Medical Math

Can be fun!

What we will cover

- Metric system
- Syringe reading
- Needle sizes
- Weighing animals
- Record keeping
- Administering drugs
  - Calculating the dose
  - Making solutions
  - Diluting meds
  - Drawing up meds

Although our drug calculations here are valid for any method of administration, we will only be discussing how to use PO (oral) drugs in this presentation.

Metric system

What ARE all these things?

Kilograms (kg)

Cubic Centimeters (cc)

Milliliters (mL or ml)

Milligrams (mg)

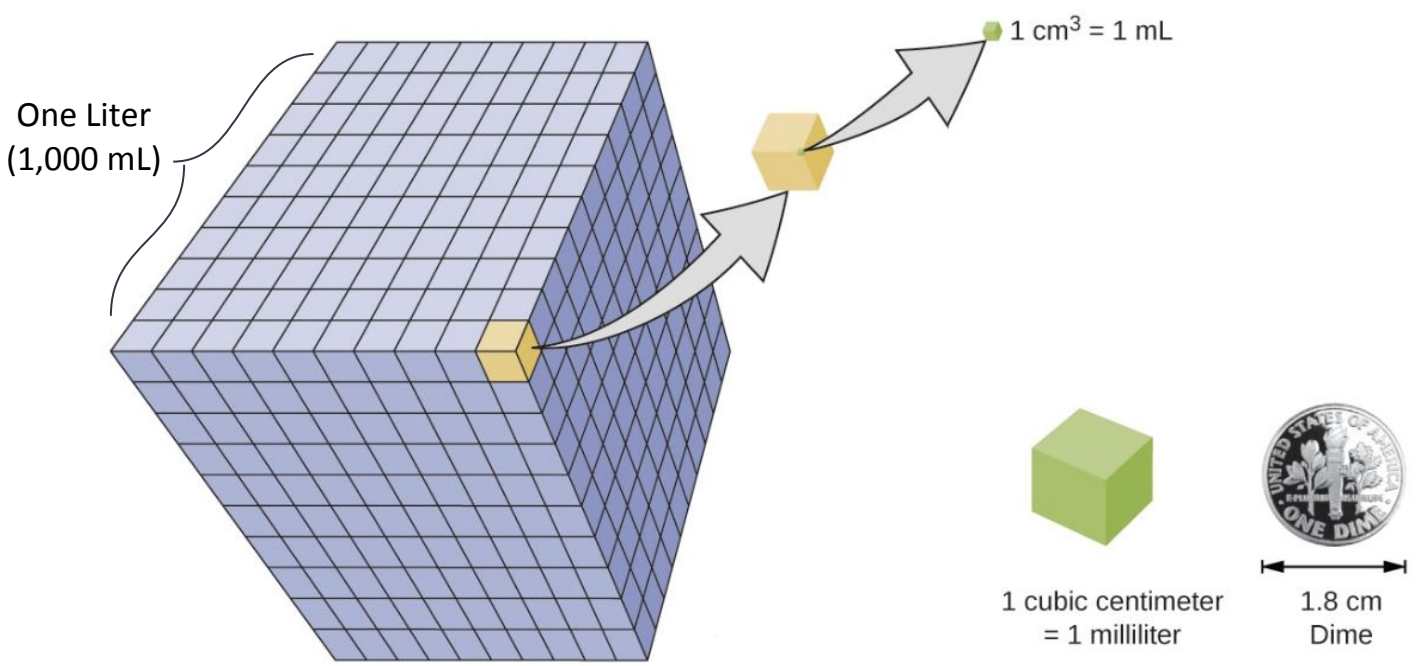
Grams (gm or g)

Terms for volumes and weights

One milliliter and one cubic centimeter are both measures of VOLUME and are the same.

The primary difference is that milliliters are used for liquid amounts only while cubic centimeters are used for liquids AND solids.

One gram is a measure of WEIGHT.


One Liter
(1,000 mL)
1 cm3 = 1 mL
1 cubic centimeter
= 1 milliliter
1.8 cm
Dime

Decimals

Multiplication & Division

Yikes!

- The metric system is based on powers of 10.
- We all use decimals….think MONEY!
- Multiplying or dividing by powers of 10 is simple! Just move the decimal to the right or the left by the numbers of zeros in the multiplier.

Multiplication

Move the decimal to the right;

……one space for each power of 10.

Examples:

$0.03 \times 1000 = 30$

$0.004 \times 100 = 0.4$

How to remember: You should end up with a bigger number!

Division

Move the decimal to the left;

……one space for each power of 10.

Examples:

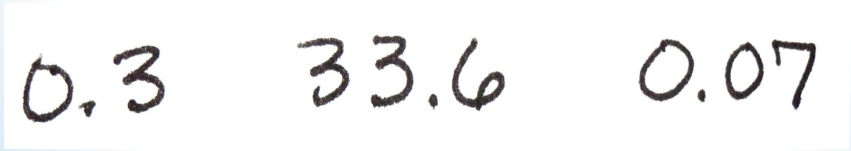
$0.03 \div 1000 = 0.00003$

$4 \div 100 = 0.04$

How to remember: You should end up with a smaller number!

To avoid confusion, you should always show at least one number to the left of a decimal, even (or especially) if it's a zero! Otherwise the decimal can be overlooked.

Examples:



Needle gauges

- The bigger the number, the smaller the diameter of the needle.
- A fairly short needle is good for most rehabber uses.
- You may need a larger needle (smaller gauge) to draw up fluids; then switch to a smaller one (larger gauge) for administering.

Reading a syringe

- Most meds for a small bird or mammal will require a 0.5 cc or a 1.0 cc syringe. *You cannot use a 3.0 cc syringe and get an accurate measurement of a small amount!*
- You *can* use a 3.0 cc syringe or larger to administer subq fluids.

Some types of 1.0 cc syringes

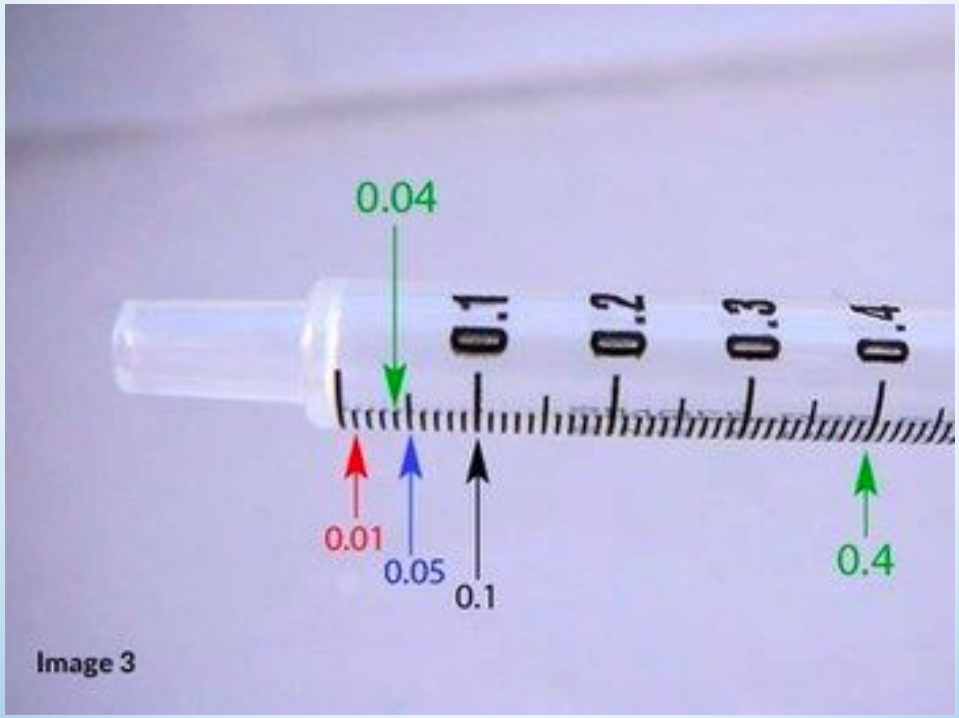
Tuberculin syringe

Insulin syringes

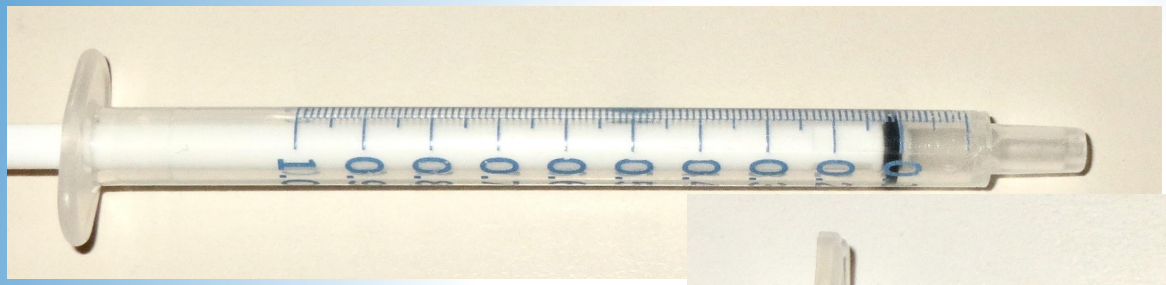
The tuberculin syringe has a hub with a removable needle, and is what you want to use for oral drugs.

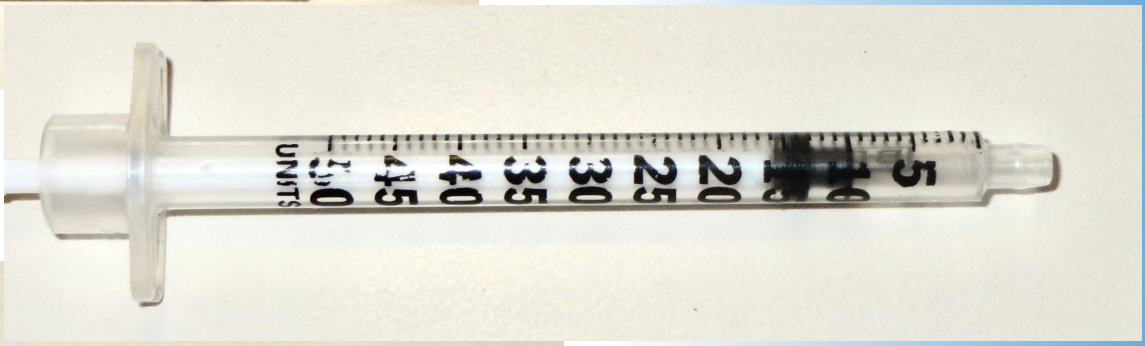
Insulin syringes can be used to give sub-q fluids to very small birds and animals.

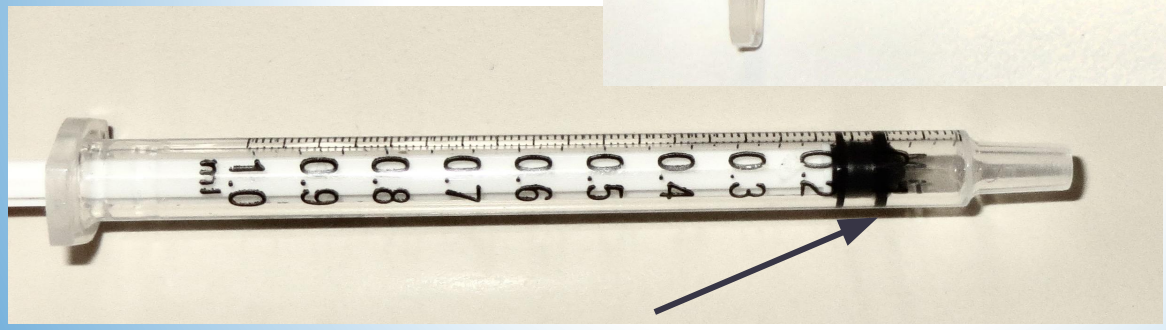
Increments of a 1.0 cc syringe



All of these would contain 0.1 cc of fluid

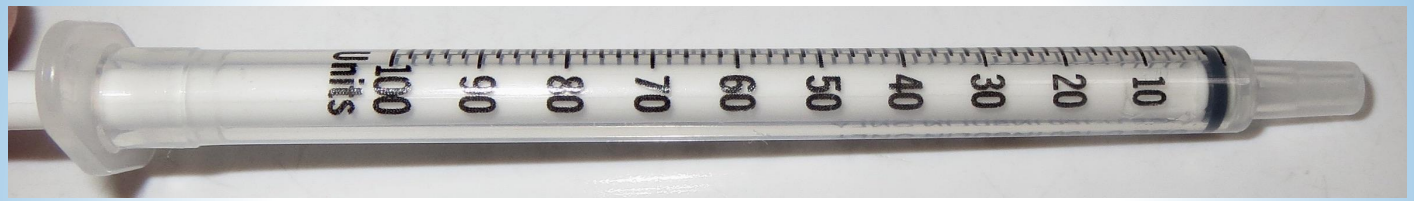


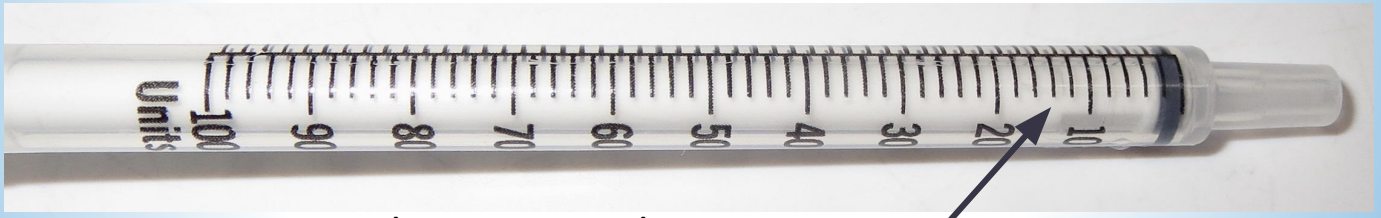




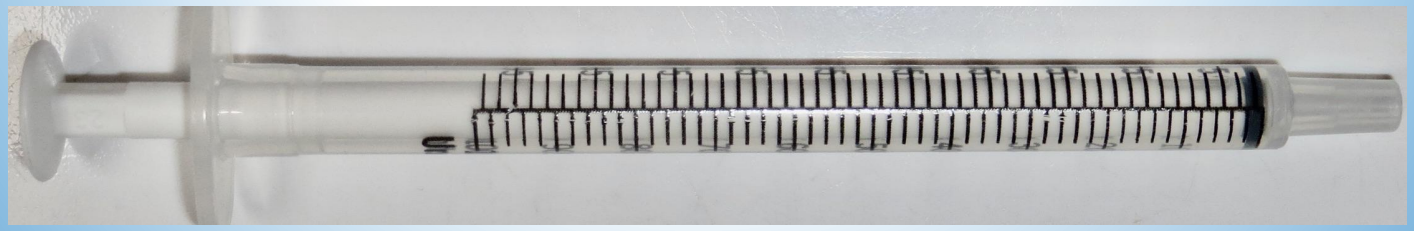
When there is a dome on the plunger rubber, you should measure from where the rubber touches the barrel.

This type of o-ring syringe can be misleading

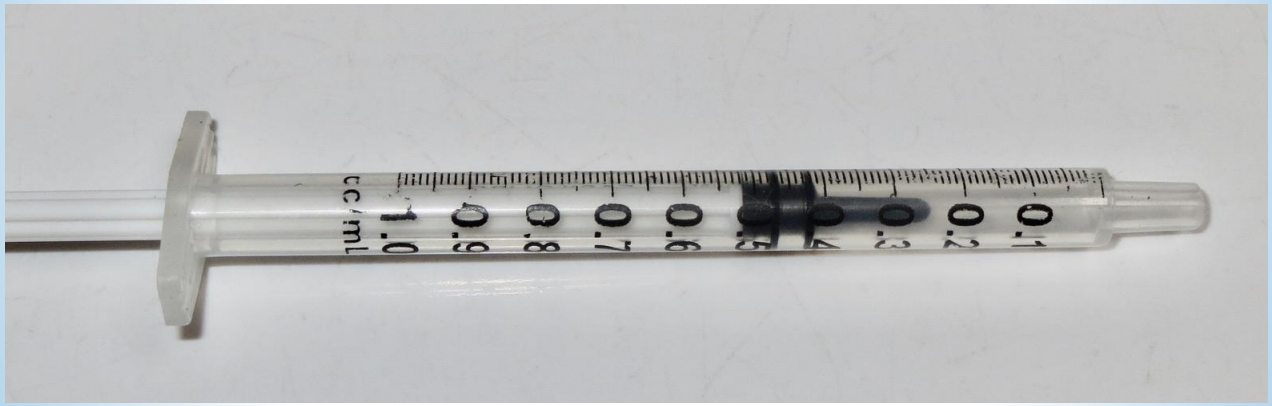




Each increment here is 0.02 cc



This syringe type is great for medication



It doesn’t leave any medication in the hub.

Start with the basics

How much does your animal weigh?

- For most rehabbers of birds or small mammals, it's a matter of grams!
- Unless your new arrival is cold or bleeding heavily, the very first thing you should do is to get a weight.

Recordkeeping

- Writing down weights, feedings & elimination, and medications are critical to the care of any animal.
- If you have more than one animal to care for, you will not remember what you have done for them!
- Plus, it’s part of the requirements for our license!

Now, let's get to the fun stuff!

Drug calculations

If your vet tells you exactly how much of a drug to give your animal, you won't have to do these calculations, but it's nice to understand how it works, anyway!

Basic principle

The amount of medication given to any animal depends on the animal's weight.

You cannot give them "just a little bit"!

“Dosage”: definition

- Amount of medication to administer for each *unit of weight* of an animal

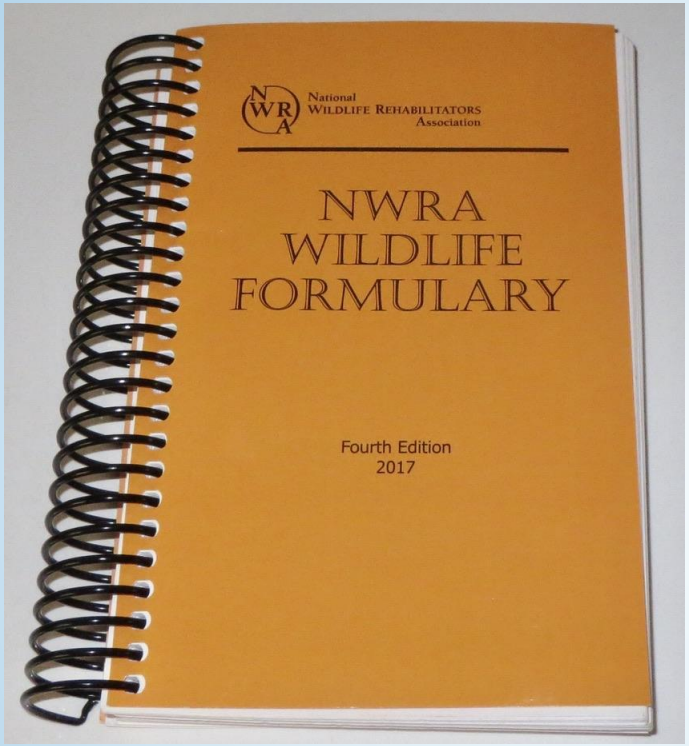
- Is stated in milligrams (of the drug) per kilogram of body weight → (mg/kg)

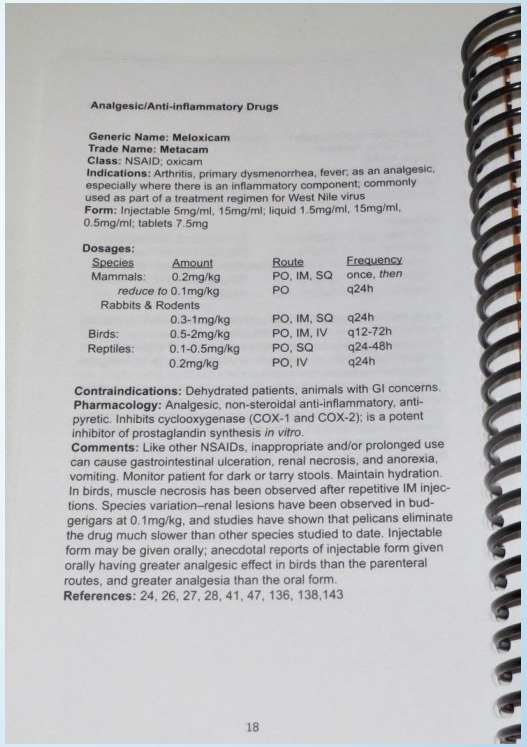
This is different from “dose”, which is the amount of medication you give an animal at one specific time.

The NWRA Wildlife Formulary lists dosages for many medications for wild animals.

Or, your vet may have a dosage that he or she prefers.

But remember…..*the dosage is based on the weight of the animal.*





Analgesic/Anti-inflammatory Drugs

Generic Name: Meloxicam
Trade Name: Metacam
Class: NSAID; oxicam
Indications: Arthritis, primary dysmenorrhea, fever; as an analgesic, especially where there is an inflammatory component; commonly used as part of a treatment regimen for West Nile virus
Form: Injectable 5mg/ml, 15mg/ml; liquid 1.5mg/ml, 15mg/ml, 0.5mg/ml; tablets 7.5mg

Dosages:

Species	Amount	Route	Frequency
Mammals:	0.2mg/kg	PO, IM, SQ	once, *then*
reduce to	0.1mg/kg	PO	q24h
Rabbits & Rodents			
	0.3-1mg/kg	PO, IM, SQ	q24h
Birds:	0.5-2mg/kg	PO, IM, IV	q12-72h
Reptiles:	0.1-0.5mg/kg	PO, SQ	q24-48h
	0.2mg/kg	PO, IV	q24h

Contraindications: Dehydrated patients, animals with GI concerns.
Pharmacology: Analgesic, non-steroidal anti-inflammatory, anti-pyretic. Inhibits cyclooxygenase (COX-1 and COX-2); is a potent inhibitor of prostaglandin synthesis *in vitro*.
Comments: Like other NSAIDs, inappropriate and/or prolonged use can cause gastrointestinal ulceration, renal necrosis, and anorexia, vomiting. Monitor patient for dark or tarry stools. Maintain hydration. In birds, muscle necrosis has been observed after repetitive IM injections. Species variation–renal lesions have been observed in budgerigars at 0.1mg/kg, and studies have shown that pelicans eliminate the drug much slower than other species studied to date. Injectable form may be given orally; anecdotal reports of injectable form given orally having greater analgesic effect in birds than the parenteral routes, and greater analgesia than the oral form.
References: 24, 26, 27, 28, 41, 47, 136, 138,143

The NWRA formulary has a range of dosages for each drug for each animal group, so you will have to have advice from your veterinarian to decide which number to use as your dosage.

(But, veterinarians don't always agree with each other on dosages for wildlife!)

Now for some fifth-grade arithmetic!

Multiplication of Fractions

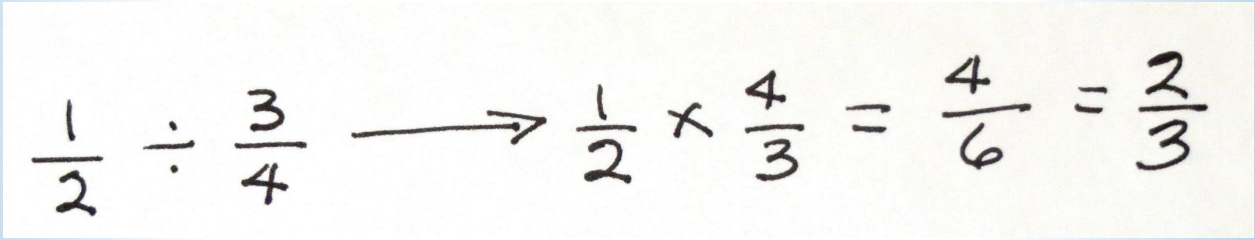
(multiply the numerators & denominators)

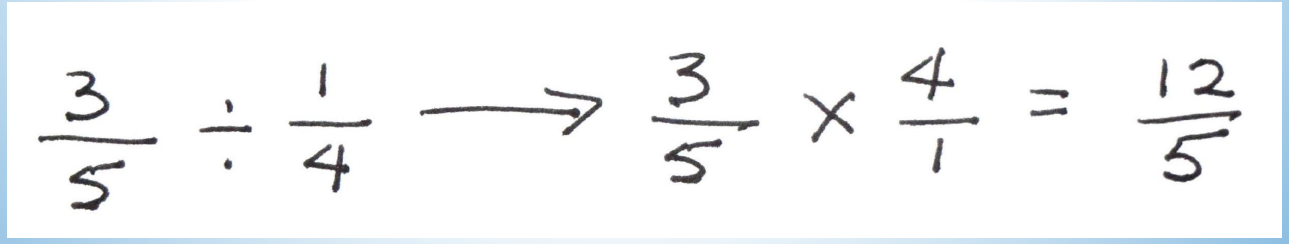
$$\frac{1}{2} \times \frac{2}{3} = \frac{2}{6} = \frac{1}{3}$$

$$\frac{2}{5} \times \frac{2}{3} = \frac{4}{15}$$

Division of Fractions

To divide fractions: Invert the denominator and then multiply





We will not try to explain why this is done!

“Ours is not to reason why;
just invert and multiply!”

Let’s do Ratios!

A ratio is like a fraction with units.

It’s a comparison of two quantities.

Here are the ratios we will use in this formula:

- mg/kg (or how many milligrams of the drug is prescribed for each kilogram of the animal)
- mg/ml (or how many milligrams of the drug are in each milliliter of it)

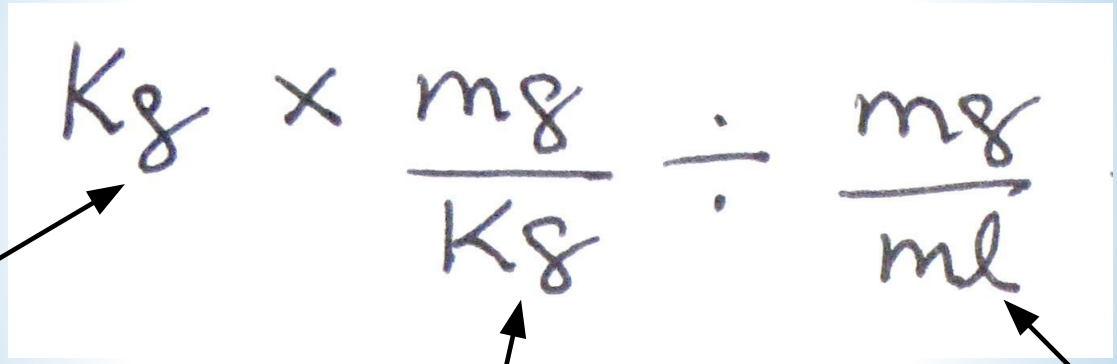
Formula to calculate a drug dose:

weight(kg) X dosage ÷ concentration = dose

We use three figures to input into this equation:

- Weight of the animal.
- Dosage we have been given for this particular drug for this type of animal.
- Concentration of this drug.

Formula to calculate the dose of a drug

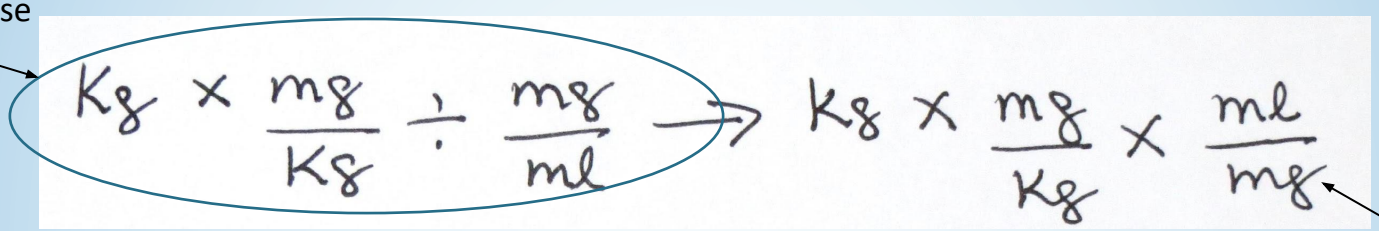


weight(kg) X dosage ÷ concentration

Multiplying and cancelling units

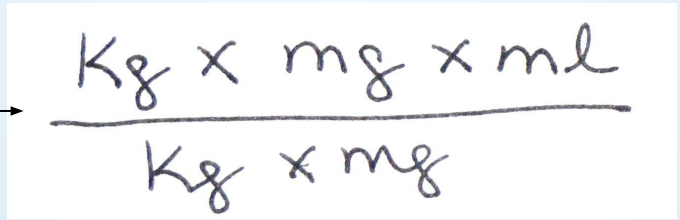
(How we end up with a unit of "mL" when we do this calculation)

Formula for dose

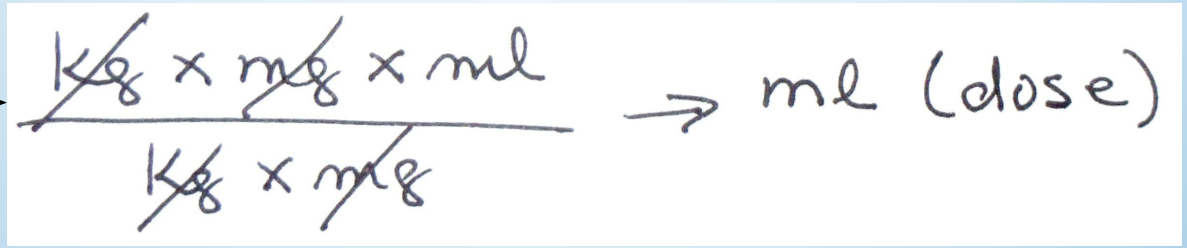


Inverted denominator

Multiply numerators & denominators



Cross out units that are above and below



Since most of the animals in our care are small, they will be weighed in grams, rather than kilograms.

Therefore, we need to divide the gram-weight by 1,000 to convert to kilograms.

1,000 g = 1 kg

For many of the commonly used drugs, we usually have a single concentration.

BUT, some can have a different concentration. Metacam is one we use often, and it comes in 0.5 mg/mL and 1.5 mg/mL (which is triple the strength!)

So, it is critical that you know your concentration!

Let’s have some examples!

Animal weighs 80 g
Drug dosage: 22 mg/kg
Concentration: 62.5 mg/mL

$$\frac{80\,g}{1000} \times \frac{22\,mg}{Kg} \div \frac{62.5\,mg}{ml} = 0.028\,ml$$

Animal weighs 150g
Drug dosage: 0.5 mg/kg
Concentration: 0.5 mg/mL

$$\frac{150g}{1000} \times 0.5\ \frac{mg}{Kg} \div 0.5\ \frac{mg}{ml} = 0.15\ ml$$

Animal weighs 20 g
Drug dosage: 20 mg/kg
Concentration: 48 mg/mL

$$\frac{20\,g}{1000} \times 20\,\frac{mg}{Kg} \div 48\,\frac{mg}{ml} = 0.008\,ml$$

This dose can be rounded up to 0.01 cc, or you can dilute the drug by 10 times and then give 0.1 cc.

Most of the doses we will administer as rehabbers of small animals will be well-under 0.5 mL…….and usually under 0.05 mL.

So, if your calculation comes up with more than that, re-check your numbers!

Diluting drugs

If you have a very small animal or a drug with a strong concentration, you may end up with a dose that's less than 0.01 cc. In this case, you will need to dilute the drug to have a measurable dose.

To dilute by a factor of 10, draw up 0.9 cc's of sterile water, and then 0.1 cc of the drug.

Then, move the decimal for your concentration one space to the left before you calculate.

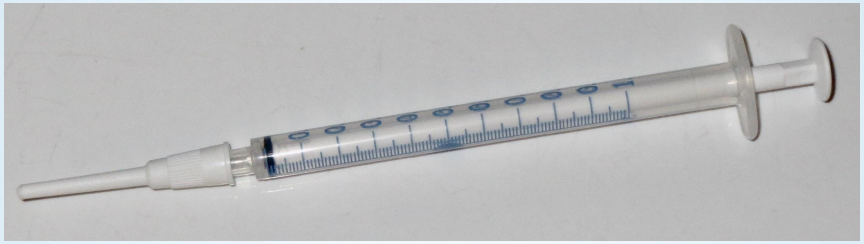
Keep diluted drugs refrigerated.

Making a solution

(if you are starting with a tablet or other solid)

- What liquid is it soluble in?
- Calculate the volume of solvent ahead of time!
- Mix solution *thoroughly* immediately prior to use.
- Keep solution refrigerated.
- Keep in dark if light-sensitive.

When administering meds to a songbird, you should use a cannula on the end of a 1.0 cc syringe.



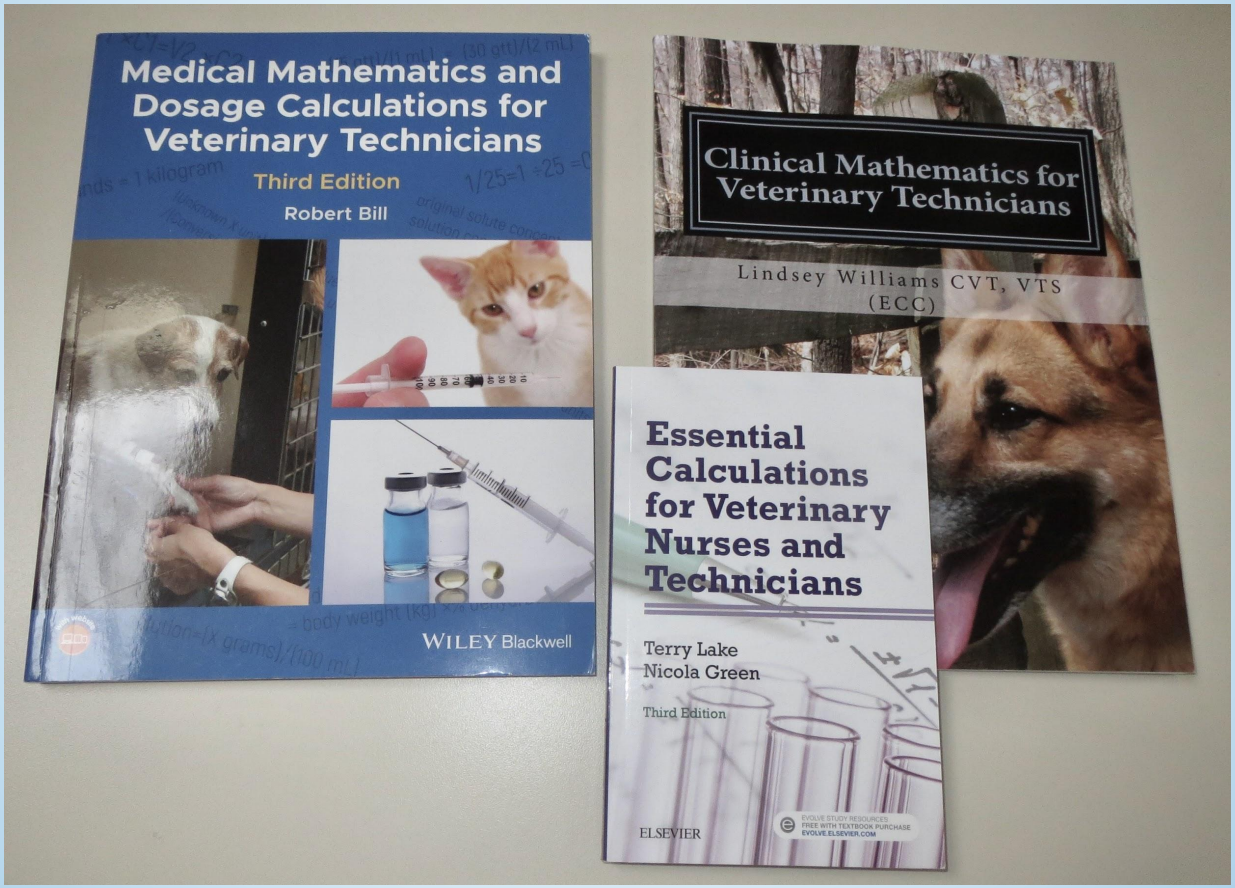
Draw up at least 0.1 cc more of the drug than you need for the dose, put the cannula tip on the syringe, and push the drug out to the desired measurement.

Those pesky air bubbles!

Be sure you do not have an air bubble in the syringe when you pull up the medication. Even a small bubble can corrupt your measurement.

A small plastic bottle with a Yorker tip is great for filling a syringe without causing a bubble. (Insert the syringe and turn the bottle upside down to draw it in.)

References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