

KEY

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Solubility vs Temperature: Graphing & Interpolating

HPS@SHS

Name _____ per. _____

Solubility is the amount of a solute that can be dissolved in a fixed amount of solvent at a particular temperature. When determining the solubility of substances it is important that the amount of solvent remains constant (does not change). In the solubility listed below, the amount of solvent (water) is kept constant at 100 grams (100 mL). The only variable that is changed is the temperature of the solvent.

A solution that is able to hold more solute (than is presently dissolved) at a particular temperature is *unsaturated*. A solution that is holding the maximum solute at a particular temperature is *saturated*. Under certain conditions (your teacher will explain) a solution can hold more solute than the usual maximum amount at a particular temperature. This is called a *supersaturated* solution.

Below is a table showing the maximum amount of solute of that can be dissolved in 100.00 mL of water (solvent) at various temperatures.

SOLUBILITY AS A FUNCTION OF TEMPERATURE
(Grams of solute per 100 grams of water)

Compound	0° C	20° C	40° C	60° C	80° C	100° C
1 • $Ba(OH)_2$ barium hydroxide	2 g	4 g	8 g	21 g	101 g	230 g
2 ■ Cs_2SO_4 cesium sulfate	21 g	10 g	6 g	3 g	2 g	1 g
3 ▲ $C_{12}H_{22}O_{11}$ sugar	180 g	204 g	238 g	287 g	362 g	487 g
4 ▼ KCl potassium chloride	28 g	34 g	40 g	46 g	51 g	56 g
5 ◆ KI potassium iodide	128 g	144 g	162 g	176 g	192 g	206 g
6 ○ KNO_3 potassium nitrate	14 g	32 g	61 g	106 g	167 g	245 g
7 * $NaCl$ sodium chloride	34 g	35 g	36 g	37 g	38 g	39 g

Graph the solubility of the compounds listed above on one grid. Use your *Graphing Scientific Data* note sheet from earlier in this year to refresh your memory on graphing data.

Draw a *smooth* curve for each substance - do not simply connect the points. To tell them apart, use different colors for curves and label each curve with the compound's formula.

Using a good scale, make your graph cover at least 75% of your full page graph paper.

Temperature is the independent variable. Staple your graph to this sheet when you turn it in.

Use your graph to answer the following questions.

1. Generally, what relationship is there between temperature and solubility?

FOR SOLID SOLUTES: ↑ TEMP = ↑ SOLUBILITY (OPPOSITE FOR GASEOUS SOLUTES)

2. Which substance's solubility is most effected by temperature? $Ba(OH)_2$ - STEEPEST CURVE

3. Which substance's solubility is least effected by temperature? $NaCl$ - FLAT SLOPE

4. How much sugar can be dissolved in 100 grams of water at:

a. 15° C ≈ 195g b. 50° C ≈ 260g c. 85° C ≈ 395g

5. How much potassium nitrate can be dissolved in 100 grams of water at:

a. 25° C ≈ 40g b. 45° C ≈ 73g c. 75° C ≈ 150g

6. How much sodium chloride can be dissolved in 100 grams of water at:

a. 10° C ≈ 34g b. 55° C ≈ 37g c. 85° C ≈ 38g

6. At which temperature would the following solutions be saturated?

- a. 15 g of $\text{Cs}_2\text{SO}_4 \approx 12^\circ\text{C}$ b. 210 g of $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ (sugar) $\approx 24^\circ\text{C}$
c. 130 g of $\text{KI} \approx 4^\circ\text{C}$ d. 30 g of $\text{KCl} \approx 6^\circ\text{C}$

7. Determine if each of the following solutions is:

- | | | |
|---|-----------|----------------|
| unsaturated | saturated | supersaturated |
| <u>UNSAT.</u> (POINT IS BELOW LINE) a. Dissolving 210 grams of sugar in 100 mL of water at 35°C .
Y X | | |
| <u>SUPERSAT.</u> (POINT IS ABOVE LINE) b. Dissolving 188 grams of KI in 100 mL of water at 65°C .
Y X | | |
| <u>SATURATED</u> (POINT IS ON THE LINE) c. Dissolving 8 grams of Cs_2SO_4 in 100 mL of water at 30°C .
Y X | | |
| <u>UNSAT.</u> (POINT BELOW LINE) d. Dissolving 34 grams of KNO_3 in 100 mL of water at 47°C .
Y X | | |

8. Circle the substance that is more soluble:

- a. At 30°C : KCl or NaCl b. At 90°C : KI or KNO_3
c. At 85°C : $\text{Ba}(\text{OH})_2$ or KNO_3

9. At 80°C a saturated solution of barium hydroxide contains 101 grams of $\text{Ba}(\text{OH})_2$ and 100 grams of water. Because of this barium hydroxide is now the solvent and water is the solute. At what temperature does this occur with KNO_3 ?

Answer: 59°C (@ that temp, 101 g is slightly above the KNO_3 line)

10. The solubility of NaCl varies little with temperature while the solubility of KNO_3 is greatly affected by temperature. How would life on in the oceans be different if the solubility curve of NaCl looked like KNO_3 ? Explain your answer.

COOLER REGIONS WOULD BE LESS SALTY, AND WARMER REGIONS (POLES) WOULD BE MUCH SALTIER. SO TYPES OF OCEAN LIFE WOULD VARY MORE DUE TO THEIR ABILITIES TO TOLERATE LOW/HIGH SALT CONCENTRATIONS)

11. Look at your graph and write 2 totally different conclusions about the effect of temperature on the solubility of different substances:

ANSWERS VARY, BUT:

a. FOR ALL SUBSTANCES BUT Cs_2SO_4 , AS TEMP \uparrow , SO

DOES SOLUBILITY - SO THEY MUST BE SOLIDS.

b. Cs_2SO_4 MUST BE A GAS, BECAUSE GASES BECOME LESS

SOLUBLE @ HIGHER TEMPS (THEY "UN-DISSOLVE), AND Cs_2SO_4 'S LINE HAS A NEGATIVE SLOPE.

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KEY

3 $C_{12}H_{22}O_{11}$

GRAMS SOLUTE / 100ML H₂O

490-

450

400

350

300

250

200

150

100

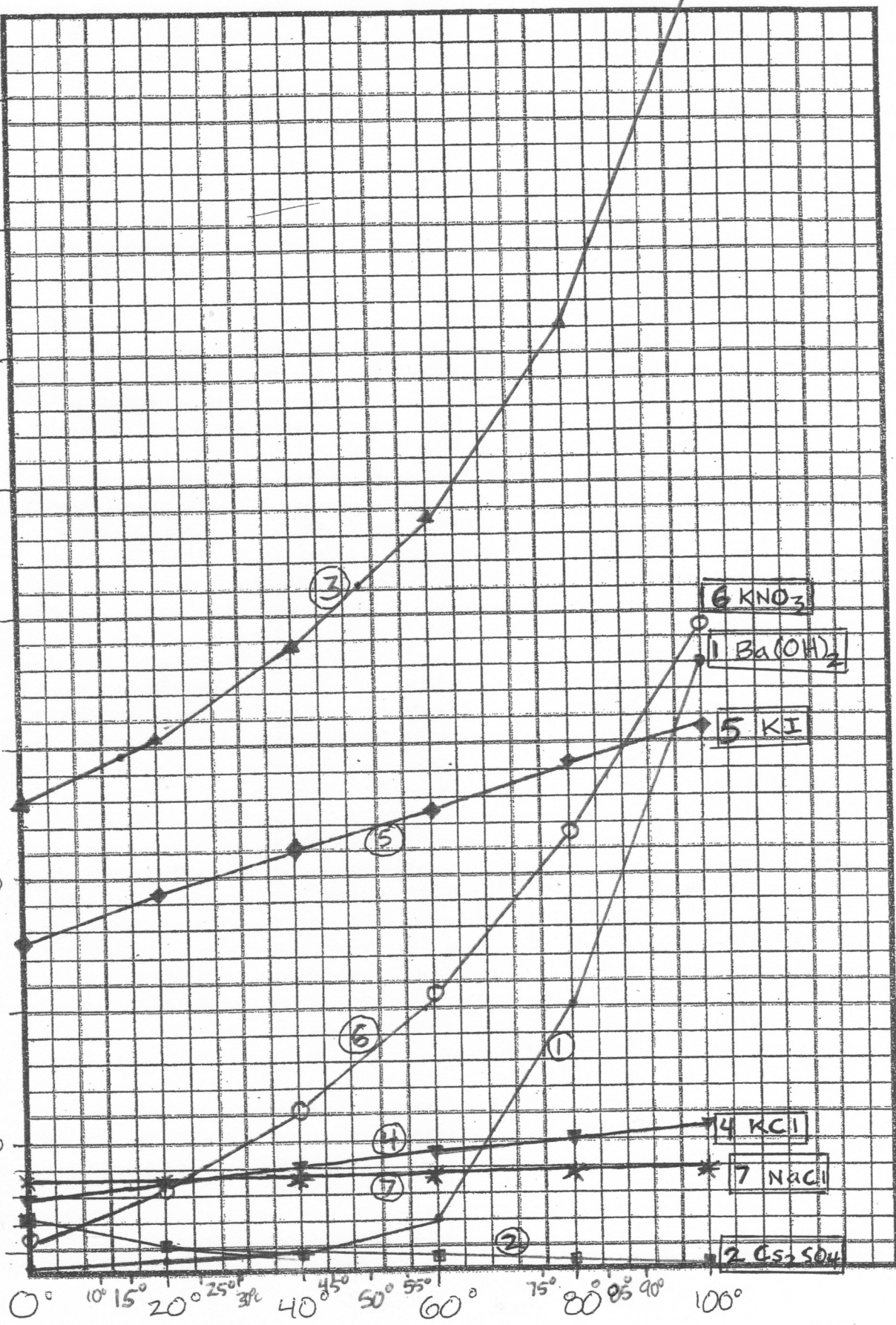
50

40

30

20

10



TEMP °C

6 KNO_3

1 $Ba(OH)_2$

5 KI

4 KCl

7 $NaCl$

2 $CaSO_4$