Enhancing Mathematics Instruction in Career and Technical Education

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Curriculum Maps

- Begin with CTE Content
- Look for places where math is part of the CTE content (V-Tecs, AYES, MarkED, state guides, last year's maps)
- Create "map" for the school year
- Align map with planned curriculum for the year (scope & sequence)

Curriculum Mapping

CTE PROGRAM	CTE UNIT	CTE CONCEPTS	MATH CONCEPTS
Health Occupations	Human Structure and Function	Compare cell, tissue, organ and body systems relationships	Solve linear equations Read and interpret graphs and charts Problem solving involving statistical data Ratio and Proportion
Construction	Dry wall	Determine amount of wall board to purchase for a specific room	Multiplication and division of whole numbers and decimals Area of rectangle

Curriculum Mapping

CTE PROGRAM	CTE UNIT	CTE CONCEPTS	MATH CONCEPTS
Culinary Arts	Cooking large quantities	Increase recipes to make large quantities of a food item for a banquet	Fractions Ratio & Proportion
Business / Marketing	Distribution	Control inventory: order, receive, count, maintain	Ratio/Percentages Graphing/Predictions Algebraic Expressions Equations
Manufacturing Technology	Measurement	Measure items for production	Number Sense Fractions Decimals Angles

Sample Curriculum Map

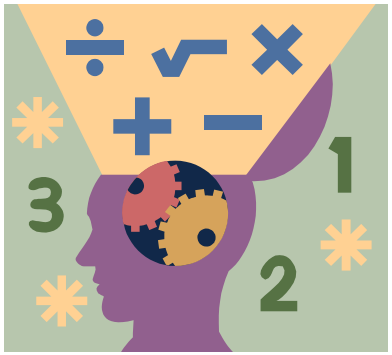
Agricultural Mechanics Curriculum	Mathematics Content Standards	PASS Standards	NCTM Standards
Determining sprayer nozzle size given flow rate and speed	Problem solving involving cross-sectional area, volume, and related rates	PASS Process Standard 1: Problem Solving	NCTM Problem Solving Standard for Grades 9-12
Determine pipe size and water flow rates for a water pump	Problem solving involving cross-sectional area, volume, and related rates		
Determine amount of paint needed to paint a given surface (calculate surface area, etc)	Problem solving involving surface area, ratio and proportions		
Determine the concrete reinforcements and spacing needed when building a concrete platform or structure	Problem solving involving cross-sectional area, volume, and related rates		

Sample Curriculum Map

Health Standards Identification	Health Skill	Mathematics Content Standards	Michigan Content Standard
Analyze methods for the control of disease.	Prognosis and diagnosis Body planes Range of motion Pharmacy calculations (for pharmacy techs	Solve linear equations Read and interpret graphs and charts Problem solving involving statistical data Ratio and Proportion	1.2 Students describe the relationships among variables, predict what will happen to one variable as another variable is changed, analyze natural variation and sources of variability to compare patterns of change.
Analyze changes in body systems as they relate to disease, disorder and wellness	Cultures and sensitivity Lab techniques Blood sugar and user failure versus accurate sample collection C & S of wounds, collection contamination process and outcome	Calculate time, temperature, mass measurement and compare to known standards Interpretation of measurement results Calculate accurate measurement in both metric and English units	2.3 Students compare attributes of two objects or of one object with a standard (unit) and analyze situations to determine what measurement(s) should be made and to what level of precision

The Pedagogy

1. Introduce the CTE lesson
2. Assess students' math awareness
3. Work through the ***embedded*** example
4. Work through ***related, contextual*** examples
5. Work through ***traditional math*** examples
6. Students demonstrate understanding
7. Formal assessment



Element 1:
Introduce the CTE lesson

- Explain the CTE lesson.
- Identify, discuss, point out, pull out the math embedded in the CTE lesson.

Element 2:
Assess students' math awareness

- Begin "bridging" between the CTE and math.
- Introduce math vocabulary *through* the math *embedded* in the CTE.
- Use methods and techniques to assess the whole class.

Element 3: Work through the math example *embedded* in the CTE lesson

- Work through the steps or processes of the *embedded* math example.
- Continue to bridge the CTE and math vocabulary.

Element 4: Work through *related, contextual math-in-CTE* examples

Using the same embedded math concept:

- Work through similar problems in the same occupational context.
- Use examples of varying levels of difficulty; order from basic to advanced.
- Continue to bridge CTE and math vocabulary.
- Check for understanding.

Element 5: Work through *traditional math* examples

Using the same embedded math concept:

- Work from applied to abstract problems.
- Work through examples as they may appear on standardized tests.
- Move from basic to advanced problems.
- Continue to bridge CTE-math vocabulary.
- Check for understanding.

Element 6: Students demonstrate understanding

- Provide students with opportunities to demonstrate their understanding of the math concepts embedded in the CTE.
- Connect the math back to CTE context.
- Conclude the lesson with CTE.

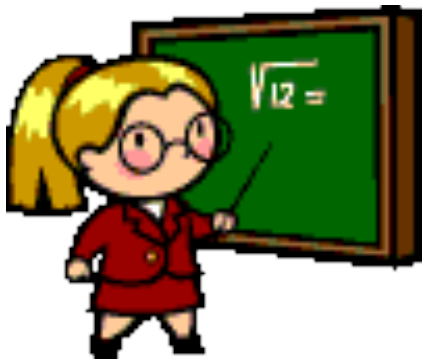
Element 7: Formal Assessment

- Include math questions in formal assessments, for example:
  - CTE unit exams
  - CTE project assessments

Some Final Thoughts…

1 math concept ≠ 1 lesson ≠ 1 class period

Lessons can address one or more concepts and/or last longer than one class period.



PEDAGOGY:
The "Seven Elements" *in brief*

1. Introduce the CTE lesson
2. Assess students' math awareness
3. Work through *embedded* example
4. Work through *related, contextual* example
5. Work through *traditional* example
6. Students demonstrate understanding
7. Formal assessment

Tractor Pull

- What type of things will you see?
- What type of tractors could be there?
- How do tractor pulls work?
- What type of tools are needed?
- What are some of the safety concerns of attending?

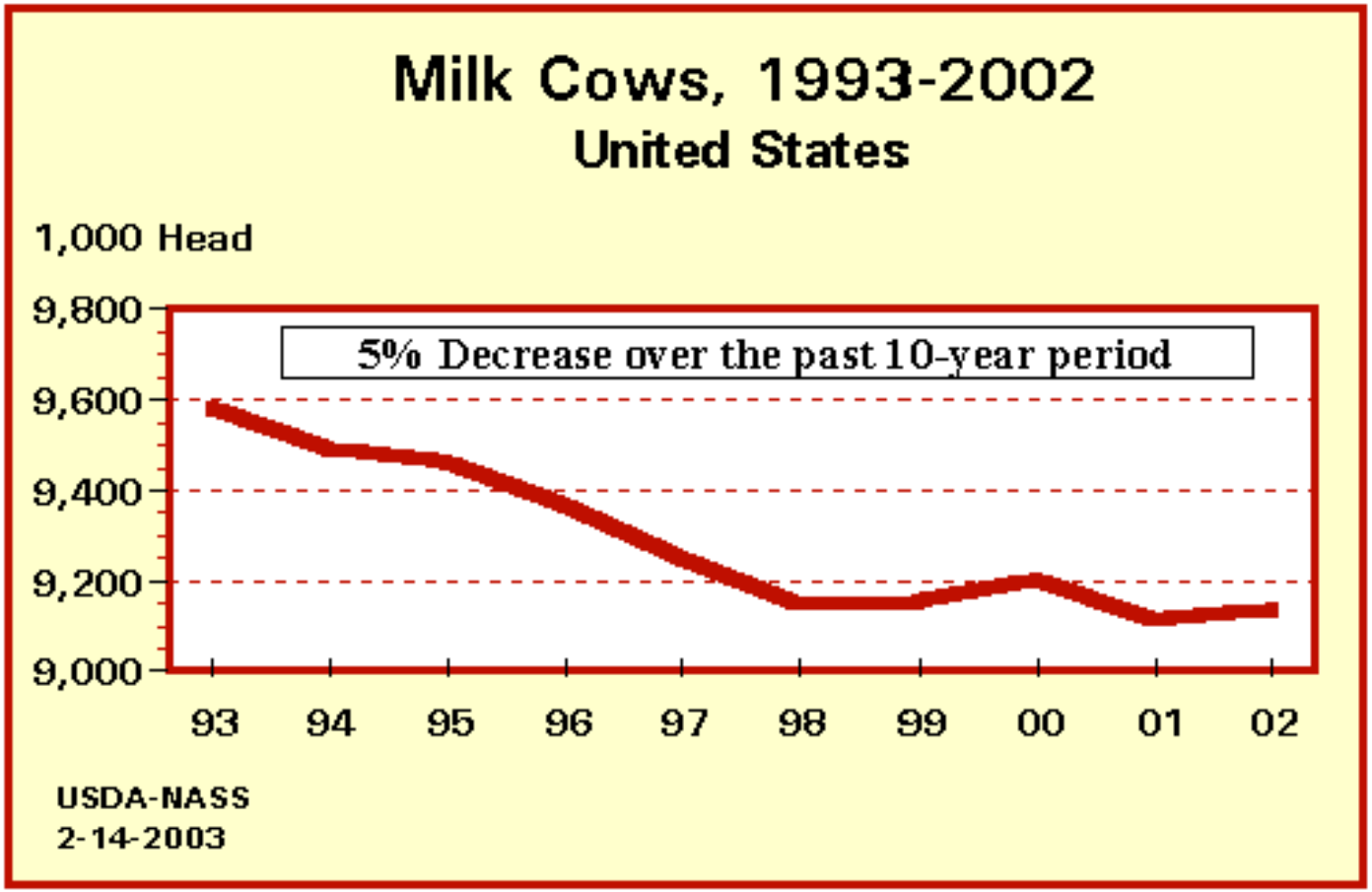
Can You Hear Me Now?

Measuring Noise Levels

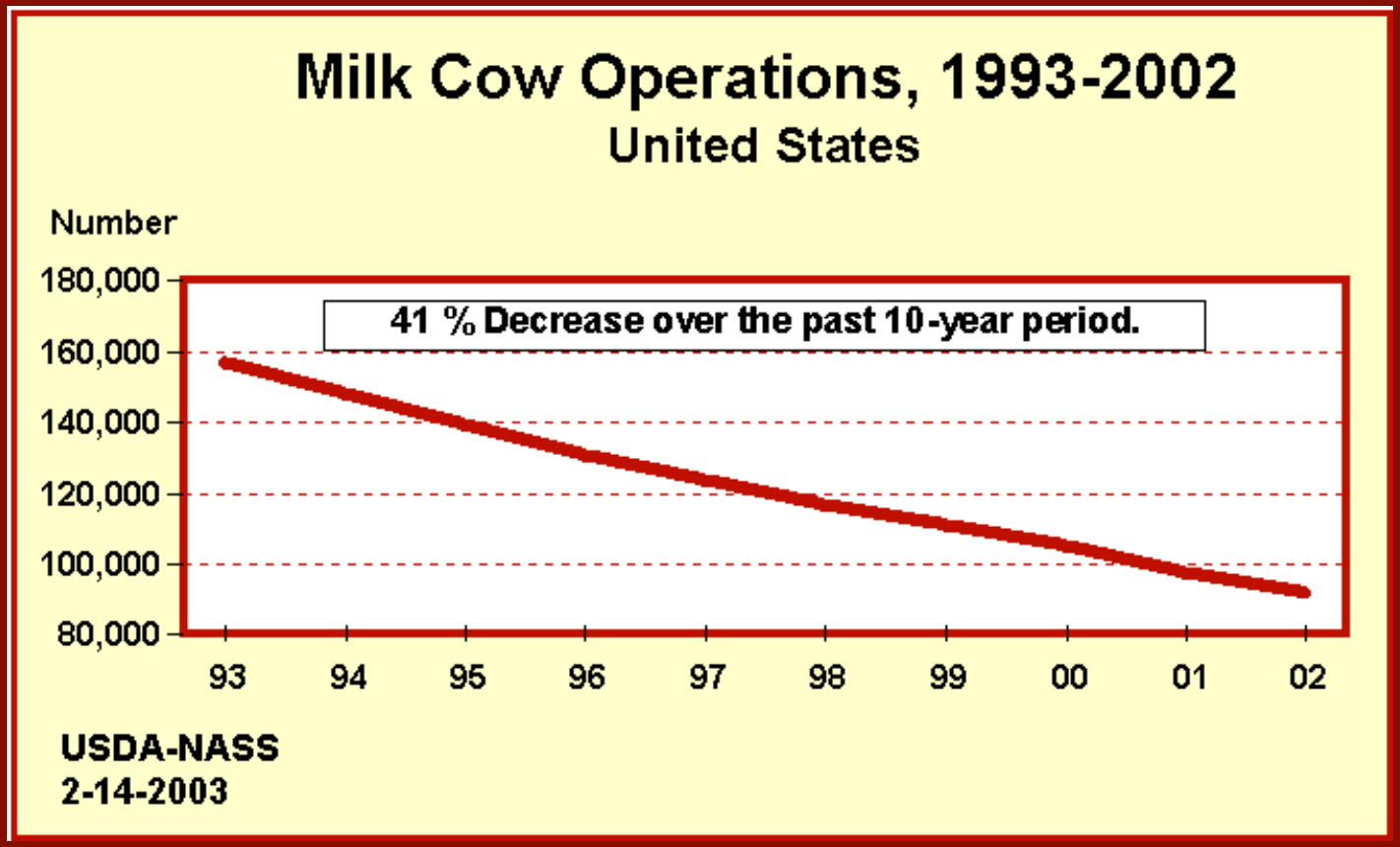
Decibel (dB) Levels of Common Sounds at Typical Distance From Source

0	Acute threshold of hearing
15	Average threshold of hearing
20	Whisper
30	Leaves rustling, very soft music
40	Average Residence
60	Normal speech, background music
70	Noisy office, inside auto @ 60 mph
80	Heavy traffic, window AC
85	Inside acoustically insulated protective tractor cab in field.
90	OSHA limit—hearing damage on excess exposure to noise above 90 dB.
100	Noisy tractor, power mower, ATV, snowmobile, motorcycle, in subway car, chain saw
120	Thunderclap, jackhammer, basketball crowd, amplified rock music.
140	Threshold of pain—shot gun, near a jet taking off, 50 hp siren (100’)

How many milk cows were there in the U.S. in 1993? What about 2002?



According to the previous graph, milk production decreased by 5% but the number of dairies decreased by 41%. How can this be?



Y Axis…

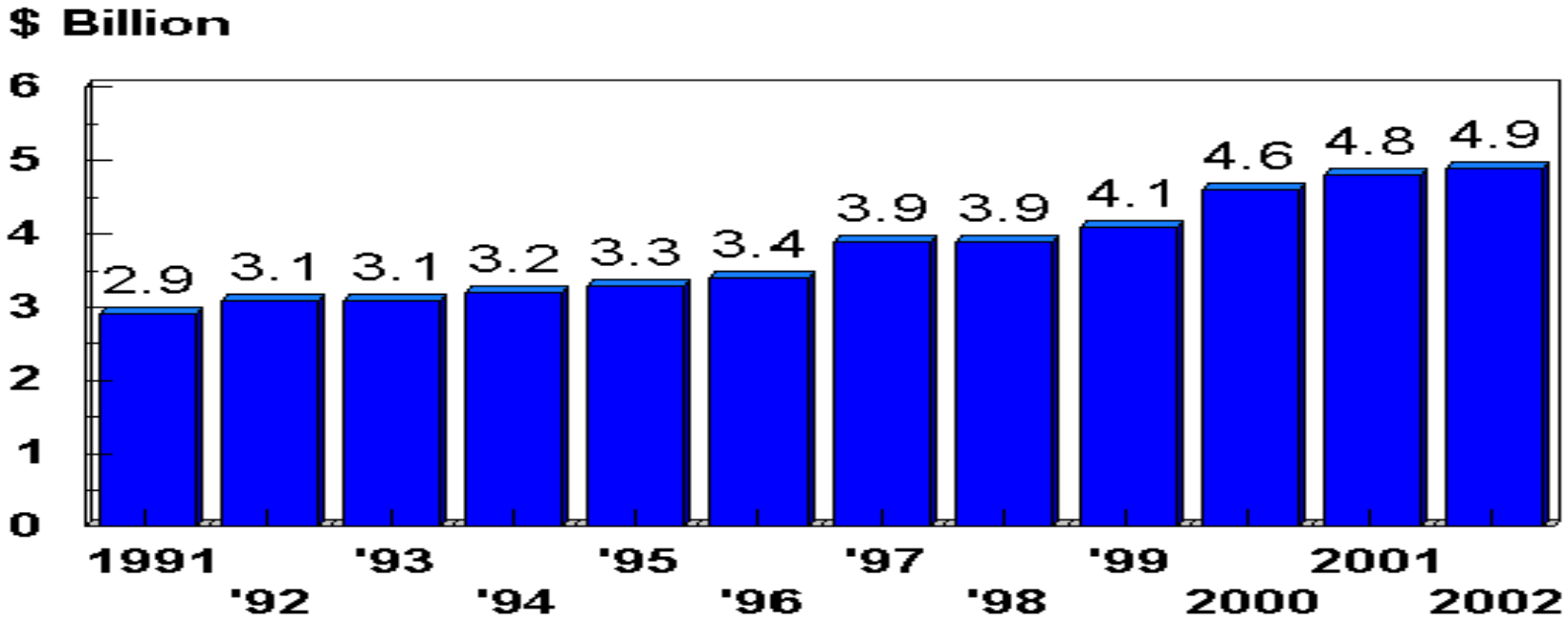
Dependent Variable

X Axis… Independent Variable

Using a decibel meter, record the dB levels of 10 different sounds. Construct a bar graph of the information obtained.

Floriculture Crops

Value of Sales at Wholesale, 1991 - 2002
36 Surveyed States



Operations with $10,000+ Sales

USDA-NASS
April 2003

How to use the dB meter

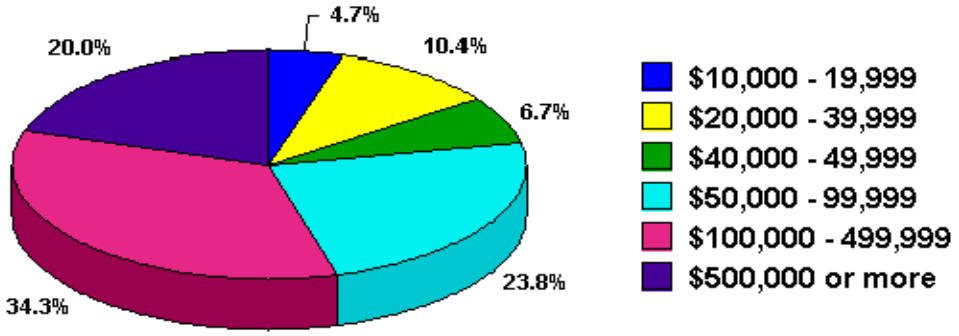
- Identify the sound recorded
- Set the range on the meter
- Read the sound level
- If the meter says LO move the dial to a lower range
- If the meter is maxed out move the range higher
- Record your data

Duration of sound permitted at various sound levels. Without hearing protection

Duration in Hrs	Sound Level in dB
32	80
16	85
8	90
4	95
3	97
2	100
1.5	102
1	105
0.5	110
0.25	115
none with out hearing protection	OVER 115

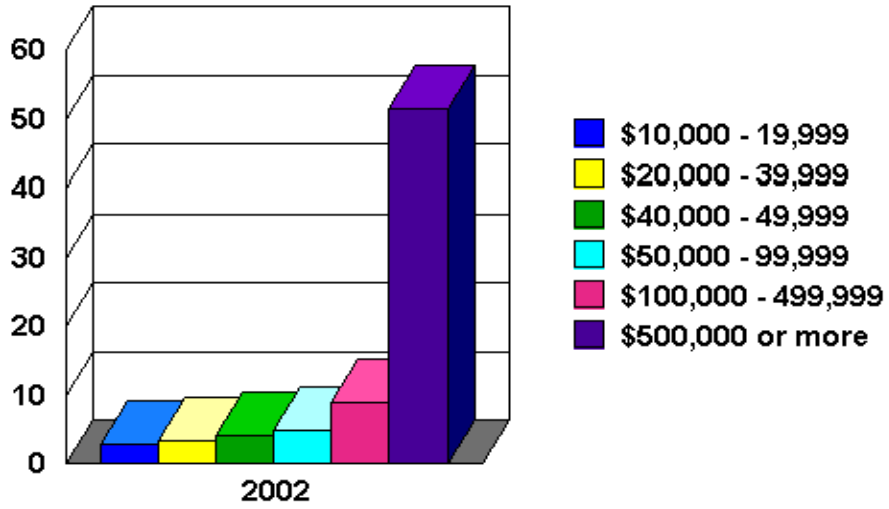
Operations with Hired Workers

by Percent of Total Operations with Hired Workers



Total Number of Operations 8,106

Average Number of Hired Workers



Alice's Areas

Health Study
Michigan

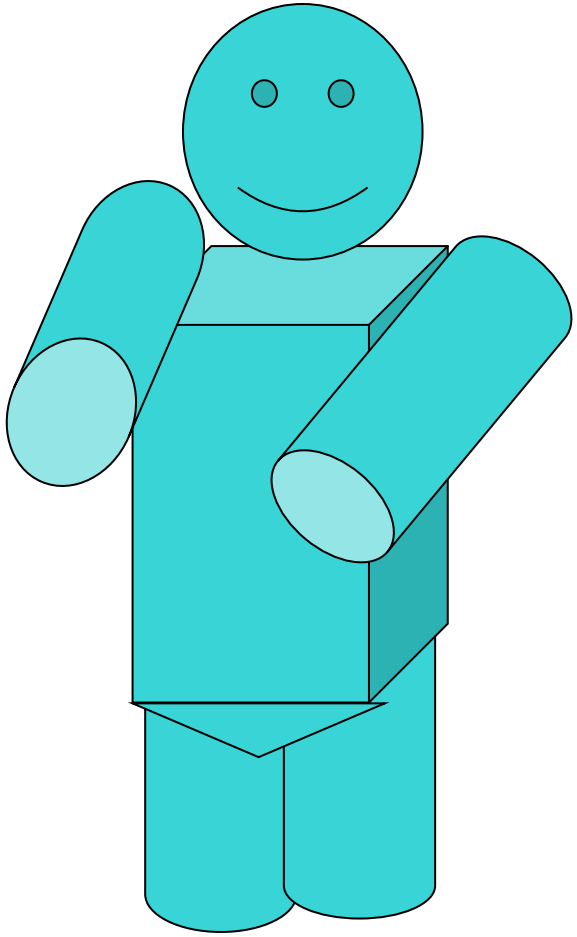
Introduction

The ability to calculate the area of an office, lab, piece of filter paper, or culture medium may be important in a hospital or clinical setting. In addition, in burn care we use a system to help us determine the percent of body surface area that is burned. We will look at a system called the “rule of nines” and how developers may have figured these percentages.

Alice's Areas

- Your patient, Alice, came into the Emergency Department with partial and full thickness burns to her entire right (R) leg after falling into a camp fire.
- You are to calculate the area of the burn and determine the percentage of her body that is burned.

Meet Alice…



Find the percentages of each part

- **Head** 2000/22222(100)
  =9%
- **Arms** 2000/22222(100)
  =9% each
- **Thorax** 8000/22222(100)
  =36%
- **Legs** 4000/22222(100)
  = 18% each
- **Perineal** 222/22222(100)
  =1%

Rule of nines

Sample Problem 2

- A circular culture plate with a radius of 5cm is placed in an open area outside a clinic for six hours.
- At the end of this time the plate is taken to lab for examination.
- It is observed that there are 54 grains of pollen per square centimeter of surface area.
- Determine the area of the plate and the number of pollen grains present.

Traditional Math Examples

1. What is the surface area of a basketball that has a radius of 15cm?

http://www.nba.com/

Ohm's Law in Automotive Class

Element 1:
Introduce the Automotive lesson

- A student brought this problem to class:
- He has installed super driving lights on a 12 volt system. His 15 amp fuse keeps blowing out. He has 0.4 Ohms of resistance.

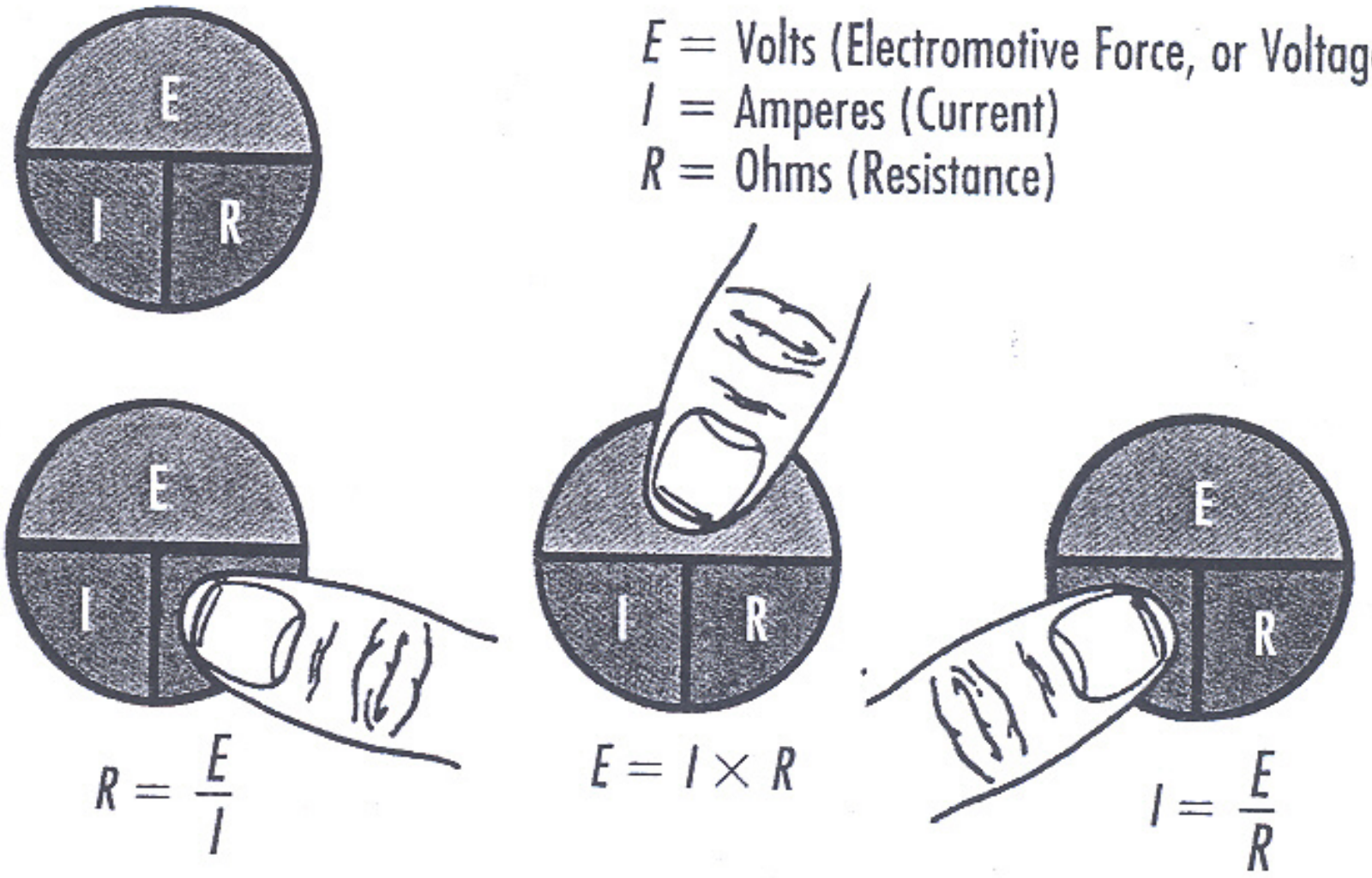
Element 2:
Find out what students know:

- Discuss what they know about voltage, amperes, and resistance.

  Volt is a unit of electromotive force (**E**)
  Ampere is a unit of electrical current (**I**)
  Ohm is the unit of electrical resistance (**R**)

Element 2:
Find out what students know:

- What is an Ohm?
- Where did the name come from?
- Georg Ohm was a German physicist. In 1827 he defined the fundamental relationship between voltage, current, and resistance.
- Ohm's Law: $\mathbf{E = I\,R}$


E = Volts (Electromotive Force, or Voltage)
I = Amperes (Current)
R = Ohms (Resistance)
E
I
R
$R = \frac{E}{I}$
$E = I \times R$
$I = \frac{E}{R}$

Element 3:
Work through the embedded problem:

- The student has installed super driving lights on a 12 volt system. His 15 amp fuse keeps blowing. He has 0.4 Ohms of resistance.

Element 3:

Work through the embedded problem:

- Continue bridging the automotive and math vocabulary.
- The basic formula is:

$$\mathbf{E = I\ R}$$

We know **E** (volts) and **R** (resistance).

We need to find **I** (amps).

Element 3:

Work through the embedded problem:

- We need to isolate the variable.
- We do that by dividing **IR** by **R**, which leaves **I** by itself.
- What you do to one side of the equation you must do to the other...therefore **E** is also divided by **R**.

$$\mathbf{I = E / R}$$

Element 3:

Work through the embedded problem:

$$I = E / R$$

$$I = 12 / 0.4$$

$$I = 30 \text{ amps}$$

- The student needs a 30 amp fuse to handle the lights.

Element 4:
Work through related, contextual examples

- A 1998 Ford F-150 needs 180 starting amps to crank the engine. What is the resistance if the voltage is 12v?

$$R = E / I$$

$$R = 12 / 180$$

$$R = .066... \text{ Ohms}$$

Element 4:
Work through related, contextual examples

- If the resistance in the rear tail light is 1.8 Ohms and the voltage equals 12v, what is the amperage?

$$I = E / R$$

$$I = 12 / 1.8$$

$$I = 6.66 \text{ amps}$$

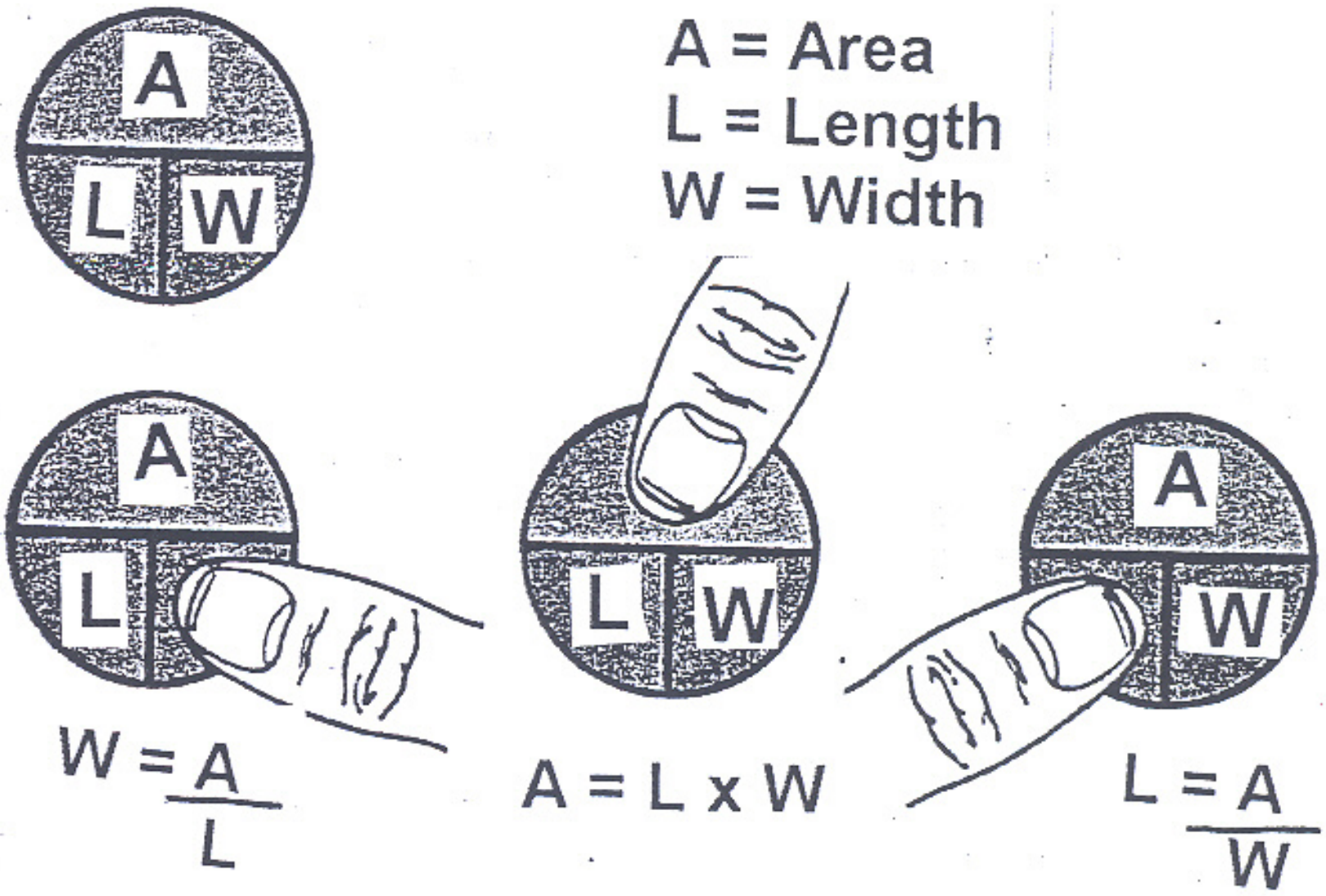
Element 4:
Work through related, contextual examples

A 100-amp alternator has 0.12 Ohms of resistance. What must the voltage equal?

$$E = I R$$

$$E = 100(0.12)$$

$$E = 12 \text{ volts}$$


A = Area
L = Length
W = Width
A
L W
A
L
W = A / L
A
L W
A = L x W
A
W
L = A / W

Element 5:
Work through traditional math examples

- The formula for area of a rectangle is A = LW where A is the area, L is the length and W is the width.
- Find the area of a rectangle that has a length of 8 ft. and an area of 120 sq. ft.

A / L = W

120 sq ft / 8 ft = W

15ft = W

Element 5:
Work through traditional math examples

- The formula for distance is D = RT where D is the distance, R is the rate of speed in mph and T is the time in hours.
- If a car is traveling at an average speed of 55 mph and you travel 385 miles, how long did the trip take?

D = RT

T = D / R

T = 385 / 55 mph

T = 7 hours

Element 6:
Students demonstrate understanding

- Students now given opportunities to work on similar problems using this concept:

  Homework

  Team/group work

  Project work

Element 6:
Students demonstrate understanding

- A vehicle with a 12 volt system and a 100 amp alternator has the following circuits:

  30 amp a/c heater

  30 amp power window/seat

  15 amp exterior lighting

  10 amp radio

  7.5 amp interior lighting

1. Find the total resistance of the entire electrical system based on the above information.
2. Find the unused amperage if all of the above circuits are active.

Element 7:
Formal Assessment

- Include math questions in formal assessments... both embedded problems and traditional problems that emphasize the importance of math to automotive technology.

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