

Chemistry 20 – Lesson 17
Solubility

/69

1. **The classification of a solution depends on the state of the solvent and not the solute.**

- /3
- | | |
|-------------------------|---------------|
| a) sugar and water | liquid |
| b) air | gas |
| c) copper and zinc | solid |
| d) carbonated beverage | liquid |
| e) alcohol and water | liquid |
| f) table salt and water | liquid |

2. What is an alloy?

/1 **An alloy is a solid solution of two or more metals.**

3. Why are water and gasoline (C_8H_{18}) mutually insoluble?

/1 **Water is polar, gasoline is non-polar. Polar and non-polar compounds tend to not mix.**

4. Explain why iodine has a low solubility in water but high solubility in cyclohexane (C_6H_{12})?

/1 **Iodine is non-polar. Therefore it dissolves in non-polar cyclohexane but not in polar water.**

5. From the list below, select those substances which have good solubility in water and those that have good solubility in carbon tetrachloride:

/3

Cl_2	soluble in CCl_4
CH_3OH	soluble in H_2O
C_6H_{14}	soluble in CCl_4
NH_3	soluble in H_2O
Br_2	soluble in CCl_4
HCl	soluble in H_2O

6. How does the solubility of CO_2 in water vary with:

/3

A. an increase in pressure of $CO_2(g)$? Explain your answer.

The solubility of the CO_2 will increase since an increase in gas pressure increases solubility.

B. an increase in water temperature? Explain your answer.

The solubility of CO_2 will decrease since an increase in solvent temperature decreases the solubility of gases.

C. a decrease in water temperature? Explain your answer.

The solubility of CO_2 will increase since a decrease in solvent temperature increases the solubility of gases.

7. How does the solubility of washing soda (Na_2CO_3) in water vary with:

/2

A. an increase in pressure? Explain your answer.

The solubility of Na_2CO_3 does not depend on pressure, therefore its solubility will not be affected.

B. an increase in temperature? Explain your answer.



The solubility of Na_2CO_3 will increase since an increase in temperature increases the solubility of solids in liquids.

8. Silver chloride has very low solubility in water. Will stirring increase the solubility of silver chloride in water? Explain.
- /2 **No. Solubility is independent of stirring. Stirring may increase the rate of dissolving, but it will not affect if the compound is soluble or not.**

9. (24 marks)

	Name of compound	Chemical Formula	Phase at STP	Soluble in water?
eg.	sodium chloride	$\text{NaCl}_{(\text{aq})}$	solid	yes
1	silver iodide	$\text{AgCl}_{(\text{s})}$	solid	no
2	methanol	$\text{CH}_3\text{OH}_{(\text{aq})}$	liquid	yes
3	tin (II) phosphate	$\text{Sn}_3(\text{PO}_4)_2 (\text{s})$	solid	no
4	lithium sulphide	$\text{Li}_2\text{S}_{(\text{aq})}$	solid	yes
5	hydrogen carbonate	$\text{H}_2\text{CO}_3_{(\text{aq})}$	solid	yes
6	zinc hydroxide	$\text{Zn}(\text{OH})_2 (\text{s})$	solid	no
7	sucrose	$\text{C}_{12}\text{H}_{22}\text{O}_{11} (\text{aq})$	solid	yes
8	gold (I) bromide	$\text{AuBr}_{(\text{aq})}$	solid	yes
9	lead (IV) acetate	$\text{Pb}(\text{CH}_3\text{COO})_4 (\text{s})$	solid	no
10	calcium sulphate	$\text{CaSO}_4 (\text{s})$	solid	no
11	ammonium hydroxide	$\text{NH}_4\text{OH}_{(\text{aq})}$	solid	yes
12	aluminum sulphide	$\text{Al}_2\text{S}_3 (\text{s})$	solid	no
13	barium hydroxide	$\text{Ba}(\text{OH})_2 (\text{aq})$	solid	yes
14	paraffin wax	$\text{C}_{25}\text{H}_{52} (\text{s})$	solid	no
15	mercury (I) carbonate	$\text{Hg}_2\text{CO}_3 (\text{s})$	solid	no
16	manganese (IV) bromide	$\text{MnBr}_4 (\text{aq})$	solid	yes
17	iron (III) sulphite	$\text{Fe}_2(\text{SO}_3)_3 (\text{s})$	solid	no
18	antimony (III) sulphide	$\text{Sb}_2\text{S}_3 (\text{s})$	solid	no
19	barium sulphide	$\text{BaS}_{(\text{s})}$	solid	no
20	ammonia	$\text{NH}_3 (\text{aq})$	gas	yes
21	nickel (III) sulphide	$\text{Ni}_2\text{S}_3 (\text{s})$	solid	no
22	francium thiosulphate	$\text{Fr}_2\text{S}_2\text{O}_3 (\text{aq})$	solid	yes
23	ammonium sulphide	$(\text{NH}_4)_2\text{S}_{(\text{aq})}$	solid	yes
24	lead (II) bromide	$\text{PbBr}_2 (\text{s})$	solid	no



10. What is a *saturated solution*?
/1 **A saturated solution is a solution where no more solute can dissolve.**
11. What is a *supersaturated solution*?
/2 **A supersaturated solution is a solution where more solute is dissolved than should be at that temperature. A supersaturated solution is formed when a saturated solution is cooled to a lower temperature. As it cools the molar saturation decreases, but the amount of dissolved solute remains the same. When the solution crystallises it is no longer supersaturated.**
12. What is *dynamic equilibrium*?
/2 **Dynamic equilibrium refers to the process where the overall concentration of a saturated solution does not change, but there is still an active process of dissolving and crystallization still taking place.**
13. Give examples of two liquids that are immiscible and two that are miscible with water.
/2 **immiscible – oil and gasoline
miscible – ethanol and methanol**
14. Can more oxygen dissolve in a litre of water in a cold stream or a litre of water in a warm lake? Include your reasoning.
/1 **The cooler the liquid the greater the solubility of a gas in the liquid. Therefore the cool water will contain more dissolved oxygen.**
15. State why you think clothes might be easier to clean in hot water.
/1 **Both soap and dirt are more soluble in water.**
16. Why do carbonated beverages go “flat” when opened and left at room temperature and pressure?
/1 **At room temperature gases are not very soluble. In addition, the pressure inside a closed can is greater than in an open can. Less pressure translates into lower solubility.**
17. Write a balanced chemical equation to represent the simultaneous dissolving and crystallizing of sodium chloride for a saturated solution in contact with excess solute.
/1 **$\text{NaCl}_{(s)} \rightleftharpoons \text{NaCl}_{(aq)}$**
18. Give definitions for the following terms:
/1 **Qualitatively, solubility is whether one substance can dissolve in another substance.**

/1 **Quantitatively, solubility is the concentration of a saturated solution at a given temperature.**

19.

$$n = \frac{m}{M}$$

$$c = \frac{n}{v}$$

/4

$$n = \frac{40.0\text{g}}{74.55 \frac{\text{g}}{\text{mol}}}$$

$$c_{\text{KCl}} = \frac{0.5366\text{mol}}{0.2000\text{L}}$$

$$n = 0.5366\text{mol}$$

$c_{\text{KCl}} = 2.68 \frac{\text{mol}}{\text{L}} @ 40^\circ\text{C}$

20.

$$n = \frac{m}{M}$$

$$c = \frac{n}{v}$$

/4

$$n = \frac{45.2\text{g}}{36.46 \frac{\text{g}}{\text{mol}}}$$

$$c_{\text{HCl}} = \frac{1.24\text{mol}}{0.100\text{L}}$$

$$n = 1.24\text{mol}$$

$c_{\text{HCl}} = 12.4 \frac{\text{mol}}{\text{L}} @ 25^\circ\text{C}$

21.

$$n = \frac{m}{M}$$

$$c = \frac{n}{v}$$

/4

$$n = \frac{35.7\text{g}}{58.44 \frac{\text{g}}{\text{mol}}}$$

$$c_{\text{NaCl}} = \frac{0.611\text{mol}}{0.100\text{L}}$$

$$n = 0.611\text{mol}$$

$c_{\text{NaCl}} = 6.11 \frac{\text{mol}}{\text{L}} @ 0^\circ\text{C}$

22.

$$n = c v$$

$$m = n M$$

$$n_{\text{sucrose}} = 3.80 \frac{\text{mol}}{\text{L}} (0.250\text{L})$$

$$m_{\text{sucrose}} = 0.95\text{mol} (342.24 \frac{\text{g}}{\text{mol}})$$

/4

$$n_{\text{sucrose}} = 0.95\text{mol}$$

$m_{\text{sucrose}} = 325\text{g}$