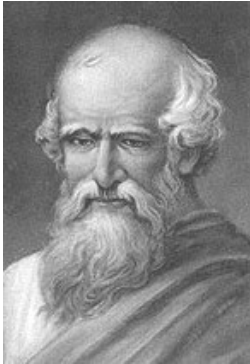


ARCHIMEDES AND THE POWER OF MATH *TEACHERS' GUIDE*



THANK YOU VERY MUCH FOR BRINGING YOUR STUDENTS TO SEE ARCHIMEDES & THE POWER OF MATH! I HOPE YOU AND YOUR CHARGES ENJOY THE SHOW. THIS SHOW WAS DEVELOPED NOT TO TEACH MATH (WHICH I DON'T PRESUME TO BE QUALIFIED FOR) BUT TO SHOW YOUNG STUDENTS SOME OF THE INCREDIBLE THINGS THEY CAN ACHIEVE WITH MATH IF THEY JUST STICK WITH IT. IN MY RESEARCH I LEARNED VERY EARLY ON THAT MATH IS INDEED "COOL, FUN AND POWERFUL!" YOU MATH TEACHERS ALREADY KNOW THAT. I HAD TO RE-LEARN IT. AND I HOPE I CAN PASS SOME OF THAT EXCITEMENT ALONG TO YOUR KIDS.

JUST WHO WAS ARCHIMEDES?



WE ACTUALLY KNOW VERY LITTLE ABOUT ARCHIMEDES. AND WHAT WE DO KNOW COMES FROM SECOND- OR THIRD-HAND SOURCES. HERE'S WHAT WE KNOW:

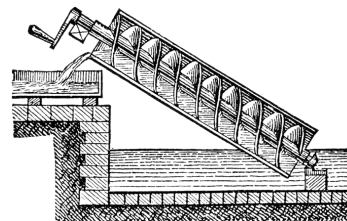
HE WAS BORN IN SYRACUSE ON SICILY AROUND 287 BC. HE MAY HAVE BEEN RELATED TO HERIO II, THE RULER OF SYRACUSE. WE HAVE NO RECORD OF A WIFE OR CHILDREN. HE LIKELY STUDIED IN ALEXANDRIA, EGYPT. HE LIVED FOR SEVENTY-FIVE YEARS BEFORE BEING KILLED DURING A ROMAN INVASION OF SICILY DURING THE SECOND PUNIC WAR, 212 BC. TRADITION SAYS HE WAS KILLED BY A ROMAN SOLDIER WHEN HE REFUSED TO LEAVE HIS GEOMETRIC STUDIES. HIS FINAL WORDS WERE, "DON'T DISTURB MY CIRCLES!" OTHER QUOTES: "GIVE ME A PLACE TO STAND AND A LEVER LONG ENOUGH AND I WILL MOVE THE EARTH." "EUREKA!" "RISE ABOVE ONESELF AND GRASP THE WORLD!"

HIS ACCOMPLISHMENTS

INVENTIONS

LARGEST SHIP IN ANCIENT WORLD
ARCHIMEDES SCREW
IMPROVED BLOCK AND TACKLE
IMPROVED CATAPULT
ODOMETER
PLANETARIUM

"WEAPONS OF MATH DESTRUCTION"



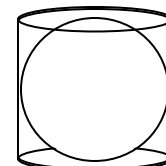
DISCOVERIES

PRINCIPLE OF DENSITY
'*LEGEND OF GOLDEN CROWN*'
METHODOLOGY OF LEVERS



MATHEMATICS

DEvised SYSTEM FOR CALCULATING HUGE NUMBERS
DETERMINED VOLUME AND AREA OF A SPHERE
EQUALS 2/3 OF CYLINDER THAT CONTAINS IT



DETERMINED VALUE OF PI BETWEEN $3 \frac{1}{7}$ AND $3 \frac{10}{71}$
THROUGH "PROOF BY CONTRADICTION" AND "METHOD OF EXHAUSTION"

(NOT SURE WHAT THOSE ARE BUT, AS TEACHERS, I FIGURED YOU COULD RELATE TO THE TERMS!)

THE MATH TRICKS

A FEW TONGUE-IN-CHEEK MATH TRICKS BEFORE THE SHOW !

#1

USE THE SAME NUMBER THREE TIMES TO GET THE SUM SIXTY. BUT THAT NUMBER CANNOT BE TWENTY!

$$\begin{array}{r} + \\ \hline 60 \end{array} \quad \Rightarrow \quad \begin{array}{r} 55 \\ + 5 \\ \hline 60 \end{array}$$

#2

ADD A SINGLE LINE TO THE FOLLOWING EQUATION TO MAKE IT TRUE! BUT THE LINE CANNOT GO THRU THE EQUAL SIGN!

$$5 + 5 + 5 = 550$$
$$5 \text{ (with a line over it)} + 5 + 5 = 550$$

#3

CAN YOU PUT ONE MATHEMATICAL SYMBOL BETWEEN THE 5 AND 9 BELOW TO PRODUCE A NUMBER BETWEEN 5 AND 9?

5 9

USE A DECIMAL POINT TO MAKE IT 5.9!*

#4

RE-ARRANGE THE FOLLOWING SYMBOLS AND NUMBERS INTO A TRUE EQUATION

$$2 \ 3 \ 4 \ 5 \ + \ =$$
$$4 \ + \ 5 \ = \ 3^2^*$$

*I REALIZE THAT SOME OF YOUR CHILDREN MAY NOT HAVE LEARNED THE CONCEPTS OF DECIMAL POINTS AND EXPONENTS. I GIVE A SIMPLIFIED EXPLANATION OF WHAT THEY ARE DURING THE SHOW. A SIMPLE ENOUGH EXPLANATION SO THAT I CAN USE THEM A LITTLE BIT LATER ON.

THE SHOW

THE SHOW IS BROKEN UP INTO ROUGHLY FOUR PARTS HIGHLIGHTING FOUR BRANCHES OF MATHEMATICS:

ARITHMETIC – NUMBERS, ADDITION, SUBTRACTION, MULTIPLICATION AND DIVISION

THE NUMBER ZERO, ROMAN NUMERALS, THE NUMBER PI

ALGEBRA – HOW NUMBERS WORK TOGETHER

RECOGNIZING PATTERNS

GEOMETRY – THE STUDY OF SHAPES

HOW FORMULAS CAN DESCRIBE COMPLEX SHAPES

TRIGONOMETRY– USING THE PROPERTIES OF A RIGHT TRIANGLE TO SOLVE PROBLEMS

THEY'RE USING THIS ALREADY, THEY JUST DON'T KNOW IT!

THE SINE WAVE IN JUMP-ROPE & HEARING SOUND AND ALONG THE WAY WE HINT AT MATH HISTORY, THE ANCIENT WORLD AND...

THE LEGEND OF THE GOLDEN CROWN

(I KNOW THE SCIENCE HERE IS SKETCHY. BUT IT TAKES TOO LONG TO EXPLAIN THE IMPLAUSIBILITY OF MEASURING MINUTE VOLUMES IN THE ANCIENT WORLD AS OPPOSED TO THE EASE OF COMPARING DENSITIES!)

AND

THE WEAPONS OF MATH DESTRUCTION

BECAUSE THERE'S NOTHING LIKE SHOOTING SOMETHING OR BURNING SOMETHING UP TO CAPTURE A KID'S ATTENTION!

AND THIS IS PRETTY HISTORICALLY ACCURATE.

YOU MIGHT CHECK OUT THE MYTHBUSTERS EPISODES I MENTION ONLINE!

(BECAUSE UNFORTUNATELY THE ONLY OTHER THING THAT CAPTURES A KID'S ATTENTION IS WHEN YOU SHOOT SOMETHING OR BURN SOMETHING UP ON TELEVISION!)

SOME WEB STUFF YOU'LL LIKE!

THE FUNCTION OF EXPONENTS IS NICELY SHOWN BY SEVERAL "POWERS OF TEN" VIDEOS ON YOUTUBE. "THE MEGAPENNY PROJECT" ON SEVERAL SITES DEMONSTRATES IT REALLY WELL USING, WHAT ELSE, PENNIES!

SEARCH "GALLOPING GERTIE" ON YOUTUBE TO SEE THE LARGEST SINE WAVE EVER, THE TACOMA NARROWS BRIDGE, FALLING VICTIM TO STRONG WINDS AND SOME BAD MATH IN ITS DESIGN.

AND FINALLY, THE FIBONACCI SEQUENCE DESCRIBED ON THIS MANUAL'S LAST PAGE IS BEAUTIFULLY ILLUSTRATED AS NATURE'S INSPIRATION FOR THE FORMATION OF A NAUTILUS' SHELL IN A YOUTUBE VIDEO CALLED "NATURE BY NUMBERS," BY JOHAN TROCH.

THE LATEST AND GREATEST MATH WEBSITES

FOR YOUR STUDENTS' EDIFICATION AND EDUCATION

WWW.MATHPLAYGROUND.COM

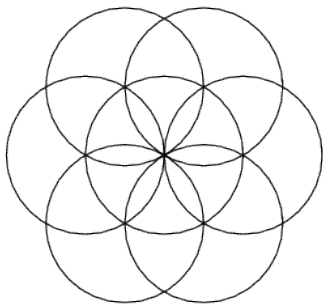
COVERS ALL THE BASICS WITH SIMPLE EXPLANATIONS AND FRIENDLY GRAPHICS

MY PERSONAL FAVORITE...

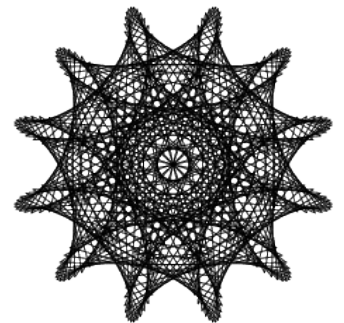
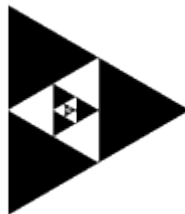
WWW.MATHWORLD.WOLFRAM.COM

A LOT OF THIS MAY BE ABOVE YOUR KIDS' HEADS.
BUT IT'S A GREAT SOURCE FOR THE AMAZING THINGS MATH CAN DO.

FROM THE BEAUTY OF MATH, SIMPLE & COMPLEX!



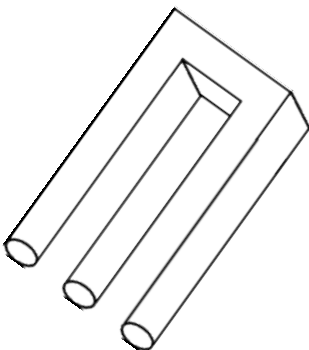
"THE SEED OF LIFE"



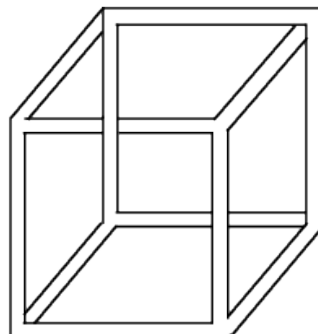
THE MAURER ROSE

NESTED POLYGONS

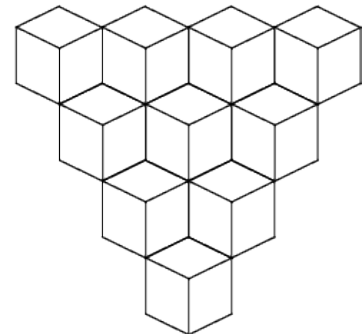
...TO CLASSIC MATHEMATICAL IMPOSSIBILITIES!



"THE IMPOSSIBLE FORK"



"THE FREEMISH CRATE"



"THE NECKER CUBE"

THE NINE WHIZZER RULE

DURING THE SHOW WE MENTION THAT MANY MATHEMATICAL BREAKTHROUGHS CAME ABOUT WHEN SOMEONE RECOGNIZED A PATTERN IN A SERIES OF NUMBERS (YOUR STUDENTS HAVE BEEN DOING THIS SINCE KINDERGARTEN).

BASICALLY, WHAT COMES NEXT?

2, 4, 6...8

5, 10, 15, 20, 25...30

9, 18, 27, 36, 45, 54, 63, 72, 81...90

BUT IN THE THIRD SERIES (MULTIPLES OF NINE) A SECOND PATTERN IS PRESENT.

IF YOU ADD THE DIGITS OF ANY MULTIPLE OF NINE, THE RESULT IS NINE!

$$2+7=9$$

$$5+4=9$$

AND THIS IS TRUE OF ANY MULTIPLE OF NINE!

NO MATTER HOW LARGE!

TRY **261**? $2+6+1=9$ $261/9=29$

HOW ABOUT **17,523**? $1+7+5+2+3=18$ $1+8=9$ $17,523/9=1947$

HOW ABOUT **2,427,912**? $2+4+2+7+9+1+2=27$ $2+7=9$ $2,427,932/9=269768$

THE NINE WHIZZER RULE!

USEFUL? MAYBE NOT SO MUCH. BUT IT DOES LET US PERFORM A PRETTY COOL MIND-READING TRICK!

THE LARGE EXAMPLE NUMBERS ABOVE WERE SELECTED BECAUSE THEIR DIGITS ADDED UP TO NINE.

WHAT IF A LARGE NUMBER WAS GENERATED RANDOMLY BY AN AUDIENCE MEMBER **AND** A MULTIPLE OF NINE?

NOT AS HARD AS YOU MIGHT IMAGINE!

BY HAVING AN AUDIENCE MEMBER GENERATE A NUMBER 8 OR 9 DIGITS LONG BY MULTIPLYING SINGLE DIGITS ON A CALCULATOR, THE RESULTANT HUMONGOUS NUMBER IS ALMOST ASSUREDLY A MULTIPLE OF NINE!

AT SOME POINT THE VOLUNTEER HITS 9, 3 TWICE OR A 3 AND A 6. $6=2 \times 3$, REMEMBER?

YOU NOW HAVE AN ENORMOUS MULTIPLE OF NINE!

HAVE THE VOLUNTEER WRITE THE NUMBER DOWN WITHOUT YOU SEEING IT.

HERE'S ONE I JUST MADE UP ON MY CALCULATOR:

60,963,840

HAVE THE VOLUNTEER MARK ONE OF THE DIGITS. SAY, THE 3. NOW YOU HAVE:

60,963,840

ASK THE VOLUNTEER TO SLOWLY READ ALL THE DIGITS FROM LEFT TO RIGHT EXCEPT FOR HIS MARKED NUMBER.

ADD THOSE NUMBERS IN YOUR HEADS AS HE READS THEM:

$$6 + 0 + 9 + 6 + 8 + 4 + 0 = 33$$

$$3 + 3 + 6$$

BUT YOUR DIGITS HAVE TO EQUAL 9! WHAT'S THE MISSING NUMBER?

$$9 - 6 = 3$$

AND THAT'S THE EXACT NUMBER HE MARKED! YOU'RE ONLY IN TROUBLE IF THE MARKED NUMBER IS 9 OR 0 BECAUSE YOUR SUM WILL BE 9!

TIME FOR FANCY FOOTWORK! SAY YOU CAN SEE THE MISSING NUMBER AND CAN TELL IT'S ROUND. ASK, "DOES IT HAVE A TALE?"

IF "YES," IT'S A 9. IF "NO," IT'S A ZERO!

HERE'S A MORE ADVANCD PATTERN THAT WE DON'T GET TO EXPLORE IN THE SHOW
BUT CAN BE USED FOR AN AMAZING TRICK

The Fabulous Fibonacci Sequence

A VOLUNTEER CREATES A RANDOM SERIES OF TEN NUMBERS BY CHOOSING TWO SINGLE DIGIT NUMBERS, SAY 3 &

5. THE VOLUNTEER THEN ADDS THOSE TWO NUMBERS TOGETHER. $3 + 5 = 8$

THEN ADD THE SUM TO THE LAST DIGIT TO GENERATE THE NEXT NUMBER. $5 + 8 = 13$.

CONTINUE UNTIL YOU HAVE A SERIES OF TEN NUMBERS, IN THIS CASE:

3 5 8 13 21 34 55 89 144 233

THEN CHALLENGE THE VOLUNTEER TO ADD THOSE NUMBERS UP FASTER THAN YOU
USING PAPER & PENCIL, CALCULATOR, WHATEVER.

BEFORE YOUR VICTIM BARELY BEGINS, YOU ANNOUNCE YOU ANSWER.

605

HOW DID YOU ADD SO QUICKLY? IT'S NOT REALLY A RANDOM SERIES OF NUMBERS
EVEN THOUGH THE VOLUNTEER CAN CHOOSE ANY TWO NUMBERS WITH WHICH TO START.

IT'S CALLED A **FIBONACCI SEQUENCE!** IT HAS SEVERAL UNIQUE PROPERTIES.

THE ONE WE'RE INTERESTED IN IS VERY, VERY OBSCURE:

THE SUM OF THE FIRST TEN NUMBERS OF A FIBONACCI SEQUENCE

EQUALS THE SEVENTH NUMBER MULTIPLIED BY ELEVEN!

(I TOLD YOU IT WAS VERY, VERY OBSCURE!)

IN THIS CASE,

$$55 \times 11 = 605$$

BUT HOW DO I MULTIPLY A NUMBER BY ELEVEN IN MY HEAD SO QUICKLY?!

AYE, THERE'S THE RUB!

(AND A HANDY MATHEMATICAL SHORTCUT MORE USEFUL THAN THE FIBONACCI SERIES ITSELF!)

TO MULTIPLY A TWO DIGIT NUMBER BY ELEVEN, YOU SEPARATE THE TWO DIGITS BY A SPACE

AND PLACE THE SUM OF THE TWO NUMBERS IN THE MIDDLE! (IF THE SUM HAS TWO DIGITS,

AS IN THIS CASE, YOU CARRY THE FIRST DIGIT.)

55

5 5

5 5+5 5

5 10 5

5+1 0 5

605

WHAT OTHER SECRETS DOES THE FIBONACCI SEQUENCE HOLD?

IF YOU DIVIDE ANY NUMBER BY THE NUMBER IN FRONT OF IT,

THE QUOTIENT IS VERY CLOSE TO THE *GOLDEN RATIO* OF 1.618034.

A FIBONACCI SEQUENCE CAN BE USED TO DESCRIBE THE SPIRAL OF A NAUTILUS SHELL.

A REVERSE FIBONACCI SEQUENCE IS USED FOR PREDICTING STOCK PRICES,

FIBONACCI WAS THE NICKNAME OF LEONARDO BOGOLIO, AN ITALIAN MATHEMATICIAN WHO LIVED AROUND 1200.

BESIDES HIS SEQUENCE, HE ALSO SPREAD THE USE OF HINDU-ARABIC NUMERALS WE USE TODAY TO EUROPE

REPLACING ROMAN NUMERALS! LOOK HIM UP ONLINE!