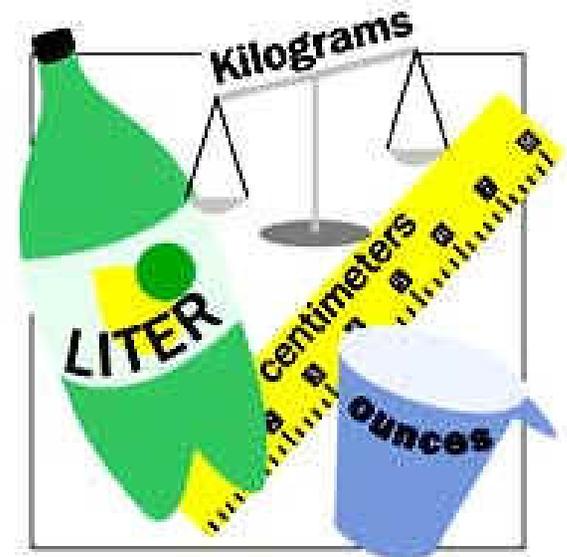




Metric System & Medical Math



Math Biomed

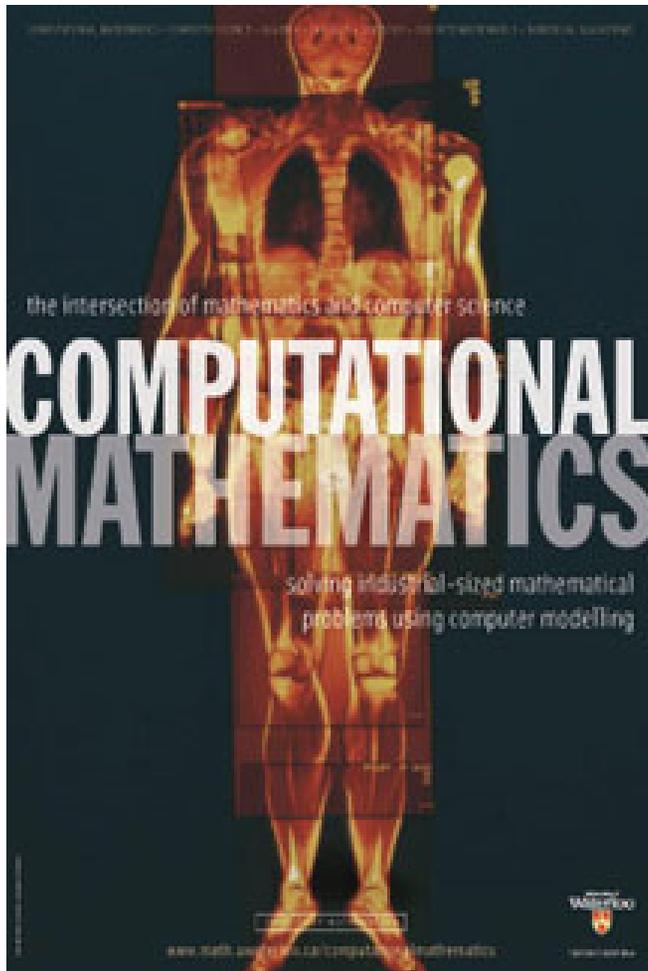
Why do you need to learn math?

- To calculate medication dosages
- To take height and weight readings
- To measure intake and output
- To calculate burn areas
- For billing and bookkeeping tasks
- To perform lab tests
- To mix cleaning solutions
- To calculate feeding and caloric requirements'
- To regulate IV dose

What are some other ways math is used?

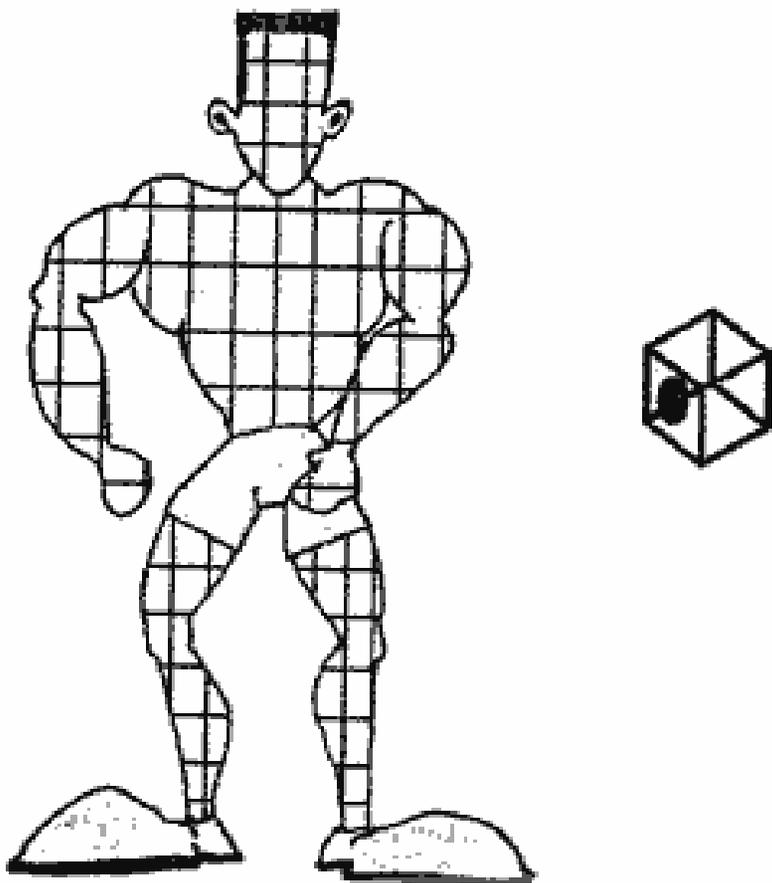
- Radiology
- Physical / Occupational therapy
- Surgery
- Chemotherapy
- Forensics
- Autopsies
- Environmental health
- Toxicology
- Pharmacy
- OB GYN
- Pediatrics
- Research
- Respiratory therapy



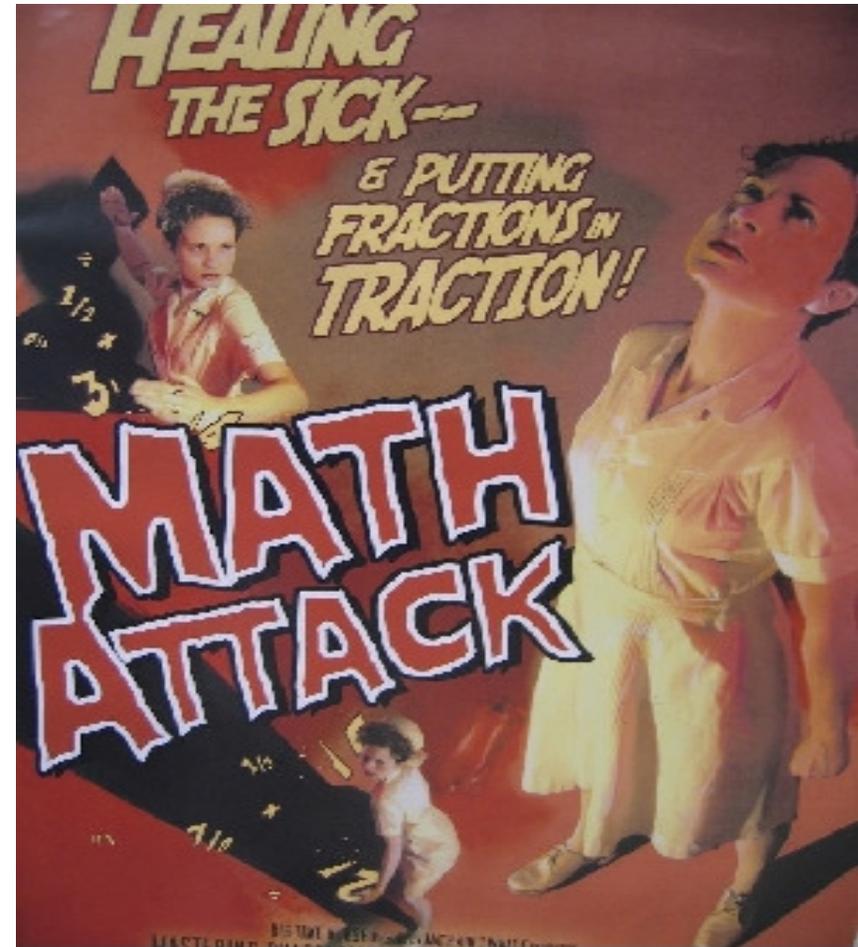
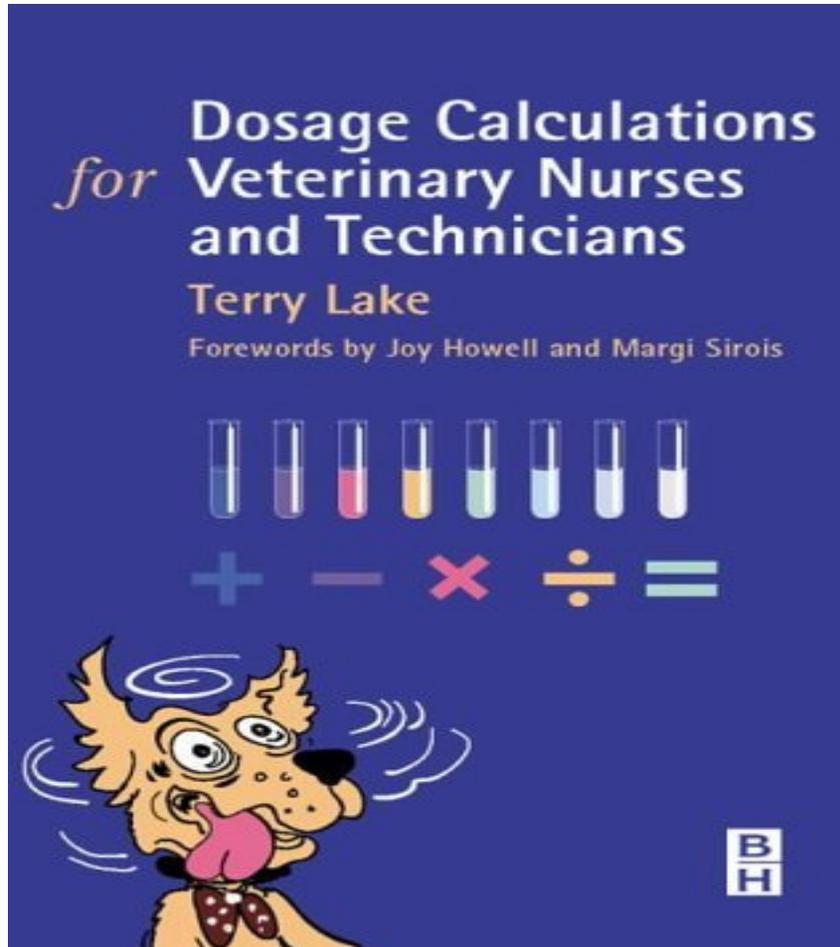


-
- **"A picture is worth a thousand words." This truism captures the reason medical imaging is so important for health and medical research. But medical images hold far more information than even the best doctors can extract. It is through computational mathematics that doctors are able reap the full benefits of today's technology.**

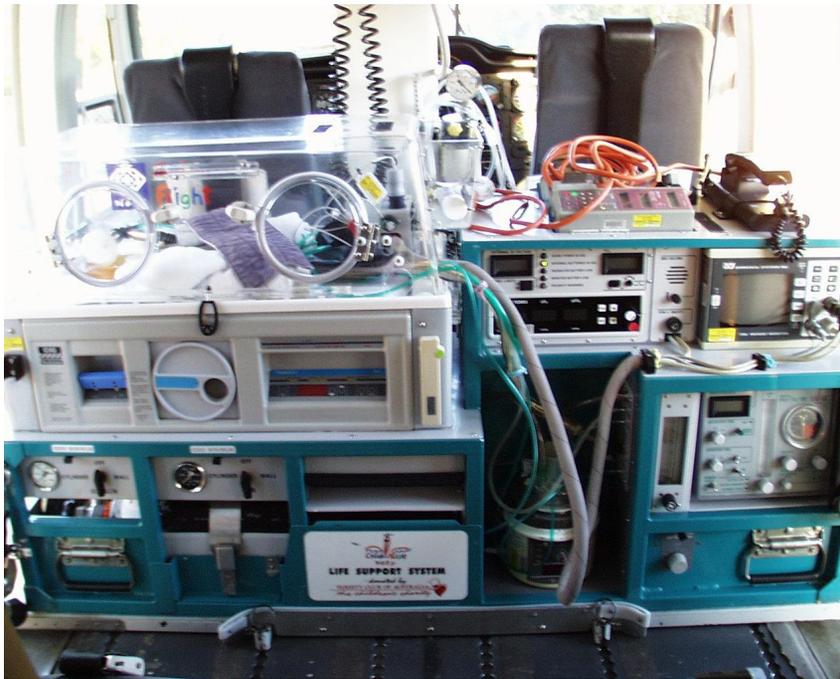
Typically, critical care IV orders are written, "mcg./kg../min." -
micrograms per kilogram per minute.



The wrong dose can kill!



Neonatal Flight transport



Vent's

- If a stable FIO₂ cannot be achieved, VCO₂ may be used to estimate REE by assuming an RQ of 0.83 and the largest expected error is an:
- Underestimation of 25% for RQ of 1.2
- Overestimation of 19% for RQ of 0.67
- A simultaneous measure of PaCO₂ and VCO₂ will allow calculation of pulmonary dead space and components of ventilation using the Bohr equation:
- $VE = VCO_2 \times 0.863 \text{ PaCO}_2 \times (1 - VD/VT)$

Infant weight is 2 lbs 8 oz

- 16 oz = 1 lb
- 1 kg = 2.2 lbs
- Infant is 26 weeks
- How much gentamicin will you give?

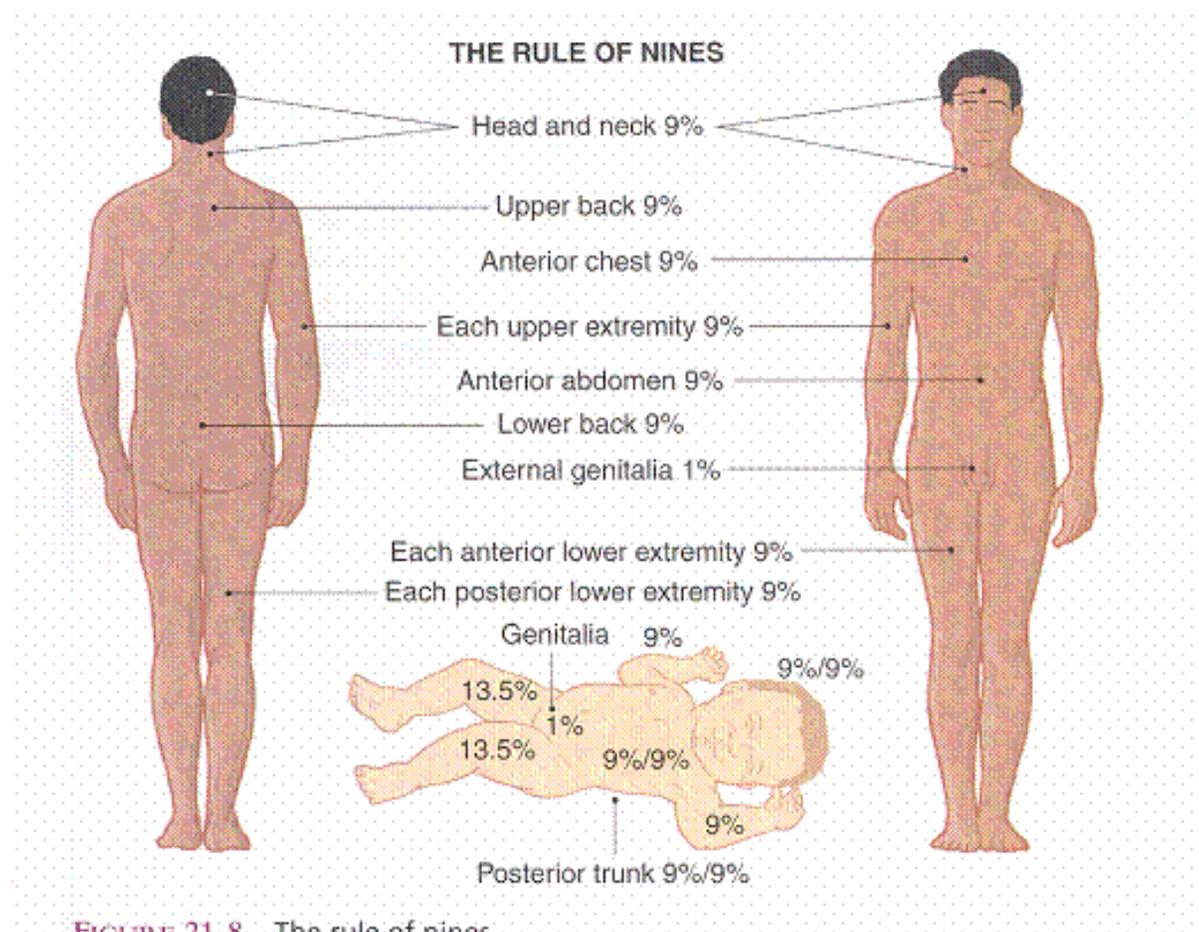
Drug	Postconceptional Age* (wk)	Dose (mg/kg [†])	Dosing Interval (h)
Gentamicin	< 24	2.5	q 36
	25–27	2.5	q 24
	28–29	3.0	q 24
	30–37	2.5	q 18
	> 37	2.5	q 12
Vancomycin	< 29	18	q 24
	30–36	15	q 12
	37–44	10	q 8

*Postconceptional age refers to the sum of gestational and postnatal ages.

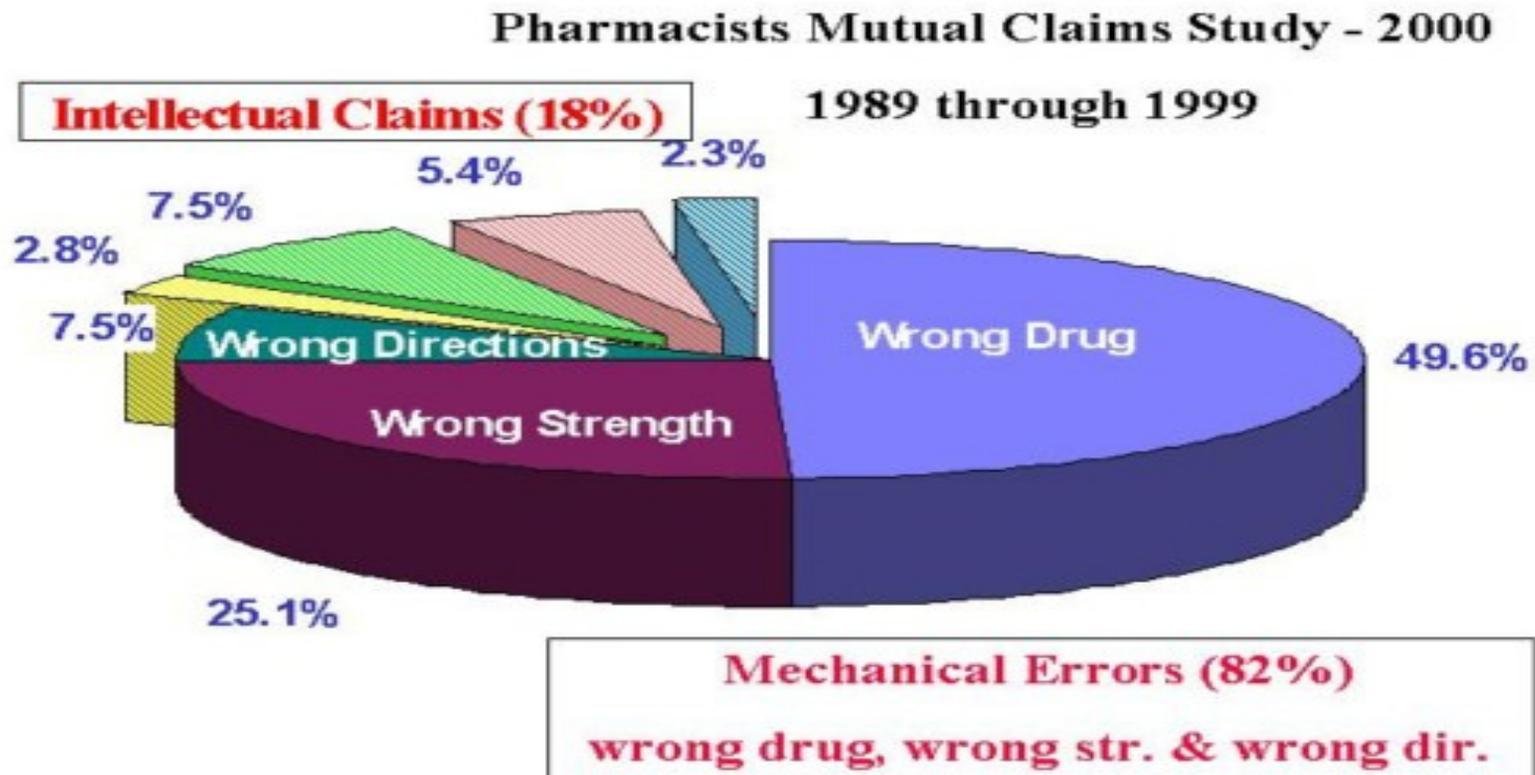
[†]Dose derived from published pharmacokinetic data and therapeutic drug monitoring information.

Burns

- 25 kcal/kg + 40 kcal/total **body** surface area burn



It is the nurses responsibility to know normal dosages



© 2000, Pharmacists Mutual Insurance Co.

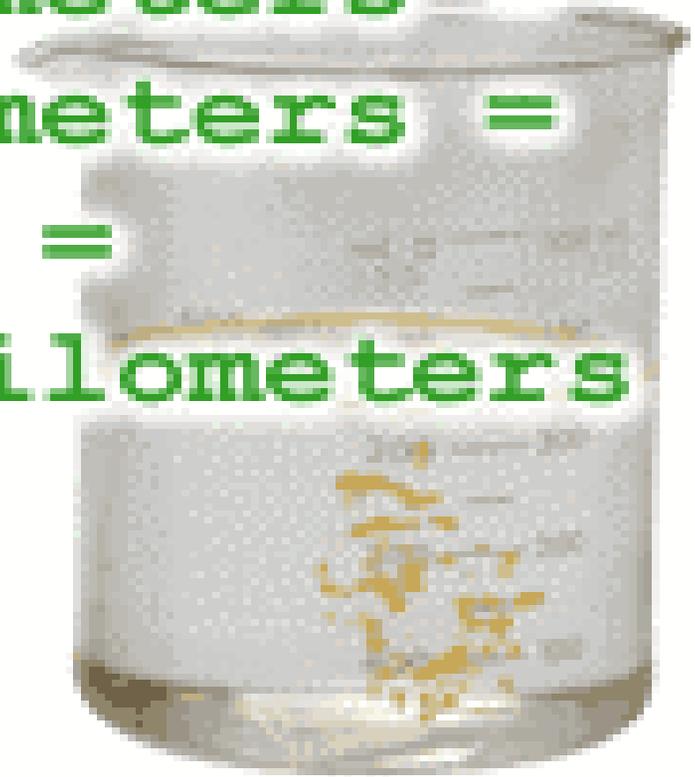
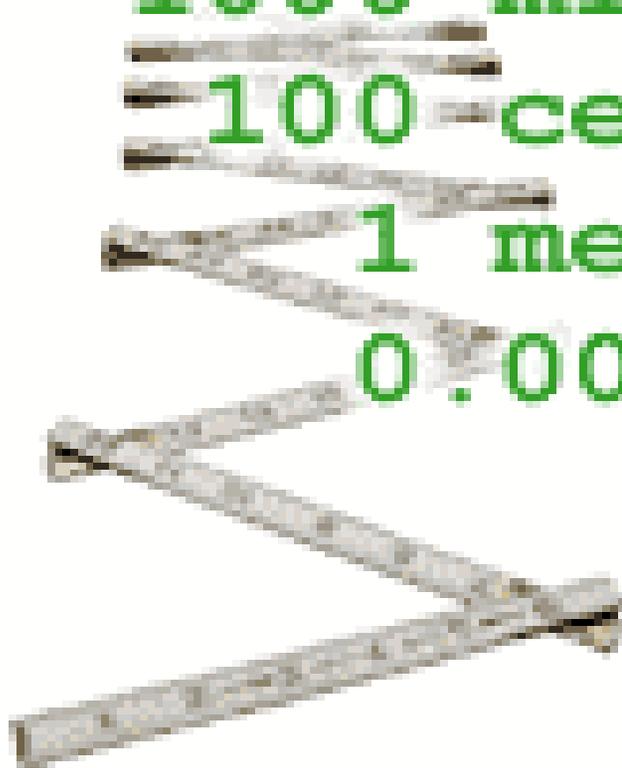
Metric System

1000 millimeters =

100 centimeters =

1 meter =

0.001 kilometers



This cartoon doesn't measure up.

Long ago, parts of the human body were often used as units of measure. The length of the king's foot or the distance from the tip of his nose to his fingertips were both common units of measure.

The problem with this type of measuring system was that it was different from country to country and the existing measurements would often change as soon as a new king was crowned. More than 200 years ago, the metric system was created with the purpose of establishing a universal system of measurement that could easily be used by people all over the world regardless of their country of origin.

The Celsius scale is used to measure the temperatures experienced by most people. Water freezes at 0°C (32°F) and boils at 100°C (212°F). The normal body temperature for a human being is about 37°C (98.6°F).

Symbol	Prefix	Increase or Decrease
Y	yotta	One septillion
Z	zetta	One sextillion
E	exa	One quintillion
P	peta	One quadrillion
T	tera	One trillion
G	giga	One billion
M	mega	One million
K	kilo	One thousand
h	hecto	One hundred
d	deka	Ten
da	deci	One-tenth
c	centi	One-hundredth
m	milli	One-thousandth
μ	micro	One-millionth
n	nano	One-billionth
p	pico	One-trillionth
f	femto	One-quadrillionth
a	atto	One-quintillionth
z	zepto	One-sextillionth
y	yocto	One-septillionth

France officially began using the metric system in 1795.

30°C = 86°F
20°C = 68°F
10°C = 50°F
0°C = 32°F

The modern version of the metric system is called "Le Système International d'Unités" or "SI" for short.

Why did the bottle insist on being at the front of the shelf? Because it was a liter, not a follower.

Meter is derived from the Greek word for "measure."

Knock knock. Who's there? Millie. Millie, who? Millimeter.

What do you get when you cross 1,000 milligrams with a cookie? A gram cracker.

The metric system is a decimal-based system. This means that units in the metric system are related to each other by factors of 10.

The United States is the only technologically advanced country in the world that does not use the metric system as its main system of measurement.

OLD SCALE
In 1790, a search for ways to reform the existing system of measurement used in France led to the creation of the first metric system. The option for people to use the metric system in the United States became legal in 1866.

WORD SEARCH

Can you find the hidden words? Search carefully because some words are backward or diagonal.

YOTTA	MEGA	NANO
ZETTA	KILO	PICO
EXA	HECTO	FEMTO
PETA	CENTI	ATTO
TERA	MILLI	ZEPTO
GIGA	MICRO	YOCTO

M E T R I C I S G R E A T
L E A R N Y C R O T T A I
H U R R Y V E S R A Y L Z
L E T Z A P N A C A L F E
P A C C E A T T I F E P
P U N T N T I E M O A T
B O N O O R T L E A M T O
S T A Y P E T A G I G O P
H E A P I C O X A K E L P
G O O D N E S E Y O C T O

Seventeen nations, including the United States signed the "Treaty of the Meter" in 1875. This treaty was designed to improve, maintain and standardize the metric measuring systems.

To download a Shortcuts teacher's guide or view a list of upcoming topics, go to www.comics.com/shortcuts

E-mail us at: jdharris@verizon.net

The word "weight" is often used when we mean "mass." Mass is the amount of material contained in an object. Weight is the force of gravity on that object.

WEIGHT a MiNuTe!
Can you spot all six differences between these two scenes?



ANSWERS: 1. Eyes are moved. 2. Hat is moved. 3. Cap is higher. 4. Tie is shorter. 5. Reflector on back is missing. 6. Building is smaller.

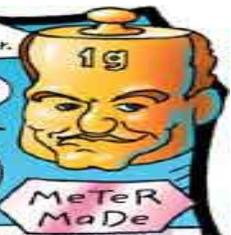
Shortcuts

by Jeff Harris

GETTING TO THE POINT OF THE Metric System

This edition of Shortcuts is sponsored by Kelsey Grammer.

I might be a lightweight, but I'm a heavy thinker.



Where would you buy 36 inches? At a yard sale.

MeTeR MaDe

The length of a meter was established in 1793 as 1/10,000,000 of the distance from the North Pole to the Equator. Today, the length of the meter is more precisely described as the distance light travels in a vacuum in 1/299,792,458 of a second.

For more information on the metric system, check out these Web sites:
www.nist.gov/public_affairs/kids/metric.htm
www.cofc.edu/~frysingj/5Iguidelines.htm
<http://lamar.colostate.edu/~hillger/>
<http://metric1.org/>

An easy way to remember some degree Celsius temperatures is with the poem - Thirty is hot, twenty is nice, ten is chilly, zero is ice!

All You Will Need to Know About Metric

(For Your Everyday Life)

10

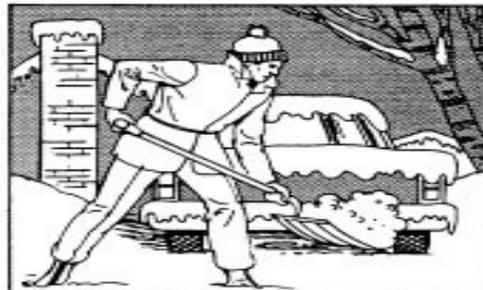
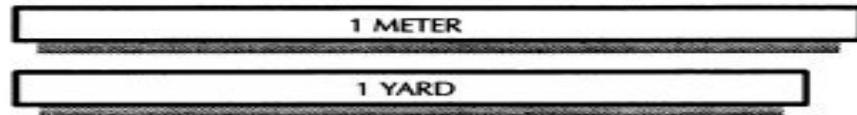
Metric is based on the Decimal system

The metric system is simple to learn. For use in your everyday life you will need to know only ten units. You will also need to get used to a few new temperatures. Of course, there are other units which most persons will not need to learn. There are even some metric units with which you are already familiar; those for time and electricity are the same as you use now.

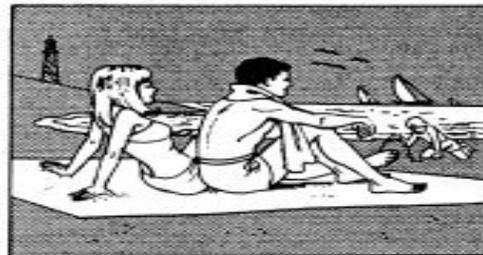
BASIC UNITS

- METER:** a little longer than a yard (about 1.1 yards)
LITER: a little larger than a quart (about 1.06 quarts)
GRAM: a little more than the weight of a paper clip

(comparative sizes are shown)



25 DEGREES FAHRENHEIT



25 DEGREES CELSIUS

COMMON PREFIXES

(to be used with basic units)

- milli:** one-thousandth (0.001)
centi: one-hundredth (0.01)
kilo: one-thousand times (1000)
For example
 1000 millimeters = 1 meter
 100 centimeters = 1 meter
 1000 meters = 1 kilometer

1 LITER



1 QUART

OTHER COMMONLY USED UNITS

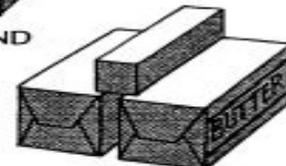
- millimeter:** 0.001 meter diameter of a paper clip wire
centimeter: 0.01 meter a little more than the width of a paper clip (about 0.4 inch)
kilometer: 1000 meters somewhat further than 1/2 mile (about 0.6 mile)
kilogram: 1000 grams a little more than 2 pounds (about 2.2 pounds)
milliliter: 0.001 liter five of them make a teaspoon

OTHER USEFUL UNITS

- hectare:** about 2 1/2 acres
metric ton: about one ton



1 POUND

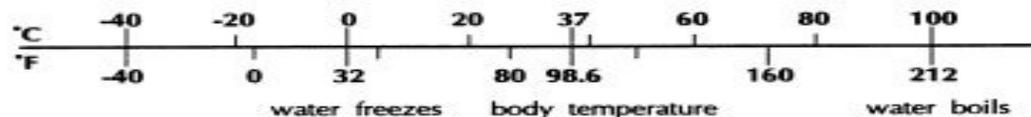


1 KILOGRAM

WEATHER UNITS:

FOR TEMPERATURE
degrees celsius

FOR PRESSURE
kilopascals are used
100 kilopascals = 29.5 inches of Hg (14.5 psi)



METRIC MEASURES UP

Approximate Conversions from Metric Measures



<i>Symbol</i>	<i>When You Know</i>	<i>Multiply by</i>	<i>To Find</i>	<i>Symbol</i>				
LENGTH								
mm	millimeters	0.04	inches	in				
cm	centimeters	0.4	inches	in				
m	meters	3.3	feet	ft				
m	meters	1.1	yards	yd				
km	kilometers	0.6	miles	mi				
AREA								
cm ²	square centimeters	0.16	square inches	in ²				
m ²	square meters	1.2	square yards	yd ²				
km ²	square kilometers	0.4	square miles	mi ²				
ha	hectares (10,000 m ²)	2.5	acres					
MASS (weight)								
g	grams	0.035	ounces	oz				
kg	kilograms	2.2	pounds	lb				
t	metric ton (1,000 kg)	1.1	short tons					
VOLUME								
mL	milliliters	0.03	fluid ounces	fl oz				
mL	milliliters	0.06	cubic inches	in ³				
L	liters	2.1	pints	pt				
L	liters	1.06	quarts	qt				
L	liters	0.26	gallons	gal				
m ³	cubic meters	35	cubic feet	ft ³				
m ³	cubic meters	1.3	cubic yards	yd ³				
TEMPERATURE (exact)								
°C	degrees Celsius	multiply by 9/5, add 32	degrees Fahrenheit	°F				
°C	-40	-20	0	20	37	60	80	100
°F	-40	0	32	80	98.6	160	212	
		water freezes		body temperature			water boils	



United States Department of Commerce
 Technology Administration
 National Institute of Standards and Technology
 Metric Program, Gaithersburg, MD 20899

METRIC CONVERSION CARD

Approximate Conversions to Metric Measures

<i>Symbol</i>	<i>When You Know</i>	<i>Multiply by</i>	<i>To Find</i>	<i>Symbol</i>
LENGTH				
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
AREA				
in ²	square inches	6.5	square centimeters	cm ²
ft ²	square feet	0.09	square meters	m ²
yd ²	square yards	0.8	square meters	m ²
mi ²	square miles	2.6	square kilometers	km ²
	acres	0.4	hectares	ha
MASS (weight)				
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	metric ton	t
VOLUME				
tsp	teaspoons	5	milliliters	mL
Tbsp	tablespoons	15	milliliters	mL
in ³	cubic inches	16	milliliters	mL
fl oz	fluid ounces	30	milliliters	mL
c	cups	0.24	liters	L
pt	pints	0.47	liters	L
qt	quarts	0.95	liters	L
gal	gallons	3.8	liters	L
ft ³	cubic feet	0.03	cubic meters	m ³
yd ³	cubic yards	0.76	cubic meters	m ³
TEMPERATURE (exact)				
°F	degrees Fahrenheit	subtract 32, multiply by 5/9	degrees Celsius	°C



Metric System Mnemonics

K

—|—0|E|0|0|—

H

e|c|t|0|E|e|e|—

D

e|k|E|e|—

M

r|e|—

D

e|c|E|e|—

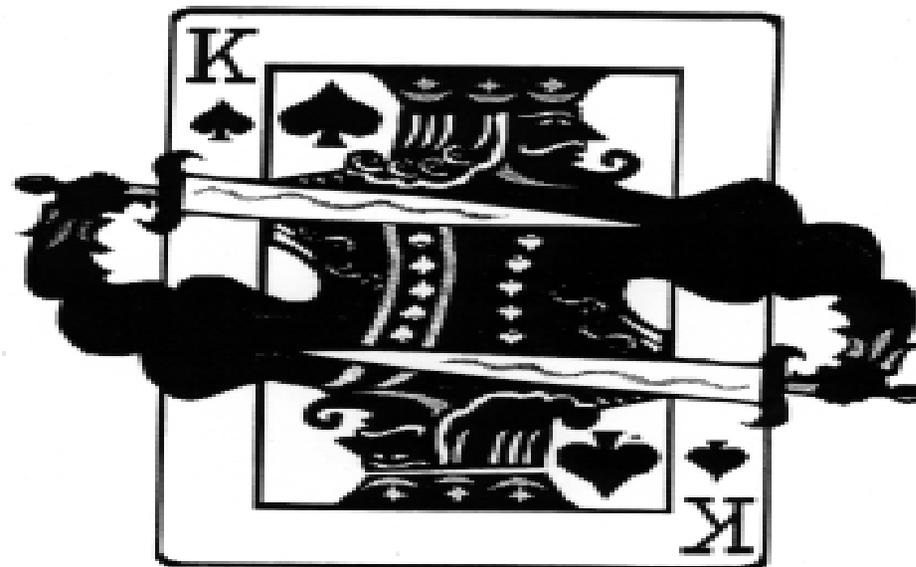
C

e|c|t|E|e|—

M

—|—|E|e|—

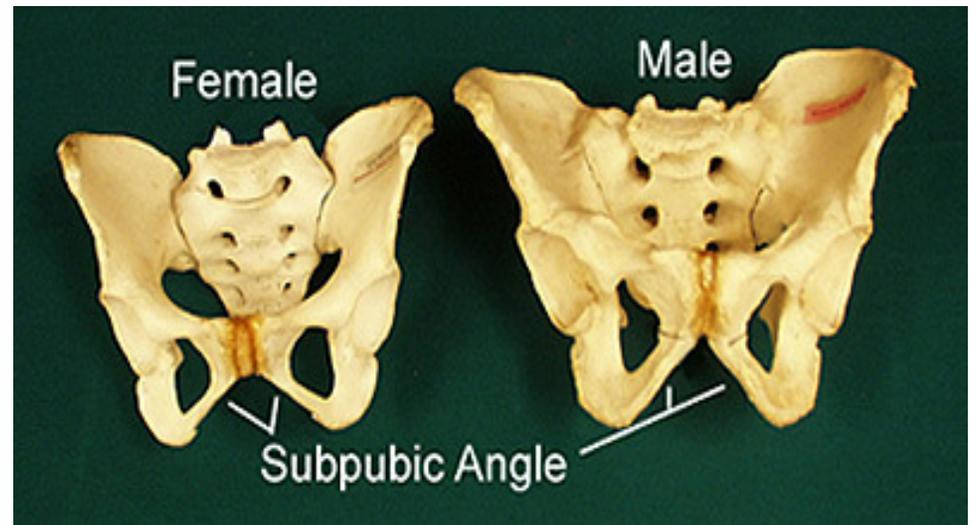
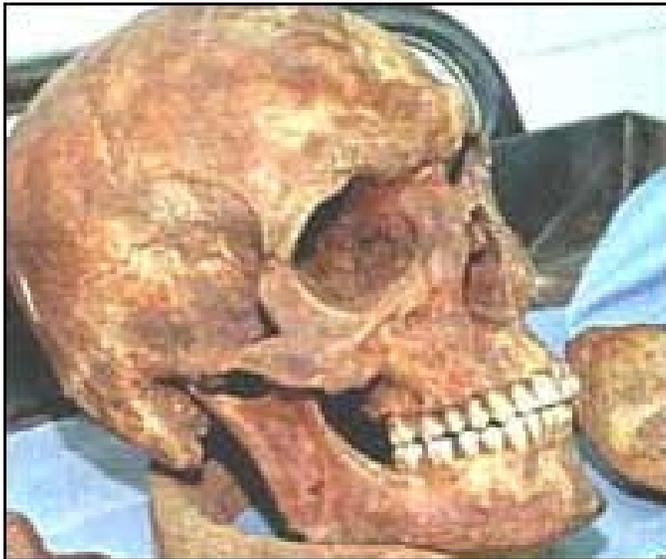
King
Henry
Died
Monday
Drinking
Chocolate
Milk.

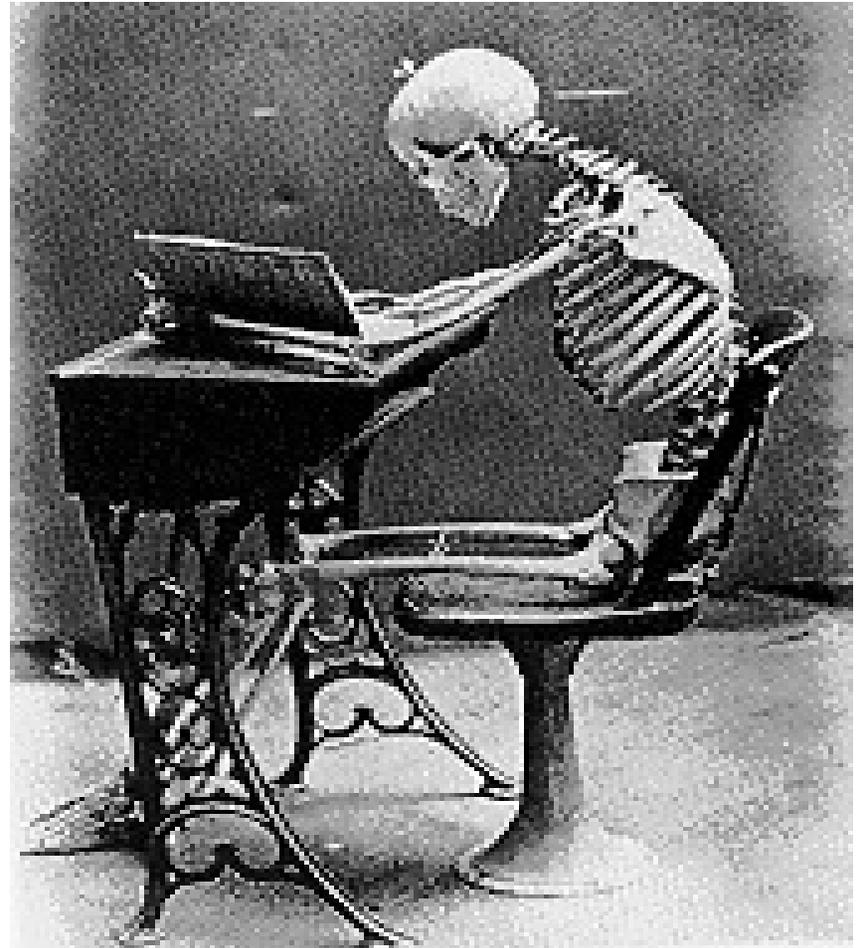
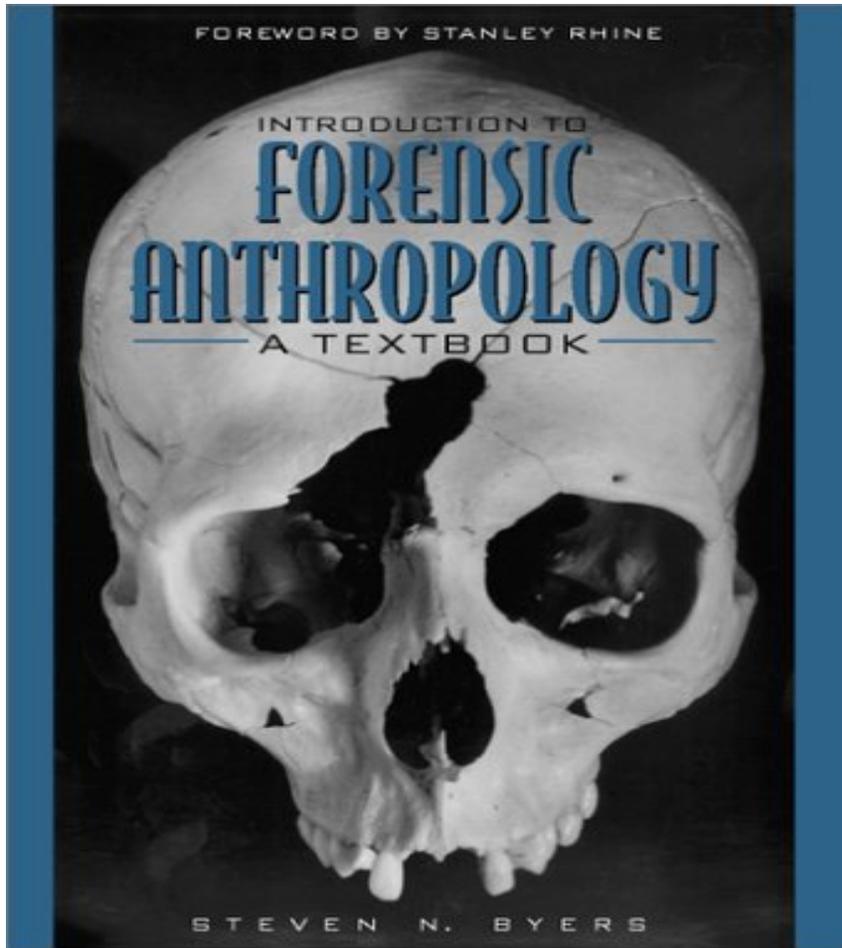


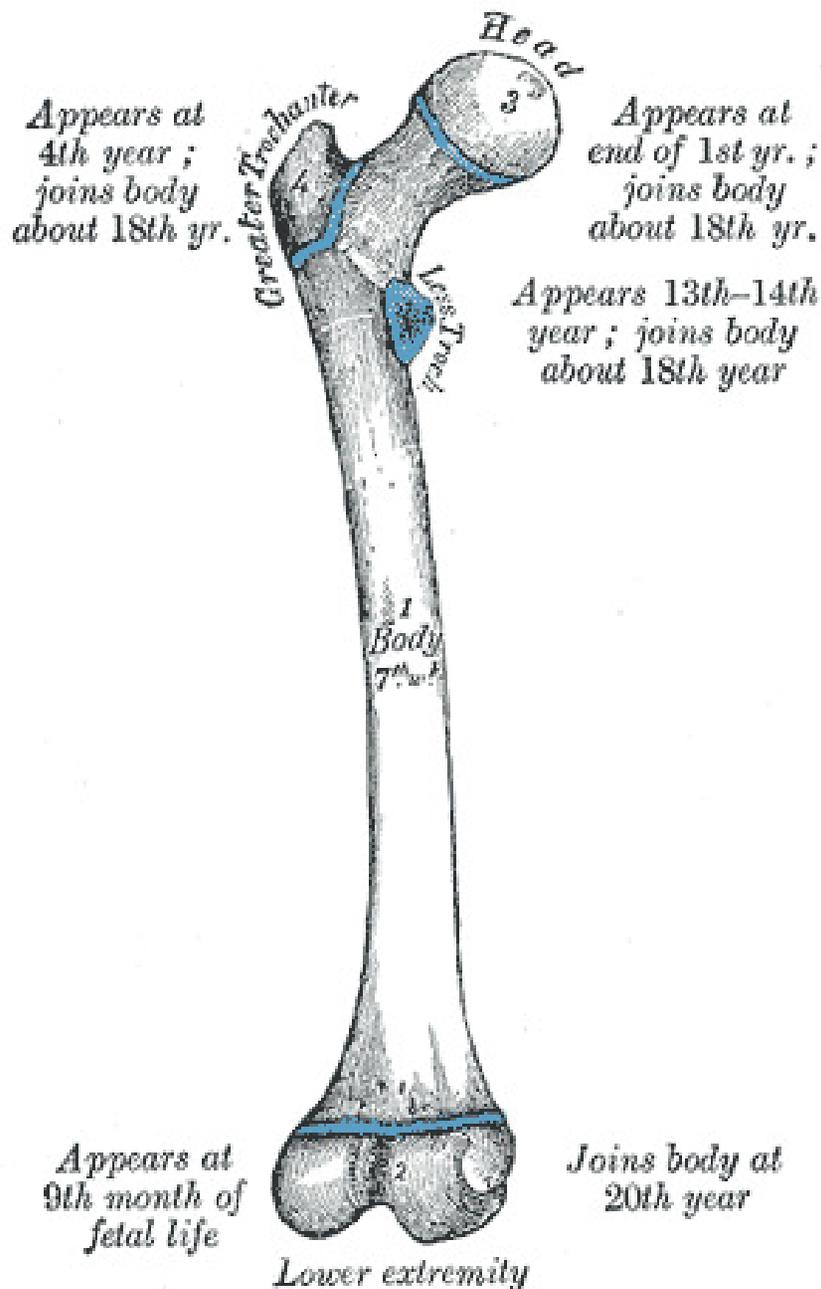
MATH DUTHEU

17

Sex and Race







- Height – An intact corpse can be measured, but a disarticulated or incomplete skeleton has to be pieced together. One rule of thumb is that height is about five times the length of the humerus, but there are formulas for height based on other major bones as well (spine, tibia, and femur).

Body temperature

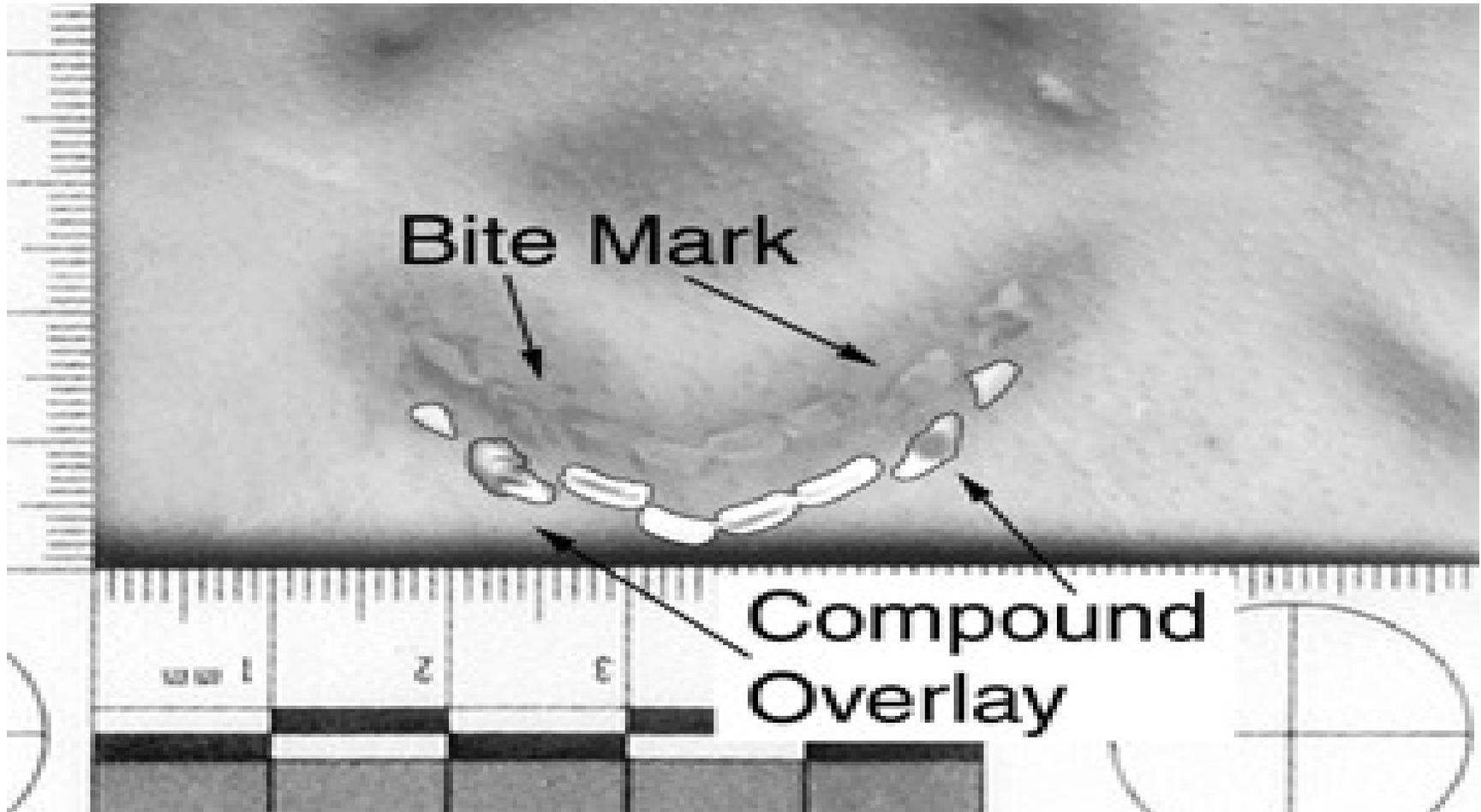
- **TEMPERATURE**
- The metric system measures temperature using the **Celsius** scale. On this scale, water freezes at 0°C and boils at 100°C. Each degree is 1/100th of the scale. Normal human body temperature is 37 °C and comfortable room temperature is about 21°C.
- A homicide detective can tell how long ago a person died by the temperature of the body when found. (They also take into account room temperature and size.)

Calculating Height

- **Find Out by Calculating**

- Scientists use these formulas to approximate a person's height H , in inches, when they know the length of the tibia t , the humerus h , or the radius r .
- Male $H = 32.2 + 2.4t$ Female $H = 28.6 + 2.5t$ $H = 29.0 + 3.0h$ $H = 25.6 + 3.1h$ $H = 31.7 + 3.7r$ $H = 28.9 + 3.9r$
- Use your tibia, humerus, and radius bone lengths to calculate your height. Are the calculated heights close to your actual height? Explain.
- An archaeologist found an 18-in. tibia on the site of an American colonial farm. Do you think it belonged to a man or a woman? Why?
- Choose one radius measurement from the data you collected for the **Find Out by Graphing** question above. Calculate the person's height. Can you tell whose height you have found? Explain.

Forensics



Nursing

3mg/kg/min

*2 drops in
each eye bid*

250 mg tablet qd

60-120mcg/kg/hour

3 tsp. Qid

30mcg/ks/min

USING ROMAN NUMERALS

- **Used for some drugs and solutions**
- **Used for ordering some supplies**
- **KEY NUMERALS:**
- **I, V, X, C, D, M**

- **Usually, no more than 3 of any one Roman Numeral is used to represent a number**



- I The easiest way to note down a number is to make that many marks - little I's. Thus I means 1, II means 2, III means 3. However, four strokes seemed like too many....
- V So the Romans moved on to the symbol for 5 - V. Placing I in front of the V — or placing any smaller number in front of any larger number — indicates subtraction. So IV means 4. After V comes a series of additions - VI means 6, VII means 7, VIII means 8.
- X X means 10. But wait — what about 9? Same deal. IX means to subtract I from X, leaving 9. Numbers in the teens, twenties and thirties follow the same form as the first set, only with X's indicating the number of tens. So XXXI is 31, and XXIV is 24.

<http://www.oswego.org/ocsd-web/games/StopTheClock/sthec5.html>

- Military time numbers the 24 hours of the day from 1 to 24, rather than repeating the cycle of 12 hours twice. In several countries, time is kept on this 24-hour cycle.
- **Instructions**
- **STEP 1:** Note that the military clock begins with 0000 hours, sometimes called 2400 hours. When spoken aloud, this is said, "twenty-four hundred hours," which is the equivalent of midnight.
- **STEP 2:** Name morning hours as follows: 1 a.m. is 0100 hours, called "oh one hundred hours"; 2 a.m. is 0200, "oh two hundred hours"; and so forth. This pattern continues for the morning hours just as with the standard method of telling time until noon, which is 1200 hours ("twelve hundred hours").
- **STEP 3:** Remember that military time continues to ascend for the afternoon hours rather than beginning a new 12-hour cycle. Thus, 1 p.m. is now 1300 hours, or "thirteen hundred hours"; 2 p.m. is 1400 hours; and so forth. This pattern continues until midnight, at which point the military clock begins again.
- **STEP 4:** Determine afternoon hours in military time simply by subtracting 1200 from them. For example, 1800 hours is 6 p.m. in standard time: $1800 - 1200 = 600$; 2200 hours is 10 p.m.: $2200 - 1200 = 1000$.



