Skills for Nursing & Healthcare Students

Study skills, maths and science

Second Edition

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SKILLS FOR

Nursing and Healthcare Students

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TABLE 2.2 The values of some common exponents used in scientific notation.

Exponent	Value	Term
10^9	1 000 000 000	billions
10^6	1 000 000	millions
10^3	1 000	thousands
10^2	100	hundreds
10^1	10	tens
10^0	1	ones
10^{-1}	1/10	tenths
10^{-2}	1/100	hundredths
10^{-3}	1/1 000	thousandths
10^{-6}	1/1 000 000	millionths
10^{-9}	1/1 000 000 000	billionths

TIME TO TRY

Express the two numbers below in scientific notation.

24 000 000 = ____________

0.003 = ____________

If you did this correctly, you got 2.4×10^7 and 3×10^{-3}.

APPLYING THE THEORY

Having a number with a large number of 0s can be confusing to read and one could be added or missed when it is written, therefore we use scientific notation. You will see these numbers used on blood reports, e.g. Red blood cells = 5.5×10^{12}/l which would otherwise have to be written as 5 500 000 000 000 cells per litre! (Count the number of places, from the last 0, that the decimal point has been moved.)

My cell's bigger than your cell! **Ratios and proportions**

- Sodium and potassium move across cell membranes in a 3:2 relationship.
- In the United States, the ratio of males to females at birth is about 105:100.
- The ratio of males to females declines steadily until, after age 85, it is only 40.7:100.

Welcome to the comparatively interesting realm of ratios. A **ratio** expresses a relationship between two or more numbers – it is a way to compare them. Ratios can be expressed using a colon between the numbers (as above), as a fraction, or by using the word 'to'. For example, carbohydrates contain hydrogen and oxygen in a 2 to 1 ratio, meaning there are twice as many hydrogen atoms in carbohydrates as there are oxygen atoms.

Ratios are used for comparison, and they can also be expressed as fractions. For example, a ratio of 1:2 means the same as 1/2. Look at that carefully, though. Let's say the ratio of men to women in your anatomy class is 1:2. We're not saying that half of the class are men, we are saying there are half as many men as women.

If you have a ratio, how can you find out what fraction of the whole is represented by each group? Suppose that you are in a class where there are 3 men to 1 woman. The ratio of men to women would be 3:1. Add the individual numbers in the ratio together to get the denominator, in this case the number would be 4: $(3 + 1)$. You can now make this into fractions using the individual numbers in the ratio as the numerators. In this example it means that 3/4 of the class are men and 1/4 are women.

If ratios can be expressed as fractions, they can also be expressed as decimals and percentages. Because they can be written as fractions, they can also be reduced like fractions. For example, a ratio of 4:6 is the same as 4/6, which is the same as 2/3. When working with ratios, it is critical to write them in the correct order. If an anatomy class has 10 males and 20 females, the ratio of males to females is 10:20. If we write it as 20:10, it means there are twice as many males as females, which is not true.

TIME TO TRY

Empty your pocket or purse of change. Separate the coins by denomination. Count all of the coins in each category. Now express those numbers in a ratio: ____________

Why is it important to indicate the order in which you are listing the coins? ____

If you did this correctly, you should have indicated the order of the coins, because without that reference, we have no idea what number corresponds with which coin. Perhaps you had 5 pennies, 4 20p pieces 3 50p coins, and 2 £1.00 coins. If you wrote your ratio in that order, it would be 5:4:3:2.

We also use ratios to discuss quantities in a certain amount. For example, there are about 280 million haemoglobin molecules in each red blood cell. That can be expressed as 280 million/cell, which looks more like a fraction, but it is really saying the ratio is 280 million to 1. Rates are also a special type of ratio. A red blood cell travels about 700 kilometres in its 120-day lifespan, giving a ratio of 700 kilometres/120 days. Drug doses are also often given in this rate format: for example, 5 milligrams per kilogram of body weight.

Proportions are statements of equal ratios. A simple example would be to say $1/2 = 4/8$. In science, we often use proportions to solve problems. To see how, examine a generic version:

$$\frac{a}{b} = \frac{c}{d}$$

Because these two ratios are equal, their cross-products are also equal, due to some basic laws of maths. This means that the product of multiplying the first numerator (a) by the second denominator (d) equals the product of multiplying the second numerator (c) by the first denominator (b):

$$a \times d = c \times b$$

Let's say we want to know how many times the heart beats in an hour. Assume that the heart beats on average 80 beats per minute. We know there are 60 minutes per hour. So, we can set up the proportion,

1. Set up the proportion with what is known, using 'x' to represent the information you are seeking.

$$\frac{80 \text{ beats}}{1 \text{ minute}} = \frac{x \text{ beats}}{60 \text{ minutes}}$$

2. Next, cross-multiply to solve for 'x'.

$$\frac{80 \text{ beats}}{1 \text{ minute}} = \frac{x \text{ beats}}{60 \text{ minutes}}$$

$80 \times 60 = 4800$, and $1x = x$

So $x = 4800$ beats per 60 minutes, or 1 hour

FIGURE 2.4 Using proportions to determine how many times the heart beats in an hour.

filling in the information we know and using 'x' to represent the value we are trying to determine:

$$\frac{80 \text{ beats}}{1 \text{ minute}} = \frac{x \text{ beats}}{60 \text{ minutes}}$$

We know we can **cross-multiply** (**Figure 2.4**). When we do that, we get $4800 = x$, so there are 4800 beats per 60 minutes, or per hour. In fact, there is a simpler way to write this problem, which is a shorter version of cross-multiplying. We know there are 80 beats per minute, and 60 minutes per hour, so we can calculate the beats per hour as follows:

$$\frac{80 \text{ beats}}{\text{minute}} \times \frac{60 \text{ minutes}}{\text{hour}} = \frac{4800 \text{ beats } \cancel{\text{minutes}}}{\cancel{\text{minute}} \text{ hour}} = \frac{4800 \text{ beats}}{\text{hour}}$$

Notice that the units are shown, and in the next to last step, minutes appear on both the top and bottom. That means they cancel each other out, so we are left with beats per hour, which is the correct unit. Using the units can be an easy way to ensure that you have set up the problem correctly. This is another example of taking the time to think through the problem before you start – the units should make sense when you are done.

There are other ways in which proportions are used in science. You may well come across the terms **directly proportional** and **inversely proportional.** These terms are used to explain relationships and are often used to compare rates of change.

When you breathe in (inhale), muscles contract and increase the volume of the chest cavity. The lungs are attached to the inner chest wall and so also move as the chest expands, increasing the lung volume. The lung volume is *directly proportional* to the expansion of the chest under normal circumstances. As the lung volume increases the pressure inside the lung decreases, causing air to be sucked in.

During exhalation (breathing out) the lung volume decreases and the pressure inside the lung increases causing air to be pushed out. As volume increases, the pressure decreases and when the volume decreases the pressure increases. These lung volume parameters and pressure are *inversely proportional*: when one goes up the other goes down.

✔ **QUICK CHECK**

An average person takes about 12 breaths per minute. How many breaths do they take in an hour? _______________

Answer: Set up the proportion: 12 breaths/minute = x breaths/60 minutes.
Cross-multiply: 12   60 = 720 = x, so x = 720 breaths per hour.

Who ever heard of a centimetre worm? **The metric system**

The **metric system,** or **Système Internationalè (SI)**, is universally used in science and by almost every country in the world except the United States. You have undoubtedly had brushes with learning the metric system, and you may have found it difficult.

WHY SHOULD I CARE?

Science uses metric measurement almost exclusively, so you will need a basic understanding of metric units for your course work and for your future career. In addition, almost everyone on our planet – except the United States – uses the metric system.

The metric system is amazingly simple because it is all based on the number 10, so obviously decimals are easy. For our purposes, we'll learn four main units used in science: those that deal with length or distance, mass, volume and temperature. Each of these has a standard or base unit:

- The basic unit of length (or distance) is the **metre** (**m**).
- The basic unit of mass is, technically, the **kilogram** (**kg**), but many sources use the **gram** (**g**) as the base unit instead.
- The basic unit of volume is the **litre** (**l**). (Sometimes litre is abbreviated as L to avoid confusion with the numeral 1.)
- The basic unit of temperature is the **degree Celsius** (**°C**).

These are the base units, but more convenient units are derived from these. For example, a metre is just a bit longer than 3 feet (39.34 inches), so it is not a convenient unit for measuring the size of, say, your finger or a cell. Smaller units of the metre, based on the powers of 10, are used instead. These units are named by adding the appropriate prefix to the term *metre* (Table 2.3). **Centi**- means 1/100, and there are 2.54 centimetres (cm) in an inch, so centimetres work well for measuring fingers. Cells are microscopic, so they are best measured in even smaller units, such as micrometres – one micrometre = 1 millionth of a metre. Driving between cities, you can best measure the long distances in kilometres, each of which equals 1000 metres. Again, all metric units are based on 10. Think about that – you first learn to count from 1 to 10, then you can count by tens to 100, then by hundreds to 1000, and so on. It is an easy system.

Table 2.3 provides many of the prefixes and their base-10 equivalent. In anatomy and physiology, you will use some units more often than others. For length or distance, which is a straight linear measurement, you will mostly work in metres, centimetres, millimetres (1/1000 m), and micrometres. For mass, which is the actual physical amount of something, you will most often refer to kilograms (1000 grams), grams and milligrams (1/1000 g). For volume, which refers to the amount of space something occupies, the most common units will be litres and millilitres.