Problem Set - Calculating Concentrations #1 - Answers

1. A solution was prepared that had a total volume of 2.30 liters by dissolving 17.0 grams of NaCl in water. Showing all of your work, what is the concentration of NaCl in this solution?

Note: When this problem set was originally prepared, we treated atomic weights as whole or half integer numbers. For Fall 2007 and later, we will use the full 4+ significant Figures for these atomic weights and will carry these greater number of significant figures to our final answers

Note: The number of significant figures in this problem = 3. [1]

$\mathbf{V}_{solution}$ = 2.30 l

$\mathbf{W}_{NaCl}$ = 17.0 g

$\mathbf{MW}_{NaCl}$ = (1 x 23.0) + (1 x 35.5) = 58.5 g/mole

$\mathbf{n}_{NaCl} = \mathbf{W}_{NaCl} / \mathbf{MW}_{NaCl}$ = (17.0 g) / (58.5 g/mole) = 0.0291 moles = 2.91×10^{-1} moles [2]

$[\ ]_{NaCl} = \mathbf{[NaCl]} = \mathbf{n}_{NaCl} / \mathbf{V}_{solution}$ = (2.91×10^{-2} moles) / (2.30 l) = ~~0.126 moles/l~~ = 1.26×10^{-1} moles/l

---

2. If 12 grams of $C_6H_{12}O_6$ were dissolved in water to give a final volume of 1.2 liters, what would be the concentration of this compound in solution? Show all work.

Note: The number of significant figures in this problem = 2.

$\mathbf{V}_{solution}$ = 1.2 l

$\mathbf{W}_{C6H12O6}$ = 12 g

$\mathbf{MW}_{C6H12O6}$ = (6 x 12) + (12 x 1) + (6 x 16) = 180 grams/mole = 1.8×10^{2} g/mole

$\mathbf{n}_{C6H12O6} = \mathbf{W}_{C6H12O6} / \mathbf{MW}_{C6H12O6}$ = (12 g) / (180 g/mole) = 0.0667 moles = 6.7×10^{-2} moles

$[\ ]_{C6H12O6} = \mathbf{[C_6H_{12}O_6]} = \mathbf{n}_{C6H12O6} / \mathbf{V}_{solution}$ = (6.7×10^{-2} moles) / (1.2 l) = ~~0.0556 moles/l~~ = 5.6×10^{-2} moles/l

---

3. If 12.01 grams of $C_6H_{12}O_6$ were dissolved in water to give a final volume of 1.200 liters, what would be the concentration of this compound in solution? Show all work.

Note: The number of significant figures in this problem = 4.

$\mathbf{V}_{solution}$ = 1.200 l

$\mathbf{W}_{C6H12O6}$ = 12.01 g

$\mathbf{MW}_{C6H12O6}$ = (6 x 12.01) + (12 x 1.01) + (6 x 16.00) = 180.18 grams/mole = 1.802×10^{2} g/mole

$\mathbf{n}_{C6H12O6} = \mathbf{W}_{C6H12O6} / \mathbf{MW}_{C6H12O6}$ = (12.01 g) / (180.18 g/mole) = 0.06666 moles = 6.666×10^{-2} moles

$[\ ]_{C6H12O6} = \mathbf{[C_6H_{12}O_6]} = \mathbf{n}_{C6H12O6} / \mathbf{V}_{solution}$ = (6.666×10^{-2} moles) / (1.200 l) = ~~0.05555 moles/l~~ = 5.555×10^{-2} moles/l

---

[1] Note: The underlined numbers are the ones that will be checked in assigning partial and final grades for the questions.

[2] Note: It is OK to carry "too many" significant figures during your calculations (i.e., no points will be deducted from carrying too many). However, only the correct number of significant figures may be used in the final answer (i.e., the one(s) asked for in the question).

4. If 12 grams of $C_6H_{12}O_6$ were dissolved in water to give a final volume of 1,200 ml, what would be the concentration of this compound in solution? Show all work.

Note: The number of significant figures in this problem = 2.

V $_{solution}$ = 1,200 ml

Conversion of milliliters to liters ⇒ 1,000 ml = 1 l

V $_{solution}$ = 1,200 ml / 1,000 ml/l = 1.200 l

W $_{C6H12O6}$ = 12 g

MW $_{C6H12O6}$ = (6 x 12) + (12 x 1) + (6 x 16) = 180 grams/mole = 1.8×10^2 g/mole

n $_{C6H12O6}$ = **W** $_{C6H12O6}$ /**MW** $_{C6H12O6}$ = (12 g) / (180 g/mole) = 0.0667 moles = 6.7×10^{-2} moles

[ ] $_{C6H12O6}$ = **[$C_6H_{12}O_6$]** = **n** $_{C6H12O6}$ / **V** $_{solution}$ = (6.7 x 10^{-2} moles) / (1.200 l) = ~~0.056 moles/l~~ = 5.6×10^{-2} moles/l

---

5. A solution was prepared that had a total volume of 1,245 liters by dissolving 2,444 grams of NaCl in water. Showing all of your work, what is the concentration of NaCl in this solution?

Note: The number of significant figures in this problem = 4.

V $_{solution}$ = 1,245 l

W $_{NaCl}$ = 2,444 g

MW $_{NaCl}$ = (1 x 22.99) + (1 x 35.45) = 58.44 grams/mole = 5.844×10^1 g/mole

n $_{NaCl}$ = **W** $_{NaCl}$ /**MW** $_{NaCl}$ = (2,444 g) / (58.44 g/mole) = 41.82 moles = 4.182×10^1 moles

[ ] $_{NaCl}$ = **[NaCl]** = **n** $_{NaCl}$ / **V** $_{solution}$ = (41.82 moles) / (1,245 l) = ~~0.03359 moles/l~~ = 3.359×10^{-2} moles/l

---

6. A solution was prepared that had a total volume of 1,245 liters by dissolving 2.444 kilograms of NaCl in water. Showing all of your work, what is the concentration of NaCl in this solution?

Note: The number of significant figures in this problem = 4.

V $_{solution}$ = 1,245 l

W $_{NaCl}$ = 2.444 kg

Conversion of kilograms to grams ⇒ 1,000 g = 1 kg

W $_{NaCl}$ = 2.444 kg x 1,000 g/kg = 2,444 g

MW $_{NaCl}$ = (1 x 22.99) + (1 x 35.45) = 58.44 grams/mole = 5.844×10^1 g/mole

n $_{NaCl}$ = **W** $_{NaCl}$ /**MW** $_{NaCl}$ = (2,444 g) / (58.44 g/mole) = 41.82 moles = 4.182×10^1 moles

[ ] $_{NaCl}$ = **[NaCl]** = **n** $_{NaCl}$ / **V** $_{solution}$ = (41.82 moles) / (1,245 l) = ~~0.033,59 moles/l~~ = 3.359×10^{-2} moles/l

---

7. A solution was prepared that had a total volume of 1,245,000 milliliters by dissolving 2.444 kilograms of NaCl in water. Showing all of your work, what is the concentration of NaCl in this solution?

Note: The number of significant figures in this problem = 4.

$\mathbf{V}_{solution}$ = 1,245,000 ml

Conversion of milliliters to liters ⇒ 1,000 ml = 1 l

$\mathbf{V}_{solution}$ = 1,245,000 ml / 1,000 ml/l = 1,245 l

$\mathbf{W}_{NaCl}$ = 2.444 g

Conversion of kilograms to grams ⇒ 1,000 g = 1 kg

$\mathbf{W}_{NaCl}$ = 2.444 kg x 1,000 g/kg = 2,444 g

$\mathbf{MW}_{NaCl}$ = (1 x 22.99) + (1 x 35.45) = 58.44 grams/mole = 5.844×10^{1} g/mole

$\mathbf{n}_{NaCl} = \mathbf{W}_{NaCl} / \mathbf{MW}_{NaCl}$ = (2,444 g) / (58.44 g/mole) = 41.82 moles = 4.182×10^{1} moles

$[\ ]_{NaCl} = \mathbf{[NaCl]} = \mathbf{n}_{NaCl} / \mathbf{V}_{solution}$ = (41.82 moles) / (1,245 l) = 3.359×10^{-2} moles/l

---

8. A solution was prepared that had a total volume of 1.245×10^{3} liters by dissolving 2.444×10^{3} grams of NaCl in water. Showing all of your work, what is the concentration of NaCl in this solution?

Note: The number of significant figures in this problem = 4.

$\mathbf{V}_{solution}$ = 1.245×10^{3} l = 1,245 l

$\mathbf{W}_{NaCl}$ = 2.444×10^{3} g = 2,444 g

$\mathbf{MW}_{NaCl}$ = (1 x 22.99) + (1 x 35.45) = 58.44 grams/mole = 5.844×10^{1} g/mole

$\mathbf{n}_{NaCl} = \mathbf{W}_{NaCl} / \mathbf{MW}_{NaCl}$ = (2,444 g) / (58.44 g/mole) = 41.82 moles = 4.182×10^{4} moles

$[\ ]_{NaCl} = \mathbf{[NaCl]} = \mathbf{n}_{NaCl} / \mathbf{V}_{solution}$ = (41.82 moles) / (1,245 l) = ~~0.03359 moles/l~~ = 3.359×10^{-2} moles/l

---

9. A solution was prepared that had a total volume of 7.846 liters by dissolving 1.256 grams of MgI_2 in water. Showing all of your work, what is the concentration of MgI_2 in this solution?

Note: The number of significant figures in this problem = 4.

$\mathbf{V}_{solution}$ = 7.846 l

$\mathbf{W}_{MgI2}$ = 1.256 g

$\mathbf{MW}_{MgI2}$ = (1 x 24.31) + (2 x 126.91) = 278.13 grams/mole = 2.781×10^{2} g/mole

$\mathbf{n}_{MgI2} = \mathbf{W}_{MgI2} / \mathbf{MW}_{MgI2}$ = (1.256 g) / (278.13 g/mole) = 4.516×10^{-3} moles

$[\ ]_{MgI2} = \mathbf{[MgI_2]} = \mathbf{n}_{MgI2} / \mathbf{V}_{solution}$ = (4.516×10^{-3} moles) / (7.846 l) = 5.756×10^{-4} moles/l

---

10. A solution was prepared that had a total volume of 1.6 liters by dissolving 2.4 x 10^{-4} grams of CdS in water. Showing all of your work, what is the concentration of CdS in this solution?

Note: The number of significant figures in this problem = 2.

$\mathbf{V}_{solution}$ = 1.6 l

$\mathbf{W}_{CdS}$ = 2.4 x 10^{-4} g

$\mathbf{MW}_{CdS}$ = (1 x 112.41) + (1 x 32.06) = 144.47 grams/mole = 1.4 x 10^{2} g/mole

$\mathbf{n}_{CdS} = \mathbf{W}_{CdS} / \mathbf{MW}_{CdS}$ = (2.4 x 10^{-4} g) / (144.47 g/mole) = 1.7 x 10^{-6} moles

$[\,]_{CdS}$ = **[Cds]** = $\mathbf{n}_{CdS} / \mathbf{V}_{solution}$ = (1.66 x 10^{-6} moles) / (1.6 l) = 1.0 x 10^{-6} moles/l

---

11. A solution was prepared that had a total volume of 4.81 liters by dissolving 2.4 x 10^{-6} grams of BaSe in water. Showing all of your work, what is the concentration of BaSe in this solution?

Note: The number of significant figures in this problem = 2.

$\mathbf{V}_{solution}$ = 4.81 l

$\mathbf{W}_{BaSe}$ = 2.4 x 10^{-6} g

$\mathbf{MW}_{BaSe}$ = (1 x 137.33) + (1 x 78.96) = 216.29 grams/mole = 2.2 x 10^{2} g/mole

$\mathbf{n}_{BaSe} = \mathbf{W}_{BaSe} / \mathbf{MW}_{BaSe}$ = (2.4 x 10^{-6} g) / (216.29 g/mole) = 1.1 x 10^{-8} moles

$[\,]_{BaSe}$ = **[BaSe]** = $\mathbf{n}_{BaSe} / \mathbf{V}_{solution}$ = (1.1 x 10^{-8} moles) / (4.81 l) = 2.3 x 10^{-9} moles/l

---

12. A solution was prepared that had a total volume of 2.333 milliliters by dissolving 2.4 grams of CaO in water. Showing all of your work, what is the concentration of "CaO" in this solution?

Note: The number of significant figures in this problem = 2.

$\mathbf{V}_{solution}$ = 2.333 ml

Conversion of milliliters to liters ⇒ 1,000 ml = 1 l

$\mathbf{V}_{solution}$ = 2.333 ml / 1,000 ml/l = 2.333 x 10^{-3} l

$\mathbf{W}_{CaO}$ = 2.4 g

$\mathbf{MW}_{CaO}$ = (1 x 40.08) + (1 x 16.00) = 56.08 grams/mole = 5.6 x 10^{1} g/mole

$\mathbf{n}_{CaO} = \mathbf{W}_{CaO} / \mathbf{MW}_{CaO}$ = (2.4 g) / (56.08 g/mole) = 4.3 x 10^{-2} moles

$[\,]_{CaO}$ = **[CaO]** = $\mathbf{n}_{CaO} / \mathbf{V}_{solution}$ = (4.3 x 10^{-2} moles) / (2.333 x 10^{-3} l) = 1.8 x 10^{1} moles/l

---

13. If 12.01 grams of $C_{12}H_{22}O_{11}$ were dissolved in water to give a final volume of 1.6 liters, what would be the concentration of this compound in solution? Show all work.

Note: The number of significant figures in this problem = 2.

$\mathbf{V}_{solution}$ = 1.6 l

$\mathbf{W}_{C12H22O11}$ = 12.01 g

$\mathbf{MW}_{C12H22O11}$ = (12 x 12) + (22 x 1) + (11 x 16) = 342 grams/mole = 3.4×10^{2} g/mole

$\mathbf{n}_{C12H22O11} = \mathbf{W}_{C12H22O11} / \mathbf{MW}_{C12H22O11}$ = (12.01 g) / (342 g/mole) = 3.5×10^{-2} moles

$[\ ]_{C12H22O11} = \mathbf{[C_{12}H_{22}O_{11}]} = \mathbf{n}_{C12H22O11} / \mathbf{V}_{solution}$ = (3.5×10^{-2} moles) / (1.6 l) = 2.2×10^{-2} moles/l

---

14. If 4.6 grams of C_2H_6O were dissolved in water to give a final volume of 1.6 liters, what would be the concentration of C_2H_6O in solution? Show all work.

Note: The number of significant figures in this problem = 2.

$\mathbf{V}_{solution}$ = 1.6 l

$\mathbf{W}_{C2H6O}$ = 4.6 g

$\mathbf{MW}_{C2H6O}$ = (2 x 12) + (6 x 1) + (1 x 16) = 46 grams/mole = 4.6×10^{1} g/mole

$\mathbf{n}_{C2H6O} = \mathbf{W}_{C2H6O} / \mathbf{MW}_{C2H6O}$ = (4.6 g) / (46 g/mole) = 1.0×10^{-1} moles

$[\ ]_{C2H6O} = \mathbf{[C_2H_6O]} = \mathbf{n}_{C2H6O} / \mathbf{V}_{solution}$ = (1.0×10^{-1} moles) / (1.6 l) = 6.3×10^{-2} moles/l