Other concentration units.

1. Calculate the mole fraction of water in a mixture consisting of 9.00 g water, 120.0 g acetic acid, and 115.0 g ethyl alcohol C_2H_6O.

2. Determine the mole fraction of both substances in a solution containing 36.0 g water and 46.0 g glycerin, $C_3H_5(OH)_3$.

3. The density of a 2.03M of acetic acid solution in water is 1.017 g /mL. Calculate the molality of the solution.

4. Determine the volume of a nitric acid solution (that has a density 1.11 g /mL , 19.0% nitric acid by weight) that can be prepared by diluting 50.0 mL of a concentrated nitric acid solution with water. The concentrated nitric acid solution has a density 1.42 g/mL, 69 8% nitric acid by weight. Determine the molarity and molality of the concentrated and dilute acid solutions.

5. Density of a 10% by mass of KCl solution is 1.06 g/mL. Calculate the molality, the molarity, and the mole fraction of KCl in these solutions.

6. An aqueous solution is 15.0 % by mass of copper(II)sulfate pentahydrate ($CuSO_4 \cdot 5H_2O$). What is the molarity of copper sulfate in the solution at 20°? The density of the solution at 20°C is 1.167 g/mL.

Answers

1. The molar mass of water, acetic acid, and Ethel alcohol are 18.02, 60.02., and 46.07 g/mole, respectively.

9.00g H_2O	1 mole H_2O	0.499 4 mole H_2O
	18.02 g H_2O	

120.0 g $HC_2H_3O_2$	1 mole $C_2H_3O_2$	1.999 mole $C_2H_3O_2$
	60.02 g $C_2H_3O_2$	

115.0 g C_2H_6O	1 mole C_2H_6O	2.496 molC_2H_6O
	46.07 g C_2H_6O	

0.499 mol H_2O	0.0999 8, 0.100
4.99 mol	

2. The molar mass of glycerol is 92.0 g/mol; the molar mass of water is 18.0 g/mol.

36.0g H_2O	1 mole H_2O	1.998 mole H_2O
	18.02 g H_2O	

46.0 g $C_3H_5(OH)_3$	1 mole $C_3H_5(OH)_3$	0.499 5 mole $C_3H_5(OH)_3$
	92.009 g $C_3H_5(OH)_3$	

1.998 mol H_2O	0.800
2.498 mol	
0.4995$C_3H_5(OH)_3$	0.999 96; 0.200
2.498 mol	

3. 1.00 L of solution contains 2.03 moles of acetic acid (HAc). 1.00L solution has a mass of 1017 g because the mass of 1.00 mL is 1.017 g.

Mass of HAc in 1.00L of solution	2.03 moles HAc	60.05 g HAc	122 g HAc
		1 mol HAc	

Mass of water in 1.00L of solution	1017 g sol'n – 122 g	895 g water

Molality of the solution	2.03 mols HAc	2.27 m HAc
	0.895 kg water	

4. There are many approaches to solving this problem. This is mine.

What I know from the given data

	Concentrated acid	Diluted acid
Density	1.42 g conc sol'n = 1 mL conc sol'n	1.11 g dil sol'n = 1 mL dil sol'n
%	69.8 g HNO_3 = 100.0 g sol'n	19.0 g HNO_3 = 100.0 g sol'n
MM acid	63.02g acid = 1 mole acid	
MM water	18.02 g water = 1 mol water	

I needed to find 5 values: $M_{HNO3\ conc.}$ $M_{HNO3\ dil.,}$ $m_{HNO3\ conc.,}$ $m_{HNO3\ dilc.,}$ volume of the concentrated acid used for the dilution.
Plan: If I can get the molarity's of the solutions, I can do the dilution. If I know the volumes of my solutions, I can use that information to get molality.

Finding the molarities

$M_{HNO3\ conc}$	69.8 g HNO_3	1 mole HNO_3	1.42 g sol'n	1000 mL	15.7 M HNO_3
	100.0 g sol'n	63.02g HNO_3	1 mL sol'n	1 L	

$M_{HNO3\ conc}$	19.0 g HNO_3	1 mole HNO_3	1.11 g sol'n	1000 mL	3.35 M HNO_3
	100.0 g sol'n	63.02g HNO_3	1 mL sol'n	1 L	

Dilution: 15.7 M X 50.0 mL = 3.35 M X V, V = 234 mL dilute HNO_3

Find the molarities. I know I have 50.0 mL of the concentrated solution. In a dilution, the moles are constant; the moles of the dilute solution equal the moles of the concentrated solution. However, it is easier to get the information from the % mass and the molar mass.
A 69.8% solution means I have 30.2 g of water in the concentrated solution

$m_{HNO3\ conc}$	69.8 g HNO_3	1 mole HNO_3	1000g	36.7 m HNO_3
	30.2 g water	63.02g HNO_3	1 kg	

A 19.0% solution means I have 82 g of water in the diluted solution

$m_{HNO3\ dil}$	19.0 g HNO_3	1 mole HNO_3	1000g	3.72 m HNO_3
	81.0 g water	63.02g HNO_3	1 kg	

5. Start by using 100 g of solution.

M_{KCl}	10.0g KCl	1 mole KCl	1.06g sol'n	1000 mL	1.42 M KCl
	100.0 g sol'n	74.55 g KCl	1 mL sol'n	1 L	

m_{KCl}	10.0g KCl	1 mole KCl	1000g	1.49 mKCl
	90.0 g water	74.55 g KCl	1 kg	

4.994 mol H_2O	0.8999, 0.900
5.549 mol	
0.554 9 mol KCl	0.100
5.549 mol	

6. similar to other problems above

$M_{CuSO4•5H2O}$	15.0 g $CuSO_4•5H_2O$	1 mole $CuSO_4•5H_2O$	1.167 g sol'n	1000 mL	0.701 $CuSO_4•5H_2O$
	100.0 g sol'n	249.72g $CuSO_4•5H_2O$	1 mL sol'n	1 L	

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