

# **DRUG CALCULATIONS 2**

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This Booklet is designed to accompany Booklet 1 and is structured to contain at the start some examples of calculations that students have stated they find difficult followed by a step by step approach to solving the problem

No claim is made that the approach used is the simplest, or that it is the only, or even the best approach to solving that particular problem.

What is intended is to show how, by breaking the problem down into simple steps, the question posed can be understood and so a calculation be undertaken (That is both logical and easy to follow) and one that will provide the answer.

Some Questions have necessary information included in them. However this information may be in standard reference sources such as the BNF and so in the pre-registration exam, this information may not be provided and it would be necessary to know that the information was in the reference sources and also where to find it. This is a check that you are familiar with those reference sources.

## The Use and Abuse Of Formulas

This is a more complicated section that looks at a single problem and then several different formulas that can be used to solve the problem – and so justify why no single formula alone is appropriate to any specific problem.

<p style="text-align: center;"><b><u>Why I do not use Formulas</u></b></p> <p>Let us look at a very simple question - You have 100g of salicylic acid ointment 2% w/w. What weight of salicylic acid powder do you need to add to make a 30% w/w Ointment ?</p> <p>A 30g B 35g C 40g D 45g E 50g</p>	<div style="text-align: center;"> <p style="font-size: small;">TODAY'S MATH LESSON IS .... HEY, WHO WROTE JUNK ON MY MATH BOARD ?</p> </div>
<p>A formula must be understood before you start of a calculation - otherwise that formula needs to be explained in detail so that it is understood before it can be used</p>	
<p>You have 100g of salicylic acid ointment 2% w/w.</p> <p>What weight of salicylic acid do you need to add to make a 30% w/w Ointment ?</p> <p>A 30g B 35g C 40g D 45g E 50g</p>	<p>What Formula should be used to calculate an answer. More importantly - How does anyone know intuitively which formula to use ?</p> <p><math>C1/V1 = C2 / V2</math> ?</p> <p><math>C1 / V2 = C2 / V1</math> ?</p> <p>Alligation ?</p> <p>Algebra / Logic / intuition ? (These all have a place !)</p> <p>Something else ?</p>
<p>Each formula uses a slightly different mathematical approach = , ratios, equivalence, proportions convergence etc.</p> <p>Which formula you use will depend on who taught you Maths, what method they used and what you remember.</p>	

**Here is a Solution Using  $C1/V1 = C2/V2$**

A common formula used for calculating amounts in volumes is  $C1 / V1 = C2 / V2$   
Using this formula (where the two volumes are actually the same) gives

$$((100 \times 2/100) + X) / (100+X) = ((100+ X) \times (30/100))/(100+ X) \text{ or more simply}$$

$$(2+X) / (100+X) = ((100+ X) \times (30/100))/(100+ X) \text{ since we know that 2\% of 100gms is 2gms}$$

Remember  $(2 + X)$  = total amount of drug (original amount in the 4% plus the amount you add)

$(100+X)$  = total weight of the final 30% salicylic acid ointment so  $(2+X) / (100+X)$  is simply equivalent to  $C1 / V1$

$((100+ X) \times (30/100))$  is also the total amount of drug = 30% of the final weight and  $((100+ X) \times (30/100))/(100+ X)$  is simply equivalent to  $C2 / V2$

If both sides of the equation are multiplied by  $(100 + X)$  we get

$$(2 + X) = ((100+ X) \times (30/100)) \quad \text{Then multiplying by 100}$$

$$200 + 100X = 3000 + 30X$$

$$70X = 2800 \quad X = 2800/70 \quad X = 40$$

**This is not a simple calculation !!**

(Note the algebraic method used later is essentially identical. It just starts in a different way)

This method relies on the *concentration* remaining constant and so calculating the amount in 'different' volumes. In this example, two different 'expressions' for the same volume are used where the value  $X$  is unknown.

The two expressions are :-

$(2+X) / (100+X)$  - An expression giving the ratio of Salicylic acid  $(2+X)$  to volume using the concentration in the original ointment and the amount that is then added to bring the concentration up to 30%

and

$((100+ X) \times (30/100))/(100+ X)$  - An expression giving the ratio of Salicylic acid (30% of final volume) to volume using the final weight of ointment  $(100+X)$

By assuming the concentration remains constant, the two expressions can be considered to be equal and so  $X$  can be calculated.

**Here is a Solution Using  $C_1 \times V_2 = C_2 \times V_1$**

Another often used formula is  $C_1 \times V_2 = C_2 \times V_1$

This is usually used to compare the same amounts in two different concentrations but can also be used where the concentration is the same. In this instance, the formula is very similar to the previous page as  $C_1 = C_2$  and  $V_1 = V_2$ . This gives :-

$((100 \times 2/100) + X) \times (100 + X) = ((100 + X) \times (30/100)) \times (100 + X)$  or again simplifying a bit

$$(2 + X) \times (100 + X) = ((100 + X) \times (30/100)) \times (100 + X)$$

In this case dividing by  $(100 + X)$  gives

$$(2 + X) = ((100 + X) \times (30/100)) \quad \text{Then multiplying by 100 to simplify ..}$$

$$200 + 100X = 3000 + 30X$$

$$70X = 2800 \quad X = 2800/70 \quad X = 40$$

(Note - the algebraic method used later is essentially identical - Also this is actually identical to  $C_1 / V_1 = C_2 / V_2$  as here  $V_1 = V_2$ )

This method relies on the *amount* remaining constant and so calculating this from the concentration in different volumes. However in this example, two different 'expressions' for the same volume are used where the value X is unknown.

The two expressions are :-

$(2 + X) \times (100 + X)$  - An expression giving the amount of Salicylic acid  $(2 + X)$  in volume 1 multiplied by Volume 2  $(100 + X)$   
and

$((100 + X) \times (30/100)) \times (100 + X)$  - An expression giving the ratio of Salicylic acid (30% of final volume) in Volume 2 multiplied by Volume 1  $(100 + X)$

Again, the assumption is that the amount of Salicylic acid in the 2 volumes is identical (and the volumes here are identical- we simply have two different expressions for the amount of Salicylic acid) and so the two expressions can be considered equal.

In fact  $C_1 / V_1 = C_2 / V_2$  and  $C_1 \times V_2 = C_2 \times V_1$  can in this example be reduced to  $(2 + X) = ((100 + X) \times (30/100))$ - this is a bit of a simplification as in reality it should be written as

$$((100 \times 2 / 100) + X) = ((100 + X) \times (30/100))$$

as we are already reducing  $((100 \times 2 / 100) + X)$  to  $(2 + X)$  If the amount of 2% ointment were not 100gms we would need to use the full expression.

**Here is a Solution Using Alligation**

ALLIGATION

As the powder is 100% pure, using alligation you would get :-

$$PA = 30 - 2 = 28 \quad (PA = Fc - Bc) \quad \text{and}$$

$$PB = 100 - 30 = 70 \quad (PB = Ac - Fc)$$

Total parts = 98 (28 + 70)      28 of which are pure Salicylic Acid

Now 70 parts weigh 100gms

So 1 part weighs  $100 / 70 = 1.43$  (approximately)

So 28 parts weigh  $28 \times (100 / 70)$  gms or  $28 \times 1.43 = 40$ gms

You can then double check       $100 + 40 = 140$  gms

30% of this =  $140 \times 30 / 100$ gms      = 42

Now the original 100gms contained 2gms (2%)

You added 40gms so total is  $40 + 2 = 42$ gms.

Explaining Alligation is a little complicated but it is a statistical method that looks at how much one solution is 'concentrated' and how much another solution is 'diluted' when the two are mixed

e.g. if we mix 100% of drug with water in a 50:50 ratio (actually a 1:1 ratio) ,

the drug becomes a 50% solution and is weaker by 50%.

The water becomes a 50% solution and is stronger in drug by 50%

However it can also be looked on as the water becoming weaker by 50% and the drug becoming stronger in water content by 50%

The formula looks at the current strength of a 'drug' and the proportion of diluent that needs to be added as a ratio of the drug to change its strength to something else

The more a drug is diluted, the greater the ratio of diluent that is required. Compared to the original volume of drug. The ratio of diluent will remain consistent

e.g. to dilute something by 50% will always require an equal volume of diluent to drug so the ratio is always 1:1 regardless of actual volume.

**Here is a solution using Algebra**

Using algebra (simultaneous equations) is a bit more tricky

let the amount you are going to add be equal to Xgms

$100 + X = \text{final amount}$

$(100 \times 2/100) + X = (100+X) \times 30/ 100$       ( $100 + X = \text{final amount}$  and  $30/100 = 30\%$  of that amount )

the right hand side of the equation can also be written as  $((100 + X) \times 30) / 100$

Now multiplying each side of the equation by 100 gives

$$(2 + X) \times 100 = 3000 + 30X \qquad ((100+ X) \times 30) = 3000 + 30X$$

$$200 + 100X = 3000 + 30X \qquad \text{swapping this around gives}$$

$$100X - 30X = 3000 - 200 \qquad \text{and this now gives}$$

$$70X = 2800$$

$$X = 2800 / 70 \quad X = 40$$

However if you look back , this method is actually identical to  $C1/V1=C2/V2$  as a 'formula'

The algebraic method is very similar to the  $C1 \times V2=C2 \times V1$  method but ignores the volumes (as they are known to be the same)

Thus the two expressions for the quantities of Salicylic acid are equal :-

$$\text{i.e. } - (100 \times 2/100) + X = (100+X) \times 30/ 100$$

Algebra is often considered to be the most difficult approach but if you can analyse a problem easily and accurately, it often offers the best approach to a simple and rapid solution.

Writing down simple relationships in English (or your first language and then turning those relationships into simple algebraic relationships can work wonders.

Cont.....

**Here is a Solution Using Deduction**

You know that in 100gms of ointment you have 2gms drug (that's what 2% means !). So to increase the strength to 30% you will need to add at least 28gms of drug (as there would be 30gms in 100gms of 30% Ointment).

Take a guess at adding 30gms

Your total amount of ointment will be 130gms and amount of drug will be 32gms (30 + 2) (as there are 2gms in the original 2% ointment)

30% of 130 is  $130 \times (30/100) = 39$  -i.e. 7gms more than you have.....

So add 37gms to 100gms of 2%

Your total amount of ointment will be 137gms and of drug is 39gms

30% of 137 is  $137 \times (30/100) = 41$  -i.e. 2gms more

So add 39gms

Your total amount of ointment will be 139gms and of drug is 41gms

30% of 139 is  $139 \times (30/100) = 41.7$  -i.e. 0.7gms more

so add 39.7gms

Your total amount of ointment will be 139.7gms and of drug is 41.7gms

30% of 139.7 is  $139.7 \times (30/100) = 41.91$  -i.e. 0.21gms more

So add 39.91gms

Your total amount of ointment will be 139.91gms and of drug is 41.91gms

30% of 139.91 is  $139.91 \times (30/100) = 41.973$  -i.e. 0.063gms more

so add 39.971gms... This is now almost 40gms

You can keep going with this and the value will get closer and closer to 40gms as the amount to add.

This method is easy to understand when written out as above but..

This method of deduction can be written mathematically but becomes more complicated than is necessary

It is a recursive form of the formula  $((100 \times 2/100) + X) \times (30/100) - (2 + X) =$  (or tends to ) 0

As X is guessed the first expression becomes  $((100 \times 2/100) + X) \times (30/100) - (2 + X) = Y$

and the formula becomes  $((100 \times 2/100) + (X + y_1 + y_2 + y_3 + \dots)) \times (30/100) - (2 + (X + y_1 + y_2 + y_3 + \dots)) =$  tends to 0

This is a clumsy way of writing this and this mathematical formula / method is usually used for much more complex problems.

### **Fed up with Formulas.....**

**(well you will still need to 'calculate' something )**

Another method of calculating which of 5 answers is correct is to choose the middle answer C and calculate backwards to the question. (Remember answers in an MCQ should be in sequence – alphabetical or mathematical – ascending or descending ).

You have 100gms of 2%

Answer C is 40gms

So add 40gms

Total weight = 140gms

30% of 140gms = 42 (30 x 40 / 100) and total drug is 40gms + 2% of 100gms = 42

So this answer is correct.

Had the value calculated been too large, then a smaller value from the choice of answers would be the correct answer and vice versa.

The degree of error would indicate which value is likely to be correct from the choice of answers

e.g. Choose Answer B

Add 35gms pure drug to 100gms of 2%

Total amount = 135gms of which 30% is 40.5gms. However you only added 35gms and had 2gms in the 100gms

The total drug is 37gms but you need 40.5gms to be a 30% ointment so in reality you would need to add more.

The difference is 3.5gms so the next larger value choice is likely to be correct (as 40gms (C) would add an extra 5gms but 45gms (D) would add an extra 10gms)

But let's carry on with Formulas...

### Here is a Solution Using Graphs

You know that the total amount of drug will be  $X + 2$

You also know that you will be adding the amount  $X$  to 100gms of Ointment and that it will then be 30%

So  $(X + 100) \times (30/100)$  will equal  $X + 2$  ( $(X + 100) \times (30/100)$ ) is the formula for calculating 30% of the final amount)

You could plot a graph of these two 'equations' using different values of  $X$

This would give two sets of values

$$Y1 = X + 2$$

$$Y2 = (X+100) \times (30/100) \quad (\text{remember that } 30/100 = 30\%)$$

You may think this is getting complicated but remember we started with a simple example - a more difficult one might benefit from this method ! Here are some values for  $X$  and the values you would obtain using the two different equations

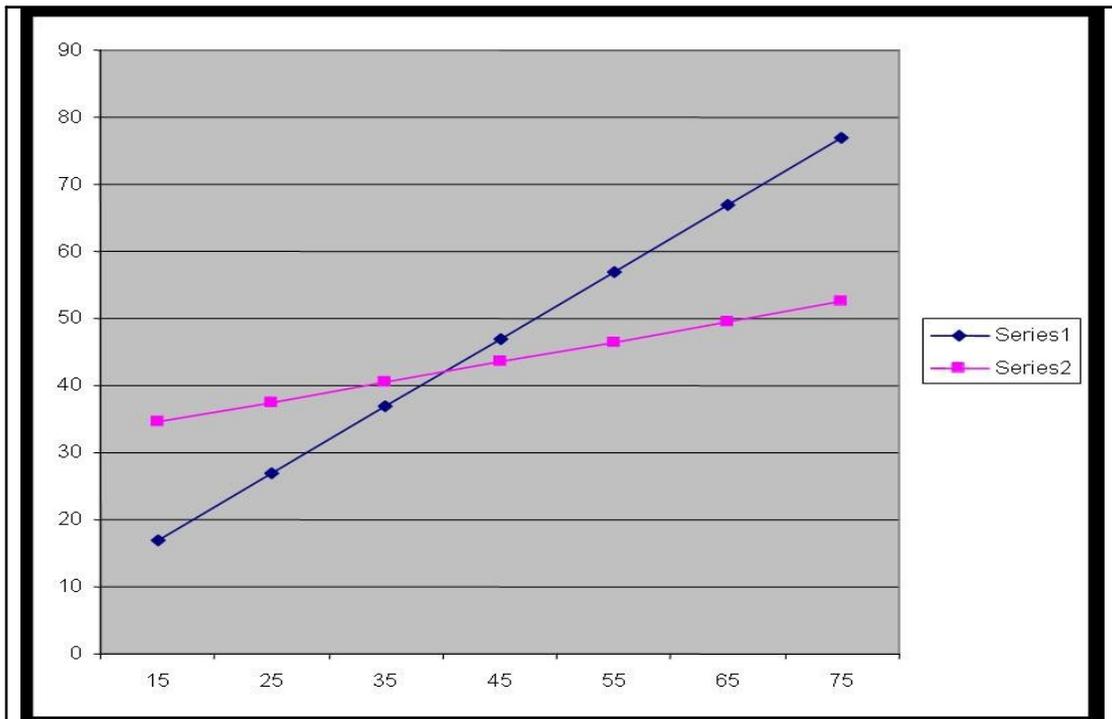
$$Y1 = X + 2 \quad (\text{and } Y = (100 \times 2/100) + X)$$

$$Y2 = (X+100) \times (30/100)$$

X	Y1	Y2
15	17	34.5
25	27	37.5
35	37	40.5
45	47	43.5
55	57	46.5
65	67	49.5
75	77	52.5

The correct answer will be found from where these two graphs cross (or intersect). The points where the graphs cross is where the two expressions or formulas are equal . The two expressions are simple forms of the total amount of salicylic acid. Those of you clever enough will see that this is essentially the same as  $C1/V1$  or  $C1 \times V2$  or the algebraic method but simply calculating the answer by drawing graphs. More complicated expressions (or equations) would produce a convergence at 40gms rather than 42gms.

In fact  $C1/V1 = C2/V2$  is the same as  $C1 \times V2 = C2 \times V1$



### Here is a Solution Using Graphs

Here is the Graph of those two equations. Looking at the graph, the two lines cross at a value of

42gms for Y and a value of 40 for X.

Although appearing complicated, it is possible to use this method where the actual percentages were not so simple –

Think of starting with 2.74% and making the strength up to 28.6%. This would be very difficult to calculate manually but you could simplify it using this method and using whole numbers for calculating points on the graph and calculating the value where the two graphs intersect.

### So why no formulas

Because to use a formula YOU must know and understand that formula in advance and how to use it

You must be able to use it to calculate a correct answer with several variations of the same problem and instantly recognise that you can apply that formula to a particular problem (and how to apply it to that problem ) before you can use it.

Most of the 'formulas' on the previous pages are actually identical but are shown using different starting approaches to the problem.

Remembering a 'Formula' is only of any real value if it is simple to remember and can be readily applied to multiple problems.

**Otherwise**

You must work out how to arrive at the answer (or method) from first principles to identify a suitable formula to use

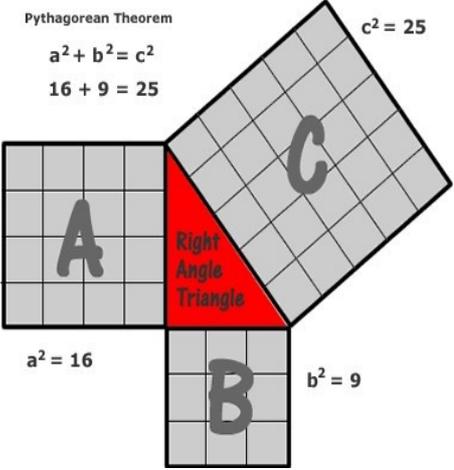
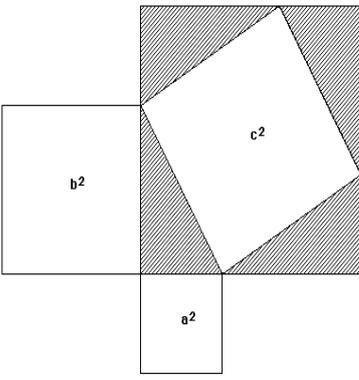
– By which time you will probably have calculated the answer.....

And probably understood the problem far better.

Look at my examples. They all say **..A solution using ...**as many more are possible

Simple analysis of the question, breaking it down into simple steps clarifies the question and often considerably simplifies any calculation

**We all know Pythagoras' Theorem and learn it very early on in life - but do we understand why it works. Look at the diagrams below for two very similar explanations.**

<p>Pythagorean Theorem</p> $a^2 + b^2 = c^2$ $16 + 9 = 25$  <p><math>a^2 = 16</math></p> <p><math>b^2 = 9</math></p> <p><math>c^2 = 25</math></p>	<p>PYTHAGORAS'S THEOREM</p> <p>In a right angled triangle the area of the square on the hypotenuse is the sum of the areas of the squares on the other two sides.</p>  <p><b>HERE IS A PROOF:</b></p> <p>Fit copies of the triangle around <math>c^2</math>.</p> <p>The area of the big square is area <math>(a+b)^2</math></p> <p>The triangle's area is <math>ab/2</math>.</p> <p>Hence <math>(a+b)^2 = c^2 + 4(ab/2)</math>.</p> <p>So <math>a^2 + 2ab + b^2 = c^2 + 2ab</math></p> <p>and thus <math>a^2 + b^2 = c^2</math>.</p>
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## PAEDIATRIC WEIGHTS

AGE	WEIGHT		HEIGHTS		SURFACE	%age OF ADULT DOSE
	kg	lb	cm	in	AREA m <sup>2</sup>	
<b>Newborn</b>	3.4	7.5	50	20	0.23	12.5
<b>1 month</b>	4.2	9	55	22	0.26	14.5
<b>2 months</b>	4.5	10	52	21	0.28	15
<b>3 months</b>	5.6	12	59	23	0.32	18
<b>4 months</b>	6.5	14	62	24	0.36	20
<b>6 months</b>	7.7	17	67	26	0.40	22
<b>8 months</b>	8.5	19	72	28	0.44	25
<b>1 year</b>	10	22	76	30	0.47	28
<b>18 months</b>	11	24	90	35	0.53	30
<b>3 years</b>	14	31	94	37	0.62	33
<b>5 years</b>	18	40	108	42	0.73	40
<b>7 years</b>	23	51	120	47	0.88	50
<b>10 years</b>	30	66	142	56	1.09	60
<b>12 years</b>	37	81	145	58	1.25	75
<b>14 years</b>	45	110	150	59	1.38	80
<b>16 years</b>	58	128	167	67	1.65	90
<b>Adult</b>						
<b>Male</b>	68	150	173	68	1.80	-
<b>Female</b>	56	123	163	64	1.60	-

Using this to calculate the percentage of an adult dose should only be used if a specific paediatric dose cannot be found as this chart assumes the child is 'average'.

There is a small table of the ages of children and their ideal weights in the rear of the BNF.

## CONVERSION OF WEIGHTS - ADULT

St	Lb	Kg	St	Lb	Kg	St	Lb	Kg	St	Lb	Kg	St	Lb	Kg	St	Lb	Kg
<b>4 Stone</b>		<b>25.4</b>	6	5	40.4	8	10	55.3	<b>11 Stone</b>		<b>69.9</b>	13	5	84.8	15	10	99.8
4	1	25.9	6	6	40.8	8	11	55.8	11	1	70.3	13	6	85.3	15	11	100
4	2	26.3	6	7	41.3	8	12	56.2	11	2	70.8	13	7	85.7	15	12	101
4	3	26.8	6	8	41.7	8	13	56.7	11	3	71.2	13	8	86.2	15	13	101
4	4	27.2	6	9	42.2	<b>9 Stone</b>		<b>57.2</b>	11	4	71.7	13	9	86.6	<b>16 Stone</b>		<b>102</b>
4	5	27.7	6	10	42.6	9	1	57.6	11	5	72.1	13	10	87.1	16	2	102
4	6	28.1	6	11	43.1	9	2	58	11	6	72.6	13	11	87.5	16	4	103
4	7	28.1	6	12	43.5	9	3	58.5	11	7	73	13	12	88	16	6	104
4	8	29	6	13	44	9	4	59	11	8	73.5	13	13	88.5	16	8	105
4	9	29.5	<b>7 Stone</b>		<b>44.5</b>	9	5	59.4	11	9	74	<b>14 Stone</b>		<b>88.9</b>	16	10	106
4	10	30	7	1	44.9	9	6	59.9	11	10	74.4	14	1	89.4	16	12	107
4	11	30.4	7	2	45.4	9	7	60.3	11	11	74.9	14	2	89.8	<b>17 Stone</b>		<b>108</b>
4	12	30.8	7	3	45.8	9	8	60.8	11	12	75.3	14	3	90.3	17	2	109
4	13	31.3	7	4	46.3	9	9	61.2	11	13	75.8	14	4	90.7	17	4	110
<b>5 Stone</b>		<b>31.8</b>	7	5	46.7	9	10	61.7	<b>12 Stone</b>		<b>76.2</b>	14	5	91.2	17	6	111
5	1	32.2	7	6	47.2	9	11	62.1	12	1	76.7	14	6	91.6	17	8	112
5	2	32.7	7	7	47.60	9	12	62.6	12	2	77.1	14	7	92.1	17	10	112
5	3	33.1	7	8	48	9	13	63	12	3	77.6	14	8	92.5	17	12	113
5	4	33.6	7	9	48.5	<b>10 Stone</b>		<b>63.5</b>	12	4	78	14	9	93	<b>18 Stone</b>		<b>114</b>
5	5	34	7	10	49	10	1	64	12	5	78.5	14	10	93.4	18	2	115
5	6	34.5	7	11	49.4	10	2	64.4	12	6	79	14	11	93.9	18	4	116
5	7	34.9	7	12	49.9	10	3	64.9	12	7	79.4	14	12	94.3	18	6	117
5	8	35.4	7	13	50.3	10	4	65.3	12	8	79.8	14	13	94.8	18	8	118
5	9	35.9	<b>8 Stone</b>		<b>50.8</b>	10	5	65.8	12	9	80.3	<b>15 Stone</b>		<b>95.3</b>	18	10	119
5	10	36.3	8	1	51.3	10	6	66.2	12	10	80.7	15	1	95.7	18	12	120
5	11	36.7	8	2	51.7	10	7	66.7	12	11	81.2	15	2	96.2	<b>19 Stone</b>		<b>121</b>
5	12	37.2	8	3	52.2	10	8	67.1	12	12	81.6	15	3	96.6	19	2	122
5	13	37.7	8	4	52.6	10	9	67.6	12	13	82.1	15	4	97.1	19	4	122
<b>6 Stone</b>		<b>38.1</b>	8	5	53	10	10	68	<b>13 Stone</b>		<b>82.6</b>	15	5	97.5	19	6	123
6	1	38.6	8	6	53.5	10	11	68.5	13	1	83	15	6	98	19	8	124
6	2	39	8	7	54	10	12	68.9	13	2	83.5	15	7	98.4	19	10	125
6	3	39.5	8	8	54.1	10	13	69.4	13	3	83.9	15	8	98.9	19	12	126
6	4	39.9	8	9	54.9				13	4	84.4	15	9	99.3	<b>20 Stone</b>		<b>127</b>

**1 Stone = 6.35Kg**

**1lb = 0.45Kg**

**1oz = 28 grammes**

## **Freezing Point Depression**

This is a mathematical concept that crops up in the pharmacy undergraduate course but has also, recently, started creeping into the pre-registration exam.

It can be assumed within any exercises you are given that the Freezing Point of water is depressed by the same amount by the same number of molecules regardless of what those molecules are.

(Note :- Freezing point depression: of a solution is a colligative property associated with the number of dissolved molecules. The lower the molecular weight, the greater the ability of a molecule to depress the freezing point for any given concentration. For example, in ice cream manufacturing, monosaccharides such as fructose or glucose produce a much softer ice cream than disaccharides such as sucrose, if the concentration of both is the same. Colligative properties are properties of solutions that depend on the number of molecules in a given volume of solvent and not on the properties of the molecules themselves (e.g. size or mass) of the molecules - i.e. physical number of rather than chemical properties of)

(i.e. it is assumed that the osmotic pressure of the two solutions would be equal - in real life there will be minor variations but we can ignore these here).

What use is this. Well blood freezes at -0.52 centigrade. Any solution of chemicals in water that also freezes at -0.52 centigrade is therefore isotonic.

Now by slowly adding a chemical to water and finding out what temperature it freezes at it will be found that when solutions are relatively weak, the concentration and freezing point depression produce a straight line or linear graph.

As an example If a drug at a concentration of 0.01% depresses the freezing point by 0.1 centigrade, then a concentration of 0.02% will depress the freezing point by 0.2 centigrade.

The importance of Freezing Point depression is that any concentration of a chemical which depresses the freezing point by 0.52 centigrade would be isotonic with blood. (here it would be 0.052% of the drug in the example above).

So by knowing by how much a drug depresses the freezing point, it is possible to work out how to produce an isotonic solution without knowing the molecular weight

*(in fact you can use the freezing point depression to calculate the molecular weight - see later).*

### **Here is an example of Freezing Point Depression.**

Drug A is known to lower the freezing point of water by 0.185 centigrade (or Celsius) at a strength of 1%. What strength solution would be isotonic with blood.

Now blood freezes at -0.52 centigrade and we know at weak strengths the freezing point depression is linear

So  $0.185 / 0.52 = 1 / X$  (note this is very similar to the  $C1 / V1 = C2 / V2$  formula) also we should use  $-0.185 / -0.52$  but this is the same as  $0.185 / 0.52$

So  $X = (0.52 \times 1) / 0.185 = 0.52 / 0.185$   
= 2.81%. This means a strength of 2.8% would be isotonic with blood.

Now here I have used a formula !!!!!

You can however do this calculation in simple steps

1% depresses FP by 0.185 degrees C

2% depresses FP by 0.370 degrees C

3% depresses FP by 0.555 degree C

So the answer lies between 2 and 3%

0.1% would depress the FP by 0.085 (Divide 0.185 by 10)

So 2.9% would depress FP by  $0.555 - 0.085 = 0.5635$  degrees C

And

2.8% would depress FP by  $0.5635 - 0.0185 = 0.518$  degrees C

So the answer is 2.8% to 1 decimal place.

### **Freezing Point Depression 2**

(This is unlikely in a pre-reg exam and is for completeness.)

The example given above page applies if a chemical in solution does not ionise - the freezing point has a simple linear relationship to low concentration.

If a chemical ionises in solution, then the relationship between freezing point depression and concentration can be calculated using a simple formula.

$i = \text{degree of ionisation} = (0.2 \times \text{No. Of Ions}) \times 0.8$

(i.e. Freezing point depression is related to the number of Ions produced and the degree of ionisation)

Now One gram molecular weight (M) of any non-electrolyte decreases freezing point by ca. 1.86 °C. For electrolytes the value of "i" - the degree of dissociation must also be calculated and the freezing point depression produced by one gram- molecular weight is multiplied by the degree of ionisation

By substituting in the above formula it can be seen that :-

No. of ions produced by dissociation	i or Dissociation Factor	Freezing point depression of Gram Molecular weight in 1000mls
No dissociation (unionised)	1	1.86
two ions	1.8	2.976
three ions	2.6	4.83
four ions	3.4	6.32
five ions	4.2	7.81

Note that if a molecule ionises then "i" must be greater than 1 and also that a linear relationship with FP depression really only holds at low concentrations

To calculate the weight of Sodium Chloride that will depress the freezing point by 0.52 degrees, we know that 58.5gms of an undissociated NaCl would depress the freezing point by 1.8 degrees.

So by adding in the degree of ionisation

$$1.86 \times i / 0.52 = \text{MWt} / X \quad (\text{Note the similarity to } C1/V1=C2/V2)$$

The Equ. could be written  $X/0.52 = \text{MWT} / (1.86 \times i)$

$$1.86 \times 1.8 / 0.52 = 58.5/X \quad \text{or} \quad X = 58.5 \times 0.52 / 1.8 \times 1.86$$

$$X = 9.09\text{gms}$$

An isotonic solution would contain 9.09gms in 1000mls  
I.E. a strength of 0.9% - is this familiar !!

### Freezing Point Depression - cont

From the above, a formula for calculating the strength of any chemical which would be isotonic is

$$\text{Wt in 1000mls} = \text{MWt (in 1000mls)} \times 0.52 / 1.86 \times i$$

Another less easy to remember formula is one for calculating the weight of Sodium chloride that is equivalent to the weight of another chemical with respect to freezing point depression.

$$\text{Sodium chloride equivalent} = (\text{MWt NaCl} \times i \text{ Factor for chemical}) / (i \text{ Factor for NaCl} \times \text{MWt chemical})$$

Since two of these values are known the formula can be reduced to

$$\text{Sodium chloride equivalence (E)} = 32.5 \times i \text{ factor of chemical} / \text{MWt of chemical}$$

This can be used when the freezing point depression associated with a chemical is not known. I.e. you could calculate isotonicity from knowing :-

- 1) the freezing point depression produced by a particular strength of a chemical
- 2) Its molecular weight and the number of ions produced on dissociation

Note - The values in the table on the previous page can be used in calculating isotonicity but the values are calculated values for concentrations of 80% or more and FP depression is linear only at low concentrations.

**Example 1** - Supposing a Drug has a Sodium chloride equivalent of 0.23 (This is the value for Pilocarpine nitrate)  
What concentration would produce an isotonic solution

The equivalent weight of Drug to Sodium Chloride would be

$$9\text{gms (in 1000mls)} \times 0.23 = 2.07 \text{gms (in 1000mls)} = 0.207\%$$

This explains why Pilocarpine eye drops sting - they are all hypertonic !

**Example 2** A 3% concentration of a drug depresses the freezing point by 0.24 degrees. What strength of the drug would be isotonic

$$3 / 0.24 = X / 0.52 \quad (\text{i.e. } 1\% \text{ depresses freezing point by } 0.08 \text{ } ^\circ\text{C})$$
$$X = 3 \times 0.52 / 0.24 = 6.5\% \quad (\text{i.e. } X \% \text{ depresses freezing point by } 0.52\% \text{ and equals } 0.52/0.08 \text{ } ^\circ\text{C})$$

**Example 3** Pilocarpine has molecular weight of 271.3gms From example 1 we know the sodium chloride equivalence is 0.23. How many ions does pilocarpine Nitrate dissociate into ?

From Q1, Sodium chloride equivalent = (MWt NaCl x i Factor for chemical) / (i Factor for NaCl x MWt chemical)

$$0.23 = (58.5 \times i) / 1.8 \times 271.3$$

$$i = 0.23 \times 1.8 \times 271.3 / 58.5 = 1.91$$

= 2 (to the nearest whole number )

The likely answer is therefore 1.8 for i - which means it dissociates into 2 ions.

These equations rarely produce nice round numbers. the choice is now whether 2 is nearer 1.8 for 2 ions or 2.6 for 3 ions. 2 is closer to 1.8 than 2.6.

(The formula for Pilocarpine nitrate is  $C_{11}H_{16}N_2O_2 \cdot HNO_3$  - i.e it would dissociate into 2 'ions' You would not be expected to know this formula).

There are some examples of FP Depression below

### Freezing Point Depression Questions

- 1). Calculate the E value of Papaverine HCl given that it dissociates into two ions and has a molecular weight of 376

Sodium chloride equivalent = (MWt NaCl x i Factor for chemical) / (i Factor for NaCl x MWt chemical)

$$E = (58.5 \times 1.8) / 1.8 \times 376$$

$$= 58.5 / 376$$

$$= 0.155$$

if you can't calculate this easily then

$$58.3 / 376$$

$$= (\text{approx}) 60/360$$

$$= 1/6 = 0.167$$

but the actual value will be smaller .

You could also try 60/400 and get  $6/40 = 0.15$

Then take the difference between 0.15 and  $0.167 = 0.158$

- 2) Drug A has a freezing point depression of 0.185 degrees at 1% and Drug B has a freezing point depression of 0.3 degrees at 1% How much Sodium chloride would be needed to make a solution containing 2% of drug A and 0.5% of drug B ?

$$2\% \text{ of Drug A would depress the freezing point by } 0.185 \times 2 = 0.37 \text{ } ^\circ\text{C}$$

$$0.5\% \text{ of Drug B would depress freezing point by } 0.3 \times 0.5 = 0.15 \text{ } ^\circ\text{C}$$

The freezing point of the combined solutions would depress freezing point by  $0.37 + 0.15 \text{ } ^\circ\text{C} = 0.52 \text{ } ^\circ\text{C}$

The solution would be isotonic and therefore no Sodium chloride is required.

- 3). Dibucaine produces a freezing point depression of 0.16 degrees at a concentration of 2%.  
What concentration of Sodium chloride would make the solution isotonic.

0.9% Sodium chloride is isotonic

You need to depress the freezing point by a further  $0.52 - 0.16$  degrees  
 $= 0.36$  degrees

0.9% is equivalent to 0.52degrees

or 0.1% for every  $0.52/9 = 0.0578$  degrees

so the concentration required

$= (0.36/0.0578) \times 0.1$  degrees

$= 0.623\% = 0.625\%$  approx would probably be practical

Note the question does not require you to know any specific volume.

0.623% Sodium Chloride + 2% Dibucaine would be isotonic.

- 4) Your patient is too ill to receive oral drugs and so has been prescribed Drug A 4gms daily by intravenous infusion for 5 days.  
Drug A is not available commercially and you are required to prepare and sterilise (in your licensed Aseptic Unit) a single batch of infusion that will provide 5 days' treatment.  
The Pharmacopoeial monograph for Drug A indicates that infusions of Drug A should be prepared to a standard concentration of 4% with water.  
The solution should be made isotonic using sodium chloride powder. Drug A has a Freezing Point Depression effect of  $0.234^{\circ}\text{C}$  at 2%.

a) You will be making the infusion of Drug A in one batch according to the pharmacopoeial monograph. What volume of infusion (expressed in litres) would you need to prepare in total to cover 5 days' treatment (you are not required to calculate for wastage and can assume that Drug A is stable if stored in a fridge for 10 days)?

b) What amount of sodium chloride expressed as milligrams would make your total volume of Drug A infusion isotonic when prepared according to (a) above?

- a) 4g for 5 days = 20g Drug A  
Standard concentration is 1%  
4% means 4g in 100ml therefore  
you will require 8g in 2000ml

(This assumes the displacement is minimal and can be ignored 8g in 200mls is 4% and so any displacement is likely to be smaller than 20mls – below 10% error )

- b) Drug A has FP depression of  $0.234\text{ }^{\circ}\text{C}$  at 2%  
4% means the strength will be doubled and so  
 $\text{FPD} = 0.234\text{ }^{\circ}\text{C} \times 2 = 0.468\text{ }^{\circ}\text{C}$   
FPD of an isotonic solution is  $0.52\text{ }^{\circ}\text{C}$   
You need to depress the freezing point by a further  $0.52 - 0.468$  degrees  
 $= 0.052\text{ }^{\circ}\text{C}$   
 $0.9\%$  is equivalent to  $0.09\%$   
or  $0.09\%$  will depress the freezing point by  $0.052\text{ }^{\circ}\text{C}$ .
- $0.09\%$  Sodium Chloride +  $4\%$  drug A would be isotonic.

# **WORKED** **EXAMPLES**

### Example 1 Drug clearance from the body

- 1) A teenager is admitted to A and E with a suspected overdose of Theophylline. On admission, their serum Theophylline level is 30mg/ Litre  
On checking , you find that Theophylline has a clearance of 0.045 litres / Kg / hour. The patient weighs 70Kg  
How much Theophylline by weight will be removed in 24 hours
- a) 325mg
  - b) 850mg
  - c) 1480mg
  - d) 2268mg
  - e) 3560mg

Comment – Look at the range of answers from 325 to 3560.  
Each answer is significantly larger the one before (A-B and C-D-E) with a large gap between D and E  
So a bit of rough estimating shouldn't be a problem.

What facts aren't needed ...- it isn't clear if any values are not needed.  
(actually all values are needed )

Look at the 'numbers' you have and which will be used  
30 0.045 70 and 24

Look at the clearance value it tells by **VOLUME** how much is cleared per hour but also per Kg

So we can calculate the clearance in 24 hours  $= 0.045 \times 24$  **LITRES /Kg**  
 $= 1.08$  **LITRES /Kg**

**But this is per Kg** (and the patient weighs 70Kg)

So we can now calculate how much this patient clears in 24 hours in total  
 $= 1.08 \times 70$  **LITRES**  
 $= 75.6$  **LITRES for this patient**

If 75.6 Litres is cleared in 24 hours, then the amount of drug cleared will be  
 $= 75.6 \times 30$ mg

WHY - Because each litre contains 30mg

Now don't calculate this value but just look –

It will be greater than 1500mg x 20  
So A,B and C are incorrect – too small  
It will be less than 7500mg x100  
So D and E are both in the right range  
It will be a lot less than 3750 x 50  
(half of 7500)  
**So only D can be correct**  
**And  $75.6 \times 30 = 2268$ mg**

**A Suggested Formula** Amount removed =  $(0.045 \times 24 \times 70 \times 30)$

## Example 2 Bioequivalence

- 2) A Patient is admitted to hospital having suffered a stroke. Before admission, they were taking Digoxin tablets at a dose of 125mcg daily. Now they cannot swallow and need to be given Digoxin elixir. Digoxin tablets have a bioavailability of 0.7 Digoxin elixir has a bioavailability of 0.8 What is the equivalent dose of Digoxin elixir ?
- a) 70mcg
  - b) 87.5mcg
  - c) 110mcg
  - d) 140mcg
  - e) 180mcg

Read the question carefully - what does the bioavailability mean

Only 70% of the tablet dose is effective. Only 80% of the elixir dose is effective

So **MORE** of the elixir is effective dose mcg for mcg

So a **SMALLER** dose of elixir has the same effect. This eliminates D and E

One has a bioavailability of 70% and one a bioavailability of 80%

There is about 10% difference between their bioavailabilities

So the doses are not going to differ significantly but by around 10%

So A and B are likely to be too small

A is about 40% less and B is about 30% less

(these are rough calculations)

And so C is likely to be correct

Now if you wish, you can calculate.

How much of the tablet is effective =  $125 \times 0.7$  using bioavailability  
Or =  $125 \times 70/100$  using percentage  
= 87.5mcg

**Now here is a trap – Answer B is 87.5mcg but this is not the correct answer**

If you don't think about what is being asked, you could easily choose this answer

The elixir has a bioavailability of 0.8 NOT 1 So a higher dose than 87.5mcg is needed

Again only C can be correct

What we now know is that 87.5mcg is 80% of the dose that is needed

Let X = the dose needed and 80% of this is 87.5mcg

Again you should see that it is over 100mcg and only C can be correct

X =  $87.5 \times 1/0.8$  using bioavailability  
Or =  $87.5 \times 1/0.8$  using percentage  
= 109.375 mcg  
= 110mcg

Formula Dose of elixir =  $(125 \times 0.7) / 0.8$  Looks simple but you need to know why this formula is correct

It's derived from  $(125 \times 0.7) = (X \times 0.8)$  which states one bioequivalent dose is the same as the other.

This question has a minor 'design' flaw – Answer b is 87.5mcg so the correct answer should use the same level of accuracy and be 109.5mcg .

### 3 – Making a cream or ointment more concentrated- An Explanation

Questions of this nature usually ask :-

How much pure drug needs to be added to Xgms of cream which is Y% to make it Z % cream ? e.g. How much pure drug needs to be added to 200gms of cream which is 5% to make it 10% cream ?

The obvious – **and INCORRECT**- approach is to calculate that 200gms of 5% contains 10gms and 200gms of 10% contains 20gms – calculate the difference and give that as the answer – 10gms

**Why is this wrong :-** 200gms of 5% does contain 10gms of drug. However when you add 10gms of drug to make it 10% the total amount is 210gms. The amount of drug in 210gms is 20gms – this is not 10% of 210gms – it is 1gm short

The same error is often made if the question is posed in a slightly different way :- How much pure drug needs to be added to cream which is 5% to make 200gms of 10% cream ?

The obvious – **and INCORRECT**- approach is the same as above – calculate the difference and give that as the answer – 10gms

**Why is this wrong :-** If you are going to add 10gms of drug to 5% cream to make 200gms of 10%, you will add it to 190gms of 5% cream. 190gms of 5% cream does not contain 10gms – it contains 9.5gms. When you add the 10gms of pure drug, the total amount of drug is 19.5gms – i.e. 0.5gms short.

The error using the simple and incorrect method used above gets less and less as the difference in strength gets less and less but tries it converting 1% to 25%

200gms of 1 % contain 2gms.            200gms of 25% contain 50gms - 4gms = 48gms  
So add 48gms of drug.. Total weight is now 248gms of which 52gms is drug – that's a concentration of 19.35% not 25% - a very significant error – the correct answer is 64gms

So when asked to calculate how much of a pure drug you need to add to make something more concentrated remember that you will always need **more** than the difference in strengths. The greater the difference in strengths, the greater the amount you will need to add.

Here is a brief table of how much drug is needed to convert **200gms of 2% cream** to

New strength	Amount of drug needed
4%	4.16gms
5%	6.57gms
10%	17.78gms
20%	45gms

To calculate the answer you can use Algebra or Alligation or any other method that works for you.

### **Example 3 - Making a cream stronger**

A cream contains 10% w/w Coal Tar Solution.

What weight of Coal Tar Solution should be incorporated into this cream to produce 30g of cream containing 12% w/w Coal Tar solution.

- a) 0.20gms
- b) 0.24gms
- c) 0.36gms
- d) 0.66gms
- e) 0.72gms

- 1) Read the Question - the question asks for the WEIGHT of a solution. Beware of this as the answer might give options as both weights and volumes
- 2) Look at the answers – there is at least 10% difference between them and for some, significantly more

There are several ways of tackling this :-

#### **1) Rough estimate (Always useful to get an initial idea of the correct answer)**

30gm of 10% contains 3gms and 30% of 12% contains 3.6gms –  
Difference is 0.6gms so answer will be APPROXIMATELY 0.6gms  
..but slightly more than 0.6gms as you will be adding it to less than 30gms so there will be less than 3gms in the (less than 30gms of) cream you use .  
if only 1 answer is near this, then that will be the correct one .

In this example and in an exam this simple approach often works well. – **Answer D**

#### **2) Alligation**

Please look elsewhere for the explanation of alligation

$$\begin{array}{lll} Pa = Fc - Bc & Pa = 12 - 10 = 2 & \text{We need 2 parts of pure drug-- by weight} \\ Pb = Ac - Fc & Pb = 100 - 12 = 88 & \text{(A is pure drug so has a strength of} \\ & & \text{100\% and we need 88 parts)} \end{array}$$

But remember that the total number of parts equals 30gms  
so 30gms = 90 parts (88 + 2)

You need to calculate 2 parts for the amount of pure drug (Coal Tar solution)

$$1 \text{ part} = 30/90\text{gms} \quad \text{so } 2 \text{ parts} = 2 \times 30/90 = 60/90 = 6/9 = 0.666\text{gms} \quad \text{Answer D}$$

### 3) Algebra

Let X = amount of pure drug you will add                      and  
Let Y = amount of 10% cream you will add it to.      Final amount = 30gms

So 12% of 30gms = X + 10% of Y

$$\text{Also } Y + X = 30\text{gms} \quad (\text{i})$$

$$\text{so } 30 \times 12/100 = X + (Y \times 10/100) \quad (\text{ii})$$

(12/100 = 12% - if it's easier for you, multiply by 0.12)

You can rearrange the equation (i)  $Y = 30 - X$

and now substitute for Y in equation (ii) to give an equation that only has X in it.

$$30 \times (12/100) = X + ((30-X) \times 10/100) \quad \text{Now multiply both sides by 100}$$

$$30 \times 12 = 100X + ((30-X) \times 10)$$

$$360 = 100X + 300 - 10X \quad \text{Rearranging this gives}$$

$$90X = 60$$

$$X = 60/90 = 0.666\text{gm} \quad \text{Answer D}$$

#### Example 4 Water of Crystallisation

You are required to produce 1.5 litres of a Copper Sulphate solution containing 600 ppm of Copper Sulphate. You have Copper Sulphate Crystals that are 97.5% pure (The impurities are not important.)

The molecular weight of Copper Sulphate (is  $\text{CuSO}_4$ ) 159.7 and

The molecular weight of Copper Sulphate Crystals ( $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ ) is 249.7

What quantity of crystals are required to produce 1.5 Litres.

- a) 1.0gms
- b) 1.2gms
- c) 1.45gms
- d) 1.70gms
- e) 2.05gms

Read the Question - What can you find that is useful.

The relative weights are 160 and 250 (approximately) that is about 2 to 3 or 1:1.5

The purity is nearly 100% so will only make a small difference.

You have weights and also strength in ppm.

Convert the strength to something more practical – percentage strength

600ppm is 6 parts in 10,000 (Divide each side by 100)

6 parts in 10,000 is 0.06 parts in 100 (again divide again by 100)

You therefore require a 0.06% solution

This equals 0.06gms in 100mls

Or

0.6gms in 1,000mls

or

0.9gms in 1,500mls (1.5litres)

Here is a rough estimate of the answer

- this suggests that you need 0.9gms Copper Sulphate
- This would equal 1.5 times as much Copper Sulphate crystals
- $= 0.9 \times 1.5 = 1.35\text{gms}$  and suggest B or C as the correct answer
- Again if you know your maths well you should know that the ration is slightly larger than 1:1.5 (Its actually 1 :1.56) and also the crystals are a little impure – therefore the 1.35 is too small rather than too large
- This eliminates answers A, D and E and suggests C is correct

However as you are adding Copper Sulphate crystals.

For every 159.7gms of Copper sulphate you require 249.7gms of Copper Sulphate crystals

This means for 0.9gms you would need  $0.9 \times (249.7/159.7)$  gms of crystals

This using a calculator this equals 1.407gms Copper Sulphate Crystals

You could try and do it without a calculator

(ppm = Parts Per Million)

### Example 5a – Double Dilutions

These questions are often posed in a variety of ways but essentially have the same problem :-

There are three solutions

A – a concentrated or stock solution

B – a Solution that is prepared for giving to a patient or medic from Solution A

C the final solution which is obtained by diluting Solution B

Remember A is stronger than B and B is stronger than C

Also it is quite common for the way the strength of the solution is expressed to change

e.g. A is 50% Solution

B has a strength of 20mg in 1ml

C has a concentration of 1 in 50,000

These problems can be calculated quite easily by using simple steps rather than using formulas of the  $C_1 v_1$  variety which end up with very complicated or tricky expressions that are prone to error in an exam.

- 1) look at the answers given – what expression of strength is used (If the answers simply give a volume of one of the solutions, then the answer is in the strength of that solution )
- 2) When calculating convert to that expression of strength

#### A simple example

Using A, B and C from above, how many mls of B and how many mls of A are equal to 1 Litre of C

First we know that C has a concentration of 1 in 50,000 - convert this to a concentration expressed in mg in 1ml

1 in 50,000 is 1gm in 50,000  
= 1000mg in 50,000mls  
= 1mg in 50mls (Dividing by 1000)  
= 20mg in 50 x 20mls = 1000mls

So 1000mls of C has the same amount of drug in it as 1ml of Solution B = 20mg  
1000mls of C are equal in AMOUNT to 1ml of Solution B

Now let's take solution A

Solution B contains 20mg in 1ml  
= 20000mg in 1000mls (Multiply by 100)  
= 20gm in 1000mls = 2%

Solution A is 50% so it is 25 times stronger

So 1ml of Solution B is equal to 1/25mls of Solution A  
= 0.04mls

We now have the relationship :-

0.4mls of A contain the same amount of drug as 1ml of solution B or 1000mls of solution C

or 1ml of A contains the same amount of drug as 25mls of B or 25 Litres of C

The ratios are 1 : 25 : 25000

The questions that do come up usually ask you to calculate something about solution A or B by providing information about solution C. By using simple steps as above this is easy. These problems can be solved easily by breaking the problem down into simple steps..

### Example

e.g. A stock solution containing 25mg in 1ml of Drug X is used to prepare an intermediary solution such that when the intermediary solution is diluted 1 in 250, a 1 in 80,000 solution is obtained.

What is the strength of the intermediary solution and how much of the stock solution is needed to supply 500mls of the intermediary solution.

Step 1 – What is the concentration of the intermediary solution ?

It is 250 times stronger than 1 in 80,000

Why – because when diluted 1 in 250 we get a 1 in 80,000 solution

So the strength is 1 in  $80,000 / 250$   
 $= 8,000/25$  (divide by 10)  
 $= 800/2.5$  (divide by 10)  
 $= 1600/5$  (multiply by 2)  
 $= 320$

So the intermediary solution is 1 in 320 (Yes it's an odd strength)

1 in 320 = 1/3.2 in 100

not easy but try dividing 10 by 3.2 = 3 approx. then divide by 10 again

So the strength is approximately 0.3%

The actual value is 0.3125

BUT this value is easy to calculate if you know your tablet strengths as it's a value that crops up regularly :-

$\frac{1}{2} = 0.5$   $\frac{1}{4} = 0.25$   $\frac{1}{8} = 0.125$   $\frac{1}{16} = 0.0625$  and  $\frac{1}{32} = 0.3125$

So we now know that the intermediary solution contains 312.5mg in 100mls ( 0.3125% or 0.3125 in 100 or 1 in 320 )

Step 2 Solution A contains 25mg in 1ml  
= 250mg in 10mls  
= 2500mg in 100mls (2.5%)

To dilute A to B would require a dilution of  $2500 / 312.5$

Why Because A contains 2500mg in 100mls and B contains 312.5mg in 100mls

So to dilute A to B would require a dilution of  $2500 / 312.5$

Now this isn't an easy calculation



## Example 6 Displacement Values

Displacement Values are used where it is possible to know the volume of the end product but not the weight. It is common practice to assume that 1ml of all liquids weigh 1gm but in fact this is true only for water – and only at 4 centigrade at normal atmospheric pressure.

With solid drugs, volume is rarely important – what is the volume of 1gm of Paracetamol or 1gm of Aspirin

The volume occupied by solid drugs becomes important when they are incorporated into a liquid and the volume in which they are incorporated is small in relation to the amount of solid drug.

If you add 1ml of water to 1 litre of water the percentage change is 1 in 1001 or 0.09%

If you add 1ml of water to 5mls, the percentage change is 1 in 6 or 16.6%

If you have a 500mg vial of Amoxicillin and add 2mls of water – what is the final volume and how do you calculate a dose that is less than 500mg – for a child ?

How do you add a solid drug by weight to a suppository base so that the final volume (which is fixed before you add the drug as the suppository mould is preset) contains a fixed amount (by weight) of the drug ?

Suppository moulds are given a weight – e.g. 2gms that relates to the weight of the suppository made in that mould using a particular base – usually Theobroma Oil. However drugs may have a different density to Theobroma oil so the same weight may have a different volume ?

Dry Powder ampoules contain a fixed weight of drug. – how much water or diluent is added depends on its solubility but what volume does that drug contribute to the final solution ?

The answer to both of these problems is provided by the displacement value.

This value represents the equivalent volume that the solid drug will contribute to the final solution.

With ampoules, the displacement value is, in real life, rarely stated and needs to be obtained from the manufacturer

With the manufacture of Suppositories, the values are obtained from tables and can be provided by the manufacturers of the pure drug on request.

In an exam, the values will always be provided.

### Example Ampoules

- a) Drug X 500mg – Displacement Value 0.6mls

This means that 500mg of the drug occupies a volume equivalent to 0.6mls  
If you add 1.4mls, the final volume will be  $1.4 + 0.6\text{mls} = 2\text{mls}$

The solution in the ampoule will contain 500mg in 2mls

- b) Drug X 500mg Displacement value 1gm = 1.2mls

This means that 1gm of the drug occupies a volume equivalent to 1.2mls  
If you add 1.4mls, the final volume will be  $1.4 + 0.6\text{mls} = 2\text{mls}$  as you have 500mg in the vial.

This form of expression is avoided and the displacement value for the amount in the vial is the accepted method. It is sometimes used in calculation questions..

### Example Suppositories

- a) Drug X Displacement value 4  
Drug Y Displacement value 0.5

Here the displacement value is given as a simple number

The value is the ratio between the relative density of the drug and the suppository base.

A displacement value of 4 means that 4gms of Drug occupy the same volume as 1gm of base – the drug is heavier than the base by volume

A displacement value of 0.5 means that 0.5gms of drug occupy the same volume as 1gm of base - the drug is lighter than the base by volume.

Drug X will displace by weight  $\frac{1}{4}$  as much of the suppository base

A cube 1cm square of Drug X will weigh 4 times as much as a cube 1cm square of base

Drug Y will displace by weight TWICE as much of the suppository base

A cube 1cm square of Drug Y will weigh half as much as a cube 1cm square of base

If you are going to add the drug to a base and produce something which has the same volume but contains a known weight of the drug, you need to use the displacement value to know how much base to remove to ensure the correct amount of drug is present.

Let's add 500mg of Drug to a 2gm suppository

Drug X weighs 4 times as much as the base so 500gms will occupy the same space as  $500/4$  mg of base = 125mg

To make 1 suppository, you would remove 125mg of base so you would use 2gm -125mg Base = 1.75mg Base and add 500mg of Drug X

The final suppository would weigh  $1.75 + 0.5 = 2.25\text{gms}$

Drug Y weighs half as much as the base so 500gms will occupy the same space as  
 $500/0.5 \text{ mg of base} = 1000\text{mg} = 1\text{gm}$

To make 1 suppository, you would remove 1gm of base so you would use

$2\text{gm} - 1\text{gm Base} = 1\text{gm Base}$  and add 500mg of Drug X

The final suppository would weigh  $1 + 0.5 = 1.5\text{gms}$

This often causes confusion as the suppository is a '2gm' suppository. The '2gm' simply relates to the volume of the base if no drug is added and not to the final weight of the suppository with added drug (s)

One problem with both injections and suppositories is ensuring that a drug is evenly dispersed or dissolved throughout the base or diluent. With suppositories, this is a problem resolved during manufacturing by appropriate fine mixing and rapid solidification that prevents any time for settling.

Different liquids have different densities and if mixed carefully it is possible for a liquid with a lighter density to sit above one with a heavier density. This can sometimes be seen as a liquid crystal appearance.

Density is a major problem with Potassium Chloride Injection which when concentrated is quite dense, and if injected slowly into an IV bag can sit 'undiluted' at the base of the bag. The first few mls, when administered can then be concentrated Potassium chloride – not the diluted strength that was required – and that concentrate can be fatal - hence the reason why ready mixed bags are now standard.

**Shaken not Stirred** – when mixing the ingredients of cocktails, stirring may partially mix two or more ingredients but will leave traces of the more dense and often sweeter ingredient at the bottom of the glass so the final few sips are sweeter and this is often preferred by women – Shaking will thoroughly disperse the ingredients giving the same taste overall. Hence the view that it is more 'masculine' to drink cocktails shaken not stirred !!

## **THE CALCULATION QUESTIONS**

Calculation questions are devised to check your knowledge of drugs and ability to correctly calculate doses etc. and use reference sources.

Sometimes (In the U.K.) you need to check a reference source such as the BNF to obtain information such as the strength of an injection or the size of the vial that an injection comes in. All these questions are based on this process.

Examples are that the BNF specifies :-

**Ampoule sizes** Digoxin is only available in a 25mcg/2ml ampoule – not a 1ml

**Strengths** The BNF specifies the strength and molarity of Potassium Chloride Sterile solution Concentrate (15%)  
The BNF specifies the concentrations of ingredients in Magnesium Carbonate Aromatic etc.

**Infusion rates** For many injectable drugs

Pharmacists are often thrown by strange names and so some questions have been written using the names or strengths of preparations which a pharmacist may not be expected to be familiar with. To help, some familiar OTC preparations have been included in the questions but unfamiliar information is given about them. In some cases the drug names are entirely fictitious. In all such cases the questions can be answered using the information given in the question itself and no extra information is required.

**Examples :-** Enos Fruit Salts      ‘Meeto’      Drug X

I have attempted to check all questions thoroughly but errors are quite likely. If you find any suspected error, please e-mail me with the problem you have identified and I will reply and correct ASAP.

Please note – Answers may not work out to the exact value given. You may need to estimate which is the nearest correct answer. E.g. 19/6mg may have the answer options given as 2mg, 3mg, 4mg. 3mg is the nearest correct answer as the value is 3.16

You may find some questions repeated – or repeated from Book 1 . This book has been put together from various papers used over several years so apologies in advance – However do check each question as there may in fact be some subtle differences.

## CHAPTER 1

- 1) A child is prescribed Digoxin. Unable to take tablets, the elixir is prescribed. Their dose is 0.125mg daily. The volume of Lanoxin PG elixir that the patient should be given each day is :
- a) 0.25ml
  - b) 0.75ml
  - c) 1ml
  - d) 2ml
  - e) 2.5ml
- 2) A 3 year old weighing 14kg is prescribed Dactinomycin 450mcg/m<sup>2</sup>. The strength of the solution is 500 micrograms per ml. The patient would require which one of the following volumes of the solution per dose ?
- a) 0.28ml
  - b) 0.56ml
  - c) 1.8ml
  - d) 2.8ml
  - e) 3ml
- 3) A nurse asks your advice in preparing the following infusion, which is to be given via an infusion pump:
- 80mmol potassium ions in 1000ml in 5% Glucose
- She has ampoules of potassium chloride 1.5g in 10ml and asks your advice on what quantity should be added to the infusion to provide the correct dose. The quantity should be :-
- a) 20ml
  - b) 40ml
  - c) 60ml
  - d) 80ml
  - e) 100ml
- 4) An infusion pump is used to administer Epinephrine (Adrenaline) to a patient at a rate of 6mls per minute. Adrenaline solution 1 in 10,000 is to be administered. What quantity in milligrams of adrenaline will be supplied per hour.
- a) 36mg
  - b) 48mg
  - c) 72mg
  - d) 108mg
  - e) 162mg

5) A Patient is prescribed Prednisolone as a descending dose course. The patient is to take 80mg OD reducing by 10mg every 2 days until a dose of 10mg is reached. She is then to take 10mg for 7 days and 5mg for 7 days and then stop. How many 5mg tablets would be need to be supplied. What is the total dose of Prednisolone taken ?

- a) 725mg
- b) 755mg
- c) 775mg
- d) 805mg
- e) 825mg

6) You receive a prescription for the following :-

Benzoic Acid Ointment 3% w/w in white soft paraffin x 750gms

Which of the following is the correct formula :-

- |    | <b>Benzoic Acid</b> |    | <b>White Soft Paraffin</b> |
|----|---------------------|----|----------------------------|
| a) | 22.5gms             | to | 750gms                     |
| b) | 2.25gm              | to | 750gms                     |
| c) | 225mg               | to | 750gms                     |
| d) | 22.5mg              | to | 750gms                     |
| e) | 225mcg              | to | 750gms                     |

7). Baby S requires an antibiotic suspension for a chest infection. She weighs 15kg and has been prescribed a dose of 7.5mg/kg/day for 7 days divided as a TDS regimen. The strength of the suspension is 250mg in 5mls. What dosage should you put on the prepared medicine label ?

- a) 0.25mls
- b) 0.5mls
- c) 0.75mls
- d) 1.0mls
- e) 1.25mls

8). A patient is being given Pilocarpine eye drops 0.5% for their glaucoma. How much drug is contained in 1 drop if each 1ml contains 20 drops

- a) 1mg
- b) 500 micrograms
- c) 250 micrograms
- d) 125 micrograms
- e) 62.5 micrograms

- 9) What weight of a Drug would be contained in 600mls of a 0.02% solution ?
- 12mcg
  - 120mcg
  - 1.2mg
  - 12mg
  - 120mg
- 10) A drug has a half life of 12 hours. The drug is administered by I/V and immediately after administration, its plasma level is 68mcg/ml. What would the plasma concentration be after 36 hours ?
- 2.13mcg/ml
  - 4.25mcg/ml
  - 8.5mcg/ml
  - 17mcg/ml
  - 34mcg/ml
- 11) What quantity of Bupivacaine in mg is are contained in a 20ml vial of 2.5% injection ?
- 125mg
  - 250mg
  - 375mg
  - 425mg
  - 500mg
- 12) 1 litre infusion of Sodium Chloride 0.45%, Glucose 5% and Potassium Chloride 0.18% is intended to be given over 12 hours using a standard giving set. If the rate at which the infusion is run is 42 drops per minute, over how many hours will the infusion actually run. (assume a drop volume of 20 drops per ml)
- 8 hours approx
  - 10 hours approx
  - 12 hours approx
  - 16 hours approx
  - 24 hours approx
- 13) You have been asked to prepare an emergency loading dose of Digoxin for a patient of 0.75mg to be given over 1 hour in roughly 100mls 0.9% NaCl. by I/V infusion. Calculate what you require..
- 1 ampoule Digoxin injection in 100mls NaCl 0.9% - 100mls over 1 hour
  - 2 ampoules Digoxin injection in 100mls NaCl 0.9% - 75 mls over 1 hour
  - 3 ampoules Digoxin injection in 100mls NaCl 0.9% - 100mls over 1 hour
  - 4 Ampoules Digoxin injection in 100mls NaCl 0.9% - 50mls over 1 hour
  - 5 Ampoules Digoxin injection in 100mls NaCl 0.9% - 75mls over 1 hour

- 14) A Patient receives Diamorphine infusion over 24 hours. They currently receive a dose of 240mg over a 24 hour period using a syringe pump that is calibrated to 48mm / 24 Hours (some syringe pumps are calibrated in mm/hr). You increase the rate of infusion to 72mm / 24 hours. What dosage will they now receive ?
- a) 264mg per 24 hours
  - b) 300mg per 24 hours
  - c) 360mg per 24 hours
  - d) 480 mg per 24 hours
  - e) 720mg per 24 hours
- 15) A Drug representative offers you a special deal on Wonder Drug "Meetoo". You will get a 10% discount as free stock for the next two years providing you buy it through him. You currently use around 10,000 boxes of wonderdrug "Meetoo" every month and each box costs £1.00 and you send in your first order for 10,000. Your order arrives and you unpack 11,000 boxes (i.e. it includes your free stock). You look at the Invoice and note a price. How much should you be charged.
- a) £9000
  - b) £9900
  - c) £10000
  - d) £10,100
  - e) £11,000
- 16) Calculate the approximate dose of drug X for a 2 stone child if the recommended dose is 2.4mg/kg. (assume 1 Stone = 6.35Kg approx)
- a) 25mg
  - b) 30mg
  - c) 35mg
  - d) 40mg
  - e) 45mg
- 17) Q17 The recommended dose of drug A is 25mg/kg/day in divided doses. On admission, Mrs X says she is on three 250mg capsules twice daily. If the dose is correct, what is Mrs X approximate weight ?
- a) 50kg
  - b) 55kg
  - c) 60kg
  - d) 65kg
  - e) 70kg

- 18) 70kg patient requires Dobutamine at a dose of 15mcg/kg/min. made up as Dobutamine 250mg in 50mls dextrose 5% for slow infusion. What is the nearest correct dose in mg per hour.
- 52.5mg
  - 55mg
  - 57.5mg
  - 60mg
  - 62.5mg
- 19) Q19 Drug H is to be given as 500mg in 1 Litre of sodium chloride 0.9% over 10 hours. Calculate the drip rate if the drug is administered using a Burette set where 1ml = 60 drops
- 60 drops / minute
  - 70 drops / minute
  - 80 drops / minute
  - 90 drops / minute
  - 100 drops / minute
- 20) Q20 The reading on a syringe driver administering drug C is 35mls/hr. The additive label says '500mg in 100ml' and the patient's weight is 60kg. What dose of drug C is the patient receiving in mcg/kg/min?
- 50 micrograms
  - 100 micrograms
  - 150 micrograms
  - 200 micrograms
  - 250 micrograms
- 21) A patient is instructed to use Fucidin HC ointment twice a day on both arms and legs. The application to each arm is approximately 5gms and the application to each leg is approximately 15gms. Over a one week period, how much Hydrocortisone and how much Fusidic Acid will be applied topically. (The formula of Fucidin HC Ointment is 1% Hydrocortisone as Acetate and 2% Fusidic Acid)
- 1gm Hydrocortisone and 2gm Fusidic Acid
  - 2gms Hydrocortisone and 4gms Fusidic Acid
  - 2.8gms Hydrocortisone and 5.6gms Fusidic Acid
  - 5gms Hydrocortisone and 10gms Fusidic Acid
  - 5.6gms Hydrocortisone and 11.2gms Fusidic Acid

- 22) You have been asked to prepare 350gms x 4% Menthol in Aqueous Cream.  
How much Menthol is required ?
- 140gm
  - 70gms
  - 35gms
  - 14gms
  - 7gms
- 23) An infusion pump is used to administer Epinephrine (Adrenaline) to a patient at a rate of 4mls per minute. The patient weighs 70Kg and Adrenaline solution 1 in 10,000 is to be administered in the pump . What quantity in micrograms of adrenaline will be supplied per hour per Kilogram.
- 3,400 micrograms
  - 1,700 micrograms
  - 340 micrograms
  - 170 micrograms
  - 34 micrograms
- 24) A patient is being given Chloramphenicol eye drops 0.5% for an eye infection. How much drug is contained in 2 x 5ml bottles of these drops.
- 25mg
  - 50mg
  - 75mg
  - 100mg
  - 500mg
- 25) You are asked to infuse Turbimycin for a 50Kg patient at a rate of 120mg per hour. Which of the following would be correct.
- First Statement** :- 0.2% of Turbimycin in a 500ml infusion bag should be infused at a rate of 60mls per 30 minutes
- Second Statement** :- The infusion rate would be 80mcg / Kg / Min
- Choose
- If both statements are True and the second statement is an explanation of the first statement
  - If both statements are True and the second statement is not an explanation of the first statement
  - If statement 1 is True and statement 2 is False
  - If statement 1 is False and statement 2 is True
  - If both statements are False

## CHAPTER 2

- 1) You have been asked to supply some Lidocaine suppositories (using Cocoa Butter as a base) for a patient. The suppositories will be made using a 4gm mould and each suppository will contain 10mg Lidocaine. You need to supply 50 suppositories. Given that the displacement value of Lidocaine in Cocoa Butter is 0.5, calculate how much base and active ingredient are required if a surplus of 5 suppositories are to be made.

- a) 199.75gms Base + 500mg Lidocaine
- b) 200mg Base + 500mg Lidocaine
- c) 219.450mg Base + 550mg Lidocaine
- d) 218.900gms Base + 550mg Lidocaine
- e) 220gms Base + 550mg Lidocaine

- 2) Enos Fruit Salts contain
- |                    |         |
|--------------------|---------|
| Citric Acid        | 2.18gms |
| Sodium Bicarbonate | 2.32gms |
| Sodium Carbonate   | 0.5gms  |
- in each 5gm sachet

Given that the GmMwt of Sodium Bicarbonate is 84gms and the GmMwt of Sodium Carbonate is 106gms, calculate the approximate number of millimols of Sodium in each 5gm sachet

- a) 18mmols
- b) 24mmols
- c) 30mmols
- d) 36mmols
- e) 42mmols

- 3) Pripsen sachets contain 4gms piperazine citrate and 15.3mg Sennosides per sachet.

It is recommended that they are prepared by dissolving the granules in a glass of water or milk. Assuming that there is no displacement, what is the approximate concentration of Sennosides if a standard glass of water is 150mls

- a) 0.01%
- b) 0.015%
- c) 0.030%
- d) 0.060%
- e) 0.15 %

- 4) Ranitidine Syrup contains 75mg in each 5mls.  
Ranitidine has a molecular weight of 350  
Approximately how many millimols of Ranitidine are there in a 10ml dose ?
- a) 3.2 mmols
  - b) 2.4 mmols
  - c) 1.6 mmols
  - d) 0.8 mmol
  - e) 0.4mmols
- 5) A patient is to be given Infliximab for crohns disease. The patient weighs 54Kg and is to be given a dose of 2.5mg/kg/dose. Infliximab comes as 100mg in 10ml and should be prepared in an intravenous solution with a final volume of 250mg which is then to be administered over 3 hours (The recommendation is a minimum of 2 hours). At what rate is the infusion actually to be administered in micrograms/ minutes ?
- a) 1000mcg / minute
  - b) 750mcg / minute
  - c) 500mcg/ minute
  - d) 250mcg/ minute
  - e) 125mcg / minute
- 6) Dioralyte sachets contain 470mg of Sodium Chloride  
Given that the Gm atomic weight of Sodium is 23 and Chloride is 35.5  
How many millimols of Sodium Chloride are there in 1 sachet of Dioralyte ?
- a) 2mmol
  - b) 4mmol
  - c) 8mmol
  - d) 12mmol
  - e) 16mmol

- 7) Dentinox contains 21mg Simeticone in each 2.5mls. What is this as a percentage ?
- a) 0.0084%
  - b) 0.084%
  - c) 0.84%
  - d) 8.4%
  - e) 84%
- 8) A patient who suffers from severe indigestion calls into your pharmacy for help and admits to taking aromatic Magnesium Carbonate Mixture at a dose of 20mls four times a day and also Rennie Duo suspension at a dose of 10mls four times a day and a 20ml dose at bedtime.  
To the nearest whole unit, how many millimols of Sodium is the patient taking each WEEK.
- a) 28 mmols
  - b) 56 mmols
  - c) 278mmols
  - d) 556mmols
  - e) 1112 mmols
- 9) A patient is prescribed Acidex an alginate containing preparation designed to protect the oesophagus from gastric reflux. The prescription contains instructions that the preparation should be taken at a dose of 10mls QDS and also at night and for 60 days supply. If the molecular weight of Calcium Carbonate is 100 approximately, Which of the following statements is correct?

	Supply Full bottles	Patient will take in total mmols Ca <sup>++</sup>	Patient will take in total mmols Na <sup>+</sup>
<b>A</b>	4	360	400
<b>B</b>	6	480	1800
<b>C</b>	8	720	800
<b>D</b>	10	900	1,000
<b>E</b>	12	1,180	1,200

- 10) An antacid preparation is calculated to contain 160mg of Sodium Bicarbonate in each 5ml dose. A patient has taken 600 mls over the last 24 hours. Calculate the number of millimols of Sodium that the patient has ingested given that the formula of Sodium Bicarbonate is  $\text{NaHCO}_3$  and that the respective weights are Sodium 23 and Bicarbonate ( $\text{HCO}_3$ ) is 61
- a) 57mmols
  - b) 114mmols
  - c) 228mmols
  - d) 342mmols
  - e) 456mmols
- 11) A child is seriously ill and is being administered an infusion of an antibiotic that is made up as a solution containing 250mg in 100mls. This is to be administered at a rate of 1.25mg / Kg / 30 minutes. The child weighs 18Kg. To the nearest half hour, how many hours and minutes will the infusion run for ?
- a) 3 hours and 30 minutes
  - b) 4 hours
  - c) 4 hours and 30 minutes
  - d) 5 hours
  - e) 5 hours and 30 minutes
- 12) How much Potassium permanganate is there in 350mls if the concentration is a 1 in 8000000 solution ?
- a) 52.55mcg
  - b) 43.75mcg
  - c) 37.50mcg
  - d) 32.55mcg
  - e) 29.55mcg

- 13) **FIRST STATEMENT** 75mls of 1.8% saline diluted 50% contains 15mmols of Sodium Chloride
- SECOND STATEMENT** The Gm Molecular weight of Sodium Chlorides is 58.5gms

Read these two statements and choose

- a) If both statements are True and the 2nd statement is a correct explanation of the first
- b) If both statements are True but the 2nd statement is NOT a correct explanation of first
- c) The first statement is true and the second is false
- d) The first statement is False and the second is True
- e) Both statements are False
- 14) A Patient is admitted to casualty having taken an overdose of soluble Paracetamol 500mg.  
The half life of Paracetamol is 2 hours  
Their blood levels show a concentration of 80mg / Litre  
It is estimated that their Total Volume of distribution is equivalent to 40 Litres and the patient claims it is exactly 6 hours exactly since they ingested the paracetamol  
If the amount absorbed is 40% of the total amount taken how many tablets did they take ? (Ignore any delay between the taking and absorption)
- a) 156 tablets
- b) 128 tablets
- c) 112 tablets
- d) 96 tablets
- e) 84 tablets
- 15) A current formulation of Dilicardin has a bioavailability of 40% and is supplied as a tablet with a strength of 400mg. The dose is a single tablet twice daily for 15 days  
A new formulation is made available which has a bioavailability of 90% and is supplied as a 200mg tablet. Again the dose is a single tablet twice daily for 15 days  
The drug costs £ 200 per Kg  
Ignoring all other costs, how much is saved in using less drug when manufacturing 2 million packs of 30 x 200mg tablets instead of 400mg
- a) £24,000
- b) £120,000
- c) £240,000
- d) £1,200,000
- e) £2,400,000

- 16) 750g of an ointment containing 2.15% w/w of a single active ingredient have been prepared. What is the weight of active ingredient contained in 20g of the ointment ?
- a) 4.3gms
  - b) 2.13gms
  - c) 430mg
  - d) 215mg
  - e) 413 micrograms
- 17) A young male patient requires 0.42mg adrenaline. The ward nurse phones the pharmacy and informs you that the only stock on the ward is a 1 in 10,000 solution. What volume of injection will the nurse require ?
- a) 0.42mls
  - b) 4.2mls
  - c) 10mls
  - d) 21mls
  - e) 42mls
- 18) What is the percentage strength of a solution containing 32gms in 2,500mls ?
- a) 6.40%
  - b) 3.20%
  - c) 1.80%
  - d) 1.28%
  - e) 0.64%
- 19) A nurse has a caustic solution for cleaning the floor. The concentrate states that the caustic (not the solution) must be diluted to 1 part in 6000 or greater otherwise it can cause skin irritation. She needs to instruct the cleaner how to dilute this and she has only a litre jug graded in 10ml units. The concentrate states that it contains 5gms in every 20mls of solution. Which of the following would be an appropriate recommendation
- a) Dilute 10mls to 15 litres with tapwater
  - b) Dilute 10mls to 60 litres with tapwater
  - c) Dilute 10mls to 150 litres with tapwater
  - d) Dilute 10mls to 600 litres with tapwater
  - e) Dilute 10mls to 1500mls with tapwater

20) You receive a prescription that requires you to supply :-

300gms of an Ointment containing 2.5% of Drug Y

You only have a 1% preparation of the drug and a container of the pure drug.

The prescription is urgent so you are required to extemporaneously prepare a 2.5% ointment by adding the pure drug to 1% Ointment.

How much pure drug do you need to add to 250gms of 1% Ointment to make it 2.5%

- a) 3.5gms
- b) 3.75gms
- c) 3.85gms
- d) 4.25gms
- e) 4.85gms

21) An infusion pump is set up to administer a drug at the rate of 4.5mcg per Kg every minute to a patient who weighs 85Kg.

What dose of drug (to the nearest 10mg) will the patient receive if the drug is administered for a total of 3 hours ?

- a) 60mg
- b) 70mg
- c) 80mg
- d) 90mg
- e) 100mg

22-24) Questions 22-24: Each of the questions below concern quantities of Sodium Bicarbonate. Choose the correct answer for each

	A	B	C	D	E
	0.5gms	1.0 gms	1.5 gms	5gms	10gms
<b>Q 22</b> This is contained in Aromatic Magnesium Carbonate 20mls	A	B	C	D	E
<b>Q 23</b> This is contained in 30 mls Magnesium Trisilicate Mixture	A	B	C	D	E
<b>Q 24</b> This is contained in 10mls Kaolin and Morphine Mixture	A	B	C	D	E

25) Calculate the approximate dose of drug X for a 2 stone child if the recommended dose is 2.4mg/kg. (Assume 1 Stone = 6.35Kg approx)

- a) 25mg
- b) 30mg
- c) 35mg
- d) 40mg
- e) 45mg

-----

## **Chapter 3**

- 1) The recommended dose of drug A is 25mg/kg/day in divided doses. On admission, Mrs X says she is on three 250mg capsules twice daily. If the dose is correct, what is Mrs X approximate weight ?
- a) 50kg
  - b) 55kg
  - c) 60kg
  - d) 65kg
  - e) 70kg
- 2) 70kg patient requires Dobutamine at a dose of 15mcg/kg/min. made up a Dobutamine 250mg in 50mls dextrose 5% for slow infusion. What is the nearest correct dose in mg per hour.
- a) 52.5mg
  - b) 55mg
  - c) 57.5mg
  - d) 60mg
  - e) 62.5mg
- 3) Drug H is to be given as 500mg in 1 Litre of sodium chloride 0.9% over 10 hours. Calculate the drip rate if the drug is administered using a Burette set where 1ml = 60 drops
- a) 60 drops / minute
  - b) 70 drops / minute
  - c) 80 drops / minute
  - d) 90 drops / minute
  - e) 100 drops / minute
- 4) The reading on a syringe driver administering drug C is 35mls/hr. The additive label says '500mg in 100ml' and the patient's weight is 60kg. What dose of drug C is the patient receiving in mcg/kg/min?
- a) 50 micrograms
  - b) 100 micrograms
  - c) 150 micrograms
  - d) 200 micrograms
  - e) 250 micrograms

5) A patient is to be given Levomepromazine. It has been calculated that the volume of distribution of Levomepromazine is 15 litres / Kg and maximum blood levels are reached 30-90 minutes after an intramuscular dose. It is also estimated to have a half life of 20 hours. A patient weighing 60Kg is administered a dose of 50mg in 2mls by intramuscular injection. As it undergoes considerable first pass metabolism, it has an effective bioavailability of 80%. What would be the expected concentration in the blood after 60 minutes assuming maximum blood concentration has been achieved.

- a) 0.445 micrograms / Litre
- b) 4.445 micrograms / litre
- c) 44.5 micrograms / litre
- d) 445 micrograms / litre
- e) 4.45 mg / Litre

6) A patient is to be given Levomepromazine. It has been calculated that the volume of distribution of Levomepromazine is 15 litres / Kg and maximum blood levels are reached 30-90 minutes after an intramuscular dose. It is also estimated to have a half life of 20 hours. A patient weighing 60Kg is administered a dose of 50mg in 2mls by intramuscular injection. As it undergoes considerable first pass metabolism, it has an effective bioavailability of 80%.

The patient is not administered any further dose.

What would be the approximate blood concentration after 60 hours.

- a) 550 micrograms / litre
- b) 225 micrograms / litre
- c) 110 micrograms / litre
- d) 55 micrograms / litre
- e) 5.5 micrograms / litre

7) A patient keeps a migraine diary and records that every week, they suffer a migraine on average three days out of every seven. They are able to control their migraine taking half the maximum daily dose of Paracetamol and call into the surgery to request a prescription for the next three months as they are visiting a relative on a remote Scottish island. The doctor asks you to calculate how many tablets are the minimum that he will be required to prescribe assuming there are 4 weeks per month. How many should he prescribe ?

- a) 56
- b) 84
- c) 144
- d) 168
- e) 224

- 8) A patient is to be anaesthetised using Propofol by continuous infusion in Glucose 5%. The initial solution is to be made using a 50ml vial of propofol 20mg in 1ml. The infusion is to be made using the maximum permitted amount of Glucose 5% and is to be administered over 3 hours to maintain anaesthesia. At what rate per minute should the prepared infusion be administered.
- a) 1.4 mls
  - b) 2.8 mls
  - c) 5.6 mls
  - d) 11.2 mls
  - e) 28 mls
- 9) A Patient who weighs 75kg has been taking Phenytoin Infatabs for the last Few years at a dose of 4mg / Kg daily (as three doses) as these were found to be the most suitable preparation for him due to problems with swallowing. He is now to be switched to Phenytoin suspension to be administered via a nasogastric tube three times a day. The patients G.P. phones and asks what the correct dosage would be and how much would be required for 4 weeks supply. Which of the following would be correct :-
- a) 15mls TDS x 1,260mls
  - b) 17.5mls TDS x 1,470mls
  - c) 20mls TDS x 1,680mls
  - d) 22.5mls TDS x 1,890mls
  - e) 25mls TDS x 2,100mls
- 10) A Patient is advised to use Chlorhexidine and Cetrimide sachets as a mild antibacterial for bathing her feet twice a day. The patient uses one 25ml sachet on each foot and uses the preparation twice daily for two weeks. How much Chlorhexidine was used ?
- a) 300mg
  - b) 210mg
  - c) 150mg
  - d) 120mg
  - e) 70mg
- 11) A Patient is advised to use Chlorhexidine and Cetrimide sachets as a mild sachet on each foot and uses the preparation twice daily for two weeks. How much Cetrimide was used in ONE week
- a) 3.50gm
  - b) 2.70gm
  - c) 2.10gm
  - d) 1.05gms
  - e) 0.75gms

- 12) A GP asks you to dispense a cream containing 3% Dithranol in Lassars Paste for a patient with psoriasis. You only have Dithranol 0.5% in Lassars Paste and Dithranol Powder . How much Dithranol Powder would you need to add to 500gms of 0.5% Dithranol in Lassars Paste to make it 3%
- 15.00gms
  - 14.5gms
  - 13.8gms .
  - 12.9gms
  - 11.8gms
- 13) You are given two solutions – Ethanol 25% and Ethanol 90% and are asked to prepare 500mls of a solution of Ethanol containing 40%. What volume of each should be used to the nearest 0.5mls ?
- 54.5mls of 25% + 445.5mls of 90%
  - 72.5mls of 25% + 427.5mls of 90%
  - 108.5mls of 25% + 391.5mls of 90%
  - 275.5mls 25% + 224.5mls of 90%
  - 384.5mls of 25% + 115.5mls of 90%
- 14) You have one ampoule of each of two injectable forms of the same drug  
 One contains 25mg in 2mls for IV injection  
 The second contains 300mg in 10mls for IV injection.  
 You need a dose of 325mg to be added to 1 Litre of Infusion fluid.  
 You add both ampoules to the 1 Litre of fluid which is then to be infused over 1hour for a child with an acute infection.  
 What is the percentage concentration of the 1 Litre of fluid containing Drug X
- 0.00325%
  - 0.0325%
  - 0.0525%
  - 0.325%
  - 0.525%
- 15) You have been asked to prepare 420gms x 2.5 % Coal Tar in Aqueous Cream. How much Coal Tar is required ?
- 2.5gms
  - 4.2gms
  - 5.1gms
  - 7.5gms
  - 10.5gms

- 16) You are asked to provide a preparation of Triplimycin in Aqueous Cream that a patient is to apply to both lower limbs twice a day for 7 days. The patient is questioned and indicates that on applying the preparation to a single limb, they use approximately 7gms when correctly applied.  
Which of the following would be correct.

**First Statement** 200gms of the preparation should be supplied to the Patient

**Second Statement** 200gms represents an appropriate supply for use on both limbs for 1 week

Choose

- a) If both statements are correct and statement 1 is explained by statement 2
  - b) If both statements are correct and statement 1 is not explained by statement 2
  - c) If statement 1 is true and statement 2 is false
  - d) If statement 1 is false and statement 2 is true
  - e) If both statements are false.
- 17) A mixture contains two drugs A and B in the ratio of 25:1. A child takes a dose of 5mls and this contains a 1.5 % solution of Drug A . How many micrograms of Drug B does a 5ml dose contain ?
- a) 3 micrograms
  - b) 30 micrograms
  - c) 300 micrograms
  - d) 3000 micrograms
  - e) 30,000m micrograms

- 18) A 60Kg patient is to be given the antibiotic Ampitetracin and the recommendation is that it should be administered at a rate of 30 mg per minute.  
Which of the following statements is correct

**First Statement** A 0.5% of Ampitetracin in a 1 Litre infusion bag should be infused at a rate of 30mls per 30 minutes

**Second Statement** :- A rate of 30mg per minute represents an infusion rate of 30mg / Kg / Hour

Choose

- a) If both statements are correct and statement 1 is explained by statement 2
- b) If both statements are correct and statement 1 is not explained by statement 2
- c) If statement 1 is true and statement 2 is false
- d) If statement 1 is false and statement 2 is true
- e) If both statements are false.

- 19) You are required to calculate the daily dose of a drug for an epileptic Child who is 2 years old. The child weighs 12 kg. and recommended dose for a child of this age is 150mcg/ kg/ 8hrs by slow infusion . It is intended to infuse the drug in 250mls Saline over 24 hours. The injection comes in a strength of 25mg in 10ml.  
What volume of injection to the nearest 0.1ml needs to be added to the infusion bag
- a) 2.0mls
  - b) 2.2mls
  - c) 2.4mls
  - d) 2.6mls
  - e) 2.8mls
- 20) A child is to be supplied with Ventolin inhalers for treatment during a 2 month holiday. The child who is 8 years old uses his inhaler at the maximum dose of eight puffs a day. He also states that every two or three days he may need to use a few extra puffs. How many inhalers would be needed to provide for the holiday ?
- a) 1 Inhaler
  - b) 2 Inhalers
  - c) 3 Inhalers
  - d) 4 Inhalers
  - e) 5 Inhalers
- 21) A patient is instructed to use Fucidin HC ointment twice a day on both arms and legs. The application to each arm is approximately 5gms and the application to each leg is approximately 15gms. Over a one week period, how much Hydrocortisone and how much Fusidic Acid will be applied topically. (The formula of Fucidin HC Ointment is 1% Hydrocortisone as Acetate and 2% Fusidic Acid)
- a) 1gm Hydrocortisone and 2gm Fusidic Acid
  - b) 2gms Hydrocortisone and 4gms Fusidic Acid
  - c) 2.8gms Hydrocortisone and 5.6gms Fusidic Acid
  - d) 5gms Hydrocortisone and 15gms Fusidic Acid
  - e) 10gms Hydrocortisone and 30gms Fusidic Acid

- 22) You receive a prescription that requires you to manufacture 20 x 200mg Clotrimazole Pessaries. Each pessary will be made using a 3gm suppository mould. The displacement value of Clotrimazole in the base (Witepsol) is 0.5. To ensure you can supply the full quantity, it is recommended that you manufacture a total quantity of 24. What quantities of base and Clotrimazole will be required ?
- a) 58gms Base + 4gms Clotrimazole
  - b) 60gms Base + 4gms Clotrimazole
  - c) 66gms Base + 4.4gms Clotrimazole
  - d) 69.6gms Base + 4.8gms Clotrimazole
  - e) 72gms Base + 4.8gms Clotrimazole
- 23) A patient is advised to use a mild solution of Potassium Permanganate and the prescription is sent to your pharmacy. The prescription calls for a solution to be provided that when 25mls is diluted 1 in 5,000 litres will provide a solution that is a 1 in 20 million solution.  
You are asked to provide sufficient of the solution for the patient to use twice daily for two weeks.  
You have a stock solution of 35% Potassium Permanganate.  
How much of this stock solution will be required and what volume of solution should you provide when dispensing the prescription.
- a) 10mls + 700mls
  - b) 15mls + 700mls
  - c) 20mls + 700mls
  - d) 25mls + 700mls
  - e) 30mls + 700mls
- 24) You are in charge of the manufacturing department of a large hospital pharmacy. A patient in the community requires a 0.02% solution of Chlorhexidine in 100ml bags to be used as a bladder washout to maintain the patency of an indwelling catheter. You are asked to supply sufficient for use three times a day for 28 days.  
Assuming that there is no waste during manufacturing, how much Chlorhexidine is required.
- a) 0.0168gms
  - b) 0.168gms
  - c) 0.2gms
  - d) 1.68gms
  - e) 2.0gms

25) An injection contains 25mg of active ingredient in each 12.5ml ampoule

**First Statement** :- 1ml represents 8% of the volume in each ampoule

**Second Statement** :- 1ml contains 2mg of active ingredient

Decide whether the first statement is true or false

Decide whether the second statement is true or false. Then choose :-

- a) If both statements are true and the second statement is a correct explanation of the first statement
- b) B If both statements are true and the second statement is NOT a correct explanation of the first statement.
- c) If the first statement is true but the second statement is false.
- d) If the first statement is false but the second statement is true.
- e) E If both statements are false.

## **CHAPTER 4**

- 1) You are asked to check on the administration of Dopamine which has been made up to a concentration of 80mg in 500ml in an infusion pump running at the rate of 1 drop per minute. The prescribed dose is 2 - 5 micrograms / kg / min. The Patient's weight is 65kg. What dose is the pump actually delivering to the patient if there are 20 drops in 1ml to the nearest 0.5 mcg?
- a) 9.5mcg/ mg / hour
  - b) 8.5mcg/kg / hour
  - c) 7.5mcg /kg / hour
  - d) 6.5mcg / kg / hour
  - e) 5.5mcg / kg / hour
- 2) How much potassium permanganate would be needed in order to prepare one Litre of a 1 in 40,000 solution ?
- a) 400mg
  - b) 250mg
  - c) 40mg
  - d) 25mg
  - e) 4mg
- 3) A patient is taking generic Carbamazepine tablets at a dose of 100mg in the morning, 200mg twice at midday and 400mg at night. The clinician wishes to switch the patient to modified release tablets to be taken twice daily. However while the bioavailability of the standard tablets is 80%, the bioavailability of the generic modified release tablets is 60% ? What would be an appropriate dose of the modified release tablets (These available as both 200 and 400mg tablets with the same bioavailability). The doctor would prefer a lower rather than a higher dose
- a) 1 x 400mg MR Tablet OM and 2 x 400mg Tablet Nocte
  - b) 1 x 200mg MR Tablet OM and 2 x 400mg Tablet Nocte
  - c) 1 x 200mg MR Tablets OM and  
1 x 200mg + 1 x 400mg MR Tablets Nocte
  - d) 1x 200mg MR Tablets OM and 1 x 400mg MR tablet Nocte
  - e) 1x 200mg MR + 1 x 200mg MR Tablets Nocte

4) **FIRST STATEMENT** 250mls of 0.005% w/w solution contains 75mg of active ingredient

**SECOND STATEMENT** There are 250 micrograms in every 5mls of a 0.005% solution

**Read the two statements and then choose**

- a) If both statements are True and the 2nd statement is a correct explanation of the first
  - b) If both statements are True but the 2nd statement is NOT a correct explanation of first statement
  - c) The first statement is true and the second is false
  - d) The first statement is False and the second is True
  - e) Both statements are False
- 5) A tablet manufacturer is preparing a solid dosage form of a new antipsychotic. The drug is extremely potent with a narrow therapeutic window and the MHRA state that the acceptable limits of potency as 98-105% The tablet is to be administered starting at 25mg up to a maximum dose of 150mg at night. Which of the following statements is or are correct about the drug .
- 1) To comply with MHRA requirements the minimum daily dose must not be below 24.5mg
  - 2). The maximum evening dose must lie within the limits of 147 and 157.5mg
  - 3). To comply with MHRA requirements each tablet must have a strength between 24mg and 26mg
- Choose :
- a) If 1, 2 and 3 are correct
  - b) If 1 and 2 only are correct
  - c) If 2 and 3 only are correct
  - d) If 1 only is correct
  - e) If 3 only is correct
- 6) A patient is accidentally administered ten 4ml sachets of Mucoclear, a solution containing hypertonic saline (Sodium Chloride 4%). Approximately how many millimols of Sodium chloride have been administered ? (The atomic weight of Sodium is 23 and Chlorine is 35.5)
- a) 5.4 mmols
  - b) 27mmols
  - c) 54mmols
  - d) 81mmols
  - e) 108mmols

- 7) A patient has their blood Sodium levels measured and the level is found to be in excess of 150mmols/Litre. On questioning the patient, they admit that they have been taking Gaviscon Advance for oesophageal reflux. On further questioning, the patient admits that they exceed the maximum recommended dosage and in fact take around 25mls QDS..  
How many mmols of Sodium ions is the patient possibly taking during a 24 hour period.
- 2.3mmols each day
  - 23mmols each day
  - 46mmols each day
  - 69mmols each day
  - 84mmols each day
- 8) You receive a prescription that requires you to supply 1800mls of 50 % Ethanol.  
In stock you have a 70% solution and a 10% Solution. What quantities of each to the nearest 1ml are required to be mixed to produce a 50% solution.
- 300mls of 70% and 1500mls 10% ethanol
  - 600mls of 70% and 1200mls 10% ethanol
  - 800mls of 70% and 1000mls of 10% ethanol
  - 1000mls of 70% and 800mls of 10% ethanol
  - 1200mls 70% e and 600mls 10% ethanol
- 9) You have been asked to extemporaneously dispense three different medicines in a liquid form. You will have to make each using crushed tablets and the recommended suspending agent.  
Which of the following formula would you be happy to use?
- 1) Prescribed :- 100mls of Furosemide suspension 60mg/5mL:  
Crush 20 x 40mg tablets and make up to 100mLs
  - 2) Prescribed :- 200mls of Spironolactone suspension 25mg/5mLs  
Crush 10 x 100mg tablets and make up to 200mLs
  - 3) Prescribed :- 150mls Captopril suspension 12.5mg /5mLs:  
Crush 15 x 25mg tablets and make up to 150mLs
- Choose :
- If 1, 2 and 3 are correct
  - If 1 and 2 only are correct
  - If 2 and 3 only are correct
  - If 1 only is correct
  - If 3 only is correct

10) A patient is being given Antibiocillin eye drops 2.5% for an eye infection. If the patient uses 1 drop in each eye SIX times a day, how much drug is administered daily. You may assume that 20 drops = 1ml

- a) 15mg
- b) 12mg
- c) 9mg
- d) 6mg
- e) 3mg

11) A Consultant requests the following :-

Dithranol 7.5%  
Salicylic Acid 2.5%  
in White soft paraffin - Mitte 250gms

Which of the following are the correct quantities to use :-

	<b>Dithranol</b>	<b>Salicylic Acid</b>	<b>White Soft Paraffin</b>
a)	6gm	3gm	250gm
b)	12gm	6gm	250gm
c)	15gm	3gm	232gm
d)	12gm	6gm	232gm
e)	17.5gm	6.5gm	226gm

12) Drug X, a class 1 anti-arrhythmic is renally excreted. It is administered by intravenous infusion. The data sheet provides the following recommendations :-

<b>Creatinine Clearance</b>	<b>Dosage</b>	<b>Frequency</b>
>50ml/min	5mg/ kg	12 hrly
25-50ml/min	2.5mg/ kg	12 hrly
10-25ml/min	2.5mg/kg	24 hrly
0-10ml/min	1.25mg/ kg	24 hrly

The formula to use for Creatinine Clearance (CC) is

$$CC = (1.2 (140 - A) \times W) / SC$$

A = Age, W = Weight (Kg) SC = Serum Creatinine (mmol/L)

You have a patient who is a 60yr old non obese male. He weighs 50kg and his last plasma Creatinine was measured as 300mmol/L. This is remaining steady. Which of the following doses of Drug X would be appropriate :-

- a) 275mg x 12hrs
- b) 125mg x 12 hrs
- c) 125mg x 24 hrs
- d) 75mg x 12 hrs
- e) 75mg x 24 hrs

- 13) A pharmacy has a stock solution a 25% Solution of Chlorhexidine. A prescription is received for 4 litres of a 40% solution. This needs to be made by adding Chlorhexidine powder. How much Chlorhexidine (to the nearest 10gms) needs to be added ?
- 500gm + 3,500mls of 25% solution
  - 600gm + 3,400mls of 25% solution
  - 700gms + 3,300mls of 25% solution
  - 800gms + 3,200mls of 25% solution
  - 900gms + 3,100mls of 25% solution
- 14) What is the correct dose volume of Epanutin Syrup for a child weighing 30kg given that the initial daily dose is 5mg/Kg. Phenytoin suspension contains 60mg in 10ml and is recommended to be given at 12 hourly intervals
- 25.0mls BD
  - 17.5mls BD
  - 15.0mls BD
  - 12.5mls BD
  - 10.0mls BD

**Questions 15-17: These concern the number of millimols of Sodium Chloride shown below :-**

- |   |          |                                      |
|---|----------|--------------------------------------|
| A | 100 mmol |                                      |
| B | 150mmol  |                                      |
| C | 200mmol  | (The Atomic weights are :- Na = 23 ) |
| D | 250mmol  | ( and Cl = 35.5 )                    |
| E | 500mmol  |                                      |

- 15) 15gm of Sodium Chloride contains approximately how many millimols of NaCl
- 16) 1000mls of a low sodium antacid must contain less than this quantity of Sodium in mmols
- 17) Is the top of the approximate normal human plasma level of mmols Sodium<sup>+</sup> (as chloride) per Litre and is equivalent to a concentration roughly equivalent to 0.9% Sodium Chloride

18) Which of the following statements is or are correct :-

- 1) 150mg oral Morphine sulphate is approximately equivalent to 45mg Diamorphine hydrochloride intramuscular
- 2) 150mg oral Morphine sulphate is approximately equivalent to 75mg Oxycodone oral
- 3) 360mg oral Morphine sulphate is approximately equivalent to 1 x Fentanyl '75' patch

Choose :

- a) If 1, 2 and 3 are correct
- b) If 1 and 2 only are correct
- c) If 2 and 3 only are correct
- d) If 1 only is correct
- e) If 3 only is correct

19) A patient is admitted to Accident and Emergency with a toxic plasma concentration of 52 micrograms/ml of Antibugoxacillimycin. The drug's half life is 10.5 hours. How long, in hours, will it take for the plasma concentration to fall to 1.625 micrograms/ml ? (assume absorption and distribution is complete and elimination is described by a 1st order reaction).

- a) 10.5 hrs
- b) 21 hrs
- c) 31.5hrs
- d) 42 hrs
- e) 52.5hrs

20) A patient requires a topical steroid for the treatment of severe resistant eczema. The only steroid they respond to is Clobetasol but the clinician feels that the commercial preparation is too strong. and writes a prescription for 3 x 250gms of Clobetasol 0.0125% . What quantity of commercial Dermovate cream is required to extemporaneously dispense this product ?

- a) 187.5gms
- b) 125.5gms
- c) 75gms
- d) 25gms
- e) 18.75gms

- 21) While running a workshop on pharmacokinetics for a group of pharmacy students you are asked to explain what is meant by 'half-life'. To check that they have understood your explanation you ask them to answer the following question.  
If a medicine has a plasma elimination half-life of 4 hours how much of the medicine present in the plasma will be eliminated after 8 hours?  
The correct answer is:
- a) 25%
  - b) 40%
  - c) 50%
  - d) 67%
  - e) 75%
- 22) What volume of Concentrated Chloroform Water BP is required to prepare 200ml of Chloroform Water BP?
- a) 2.5ml
  - b) 5ml
  - c) 10ml
  - d) 50ml
  - e) 100ml
- 23) A coated tablet has a dry weight of coating of 10mg/tablet. The coating solution is prepared to contain 10%w/v of coating material. How long is needed to coat a batch of 1 million tablets at a spray rate of 250mL/min, given that coating efficiency is 100%?
- a) 25 min
  - b) 40 min
  - c) 100 min
  - d) 250 min
  - e) 400 min
- 24) What volume of a 40% w/v stock solution of Benzalkonium chloride is required to provide a final preservative concentration of 0.01% w/v in a 5 litre batch of an ophthalmic solution?
- a) 1.25ml
  - b) 2.5ml
  - c) 5.0ml
  - d) 7.5ml
  - e) 12.5ml

- 25) If 400mg of potassium permanganate is dissolved in 2.5litres of water, what is the percentage strength of the resulting solution?
- a) 0.008%
  - b) 0.016%
  - c) 0.032%
  - d) 0.064%
  - e) 0.08%

## **Chapter 5**

- 1) A two year old child is prescribed Tagamet Syrup to relieve severe gastro-oesophageal reflux. The dose (which you may assume to be safe and correct) is to be 120mg tds. To aid with drug administration the prescription states that the doses should be given as 5mL units. How much Tagamet Syrup and how much diluent (syrup BP) would you need to use to provide exactly 7 days' supply of the product?
- a) 42mLs of Tagamet Syrup and 63mLs of syrup BP
  - b) 44mLs of Tagamet Syrup and 61mLs of syrup BP
  - c) 60mLs of Tagamet Syrup and 40mLs of syrup BP
  - d) 63mLs of Tagamet Syrup and 42mLs of syrup BP
  - e) 92mLs of Tagamet Syrup and 63mLs of syrup BP
- 2) Mrs X is a patient who has had difficulty withdrawing from benzodiazepines. She is currently taking two Temazepam 20mg tablets each night. The decision is taken to transfer Mrs X to Diazepam tablets and instigate a reduction protocol. How many diazepam 10mg diazepam tablets would be needed to supply the equivalent dose of benzodiazepine to the patient for the first fortnight of treatment, where there is no dose equivalent reduction?
- a) 7
  - b) 14
  - c) 28
  - d) 42
  - e) 56
- 3) 3. You receive a private prescription for 60 carbocistene capsules 375mg. A pack (30) of carbocistene capsules 375mg costs £4.50 trade exc. VAT. Your dispensing fee for private prescriptions is £1.60 if the ingredient cost is less than £8.00, or 20% if the ingredient cost is £8.00 or above. What is the total price for this prescription?
- a). £5.40
  - b). £6.10
  - c). £10.60
  - d). £10.80
  - e). £12.20

- 4) You give a patient 200mLs of a 0.09% w/v mouthwash. He needs to prepare doses of 20mL of a 0.045% w/v solution, by diluting the mouthwash with potable water. What dilution would this constitute?
- a) 1 : 1
  - b) 2 : 1
  - c) 1 : 2
  - d) 10 : 1
  - e) 1 : 10
- 5) A seven year old patient of ideal body weight is admitted to hospital with suspected severe accidental iron poisoning. The decision is taken to immediately begin the patient on desferrioxamine mesilate at a dose of 15mg/kg/hour for the first hour and then reduce to 10mg/kg/hour for a further 2 hours How much desferrioxamine mesilate would the patient receive in the first three hours of treatment?
- a) 460mg
  - b) 575mg
  - c) 805mg
  - d) 825mg
  - e) 920mg
- 6) An ampoule contains 12.5% w/v of active ingredient. The ampoules are supplied as 10mL volume. How many ampoules are needed to produce a 1 litre bag of final concentration 0.5% w/v active ingredient?
- a) A 0.5 ampoules
  - b) B 4 ampoules
  - c) C 6.5 ampoules
  - d) D 8.25 ampoules
  - e) E 10 ampoules
- 7) What weight of zinc sulphate is required to produce 250mL of a solution such that 5mLs of this solution diluted to 300mLs would produce a 0.02% w/v solution
- a) A 300mg
  - b) B 600mg
  - c) C 1.2g
  - d) D 1.5g
  - e) E 3g

- 8) You receive a prescription asking you to prepare 24 Witepsol pessaries (in 2g moulds), each containing 400mg of drug A. What weights of base and medicament are required? (Displacement value of Drug A = 1.2)
- a) 38.4g base, 9.6g drug A
  - b) 38.4g base, 8g drug A
  - c) 40g base, 9.6g drug A
  - d) 40g base, 8g drug A
  - e) 48g base, 9.6g drug A
- 9) How much Glucose 5% w/v would you need to add to Diazepam solution 0.5% w/v to make an intravenous infusion of Diazepam of 200mg in 1 litre
- a) 960mLs
  - b) 660mLs
  - c) 800mLs
  - d) 96mLs
  - e) 960.6mLs
- 10) You receive a prescription asking you to provide a patient with Nitrofurantoin oral suspension at a dose of 200mg daily in 4 divided doses, to be taken with food for seven days. What volume of suspension do you need to supply the patient? (You supply Furadantin Suspension)
- a) 140mLs
  - b) 280mLs
  - c) 420mLs
  - d) 560mLs
  - e) 1120mLs

**Directions for questions 11 to 16.**

For each numbered question select the one lettered option above it which is most closely related to it. Within each group of questions each lettered option may be used once, more than once, or not at all

Questions 11 to 13 concern the following quantities:

- a) 2.5
- b) 7.5
- c) 15
- d) 70
- e) 130

- 11) The number of millimoles of phosphate in 500mLs of Clinimix N9G20E 女
- 12) The number of milligrams of ferrous iron present in two tablets of ferrous gluconate 300mg
- 13) The weight, in grams, of calcium carbonate which provides 1g of calcium in Cacit effervescent tablets

Questions 14 to 16 concern the following quantities:

- a) 2
- b) 20
- c) 98
- d) 196
- e) 200

- 14) The amount of proguanil 100mg tablets you would provide to two healthy adults to provide malaria chemoprophylaxis for a two week holiday
- 15) The correct weight, in milligrams, of chlorhexidine gluconate powder required to prepare 200mLs of a 1 in 10000 solution
- 16) The weight, in grams, of alpha tocopheryl acetate required to prepare 5 litres of a 0.04% w/v suspension

**Directions for questions 17 to 18.**

For each of the questions below, **ONE** or **MORE** of the responses is (are) correct. Decide which of the responses is (are) correct, then choose

- a) if 1, 2 and 3 are correct
- b) if 1 and 2 only are correct
- c) if 2 and 3 only are correct
- d) if 1 only is correct
- e) if 3 only is correct

17) A six-year-old child weighing 21kg is to be treated with diclofenac sodium to relieve the pain of juvenile arthritis. Which of the following fall within BNF recommendations?

- 1 one 25mg suppository tds
- 2 one 50mg tablet mane
- 3 two 12.5mg suppositories mane, one at 1.00pm and two nocte

18) A syringe driver is delivering cyclizine infusion 300mg/50mLs at a rate of 1mL/hour to a 60kg patient. Which of the following statement(s) is/are correct?

- 1 the patient receives 0.144g of cyclizine each day
- 2 the dose received is approximately 1.67microgram/kg/min
- 3 the concentration of the infusion fluid is 6% w/v

**Directions for questions 19 to 20.**

The following questions consist of a statement in the left-hand column followed by a second statement in the right hand column

Decide whether the first statement is true or false

Decide whether the second statement is true of false

Then choose:

- a) if both statements are true and the second statement is a correct explanation of the first statement
- b) if both statements are true but the second statement is NOT a correct explanation of the first statement
- c) if the first statement is true but the second statement is false
- d) if the first statement is false but the second statement is true
- e) if both statements are false

19) **FIRST STATEMENT :-** An infusion strength of 0.025% Haloperidol in a syringe driver may cause diamorphine in the mixture to precipitate out after 24 hours

**SECOND STATEMENT :-**Mixtures of Diamorphine and Haloperidol are liable to precipitation after 24 hours if the concentration of haloperidol exceeds 2mg/mL

20) **FIRST STATEMENT :-** A 150g jar of a 0.0035% w/w cream Contains 525micrograms of active ingredient

**SECOND STATEMENT :-**There are 35mg of active ingredient in 100g of the cream

21) A patient is prescribed potassium permanganate 4% w/v solution with instructions to dilute the solution for soaking feet in a 10L bucket. The final solution should be 1 in 10,000. What volume of 4% solution should you tell them to add to the 10L of water?

- a) 25ml
- b) 50ml
- c) 75ml
- d) 100ml
- e) 125ml

22) You receive the following script: "Send 200ml Benzalkonium chloride solution which when diluted 1 in 20 produces a 1 in 500 solution" There is a concentrate available containing 50% w/v. What volume of concentrate is needed?

- a) 8ml
- b) 12ml
- c) 16ml
- d) 20ml
- e) 24ml

- 23) Calculate how much concentrated chloroform BP is required to produce 20,000 litres of double strength Chloroform water BP
- a) 250mls
  - b) 500mls
  - c) 750mls
  - d) 1000mls
  - e) 2000mls
- 24) How much Concentrated Rose Water BP is required to produce 1,500mls of Single Strength Rose Water BP.
- a) 3.75mls
  - b) 7.0mls
  - c) 37.5mls
  - d) 70mls
  - e) 140mls
- 25) A patient has been taking Ferrous Fumarate 225mg tablets at the rate of 4 tablets daily. Their bioavailability is calculated to be 80%. Due to an operation, the patient is now unable to swallow the tablets and has been changed to Sytron Elixir. This is calculated to have a bioavailability of 100%. Ferrous fumarate 225mg tablets contain the equivalent of 100mg Iron (Fe<sup>++</sup>) Sytron contains Sodium ferridate equivalent to 27.5mg Iron (Fe<sup>++</sup>) in each 5mls  
Calculate to the nearest 5mls, the equivalent dose of Sytron.
- a) 8 x 5ml Spoonsful
  - b) 10 x 5ml Spoonsful
  - c) 12 x 5ml Spoonsful
  - d) 14 x 5ml Spoonsful
  - e) 16 x 5ml Spoonsful
-

## **Chapter 6**

- 1) Potassium permanganate is often available as a concentrate that requires dilution and its final strength is usually expressed as a ratio such as 1 in 8000. What is the percentage of the concentrate that requires a 1 in 50 dilution to produce a 1 in 8000 final solution ?
- a) 1.03%
  - b) 0.85%
  - c) 0.625%
  - d) 0.50%
  - e) 0.3125%
- 2) You have been asked to administer 150mg of a drug in 1 litre of NaCl at a rate of 60micrograms per Kg / Hour for a 50Kg Female Patient. Assuming 20 drops per ml, what is the nearest approximate whole drop rate per minute that needs to be set on the giving set.
- a) 5 drops
  - b) 7 drops
  - c) 9 drops
  - d) 12 drops
  - e) 15 drops
- 3) You require a paediatric dose of a drug that is only available as 60mg tablets. It is intended to make up powders so that these may be sprinkled on the child's food to disguise the taste. You need to make 10 powders each weighing 200mg containing 24mg of a drug and using Lactose as the diluent as the child is can tolerate Lactose. Which of the following would meet your requirements (Assume no waste) :-
- a) Four tablets made up to 1.80g with lactose
  - b) Four tablets made up to 2.00g with lactose
  - c) Four tablets made up to 2.60g with lactose
  - d) Four tablets made up to 3.00g with lactose
  - e) Four tablets made up to 3.60g with lactose

- 4) A patient requires Potassium supplementation through their IV solution. Their current Potassium level is 2.9mmols / Litre. The Parenteral Nutrition Team recommend that the equivalent of 50 mmol of Potassium be added to a to a 1L bag of 0.9% Sodium Chloride. If you use Potassium Chloride Concentrate Sterile Solution you would need to add :-
- a) 15ml to each 1 Litre bag
  - b) 20ml to each 1 Litre bag
  - c) 25ml to each 1 Litre bag
  - d) 30ml to each 1 Litre bag
  - e) 35ml to each 1 Litre bag
- 5) You receive a prescription form FP10 in your pharmacy for paediatric chloral hydrate. It is not commercially available so you contact the GP and arrange for a substitute prescription for Welldorm Elixir. The dose of Chloral Hydrate was to be 50mg/Kg at night The GP asks you the equivalent dose of Welldorm. What is the equivalent dose of Welldorm Elixir to the nearest 1ml if the child weighs 8Kg
- a) 10ml
  - b) 12ml
  - c) 15ml
  - d) 18ml
  - e) 20ml
- 6) A Patient on your ward requires inotropic support using Dobutamine. The recommended dosage for Dobutamine hydrochloride by IV infusion is 10mcg / Kg / minute. One 20ml vial of Dobutrex is added to 1 Litre of Sodium Chloride 0.9% w/v. The patient is an 75Kg adult. Assuming no adjustment is required for deal body weight etc., What should the infusion rate, in mls / minute, be set at:
- a) 1.0ml
  - b) 1.5ml
  - c) 2.0ml
  - d) 2.5ml
  - e) 3.0ml

- 7) A Patient is receiving a Diamorphine infusion over 24 hours. They are currently receiving a dose of 150mg over a 24 hour period using a syringe pump that is calibrated to 36mm / 24 hours (note that some syringe pumps are calibrated in mm/hr). You increase the rate of infusion to 54mm / 24 hours. What dosage is the patient now receiving ?
- 175mg /24 hours
  - 200mg /24 hours
  - 225mg / 24 hours
  - 250mg / 24 hours
  - 300mg / 24 hours
- 8) A solution of Sodium Acid Phosphate contains 109.2gms in 1 Litre. This is equivalent to a 0.7 molar solution. What is the Gram Molecular Weight or Relative Molecular Mass of Sodium Acid Phosphate.
- 3.12 gms
  - 15.6 gms
  - 31.2 gms
  - 156 gms
  - 312gms
- 9) The formula for Screenistat Ointment is as follows :-  
 Screenistat 2gm  
 Beeswax 20gm  
 White Soft Paraffin 30gm  
 Light Liquid Paraffin 25mls  
 Cetoseryl Alcohol 33gms
- You are required to manufacture 750gm of the above. Which is the correct formula:
- | Ingredient     | A     | B     | C     | D     | E     |
|----------------|-------|-------|-------|-------|-------|
| Screenistat    | 14gm  | 28gm  | 28gm  | 14gm  | 28gm  |
| Beeswax        | 140gm | 140gm | 140gm | 140gm | 140gm |
| WS Paraffin    | 210gm | 210gm | 210gm | 210gm | 210gm |
| LL Paraffin    | 175gm | 175gm | 175ml | 175ml | 175gm |
| Cetoseryl Alc. | 231gm | 231ml | 231ml | 231gm | 231gm |
- 10) What amount of base is required to manufacture 50 suppositories, each containing 100mg Theophylline if each suppository will weigh 1gm and the displacement value of Theophylline is 0.5
- 40gms
  - 42.5gms
  - 45gms
  - 47.5gms
  - 50gms

- 11) What weight of white soft paraffin is required to make 250g of the following ?
- |                     |         |
|---------------------|---------|
| Zinc oxide          | 12%     |
| Salicylic acid      | 1%      |
| Starch              | 15%     |
| White soft paraffin | to 100% |

- a) 70g
- b) 100g
- c) 150g
- d) 180g
- e) 200g

- 12) Which one of the following shows the correct weights of sodium chloride and anhydrous glucose present in 500mL of intravenous infusion containing sodium chloride 0.18% and anhydrous glucose 4%?

- a) Sodium chloride 0.18 g and anhydrous glucose 20 g
- b) Sodium chloride 0.9 g and anhydrous glucose 20 g
- c) Sodium chloride 0.9 g and anhydrous glucose 40 g
- d) Sodium chloride 1.8 g and anhydrous glucose 20 g
- e) Sodium chloride 1.8 g and anhydrous glucose 40 g

- 13) An injection solution requires a concentration of 0.5% w/v of active ingredient. How much of the active ingredient is needed to prepare 500 Litres of solution?

- a) 0.25Kg
- b) 0.50Kg
- c) 1.00Kg
- d) 2.50Kg
- e) 5.00Kg

- 14) Salbutamol Tablets BP are available as tablets containing Salbutamol sulphate equivalent to 2 mg and 4 mg of Salbutamol. To prepare Salbutamol 2 mg tablets, what weight of Salbutamol sulphate is needed in each tablet? (March 2003)

Molecular weights: Salbutamol:  $C_{13}H_{21}NO_3$  = 239.3  
 Salbutamol sulphate:  $(C_{13}H_{21}NO_3)_2SO_4$  = 576.7

- a) 0.83 mg
- b) 1.66 mg
- c) 2.00mg
- d) 2.41
- e) 4.82 mg

- 15) A tablet contains 5% w/w of binder, which is added to the other ingredients during granulation as a 25% w/v solution. What volume of this solution is required for the manufacture of 500,000 x 100 mg tablets? (March 2003)
- 50 litres
  - 25 litres
  - 12.5 litres
  - 10 litres
  - 5 litres

A variation on this question which you can try contains a tablet core of weight 1.9gms which will be coated to a weight of 2gms. 100mg of coating will be added using a 25% solution. If the coating is added at the rate of 10mcg / second , how long will it take to coat 1 million tablets

- 16) A sugar coated tablet has a dry weight of coating of 10mg/tablet. The coating solution is prepared to contain 10% w/v of coating material. How long is needed to coat a batch of 1 million tablets at a spray rate of 250mL\_min of coating solution. Assume that coating efficiency is 100%? (a variation on March 2004)
- 25 min
  - 40 min
  - 100 min
  - 250 min
  - 400 min

- 17) This concerns the following formula that can be used to calculate paediatric doses: (November 2002)

$$\text{Approximate dose for child} = \frac{\text{surface area of patient (m}^2\text{)} \times \text{adult}}{1.8}$$

If the adult dose of a medicine is 300 mg, what is the approximate dose for a 5 year old with a body surface area of 0.72m<sup>2</sup>?

- 120 mg
- 140 mg
- 180 mg
- 200 mg
- 240 mg

18) Approximately how many millimoles of sodium ions are there in 50mL of sodium chloride solution 0.9% w/v? (November 2003)  
[atomic weight of sodium = 23; atomic weight of chlorine = 35.5]

- a) 0.0077
- b) 0.23
- c) 0.77
- d) 2.3
- e) 7.7

19) Assume that it is correct that Granicidin for a 50Kg patient should be infused at a rate of 240mg per hour and answer with regard to the correctness of the following statements

**First Statement :-** 0.2% of Granicidin in a 500ml infusion bag should be infused at a rate of 60mls per 30 minutes

**Second Statement :-** This represents an infusion rate of 80mcg / Kg / Min

Decide whether the first statement is true or false

Decide whether the second statement is true or false Then choose

- a) If both statements are true and the second statement is a correct explanation of the first statement
- b) If both statements are true and the second statement is NOT a correct explanation of the first statement.
- c) If the first statement is true but the second statement is false.
- d) If the first statement is false but the second statement is true.
- e) f both statements are false.\_

20) **First Statement :-** 2 Litres of 8.4% Sodium Bicarbonate Solution provides 2000 mmols each of Na<sup>+</sup> and HCO<sub>3</sub><sup>-</sup>

**Second Statement :-** 8.4% w/v Sodium Bicarbonate solution contains 1mmol/ml of electrolytes

Decide whether the first statement is true or false

Decide whether the second statement is true or false Then choose

- a) If both statements are true and the second statement is a correct explanation of the first statement
- b) If both statements are true and the second statement is NOT a correct explanation of the first statement.
- c) If the first statement is true but the second statement is false.
- d) If the first statement is false but the second statement is true.
- e) f both statements are false.\_

## Chapter 6 – Extra questions – not in MCQ Style

### Question

- 1) 200gms of Dithranol Ointment contain 6gms Dithranol.  
If 45gms of this is diluted to 900gms, what strength as a percentage of dithranol is the diluted ointment ?
- 2) 50gms of Acriflavine cream is diluted to 300gms. The concentration of the diluted cream is 0.1%.  
What was the concentration of the original cream ?
- 3) What quantity of Codeine Phosphate Solution 30mg in 5mls is needed to provide 200mls  
of a solution containing a total of 10mg Codeine Phosphate.
- 4) A stock solution of Potassium permanganate is 0.25%.  
How much of this is needed to prepare 6 litres of 1 in 12,000 solution
- 5) A solution of Alcohol contains 90% w/v Alcohol.  
How much of this is needed to provide 500mls of a 4.5% Alcohol solution ?
- 6) A solution of Frusemide is needed and to prepare this you will need to dissolve 40mg tablets in water.  
If you need to prepare a solution containing 50mcg in 10mls,  
what volume must you prepare from 1 40mg tablet.
- 7) You have two solutions containing 60% and 5% respectively of the same ingredient.  
How much of each do you need to prepare 200mls of 10% solution
- 8) You have two solutions containing 80% and 15% respectively of the same ingredient.  
How much of each do you need to prepare 400mls of 20% solution
- 9) You have two solutions containing 90% and 30% respectively of the same ingredient.  
If you used 200mls of the 30% to prepare 600mls of solution with the remainder being 90%,  
what is the strength of the final solution.
- 10) A cream contains 3.5% of active ingredient. What ratio dilution is required to produce a 0.7% cream ?

### Question

- 11) What quantities are required for 20mls of Sodium Bicarbonate Ear Drops  
If the formula is 5% Sodium Bicarbonate w/v, Glycerol 30% v/v and water to 100% ?
- 12) This is the formula for St. George's Hospital Peppermint Water :-  
Conc. Peppermint Water 1 part v/v  
Methylhydroxybenzoate 1% w/v  
Propylhydroxybenzoate 0.3% w/v  
Water to 40 parts  
How much of each ingredient is required to produce 5 Litres
- 13) What quantity of Concentrated Aniseed Water is required to produce 3 Litres of Calcium Carbonate Suspension if the Suspension contains 0.1% Aniseed Water ?.
- 14) A Coal Tar and Salicylic Acid Ointment contains 2% of each by weight in Wool Alcohols Ointment  
What quantity of each is required to prepared 1/2 a Kilogram ?
- 15) An aqueous Anaesthetic Cream contains the following ingredients  
Lidocaine (Lignocaine) 1% w/v  
Cetomacrogol emulsifying wax 5%  
Phenoxyethanol 0.5% v/w  
Glycerol 1 part in 25 v/w  
Calamine 1 / 25th by weight  
Chlorphenamine 0.5% w/w  
How much of each is required to produce 50gms
- 16) What is 0.05% expressed as a percentage by parts (1 in X)
- 17) What is 1/8th of 40%
- 18) If a 50% solution is diluted 30 times and that solution is then diluted a further 100 times,  
What is the final concentration as a percentage.
- 19) If 50% of a 4% ointment is diluted with White Soft paraffin to produce 600gms of 0.05% Ointment,  
what was the original amount of ointment ?
- 20) A solution contains Sodium Chloride 1 in 500.  
How much Sodium Chloride needs to be added to convert the solution to 1 in 20 ??

## **ANSWERS**

Please remember that there are many ways that an answer for any of these questions can be obtained.

These explanations are not exhaustive. You may know a quicker and easier way. In which case, that is the method you should use.

What I have tried to do is show how you can break the problem down into simple or simpler stages and so understand what is being asked a little bit better.

Some explanations are longer than others and with some a number of different methods are shown.

## Chapter 1 Questions

### Calculations - Answers

- 1) **E** A simple calculation but you need to check BNF for strength  
The elixir contains 50mcg in 1ml  
 $0.125\text{mg} = 125\text{mcg} = 2.5\text{mls}$
- 2) **B** Conversion charts of age and weight to body surface area were originally in the BNF but have now been transferred to the paediatric BNF. If you check there, the body weight conversion chart gives  
 $14\text{kg} = 0.62\text{m}^2$  then calculate.  $(450 \times 0.62 = 279 \text{ } 279/500 = 0.558 = 0.56\text{mls})$
- 3) **B**  $1.5\text{gm} = 20\text{mmols}$  you need 80 mmols so you need  $4 \times 10\text{ml} = 40$
- 4) **A** 1 in 10,000 is equivalent to 1gm in 10,000mls or 1,000mg in 10,000mls  
Which simply put is 1mg in 10mls  
The rate is 6mls per minute =  $6 \times 60\text{mls per hour}$   
= 360mls / hour  
10 mls contains 1mg so 360mls contain  $360/10\text{mg} = 36\text{mg}$
- 5) **D** The dose is  $(80\text{mg} \times 2) + (70\text{mg} \times 2) + (60\text{mg} \times 2) + (50\text{mg} \times 2) + (40\text{mg} \times 2) + (30\text{mg} \times 2) + (20\text{mg} \times 2) + (10\text{mg} \times 7) = (5\text{mg} \times 7)$   
This can be simplified as  $(80+70+60+50+40+30+20) \times 2 + (10 + 5) \times 2$   
=  $(350 \times 2) + (15 \times 7)$   
=  $700 + 105$   
= 805mg
- 6) **A** This should be easy 3% of 750gms must be between 21gms and 24gms  
- as those are 3% of 700 and 800 respectively and **ARE SIMPLE** to calculate  
Only A is in the right value range so there is no need to spend a long time calculating.
- 7) **C** – see below  
The correct individual dose is  $(15 \times 7.5)\text{mg} / 3 = 37.5\text{mg}$   
The strength is 250mg in 5ml or 25mg in 0.5ml  
Now 37.5 is  $25 + 12.5$  (half of 25)  
So the dose is  $0.5\text{ml} + 0.25\text{ml} = 7.5\text{mls}$   
Alternatively you can use  $(5 \times 37.5) / 250 = 0.75$   
From  $(250/5) = (37.5/X)$
- 8) **C** We often fail to think about the ‘dose’ contained in an eye drop.  
 $0.5\% = 500\text{mg}$  in 100mls  
= 5mg in 1ml  
=  $(5 / 20)\text{mg}$  in 1 drop or  $\frac{1}{4}$  mg  
= 0.250mg  
= 250 micrograms in 1 drop
- 9) **E**  $0.02\% = 0.02\text{gms}$  in 100mls  
= 20mg in 100mls  
=  $20 \times 6\text{mg}$  in 600mls  
= 120mg
- 10) **C** the concentration would have ‘halved’ three times.  
after 12 hours the concentration would be 34mcg/ml  $68/2$   
after 24 hours the concentration would be 17mcg/ml  $34/2$   
after 36 hours the concentration would be 8.5mcg/ml  $17/2$
- 11) **E**  $2.5\% = 2.5\text{gm}$  in 100ml  
=  $2.5/5\text{gms}$  in 20mla  $(2.5 \times 20)/100$   
= 0.5gms  
= 500mg
- 12) **A**  $42 \text{ drops} / \text{minute} = (42 / 20)\text{mls} / \text{minute}$   
=  $(42 / 20) \times 60 \text{ mls per hour}$   
=  $2.1 \times 60\text{mls} / \text{hour}$   
= 126mls / hour  
This should now indicate that the answer must be less than 10 i.e. **A**  
So the infusion will last =  $1000 / 126 \text{ hours}$   
= 7.9999 hrs  
= 8 hrs

- 13) B This is one of those questions that look far worse than they are.  
Digoxin injection contains 250mcg in 1ml but in 2ml ampoules  
So 750 mcg is contained in 2 ampoules  
2 ampoules would be added to the bag and 75 mls run over 1 hour  
(Note that roughly allows more variation in total volume than approximately).
- 14) C simply put the rate is increased by 50% so 240mg per 24 hours becomes  
360mg per 24 hours 4
- 15) B This is actually a simple calculation.  
You receive 1,100 items and pay 90p each  
10% means 10% so for 11,000 boxes with a 10% discount you should pay 90p each –  
i.e. £9,900 not £10,000. If you pay £10,000 you are paying 10,000/11,000p each =  
90.9p. Over 2 years you would be using 10,000 x 12 x 2 boxes = 240,000 boxes. If  
you paid 90.9p each instead of 90p, then you would overpay by £2,160. 2,400 boxes  
of Ranitidine at £8.63 each. If overcharged by 0.09% would amount to £180, a small  
but significant amount that could easily be overlooked but it would cover the costs of  
a Reps visit !!  
On a drug bill of £10 million. A 0.09% overcharge would represent around £9,000
- 16) B this is easy  $6.35 \times 2 \times 2.4$
- 17) C again easy –  $(250 \times 3 \times 2) / 25$   
Mrs X is on 250mg x 3 x 2 mg daily = 1500mg  
Her weight is therefore 1500/25 = 60kg
- 18) E The dose is  $70 \times 15\text{mcg} / \text{minute} = 1050\text{mcg}$   
 $= 1050 \times 60\text{mcg} / \text{hour}$   
 $= 1050 \times 60 / 1000 \text{ mg} / \text{hour}$   
 $= 63\text{mg}$  or 62.5 approximately  
Note this relies on observation. The dose is asked for in mg not mls.
- 19) E Ignore the drug strength, it's irrelevant  
1000mls over 10 hours = 100mls per hour  
 $= 100 / 60 \text{ mls} / \text{minute}$   
 $= (100 \times 60) / 60 \text{ drops} / \text{minute}$   
 $= 100$
- 20) A  $500\text{mg}$  in 100mls =  $(500 \times 35) / 100 \text{ mg}$  in 35mls  
 $= 175\text{mg} / \text{hour}$   
 $= 175 / 60 \text{ mg} / \text{minute}$   
 $= 3 \text{ mg}$  approximately  
 $= 3000\text{micrograms}$   
 $= 3000 / 60 \text{ micrograms} / \text{minute}$   
 $= 50 \text{ micrograms} / \text{minute}$
- 21) E 5.6gms Hydrocortisone and 11.2gms Fusidic Acid  
A patient is instructed to use Fucidin HC ointment twice a day to the affected area on  
both arms and legs. The application to each arm is approximately 5gms and the  
application to each leg is approximately 15gms. Over a one week period, how much  
Hydrocortisone and how much Fusidic Acid will be applied topically.  
The formula of Fucidin HC Ointment is 1% Hydrocortisone as Acetate and 2%  
Fusidic Acid  
Each day they will apply  $(2 \times 2 \times 5) + (2 \times 2 \times 15)\text{gms} = 80\text{gms}$  – 2 arms and 2 legs  
Over 1 week they will apply  $7 \times 80\text{gms} = 560\text{gms}$   
You should be able to estimate that 560gms will contain 5.6gms Hydrocortisone and  
double that of Fusidic acid = 11.6gms
- 22) D 14gms  $(4 \times 3.5)\text{gms}$  as there are 4gms Menthol in every 100gms  
Or if you want a full formula  $(4 \times 350) / 100$
- 23) C 4mls per minute = 240mls per hour  $(4 \times 60)$   
1 in 10,000 is 1gm in 10,000 mls = 1mg in 10mls  
or 0.1gm (100mg) in 1000mls  
or 0.01gm (10mg) in 100mls = 10mg in 100ml  
or 0.024gm (24mg) in 240mls  $(100 \times 2.4) = 24\text{mg}$   
or  $((4 \times 60) / 10,000)\text{gms} = 24\text{mg}$   
or  $((4 \times 60) / 10,000) * 1000 \text{ mg} = 24\text{mg}$   
 $24\text{mg} / 70 = 24000 / 70 = 240 / 7$   
 $= 340\text{micrograms}$  approx.



## Chapter 2 Questions

- 1 D** You have been asked to supply some Lidocaine suppositories using Cocoa Butter as a base for a patient. The suppositories will be made using a 4gm mould and each suppository will contain 10mg Lidocaine. You need to supply 50 suppositories. Given that the displacement value of Lidocaine in Cocoa Butter is 0.5, calculate how much base and active ingredient are required if a surplus of 5 suppositories are to be made.
- To make 55 suppositories at 4gms – total weight =  $55 \times 4$   
= 220gms
- Displacement value of Lidocaine = 0.5.  
This means 0.5 gm Lidocaine displaces 1gms base.  
Weight of Lidocaine required =  $55 \times 10\text{mg}$   
= 550mg
- 550mg Lidocaine displaces  $(550/0.5)\text{mg}$  Base = 1,100mg Base  
= 1.1gm
- Therefore we will need 220gm – 1.1mg Base = 218.9mg Base  
And 550mg Lidocaine
- You should be able to eliminate E as being incorrect as 220mg is the total amount of base without any ingredient added and the Lidocaine will displace some of the base.
- 2 D** Enos fruit salts contain Citric Acid 2.18gms, Sodium Bicarbonate 2.32gms And Sodium Carbonate 0.5gms in each 5gm sachet Given that the GmMwt of Sodium Bicarbonate is 84gms and Sodium Carbonate is 106gms, calculate the approximate number of millimols of Sodium in each 5gm sachet
- 84gms Sodium Bicarbonate = 1000mmols Sodium  
2.32gms =  $(2.32/84) \times 1000\text{mmols}$   
=  $(2.3/84) \times 1000$  (approximately)  
= 2300/84  
= 200/6 (approx) (Divide by 12)  
= 26.7 (approx)
- $(2.32/84) \times 1000\text{mmols} = 27.6$  (so by estimating our error was 0.7)
- 106gms Sodium Carbonate = 1000mmols Carbonate and  
2000mmols Sodium  
as the formula is  $\text{Na}_2\text{CO}_3$
- So 0.5gms Sodium Carbonate =  $(0.5 \times 2/106) \times 1000$   
= 1000/106  
= 10 (approximately)  
= 9.43 (accurate)
- Note -in one there was a slight overestimate and one a slight underestimate.  
The total =  $26.7 + 9.43 = 36.13$   
My rough estimate gave  $26.7 + 10 = 36.7$   
Either way the nearest correct answer is D
- 3 A** This is relatively easy
- 15.3mg in 150ml  
= 10mg in 100mls (Approx)  
1000mg in 100mls = 1%  
100mg in 100mls = 0.1%  
10mg in 100mls = 0.01%
- Interestingly, there is no guidance on how much water or milk to use to make up Pripsen sachets so the eventual ‘glass’ could have a variable concentration. For children aged 1-6 the advice is one 5ml spoonful of the sachet contents in the morning. (No given volume)  
The dose for a 3month to 1 year old child is 2.5mls spoonful of the sachet contents. (No given volume)

- 4 E Ranitidine Syrup contains 75mg in each 5mls.  
Ranitidine has a molecular weight of 350  
How many millimols of Ranitidine are there in a 10ml dose.
- |                           |                            |
|---------------------------|----------------------------|
| 350gms Ranitidine contain | 1 mol                      |
|                           | = 1000mmols                |
| 350mg                     | = 1 mmol (350/1000 x 1000) |
| 10mls will contain        | 75 x 2 = 150mg             |
| 150mg                     | = 150/350 mmols            |
|                           | = 30/70                    |
|                           | = 3/7                      |
|                           | = 0.427 mmols or 0.4 mmols |
- 5 B This calculation must be done in several steps and there is some unnecessary information. (This is added to distract you and is common in official questions  
The patient weighs 54Kg and the dose is 2.5mg/Kg.  
Therefore the dose is 54 x 2.5mg = 135mg  
It is not necessary to know that it comes as 100mg in 10mls.  
However if you were asked 135mg is contained in 13.5mls total by volume  
This is added to an intravenous solution to give 135mg in 250mls  
Again this really isn't important – what is important is the time it is administered over which is 3 hours
- 135mg over 3 hours = 135/3 mg in 1 hour = 45mg / hour  
45mg / hour = 45/60mg minute  
3/4mg / minute (Divide by 15)  
=750mcg / minute
- NOTE :-** What could have been asked for is the flow rate per minute  
The rate is 250mls / 3 hours  
= 250 / (3 x 60) mls / minute  
= 250/180mls / minute  
Note that this is just a bit bigger than 240/180 = 4/3mls / minute  
= 1.33mls / minute approximately but is really a bit bigger.  
The actual answer is 1.38mls or 1.4mls to 1 decimal place
- 6 C If you look in the BNF under section 9.2.1.2 there is value provided but this includes the Sodium in the Disodium Hydrogen Citrate  
Some calculation questions will need you to refer to the BNF but it's likely the answer will still need some calculation. Here is the calculation.  
Gm MWt of Sodium Chloride is 58.5  
Round up the 58.5 to 60 (this won't introduce too great an error)  
60gms = 1Mol so  
60gms = 1000mmols  
60mg = 1 mmol  
So number of millimols in 470mg = 470/60  
= 47/6 = 8mmols (approximately)
- 7 C 21mg in 2.5mls  
= 21/2.5mg in 1ml  
= 21/ 2.5 x 100 mg in 100mls  
= 21 x 40mg in 100mls  
= 840mg in 100mls  
=0.84gms in 100mls  
= 0.84%  
Please note that Answer E should stand out as being obviously wrong.

- 8 D 20mls Magnesium Carbonate four times each day  
 6mmol Na in 10mls =  $6 \times 2 \times 4$  mmols each day  
 = 48mmols each day  
 =  $48 \times 7$  each week = 336mmols

Rennie duo 10mls four times a day and 20mls at night  
 = 60mls a day

Rennie Duo contains 2.6mmols Na in 5mls  
 = 5.2 in 10mls  
 =  $5.2 \times 6$  in 60mls  
 = 31.2mmols per day  
 =  $31.2 \times 7$  mmols in 1 week  
 = 218.4mmols

Total in 1 week =  $218.4 + 336$  mmol  
 = 556.4mmols

**NOTE**

556mmols of Sodium equate to 12.8gms Sodium which in combination with Chloride would equate to 32.5gms Salt per week and an intake of over 4gms a day – i.e. over the daily recommended maximum.

- 9 B This looks very difficult but isn't.  
 10mls QDS and also at night = 50mls per day  
 60 days' supply =  $50 \times 60 = 3,000$ mls  
 500ml per bottle =  $3000/500$   
 = 6 bottles.

In BNF it states that each 5ml contains 3mmols Na  
 So total number of Sodium =  $(3000/5) \times 3$  mmols  
 = 600mmols x 3 mmols Sodium  
 = 1800mmols

Gm MWt of Calcium Carbonate is 100gm  
 Strength in Acidex = 80mg in 5ml  
 =  $80 \times (3000/5)$  in total  
 = 48,000mg in total  
 = 48 gms

Now there are several ways to calculate the number of mmols

This is the easiest 100gms = 1000mmols  
 So 48gms = 480mmols

ALSO – If you calculate one value and know you have calculated correctly, only one answer can be correct. There is no need to calculate the remainder.

In the UK you cannot supply on prescription in bottles larger than 500mls

This eliminates Answer A ( $3000/4 = 750$ mls – Not allowed)

Standard bottles are 50,150,200,300 and 500mls

So C cannot be correct ( $3000/8 = 375$ mls per bottle)

That leaves B, D and E to test

- 10 C An antacid preparation is calculated to contain 160mg of Sodium Bicarbonate in each 5ml dose. A patient has taken 600 mls over the last 24 hours. Calculate the number of millimols of Sodium that the patient has ingested given that the formula of Sodium Bicarbonate is  $\text{NaHCO}_3$  and that the respective weights are Sodium 23 and Bicarbonate ( $\text{HCO}_3$ ) is 61  
 The molecular weight of Sodium Bicarbonate is 84 (61 + 23)  
 Therefore 84gms Sodi. Bicarbonate contain 1000mmols Sodium (1 Mol).  
 The patient has ingested 600mls =  $120 \times 5$ mls ( $600/5$ )  
 =  $120 \times 160$ mg  
 = 19200mg  
 = 19.2gms

Now 84gms contains 1000mg

19.2 gms is nearly 20gms

20gms is nearly  $\frac{1}{4}$  of 84

$\frac{1}{4}$  of 1000 is 250

So you should now be able to eliminate at least 3 answers A,B and E

As these are either far too small or far too big.

You are left with 228 and 342mmols

cont....

Now 19.2 is less than  $\frac{1}{4}$  of 84

So the answer must be less than  $\frac{1}{4}$  of 1000 = 250

Therefore only C can be correct

$$\begin{aligned} \text{The correct answer is obtained as follows} &= (1000/84) \times 19.2 \\ &= 19,200 / 84 \\ \text{divide by 12} &= 1,600 / 7 \\ &= 228.6 \text{ mmols} \end{aligned}$$

The last two questions (9 and 10) are designed to show how what appears to be a very difficult calculation can be considerably simplified or in fact is a very easy calculation.

- 11 E** The trick with this question is to calculate in minutes not hours  
Antibiotic 250mg in 100mls  
administered at a rate of 1.25mg / Kg / 30 minutes  
The child weighs 18Kg.  
How long will the infusion run for ?  
1.25mg / kg / 30 minutes  
= 1.12 x 18 mg every 30 minutes =  
= 2 x 1.25mg x 18mg every hour  
= 45mg per hour (or per 60 minutes)  
= 45/60 mg per minute  
= 0.75mg / minute  
The infusion will therefore run for  
250 / 0.75 minutes  
At this point you should see it will be more than 250 minutes  
250 minutes is 4 hours and 10 minutes which eliminates two answers  
= 500/1.5  
= 100/0.3  
= 1000/3  
= 333 minutes  
= 333/60 = 5 hours and 33 minutes  
= 5.5 hours approximately  
(Alternatively 250/0.75 = 250 x 4/3)
- 12 B** How much potassium permanganate is there in 350mls 1 in 8000000  
1 in 8000000 is  
1000mg in 8000000mls  
= 1mg in 8000mls (Divide by 1000)  
= 1000mcg in 8000mls  
= 1mcg in 8mls  
= 1.25mcg in 10mls (remember 1/8 = 0.125)  
= 12.5mcg in 100mls  
= 37.5mcg in 300mls  
= 6.25mcg in 50mls  
= 43.5mcg in 350mls  
A formula would be  
 $((1 \times 1000 \times 1000)/8000000) \times 350$

- 13 D** This isn't as difficult as it looks  
 75mls of 1.8% diluted 50/50 gives a 0.9% solution of Sodium Chloride  
 YOU SHOULD KNOW THIS IS ISOTONIC AND THAT.....  
 1 Litre of 0.9% Sodium Chloride contains 150mmols (actually slightly more).  
 So 150mls would contain approximately 22.5mmols  
 (100mls contains 15mmols and 50mls contains 7.5mmols)  
 This shows that Statement 1 is incorrect

You will also be expected to know the atomic weights of Sodium and Chlorine  
 The Gm Molecular weight of Sodium Chloride is 58.5gms  
 BEWARE - There is no way out of being expected to know this  
 So Statement 2 is Correct.  
 This means D is the correct answer

The Gm Molecular weight of Sodium Chloride is $23 + 35.5\text{gms} = 58.5\text{gms}$
So statement <b>B</b> is correct.
This eliminates Answers <b>C</b> and <b>E</b>
So only A,B and D can be correct
75mls of 1.8% diluted 50% becomes 150mls containing 0.9% Sodium Chloride.
This is very approximately 1%
= 1.5gms in 150mls (1.45gms is more accurate)
58.5gms represents the gm molecular weight of sodium Chloride.
So 58.5gms in 1000mls represents a molar solution
58.5gms in 1000mls represents 1000millimols in 1000mls
$58.5\text{gms} = 1 \text{ Mol} = 10000\text{millimols}$ .
= 5.85gms in 100mls
$5.85\text{gms} = 100\text{mmols}$ (divide 1000 by 10)
$0.585\text{gms} = 10\text{mmols}$ (Divide by 10)
Double this = $1.170\text{gms} = 20\text{mmols}$
1.5gms cannot contain a smaller number of millimols than 1.170gms (1.5gms contains 25.64mmols)
So Statement A is incorrect
Therefore Statement A is incorrect and Statement B is correct
The correct answer to the question is <b>D</b>
There are different ways of doing this question.
One way is to use the formula
$(1.5/58.5) \times 1000 = 25.64\text{mmols}$
This gives the number of mmols in 1.5gms
Alternatively you can use
$(58.5/1000) \times 15 = 0.8775\text{gms}$
This gives the number of gms equal to 15mmols

- 14 B** A Patient is admitted to casualty having taken an overdose of soluble Paracetamol.  
 The half life of Paracetamol is 2 hours  
 Their blood levels show a concentration of 80mg / Litre  
 It is estimated that their Total Volume of distribution is equivalent to 40 Litres and it is 6 hours since they ingested the paracetamol  
 If the amount absorbed is 40% of the total amount taken how many tablets did they take ?  
 With a half life of 2 hours, there are exactly three half lives since it was taken.  
 The amount decreases by 50% every half life so  
 Current concentration 80mg/ Litre  
 2 hours ago = 160mg/ Litre  
 4 hours ago = 320mg / Litre

6 hours ago = 640mg / litre  
 This is the point at which it was taken  
 Their total Vd = 40 litres  
 So the amount would be 640 x 40 mg  
 = 25,600mg  
 This however represents only 40% of the amount taken  
 So amount taken = 25,600 \* (100/40)  
 = 64,000mg  
 Each tablet would be 500mg  
 So number of tablets taken = 64,000 / 500 = **128**  
 In real life, this would suggest that in fact it is less than 6 hours since the tablets were actually taken

**15 E** Not as bad as it looks. Read carefully.  
 Calculate the cost of making the 200mg tablets  
 2 million packs will contain (30 x 200mg x 2000000) of drug  
 = 30 x 200mg x 2000 gms of drug (divide by 1000)  
 = 30 x 200 x 2 Kg of drug (divide by 1000 again)  
 = 12,000Kg  
 Each Kg costs £200 so the cost will be 200 x 12,000  
 = £2,400,000  
**HOWEVER** if making the 400mg tablet the cost would be double.  
 So the saving is £2,400,000  
 Simply put  
 1 x 200mg tablet with a 90% bioavailability provides 180mg of drug  
 1 x 400mg tablet with a 40% bioavailability provides 160mg drug  
 (200mg x 0.9 and 400mg x 0.4 respectively.)  
 So 1 200mg tablet will replace 1 x 400mg tablet  
 So the drug cost will simply be halved.

**16 C** 2.15% means = 2.15gms in 100gms  
 = 4.3gms in 200gms  
 = 0.43gms in 20gms  
 = 430mg

Formula  $X = 20 \times 2.13 / 100$

**17 B** But I think my method is simpler and more meaningful  
 4.2mg Adrenaline require.  
 1 in 10,000 means 1gm in 10,000 mls  
 = 1000mg in 10000mls  
 = 1mg in 10mls  
 = 0.1mg in 1ml  
 = 0.42mg in 4.2mls

You should be able to see that the answer will contain ,42'

Formula =  $10000/1000 \times 0.42$

**18 D** 32gms in 2500mls  
 = 64gms in 5000mls  
 = 128gms in 10,000mls  
 = 1.28gms in 100mls (divide by 100)  
 = 1.28%

19	A	<p><b>Using percentage</b>  5gm in 20ml  = 25gms in 100mls  = 25%  To convert to 1 in 6000  25 in 100 to 1 in 6000  Dilution coefficient =  6000 x 25 / 100  = 1 part of 25% to 1500  = 1 Litre diluted to 1500 litres  = 100mls to 150 litres  = 10mls to 15 litres</p>	<p><b>Using parts</b>  5gm in 20mls  = 1gm in 5mls  = 1 in 4    1 in 4 to 1 in 6000    6000/4  = 1 part of 1 in 4 in 1500  = 1 Litre to 1500 litres  = 100mls to 150 litres  = 10mls to 15 litres</p>
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20 C 250gms Ointment contain 1% of drug = 2.5gms in total  
You will add X amount of drug to make it 2.5%  
That will make 250gms + X gms in total  
Now (2.5 + X)gms is 2.5% of (250+X)gms

Or  $2.5 + X = (2.5 \times (250 + X)) / 100$   
Multiply both sides by 100  
 $250 + 100X = 625 + 2.5X$   
Rearrange  
 $100X - 2.5X = 625 - 250$   
 $97.5X = 375$   
 $X = 375 / 97.5$

Now this looks difficult but it is approximately  $360/90 = 4$   
Or perhaps a better estimate is  $375/100 = 3.75$  BUT  
As you rounded up to 100, the correct answer will be larger.  
So the answer is going to be about 3.75gms but just a little bit MORE.  
The correct answer is 3.85gms  
There are two possible answers B and C

If you calculate incorrectly and use the 250gms to calculate 2.5%  
You will get an answer of 6.25gms.  
If you then subtract the 2.5gms you already have, you will get 3.75gms.  
This is the wrong answer because you will add the pure drug to 250gms of 1%  
ointment and the total amount will be greater than 250gms – so 3.75gms is incorrect.

An alternative method is to use alligation  
 $P_a = 2.5 - 1 = 1.5$   
 $P_b = 100 - 2.5 = 97.5$

Now  $P_b = 250\text{gms}$  so  $97.5$  parts = 250gms

So 1 part =  $250/97.5$   
And 1.5 parts =  $(250 \times 1.5)/97$   
If you look, this is now the same calculation as in the first method  
 $375/97.5 = 3.85$

21. B An infusion pump is set up to administer a drug at the rate of 4.5mcg per  
Kg every minute to a patient who weighs 85Kg.  
What dose of drug will the patient receive if the drug is administered for a total of 3  
hours.  
The dose per minute is  $4.5 \times 85 = 382.5\text{mcg}$   
The dose per hour =  $382.5 \times 60 = 22950\text{mcg} = 22.95\text{Mg}$   
The dose over 3 hours =  $22.95 \times 3 \text{ mg} = 68.85\text{mg}$   
If this drug was being given in real life, a dose of 70mg would be  
administered over 3 hours as the ‘error’ in adding an extra 1.15mg would be  
insignificant.

- 22    **B**    See below  
23    **C**    See below  
24    **A**    You need to check in the BNF.  
                 All three preparations contain 5% Sodium Bicarbonate.
- 25    **B**    – this is easy 6.35 x 2 x 2.4

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### Chapter 3 Questions

- 1 C Again easy –  $(250 \times 3 \times 2) / 25$   
Mrs X is on  $250\text{mg} \times 3 \times 2$  mg daily = 1500mg  
Her weight is therefore  $1500/25 = 60\text{kg}$
- 2 E The dose is  $70 \times 15\text{mcg} / \text{minute} = 1050\text{mcg}$   
 $= 1050 \times 60\text{mcg} / \text{hour}$   
 $= 1050 \times 60 / 1000 \text{ mg} / \text{hour}$   
 $= 63\text{mg}$  or 62.5 approximately  
Note this relies on observation. The dose is asked for in mg not mls.
- 3 E Ignore the drug strength, its irrelevant  
 $1000\text{mls}$  over 10 hours =  $100\text{mls}$  per hour  
 $= 100 / 60 \text{ mls} / \text{minute}$   
 $= (100 \times 60) / 60 \text{ drops} / \text{minute}$   
 $= 100$
- 4 A –  $500\text{mg}$  in  $100\text{mls} = (500 \times 35) / 100 \text{ mg}$  in  $35\text{mls}$   
 $= 175\text{mg} / \text{hour}$   
 $= 175 / 60 \text{ mg} / \text{minute}$   
 $= 3 \text{ mg}$  approximately  
 $= 3000\text{micrograms}$   
 $= 3000 / 60 \text{ micrograms} / \text{minute}$   
 $= 50 \text{ micrograms} / \text{minute}$
- 5 C There is a lot of extra information here that you do not need.  
The calculation is quite simple.  
Assume an 80% bioavailability  
– that means 40mg will enter the bloodstream  
f) The volume of distribution is  $15 \times 60$  litres  
g) = 900 litres  
Therefore the concentration will be 40mg in 900 litres  
 $= 40/900 \text{ mg}$  in 1 Litre  
 $= (40 \times 1000) / 900 \text{ micrograms} / \text{Litre}$   
 $= 400 / 9 \text{ micrograms} / \text{litre}$   
 $= 44.44\text{micrograms} / \text{litre}$   
 $= 44.5 \text{ micrograms} / \text{Litre}$  (approx)
- 6 E Here you need to calculate the concentration again or, if you are sure of the answer to Question 21, you can calculate the concentration quite simply.  
The concentration to start with is  $44.5\text{mcg} / \text{Litre}$   
After 20 hours it would reach  $22.25\text{mcg} / \text{litre}$   
After 40 hours it would reach  $11.125\text{micrograms} / \text{Litre}$   
After 60 hours it would reach  $5.56 \text{ micrograms} / \text{litre}$   
 $= 5.5 \text{ micrograms}$  approximately  
  
The details on Levomepromazine are essentially correct.  
**N.B.** It does have a half live of 20 hours (15-30 hours) and it does undergo significant first pass metabolism. However its metabolites may be active so the 80% bioavailability has been used purely to provide a calculation.  
It has been claimed that the RPSGB has used linked calculation questions. However both 21 and 22 can be calculated separately and they are not dependent on knowing the answer to 21 (although you do need to calculate it in 22 ).
- 7 C The patient takes half the maximum dose – that is 4 tablets a day  
They take them on 3 days a week – so that is 12 tablets a week  
They need 3 months supply = 12 weeks  
Therefore they need  $12 \times 12 = 144$  tablets  
Its an easy calculation but an unusual setting !!

- 8 B** The dilution must not be less than 2mg / 1ml (BNF Appendix 6)  
Therefore the 50mls of 20mg in 1ml may be diluted up to a maximum volume of 500mls  
If the 500mls is administered over three hours, the flow rate per minute will be  
 $500/(3 \times 60) = 500 / 180 = 50/18 = 5.555/2$  (divide by 9)  
= 2.77mls / minute  
= 2.8mls to 2 significant figures
- 9 B** Infatabs contain Phenytoin base 50mg per tablet.  
The patient take 4 x 75mg per day = 300mg = 6 tablets = 2 x TDS  
  
Phenytoin suspension contains Phenytoin base 30mg in 5ml  
Therefore his daily dose would be 50mls (300mg)  
  
Now comes the tricky part – what is the nearest measurable dose  
17.5mls TDS is the nearest = 52.5mls  
This is an error of 5% - within reason. It would be correct to give a slightly higher dose rather than a lower dose as the aim is not to lose control of seizures.  
52.5mls x 28 days = 105 x 14 = 1,470mls
- 10 B** Twice daily for two weeks  
= 25ml x 2 per foot  
= 25 x 2 x 2 = 100mls daily  
Used for 14 days  
100 x 14 = 1400mls  
Looking in the BNF,  
The concentration of Chlorhexidine in Tisept = 0.015%  
1,400mls of 0.015% contains  
0.015gms in 100mls  
0.06gms in 400mls  
0.15gms in 1000mls  
= 0.21gms in 1400mls  
=210mg  
The formula is ( 25 x 2 x 2 x 14 x 0.015 x 1000)/100 mg
- 11 D** The concentration of Cetrime is 10 times that of Chlorhexidine  
So the amount used in 1 week is  
5 x 2 x 2 per day = 100mls  
For 7 days = 100 x 7 = 700mls  
700mls of 0.15% Cetrime contain  
7 x 0.15gms = 1.05gms  
The formula is 25 x 2 x 2 x 7 x 0.15/100 gms
- 12 D** Looks difficult but try this :-  
Using Alligation  
Pa = Fc-Bc = 3-0.5 = 2.5 parts  
Pb = Ac-Fc = 100 - 3 = 97 parts  
The parts of B = 500gms  
So 97 parts = 500gms  
So 1 part = 500 / 97  
And 3 parts = 500 x 2.5 / 97 = 1250 / 97  
= 12 + 86 / 97  
Now you should see that 86 / 97 is just under 1  
This should indicate that 12.9gms is probably correct.  
Using algebra, you know that 500gms contains 0.5 x 5gms Dithranol = 2.5gms  
500gms of 3% will contain 5 x 3gms = 15gms  
15 - 2.5 = 12.5gms  
So the answer must be greater than 12.5gms

- 13 E** Using Alligation  
 $Pa = Fc - Bc = 40 - 25 = 15$   
 $Pb = Ac - Fc = 90 - 40 = 50$   
 Total Parts = 65  
 Total Volume = 500mls  
 So 65 parts = 500mls and 1 part =  $500/65$   
 So of the 90% Solution we need  $500 \times 15/65 = 115.4\text{mls}$   
 Of the 45% solution we need  $500 \times 50/65 = 384.6\text{mls}$   
 If you look at the ratio 50 parts of weaker to 15 parts of stronger  
 You should see that it is a ratio of about 31/3 to 1  
 This will eliminate answers A,B and C  
 Check  
 $384.5\text{mls of } 25\% \text{ contain } 96.125\text{gms/mls Ethanol}$   
 $115.5\text{mls of } 90\% \text{ contain } 103.95 \text{ gms/mls Ethanol}$   
 $= 200\text{gms / mls ethanol (approx)}$   
 $= 400\text{gms in } 100\text{mls} = 40\%$
- 14 B** There are different ways of doing this but the simplest is this  
 Total amount of drug added =  $300\text{mg} + 25\text{mg} = 325\text{mg}$   
 $325\text{mg in } 1 \text{ Litre}$   
 $= 0.325\text{gms in } 1 \text{ Litre}$   
 $= 0.0325\text{gms in } 100\text{mls}$   
 $= 0.0325\%$   
 A lot of unnecessary info to eliminate in the question.
- 15 E** This is easy 100gms contains 2.5gms  
 So 420gms contains  $2.5 \times 4.2\text{gms} = 10.5\text{gms}$
- 16 A** First read the question.  
 Because both statements contain 200gms you should realize you can eliminate C and D.  
 You should also realize that you can eliminate B because if statement 2 is not true then statement 1 cannot be true.  
 So that leaves you A and E  
 You should know that at the start of the chapter on Skin in the BNF, there is a small section on suitable quantities – Section 13.1.2  
 This gives you the correct answer without calculating.  
 There is actually no calculation required.  
 If you cannot trust the BNF and you do calculate then the answer is correct :-  
 $7\text{gms per limb twice a day} = 7 \times 2 \times 2 = 28\text{gms a day}$   
 $= 28 \times 7$   
 $= 196\text{gms for } 1 \text{ week}$
- 17 D** Drug A and B are in the ratio of 25:1.  
 A 5ml dose contains 1.5 % solution of Drug A .  
 How many micrograms of Drug B does a 5ml dose contain. ?  
 A 1.5% solution contains = 1.5gms in 100mls  
 $= 1,500\text{mg in } 100\text{mls}$   
 $= 15\text{mg in } 1\text{ml}$   
 $= 75\text{mg in } 5\text{mls}$   
 Now the ratio is 25 :1  
 So there is 25 times as much of drug A as there is of drug B  
 So there is  $75/25\text{mg}$  of drug B  
 $= 3\text{mg}$   
 $= 3,000 \text{ micrograms}$   
 If you want a formula =  $(1.5 \times 1000 \times 1000 \times 5) / (100 \times 25)$   
 From Strength in micrograms of A =  $1.5 \times 1000 \times 1000$   
 Then calculate concentration of A in 5mls =  $x / 5/100$   
 Then divide by 25 to give the concentration of B =  $/ 25$   
 Combine these  $(1.5 \times 1000 \times 1000) \times 5/100$  and multiply by  $1 / 25$   
 (Note multiplying by  $1/25$  is the same as dividing by 25)

- 18 D** If you understand the problem well, you can see that Statement 2 is possibly the easiest to calculate  
 $30\text{mg} / \text{minute} = 30 \times 60\text{mg per hour}$   
 $= (30 \times 60) / 60\text{mg} / \text{kg} / \text{hour}$   
 $= 30$   
 So statement 2 is true  
 A 0.5% solution contains 500mg in 100mls  
 $= 5\text{mg in } 1\text{ml} = 30\text{mg in } 6\text{mls}$   
 So  $30\text{mg} / \text{minute} = 6\text{mls} / \text{minute by volume}$   
 $= 6 \times 30\text{mls in } 30 \text{ minutes} = 180\text{mls in } 30 \text{ minutes}$   
 So statement 1 is false  
 There is no simple way of seeing that the two statements cannot both be True so it is necessary to calculate both.
- 19 B** The required dose for each 8 hour dose is  $150 \times 12 \text{ mcg}$   
 $= 1,800 \text{ micrograms}$   
 The dose for 24 hours is  $1,800 \times 3 = 5,400\text{micrograms}$   
 $= 5.4\text{mg}$   
 $25\text{mg in } 10\text{mls} = 1\text{mg in } 10/25 \text{ mls} = 1\text{mg in } 0.4\text{mls}$   
 $5.4\text{mg in } = 5.4 \times 0.4\text{mls}$   
 $= 2.16\text{mls} = 2.2\text{mls to } 1 \text{ decimal place}$   
 For Formula fanatics  $\text{Volume} = (12 \times 150 \times 3 \times 10) / (1000 \times 25)$   
 From dose  $= (150 \times 12 \times 3 / 1000)$   
 And volume containing  $1\text{mg} = (10/25)$   
 Giving  $(150 \times 12 \times 3/1000) \times (10/25)$   
 $= (12 \times 150 \times 3 \times 10) / (1000 \times 25)$
- 20 C** This is best calculated using an estimate of an extra 2 puffs every two days  $= (2 \times 8) + 2 \text{ puffs every } 2 \text{ days.}$   
 $= 18 \text{ puffs.}$   
 2 months equal 56 days  
 For every 2 days 18 puffs are required so the total amount of puffs  
 $= 56/2 \times 18 = 504 \text{ puffs over } 2 \text{ months}$   
 If you use two extra puffs every three days this will equal  
 $3 \times 8) + 2 \text{ puffs} = 26 \text{ puffs}$   
 $= 56/3 \times 26 \text{ puffs for } 2 \text{ months} = 486 \text{ puffs}$   
 There are 200 puffs in each inhaler so this will equal 3 inhalers  
 and allow between 114 and 96 extra puffs..  
 This is a question that might come up in real life and would allow you to reassure parents etc.
- 21 E** 5.6gms Hydrocortisone and 11.2gms Fusidic Acid  
 The formula of Fucidin HC Ointment is  
 1% Hydrocortisone Acetate and 2% Fusidic Acid  
 Each day they will apply  $2 \times 5 + 2 \times 15\text{gms} = 40\text{gms}$   
 Over 1 week they will apply  $7 \times 40\text{gms} = 280\text{gms}$   
 You should be able to estimate that 280gms will contain :-  
 2.8gms of Hydrocortisone (1%) and  
 5.6% of Fusidic acid (2%)
- 22 D**  $24 \times 3\text{gm Pessaries containing } 200\text{mg Clotrimazole with a displacement value of } 0.5$   
 Total amount of Clotrimazole required  $= 24 \times 200\text{mg} = 4.8\text{gms}$   
 Total amount of base for a 3gm mould would be  $24 \times 3 = 72\text{gms}$   
 However the Clotrimazole will displace  $4.8 \times 0.5\text{gms base} = 2.4\text{gms}$   
 Therefore you will require  $72 - 2.4\text{gms Base} = 69.6\text{gms}$   
 And 4.8gms Clotrimazole  
 Don't be distracted by being asked to manufacture Pessaries instead of Suppositories.  
 The naming is purely convention and there is in fact no difference between a suppository and a pessary except where they are to be used.

- 23 C The easy part :-  
 The Patient will use 25mls twice a day for 2 weeks this equals  
 $25 \times 2 \times 14 = 700\text{mls}$   
 All the answers have this volume so in fact you do not need to calculate it  
 This intermediate solution is diluted = 25mls to 5,000 litres  
 $= 25 \text{ to } 5,000,000\text{mls}$   
 $= 1 \text{ to } 500000/25$   
 $= 1 \text{ in } 200,000$   
 This solution is a 1 in 20,000,000 solution  
 So the intermediary solution that you will dispense will be  
 2000,000 times stronger  
 $= 1 \text{ in } 20,000000/ 200,000$   
 $= 1 \text{ in } 100$   
 $= 1\%$   
 So the solution you provide will be a 1% solution  
 And you will provide 700mls of a 1% solution  
 The dilution coefficient is 1 in 35 (35% to 1%)  
 So you will require  $700/35\text{mls} = 20\text{mls}$
- 24 D  $100\text{mls} \times 3 \text{ times a day for } 28 \text{ days} = 300 \times 28\text{mls}$   
 $= 8,400\text{mls}$   
 The concentration is  $0.02\% = 0.2\text{gm in } 1000\text{mls}$   
 $= 0.2 \times 8.4 = 1.68\text{gms}$
- 25 B This question has provoked debate and no single option has proved acceptable to all.  
 However Option B has been considered correct by the majority but that majority is small . However B is my view.  
 Option B does not include any statement about the ampoule volume – only an amount contained in 1ml So the percentage of the ampoule cannot depend on a simple concentration.  
 If the two statements were reversed, Option A would be correct  
 If you put BECAUSE between the two statements, you need to add a qualifying statement to B to make it correct – “Each 1 ml contains 2mg and the ampoule size is 12.5mls”.

## Chapter 4 Questions

- 1 C You are asked to check on the administration of Dopamine which has been made up to a concentration of 80mg in 500 ml in an infusion pump running at the rate of 1 drop per minute. The prescribed dose is 2-5 micrograms / kg / min. The patient's weight is 65kg. What dose is the pump actually delivering to the patient if there are 20 drops in 1ml
- 1 drop / minute = 60 drops per hour  
 60 drops = 3mls (60/20) so the rate is 3mls / hour  
 The strength is 80mg in 500ml = 160mg in 1000mls  
 = 16mg in 100mls = 1.6mg in 10mls  
 = 0.16mg in 1ml = 0.48mg in 3mls (0.16 x 3)  
 So the patient is receiving 0.48mg in 1 hour  
 0.48mg = 480mcg (multiply by 1000)  
 So the rate / kg/ hour  
 = 480/ 65 This is very approximately 480 / 60  
 You should be able to see that the value is just under 8.  
 A quick test of 7.5 x 65 will give you 455+ 32.5 = 487.5  
 So the value is near to 7.5mcg (Actual value is 7.38mcg)  
 One formula would be  $(1 \times 60/20) \times (80 \times 1000/500) / 65$   
 (Volume of drops in 1 hour) x (Concentration in 1ml in mcg) / (Weight in Kg)
- 2 D -Another simple calculation 1 in 40000  
 is 1gm in 40,000mls or  
 0.1gm in 4,000mls or  
 $0.1\text{gm}/4 = 0.025\text{gms in } 1000\text{mls} = 25\text{mg}$   
 One formula would be  $((1 \times 1,000) / 40,000) \times 1000$
- 3 A This is not as difficult as it looks.  
 The patient now takes 100mg + (200mg x 2) + 400mg each day = 900mg in total  
 The bioavailability = 80%  
 = 900mg x 0.8 = 720mg absorbed  
 The Dr would prefer a lower rather than a higher dose  
 However with the MR tablets only 60% is released,  
 so the actual physical dose would be 700mg /0.6 = 1200mg  
 One formula to calculate the dose would be  $0.8 \times (100+200+200+400) = 0.6X$   
 However you would then need to assess how the value of X was best split over two daily doses  
**NOTE -These bioavailabilities are used here for exercise and do not relate to any currently available Carbamazepine products.**
- 4 D 0.005% equals 5mg in every 100mls ( 0.005 x 1000) for formula seekers  
 This would equal 7.5mg in every 250mls (5 x 2.5)  
 So statement 1 is wrong  
 If you can see that 250 and 5 have a relationship of 1:2 you can also see that both statements cannot be true  
 75mg in 250mls would mean 150 in 500mls which would not equate to 250X in 5mls for statement 2 so statement 1 and 2 are not linked (X = any units)  
 $0.005\% = 5\text{mg in } 100\text{mls}$   
 = 5000mcg in 100mls (multiply by 100 to convert Mg to Mcg)  
 = 50mcg in 1ml (divide by 100)  
 =250mcg in 5mls (multiply by 5)are the limits  
 So statement 2 is true
- 5 B You should read the question and see that statements 1 and 3 are incompatible.  
 If the dose must not be below 24.5mg, then E would not fit the MHRA requirements.  
 98% to 105% of 25mg 10% of 25mg is 2.5mg so 1% is 0.25mg  
 So 98% is 25mg – (0.25mg x 2) = 24.5mg – Statement 1 is correct  
 10% = 2.5mg so 5% is 1.25mg  
 105% of 25mg = 25mg + 1.25mg = 26.125mg – Statement C is incorrect.  
 Similarly for statement 2  
 98% of 150mg is 147mg 2% of 100 is 2 and 2% of 50 is 1 = 3mg  
 105% of 150mg is 157.5mg 5% of 100 is 5 and 5% of 50 is 2.5 = 7.5mg  
 So statement 2 is correct

- 6 B The GmMwt = 58.5 = 60gms approximately  
 So 60gms contains 1000mmols (approx)  
 You need to look in the BNF which lists Mucoclear of having a sachet volume of 4mls. (I have now added this to the question)  
 So 10 sachets would equal 40mls  
 As the concentration is 4% this contains  $(40/100) \times 4\text{gms} = 1.6\text{gms}$   
 $1.6\text{gms} = (1.6 \times 1000)/60 \text{ mmols (approx)}$   
 $= 27\text{mmols}$   
 Using a GmMwt of 58.5 the answer is  $(1.6 \times 1000)/58.5 = 27.35\text{mmols}$
- 7 C Check in the BNF Section 1.1.1 for the sodium content of Gaviscon Advance.  
 The sodium content is 2.3mmols / 5mls  
 Each day they are consuming around 100mls  
 The daily dose is therefore  $2.3 \times 100/5 = 46\text{mmols}$
- 8 E  $\text{Pa} = 50 - 10 = 40$   
 $\text{Pb} = 70 - 50 = 20$   
 Total parts =  $\text{Pa} + \text{Pb} = 60$   
 But you need to manufacture 1,800mls  
 Each part =  $1800/60 = 30\text{mls}$   
 $40 \text{ parts} = 30 \times 40 = 1200\text{mls}$  of Stronger  
 $20 \text{ parts} = 30 \times 20 = 600\text{mls}$  of Weaker
- 9 C  $1 \times 100\text{mLs Furosemide } 60\text{mg}/5\text{mLs} = 20 \times 60\text{mg} = 1,200\text{mg}$   
 $1,200\text{mg} = 1200/40 = 30 \text{ Furosemide tablets}$  \_  
 Statement 1 is incorrect  
 $1 \times 200\text{mLs Spironolactone } 25\text{mg}/5\text{mLs} = 40 \times 25\text{mg Spironolactone} = 1000\text{mg}$  will require 10 x 100mg tablets  
 Statement 2 is correct \_  
 $1 \times 150\text{mLs Captopril } 12.5\text{mg}/5\text{mLs} = 12.5 \times 150/5 = 375\text{mg} = 375/25 = 15 \text{ tablets}$   
 Statement 3 is correct.
- 10 A  $2.5\% = \text{equals } 2.5\text{gms}$  in 100mls  
 $= 2500\text{mg}$  in 100mls = 250mg in 10mls = 25mg in 1ml  
 Dose is 1 drop in each eye SIX times a day  
 $= 12 \text{ drops}$   
 $20 \text{ drops} = 1\text{ml}$   
 Dose =  $12/20$  of 1ml  
 $= (12/20) \times 25\text{mg}$   
 $= 300/20 = 15\text{mg}$
- 11 E  $7.5\%$  of 250gm = 17.5gm  
 $2.5\%$  of 250gm = 6.5gm  
 WSP =  $250\text{gm} - 17.5\text{gm} - 6.5\text{gm} = 226\text{gm}$
- 12 C This is a genuine question from a RPSGB sample paper !!  
 The trick is to avoid/ cut out the lengthy waffle and just calculate.

$$\begin{aligned} \text{CC} &= (1.2(140-60) \times 50)/300 \\ &= (1.2 \times 80 \times 50)/300 \\ &= (1.2 \times 400)/300 \\ &= 4800/300 \\ &= 48/3 \\ &= 16 \end{aligned}$$

therefore the dosage should be  
 $2.5\text{mg}/\text{kg} \times 24 \text{ hrs} = 2.5 \times 50 = 125\text{mg}$

If you get to a SC of 16, this gives only options C and E as being correct  
 D as 12 hourly which would be incorrect  
 As the dose is above minimal, then C would be logical as a choice if you  
 get stuck on the rest of the calculation

**(The value of 1.2 is normally given as 1.23 for males and 1.04 for females)**

- 13 D By Alligation  
 Parts of Chlorhexidine (powder) required  $PA = 40 - 25 = 15$  parts ( $PA = Fc - Bc$ )  
 Parts of Chlorhexidine 6% solution required  $PB = 100 - 40 = 60$  parts  
 ( $PB = Ac - Fc$ ) (remember the Chlorhexidine is 100%)  
 Total parts =  $60 + 15 = 75$   
 1 part =  $4000/75$  (don't calculate this yet)  
 Therefore to make 4 litres you would need  
 $(4000/75) \times 15$  parts Chlorhexidine =  $4000 / 5 = 800$ gms (mls)  
 And of Chlorhexidine 25% Solution you would need  
 $4000 - 800 = 3,200$ mls (3,200gms)  
 Or  $(4000/75) \times 60 = 4000 \times (4/5)$   
 Strictly speaking we would need to take into account specific gravity but this would have a negligible effect on the actual amount.  
**If you wanted to use algebra.....**  
 We have 4,000mls of 40% which contains  $4,000 \times (40/100)$ gms of Chlorhexidine  
 To make this we have a volume X which contains  $X \times (25/100)$  gms of Chlorhexidine  
 And a value Y of Chlorhexidine to be added  
 So  $X(25/100) + Y = 4000(40/100)$   
 Also  $X + Y = 4000$   
 The first equation can be simplified – here are two ways.....
- |                              |                                    |
|------------------------------|------------------------------------|
| a)                           | b)                                 |
| $0.25X + Y = 1600$           | $0.25X + Y = 1600$                 |
| $X + Y = 4000$               | $X + Y = 4000$                     |
| Rearrange these              | Rearrange these                    |
| $Y = 1600 - 0.25X$           | $0.25X = 1600 - Y$                 |
| $Y = 4000 - X$               | $X = 4000 - Y$                     |
| So $1600 - 0.25X = 4000 - X$ | So $X = 6400 - 4Y$ (multiply by 4) |
| Rearranging                  | Rearranging                        |
| $X - 0.25X = 4000 - 1600$    | $4000 - Y = 6400 - 4Y$             |
| $0.75X = 2400$               | $4Y - Y = 6400 - 4000$             |
| $X = 2400/0.75$              | $3Y = 2400$                        |
| $X = 3200$                   | $Y = 800$                          |
| So $Y = 4000 - 3200 = 800$   | So $X = 4000 - 800 = 3200$         |
- 14 D The daily dose is  $(5 \times 30)$ mg = 150mg  
 The strength is 60mg in 10ml so 1mg is contained in  $10/60$ mls  
 150mg is contained in  $150 \times (10/60)$ mls = 25mls  
 A dose will therefore be half that amount = 10.5mls given twice daily
- 15 D This is simple. The Gm molecular weight of Sodium Chloride is 58.5gms.  
 = approximately 60gms  
 60gms = 1000mmols (1 mol)  
 So 15gms =  $(60/15) \times 1000$ mmols = 250mmols
- 16 A This is not really a calculation but requires a check in the BNF the value given is  
 1mmol / 10ml for a low sodium antacid.  
 = 10mmol/100ml  
 = 100mmol/ 1000mls
- 17 B This is a test as you should know or at least recognise this value.  
 0.9% Sodium Chloride = 9gms / Litre  
 Therefore the concentration in mmols equals  
 $9/60 \times 1000$   
 You should use the value of 60 as the GmMWt as suggested by Q15  
 =  $900/6$   
 = 150mmols
- 18 B This is a simple question but relies on you being aware that the equivalent doses of opioid analgesics are in the Prescribing in Palliative Care section of the BNF (BNF60 pages 20 and 21).  
 These equivalences are not definitive and different values are given elsewhere.  
 However for the exam you must use the latest BNF.

- 19 E The concentration will fall by 50% every 10.5 hours so  
 after the first 10.5 hours it will be 26mcg/ml  
 after the 2nd 10.5 hours it will be 13mcg/ml  
 after the 3rd 10.5 hours it will be 6.5mcg/ml  
 after the 4th 10.5 hours it will be 3.25mcg/ml  
 After the 5<sup>th</sup> 10.5 hours it will be 1.625mcg/ml  
 The time will therefore be  $10.5 \times 5 = 52.5$  hours  
 You could work backwards 1.625  $\rightarrow$  3.25  $\rightarrow$  6.5  $\rightarrow$  13  $\rightarrow$  26  $\rightarrow$  52
- 20 A The required dilution is from 0.05% to 0.0125%  
 (Look in BNF for strength of commercial product which is 0.05%)  
 So dilution is 1 in 4  
 Therefore the quantity required is  $750/4\text{gms} = 125\text{gms}$
21. E The correct answer is: E – steps  
 After 4hrs – 50% is eliminated  
 After 8 hrs 50% of what remains is eliminated = 25% of the initial full amount  
 So the answer is 75%  
 (50% of the remaining 50% = 25% 50% + 25% = 75%)  
 In the first half life of a drug 50% is eliminated  
 In the 2<sup>nd</sup> half life 50% of the remainder = 25% of the original amount = 75%  
 In the 3<sup>rd</sup> half life 50% of the remainder = 12.5% of the original amount = 87.5%  
 In the 4<sup>th</sup> half life 50% of the remainder = 6.25% of the original amount = 93.75%  
 In the 5<sup>th</sup> half life 50% of the remainder = 3.125% of the original amount = 96.875%
- 22 B 1 in 40 so amount =  $1/40 \times 200\text{mls}$ ?  
 All concentrated waters are 40 x stronger than standard\waters
- 23 E Total weight of coating =  $10\text{mg} \times 1,000,000 = 10,000,000\text{mg} = 10,000\text{gms}$   
 Coating contains 10% so  $250\text{ms} = 25\text{gms} / \text{minute}$   
 Time =  $10,000/25$  minutes (assuming 100% efficiency)  
 = 400 minutes
- 24 A 40% diluted to 0.01% so dilution  $40 : 0.01 = 400 : 0.1 = 4000 : 1$   
 so a 1 in 4,000 dilution is required.  
 5000mls needed so  $5000/4000 = 5/4 = 1.25\text{mls}$  of 40% concentrate is required  
**Check....**  
 1.25mls of 40% solution contain  $1.25 \times (40/100)$  gms Benzalkonium chloride  
 = 0.5gms  
 5 Litres of 0.01% solution contain  $5,000 \times (0.01/100)$ gms Benzalkonium chloride  
 = 0.5gms
- 25 B If 400mg of Potassium permanganate is dissolved in 2.5litres of water, what is the  
 percentage strength of the resulting solution?  
 One way (There are lots of ways).  
 400mg in 2.5 Litres  
 = 4gms in 25 Litres  
 = 16gms in 100 litres - Answer must contain '16' so only B can be correct  
 16gms in 100 litres  
 = 1.6gms in 10 litres  
 = 0.16gms in 1 litre  
 = 0.016gms in 100mls = 0.016  
 Another (very similar) way  
 400mg in 2.5 Litres = 40mg in 250mls ( $/10$ ) = 160mg in 1 Litre (x 4)  
 = 16mg in 100mls  
 Only B has 16 in the answer so only B can be correct - check  
 1.6gm in 100mls = 1.6% Divide by 10  
 160mg in 100mls = 0.16%  
 16mg in 100mls = 0.016%  
 A Formula  $((400/1000) / 2,500) \times 100\%$

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## Chapter 5 Questions

- 1     **D**     Need strength of 120mg/5mL  
Tagamet is 200mg/5mLs  
Final volume is 5mLs x 3 (tds) x 7 (days supply) = 105mLs  
Therefore:  $120/200 \times 105 = \mathbf{63\text{mLs of Tagamet}}$   
105 (final volume) – 63 (mLs of Tagamet) = **42mLs syrup BP**
- 2     **C**     40mg temazepam is equivalent to 20mg diazepam (BNF 44 page 169)  
Therefore need 2 x 10mg tablets diazepam x 14 days = **28 tablets**
- 3     **D**     £4.50 x 2 = £9.00  
Dispensing fee = 20%  
£9.00 x 1.2 = **£10.80**
- 4     **A**     0.09% to 0.045% is a **1:1 dilution**
- 5     **C**     15mg x 23 kg = 345mg in the first hour  
10mg x 23kg x 2 = 460mg for next two hours  
Total in three hours = 345 + 460mg = **805mg**
- 6     **B**     Active ingredient = 12.5g in 100mLs  
One ampoule  $\equiv$  1.25g in 10mLs  
Need 0.5% active ingredient in 1 litre  
= 0.5g in 100mLs = 5g in 1 litre  
Therefore ampoules required =  $5/1.25 = \mathbf{4 \text{ ampoules}}$
- 7     **E**     5mLs diluted to 300mLs is a 60 x dilution  
This produces a 0.02% solution, therefore the original solution must have been  
 $60 \times 0.02\% = 1.2\% \text{ w/v}$   
This is equivalent to 1.2g in 100mLs  
= **3g in 250mLs**
- 8     **C**     Need 400mg x 24 = 9.6g of drug A  
1.2g of drug displaces 1g of Witepsol  
1g of drug displaces 1/1.2g of Witepsol  
9.6g of drug displaces  $9.6/1.2$ g of Witepsol = 8g  
will require (24 x 2) – 8g of Witepsol  
**Will need 9.6g drug and 40g base**
- 9     **A**     Diazepam (0.5% w/v)  $\equiv$  500mg in 100mLs  $\equiv$  5000mg in 1 litre  
Need 200mg in 1 litre  
 $200/5000 \times 1000\text{mL} = 40\text{mLs}$  of original solution  
Amount of Glucose 5% = 1000 – 40 = **960mLs**
- 10    **B**     Furadantin suspension is 25mg/5mL  
need  $200/25 \times 5\text{ml} = 40\text{mLs}$  each day  
 $40\text{mLs} \times 7 = \mathbf{280\text{mLs}}$  total supply
- 11    **B**     BNF 44 page 463  
15mmol of phosphate in 1 litre  
**7.5mmol** in 500mLs
- 12    **D**     BNF 44 page 444  
35mg x 2 tablets = **70mg**
- 13    **A**     BNF 44 page 468
- 14    **D**     Proguanil – two tablets each day for two people for seven weeks  
= 98 tablets per person  
= **196** tablets total supply
- 15    **B**     1 in 10 000  $\equiv$  1g in 10 000mLs  $\equiv$  10mg in 100mLs  $\equiv$  **20mg** in 200mLs
- 16    **A**     0.04% w/v suspension = 40mg in 100mLs = 400mg in 1 litre  
for 5 litres will require **2g** of tocopheryl acetate
- 17    **E**     Recommended dose 1 –12 years for juvenile arthritis 1 – 3 mg/kg daily  
Child weighs 21kg  $\therefore$  maximum daily dose = 63mg  
1. 25mg suppository tds = **75mg**  $\therefore$  overdose  
2. **50mg** would be within range but BNF specifically states **25mg tablets only**  
3.  $(2 \times 12.5) + 12.5 + (2 \times 12.5) = \mathbf{62.5\text{mg}}$   $\therefore$  within range

- 18 B 300mg/50mL at 1mL/hour = 6mg/hour x 24 = 144mg/day  
 1. 144mg = **0.144g**  
 2. 6mg/hour = 6/60mg/min = 0.1mg/min = 100micrograms/min  
 100/60 = **1.67micrograms/kg/min**  
 3. 300mg/50mL = **0.6% w/v**
- 19 D BNF 44 page 16 – infusion strength of 2mg/ml cause precipitation  
 This is equivalent to **0.2% w/v**
- 20 E First Statement - FALSE  
 0.0035% w/w  $\equiv$  3.5mg in 100g = 3500micrograms in 100g  
**5250micrograms in 150g (3500 x 1.5)**  
 Second Statement – FALSE - From above **3.5mg in 100g**
- 21 A 1 in 10,000 is final solution and we need 10 litres  
 Original is 4 in 100 (4%)  
 1 in 10,000 is 0.01 % (1 in 100 = 1 , 1 in 1000 = 0.1%)  
 So dilution is 4 to 0.01  
 = 40 to 0.1 = 400 to 1 i.e. a 1 in 400 dilution  
 So need 1/400 of 10 litres = (1/40 x 10,000)  
 = 10,000/400 = 100/4 = 25mls
- Using Formulae  $C1/V2 = C2/V1$   
 $4 / 10,000 = 0.01 / X$   
 $4X = 0.01 \times 10,000$   
 $4X = 100 \quad X = 25$   
 But needed to convert strengths. If we didn't, we would get  
 $(4 \text{ in } 100) / 10,000 = (1 \text{ in } 10,000) / X$   
 $(4 \text{ in } 100) \times X = (1 \text{ in } 10,000) \times 10,000$   
 $= (4/100) \times X = (1/10,000) \times 10,000$   
 $1/25 X = 1$   
 $X = 25$   
 Note 1 in 10,000 would be a very strong Pot. Permanganate solution.  
 Potassium Permanganate is now rarely used but calculations involving it are regular questions in the pre-reg exam.
- 22 C You will at some point need to convert from parts to percentage  
 1 in 20 produces a 1 in 500 solution so it is 20 times stronger  
 = 500/20 as a strength = 25 i.e. 1 in 25  
 Now 1 in 25 = 4 in 100 = 4%  
 But you start with 50% so to go from 50% to 4% requires a 50/4 dilution = 12.5  
 Now you need 200mls of solution obtained by diluting 1 in 12.5  
 So you need 200/12.5 = 16 (same as 400/25)
- 23 D All dilutions of a Concentrated Water BP to a Single Double Water BP are 1 in 20  
 So 1 in 20 = 20.000/20 = 1,000mls = 1 Litre
- 24 C All dilutions of a Concentrated Water BP to a Single Strength Water BP are 1 in 40  
 1 in 40 = 1,500 / 40 = 37.5mls
- 25 C 4 tablets daily = 225 x 4mg Ferrous Fumarate. According to BNF = 4 x 100mg Iron  
 Only 80% available  
 So actual dose is 4 x 100 x 0.8 = 320mg Iron.  
 Sytron contains Sodium ferridate equivalent to 27.5mg Iron in each 5mls  
 Therefore equivalent dose of Sytron  
 = 320 / 27.5  
 = 320 / 28 (approx) - Divide by 4 gives 80/7  
 $80/7 = 11.4 = 3/7$  approx. but will be just a little bit more due to rounding up  
 So nearest amount is 11 or 12 x 5ml (320/27.5 = 11.6)  
 In the exam, the difference would be great enough to select a correct answer (e.g. 10,12, or 14 5ml spoonsful)  
 In reality you would probably choose between 10 or 12 spoonsful and do blood tests to check the benefit

## Chapter 6 Questions

- 1 C 1 in 8000 is achieved by a 1 in 60 dilution. Therefore the original concentration is  $(8000/60) = 160$  or a 1 in 160 solution. 1 in 200 is 0.5% (half of 1 in 100 = 1%) 1 in 100 is 1% So 1 in 160 is going to be between 0.5% and 1% but will be less than 0.75% (1 in 150) so 0.625 is the only sensible answer
- 2 B 60 micrograms per kg for a 50kg patient = 3000mcg or 3mg per hour  
The concentration of the solution is  $150\text{mg}/1000\text{ml} = 1.5\text{mg}/10\text{ml}$   
3mg per hour = 20ml per hour =  $20/60$  or  $1/3\text{ml}$  per minute.  
Converting to drops  $20/3 = 6.67$  or 7 drops per minute is the required drip rate.  
The full formula is  
$$\left(\frac{60 \times 50}{1000}\right) \times \left(\frac{1000}{150}\right) / (60) \times 20$$
$$= (3) \times (10/1.5) / (60) \times 20$$
$$(60 \times 50 / 1000) \text{ to convert the dose to mg per hour}$$
$$\times (500/75) \text{ to convert mg to mls per hour}$$
$$\text{divide by } 60 \text{ to convert to mls per minute}$$
$$\times 20 \text{ to convert to drops per minute}$$
- 3 B 10 powders weigh 200mg each or 2gms total. They contain 10 x 24mg active ingredient or 240mg  
Therefore the total quantity of active drug needed is 240mg or 4 x 60mg tablets  
These need to be made up to 200mg each or 10 x 200mg total = 2gm
- 4 [C Potassium Chloride Concentrate Sterile Solution is a 15%w/v solution (sterile) and contains 2mmol Potassium in each 1ml. Therefore 50mmols would be contained in 25mls. See BNF40 pge 430. The original version of this question used "Potassium Chloride Strong Solution". This is not listed in the BNF.  
NB: The aim with K+ is to ensure it is **NOT** injected undiluted
- 5 C This is less difficult than it looks. The BNF states that the dose for Welldorm elixir is 0.4 – 1.3gm (15-45mls). The dose is  $50 \times 8 = 400\text{mg}$   
The answer is therefore 15mls = 0.4gm (400mg)
- 6 E Try it this way. Dobutrex 20ml contains 12.5mg/ml or 250mg in 20ml.  
We add this to 1 Litre and get 250mg in 1 Litre (1000ml) or 1mg in 4ml.  
The dose we need is 10mcg/min/kg or  $75 \times 10\text{mcg}/\text{min} = 750\text{micrograms}$  per minute.  
 $1\text{mg}$  in 4ml = 250mcg in 1ml or 750mcg in 3ml so the answer is 3ml..  
**An alternative:-** It is intended to dilute the solution from 20 to 1000.  
This is a 1 in 50 dilution. We need 750 micrograms  
20 mls contains 250mg so 2mls contains 25mg and 0.2mls contains 2.5mg and 0.02mls contains 250micrograms (0.25mg). So 0.06mls contains 750 micrograms. Now the dilution is 1 to 50 so there will be 50 times the volume in the final bag so the volume will be  $0.06\text{mls} \times 50 = 3\text{ml}$   
This again avoids using complicated formulas (just simple steps).  
To put it all in a mathematical formula the quantity required is :-  
$$(10 \times 75) / ((250 \times 1000) / 1000) = 750 / 250 = 1.5\text{mls}$$
  
(dose per Kg times number of kg) divided by ((number of mg converted to micrograms) divided by (final volume) to give micrograms per ml)  
With all calculations TRY and guess at the rough value of an answer before calculating as usually only one answer will be in the right 'ball park area'.  
The question assumes that 20ml added to 1 Litre is approx 1 litre rather than 1,020mls. If you substitute this, again the only correct answer is 3.1 to the nearest 2 significant figures (The answer will be 3mls) NOTE :- I have worked to 2 sig figures as all the values are to 2 significant figures.
- 7 C this is quite a simple calculation. The rate has been increased by 50% so the new dose is  $150\text{mg} \times 1.5 = 225\text{mg}$ . In detail, the increase represents 18mm. (54 -36) The current dose the patient is receiving is  $(150 / 36) \text{mg}/\text{mm}$ .  
The new dose will be  $(150 / 36) * 54 = 225\text{mg} / 24\text{hrs}$   
**NOTE** - with syringe pumps it is easy to increase the rate on the dial ; it is more difficult to increase the **dose** and then try to calculate the rate.  
There is a further problem attached to this question that was originally worded as what possible problems could changing the dosage introduce  
The answer centres around the problem that the syringe pump would now

- be infusing faster and therefore would not last for 24 hours. You cannot calculate easily how long it will last unless you know when it was started AND then when the rate was changed. This is a professional problem not part of the calculation.
- 8     **D**     156gms - This is a simple calculation.  
The RMM or GMW = Weight / MMOLS = 109.2 / 0.7
- 9     **D**     Look at the formula. Only Light Liquid Paraffin is in **MLs**.  
This eliminates A, B, C, E  
There is no need to calculate but you do need to know the units
- 10    **A**     You require 50 x 100mg Theophylline = 5gms  
The displacement value is 0.5 so 5gms will displace 5 / 0.5gms base  
Or 10gms  
Therefore you will need (50x1gm) – 10gm base  
= 40gms
- 11    **D**     What weight of white soft paraffin is required to make 250g of the following product?
- |                            |                |
|----------------------------|----------------|
| <b>Zinc oxide</b>          | <b>12%</b>     |
| <b>Salicylic acid</b>      | <b>1%</b>      |
| <b>Starch</b>              | <b>15%</b>     |
| <b>White soft paraffin</b> | <b>to 100%</b> |
- In 100 parts WSP represents 72 (72%)  
In 250gms WSP would represent (72 x 250) / 100 = 180gms Correct answer D
- 12    **B**     Do the easy bit first  
Glucose 4% is 4gms in 100mls or =20gms in 500mls  
That eliminates C and E  
Sodium Chloride 0.18% equals =0.18gms in 100mls  
=0.9gms in 500mls
- That eliminates A and D
- 13    **D**     The fact that the concentration is 0.5% should tell you that the answer will contain half the 'number' that is posed in the problem Thinking simply = if the strength is 0.5% you will need half the final amount in either weight or volume (depending on units). So 500 litres will require 2,500gms  
= 0.5%  
= 0.5gm in 100mls  
= 5gm in 1000mls (1 Litre)  
= 25gms in 5 litres  
= 2,500 gms = 2.5 Kilograms (Kg) in 500mls
- 14    **D**     Salbutamol Tablets BP are available as tablets containing Salbutamol sulphate equivalent to 2 mg and 4 mg of Salbutamol. To prepare Salbutamol 2 mg tablets, what weight of Salbutamol sulphate is needed in each tablet? (March 2003)  
Molecular weights: Salbutamol: C<sub>13</sub>H<sub>21</sub>NO<sub>3</sub> = 239.3  
Salbutamol sulphate: (C<sub>13</sub>H<sub>21</sub>NO<sub>3</sub>)<sub>2</sub>SO<sub>4</sub> = 576.7  
The ratio of the weight of 'Salbutamol sulphate' to 'Salbutamol' in a tablet is equal to the ratio of their molecular weights  
i.e. 576.7 to 239.3 x 2  
NB there are 2 molecules of Salbutamol in Salbutamol Sulphate)  
and X to 2mg  
so 576.7/X = (239.3 x 2) / 2  
X = (576.7 x 2) / 239.3  
= 1153.8 / (239.3 x 2)  
= 2.41  
Care here as it is too easy to express the ratio as 576.7 to 239.3

- 15 D Tablet 5% w/w binder  $\rightarrow$  25%w/v solution  
 5g/100g  $\rightarrow$  25g/100ml  
 500,000 100mg tablets = 500,000 X 0.1g = 50,000 tablets  
 As 5%w/w of tablet is the binder  
 5% of 50,000 = 2500g  
 2500g of binder with a 25g/100ml solution  
 Therefore 10,000ml of 25g/100ml solution will make  
 2500g of binder = 10L Correct answer D

A variation contains a tablet core of weight 1.9gms which will be coated to a weight of 2gms. 100mg of coating will be added using a 25% solution. If the coating is added at the rate of 10mcg / second , how long will it take to coat 1 million tablets ?

Coating per tablet is 100 micrograms

All tablets coated at same rate

Therefore only need to calculate for 1 tablet

10mcg / second

= 100mcg in 10 seconds

= 1000 mcg in 100 seconds

= 1mg in 100 seconds

= 100mg in 10,000 seconds

= 10,000/60 minutes

= 166 minutes

- 16 E The dry weight of the coating is 10mg/tablet (=0.01g/tablet)  
 Therefore dry weight of coating for 1 million tablets = 10,000g  
 The coating solution contains 10% w/v coating material = 10g in 100ml  
 =10,000g in 100,000ml (100Litres)  
 Spray rate = 250mL/minute  
 Therefore 1 Litre in 4 minutes and 100 Litres in 400 minutes  
 Or  
 10mg of coating/ tablet = 0.01g of coating/ tablet  
 10% = 10g/100ml solution  
 0.01g X ? tablets from 10g/100ml solution  
 ? = 1000 tablets  
 Therefore if 1000 tabs from 10g/100ml  
 2500 tabs from 25g/250ml/min  
 1000,000 tabs / 2500  
 = 400 min

- 17 A. Dose = (0.72m<sup>2</sup> X 300mg)/1.8  
 = 216 /1.8  
 = 2160/180  
 = 120mg

- 18 E 1 millimole Na<sup>+</sup> and Cl<sup>-</sup> = 23 + 35.5 = 58.5gm  
 58.5gms = 1mol or 1000mmols (1mmol =58.5mg)  
 0.9% = 0.9g/100ml = 900mg/100ml  
 = 450mg/50ml  
 ? millimoles of Na ions = 450mg NaCl/50ml  
 = 450 /58.5  
 = 450/60 approximately  
 =7.5mmols approximately  
 (450/58.5 = 7.69)

- 19 A Calculate the recommended dose.  
 $240\text{mg} / \text{hour} = 4\text{mg} / \text{minute} \quad (240/60)$   
 $= 4/50 \text{ mg/kg minute} = 0.8\text{mg/kg}$   
 $= 800\text{mcg} / \text{kg/ minute}$ . The recommended dose is therefore  
 $800\text{mcg/kg/min}$   
**Statement 2** is therefore clearly seen as being correct  
 $(0.8\text{mg} = 800\text{mcg})$   
**Statement 1**  
 $0.2\%$  represents  $2\text{mg}$  in  $1\text{ml}$  ( remember  $1\%$  is  $10\text{mg/ml}$ )  
 $60\text{mls} = 60 \times 2 = 120\text{mg}$  over 30 minutes  
 $120\text{mg}$  in 30 minutes =  $240\text{mg}$  in 1 hour =  $4\text{mg} / \text{minute}$   
**Statement 1 is also correct**  
Statement 1 and 2 are complimentary  
(Try putting 'because' between them) so the correct answer is A
- 20 A If you look carefully, only options A and E can be correct answers  
2 Litres of  $8.4\%$  Sodium Bicarbonate Solution provides  $2000 \text{ mmols}$   
each of  $\text{Na}^+$  and  $\text{HCO}_3^-$   
 $8.4\%$  w/v Sodium Bicarbonate solution contains  $1\text{mmol/ml}$  of electro-  
lytes.  
Both these statements are the same i.e.  $2000\text{mmols}$  in 2 litres equals  
 $1\text{mmol} / \text{ml}$ .  
 $8.4\%$  is chosen as a strength to use because of the simplicity of a  $1\text{m-}$   
 $\text{mol/ml}$  concentration.

**Chapter 6 Extra Questions – Answers**

Question	Answer
1) 200gms of Dithranol Ointment contain 6gms Dithranol. If 45gms of this is diluted to 900gms, what strength as a percentage of Dithranol is the diluted ointment ?	45 gms contains $(6/200) \times 45$ gms $= 270 / 200 = 1.35$ gms 1.35gms in 900 gms $= (1.35 / 900) \times 100\%$ $= 1.35 / 9 = 0.15\%$ w/v
2) 50gms of Acriflavine cream is diluted to 300gms. The concentration of the diluted cream is 0.1%. What was the concentration of the original cream ?	The dilution is $300 / 50 = 6$ times The concentration therefore was $0.1 \times 6 = 0.6\%$
3) What quantity of Codeine Phosphate Solution 30mg in 5mls is needed to provide 200mls of a solution containing a total of 10mg Codeine Phosphate.	30mg in 5ml $= 1$ mg in 5/30mls $= 10$ mg in $(1 \times 10)/30$ mls $= 0.333$ mls
4) A stock solution of Potassium permanganate is 0.25%. How much of this is needed to prepare 6 litres of 1 in 12,000 solution	$0.25\% = 0.25$ g in 100 $= 2.5$ g in 1000 $= 1$ g in $(2,000/2.5)$ $= 1$ in 800 The dilution is therefore $1$ in $1200/800 = 1$ in 1.5 and the quantity required $6$ litres / 1.5 = 4 Litres
5) A solution of Alcohol contains 90% w/v Alcohol. How much of this is needed to provide 500mls of a 4.5% Alcohol solution ?	500mls contains $4.5 \times 5$ gms $= 22.5$ gms as the solution is 90% this will be contained in $(100/90) \times 22.5$ mls $= 22.5 \times 1.11 = 24.97$ mls $= 25$ mls to the nearest 1ml . This assumes no contraction on mixing
6) A solution of Frusemide is needed. To prepare this you will need to dissolve 40mg tablets in water. If you need to prepare a solution containing 50mcg in 10mls, what volume must you prepare from 1 x40mg tablet.	50mcg in 10ml $= 500$ mcg in 100ml $= 1$ mg in 200mls $= 40$ mg in $200 \times 40$ mls $= 8,000$ mls $= 8$ litres
7) You have two solutions containing 60% and 5% respectively of the same ingredient.	Using alligation $P_a = 10 - 5 = 5$ parts 60%

How much of each do you need to prepare 200mls of 10% solution

$$Pb = 60 - 10 = 55 \text{ parts } 5\%$$

$$200\text{mls} = 55 \text{ parts}$$

$$\text{Volume } 60\% = (200 / 55) \times 5 = 18.18\text{mls}$$

$$\text{Volume } 5\% = (200/55) \times 50 = 181.81\text{mls}$$

- 8) You have two solutions containing 80% and 15% respectively of the same ingredient. How much of each do you need to prepare 400mls of 20% solution

$$Pa = 20 - 15 = 5 \text{ parts } 80\%$$

$$Pb = 80 - 20 = 60 \text{ parts } 15\%$$

$$400\text{mls} = 65 \text{ parts}$$

$$\text{Volume } 80\% = (400/ 65) \times 5 = 30.76\text{mls}$$

$$\text{Volume } 15\% = (400/65) \times 60 = 369.2 \text{ mls}$$

- 9) You have two solutions containing 90% and 30% respectively of the same ingredient. If you used 200mls of the 30% to prepare 600mls of solution with the remainder being 90%, what is the strength of the final solution.

$$Pa = X - 30$$

$$Pb = 90 - X$$

$$Pa + Pb = Pt$$

$$Pa = 2Pb \text{ (volume is double)}$$

$$Pb = 200\text{mls,}$$

$$\text{Final volume is } 600\text{mls}$$

$$\text{so } Pa = 600 - 200 = 400\text{mls}$$

$$\text{So } (X-30) = 2(90-X)$$

$$X - 30 = 180 - 2X$$

$$3X = 180 + 30$$

$$X = 210/30 = 70\%$$

$$\text{Final strength} = 70\%$$

- 10) A cream contains 3.5% of active ingredient. What ratio dilution is required to produce a 0.7% cream ?

$$\text{Dilution is } 3.5 / 0.7 = 350 / 7$$

$$\text{(multiplying by } 10)$$

$$= 50$$

$$\text{Dilution is therefore } 1 \text{ in } 50$$

With all the above, what I have tried to do is show simple steps towards arriving at the correct answer.

There are many other ways these questions can be answered.

If you know a method, are familiar with it and happy - then use that method.

If not try the way shown above - simply writing down stepwise what you are trying to achieve.

Each step should be a logical move towards obtaining the correct answer.

### Question

### Answer

11) What are the required quantities for 20mls of Sodium Bicarbonate Ear Drops

Sodium Bicarbonate 1gm  $(5/100) \times 20$   
Glycerol 6mls  $(30/100) \times 20$

If the formula is 5% Sodium Bicarbonate w/v, Glycerol 30% v/v and water to 100% ?

Water to 20mls

12) This is the formula for St. George's Hospital Peppermint Water

Conc. Peppermint Water 1 part v/v  
Methylhydroxybenzoate 1% w/v  
Propylhydroxybenzoate 0.3% w/v  
Water to 40 parts

How much of each ingredient is required to produce 5 Litres

Conc. Peppermint Water 125mls  
(1 / 40) x 5000

Methylhydroxybenzoate 50gms  
(1/100) x 5000

Propylhydroxybenzoate 3gms  
(0.3 / 100) x 5000

Water to 5,000mls

The 'Parts' are only used for the Pepp. Water

13) What quantity of Concentrated Aniseed Water is required to produce 3 Litres of Calcium Carbonate Suspension if the Suspension contains 10% Aniseed Water ?

3 litres contains 10 % A.W

= 300mls

= 300 / 40mls Conc. Aniseed water

= 7.5mls

14) A Coal Tar and Salicylic Acid Ointment contains 2% of each by weight in Wool Alcohols Ointment. What quantity of each is required to prepare 1/2 a Kilogram ?

1/2 Kilo = 500gm

2% of 500gms

= 10mls by volume

or 10gms by weight

15) An aqueous Anaesthetic Cream contains the following ingredients

Lidocaine (Lignocaine) 1% w/v  
Cetomacrogol emulsifying wax 5%

Phenoxyethanol 0.5% v/w

Glycerol 1 part in 25 v/w

Calamine 1 / 25th by weight

Chlorphenamine 0.5% w/w

How much of each is required to produce 50gms

Lidocaine (Lignocaine) 0.5gm

Cetomacrogol emulsifying wax 25gm

Phenoxyethanol 0.25mls

Glycerol 2mls

Calamine 2gms

Chlorphenamine 0.25gm

How much of each is required to produce 50gms

16) What is 0.05% expressed as a percentage by parts (1 in X)

0.05gms

= 0.05gm in 100

or 0.5gm in 1000

or 1gm in 2000

= 1 in 2000

17) What is 1/8th of 40% as a percentage

5% (40/8)

18) If a 50% solution is diluted 30 times and that solution is then diluted a further 100 times, What is the final concentration

The dilution is 30 x 100

= 1 in 3,000

so the final strength will be 50/3000

= 5/300

= 0.0166%

19) If 50% of a 4% ointment is diluted with White Soft paraffin to produce 600gms of 0.05% Ointment, what was the original amount of ointment ?

600gms of 0.05% contains  $0.05 \times 600$  gms  
 $= 0.3$  gms

Original strength was 4gm in 100gm  
or 1gm in 25gms ( $100/4$ ) gms  
or 0.3gms in ( $25 \times 0.3$ )gms

$(100 / 4) \times 0.3$

$= 7.5$ gms

As this is half the original quantity,  
original quantity = 15gms

$(100 \times 2 \times 0.3)/4$

**Now check**

7.5gms(50%) contains  $7.5 \times 4 / 100$  gms  
 $= 0.3$ gms

20) A solution contains Sodium Chloride 1 in 500. How much Sodium Chloride needs to be added to convert the solution to 1 in 20 ??

1 in 500 requires 1 gm in 500mls

1 in 20

$= 500/20$  in 500

$= 25$  in 500

It is therefore necessary to add 24gms to the solution to convert it to 1 in 20.

In reality this would produce a slight over-volume and be less than 1 in 20.

To ensure absolute accuracy a different calculation would be used.

You can use alligation.

The actual ratio is about 98:5 (19.6:1 )  
rather than 500:24 (20.8:1)

## **Appendices**

Alligation

Chloroform and Waters BP

Dilutions (Serial)

Dilution (Parts)

Displacement Values

## All you ever wanted to know about Alligation

Alligation is the name usually used for a process that involves calculating the result of mixing together two different concentrations of the same drug.

**Alligation** is an old (about 1728) but very practical method of solving problems related to mixtures of different strengths of the same (or different) ingredients. It has two components – which you don't really need to know about :-

**Alligation medial** is used when calculating a final concentration  
Alligation medial is merely a matter of finding a weighted mean.

**Alligation alternate** is used to find the amount of each ingredient (by concentration) needed to make a concentration of a given percentage.

Alligation alternate is more complicated and involves organizing the ingredients into high and low pairs which are then calculated against each other.

This is the method most familiar in pharmacy .

That concentration of solutions can vary from 0% to 100%

If you use 100% then the amount will be in Grams rather than Millilitres if you are adding pure drug to a solution otherwise the units will usually remain the same depending on whether you are using gms or mls .

Do remember that in allegation any volumes that are to be used are normally parts – Hopefully this is explained below but a specific volume such as 100mls may be any number of parts depending on any particular question.

## Calculating changes in concentration using Standard Algebra

To think about how the calculation works you need to use a bit of algebra to start with.

Lets call the Final Concentration  $C_f$  when we mix two different concentrations together.

If you are mixing a strong and a weak concentration then  $C_f$  must be:-

- 1) Weaker than the stronger concentration
- 2) Stronger than the weaker concentration

**NOTE** You cannot make a strong concentration any stronger by adding a weaker concentration and also you cannot make a weaker solution any weaker by adding a stronger solution.

Now if you start with a weaker solution – lets call the concentration  $C_b$

To make it stronger, you will add a stronger solution of the drug

So the stronger solution will be  $C_a$

You now know that  $C_a$  is stronger than  $C_f$   
and  $C_f$  is stronger than  $C_b$

Now if you start with a stronger solution – lets call the concentration  $C_a$

Now to make Cb stronger, you will add some of the stronger solution Ca  
How stronger it gets will depend on how much of Ca you add.

The two operations are in fact exactly the same :-

So if you start with Xmls of Ca and mix it with Ymls of Cb  
the final concentration will lie somewhere between the two concentrations.

So if you start with Ymls of Cb and mix it with Xmls of Ca  
the final concentration will lie somewhere between the two concentrations.

Now using algebra the final concentration will be somewhere between Ca and Cb

Using 100mls of 30% and 50mls of 20% gives

$$((30/100) \times 100) + ((20/100) \times 50) = ((Cf/100) \times 150) \quad (\text{don't try to remember this !!})$$

This is not an easy formula but :-

$(30/100) \times 100$	gives the amount of drug in 100mls of 30% solution	and
$(20/100) \times 50$	gives the amount of drug in 50mls of 20% solution	and
$(Cf/100) \times 150$	gives the amount of drug (as a %) in 150mls of final solution	
		(100 + 50mls)

This formula gives	$30 + 10$	$= ((Cf/100) \times 150)$
	$40$	$= CF \times 150/100$
	$40 \times 100$	$= Cf \times 150$
	$4000$	$= Cf \times 150$
Rearranging	$Cf$	$= 4000/150$
		$= 26.6\%$

Now this is a difficult calculation if you are not too good with algebra.  
However it can be simplified .

If you look at the above calculation, the ratio of the two volumes is  $2:1$   
100mls to 50mls

The two concentrations were  $30\%$  and  $10\%$

So **2 parts** of  $30\%$  were used and **1 part** of  $20\%$ .

You should be able to see that as there is more of the  $30\%$  than the  $20\%$ , the concentration will be stronger than that produced by simply mixing two equal volumes of  $30\%$  and  $20\%$  (when the final concentration would be  $25\%$  - half way between the two).

The trick with allegation is to see how the final concentration varies depending on the ratio of the different volumes used.

Using the above example – we added 100mls + 50mls

If we had used 50mls of each we would end up with a concentration of 25%.

However we added 100mls of 30% - i.e. 50mls more.

If we had used only 50mls we would have had 100mls of 25%.

Now if we add 50mls of 30% by how much does the concentration change

Using the formula above we would get

$(25/100) \times 100$	gives the amount of drug in 100mls of 25% solution	and
$(30/100) \times 50$	gives the amount of drug in 50mls of 30% solution	and
$(Cf / 100) \times 150$	gives the amount of drug (as a %) in 150mls of final solution	(100 + 50mls)

I won't give all the details but .....

This now gives us  $25 + 15 = (Cf \times 150)/100$

You should see that this is exactly the same as above and gives a concentration of 26.66%

Now using statistics, it can be shown that the final concentration can be calculated much more simply by reducing the algebraic method above ( which shows that the final concentration is dependant on the ratio of the two volumes - rather than their absolute measure - and the difference between their percentage) as follows :-

$$Cf \times Vf = (Ca/ 100) \times Va + (Cb/ 100) \times Vb$$

But  $Vf = Va + Vb$  (Va and Vb are the volumes of A and B and the final volume)

And the concentration will change depending on the ratio between the volumes of Va and Vb (multiplying Va and Vb by any number in the above equation has no effect on the final answer as Vf would also increase proportionally and cancel any effect out .)

e.g. Adding 200mls of 30% and 100mls of 20% will give the same final concentration as adding 100mls of 30% and 50mls of 20% as the final concentration simply depends on the ratio of the two different concentrations used.

So instead of Va and Vb and Vf we use Pa, Pb and Pf to represent the ratio of the volumes as parts. This is in fact a simple way of calculating the amounts.

The old method showed that the ratio by volume of the two different concentrations are as follows

$$Pa \times (Cf - Cb) : Pb \times (Ca - Cf) \quad \text{and} \quad Pf = Pa + Pb$$

This however was calculating the actual volumes  
 We can reduce this formula (which just uses simple ratios) and parts makes it a lot simpler

**and we can now also try and forget the more complicated Algebra**  
 as it becomes

$$P_a = C_f - C_b$$

$$P_b = C_a - F_c$$

$C_f$  = Final Concentration  
 $C_a$  = Concentration of Stronger Solution  
 $C_b$  = Concentration of weaker solution  
 $P_a$  = Parts of A (by Volume but change to weight if  $C_a = 100\%$ )  
 $P_b$  = Parts of B by volume  
 $P_f$  = Final Volume (=  $P_a + P_b$ ) (note the use of parts rather than  $V_a$  and  $V_b$ )  
 Now using our first example of 100mls of 30% and 50mls of 20% - we need to calculate the final percentage strength –  $C_f$

Substituting in the formulae given, we get (**and remember the volumes are being used as RATIOS to each other**)

$$P_a = C_f - C_b = P_a = C_f - 20 \dots\dots\dots A$$

$$P_b = C_a - C_f = P_b = 30 - C_f \dots\dots\dots B$$

This gives two simple algebraic equations

Using the example, now we know that  $P_A = 100$  and  $P_b = 50$  (as a ratio)

So  $P_a = 2P_b$

So we can rewrite the equations :-

$$P_a = C_f - 20$$

$$2P_b = (30 - C_f) \times 2 = 60 - 2C_f \quad (\text{I am multiplying equation B from above by 2})$$

But these two equations are equal because  $2P_b = P_a$

$$C_f - 20 = 60 - 2C_f$$

Rearranging

$$3C_f = 60 + 20$$

$$C_f = 80/3 = 26.6666\%$$

Now as the extreme limits of any concentration are 0% and 100%, you should see that you can use this to calculate any concentrating process or diluting process.

\*\*\*\*\*

### Example 1

e.g. How do you make a 10% solution into a 5% by adding water.

Cf = Final Concentration	= 5%
Ca = Concentration of Stronger Solution	= 10%
Cb = Concentration of weaker solution	= 0%
Pa = Parts of A (by Volume but change to weight if Ca = 100%)	= Pa
Pb = Parts of B by volume	= Pb ( <b>unknown</b> )

$$Pa = 10 - 5 = 5$$

$$Pb = 5 - 0 = 5$$

i.e. you use the same volume of 10% solution as pure water.

### Example 2

How do you make a 30gms of 3% ointment up to 10% using pure drug ?

Cf = Final Concentration	= 10%
Ca = Concentration of Stronger Solution	= 100%
Cb = Concentration of weaker solution	= 3%
Pa = Parts of A (by Volume but change to weight if Ca = 100%)	= Pa ( <b>unknown</b> )
Pb = Parts of B by volume	= 30 (gms)

$$Pa = 10 - 3 = 7$$

$$Pb = 100 - 10 = 90$$

$$\text{Total parts} = 97$$

$$\text{But } Pb = 90 \text{ parts} = 30\text{gms}$$

$$\text{Therefore } 1 \text{ part} = 30/90\text{gms} = 3/9 \text{ gms} = 0.333$$

$$\text{So } 7\text{parts} = 3/9 \times 7 = 2.333\text{gms}$$

So you need to add 2.33gms of pure drug to 30gms of 3% ointment to make it a 10% ointment

$$\text{Check } 30\% \text{ of } 3\% \text{ ointment contains } 3/100 \times 30\text{gms Drug} = 0.9\text{gms}$$

$$\text{Adding } 2.331\text{gms drug will give } 2.331 + 0.9\text{gms} = 3.233\text{gms drug}$$

$$\text{And the total weight of ointment when mixed will be } 30 + 3.233\text{gms} = 33.233\text{gms}$$

$$10\% \text{ of } 33.233 = 3.323\text{gms}$$

(Note when recurring decimals occur the figure can never be exactly right.).

### **Example 3**

How much 10% ointment do you need to add to 30gms of 3% Ointment to make it 6%

Cf = Final Concentration = 6%  
Ca = Concentration of Stronger Solution = 10%  
Cb = Concentration of weaker solution = 3%  
Pa = Parts of A (by Volume but change to weight if Ca = 100%) = Pa **(unknown)**  
Pb = Parts of B by volume = 30 (gms) by weight

$$Pa = 6 - 3 = 3$$

$$Pb = 10 - 6 = 4$$

Now 4 parts = 30gms so 1 part =  $30/4 = 7.5$ gms

Therefore

3 parts = 22.5gms

so you would need to add 22.5gms of 10% Ointment to 30gms of 3% Ointment to make a 6% Ointment

### **Quick Check**

$22.5 + 30\text{gms} = 52.5\text{gms total.}$

52.5gms of 6% Ointment contain  $6 \times 52.5/100\text{gms} = 3.125\text{gms Drug}$

22.5gms 10% Ointment contain  $10 \times 22.5/100\text{gms} = 2.25\text{gms Drug}$

30gms of 3% Ointment contain  $3 \times 30/100 = 0.9\text{gms Drug}$

Total amount of drug in 52.5gms is 3.125gms

### **Example 4**

How much water do you need to add to 500mls of 80% to make it 35%

Cf = Final Concentration = 35%  
Ca = Concentration of Stronger Solution = 80%  
Cb = Concentration of weaker solution = 0%  
Pa = Parts of A (by Volume but change to weight if Ca = 100%) = 500mls (by volume)  
Pb = Parts of B by volume = Pb **(unknown)**

$$Pa = 35 - 0 = 35$$

$$Pb = 80 - 35 = 45$$

Total Parts = 80 but 35 parts = 500mls

$$\text{So 1 part} = 500 / 35$$

$$\text{And 45 parts} = 500 \times 45 / 35 = 500 \times 9 / 7 = 4,500/7 = 643\text{mls (approx)}$$

### Quick check

So you would need to add 643mls water

This would give a total volume of  $643 + 500\text{mls} = 1143\text{mls}$

1143mls of 35% contain  $35 \times 1143/100\text{gms} = 4000.5\text{gms (approx)}$

500mls of 80% contain  $500 \times 80/100 = 400\text{gms}$

### NOTE -

in this example  $Pa = 35$  and  $Pb = 45$

As this is a calculation on ratios, you could divide both numbers by 5 to give

$$Pa = 7 \text{ and } Pb = 9$$

The ratio is the same and gives a total number of parts equal to 16

1 part would equal  $500/16$

7 parts would equal 500mls and 1 part would equal  $500/7\text{mls}$

9 parts would equal  $(500 \times 9)/7 = 643\text{mls}$

Try and see that  $(500 \times 7)/9$

is exactly the same calculation as  $(500 \times 35)/45$

and that both equal 643

### Example 5

You start with a 30% solution and manufacture 2 litres of a 6% Solution using a 1% solution to dilute the 30% solution. How much of each concentration was used ?

$C_f$ = Final Concentration	= 6%
$C_a$ = Concentration of Stronger Solution	= 30%
$C_b$ = Concentration of weaker solution	= 1%
$P_a$ = Parts of A (by Volume but change to weight if $C_a = 100\%$ )	= $P_a$ ( <b>unknown</b> )
$P_b$ = Parts of B by volume	= $P_b$ ( <b>unknown</b> )
$P_f$ = Parts of final solution by volume	= 2 Litres

This calculation is a little more tricky as you only know the final volume and need to calculate the value of the two constituent volumes

$$P_a = 6 - 1 = 5$$

$$P_b = 30 - 6 = 24$$

$$P_a + P_b = 2000\text{mls} \quad (2 \text{ Litres}) \quad \text{and} \quad (\text{the final volume})$$

$$\text{Total Parts} = 24 + 5 = 29 \text{ parts}$$

$$29 \text{ parts} = 2000\text{mls}$$

$$\text{So } 1 \text{ part} = 2000/29 = 69\text{mls (approx)}$$

So you need

$$5 \text{ parts of } 30\% \text{ solution} = 69 \times 5\text{mls} = 345\text{mls}$$

And

$$24 \text{ parts of } 1\% \text{ solution} = 69 \times 24 = 1656\text{mls}$$

$$1656 + 345\text{mls} = 2001\text{mls}$$

### **Check**

$$2000\text{mls of } 6\% \text{ contains } 2000 \times (6/100)\text{gms} = 120\text{gms}$$

$$345\text{mls of } 30\% \text{ contains } 345 \times (35/100)\text{gms} = 120.75\text{gms}$$

These small discrepancies should not be a problem in the exam as the difference between individual answers is around 10% or more.



So the train travelling at 100 miles an hour will travel 300 miles (3 hours)  
 And the train travelling at 75 miles an hour will travel 225 miles (3 hours)

If you cannot see the relationship immediately, you know that  
 $Pa + Pb = 3p + 4p = 525$  miles (the distance between the trains)  
 and if  $7p = 525$  then  $p = 525/7 = 75$  miles

Substituting the value of P in the equations  
 $4 \times 75 = 525 - Bc$  so the distance B travels (or solution B ontributes) =  
 $Bc = 525 - 300 = 225$  miles (or bits of solute)  
 And  
 $3 \times 75 = Ac - 525$   
 $Ac = 525 - 225 = 300$  miles (or bits of solute)

**Alternatively think about this problem in relation to time.**

Every hour Train A travels 100 miles and Train B travels 75 miles.  
 So each hour a total of 175 miles is travelled  
 The distance they are apart is 525 miles.  
 So they will meet at  $525/175$  hours  
 = 3 hours.  
 In 3 hours train A travels  $3 \times 100$  miles = 300 miles  
 And train B travels  $3 \times 75$  miles = 225 miles

**You can do this using algebra**

Train A travels a distance of A miles in 1 hour.	100
Train B travels a distance of B miles in 1 hour	75
Total distance travelled in 1 hour = A + B	175
Distance apart = C	525
Time taken to meet and crash = $C/(A + B)$	$525/175$
Distance travelled by A = $(C/(A+B)) \times A$	$(525/175) \times 100 =$
300	
Distance travelled by B = $(C/(A+B)) \times B$	$(525/175) \times 75 =$
225	
And $C = (C/(A+B)) \times A + ((C/A+B)) \times B$	$((525/175) \times 100) + ((525/175) \times$
$75) = 525$	

Now you can substitute any speeds and any distance  
 (You cannot use such a simple starting formula in alligation as we normally deal with percentage concentrations) but these are roughly the formulas from which the simple allegation equations are derived.)



## Chloroform and Waters BP

There are many different Concentrated Waters but most are now rarely used.

They are a throwback to the days of extemporaneous dispensing.

Waters were normally stored as 'Concentrated Waters to reduce space- and the concentrated waters may contain a significant amount of alcohol (around 50%).

The concentration of the water depended on its solubility in water :-

Name of Water BP	Strength (Concentrated)	Strength As 'water'	Comment
Chloroform	10%	0.25%	BP 1959 Care when diluting – easily separates
Peppermint	2.0%	0.025%	BP 1973 Concentrate is 60% alcohol
Anise	2.0%		Concentrate contains 70% alcohol
Camphor	4.0%	0.05%	
Cinnamon	2.0%	0.025%	Concentrate is 60% alcohol

Despite the problems with Peppermint Water, it is still very difficult to find any details of actual concentration anywhere of Concentrated Waters and the safety sheet for peppermint water focuses on the alcohol as a risk  
There is no readily available list of the strengths of B.P. Waters

Concentrated Chloroform Water is sometimes called Chloroform Water Concentrate.

Converting a concentrated water to standard strength water requires a 1 in 40 dilution.

Concentrated Waters and their strengths are not mentioned in the BNF or MEP.

Any pre-reg exam questions based on their percentage strength is extremely rare as there is the need to provide the strength in the actual question. The exception is Chloroform Water which is still in common use and it is expected that the strength is known.

When diluted to standard or single strength they have various properties - flavouring / preservative etc. and the concentrated form is a way of storing economically and providing ready access to a method of preparing the single strength in a preparation. Some are known as Aromatic Waters.

The common theme is that all Concentrated Waters BP are 40 times as strong as the single strength water BP.

So to dilute a Concentrated Water to a single strength requires a 1 in 40 dilution

To dilute a double strength water to a single strength water requires a 1 in 2 dilution

To dilute a concentrated water to a double strength water requires a 1 in 20 dilution

This latter dilution is important and a common component of questions – especially where this involves preparing certain extemporaneous medications. The question often requires the person answering it to distinguish between using concentrated waters and double strength waters.

Extemporaneous preparations are often made using double strength waters so that when made up to a final volume, the overall strength equals a single strength water.

E.g.

If making 300mls of an extemporaneous preparation, how much

- 1) Double strength water Chloroform Water is needed
  - 2) Concentrated Chloroform Water is needed
- 
- 1) = 150mls
  - 2) =  $\frac{1}{40}$  of 300mls = 7.5mls

## Dilutions (Serial)

Problems involving serial dilutions usually involve :-

- a) A Stock Solution - the most concentrated
- b) An intermediary solution - usually being supplied to the patient
- c) A Final Solution - prepared by the patient

These are not all inclusive and there are different versions.

A typical question asks

A Patient is to use a solution of Concentration C

If Made by diluting an intermediary solution(B) X times

How much of solution A of concentration Y is needed to supply sufficient of B for Z days (or for Z doses)

These appear complicated but can often be answered very simply as most of the values are known

Here is the same problem but with different values to be calculated.

### Example 1

A Patient is to use 2 litres of a solution of Concentration 1 in 20,000 of drug X once a day

This is to be made by diluting an intermediary solution(B) 50 times

How much of solution A of concentration 30% is needed to supply sufficient of B for 20 days.

Solution

Each 2 litres of C will be made from  $2000/50$  mls of B  
= 40mls

The concentration of B will be = 1 in  $(20,000/50)$  = 1 in 400

Convert this to percentage  
= 1 in 400  
= 0.5 in 200  
= 0.25 in 100 = 0.25%

So solution B is 0.5% and we need 40mls a day  
= 40 x 20mls in total  
= 800mls

So we need 800mls of 0.25% solution as solution B

The concentration of A is 30%

So the dilution to make 0.25%  
=  $30/0.25$   
= 120

So to convert A to B we need to dilute 1 in 120

As we need 800mls of B this would equal  $800/120$  mls A  
= 6.66mls

A Patient is to use 2 litres of a solution of Concentration X of drug once a day for 2 weeks.

This is to be made by diluting an intermediary solution(B) 150 times

Solution B is made by diluting Solution A 400 times

Solution A has a concentration of 12%

What is the concentration that the patient will use and how much of Solution B is needed.

### **Solution**

Solution B is diluted 150 times to make solution C

So every 2 litres of C is made from  $2000/150$ mls B  
= 13.33mls

For 14 days supply we would need  $14 \times 13.33$ mls  
= 186.6mls

(Note – this may be rounded to 200mls in a question)

### **What is the concentration of C**

A is 12% and is diluted 400 times to make B

So concentration of B =  $12/400$   
= 0.03%

Solution C is made by diluting B 150 times

So concentration of C =  $0.03/150$   
= 0.002%

You could use parts for the concentration if the answer is given in parts

### **What is the concentration of C in parts**

A is 12% and this is 12 in 100

and is diluted 400 times to make B

So concentration of B =  $12/400$  in 100  
= 0.03 in 100  
= 3 in 10,000

Solution C is made by diluting B 150 times

So concentration of C =  $3/150$  in 10,000  
=  $30/150$  in 100,000  
=  $300/150$  in 1,000,000  
= 2 in 1,000,000  
= 1 in 500,000

Check 1 in 2,000,000 = 0.002%

## **Dilution in Parts**

Remember this  $1\% = 1 \text{ in } 100 = 10\text{mg in } 1\text{ml}$

This has a neat combination of 3 different ways of expressing strength

1 in 100 = 1%                      1 in 10000 = 0.1%                      1 in 1000000 = 0.001%  
10mg in 1ml                      1mg in 1ml                      1 microgram in 1ml

<b>Ration (in)</b>	<b>Ratio (to)</b>	<b>Percentage</b>	<b>Strength</b>
1 in 2	1: 1	50%	500mg in 1ml
1 in 3	1:2	33.33%	333.3mg in 1ml
1 in 4	1:3	25%	250mg in 1ml
1 in 5	1:4	20%	200mg in 1ml
1 in 8	1:7	12.5%	125mg in 1ml
1 in 10	1:9	10%	100mg in 1ml
1 in 40	1:39	2.5%	25mg in 1ml
1 in 100	1:99	1%	10mg in 1ml
1 in 1000	1:999	0.1%	1mg in 1ml
1 in 8000	1:7999	0.0125%	0.125mg in 1ml
1 in 10000000	1:999999	0.001%	1mcg in 1ml

Note that the same 'values' recur and only the zeros and decimal points vary.

Note 1 in 40                      is weaker than 1 in 10  
      1 in 800                     is weaker than 1 in 100  
      1 in 8 million               is weaker than 1 in 1 million

## DISPLACEMENT VALUES

Displacement values are used where a known weight is to be added to a liquid (or solid) to arrive at a final fixed 'volume'.

I.e. the calculation involves a weight in volume.

Displacement values are not needed for w/w calculations.

Most suppository moulds are made to contain a certain known weight of a **base**.

To add a known weight of drug it is necessary to use the final 'volume' of the mould to calculate a formula as the moulds are filled to completion, and it is the final fixed **volume** that is used as the final measure.

However it is the weight of the base that occupies that final volume that is used in calculations that involve adding drugs by weight to that final volume.

Think of it this way.

When Archimedes stepped into a full bath of water and it overflowed - he shouted Eureka !

Well - how much water would he have needed to remove so that when he got in the bath, it was full to the brim but no water was spilt ?

( luckily Archimedes didn't dissolve in the water !).

The answer is a volume of water equal to the volume of Archimedes - but this water would have a different weight to Archimedes.

It is therefore highly unusual (almost impossible) to find suppository strengths specified by percentage strength as it would therefore also be necessary to know the actual weight of the final suppository and that percentage would have to equal a fixed dose of the drug.

Try thinking about what would be the real meaning of the following :-

A suppository contains 10% Paracetamol (or a tablet contains 10% paracetamol)  
compared with

A suppository contains 500mg Paracetamol (or a tablet contains 500mg Paracetamol)

A 500mg Suppository of Paracetamol contains 500mg Paracetamol, no more , no less (the suppository may weigh between 2 and 4gms or more or some unspecified weight – and its size is possibly of more importance !).

A 10% Suppository of Paracetamol contains how much ??

(a suppository weighing 2gms would contain 200mg and one of 4gms , 400mg )

A 50% Paracetamol suppository does not contain 500mg unless its total weight is exactly 1gm

E.g. How much water (by weight) is to be added to 10gms Sugar , 20 gms Sugar or 30gms of sugar to ensure a final volume of **40mls.**

As sugar has a different density to water, the answer is NOT 30, 20 or 10mls but a volume based on the density of sugar in relation to the density of water.

I.e. The displacement value is a relationship between the volumes occupied by the same weight of two different materials.

The displacement value for any single material will vary depending on what is going to be used as the base solvent or diluent.

(Many books give a single displacement value using Theobroma oil as the standard base and assume that displacement value is the same for all other bases)

e.g

The displacement value of Drug X in Theobroma oil is 4      4gms Drug X displace 1gm Theobroma oil

The displacement value of Drug X in Witepsol is 3      3gms Drug X displace 1gm Witepsol

As the diluent or base is usually water or an organic material as in suppositories, displacement values are often greater than 1

E.g. - The displacement Value of Drug A in Witepsol (a suppository base) is 5. This means 5gms drug A displace 1gm Witepsol

So to make 1 x '5gm Suppository' of Drug A in Witepsol would require 5gms Drug A and 4gms Witepsol.

Remember that the '5gm Suppository' refers to a fixed volume suppository mould.

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### Simple calculation

Drug A has a displacement value of 5 in Witepsol  
It is intended to make 20 x 4gm suppositories each containing 1gm drug A  
What quantities of each will be required.

remember the 4gm relates to a Suppository Mould

**Question :- What will each suppository weigh**

### Answer

Total weight of suppository base would be  $20 \times 4\text{gms} = 80\text{gms}$   
However we will be adding  $20 \times 1\text{gm Drug A} = 20\text{gms}$   
Displacement value is 5  
so 20gms drug A will displace  $20/5\text{gms Witepsol} = 4\text{gms}$   
so quantities will be **20gms drug A and  $(80-4) = 76\text{gms witepsol}$**

### Answer

Each suppository will weigh  $(76 + 20)/20\text{gms}$   
 $= 96/20\text{gms}$   
 $= \mathbf{4.8\text{gms}}$

An alternative way of calculating this is  $4 + 1 - (1/5)$   
 (Mould weight + Weight of drug - weight of base displaced)

When making suppositories and / or powders, it is good practice to make a slight excess to ensure a full batch can actually be made.

**Example**

A drug with a displacement value of 0.5 in Theobroma is required in suppository form. 200mg suppositories are required and a 2gm mould is available.  
 What are the quantities to be used to manufacture a batch of 24.  
 What will each suppository weigh ?

**Answer**

24 x 2gm suppositories = 48gms base  
 24 x 200mg = 4.8gms drug  
 4.8gms base displace  $(4.8/0.5)$  gms theobroma = 9.6gms  
 So weight of ingredients = **4.8gms drug A + (48-9.6) = 38.4gms Theobroma**  
 each suppository will weigh  $(4.8 + 38.4)/24$ gms  
 $= 43.2 / 24$ gms = **1.8gms**

Here are the displacement values for some drugs in Cocoa Butter (Theobroma Oil) (an old suppository base)			
Aspirin	1.1		
Alum	2.0	Phenol	1.0
Aminophylline	1.5	Quinine Hydrochloride	1.0
Cocaine Hydrochloride	1.5	Zinc Oxide	5.0
Iodoform	4.0	Zinc Sulphate	2.0
Morphine Hydrochloride	1.5		

Displacement values are also important in the manufacture of some solid dose tablets where the difference in density between a drug and Lactose (The vehicle it usually replaces) can be important.

It is imperative that both solute and solvent are named when using displacement values or displacement volumes. some texts ((introduction to Pharmaceutical calculations (pharmaceutical press 1st edition) fail to draw attention to this.

An alternative method sometimes used is to give displacement volumes. Again it is important to remember that the displacement volume will be specific for a pair of named solutes and solvents.

**Example :-**

The displacement volume for Diamorphine in water is 0.12mls per 10mg

This means that 10mg Diamorphine will displace 0.12mls water.

100mg Diamorphine will displace  $0.12 \times (100/10)$  mls = 1.2mls water

1gm (1000mg) Diamorphine will therefore displace 12 mls water

Therefore the displacement value for Diamorphine would be  $1/12$  or 0.0833

1gm Diamorphine would therefore displace  $1/0.0833$ mls water = 12 mls

What this means is that 1gm of Diamorphine has the same volume as 12mls of water

A displacement value greater than 1 indicates that a material is more dense than the solvent in which it will be mixed (and thus displace).

A displacement value less than 1 indicates that a material is less dense than the solvent in which it will be mixed (and thus displace).

Keep in mind that what you are being asked to calculate with displacement values relates to equal volumes rather than equal weights.

Many calculations involving displacement values will also require additional suppositories to be made (or included in the calculation). E.g. A prescription will be for 20 suppositories but you will be asked to calculate the quantities for 24 suppositories (to allow for loss in manufacturing).

## Molarity and Millimols

A commonly used concentration unit is Molarity.

Molarity is defined as the moles of solute per litre.

A 1 Molar solution contains 1 Mole in 1000mls

Solutions may simply be referred to as Molar solutions

E.g. A 2 Molar solution has a strength of 2 Moles /Litre

A 0.4 Molar solution has a strength of 0.4 Moles / Litre

If a solution's strength is expressed as a molarity, there is no need to specify any volume.

Compare a 2 Molar Solution and a 2% Solution

Their actual concentration is defined through the terms Molarity and Percentage as these are terms expressing defined ratios.

Molarity defines the total number of atoms or molecules in every 1000mls

Percentage defines the weight contained in every 100mls

Solutions can also be defined as containing a number of Moles / Volume

e.g. 2 Moles in 600mls.

This is less common than using the former

The second definition can be converted to the first by dividing the number of Moles or Millimoles of solute by the volume of the solution in millilitres.

e.g. a 2 Mole in 600mls is a  $2.0 / 0.6$  or 3.33 Molar solution

One Mol of any particular element or compound contains  $6.02 \times 10^{23}$  atoms or molecules (this is Avogadro's number)

and the weight of a Mole is also known as the Relative Molecular Mass

This is normally expressed in grams as the Gram Molecular Weight.

As examples,

One Mole of Hydrogen weighs 1gm.

One Mol of Sodium Chloride weighs 58.5gms

So a molecule of NaCl is 58.5 times heavier than 1 atom of Hydrogen

The symbol used for Moles is the capital letter M.

For example :-

a 3M Sodium Chloride solution, contains 3 moles of NaCl in every litre of that solution.

One Mole of any product by definition will contain 1000 millimoles

One Litre contains 1000 millilitres

So a 1M solution contains 1 Mole in 1000mls = 1000 millimols in 1000mls

= 1 millimole in 1 millilitre

So a 3M solution of Sodium Chloride contains 3 millimoles of NaCl in every millilitre of solution.

### **A Mole of any chemical is its atomic or molecular weight in grams**

An alternative, and more correct way of thinking is that Moles (mol) represent amounts of substances in the unit of Avogadro's number ( $6.022 \times 10^{23}$ ) of atoms and molecules.

Since empirical formulas e.g.  $\text{Fe}^{2+}$  ions and  $\text{Fe}_2\text{O}_3$  are used for ionic compounds, a mole represents Avogadro's number of ions or per formula as written.

A mole of  $\text{Fe}^{2+}$  has  $6.022 \times 10^{23}$  ions.

A mole of  $\text{Fe}_2\text{O}_3$  has

$1.204 \times 10^{24}$  Fe atoms (Avogadro's number  $\times 2$ ) and

$1.8066 \times 10^{24}$  O atoms (Avogadro's number  $\times 3$ ),

Which is a total of  $3.0 \times 10^{24}$  Fe and O atoms combined (Avogadro's number  $\times 5$ ) since in each molecule there are a total of 5 atoms.

The mole is a very important unit for chemical reactions, so is the skill to convert masses in g to mol.

The number of moles of a substance in a sample is the mass in g divided by the molar mass. This gives the amount in moles.

Mole = (Mass (g)) / (Molar Mass (g / mol))

(Molar Mass = Gram Atomic weight or Gram Molecular Weight)

density = mass (g) / volume (cm<sup>3</sup>)

mass = density (g cm<sup>-3</sup>) \* volume (cm<sup>3</sup>)

For Monovalent atoms or molecules – numerical values of millimoles and milliequivalents are EQUAL

Millimoles: 1/1000th molecular weight in grams

So if the Weight of 1 Mole of Sodium Chloride = 58.5gms (23 + 35.5)

The weight of 1 millimole = 58.5mg (58.5g/1000)

Milliequivalent: This is used to express the concentration of electrolytes in solution – measures the chemical activity of an electrolyte.

A milliequivalent is the weight of an ion in relation to its atomic or molecular weight that carries a single positive or negative charge – i.e. would combine with or replace one atom of Hydrogen).

E.g.

How much Ammonium Chloride must we give a 60Kg patient if the dose is 6 milliequivalents per kg ?

Ammonium Chloride Formula	= (NH Cl)
Molecular wt	= 53.5g
	= equivalent wt ( as NH and Cl are monovalent )
Millimole	= 53.5mg = Milliequivalent
6 mEq	= 6 x 53.5mg
	= 321 mg
Amount of NHCl to administer	= (Wt in Kg) x 321
	= 60 x 321
	= 19260mg
	= 19.26gms

### Simple examples

Gold has an atomic weight of 197. How many moles of gold are present in a mass of 1.0 kg?

Answer  $1000/197 = 5.076$  moles

A litre of water has a mass of 1.0 kg . The molecular weight of water is 18 (16(O) + 2(H x 2)). How many moles of water are 1.0 kg?

Answer =  $1000/18 = 55.6$  moles

Urea, Formula  $\text{CH}_4\text{N}_2\text{O}$  (Molecular Weight 54.6) , is used as a fertilizer and also used as a skin hydrater in creams.

Each year usage amounts to around 1 million tons of urea.

If 1 ton = 983 Kg , how many moles are present is this amount?

Answer

=  $983,000 / 54.6$  moles / ton

= 18,003 moles per ton

= 18,003 million moles or 18.003 billion moles

### A slightly more complex problem

Two solutions are mixed: 35mls of 0.284M KCl (Potassium Chloride) and 45mls of 0.196M AlCl<sub>3</sub> (Aluminium Chloride).

Assuming that the volumes are additive, what is the molar concentration of Cl<sup>-</sup> in the resulting solution?

(Note the above are expressed as Moles of Salt and remember there are three Cl<sup>-</sup> ions in AlCl<sub>3</sub>)

- a. 0.124M
- b. 0.235M
- c. 0.382M
- d. 0.404M
- e. 0.455M

The final concentration in moles will be ((Moles in Potassium Chloride) + (Moles in Aluminium Chloride)) / (final volume)

Answer :- (There are much quicker ways of calculating this answer – and you need a calculator !)

How many Moles of Chloride are there from the Potassium Chloride  
(35 x 0.284) / 1000 (Moles in Potassium Chloride)  
= 0.00994

How many Moles of Chloride are there in the Aluminium Chloride  
(45 x 3 x 0.196) / 1000 (Moles in Aluminium Chloride)  
= 0.02646

So total Moles = 0.00994 + 0.02646 moles  
= 0.0364 Moles

Final volume = 35 + 45mls = 90mls

So the molar concentration = (0.0364/90) x 1000  
= 0.404M

## Using the Molarity Term

### Example

A sample of NaCl weighing 5.8gms is placed in a IV Bag and made up to a volume of 500mls with sterile water.

Assuming the molecular weight of Sodium Chloride is 58, calculate the Molarity of the resulting solution.

### Solution

Convert the given grams of solute to moles of solute by dividing by the molecular weight of NaCl

$$\begin{aligned} 1 \text{ mole NaCl} &= \text{Molecular mass of NaCl expressed in grams} \\ &= 23 (\text{Na}) + 35 (\text{Cl}) = 58 \text{ grams} \\ &\quad \text{(Note these may vary in other examples)} \end{aligned}$$

$$\begin{aligned} \text{Molarity} &= 5.8 \text{ grams} \times (1 / 58) \\ &= 0.1 \text{ mole NaCl in 500mls} \end{aligned}$$

Convert given mls of solution to litres by dividing by 1000:

$$\begin{aligned} 1 \text{ litre} &= 1000 \text{ ml} \\ 500 \text{ ml}/1000 &= 0.500 \text{ litres} \end{aligned}$$

Apply the definition for Molarity:

Molarity = moles NaCl / volume of the solution in litres

$$\begin{aligned} M &= 0.1 \text{ mole in 0.500 litres} \\ &= 0.2 \text{ moles in 1 Litre} \\ &= 0.200 \text{ Molar NaCl} \end{aligned}$$

### Example 2

You weigh out 73 grams of KCl (Gm Molecular weight 73gms) and place it in a 250 ml volumetric flask.

You fill the flask up to the designated 250ml mark on the neck.

Determine the Molar concentration of this solution.

$$\begin{aligned} \text{Molarity} &= 73\text{gms} \times (1/73) \\ &= 1\text{Mole KCl in 250mls} \\ 250\text{mls} &= 0.25 \text{ Litres} \quad (250 / 1000) \\ M &= 1 / 0.25 \\ &= 4 \text{ Molar Potassium Chloride Solution} \end{aligned}$$

Alternatively 1 mole in 250mls = 2 moles in 500mls = 4 moles in 1 Litre = 4 Molar

### Example 3

I have a 5M solution of NaCl, I want to make a 100ml solution of 0.1 NaCl. What volume of the 5 Molar solution is required ?

The change in Molarity is 5M to 0.1M =  $50.1 = 50$  times dilution

Therefore the dilution required is 1 in 50

The required final volume is 100mls

To make this will require  $1/50$  of that volume (as it will be diluted 50 times)

=  $100/50$

= 2mls

So 2mls of 5 molar Sodium Chloride should be diluted to 100mls to produce a 0.1 molar solution.

### More complicated examples with Moles

#### Weight percentage and mole percentage

A chemical formula provides the formula and weight and also accurately represents the percentages of elements in the compound

If you know the percentage of constituents of a compound, you can derive its formula. (This is how organic compounds were first analysed)

Percentage based on weights is called weight percentage, and percentage based on the numbers of atoms or moles is called mole percentage.

#### **Example**

What are the weight and mole percentages of S in sulphuric acid?

Molecular weight of Sulphuric Acid  $H_2SO_4 = 98$

(Oxygen = 16, Hydrogen = 1 Sulphur = 32)

#### **Solution:**

There are 32g of S in 98.0 g of Sulphuric Acid.

Thus the Weight percentage =  $32/98 = 32.7\%$

From the formula, there is one S atom among 7 atoms in Sulphuric Acid - $H_2SO_4$

Mole percentage =  $1/7 = 14.3\%$

### Example 2

What are the weight and mole percentages of C, H, N, and O for caffeine,  
Formula :-  $C_8H_{10}N_4O_2$ ? (C=12, H=1, N= 14,O = 16)

$$\begin{aligned}\text{Molecular Weight} &= (12 \times 8) + (10 \times 1) + (14 \times 4) + (16 \times 2) \\ &= 96+10+56+32 \\ &= 194\end{aligned}$$

$$\begin{aligned}\text{Weight contributed by Carbon} &= 12 \times 8 = 96 \quad \text{etc.} \\ \text{Weight percentage for Carbon} &= 96 / 194 = 49\%, \\ \text{for Hydrogen} &= 10/194 = 5\%, \\ \text{for Nitrogen} &= 56/194 = 29\% \\ \text{and Oxygen} &= 32/194 = 16.5\%\end{aligned}$$

Mole percentage for :-

$$\begin{aligned}\text{Carbon} &= 8/24 = 33\%, \\ \text{Hydrogen} &= 10/24 = 42\%, \\ \text{Nitrogen} &= 4/24 = 16.7\%, \\ \text{Oxygen} &= 2/24 = 8.3\%\end{aligned}$$

### Example 3

A compound is calculated to have an empirical formula of CH and it has a molecular weight of 78 g/mol.

What is likely to be the molecular formula?

#### Solution:

The formula weight of CH is 13.0. (C= 12 H = 1)

Since  $78/13 = 6$ , this suggests there are 6 units of CH per molecule

The molecular formula is  $C_6H_6$ .

This is the formula for benzene.

(Note an empirical formula only gives the **ratio** of ions. For the correct molecular formula, the molecular weight must be known and for organic compounds a significant amount of additional data would be required).

### **More On Molarity**

How is the molarity for a solution computed from grams of solute and mls of solvent?

#### **Example**

How can I find the molarity of a solution that contains 1.80 g of glucose (MWt 180) in 10.0 mls of water?

#### **Solution**

Calculate the number of moles of solute (Glucose).

In this problem, it's  $1.8\text{g} / 180.0\text{ g} = 0.0100\text{ mol glucose}$ .

Calculate the number of litres of solvent =  $10\text{ ml} / 1000\text{ ml}$

=  $0.0100\text{ litres water}$ .

Divide moles of solute by Litres of solvent.

This solution has a molarity of  $0.0100\text{ mol glucose} / 0.0100\text{ litres water}$

=  $1.00\text{ mol glucose} / \text{litre water}$ .

The concentration as 1.00 M glucose on the label.

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**Do not confuse Molarity with Molality**

Molarity is the concentration in 1 Litre of Solvent (Weight in Volume).

Molality is the concentration in 1Kg Solvent (Weight in Weight)

At 4 centigrade, for any particular chemical in water molarity and molality are equal (at 4 centigrade, 1 Litre water weighs 1Kg)

**To convert molarity into molality.**

If the solution is very dilute, molality and molarity will be about the same, because 1 Litre of a dilute solution will still weigh about 1 kg.

In concentrated solutions, molality and molarity are NOT equal, and it is necessary to know the density (or specific gravity) of the solution to convert one into the other.

For example, to find the molality of a 3.00 M glucose solution with a density of 1.02 g/ml, follow this strategy:

Calculate the number of moles of solute.      It's 3.00 mol glucose in 1 L of solution.

Calculate the number of kilograms of solvent.

Find this as the difference between the mass of the solution and the mass of the solute.

The total mass of the solution is  $1000 \times 1.02 = 1.02 \text{ kg}$ .

So 1.02Kg of solution contains 3.00mmols of Glucose.

So 1Kg of the solution contains  $(3.00/1.02)$  Moles  
 $= 2.94\text{M} = 2.94 \text{ Molality}$

This also suggests that 3Moles of glucose by weight weigh 20gms more than an equivalent volume of water.

## **Millimoles and Milliequivalents**

Most solutes in the body are not measured in grams and moles, but milligrams and millimoles instead.

So we can use the term millimols and milliequivalent when discussing such substances.

Here are some things to keep in mind when converting to milliequivalents:

$$1 \text{ millimol} = 1/1000 \text{ mole} = 10^{-3} \text{ moles}$$

$$1 \text{ meq} = 1/1000 \text{ eq} = 10^{-3} \text{ eq}$$

For monovalent ions, 1 meq = 1 mmol

For divalent ions, 1 meq = 0.5 mmol

For trivalent ions, 1 meq  $\Rightarrow$  0.333 mmol ( $\Rightarrow$  means approximately)

### **Examples**

How many equivalents (mEq) are present in 80 grams of calcium (molecular weight = 40 g)?

Answer = 4 (80/2 - see above)

How many equivalents of sodium are present in 116 g of NaCl (molecular weight of Na = 23; molecular weight of Cl = 35)?

Answer = 116 / 58 = 2eq

How many millimoles of  $\text{Mg}^{+2}$  would be present in a solution containing 0.8 milliequivalents?

Answer

$0.8 / 2 = 0.4$  mmols (as the valency = 2 and mEq / valency = mmols)

How many milliequivalents of  $\text{P}^{-3}$  are present in a solution containing 6 millimoles?

Answer

$= 6 \times 3 = 18$  mEq (As the valency = 3 and mEq = mmols x valency)

## Another Example

How many equivalents of Sodium are in a given volume of saline solution ?  
 If a patient is given 200 ml of physiological saline (0.9 grams of sodium chloride dissolved in 100 ml of solution), how many equivalents of Sodium did the patient receive?

Sodium has an atomic weight of 23 and a valency of 1.

Chloride (Chlorine) has an atomic weight of 35.5 and a valency of 1

If there are 0.9 gm of NaCl in 100 mL, there are 1.8 gms in 200 ml?

So how many moles of NaCl is that, if one mole of NaCl weighs 58.5 g?  
 $= 1.8 / 58.5$  moles  
 $= 0.0307$

(0.3=031 to two significant figures or 3 decimal places)

So how many equivalents of Na -if one mole of NaCl contains one mole of Na ?  
 Sodium has a valency of 1 so 1 mole = 1 equivalent (Eq)

The answer to the problem is 0.031 Eq.

## Some Examples of Atomic and Equivalent Weights and mmols and mEq

Element or Molecule	Atomic / Molecular weight	Valency	Equivalent Weight	Mmols and MmEq
Hydrogen	1	1	1	1mmol = 1mEq
Chlorine	35.5	1	35.5	1mmol = 1mEq
Sodium	23	1	23	1mmol = 1 mEq
Iron (as Ferrous)	55.8	2	27.9	1mmol = 2mEq
Iron (As Ferric)	55.8	3	18.6	1mmol = 2 mEq
Calcium	40	2	20	1mmol = 2 mEq
Calcium Chloride CaCl <sub>2</sub>	111	Ca = 2 Cl = 1	55.5	1mmol = 2 mEq Ca 1mmol = 2 mEq Cl
Aluminium	27	3	9	1mmol = 3 MEq
Sulphate	96	2		1mmol = 2 mEq
Aluminium Sulphate Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	335	Al = 3 SO <sub>4</sub> = 2	55.8	1mmol = 6 mEq Al 1mmol = 6 mEq SO <sub>4</sub>
Sodium Bicarbonate	84	1	84	1mmol = 1 mEq

Note that for some atoms or molecules a milliequivalent appears 'equal' one atom or molecule

While for others, a milliequivalent appears less than one atom or molecule.

Remember that these are equivalent weights.

A milliequivalent is equal to the amount of that element or molecule that will replace or combine with one equivalent weight of Hydrogen.

A Normal solution contains the Gram equivalent weight in 1 Litre . so 1ml of any Normal solution is equivalent to 1ml of any other Normal solution.

## Definitions of Equivalent Weight - All are equivalent

- 1) The amount of a substance that combines with or displaces 8.0 g of oxygen (or 1.008 g of hydrogen), usually expressed in grams; for acid/base reactions, one equivalent donates or receives a mole of protons, and the equivalent weight is the ratio of the molecular weight to the number of protons involved in the reaction. For redox reactions, one equivalent donates or receives a mole of electrons, and the equivalent weight is the ratio of the molecular weight to the number of electrons involved in the reaction.
- 2) The weight in grams of an element, compound or ion which would react with or replace 1 gram of hydrogen; the molecular weight in grams divided by the valence or valency.
- 3) Equivalent: the atomic weight of an element that has the same combining capacity as a given weight of another element; the standard is 8 for oxygen. The equivalent (Eq or eq) is a reasonably common measurement unit used in chemistry and the biological sciences. It is a measure of a substance's ability to combine with other substances. It is frequently used in the context of normality.
- 4) Molar mass divided by equivalents per mole. Used to determine the normality of solutions.
- 5) The atomic or formula weight of an element or ion divided by its valence or valency. Elements or ions entering into combination always do so in quantities proportional to their equivalent weights. In oxidation-reduction reactions the equivalent weight of the reacting substance is dependent upon the change in oxidation number of the particular substances.
- 6) By definition one equivalent (or equivalent weight) of a substance is the amount of that substance which supplies or consumes one mol of reactive species.  
In order to determine the equivalent weight of a substance you must know something about the reaction but the reaction does not have to be balanced. Equivalents can help in the analysis of a substance when the balanced reaction is not known or cannot be written for whatever reason; because one equivalent always reacts with one equivalent.
- 7) The atomic weight of an element that has the same combining capacity as a given weight of another element; the standard is 8 for oxygen
- 8) A Molar Solution contains the gram molecular weight of a chemical in 1 Litre of Solution. A Normal Solution contains the gram equivalent weight in 1 litre of solution.