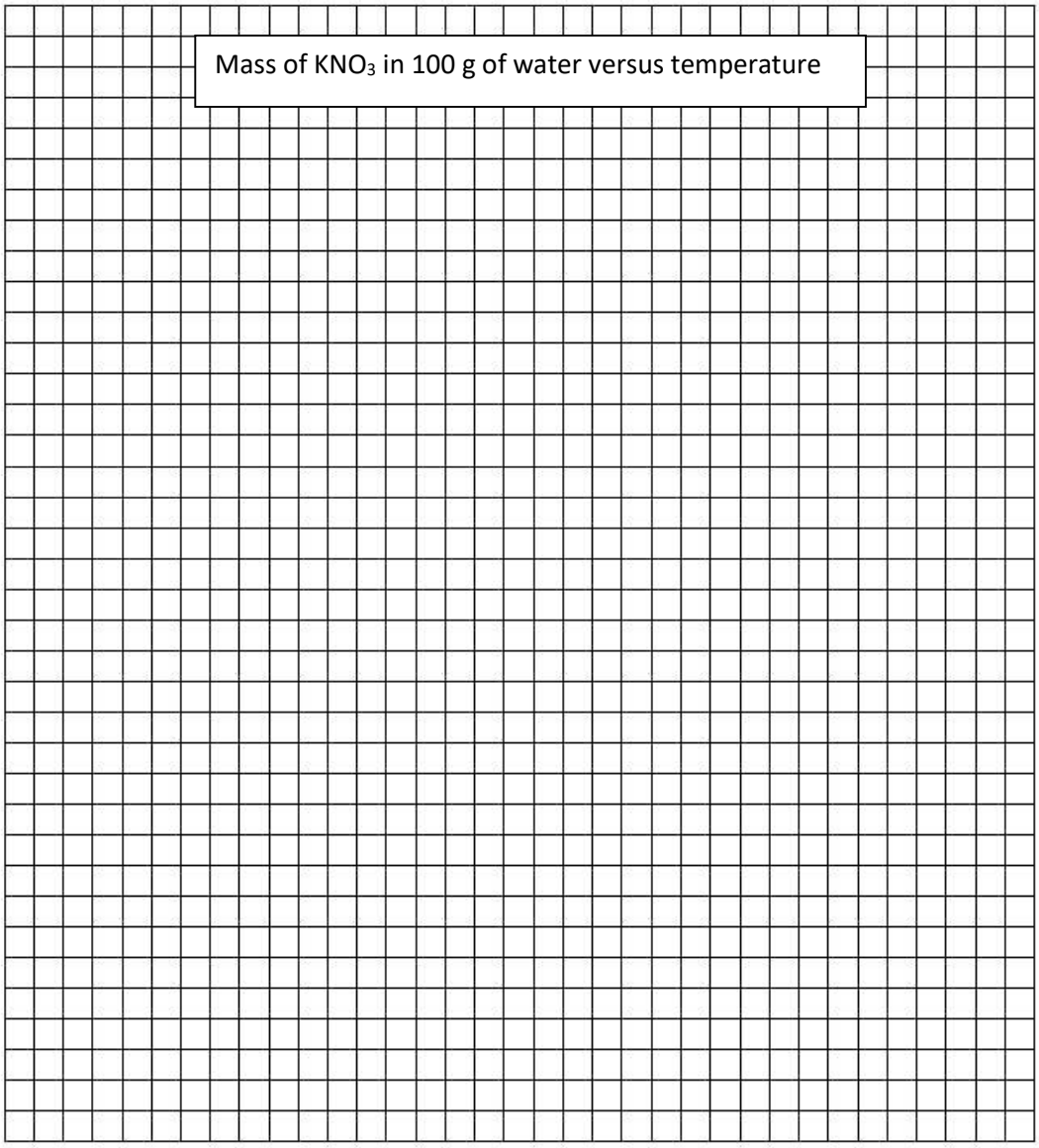


Mass of KNO_3 (g)	Mass of water (g)	Grams of KNO_3 / 100g of water	Crystallisation temperature (C°)
4	20	20	6
3	10	30	13
8	20		24
12		60	60
7	10	70	43
	30	90	55
28	20	140	75

Table 1

a. Complete the table above *3 marks*

b. Using the results from table 1 above and the graph paper on the next page to accurately plot the graph of "mass of KNO_3 in 100 g of water versus temperature" using a line of-best-fit.
6 marks



c. Use the graph that you have plotted in question 1a to answer the following questions. Show all working out in the space provided for maximum marks.

i. What is the maximum amount, in grams, of KNO_3 that can be dissolved in 25 g of distilled water at 65°C . *2 marks*

ii. A saturated solution of KNO_3 is formed using 50.0 g of water at 80 ^oC . This solution is then cooled to 60 ^oC. Calculate the amount, in grams, of KNO_3 that precipitates out of solution. *2 marks*

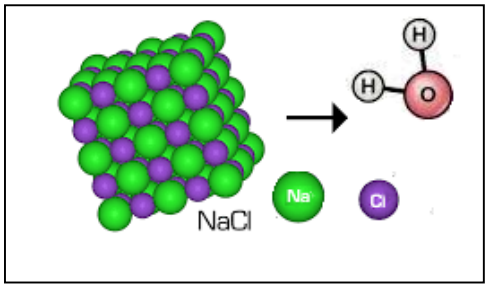
iii. Describe one improvement to the procedure and describe how this would benefit the experimental design. *2 marks*

iv. Discuss one error that may have occurred during the experiment and suggest what could be done to minimise this error. *2 marks*

v. Is the error mentioned in iv, above, a random or systematic error? Explain your answer. *2 marks*

vi. Why do salts such as potassium nitrate have a higher solubility at higher temperatures? *1 mark*

2) Consider the image on the right. It represents a crystal of NaCl and a water molecule, not drawn to scale.

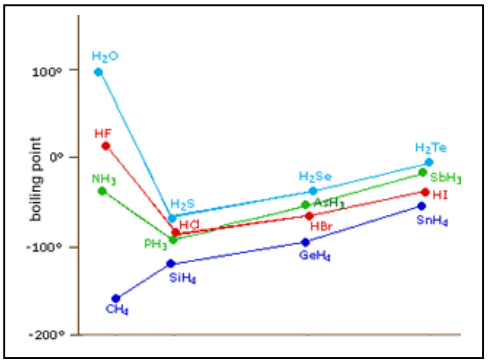


a. In the space below, show how the water molecules and the sodium and chloride ions interact with each other in solution. *2 marks*

b. Name the type of bonding that exists between the water molecules and each ion.

1 mark

3) The image below shows the relationship between the first four hydrides of groups 4,5,6 and 7 and boiling temperature.



a. Give a clear explanation as to why:
i. the first hydride of groups 5, 6 and 7 has a greater boiling point than all the other three hydrides in the same group; *2 marks*

ii. the first hydride from group 4 (CH_4) has a lower boiling point than all the other hydrides in the same group; *2 marks*

iii. the last three hydrides in all the groups steadily increase in boiling temperature;

1 mark

4) The specific heat capacity of an unknown liquid (Z) is given at 2.15 J/g/°C.

a. A mass of 15.6 g of this liquid "Z"at 25.0 °C is heated to 45.0 °C. Calculate the amount, in joules, of heat energy absorbed by the liquid. *2 marks*

b. A 4.67 gram sample of an unlabelled liquid is found in the laboratory. This sample is heated using 0.4016 kJ of heat energy and it's temperature changes from 25.0 °C to 65 °C. Is it liquid "Z"? Justify your answer with a calculation.

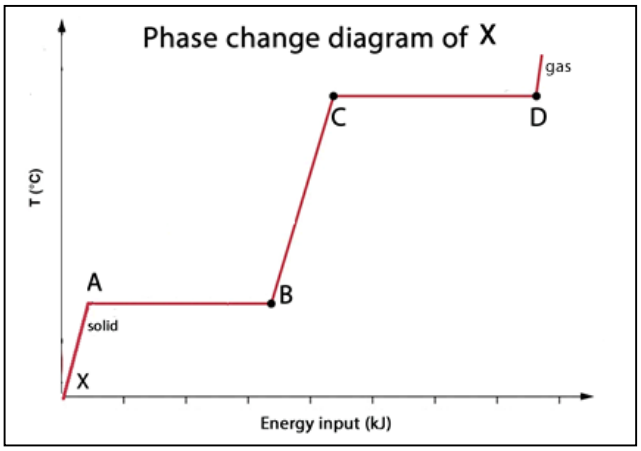
2 marks

"

c. The phase diagram of 2.00 mol of Z is shown below. Its **latent heat of vaporization** is 2.16 J/mol while its **latent heat of fusion** is 1.25 J/mol

i. In what state/s does liquid "Z"exist in segment C-D

1 mark



ii. Explain the difference in inter-molecular bonding of "Z" between segments A-B and C-D. *2 marks*

iii. Calculate the amount of energy needed to go from C to D on the graph above. *2 marks*

5) A sample of contaminated water is analysed and found to have a lead (Pb) concentration of 450 ppm. Calculate the lead concentration in %m/v. *2 marks*

6) A wine bottle is labelled as having an alcohol concentration of 13.5% v/v.
a. What volume, in mL, of alcohol is present in 75.0 mL of wine? *1 mark*

b. If the density of alcohol, at room temperature, is 0.789 g/mL, calculate the concentration of the alcohol in the wine in %m/v.

3 marks

End of test