1st Annual K5 STEAM Conference December 9, 2016

Curriculum and Professional Development

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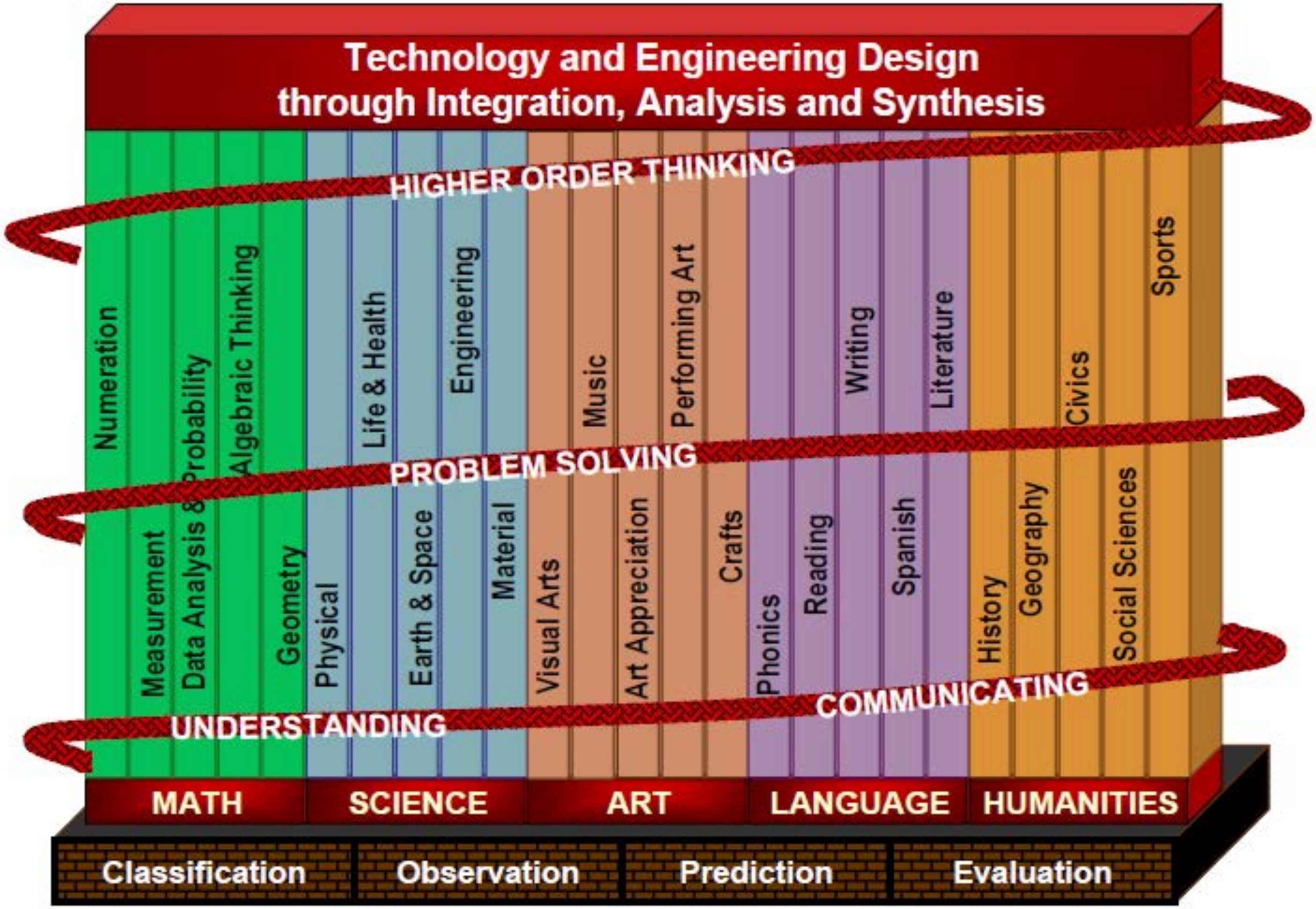
DOUGLAS L. JAMERSON, JR.
Center for Mathematics and Engineering

Curriculum is Critical for Program Success

Curriculum is Critical for Program Success

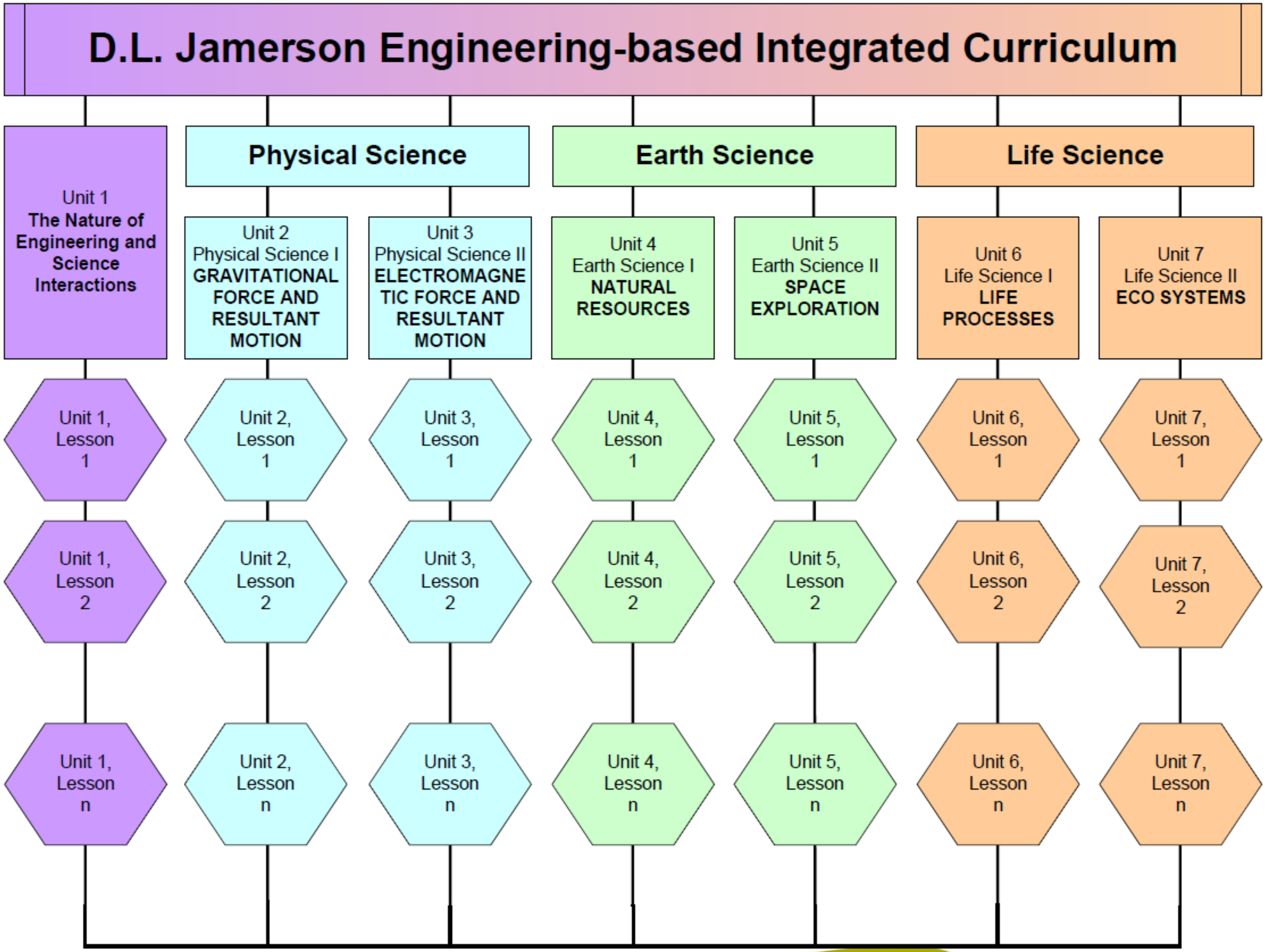


DLJ's Curriculum Follows this Science Subject Matrix

Grade	Nature of Science & Engineering	Physical Science	Earth Science	Life Science
K	What is an Engineer? Animals as Engineers	Goldilocks Just Right Chairs 3 Billy Goats Gruff (Bridges)	*The North Wind & the Sun* Weather & Climate 3 Little Pigs (Houses)	Visual Life Cycle Models Animal Mascots
1	What is an Engineer? Lego Tower Challenge	Light & Sound Waves Design a drum to communicate over a distance	Cycles in Space Design a Magnification Tool	Animals as Engineers Design a Tool
2	Engineering for Animals Design an Elephant Trunk	Design a Lego Tower/ Bridge Scale Drawing	Mapping & Modeling – 2D to 3D Design a system to prevent beach erosion	Ecosystems Design a Pollinator
3	Creating Models Boom Town Communities	Measuring Light Laser Light Maze Design	Design a parachute Solar Cooker Investigations	Animal Classification Design a new animal
4	Compare Scientists & Engineers Design a Totem Pole	K'Nex Car Investigations & Design	Build a Dugout (Native Americans) Design and Test a Boat Florida History	Garden Design Design a Water Filter
5	Fields of Engineering 3D Printed Catapult Investigations & Design	Bridge Testing & Design Design a Home Lighting System	Hurricane Preparedness Plan Design a Lunar Mission (Kennedy Space Center)	Medical Engineering for the Body Design a Lunar Habitat

DOUGLAS L.
JAMERSON, JR.
ELEMENTARY
Center for Mathematics

Curriculum is Critical for Program Success



D.L. Jamerson Engineering-based Integrated Curriculum

Unit 1
The Nature of Engineering and Science Interactions

- Unit 1, Lesson 1
- Unit 1, Lesson 2
- Unit 1, Lesson n

Physical Science

Unit 2
Physical Science I
GRAVITATIONAL FORCE AND RESULTANT MOTION

- Unit 2, Lesson 1
- Unit 2, Lesson 2
- Unit 2, Lesson n

Unit 3
Physical Science II
ELECTROMAGNETIC FORCE AND RESULTANT MOTION

- Unit 3, Lesson 1
- Unit 3, Lesson 2
- Unit 3, Lesson n

Earth Science

Unit 4
Earth Science I
NATURAL RESOURCES

- Unit 4, Lesson 1
- Unit 4, Lesson 2
- Unit 4, Lesson n

Unit 5
Earth Science II
SPACE EXPLORATION

- Unit 5, Lesson 1
- Unit 5, Lesson 2
- Unit 5, Lesson n

Life Science

Unit 6
Life Science I
LIFE PROCESSES

- Unit 6, Lesson 1
- Unit 6, Lesson 2
- Unit 6, Lesson n

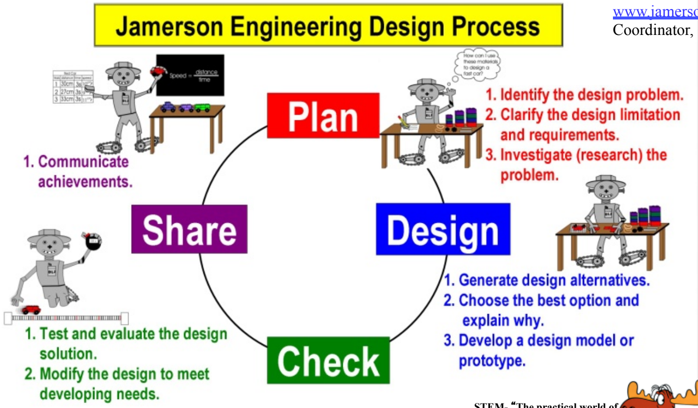
Unit 7
Life Science II
ECO SYSTEMS

- Unit 7, Lesson 1
- Unit 7, Lesson 2
- Unit 7, Lesson n

MAGNET SCHOOLS OF AMERICA

Essential Element Examples of Elementary Engineering in Elementary Education

For more information about Douglas L. Jamerson, Jr. Elementary School in St. Petersburg, FL, visit DLJ's website at www.jamerson-es.pinellas.k12.fl.us, or contact Lukas Hefty, Hefty Lukas [HEFTYL@pcsb.org], Engineering Program Coordinator, Center for Mathematics & Engineering, Douglas L. Jamerson Jr. Elementary School



Jamerson Engineering Design Process

Plan

1. Identify the design problem.
2. Clarify the design limitation and requirements.
3. Investigate (research) the problem.

Design

1. Generate design alternatives.
2. Choose the best option and explain why.
3. Develop a design model or prototype.

Check

1. Test and evaluate the design solution.
2. Modify the design to meet developing needs.

Share

1. Communicate achievements.

STEM- "The practical world of Science, Technology and Engineering governed by the abstract universe of Mathematics."

B.J Moose 1965 Moose of the Year Award Ceremony

kindergarten through 5th grade classroom teachers integrate the state mandated elementary curriculum using engineering science principles and engineering design practices appropriate for each grade level and spirally connecting these principles and practices upward through all grade levels in the school.

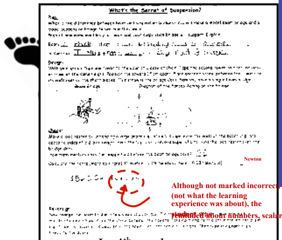
Nature of Science and Engineering Interactions	Physical Science		Earth Science		Life Science	
	Gravitational Forces and Resultant Motion	Electromagnetic Forces and Resultant Motions	Natural Resources	Space Exploration	Life Processes	Ecosystems

In kindergarten through 2nd grade, the focus is to set images and ideas regarding engineering. In the Gravitational Force and Resultant Motion Unit, the students learn what forces are and what effects they can have. The concepts of work and energy are explored.

In 2nd grade, measuring scalars takes center stage. In this case, an elephant's trunk is not baggage.

Elephant Trunks and Dolphin Tails
Page 56, December 2014
Science and Children

By 3rd grade qualitative relationships such as direct proportionality, are developed. This time it is students exploring and calculating mechanical advantage.



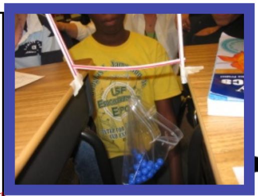
What's the Secret of Suspension?

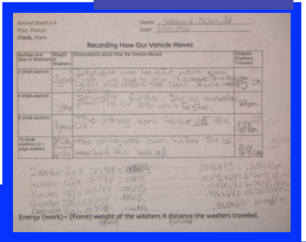
Newton

Although not marked incorrect (not what the learning experience was about), the student was reminded about numbers, scalars, and vectors.

In 4th grade

Reality and math models for that reality are connected.





Record Sheet 3-A
Plan, Design
Check, Share

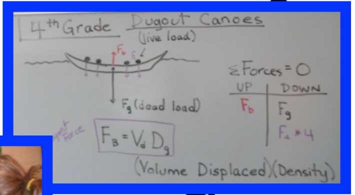
Name
Date

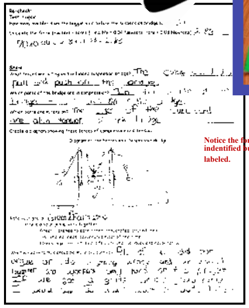
Recording How Our Vehicle Moves

Number and Size of Washers	Weight of Washers	Observations about How the Vehicle Moved	Distance Washers Traveled
2 small washers			
4 small washers			
8 small washers			
16 small washers (or 1 large washer)			

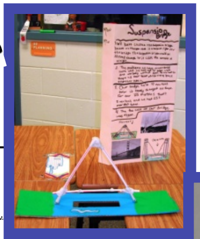
Energy (work)= (Force) weight of the washers X distance the washers traveled.

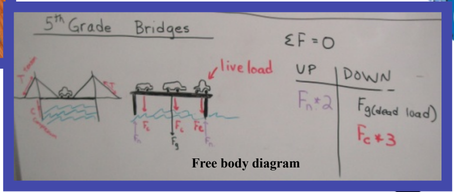
Mathematical models for developing engineering applications are the focus in 4th. In the Gravitational Force and Resultant Motion Unit, the students are calculating work, energy, and power as well as buoyant force.





Notice the force directions were indentified but the load scalar not labeled.

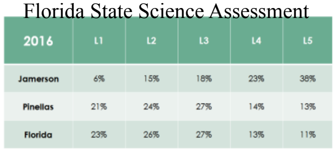




Free body diagram

In 5th grade, the students perform a complete engineering analysis, including free body/force diagrams as well as cost analysis. In this unit, bridge loads are calculated to failure. The students work with the concepts of tension, compression, and torsion.

Florida State Science Assessment



2016	L1	L2	L3	L4	L5
Jamerson	6%	15%	18%	23%	38%
Pinellas	21%	24%	27%	14%	13%
Florida	23%	26%	27%	13%	11%

61% of students exceeded expectations, #1 in Pinellas County!

Conclusion: Douglas L. Jamerson, Jr. Elementary School attains its outstanding assessment scores above District and State averages because of its "All or Nothing" approach. There is no language arts, no mathematics, no science, no fine arts. They are all merged together with every teacher contributing to each of these traditional topic areas and that is what puts the positive edge on the DLJ student.

DLJ's STREAM of Learning gets its STEAM from STEM

Professional Development is Critical for Program Success

A STEM Integration Example

Levers from an engineers perspective

DOUGLAS L.
JAMERSON, JR.
Center for Mathematics
and Engineering

The Mathamatics

Jamerson Faculty pledge

Every student that competes a K through 5th grade education experience at Jamerson will be able to solve the following specific mathematical problems.

(a) (1) x (60) = 60

(b) (2) x (30) = 60

(c) (2) x (60) = 120

(d) (4) x (30) = 120

(e) $\frac{(120)}{(60)} = 2$

(f) $\frac{(2)\ \mathrm{x}\ (60)}{(30)} = 4$

The Mathamatics

Jamerson Faculty pledge

Two specific examples

Every student that competes a K through 5th grade education experience at Jamerson will be able to associate a numerical value to a variable.

d_{up} **is an arrangement of three letters, two of which are subscripts, that can be used to identify a specific distance in the up direction.**

d_{up} **= 2 feet or perhaps** d_{up} **equals 15 feet.**

It varies with the situation!

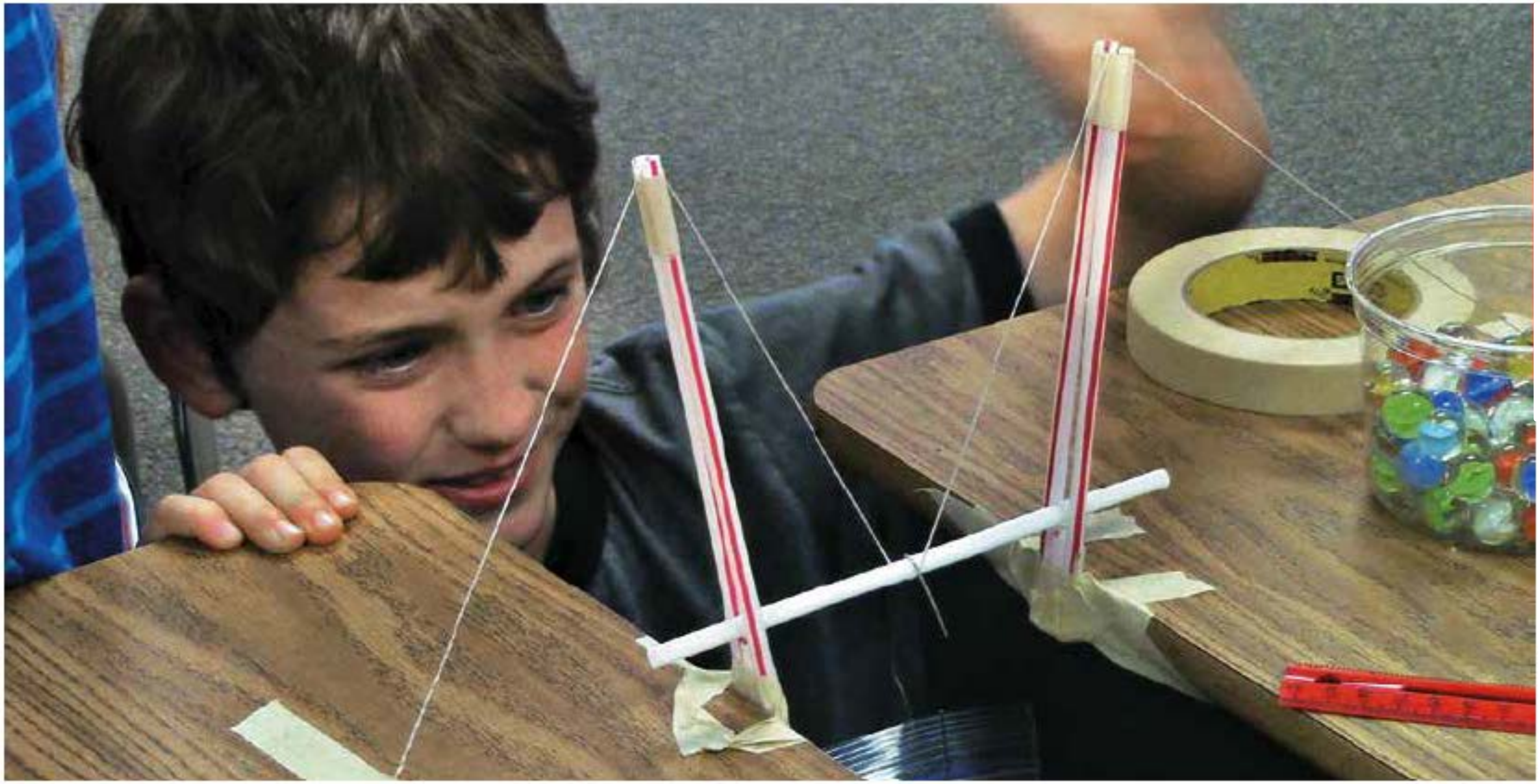
d_{down} **is an arrangement of 5 letters, 4 of which are subscripts, that can be used to identify a specific distance in the down direction.**

Variables are symbols that are made from any combination of letters and numbers with any arrangement of subscripts and/or superscripts.

Bridge Making and Design Testing

Stability Challenge:

The shape of the bridge does not change with 5 Newtons of force.
The shape of the bridge does not change with 4 Newtons of force.
The shape of the bridge does not change with 2 Newtons of force.



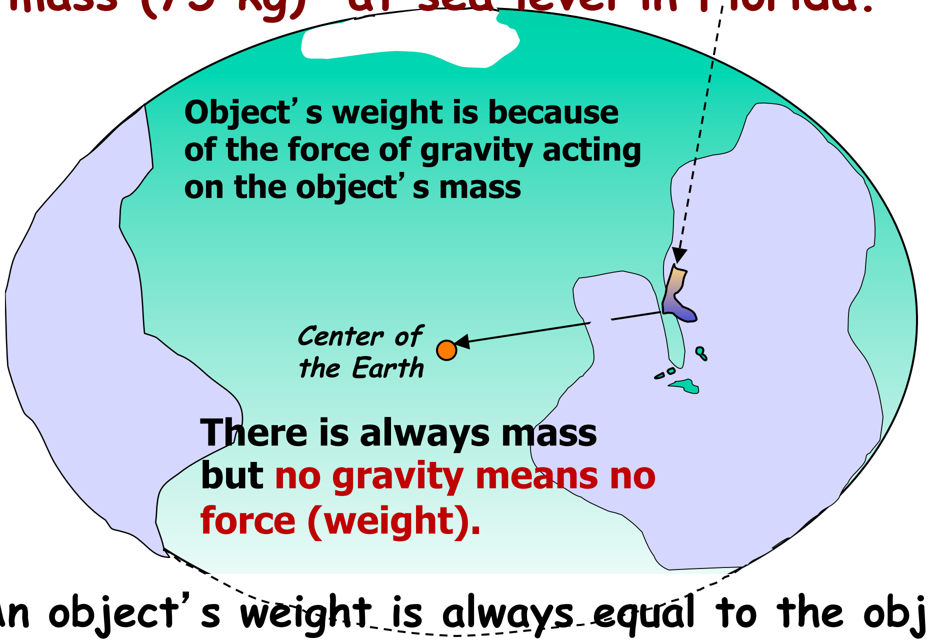
Lukas J. Hefty

But first a bit more math we want them to know

Background on force

Oversized cowboy boot with specific mass (75 kg) at sea level in Florida.

The gravitational field strength at sea level is 9.8 Newton per kilogram of mass.
(9.8 Newton/1 kilogram)



Object's weight is because of the force of gravity acting on the object's mass

There is always mass but no gravity means no force (weight).

An object's weight is always equal to the object's mass times the gravitational field strength.

What is the weight of the boot?

Remember that weight is a scalar quantity!

$$75\ \cancel{\text{kilogram}}\ \times\ 9.8\,\frac{\text{Newton}}{\cancel{\text{kilogram}}} = 735\ \text{Newton}$$

What are the units for this calculation?

How do we say this math sentence in everyday English?

75 kilograms times 9.8 Newton per kilogram equals 735 Newton

Group Grope: Background Force and Scalar Knowledge Assessment

Note: 75 times 9.8 equals 735

(1) A car's speed is 9.8 kilometers per hour, how far has it traveled in 75 hours?

(2) A car's velocity is 9.8 kilometers per hour west, how far has it traveled in 75 hours?

(3) A car's mass is 75 kilograms. If the gravitational field strength is 9.8 Newton per kilogram, what is the force of gravity on the car?

(4) A space probe's mass is 98 kilograms. If the gravitational field strength is 75 Newton per kilogram, what is the weight of the the probe? Is the probe in in Florida? Why?

What math skill(s) must be secure to answer these questions?

What math standard(s) benchmark(s) are successfully demonstrated with correct answers to these questions?

What science standard(s) benchmark(s) are successfully demonstrated with correct answers to these questions?

Bridge Making and Design Testing

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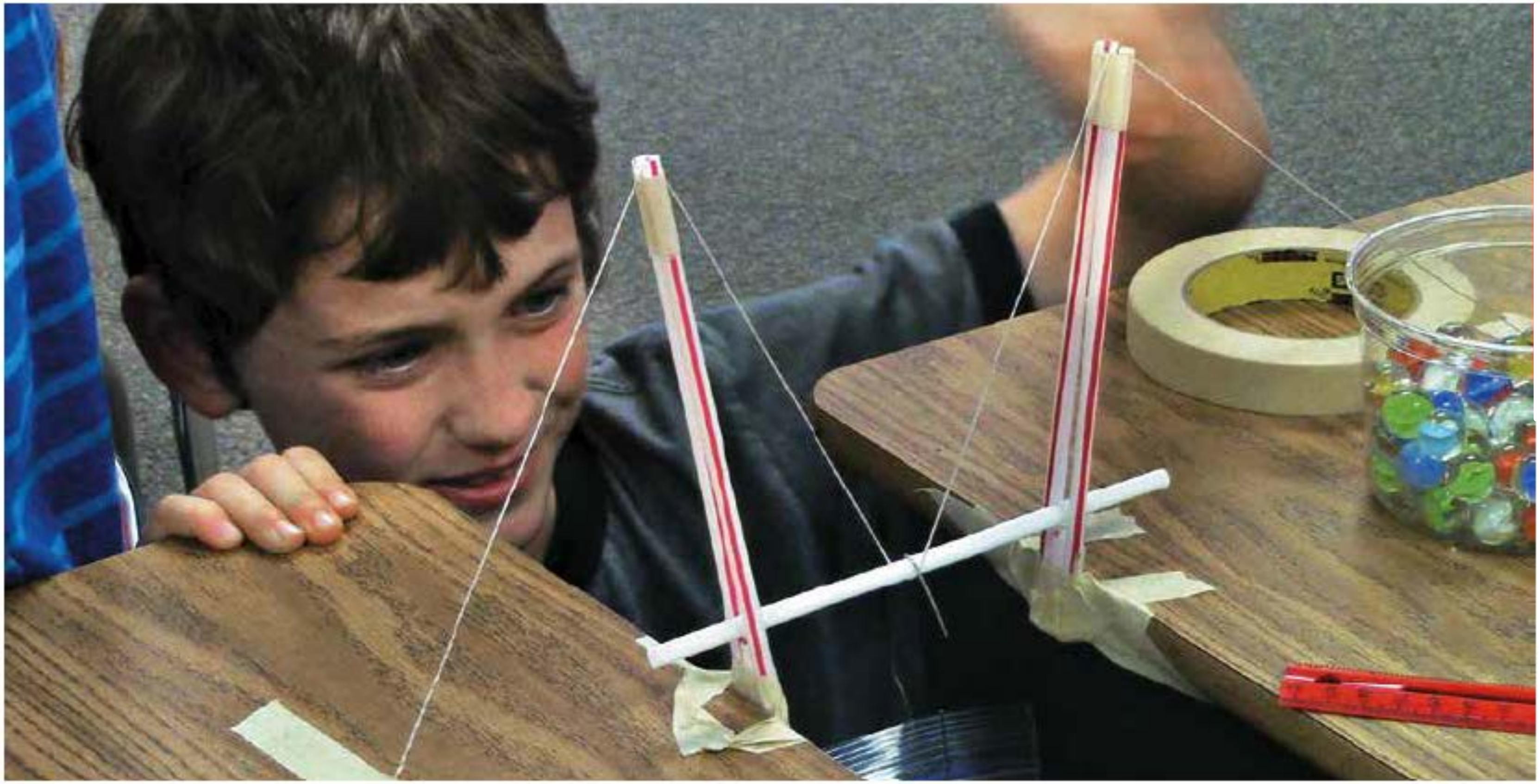


Lukas J. Hefty

Finally ready for force represented as a vector

Free Body Diagrams

(The diagrams that vectors built)

Free Body Diagram Take Home Messages

Free Body Diagrams are used by engineers to study situations that can be described by vectors.

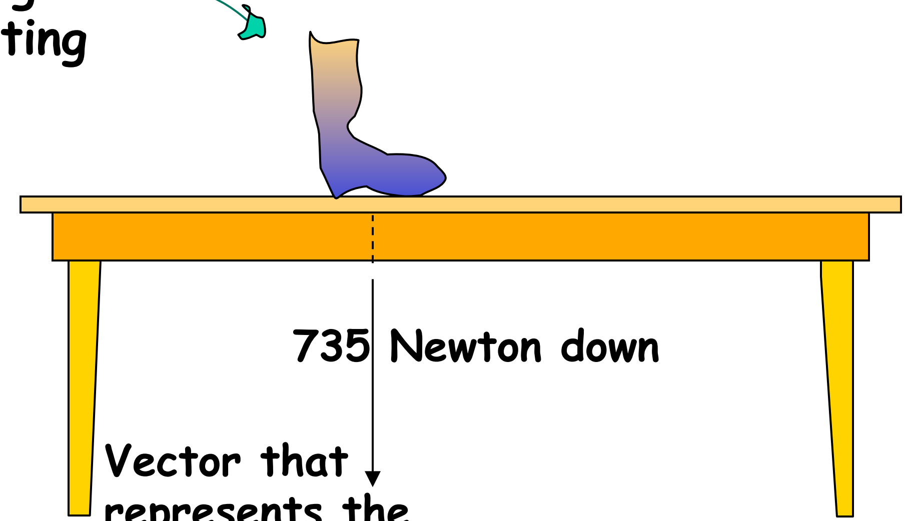
Vectors are very important mathematical tools used by engineers.

Vectors have two parts- a magnitude (a scalar value) and direction.

Any vector can be separated into a vertical component vector and a horizontal component vector.

Intro to Free Body Diagrams

Diagrams that use vectors to describe the forces on an object or a system.



A boot that weighs 735 Newton sitting on a table.

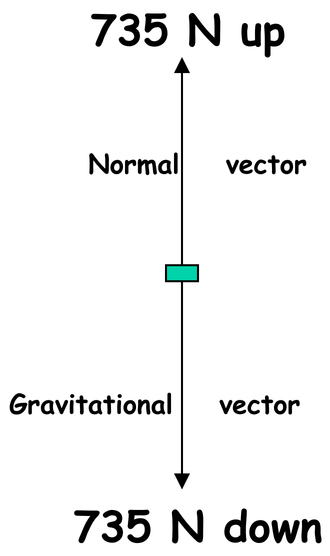
735 Newton down

Vector that represents the weight of the boot

Intro to Free Body Diagrams

Diagrams that use vectors to describe the forces on an object or a system.

If the object is not moving up or down the Free Body Diagram requires two vectors.



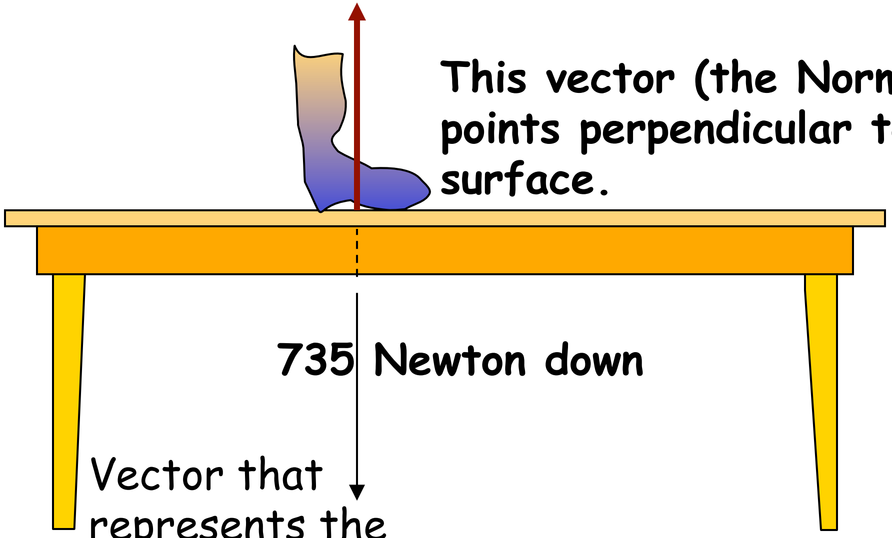
735 N up

Normal vector

Gravitational vector

735 N down

This is a very simple example of a Free Body Diagram.



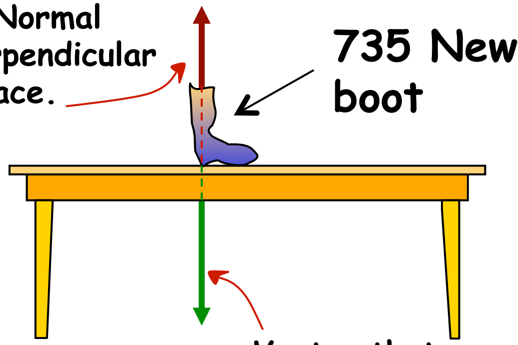
This vector (the Normal vector) points perpendicular to the table surface.

735 Newton down

Vector that represents the weight of the boot

Intro to Free Body Diagrams

What are the magnitudes and directions of the two vectors in this Free Body Diagram?



This vector (the Normal vector) points perpendicular to the table surface.

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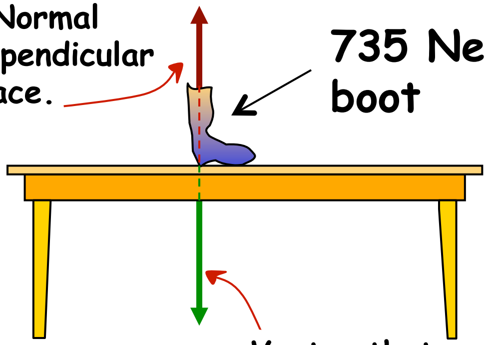

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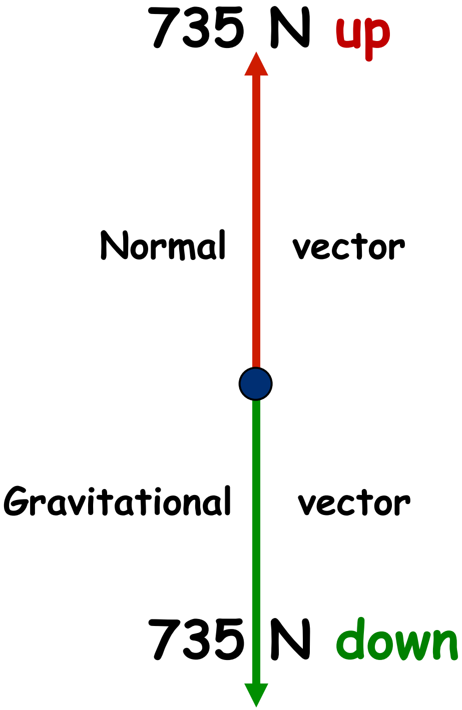
735 Newton boot

Vector that represents the weight of the boot



735 N up

Normal vector

Gravitational vector

735 N down

Intro to Free Body Diagrams

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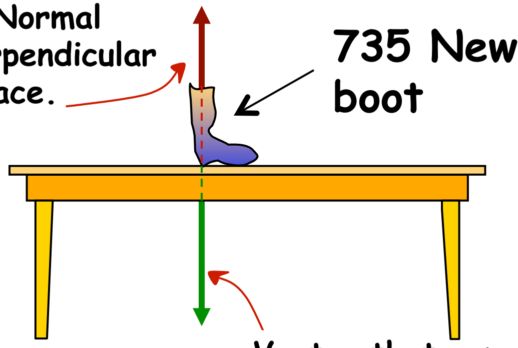


This vector (the Normal vector) points perpendicular to the table surface.

735 Newton boot

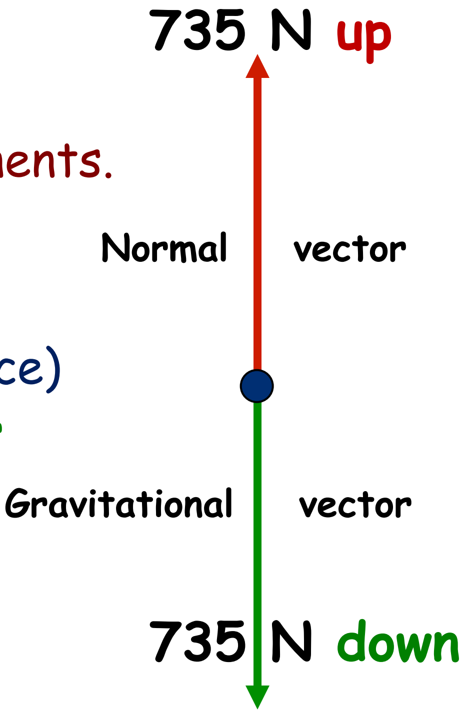
Vector that represents the weight of the boot

This is a simple Free Body Diagram with three ideas represented in its 3 components.

Normal Vector

Center of Gravity (force)

Weight (Force) Vector



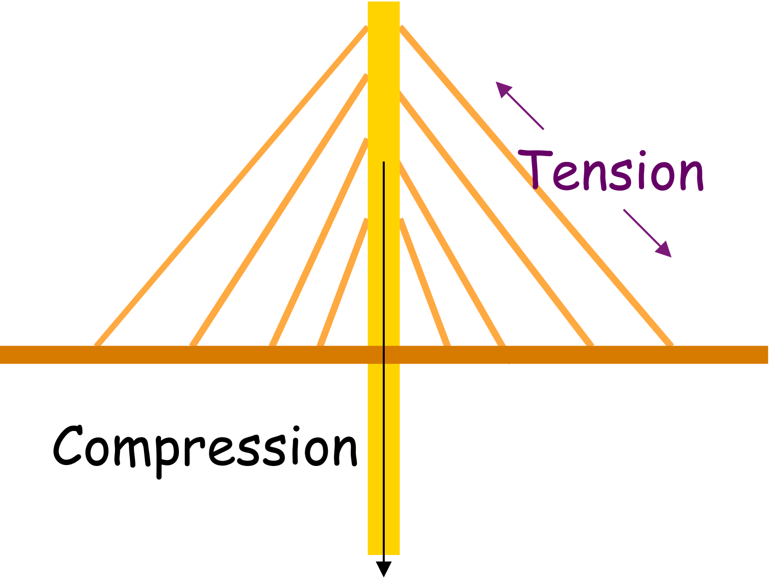
Other Free Body Diagrams get more complicated but the essential idea is to obtain pairs of vectors.

Constructing Free Body Diagram for a Bridge

Clifton England Suspension Bridge

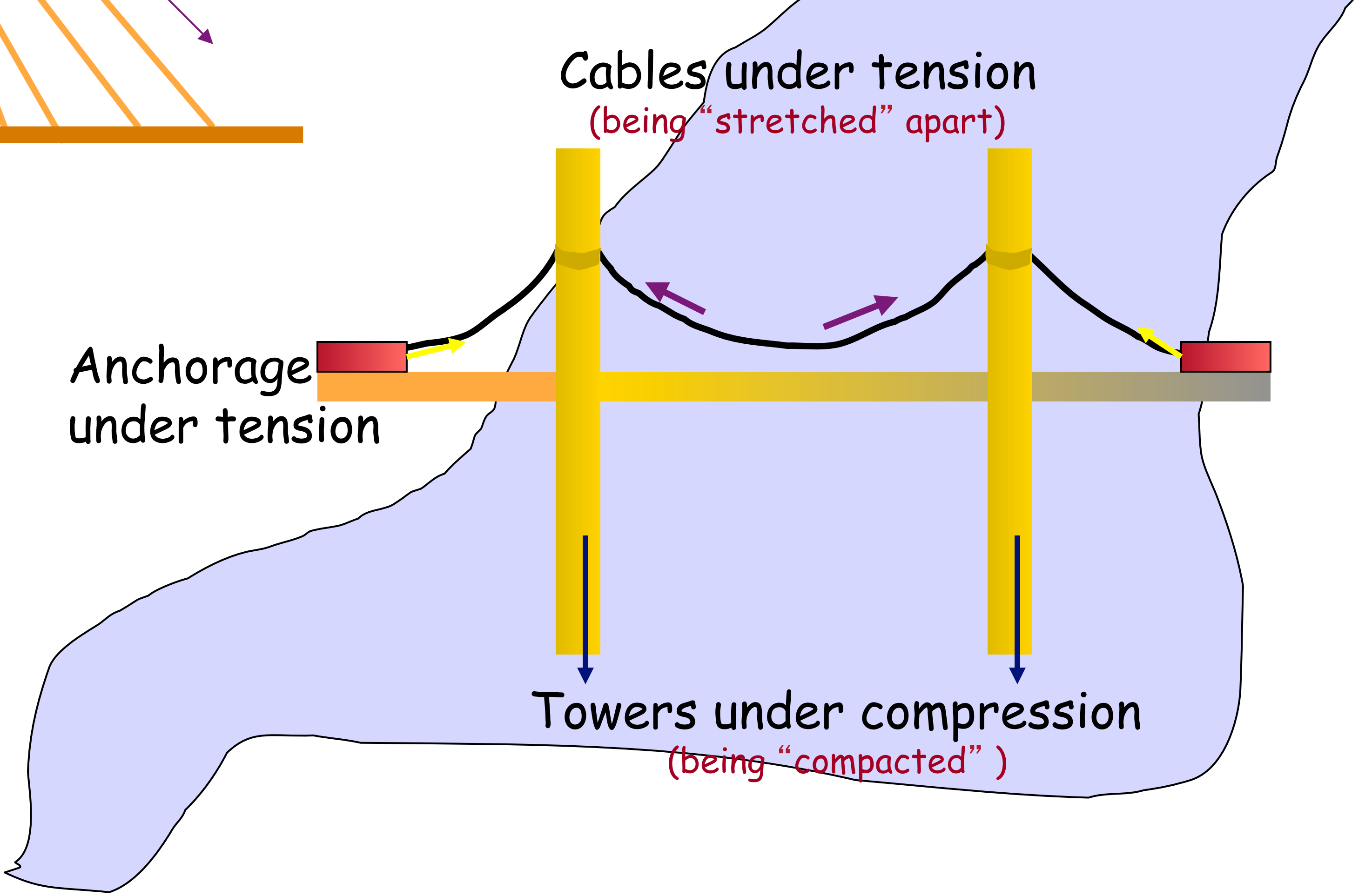
Constructing Free Body Diagrams for a Bridge

Common Vocabulary



Tension

Compression



Cables under tension
(being "stretched" apart)

Anchorage under tension

Towers under compression
(being "compacted")

Vocabulary Check

Normal Vector

Center of Gravity

Weight (Force) Vector

Compression (vector)

Tension (vector)

What bridge component(s) are in tension?

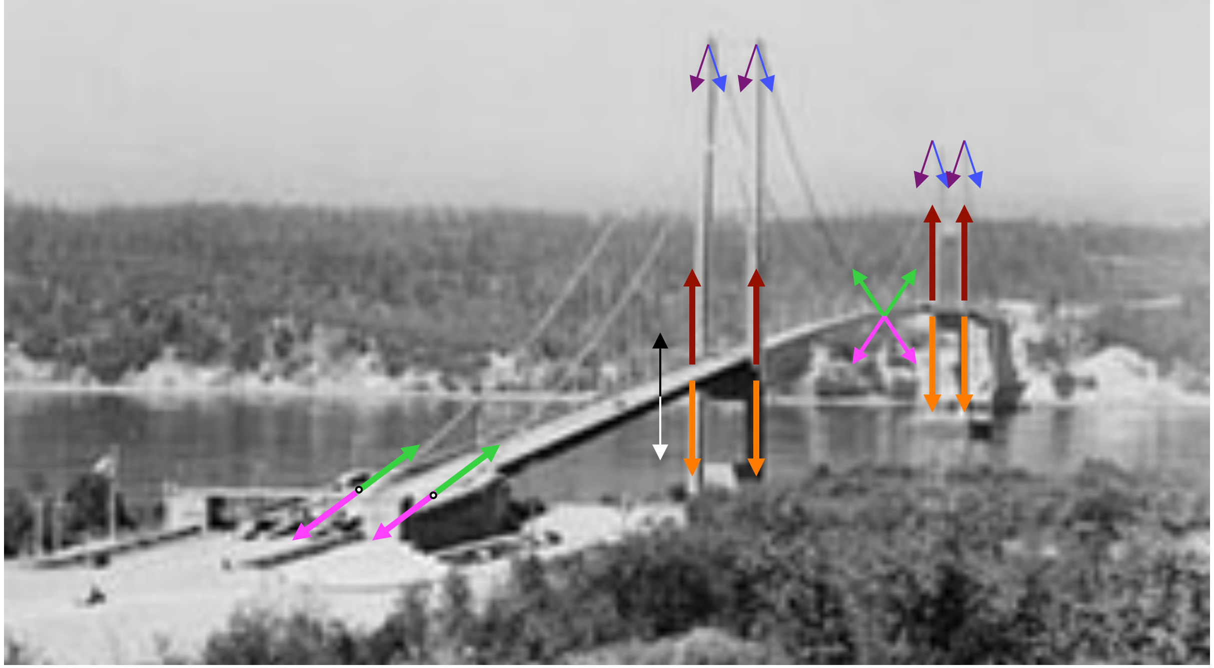
What bridge component(s) are in compression?

What bridge is this?

Constructing Free Body Diagram for a Bridge

What is the total force if all of these force vectors are added together?

What math skill(s) must be secure to answer these question?

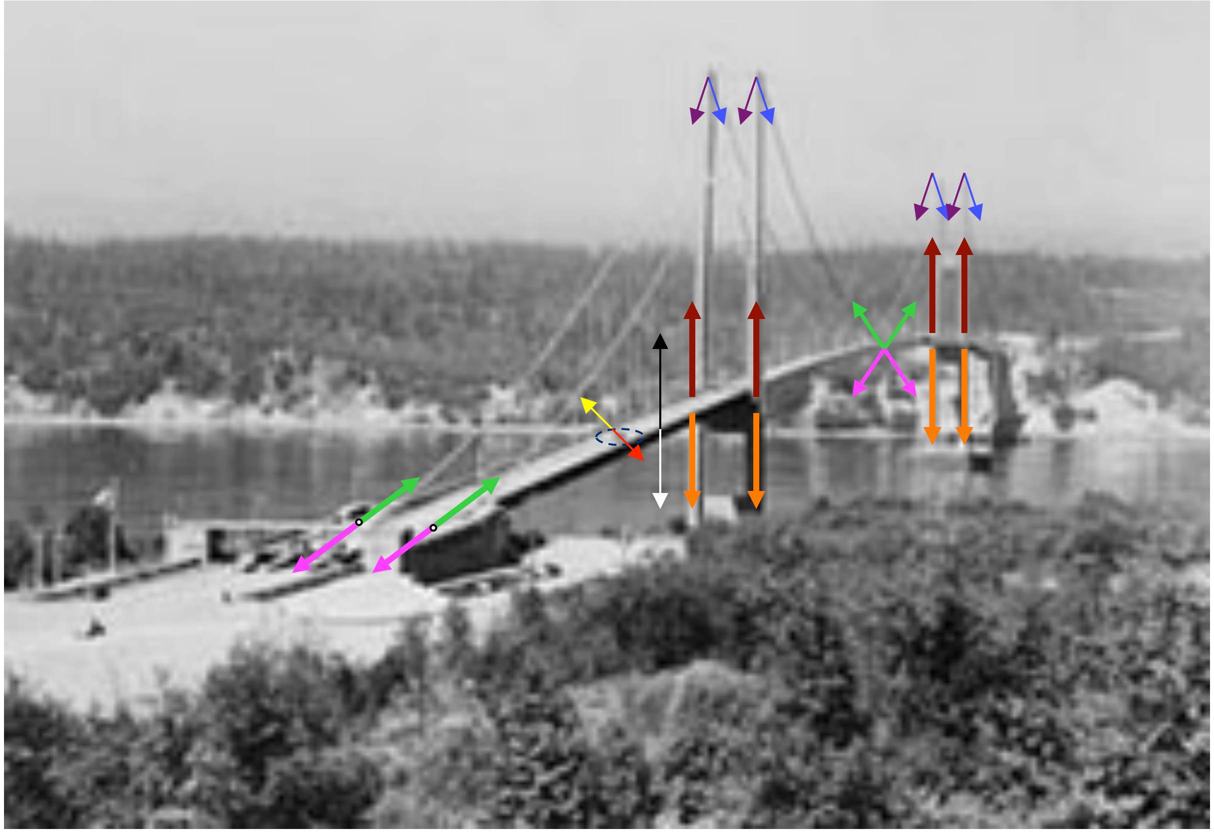


What math standard(s) benchmark(s) are successfully demonstrated with correct answer to these question?

What science standard(s) benchmark(s) are successfully demonstrated with correct answers to these question?

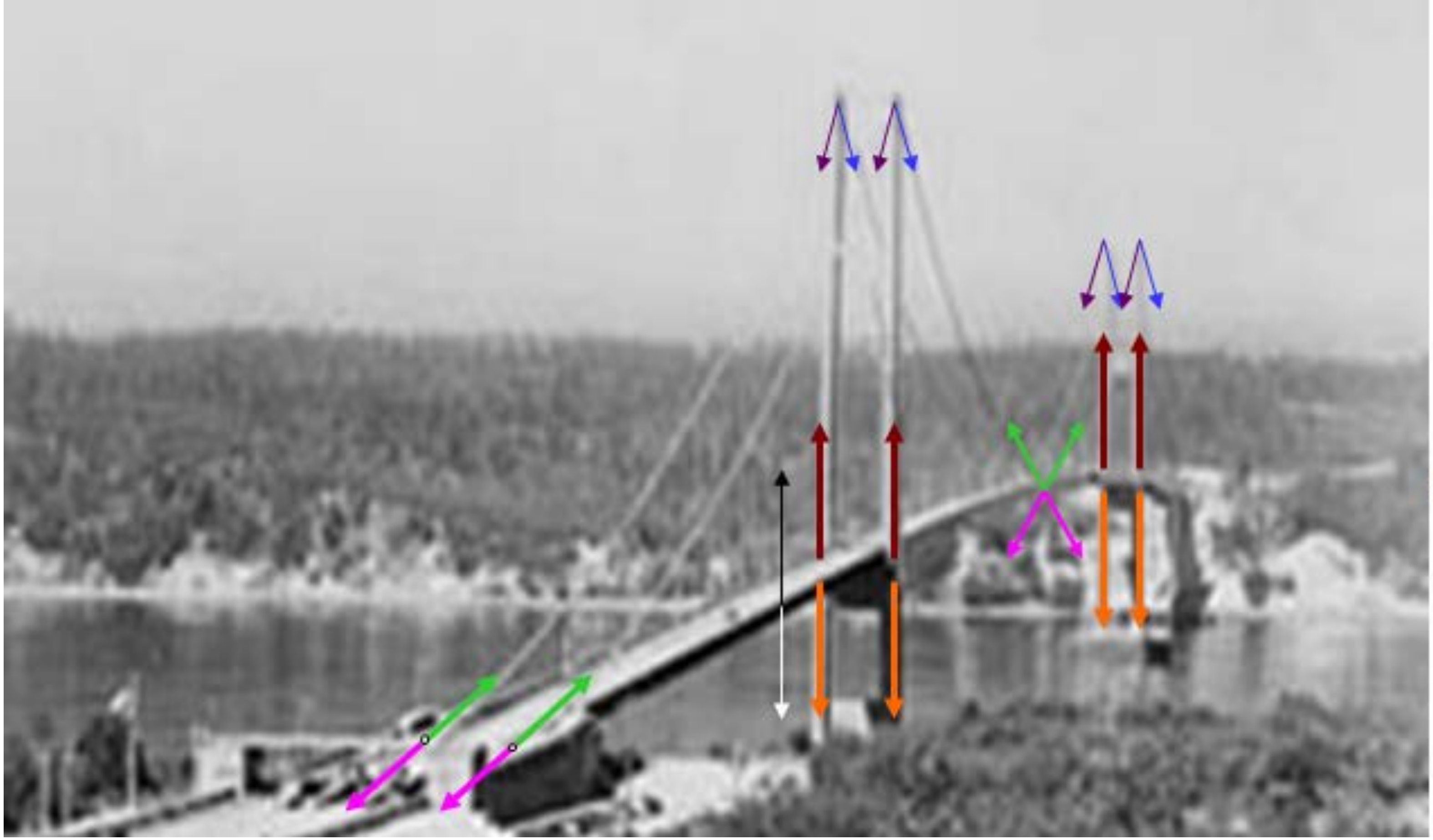
Including a Car with this Bridge

Now what is the total force if all of these force vectors are added together?



Including a Car with this Bridge

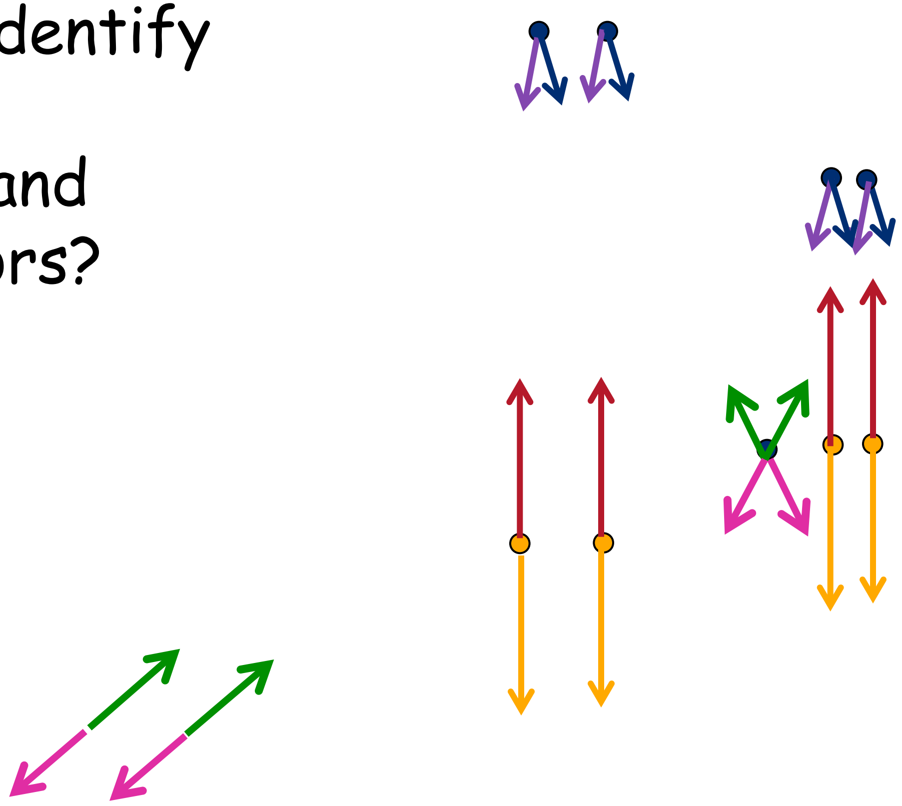
It is typical to move vector pairs to a local "center of force"

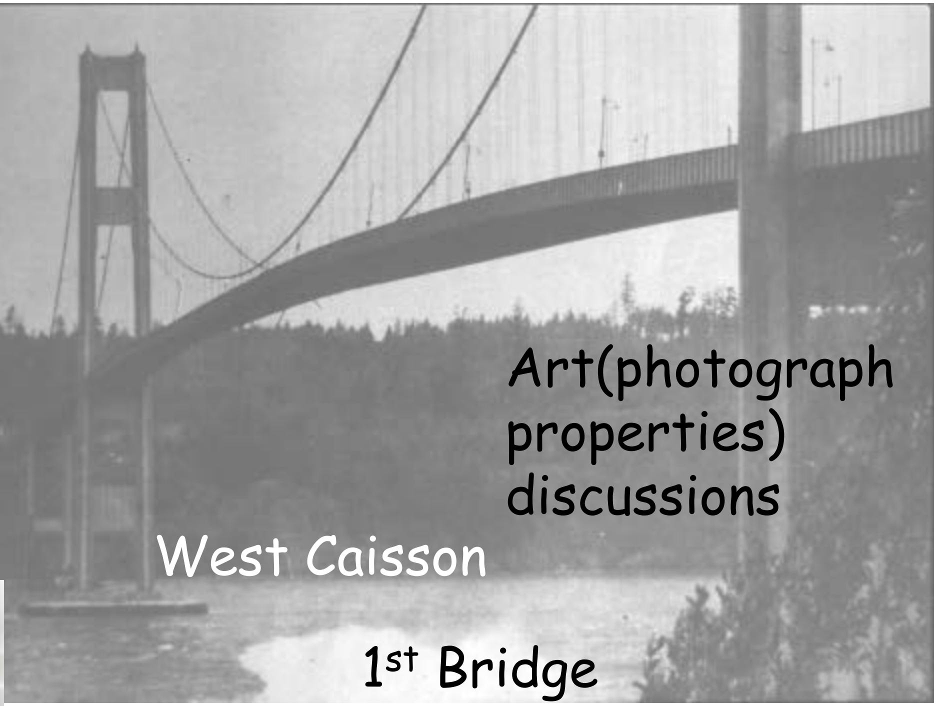


Including a Car with this Bridge

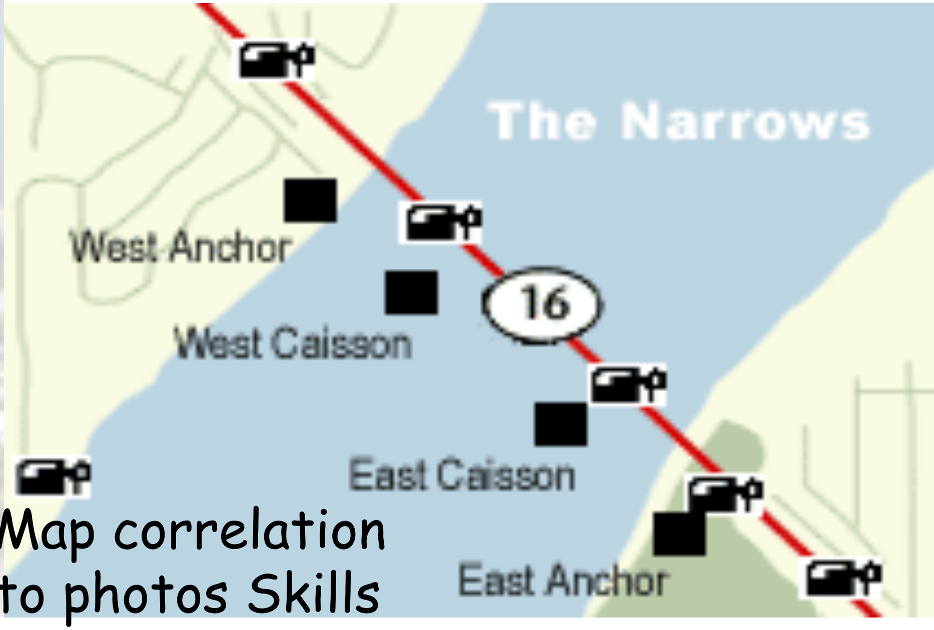
It is typical to move vector pairs to a local "center of force"

Can you still identify the, Normal, Compression and Tension vectors?





Art(photograph properties) discussions



Map correlation to photos Skills

Free Body Diagram Take Home Messages

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Any vector can be separated into a vertical component vector and a horizontal component vector.

Free Body Diagram Calculation

Green Vector representing the tension on this cable

Any vector can be separated into a vertical component vector and a horizontal component vector.

Free Body Diagram Calculation

What is the value of the Compressive force on the bridge deck because of this 100 Newton tension?

Green Vector representing the tension on this cable

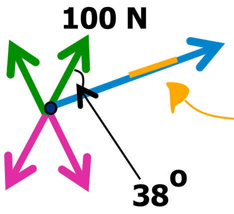
Any vector can be separated into a vertical component vector and a horizontal component vector.

Calculation aid for magnitude of horizontal component of resultant vector

What is the value of the Compressive force on the bridge deck because of this 100 Newton tension?

Angle from horizontal component (degrees)	Horizontal component magnitude divided by tension vector magnitude (ratio value)
0	1.000
36	0.819
37	0.799
38	0.788
90	0.000

Any vector can be separated into a horizontal component vector.



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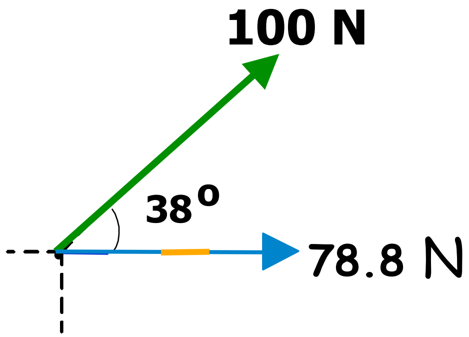
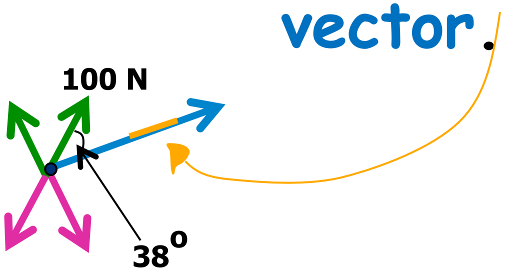


100 Newton × 0.788 = 78.8 N

(The vector you have times the chart value equals the vector you want!)

Any vector can be separated into a horizontal component vector.



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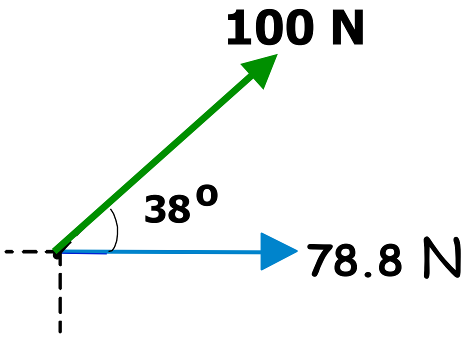

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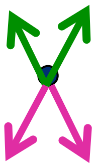
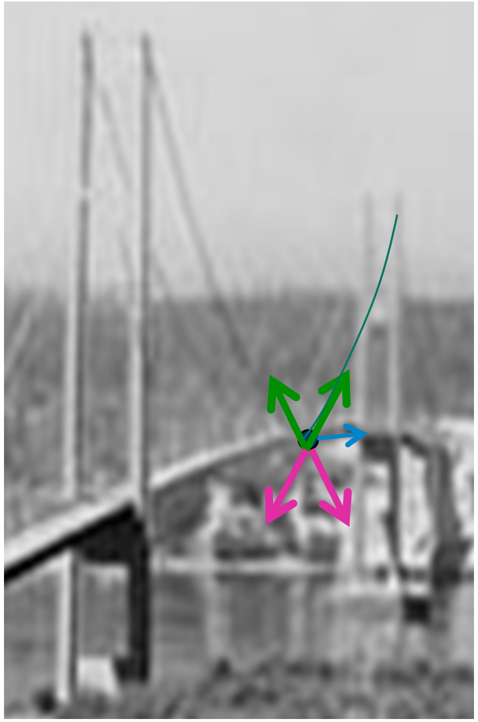
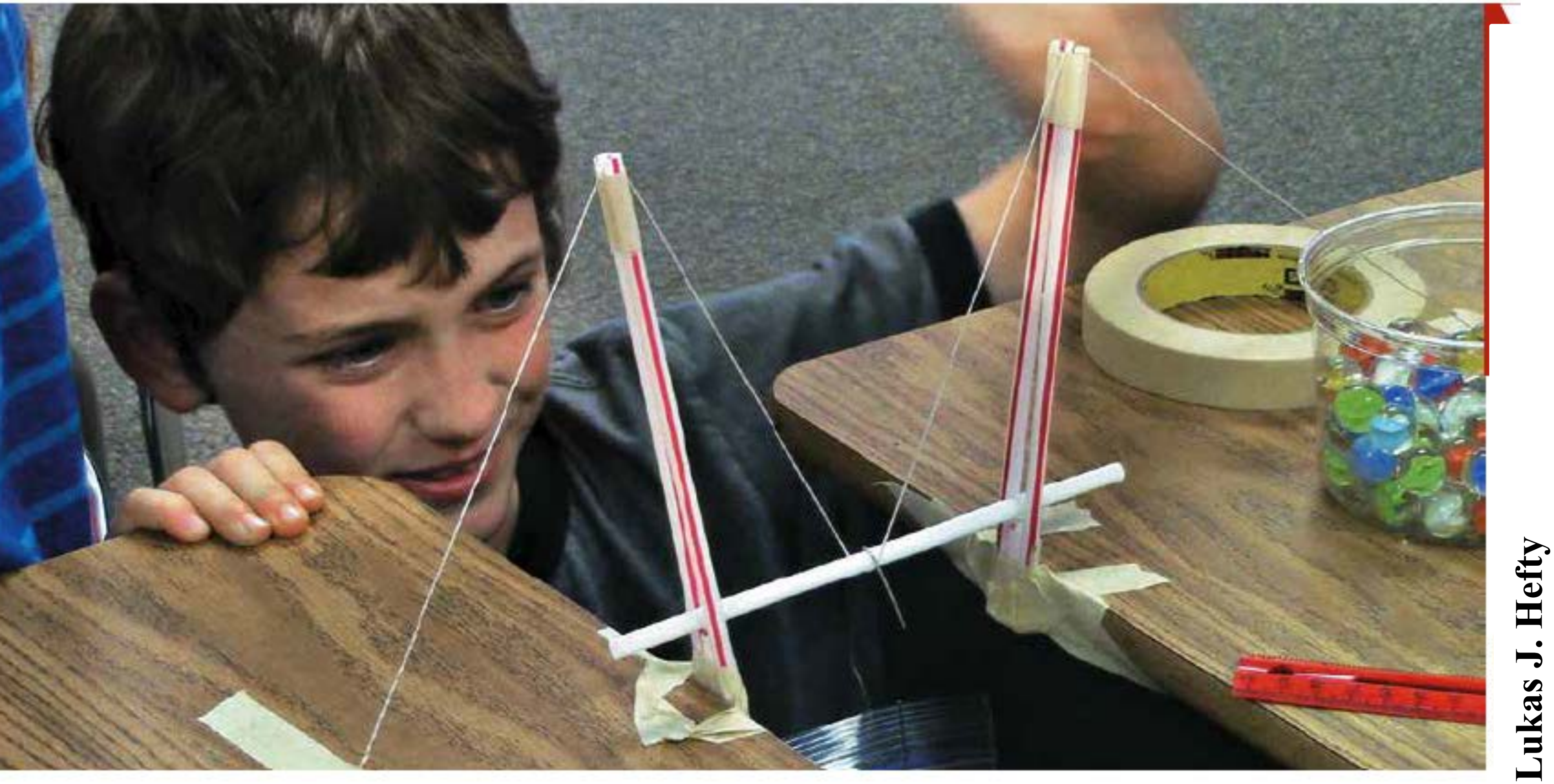


78.8 N



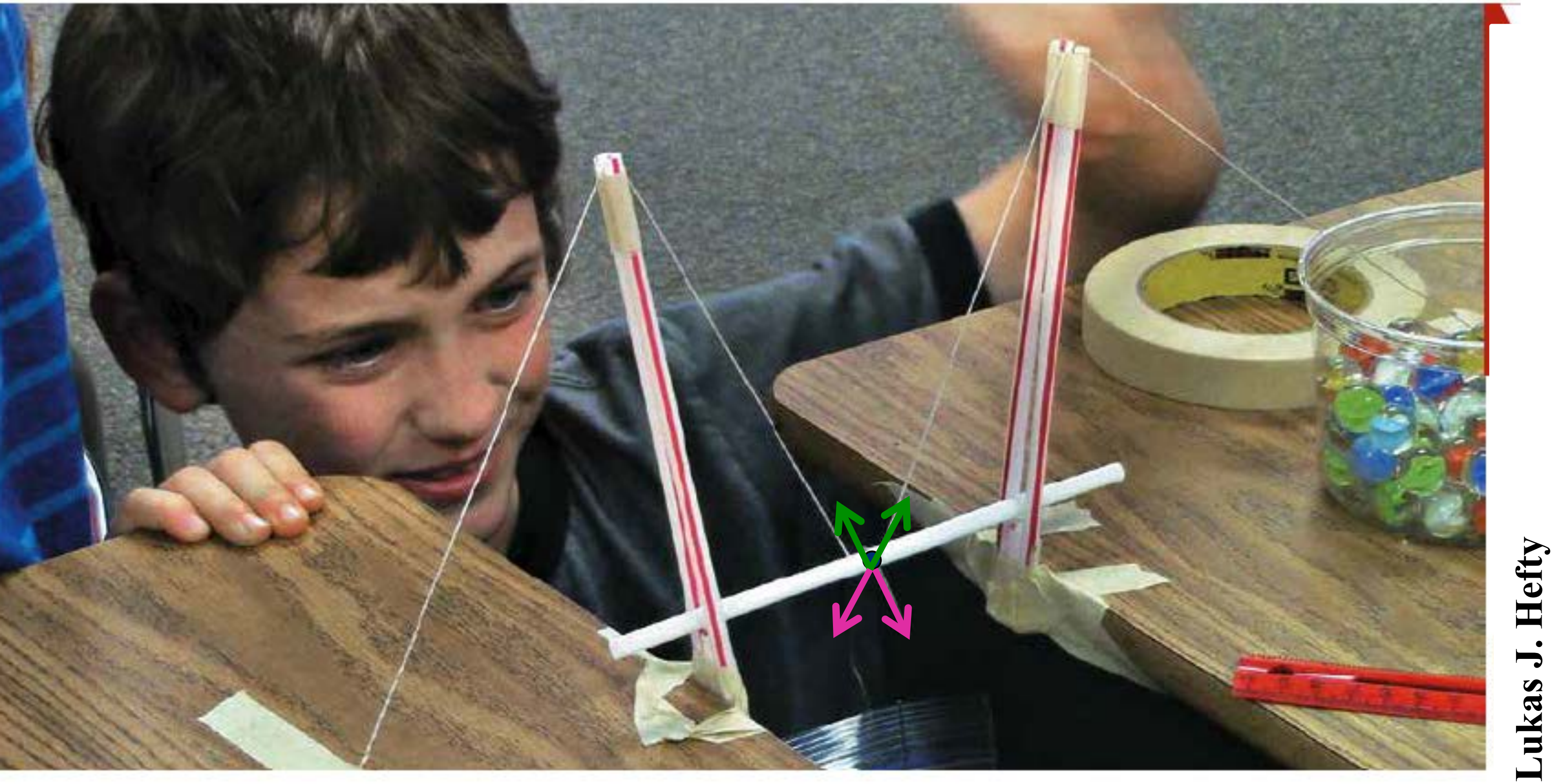
Bridge Making and Design Testing



Lukas J. Hefty

What the student sees!

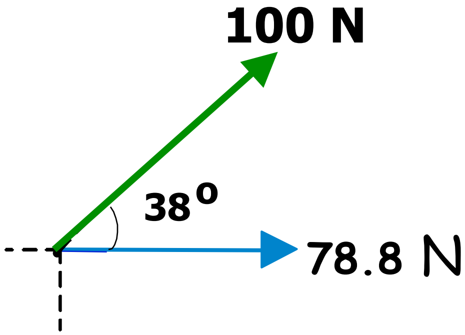
Bridge Making and Design Testing

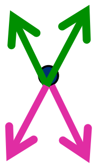


Lukas J. Hefty

What the bridge feels!

Bridge Making and Design Testing





What the engineer sees!

Material	Cost	Quantity	Item Cost
1 straw	**$300**	3+1+2+2	2400
10 cm of tape---masking or electric	**$100**	2+6+2+3	1200
10 cm of string	**$200**	[illegible]+3	1800
Total cost	x	x	5400

300
4
1200

Plan:

Discuss possible types and designs for your bridge with your team. Choose the best design and determine the materials needed. Determine the total cost of the design using the table above.

Include a sketch of your bridge below.

3

600
900
200
1700

300
x 3
900

100
20
2000