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Chapter 9:
Measurement

R&G Flossie

How much farther is it?

Not far. About thirty.

Huh?

This way to FLOSSIE

30 *miles*?

No, 30 *minutes*. It shouldn't take us more than a half-hour.

I meant how *far away* is it?

I'd guess about a million.

A *million*!?!

Wait... A million what?

free ice water FLOSSIE

Centimeters.

:ugh:

You don't seem very excited.

We're going to see the largest ball of floss in the *world*!

How big do you think it is?

The world? It's about 25,000 miles around.

Not the *world*, the ball of floss!

Ohhh... More than a thousand.

A thousand pounds?

Not pounds, *miles*.

It says right here in the brochure...

"The ball contains over one thousand miles of floss."

Floss Ball

How much does it cost?

You can't ***buy*** it!

I don't want to ***buy*** the ***floss ball***, I want to know how much we need to ***pay*** to ***see*** it!

Ohhh... The cost is three yards.

Yards!? What's a yard?

A yard is three feet.

SEE FLOSSIE

People usually pay for stuff in ***dollars*** or ***cents***. How do we pay in ***yards?!***

Easy! We bring three ***yards*** of unused floss to add to the ball.

This was definitely worth it.

Ms. Q.

Units

What is a unit?

A unit is a specific amount that can be used to compare quantities.

Huh?

It's something we use to measure stuff.

Oh! Like pounds, or inches.

Right! When do we use units?

When we want to describe how big something is.

When you buy something, the units let you know how much you need to pay...

...and how much you are getting.

Like one gallon of juice.

Or a six-inch ruler.

Or a two-pound bass!

1 gall

Take me to the river

Units make descriptions more accurate.

When you say, "The Yeti is 9 feet tall and weighs 600 pounds,"...

...it's more descriptive than just saying, "The Yeti is big and tall."

9 ft

0600 lbs

Big

Tall

Units aren't always for describing size.

We measure temperature in degrees.

Dollars and cents are units of money.

Seconds and minutes are units of time.

So are hours, days, weeks, years, decades, centuries, and millennia!

?!?

What units could we use to describe Grogg?

THERE ARE 60 SECONDS IN A MINUTE, 60 MINUTES IN AN HOUR, 24 HOURS IN A DAY, 365 DAYS IN A YEAR (366 IN A LEAP YEAR), 10 YEARS IN A DECADE, 10 DECADES IN A CENTURY (100 YEARS), AND 10 CENTURIES IN A MILLENNIUM (1,000 YEARS)!

Grogg is 58 inches tall and weighs 215 pounds.

His arm span is just over 7 feet...

...and his head is almost *9 feet* around!

His body temperature is 95 degrees Fahrenheit.

That's 35 degrees Celsius!

He is 8 years, 5 months, and 6 days old...

...and he has thirty-four cents.

There are some things about me that can't be described by numbers.

You're a riddle, wrapped in a mystery, inside an enigma.

And covered in purple fur!

G*Y*M
CUSTOMARY UNITS

It's time to begin training for this year's physical fitness test.

You will each jog...

...or fly...

...or knuckle-walk...

...or...

!?!

You will each go around a track...

How long is the track?

...while wearing a pack...

How heavy is the pack?

...and carrying a water bottle...

How much water do we get?

...for a set amount of time.

How many minutes do we have to run for?

Because you polliwogs come in a variety of sizes, I will offer you choices.

You will begin by selecting a track.

You may choose a track that is either 1 mile, 25 feet, or 100 yards around.

???

For those of you unfamiliar with the ***customary system*** of measurement, I will explain.

THE CUSTOMARY SYSTEM IS THE STANDARD SYSTEM OF MEASUREMENT IN THE UNITED STATES (AND ON BEAST ISLAND). UNITS IN THE CUSTOMARY SYSTEM ARE VERY SIMILAR TO "ENGLISH" OR "IMPERIAL" UNITS USED ELSEWHERE.

One foot is 12 inches...

...slightly taller than the page you are reading.

25 feet is about the width of a two-lane road.

The 25-foot track goes around this rug.

One yard is 3 feet, which is about the width of a doorway.

1 YARD
3 FEET

100 YARDS

100 yards is the length of a football field.

The 100-yard track goes around the basketball court.

A *mile* is 5,280 feet...

...longer than 17 football fields.

1 MILE
5,280 FEET

The one-mile track goes all the way around Beast Academy.

Which track would you choose?

The one-mile track seems too long. It takes almost 30 minutes to walk all the way around campus.

I'm not sure I could fly a whole mile without a break.

The 25-foot track is too short.

You'd get dizzy running around that thing.

So we should pick the 100-yard track!

Next, we'll choose packs.

Packs come in three weights: 1 ton, 10 pounds, or 20 ounces.

Which is the small one?

A battery weighs about an ounce. A chicken egg weighs about two ounces. An apple weighs about five ounces.

So the 20-ounce pack weighs about the same as twenty batteries, ten eggs or four apples!

1 mile
25 feet
100 yards

Pack

☐ 1 Ton
☐ 10 Pounds
☑ 20 Ounces

Bottle

☐ 1 Ounce

A pound is 16 ounces.

The book you're reading weighs about a pound.

The ten-pound pack weighs about as much as a housecat.

A ton is 2,000 pounds... the weight of 6 or 7 refrigerators...

...or one very small car.

Pack

☐ 1 Ton

☒ 10 Pounds

☐ 20 Ounces

Finally, you must select a water bottle.

Bottles come in six sizes: ounce, cup, pint, quart, gallon, and 5-gallon.

Aren't some of those for milk?

Don't worry. I rinsed them.

TUSKEN

This is one fluid ounce.*

Eight fluid ounces fill a cup.

Two cups fill a pint.

Two pints fill a quart.

Four quarts fill a gallon...

...and of course five gallons fill this five-gallon jug.

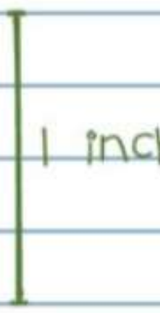
*THERE ARE TWO KINDS OF OUNCES. THE OUNCES ON THE PREVIOUS PAGE ARE USED TO MEASURE WEIGHT. THE ***FLUID OUNCES*** ON THIS PAGE ARE FOR MEASURING VOLUME (HOW MUCH SPACE SOMETHING TAKES UP).


Are there any questions before you gear up and begin your laps?
How long do we have to run for?
Your choice: half an hour, 30 minutes, or 1,800 seconds.
Woohoo!

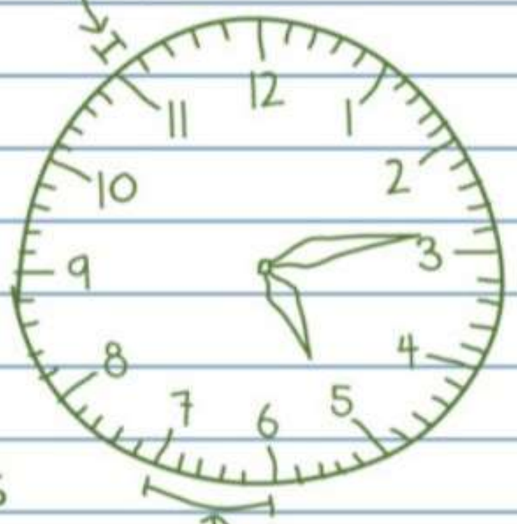
Customary Units

Lizzie

Unit (abbreviation)	Conversion
Weight	
ounce (oz)	
pound (lb)	1 lb = 16 oz
ton	1 ton = 2,000 lb
Length	
inch (in)	
foot (ft)	1 ft = 12 in
yard (yd)	1 yd = 3 ft
mile (mi)	1 mi = 5,280 ft
Volume	
fluid ounce (fl oz)	
cup (c)	1 c = 8 fl oz
pint (pt)	1 pt = 2 c
quart (qt)	1 qt = 2 pt
gallon (gal)	1 gal = 4 qt
Time	
second (sec)	
minute (min)	1 min = 60 sec
hour (hr)	1 hr = 60 min
day	1 day = 24 hr
week	1 week = 7 days
month	1 month has 28-31 days
decade	1 decade = 10 years
century	1 century = 100 years
millennium	1 millennium = 1,000 years
Temperature	
degree Fahrenheit (°F)	
Water freezes: 32 °F	
Water boils: 212 °F	



The long hand on a clock moves this far every minute.



The short hand on a clock moves this far every hour.

CAR POOL

My mom has been taking me to the upper school for piano lessons.

Yesterday, I got to eat in their cafeteria.

Cooool. How was it?

You know what the funniest thing about the upper school is?

What?

It's the little differences.

Example?

Well, in the upper school, you can get a soda at lunch. Not in a little plastic cup either, I mean a ***can*** of soda.

Oh man, I can't wait.

And do you know what they call a Quarter Pounder with Cheese in the upper school?

They don't call it a Quarter Pounder with Cheese?

Nope. They use the ***metric system.*** They call it a Hundred Grammer with Cheese.

THE METRIC SYSTEM INCLUDES UNITS LIKE GRAMS, LITERS, AND METERS. IT IS THE STANDARD SYSTEM OF MEASUREMENT IN MOST OF THE WORLD, AND IS ALSO CALLED THE "INTERNATIONAL SYSTEM."

A Hundred Grammer with Cheese! That sounds big.

I thought so too, but it's actually a little smaller than a Quarter Pounder.

Know what they call a pint of juice?

???

A ***half liter.***

What's a half liter?

It's like a pint... just a tiny bit bigger.

What do they call hash browns?

I don't know, they weren't serving breakfast.

MATH TEAM

The Metric System

Before today's math meet, we are going to learn a whole new system of measurement!

Units are *so* annoying!

Why are there ***twelve*** inches in a foot, but only ***three*** feet in a yard?!

And ***5,280*** feet in a mile?! Why couldn't they just make a mile ***5,000 feet?***

You kids are going to love the metric system...

...especially you, Alex.

In the metric system, length can be measured in centimeters, meters, and kilometers.

There are 100 centimeters in a meter...

...and 1,000 meters in a kilometer.

100 and 1,000...

...that's ***awesome!***

THIS GRAY BOX IS ONE CENTIMETER TALL. ONE INCH IS A LITTLE MORE THAN TWO AND A HALF CENTIMETERS. ONE METER IS EQUAL TO 100 CENTIMETERS, WHICH IS A LITTLE MORE THAN 39 INCHES.

Metric units of weight include grams and kilograms.

Can you guess how many grams there are in a kilogram?

1,000! Since there are 1,000 meters in a ***kilo***meter, there should be 1,000 grams in a ***kilo***gram.

Right! "Kilo" means 1,000!

A PAPERCLIP WEIGHS ABOUT 1 GRAM. A PROFESSIONAL BASEBALL BAT WEIGHS ABOUT 1 KILOGRAM, WHICH IS A LITTLE MORE THAN 2 POUNDS.

And "cent" means 100!

That's right!

There are 100 ***cent***s in a dollar!

And 100 years in a ***cent***ury!

And 100 legs on a ***cent***ipug!

Metric units of volume include ***milliliters*** and ***liters***.

A milliliter is a very small amount. A teaspoon holds about five milliliters.

There are 1,000 milliliters in a liter.

Soda is often sold in two-liter bottles.

FOR A LIST OF UNITS AND METRIC PREFIXES, SEE ALEX'S NOTES ON PAGE 100.

Today's math meet will have a lot of questions that include units.

The most important thing to know is that you can't add or subtract units unless they are the same.

3 cm

For example, this nerfle has a body that is 3 centimeters long...

...and a tongue that is 3 meters long!

How long is the nerfle with its tongue out?

3+3 is 6, but when you add 3 centimeters plus 3 meters, you don't get 6 centimeters or 6 meters...

...the units are not the same!

It doesn't make sense to add two things that are not the same.

It's like trying to add 3 apples plus 3 orangutoads.

=???

But you could change each meter into 100 centimeters, *then* add!

That's right, but we shouldn't call it ***changing***.

One meter is the ***same*** length as 100 centimeters.

When we replace 1 meter with 100 centimeters, we call it ***converting*** meters to centimeters.

To add 3 meters to 3 centimeters, we can ***convert*** the meters to centimeters.

Each meter is 100 centimeters, so 3 meters equals 300 centimeters.

3 meters + 3 centimeters

300 centimeters
+ 3 centimeters
303 centimeters

3 meters plus 3 centimeters equals 303 centimeters, so the nerfle is 303 centimeters long.

Great! How would you add 9 feet plus 2 yards?

What is 9 feet + 2 yards?

We can convert from yards to feet.

Since one yard is three feet, 2 yards equals 2×3=6 feet.

1 yard = 3 feet

2 yards = 6 feet

9 feet + 2 yards
= 9 feet + 6 feet
= 15 feet

Then we can replace 2 yards with 6 feet and add.

9 feet plus 6 feet is 15 feet.

So 9 feet plus 2 yards is 15 feet.

Perfect.

And now...

...please welcome the Little Monsters of Beast Academy and their opponents... the Bots.

It's starting, go out and take your spots!

For today's math meet, we will ask six questions involving units. The first five are each worth one point, and the final question is worth two. The team with the most points wins the meet. Is everyone ready for the first question?

Question 1:
How many feet are there in 1 mile + 1 yard + 1 foot?

A mile is 5,280 feet, a yard is 3 feet, plus 1 foot is...

...5,280+3+1=

DING!

5,284 feet!

Correct! The Little Monsters take the early lead, 1 to nothing.

Question 2:
It is now 9:50 a.m. What time will it be in 4 hours and 44 minutes?

We have to hurry, the bots have a clock!

We can add the hours first.

Try it!

In one hour, it will be 10:50 a.m.

In two hours, it will be 11:50 a.m.

In three hours, it will be 12:50 p.m.

And an hour after that, it will be 1:50 p.m.

We still have 44 minutes to add!

Ten minutes after 1:50, it will be 2:00 p.m.

That leaves just 44 − 10 = 34 minutes to add!

BZZZZT!

2:34 p.m.

Correct! Bots tie the score: 1 to 1.

Question 3:
Sammy Snail slimes three meters in five minutes. How many centimeters can Sammy slime in six seconds?

First, we need to convert meters and minutes to centimeters and seconds.

Ding!

Do you know?

Six!

Correct! The Little Monsters retake the lead, 2 to 1.

Whoa! How did you...?!?

I've been racing snails since I was four!

1 meter = 100 centimeters
3 meters = 300 centimeters

Sammy can slime 3 meters in 5 minutes.

There are 100 centimeters in a meter, so three meters is 3×100=300 centimeters.

1 minute = 60 seconds
5 minutes = 300 seconds

And there are 60 seconds in a minute, so 5 minutes is 5×60=300 seconds.

300 centimeters in 300 seconds means he's sliming one centimeter each second!

So in 6 seconds, he can slime 6 centimeters!

Question 4:
Today is Thursday. What day of the week will it be 100 days from today?

Quick! The bots have a calendar!

Try it!

In 7 days, it will be Thursday again.

...and 7 days after that is another Thursday!

There's another Thursday **every week!**

We can divide 100 days by 7 to figure out how many **weeks** there will be in 100 days...

$$\begin{array}{r} 10+4 \\ 7\overline{)\,100} \\ -70 \\ \hline 30 \\ -28 \\ \hline 2 \end{array}$$

ha ha ha

Will should have heeded robot's constant "Danger!" warnings.

MAR 27 Tues

Silly organism.

...and the remainder tells us how many extra days there are... **2!**

So 100 days after today will be 2 days after a Thursday!

$$\begin{array}{r} 10+4 \\ 7\overline{)\,100} \\ -70 \\ \hline 30 \\ -28 \\ \hline 2 \end{array}$$

BZZZZT!

Urrrgh!

Saturday.

Saturday is correct! The score is tied again, 2 to 2.

Question 5:
Plumber Pete cuts a 96-centimeter pipe into two pieces so that the long piece is 14 centimeters longer than the short piece. What is the length of the long piece of pipe?

Try it!

We need to find two numbers that add up to 96.

And one of the numbers has to be 14 more than the other.

We can use a variable!

Huh?

If we use p to represent the length of the short piece...

...we can use p+14 to represent the length of the long piece.

Because the long piece is 14 centimeters longer than the short piece!

P

P + 14

Right! And, if we put the two pieces together, we get a 96-centimeter pipe.

96

P

P + 14

Write an equation and solve for p.

p + (p+14)=96

So, $p+(p+14)=96$

p + p+14 =96

We don't need these parentheses.

p + p+14 =96
-14 -14

Now, we can subtract 14 from both sides of the equation.

p + p = 82

If $p+p$ is 82, then p must be...

Ding!

41 centimeters!

I'm sorry, that answer is incorrect.

What was Grogg's mistake?

Grogg! The length of the ***short*** piece was p!

We needed to find the length of the ***long*** piece!

The ***long*** piece is 14 centimeters longer than the short piece...

...$p+14$!

BZZZT!

55 centimeters.

Correct!

The Bots have taken the lead with just one question to go.

Question 6:

A recipe for one gallon of fruit punch calls for two quarts of pink lemonade, three pints of ginger ale, and one cup of grape juice. The rest is pineapple juice. How many ounces of pineapple juice are needed to complete the recipe?

The bots are mixing their punch!

We need to subtract 2 quarts, 3 pints, and 1 cup from 1 gallon.

Whatever is left is pineapple juice.

Try it!

But the units are all different.

And our answer needs to be in ***ounces.***

We could convert gallons, quarts, pints and cups into ounces so that the units are the same before we subtract.

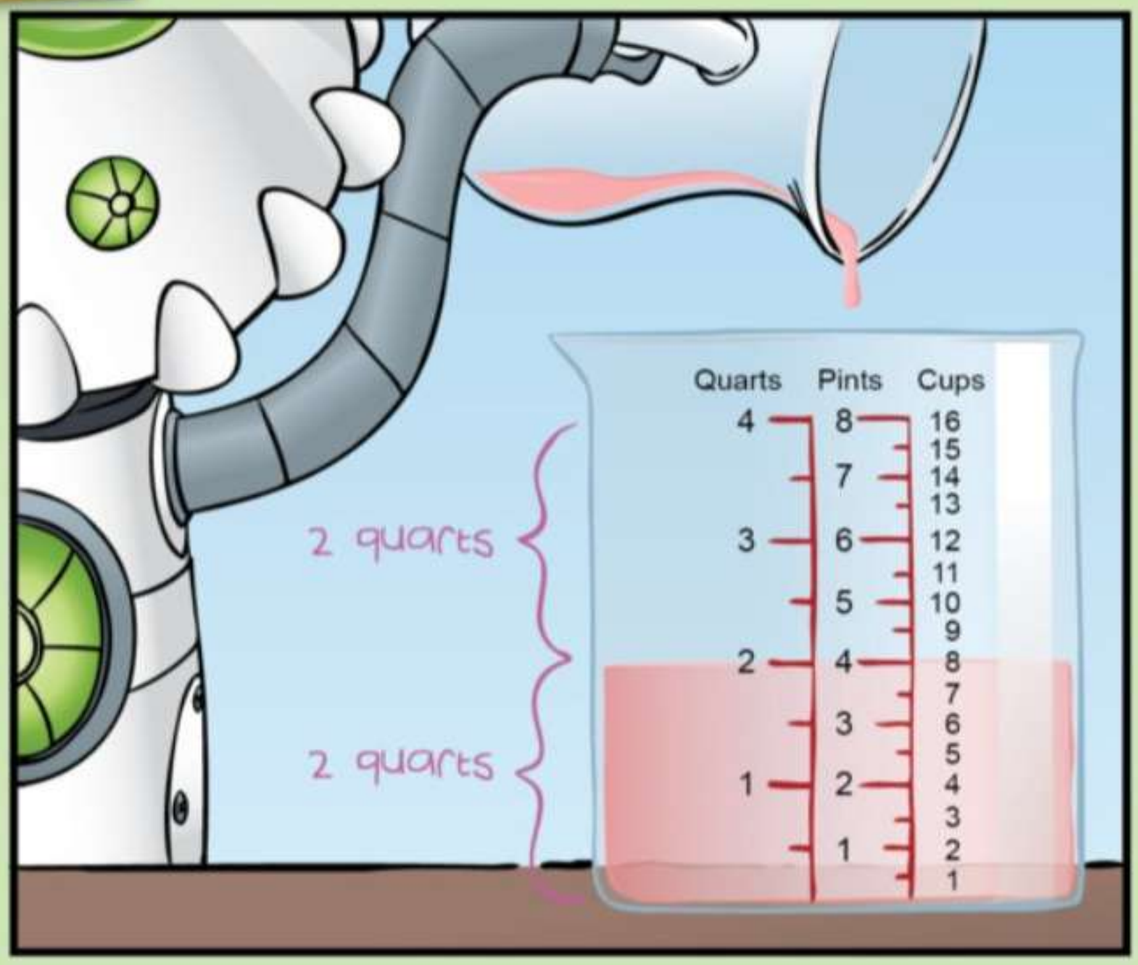
Or, we could subtract one part at a time!

There are 4 quarts in a gallon.

So, if there are 2 quarts of pink lemonade, that leaves 2 quarts for everything else.

1 gallon = 4 quarts

4 quarts
-2 quarts
2 quarts



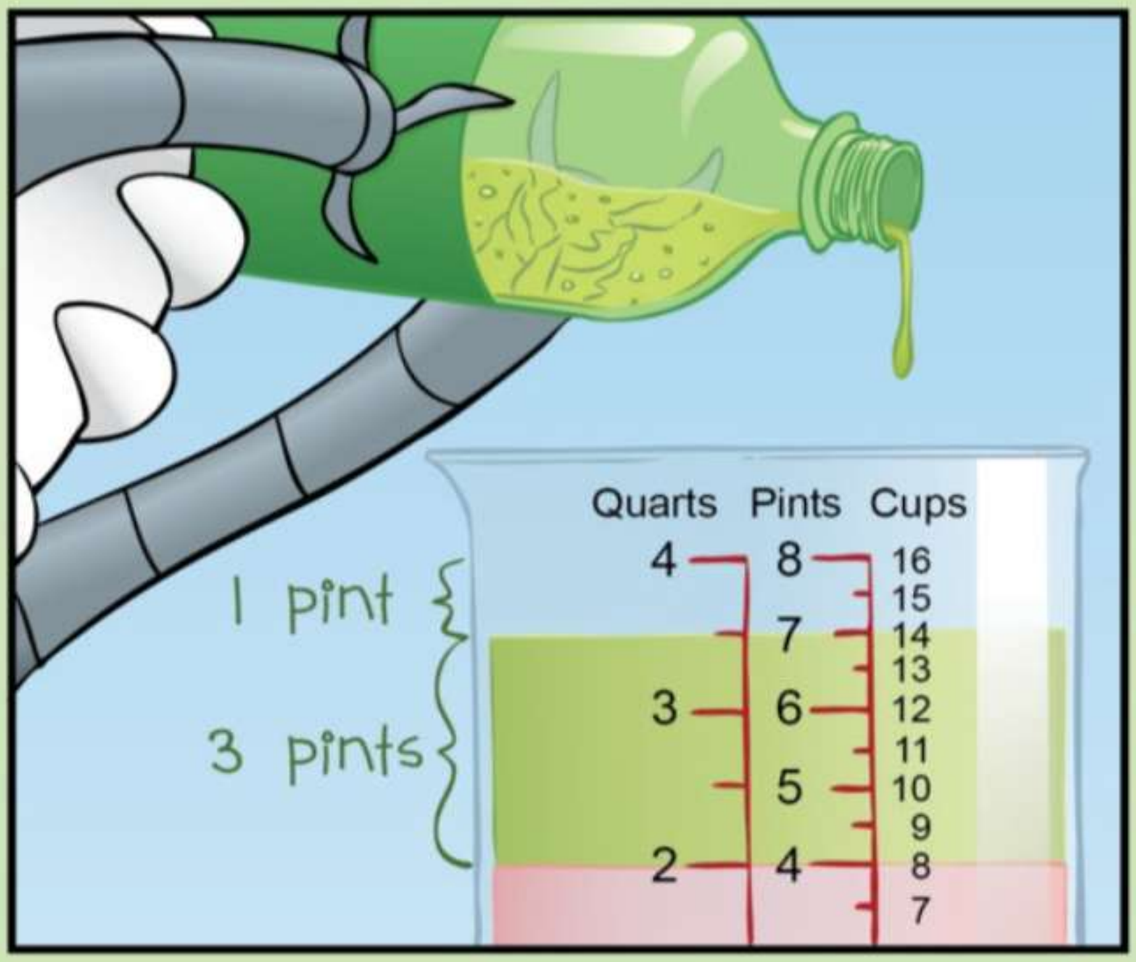
There are 2 pints in a quart...

...so 2 quarts equals 4 pints.

If there are 3 pints of ginger ale, that leaves 1 pint for everything else.

2 quarts = 4 pints

4 pints
-3 pints
1 pint

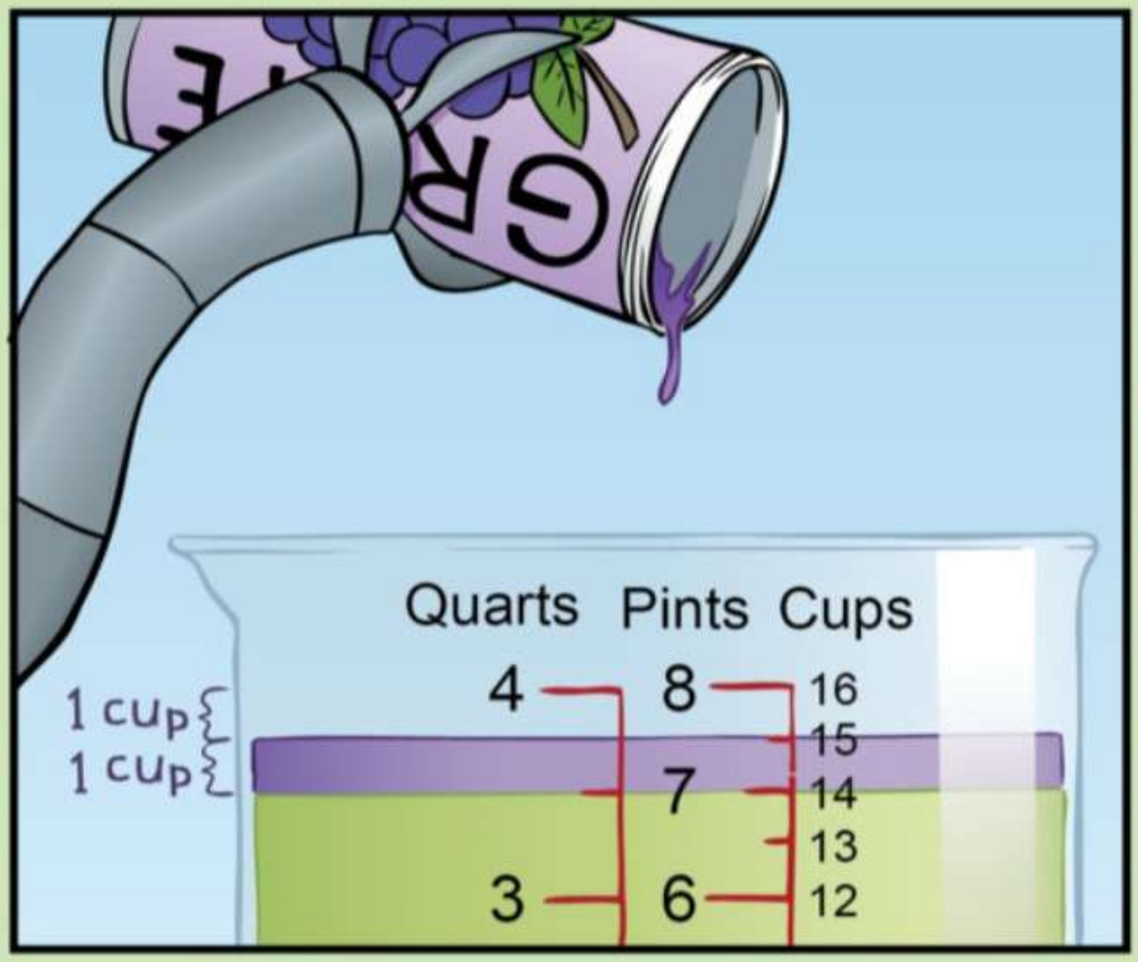


There are 2 cups in 1 pint.

So, if there is 1 cup of grape juice, that leaves room for 1 cup of pineapple juice!

1 pint = 2 cups

2 cups
-1 cup
1 cup



BZZZZT!

And 1 cup is...

8 ounces

8 ounces is *correct!*

The Bots are today's math meet champs!

GO BOTS!

APPLAUSE

We lost.

That was unexpected.

Can't win 'em all.

What does this mean?

We've never lost to the bots.

Losing is an important part of learning.

The only monsters that never lose are the ones who never try anything difficult.

If you never lose, you're probably not challenging yourself.

We'll have another chance, and we'll be better than ever!

Fruit punch?

Sure. Thanks.

The Metric System

Alex

The metric system uses prefixes.

kilo means ×1,000

For example, there are 1,000 meters in 1 **kilo**meter.

centi means ÷100

1 meter can be divided into 100 **cent**imeters.

milli means ÷1,000

1 liter can be divided into 1,000 **milli**liters.

Common Units (abbreviation)

Weight

gram (g)

kilogram (kg) 1 kg = 1,000 g

Length

centimeter (cm) 100 cm = 1 m

meter (m)

kilometer (km) 1 km = 1,000 m

Volume

milliliter (mL) 1,000 mL = 1 L

liter (L)

Other Prefixes	Conversion	Example
kilo (k)	×1,000	1 **kilo**meter = 1,000 meters
hecto (h)	×100	1 **hecto**meter = 100 meters
deka (da)	×10	1 **deka**meter = 10 meters
no prefix		1 meter = 1 meter
deci (d)	÷10	10 **deci**meters = 1 meter
centi (c)	÷100	100 **centi**meters = 1 meter
milli (m)	÷1,000	1,000 **milli**meters = 1 meter

1 millimeter

1 centimeter = 10 mm

1 decimeter = 10 cm = 100 mm

Temperature:

degrees Celsius (°C)

Water freezes: 0°C

Water boils: 100°C

Woodshop

PROPER MEASURIN'

The most common pirate treasure be a chest o' gold doubloons.

'Tis easy enough to divide a chest o' coins among any number of pirates...

...but it wasn't always coins we be findin' on me voyages.

What other treasure did you find?

All types of plundered goods!

Exquisite jewelry 'n ornaments.

The finest silks 'n textiles.

And valuable spices... cinnamon, saffron, 'n cardamom.

How did you divide jewelry, fabric, and spices?

Excellent question. Makin' sure each pirate gets a fair share takes careful measurin'!

How did you measure?

That be dependin' on the treasure.

What be the best way to measure a roll of fabric to be divided among 9 pirates?

You could weigh it!

Weigh it?!

If the fabric weighs 18 pounds, and you want to give each pirate two pounds...

...how can you cut ***fabric*** into ***two-pound pieces?!***

You should probably find the ***length*** of the fabric on the roll.

Aye, for a roll of fabric, we always find its length before dividin' the roll.

'Tis important to choose an appropriate measure.

For example, you don't measure apple cider by the foot, or by the pound.

Cider be measured by volume, usually in gallons.

And when ye be measurin' gold, weight be most important.

But items like rope 'n' fabric be measured by length.

After choosin' an appropriate measure, like length, weight, or volume...

...'tis necessary to choose an appropriate ***unit*** of measure.

For example, what units should ye be usin' to measure the length o' fabric on this roll: inches, yards, or miles?

Which units would you choose?

It's a long piece of fabric but I don't think it's a ***mile*** long.

It would take forever to find out how many ***inches*** long it is.

I guess you would measure it in yards.

Excellent!

When measurin' a small item, 'tis best to use small units.

The length of a pencil be measured in inches...

7 in (about 18 cm)

...or centimeters, if ye be usin' the metric system.

For a larger item, we use larger units.

The length of a ship be measured in yards...

44 yd (about 40 m)

...or meters, if ye be usin' the metric system.

And distances traveled by a ship be measured in miles or kilometers.

Why?

Cinnabar

Myst

Kokomo

8 miles (13 km)

44 miles (71 km)

Lilliput

Skull Island

Koholint

25 miles (40 km)

18 miles (29 km)

Tortuga

N

W

E

S

Well, what if I told you that Tortuga is about 52,000 feet across?

It's hard to get a sense of how far 52,000 feet is.

We're not used to long distances being described in feet.

Aye, but what if I told you that it be 10 ***miles*** across.

That's pretty big, but I could ride my bike that far in about an hour.

10 miles is a lot more familiar than 52,000 feet.

Small numbers are easier to work with.

Very good!

Let's look at another treasure.

Here be a jar o' saffron threads. 'Tis the world's most posh spice.

What be a proper way to measure the saffron?

Saffron

Saffron would be hard to measure by length...

Saffron

...you'd have to lay all the threads end-to-end.

The volume depends on how much you squeeze the saffron in the bottle.

Saffron

Please, don't squeeze the saffron!

You could weigh it!

Aye, and what units should ye be usin': ounces, pounds, or tons?

There's no way that saffron weighs a ton...

...it's probably close to a pound.

If it's close to 1 pound, maybe we should measure it in ounces.

We can be more accurate if we measure in ounces.

Right, because it's ***close*** to one pound...

...it might be a little more, or a little less.

Aye, 'tis more accurate to use ounces. There be 10 ounces of saffron in this jar.

Saffron

YOU *COULD* MEASURE THE SAFFRON IN POUNDS, BUT YOU WOULD HAVE TO USE A FRACTION.
WE DISCUSS FRACTIONS IN BEAST ACADEMY 3D.

So, sometimes it's better to use a big unit.

If you ask my age, you probably want it in years, not minutes.

But small units can be more accurate.

If you want to know how long I can hold my breath, I should say "70 seconds," not "zero hours."

70 seconds! No one can hold their breath for 70 seconds.

I'll take that challenge.

Time us!