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Formulations

LEARNING OBJECTIVES

By the end of this chapter you will be able to:

- Manipulate a given formula to the amount required on the prescription
- Check the calculated amounts against the original formula to ensure accuracy
- State the difference between the terms 'parts' and 'to parts'

Formulae in pharmacy are recipes either from the standard literature available or from the directions of the prescriber. Ingredients can be listed as amounts, parts or percentages. The formula may also have the amount in a greater or smaller quantity than is prescribed on the prescription.

Since ingredients with a formula have to be kept in fixed ratios, they form proportional sets. Comparison of numbers in the sets after calculation, to ensure that the proportions are maintained, is a valuable way of checking the formula and should overcome the potential for error.

Using proportional sets provides a structured approach to the problem and provides you with a method for checking accuracy.

Reducing the formula

Some reference sources provide a formula for a larger quantity than the quantity required on the prescription.

EXAMPLE 5.1

A prescription requires 200 mL of Chalk Mixture, Paediatric BP. The formula is:

<i>chalk</i>	20 g
<i>tragacanth powder</i>	2 g
<i>cinnamon water, concentrated</i>	4 mL
<i>syrup</i>	100 mL
<i>chloroform water, double strength</i>	500 mL
<i>water for preparation to</i>	1000 mL

We therefore have a formula to produce 1000 mL of the preparation but require 200 mL. Calculate the quantities required to produce 200 mL. Setting up proportional sets:

	<i>master formula</i>	<i>to make 200 mL</i>
chalk (g)	20	<i>a</i>
tragacanth powder (g)	2	<i>b</i>
cinnamon water, concentrated (mL)	4	<i>c</i>
syrup (mL)	100	<i>d</i>
chloroform water, double strength (mL)	500	<i>e</i>
water for preparation (mL) to	1000	200

We can calculate the missing values by setting up the ratio equations for corresponding pairs or by spotting.

To calculate the amount of chalk we pick out the proportional sets:

chalk (g)	20	<i>a</i>
water for preparation (mL) to	1000	200

By 'spotting', 1000 is divided by 5 to get 200, so 20 is divided by 5 to get:

$$a = 4$$

Continuing the process for other pairs of ingredients we get:

	<i>master formula</i>	<i>to make 200 mL</i>
chalk (g)	20	4
tragacanth powder (g)	2	0.4
cinnamon water, concentrated (mL)	4	0.8
syrup (mL)	100	20
chloroform water, double strength (mL)	500	100
water for preparation (mL) to	1000	200

At this stage it is important to check the relative amounts of the ingredients and re-check the ratios in order to eliminate any errors.

Increasing the formula

Some reference sources provide a formula that is for a smaller quantity than the quantity required on the prescription.

EXAMPLE 5.2

Calculate the quantities required to produce 300 mL of Aromatic Magnesium Carbonate Mixture BP using the formula:

<i>light magnesium carbonate</i>	<i>300 mg</i>
<i>sodium bicarbonate</i>	<i>500 mg</i>
<i>aromatic cardamom tincture</i>	<i>0.3 mL</i>
<i>chloroform water, double strength</i>	<i>5 mL</i>
<i>water to</i>	<i>10 mL</i>

Setting up proportional sets:

	<i>master formula</i>	<i>to make 300 mL</i>
light magnesium carbonate (mg)	300	<i>a</i>
sodium bicarbonate (mg)	500	<i>b</i>
aromatic cardamom tincture (mL)	0.3	<i>c</i>
chloroform water, double strength (mL)	5	<i>d</i>
water (mL) to	10	300

Picking out two proportional sets:

light magnesium carbonate (mg)	300	<i>a</i>
water (mL) to	10	300

Corresponding pairs are in the same ratio so:

$$\frac{300}{10} = \frac{a}{300}$$

Solving for the unknown:

$$a = \frac{300 \times 300}{10}$$

$$a = 9000$$

We continue the process to get:

	<i>master formula</i>	<i>to make 300 mL</i>
light magnesium carbonate (mg)	300	9000
sodium bicarbonate (mg)	500	15 000
aromatic cardamom tincture (mL)	0.3	9

chloroform water, double strength (mL)	5	150
water (mL) to	10	300

Again, a thorough check of the corresponding values should be made.

Formulae involving parts

Sometimes the formula for a product is expressed as parts rather than as quantities. The total amount of product will be the sum of the parts of the ingredients. From this, a formula can be produced and used to calculate the amounts of the ingredients in a required amount of product.

EXAMPLE 5.3

Consider the standard for Industrial Methylated Spirit (IMS) BP, which states that ingredients should be in the ratio 95 parts spirit to 5 parts wood naphtha. In IMS both the ingredients are liquids therefore the parts are volume in volume. How much of each ingredient is required to produce 300 L?

Setting up proportional sets:

	<i>master formula to make 300L</i>	
spirit (L)	95	<i>a</i>
wood naphtha (L)	5	<i>b</i>
IMS (L)	100 (95 + 5)	300

We can spot that:

$$b = 5 \times 3 = 15$$

$$a = 95 \times 3 = 285$$

therefore the proportional sets become:

	<i>master formula to make 300 L</i>	
spirit (L)	95	285
wood naphtha (L)	5	15
IMS (L)	100	300

Example 5.4 involves solids in a formula expressed as parts.

EXAMPLE 5.4

Find the quantities of ingredients needed to produce 50 g of product using the formula:

<i>calamine (parts weight)</i>	2
<i>yellow soft paraffin (parts weight)</i>	38

The total ointment contains 40 parts (2 + 38). Setting up the proportional sets:

	<i>master formula to produce 50 g</i>	
calamine (g)	2	x
yellow soft paraffin (g)	38	y
total (g)	40	50

Corresponding pairs of values are in the same ratio:

$$\frac{2}{40} = \frac{x}{50}$$

Solving for the unknown:

$$x = \frac{2 \times 50}{40}$$

$$x = 2.5$$

therefore:

$$y = 50 - 2.5 = 47.5$$

The proportional sets become:

	<i>master formula to produce 50 g</i>	
calamine (g)	2	2.5
yellow soft paraffin (g)	38	47.5
total (g)	40	50

It is necessary to differentiate carefully between the use of ‘parts’ and ‘to parts’. Compare the following two formulae:

Formula 1

calamine	1 part
white soft paraffin	10 parts

This is equivalent to:

calamine	1 g
white soft paraffin	10 g

This is a total of 11 g (or 11 parts).

Formula 2

calamine	1 part
white soft paraffin to	10 parts

This is equivalent to:

calamine	1 g
white soft paraffin	9 g

This is a total of 10 g (or 10 parts).

Formulae containing percentages

A formula can also be expressed in percentages. Ointments and creams are the most common examples of this. The percentages of the

ingredients can be used to produce the formula, and the ingredients in a known amount of product can be calculated.

EXAMPLE 5.5

Using the following formula, calculate the amounts of ingredients required to make 25 g:

<i>sulphur</i>	6%
<i>salicylic acid</i>	4%
<i>white soft paraffin to</i>	100%

Setting up proportional sets:

	<i>master formula</i>	<i>to make 25g</i>
sulphur (g)	6	<i>a</i>
salicylic acid (g)	4	<i>b</i>
white soft paraffin (g)	90	<i>c</i>
total ointment (g)	100	25

100 is divided by four to get 25, therefore by ‘spotting’, each amount in the first column is divided by four to get the corresponding amount in the second column. The result is:

	<i>master formula</i>	<i>to make 25 g</i>
sulphur (g)	6	1.5
salicylic acid (g)	4	1
white soft paraffin (g)	90	22.5
total ointment (g)	100	25

EXAMPLE 5.6

Find the amount of ingredients required to make 50 g of the following formulation:

<i>calamine</i>	6% <i>w/w</i>
<i>liquid paraffin</i>	7% <i>w/w</i>
<i>yellow soft paraffin to</i>	100% <i>w/w</i>

Setting up proportional sets:

	<i>master formula</i>	<i>to make 50 g</i>
calamine (g)	6	<i>a</i>
liquid paraffin (g)	7	<i>b</i>
yellow soft paraffin (g)	87	<i>c</i>
total product	100	50

By 'spotting':

$$a = 3$$

$$b = 3.5$$

$$c = 43.5$$

The formula is therefore:

	<i>master formula</i>	<i>to make 50 g</i>
calamine (g)	6	3
liquid paraffin (g)	7	3.5
yellow soft paraffin (g)	87	43.5

Practice calculations

Answers are given at the end of the chapter.

Q1 Calculate the amounts of the following required to produce 200 g of cream:

calamine	10%
zinc oxide	15%
aqueous cream to	100%

- Q2** Calculate the formula for 20 g of benzoic acid ointment compound using the formula:

benzoic acid	6%
salicylic acid	4%

(in emulsifying ointment)

- Q3** Calculate the formula required to produce 300 mL of menthol and eucalyptus inhalation from the formula:

menthol	2 g
eucalyptus oil	10 g
light magnesium carbonate	7 g
water to	100 mL

- Q4** Calculate the amounts of ingredients required to make 30 g of ointment to the following formula:

coal tar solution	12% w/w
hydrous wool fat	24% w/w
yellow soft paraffin to	100%

- Q5** Calamine and Coal Tar Ointment BP has the following formula:

calamine	12.5 g
strong coal tar solution	2.5 g
zinc oxide	12.5 g
hydrous wool fat	25 g
white soft paraffin	47.5 g

Calculate the amounts of ingredients required to produce 25 g of product.

- Q6** Zinc and coal tar paste has the following formula:

zinc oxide	6% w/w
coal tar	6% w/w
emulsifying wax	5% w/w
starch	38% w/w
yellow soft paraffin	45% w/w

Calculate the amounts of ingredients required to produce 300 g of paste.

- Q7** Calculate the amounts of ingredients required to produce 300 mL of Ammonia and Ipecacuanha Mixture BP, which has the formula:

ammonium bicarbonate	200 mg
liquorice liquid extract	0.5 mL
ipecacuanha tincture	0.3 mL
concentrated camphor water	0.1 mL
concentrated anise water	0.05 mL
double-strength chloroform water	5 mL
water to	10 mL

- Q8** Calculate the amounts of ingredients required to make 150 mL of Diamorphine Linctus BPC 1973, which has the formula:

diamorphine hydrochloride	3 mg
oxymel	1.25 mL
glycerol	1.25 mL
compound tartrazine solution	0.06 mL
syrup to	5 mL

- Q9** Calculate the amounts of ingredients required to make 3 L of the formula:

witch hazel	4 parts
glycerol	1 part
water	15 parts

- Q10** Calculate the amounts of ingredients required to make 2 L of the formula:

aluminium hydroxide	200 mg
activated dimeticone	25 mg
magnesium hydroxide	200 mg
water to	5 mL

- Q11** Calculate the amounts of ingredients required to make 30 g of coal tar and zinc ointment using the formula:

strong coal tar solution	100 g
zinc oxide, finely sifted	300 g
yellow soft paraffin	600 g

Q12 Calculate the amounts of ingredients needed to produce 200 mL of kaolin and morphine mixture using the formula:

light kaolin	200 g
sodium bicarbonate	50 g
chloroform and morphine tincture	40 mL
water sufficient to produce	1000 mL

Q13 Calculate using the following formula the amounts of ingredients needed to produce 500 g of product:

calcium carbonate	5 parts
sodium bicarbonate	5 parts
bismuth subcarbonate	3 parts

Q14 Calculate the amounts of ingredients required to make 200 g of product from the formula:

Betnovate ointment	1 part
yellow soft paraffin to	5 parts

Q15 Calculate the amounts of ingredients required to make 300 g of product from the formula:

Betnovate ointment	3 parts
yellow soft paraffin	8 parts

Answers

A1

calamine	20 g
zinc oxide	30 g
aqueous cream	150 g

A2

benzoic acid	1.2 g
salicylic acid	0.8 g
emulsifying ointment	18g

A3

menthol	6 g
eucalyptus oil	30 g
light magnesium carbonate	21 g
water to	300 mL

- A4** coal tar solution 3.6 g
 hydrous wool fat 7.2 g
 yellow soft paraffin 19.2 g
- A5** calamine 3.125 g
 strong coal tar solution 0.625 g
 zinc oxide 3.125 g
 hydrous wool fat 6.25 g
 white soft paraffin 11.875 g
- A6** zinc oxide 18 g
 coal tar 18 g
 emulsifying wax 15 g
 starch 114 g
 yellow soft paraffin 135 g
- A7** ammonium bicarbonate 6000 mg
 liquorice liquid extract 15 mL
 ipecacuanha tincture 9 mL
 concentrated camphor water 3 mL
 concentrated anise water 1.5 mL
 double-strength chloroform water 150 mL
 water to 300 mL
- A8** diamorphine hydrochloride 90 mg
 oxymel 37.5 mL
 glycerol 37.5 mL
 compound tartrazine solution 1.8 mL
 syrup to 150 mL
- A9** witch hazel 0.6 L
 glycerol 0.15 L
 water 2.25 L
- A10** aluminium hydroxide 80 000 mg
 activated dimeticone 10 000 mg
 magnesium hydroxide 80 000 mg
 water to 2000 mL
- A11** strong coal tar solution 3 g
 zinc oxide, finely sifted 9 g
 yellow soft paraffin 18 g

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A12	light kaolin	40 g
	sodium bicarbonate	10 g
	chloroform and morphine tincture	8 mL
	water sufficient to produce	200 mL

A13	calcium carbonate	192.3 g
	sodium bicarbonate	192.3 g
	bismuth subcarbonate	115.4 g

A14	Betnovate ointment	40 g
	yellow soft paraffin	160 g

A15	Betnovate ointment	81.8 g
	yellow soft paraffin	218.2 g