Pharmaceutical Calculations

Concentration Expressions

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Concentration expressions

1) Percentage preparations

- Used for relatively concentrated solutions.

- Expressed as follow:

1. Percent weight per weight (% w/w):
   Number of (g) of solute in (100 g) of solution.

2. Percent weight per volume (% w/v):
   Number of (g) of solute in (100 ml) of solution.

3. Percent volume per volume (% v/v):
   Number of (ml) of solute in (100 ml) of solution.

- % w/w used for mixtures of solids.
- % w/v used for mixtures (solid in liquid) or (gas in liquid).
- % v/v used for mixtures (liquid in liquid).

2) Ratio strength

- Used to express concentration of relatively dilute solutions.
- 1 part of solute present in how many parts of solutions.
- Expressed as 1: ……
- 1:5000 ratio strength means: 1 part of solute per 5000 parts of solution.

3) Part per million (ppm)

- Used to express concentration of extremely dilute solution.
- 1 ppm solution means that each million part of solution contain 1 part of solute (1 part of solute / 10^6 part of solution).
- Frequently used to express concentration of impurities in water.
- 10 ppm = 10 part of solute contained in 1000000 part of solution.
- In metric system ppm expressed as g/ml.

- **Example 1: How many grams of dextrose are required to prepare 4000 ml of 5% solution?**

- 5% w/v because dextrose is solid and the solution is a liquid.

5 g solute → 100 ml solution

X gram → 4000 ml solution

- X = 5 g x 4000 ml / 100 ml = 200 g

- **Example 2: How many grains of mild silver protein should be used in preparing fluid ounce iv of 10% w/v solution?**

- 4 fluid ounce = 4 x 29.57 = 118.28 ml

10 g solute → 100 ml solution

X gram → 118.28 ml solution

- X = 118.28 ml x 10 g / 100 ml = 11.828 g = 11.828 g x 15.432 = 182.53 gr

❑ **Example 3: What is the % w/v of a solution of urea if 80 ml contains 12 g?**

12 g of solute → 80 ml solution

X g solute → 100 ml solution

- X = 12 g x 100 ml / 80 ml = 15 % w/v

❑ **Example 4: What is the % w/v of a solution of strong silver protein if 2.92 g is dissolved in enough distilled water to make 240 ml?**

2.92 g of solute → 240 ml solution

X g solute → 100 ml solution

- X = 2.92 g x 100 ml / 240 ml = 1.22 g
- % w/v = 1.22 % w/v

- **Example 5: How many ml of 3% w/v solution can be made from 27 g of boric acid?**

3 g of solute → 100 ml solution

27 g solute → X ml solution

- X = 27 g x 100 ml / 3 g = 900 ml

- **Example 6: How many ml of 10 % w/v solution can be made from 11.66 g of colloidal silver iodide?**

10 g of solute → 100 ml solution

11.66 g solute → X ml solution

- X = 11.66 g x 100 ml / 10 g = 116.6 ml

❑ **Example 7:**

Rx

Liquefied phenol 2.5 %v/v

Boric acid solution ad 240 ml

2.5 ml of solute → 100 ml solution

X ml of solute → 240 ml solution

- X = 240 ml x 2.5 ml / 100 ml = 6 ml

❑ **Example 8: In preparing 250 ml of a lotion, a pharmacist used 4 ml of liquefied phenol. What was the % v/v liquefied phenol in lotion?**

4 ml of solute → 250 ml solution

X ml of solute → 100 ml solution

- X = 4 ml x 100 ml / 250 ml = 1.6 ml
- % v/v = 1.6 % v/v

❑ Example 9:

Rx

Wintergreen oil 5 % V/V

Isopropyl alcohol ad 118.28 ml

How many ml of oil should be used?

5 ml of solute → 100 ml solution

X ml of solute → 118.28 ml solution

- X = 5 ml x 118.28 ml / 100 ml = 5.91 ml

❑ Example 10: Spearmint spirit contain 10 % V/V of spearmint oil, what volume of spirit will contain 75 ml oil?

10 ml of solute → 100 ml solution

75 ml of solute → X ml solution

- X = 75 ml x 100 ml / 10 ml = 750 ml

Example 11: Express the following aqueous solutions in terms of ppm:

1) 0.01 mg/ 100 ml 2) 0.001 g/L 3) 0.0005 % w/v

1) 0.01 mg/ 100 ml

- 0.01 mg/100 ml = 0.00001 g/ 100 ml

  0.00001 g of solute → 100 ml of solution

  X g of solute → 1000000 ml of solution
- X = 1000000 ml x 0.00001 g / 100 ml = 0.1 g
- 0.1 ppm

2) 0.001 g/L

- 0.001 g/L = 0.001 g/ 1000 ml

  0.001 g of solute → 1000 ml of solution

  X g of solute → 1000000 ml of solution
- X = 0.001 g x 1000000 ml / 1000 ml = 1 g
- 1 ppm

3) 0.0005 % w/v

0.00005 g of solute → 100 ml of solution

X g of solute → 1000000 ml of solution

- X = 0.0005 g x 1000000 ml/ 100 ml = 5 g
- 5 ppm

Dilution and concentration

- If the amount of active ingredient remains constant, any change in the quantity of the solution or mixture of solids is inversely proportional to the % or ratio strength.

$$\text{Quantity } \alpha \frac{1}{\text{Strength (concentration)}}$$

❑ Law of dilution and concentration

$$\frac{\text{Original quantity}}{\text{Final quantity}} = \frac{\text{Final strength}}{\text{Original strength}}$$

❑ **When 50 ml of a solution containing 10 g of a substance, so its strength = 20% w/v:**

1) If diluted to 100 ml :

- Then, the original volume is doubled, but the original strength is reduced by ½ = 10 % w/v.

2) If concentrated to 25 ml:

- The original volume is reduced by ½, then the final strength is doubled to 40% w/v.

- **Example 1: If 500 ml of 15% v/v solution is diluted to 1500 ml , what will be the % v/v?**

Original quantity = 500 ml Final quantity = 1500 ml

Original strength = 15 % v/v Final strength = X % V/V

Original quantity / Final quantity = Final strength / original strength

500 ml / 1500 ml = X / 15 % v/v

- X = 5 % v/v

- **Example 2: If 20 ml of a 1:200 (w/v) solution of a chemical to 500 ml, what is the ratio strength?**

Original quantity = 20 ml Final quantity = 500 ml

Original strength = 1: 200 w/v Final strength = X % w/V

Original quantity / Final quantity = Final strength / original strength

20 ml / 500 ml = (1/X) / (1:200 w/v)

- 1/X = 1:5000 (w/v)

- **Example 3: If a syrup containing 65% w/v of sugar is evaporated to 85% of its volume, what is % w/v of sugar will it contain?**

Original quantity = 100 ml Final quantity = 85 ml

Original strength = 65 % w/v Final strength = X % w/v

Original quantity / Final quantity = Final strength / original strength

100 ml / 85 ml = X / 65% w/v

- X = 76.5 % w/v

- **Example 4: How many ml of 10 % w/v of ammonia water can be made from 1800 ml of 28% w/v ammonia water?**

Original quantity = 1800 ml Final quantity = X ml

Original strength = 28 % w/v Final strength = 10 % w/v

Original quantity / Final quantity = Final strength / original strength

1800 ml / X ml = 10 % / 28%

- X = 5040 ml

Dilution of alcohols and acids

- **When an alcohol or acid diluted with water :**

1. Contraction in volume occur (the final volume will be less than the additives of the original volumes), So volumes are not additive.

2. But the final weight will equal additive of the original weights, so weights are additive.

3. So, the volume of water used to dilute alcohol or acid ca not be calculated, but we take the original volume and complete with water till reach the final volume.

❑ **Example: How much water should be mixed with 5000 ml of 85% v/v to make 50% v/v alcohol?**

Original quantity = 5000 ml
Original strength = 85 % v/v

Final quantity = X ml
Final strength = 50% v/v

Original quantity / Final quantity = Final strength / original strength

5000 ml / X ml = (50% v/v) / (85% v/v)

- X = 5000 ml x 85% / 50% = 8500 ml

- **Water should be added till reach 8500 ml (the final volume).**