Connecting the "M" in STEM

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TeamBuilding

PARTNERSHIPS TECH PREP TEAMWORK

TECH PREP TEAMWORK TECH PREP PARTNERSHIPS

37 1 69 89 46 99 10 42
22 45 21 65 70 86 54 62
85 13 64 18 61 30 14 98 94 81 93
25 77 33 5 28 38 26 58
73 6 53 34 90 78
97 57 79 17 2 50 9
41 21 8 55 61 63 47
28 52 89 83 66 11 80
100 40 96 44 59 3
12 91 35 67 51
76 95 72 75 16 7 39 23
36 49 84 48 74 87 31
32 20 43 71 15
88 4 60 92 27

TECH PREP TEAMWORK TECH PREP PARTNERSHIPS

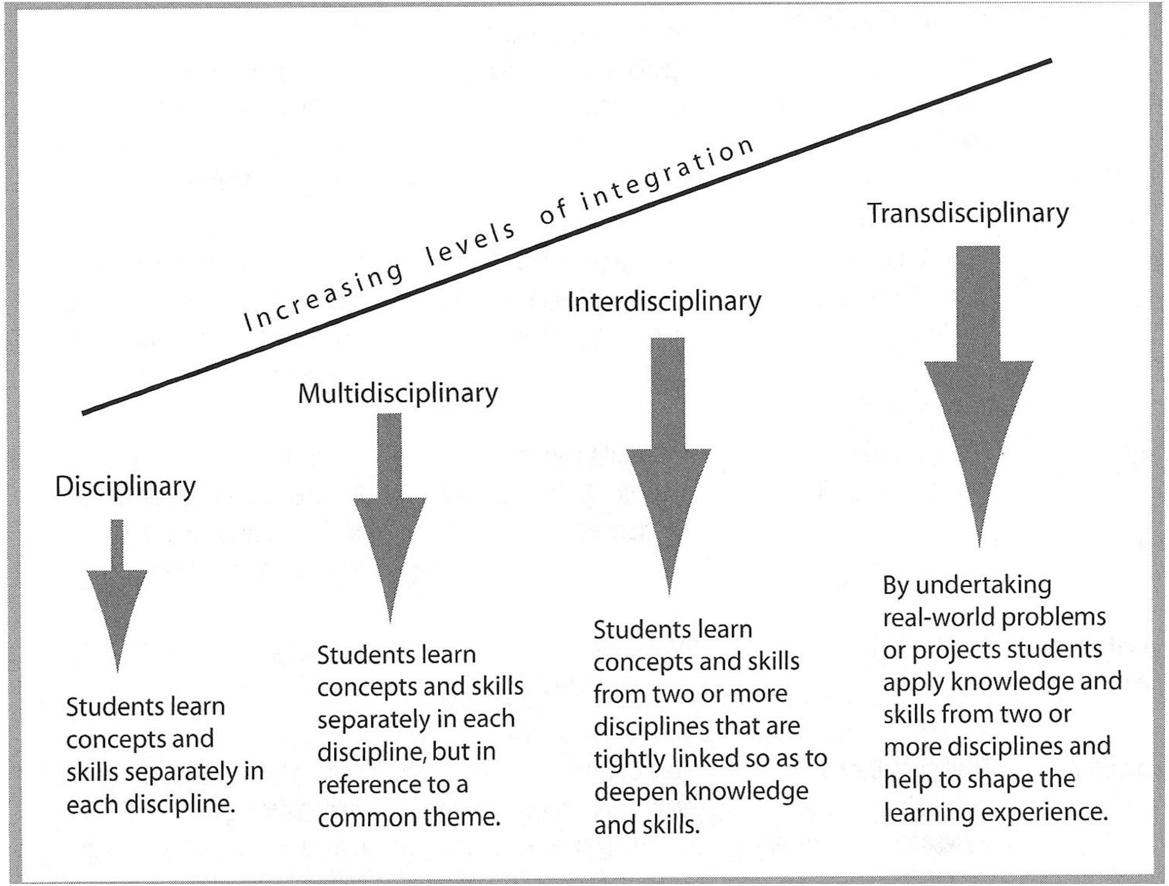
TECH PREP TEAMWORK TECH PREP

What does STEM mean to you?

SUCCESSFUL K
STEM EDUCATI
Identifying Effective A
Technology, Engineeri
Preparing the Next Generation
of STEM Innovators:
Identifying and Developing
Our Nation's Human Capital
Developing
the STEM
Education
Pipeline
NATIONAL ACADEMY OF ENGINEERING and
NATIONAL RESEARCH COUNCIL
M Integration
-12 Education
STATUS, PROSPECTS, AND
AN AGENDA FOR RESEARCH
STEM
LEARNING
IS EVERYWHE
Summary of a
Convocation on
Building Learning
Systems
ACTE
ISSUE BRIEF
JUNE 2009
CTE's Role in
Science,
Technology,
Engineering
& Math
Examining the impact of
afterschool STEM programs
A paper commissioned by the Noyce Foundation
July 2014
Anita Krishnamurthi
Afterschool Alliance
Melissa Ballard
Afterschool Alliance
Gil G. Noam
Harvard University
Afterschool Alliance
pear
NOYCE
FOUNDATION
KENTUCKY'S
Science
Technology
Engineering
Mathematics
IMPERATIVE
COMPETING IN THE
GLOBAL ECONOMY
Council
STEM Learning
n & Human Resources
NSF
ional Science Foundation

STEM from a Transdisciplinary Perspective

"The idea of transdisciplinary literally means beyond all the disciplines but connected to all the disciplines by a unifying issue or topic of inquiry."
- Basarab Nicolescu

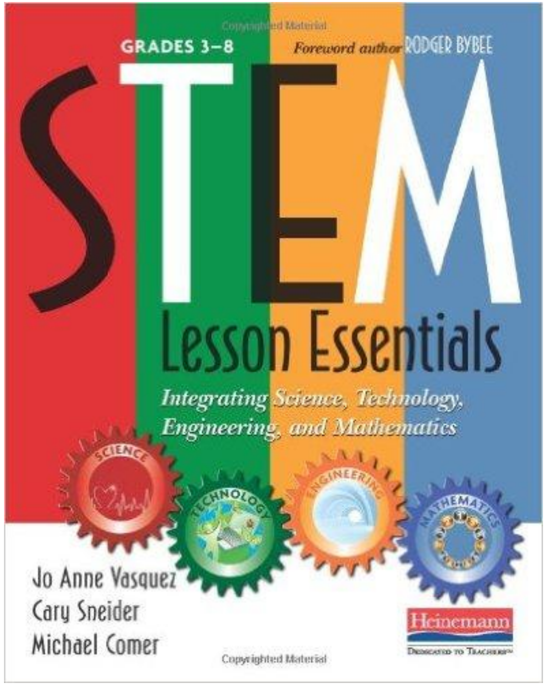


Looking at Big Ideas

- “A Big Idea is a statement of an idea that is central to the learning of mathematics, one that links numerous mathematical understandings into a coherent whole.” –Charles, *Big Ideas and Understandings as the Foundation for Elementary and Middle School Mathematics*, p. 10
- “Big ideas are about the relationship between some class of natural phenomenon and a causal explanation that helps us understand why that class of phenomena unfolds the way it does.” –Windschitl et al., *The Big Idea Primer*, p. 1

Practices at the Core

STEM Lesson Essentials



Science	Engineering	Technology	Mathematics
Ask questions.	Define problems.	Become aware of the web of technological systems on which society depends.	Make sense of problems and persevere in solving them.
Develop and use models.	Develop and use models.		Model with mathematics.
Plan and carry out investigations.	Plan and carry out investigations.	Learn how to use new technologies as they become available.	Use appropriate tools strategically.
Analyze and interpret data.	Analyze and interpret data.		Attend to precision.
Use mathematics and computational thinking.	Use mathematics and computational thinking.	Recognize the role that technology plays in the advancement of science and engineering.	Reason abstractly and quantitatively.
Construct explanations.	Design solutions.		Look for and make use of structure.
Engage in argument from evidence.	Engage in argument from evidence.	Make informed decisions about technology, given its relationship to society and the environment.	Construct viable arguments and critique the reasoning of others.
Obtain, evaluate, and communicate information.	Obtain, evaluate, and communicate information.		Look for and express regularity in repeated reasoning.

Today we're going to look explore and play!

Buckyballs

Buckyballs

(fullerenes)

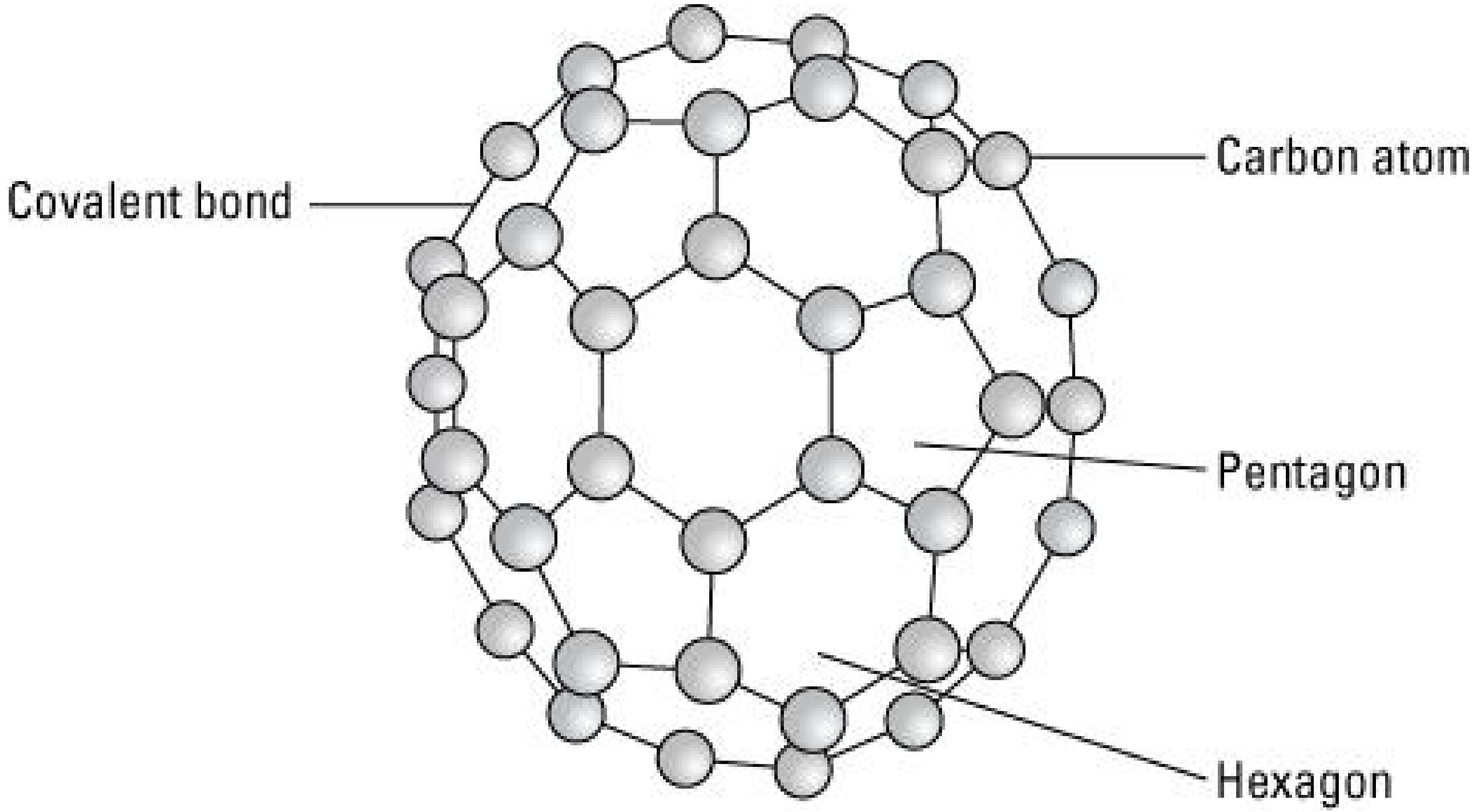
There is a fundamental principle of science: Things tend towards the lowest energy state possible. How does that play out in the molecular world? Math helps us understand this.

The (Brief) story...

- Chemist Harold W. Kroto was studying strange chains of carbon atoms found in space through microwave spectroscopy.
- It was deduced the molecule was comprised of 60 carbon atoms.
- 1985 by a trio of researchers working out of Rice University named Richard Smalley, Harry Kroto, and Robert Curl

Developing the Model for C60

- Because it was overwhelmingly dominant, Smalley reasoned the molecule had to be very stable.
    - Spherical - all bonding capabilities for carbon would be satisfied
- Another hint as to the arrangement of the molecule was that there must be a high degree of symmetry for a molecule as stable as C60.
- Constructing a model that satisfied these requirements was fairly difficult and the group of scientists experimented with several models before coming to a conclusion.

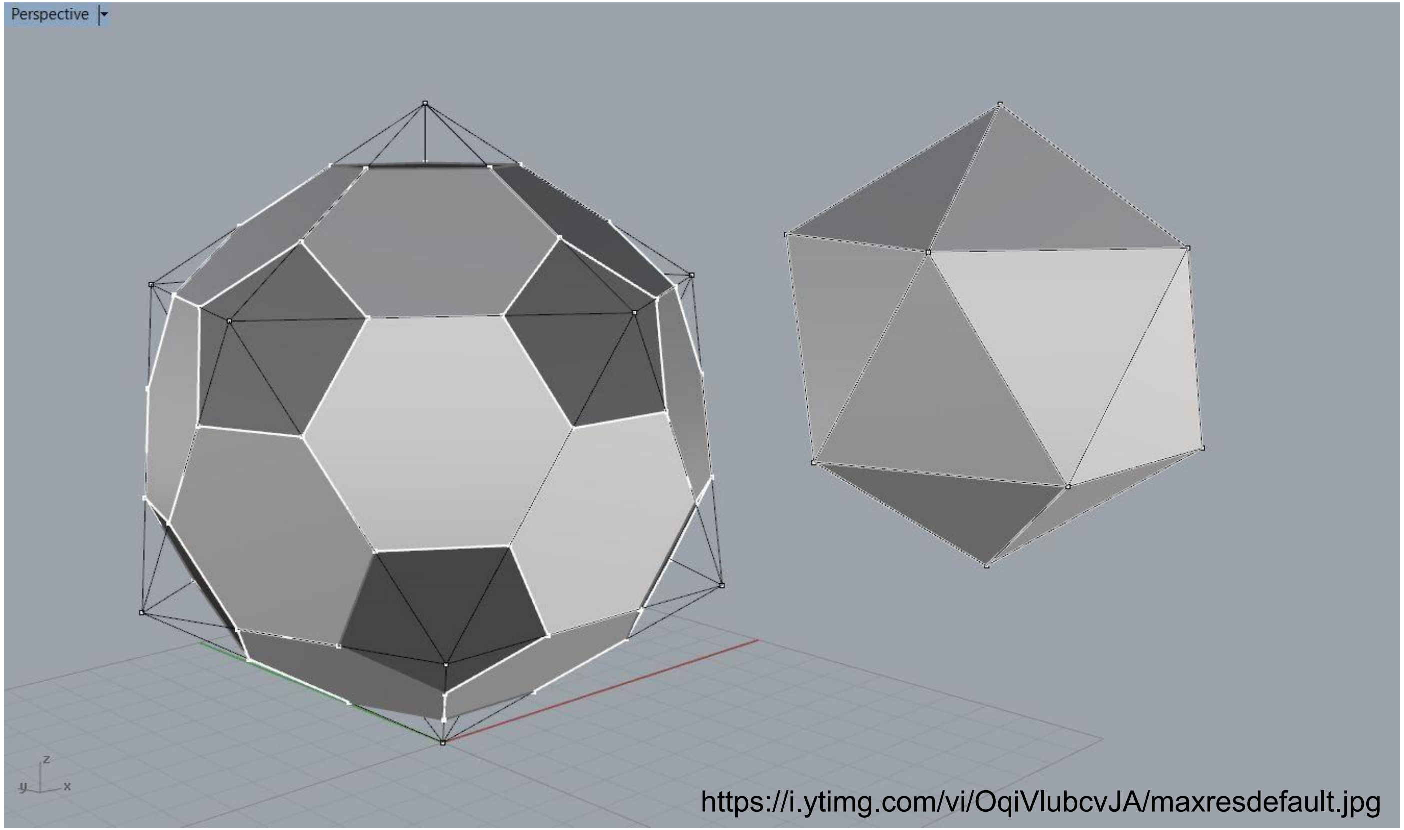

Covalent bond
Carbon atom
Pentagon
Hexagon

Platonic Solids

~

Archimedean Solids

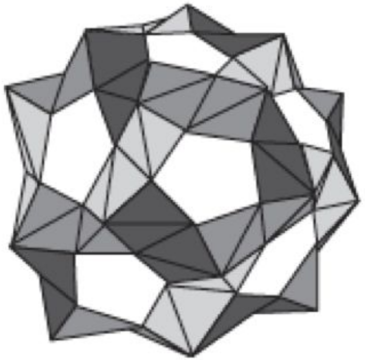
Truncated Icosahedron



https://i.ytimg.com/vi/OqiVIubcvJA/maxresdefault.jpg

Diving Deeper...

Activity 12
MAKING ORIGAMI BUCKYBALLS



For courses: geometry, graph theory

Euler's Formula allows us to calculate the number of pentagons and hexagons

More about Buckyballs

- Mathematics & The Buckyball - http://www.math.ucsd.edu/~fan/amer.pdf
- Build a Buckyball Activity - http://www.solaripedia.com/files/1074
- Race to Catch a Buckyball - http://www.pbs.org/wgbh/nova/education/activities/2216_buckybal.html
- Using Mathematica to Construct a Buckyball - http://library.wolfram.com/infocenter/Demos/106/
- Using Euler's Formula to show how the number of pentagons can be calculated - http://blog.zacharyabel.com/tag/buckyballs/
- Making Origami Buckyballs (great STEAM activity!) - http://www.rigb.org/docs/activity12_projectorigami_0.pdf

STEM Activity Stations

3-D Pens

Tetrahedral bonding angle

Ozobots

EV3 Robots

10 minutes at each station

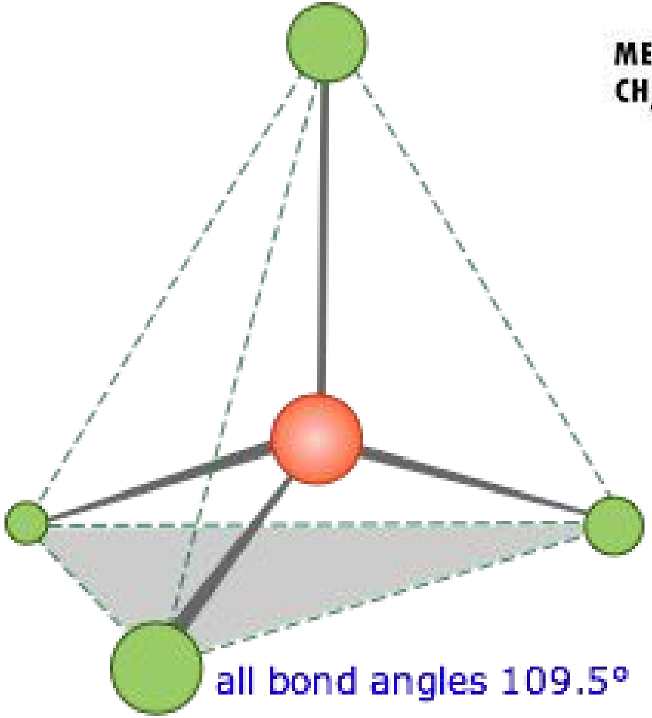
Questions?

Resource Packet will be posted in the NCTM online to download

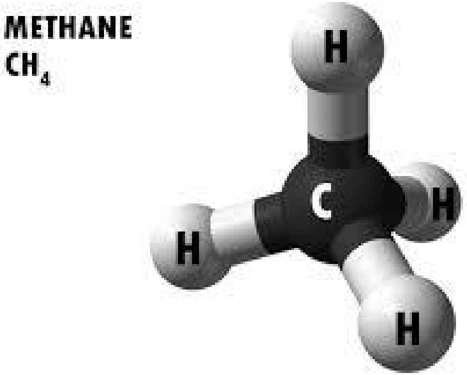
Contact - mmohr2@g.uky.edu

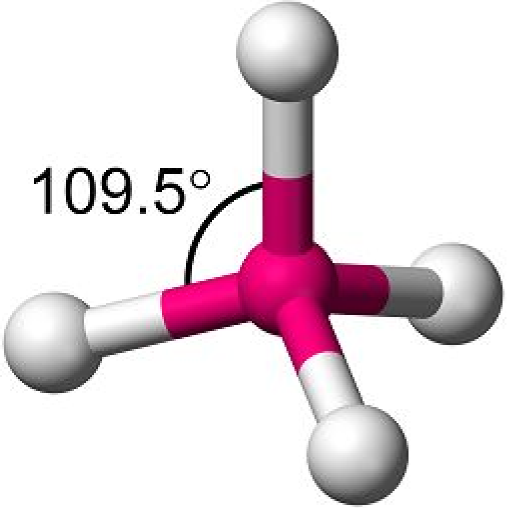
Tetrahedral Bonding Angle

Tetrahedral Bonding Angle



http://www.chem1.com/acad/webtext/chembond/CB-images/tetrahedron.png





http://study.com/cimages/multimages/16/tetrahedral.png

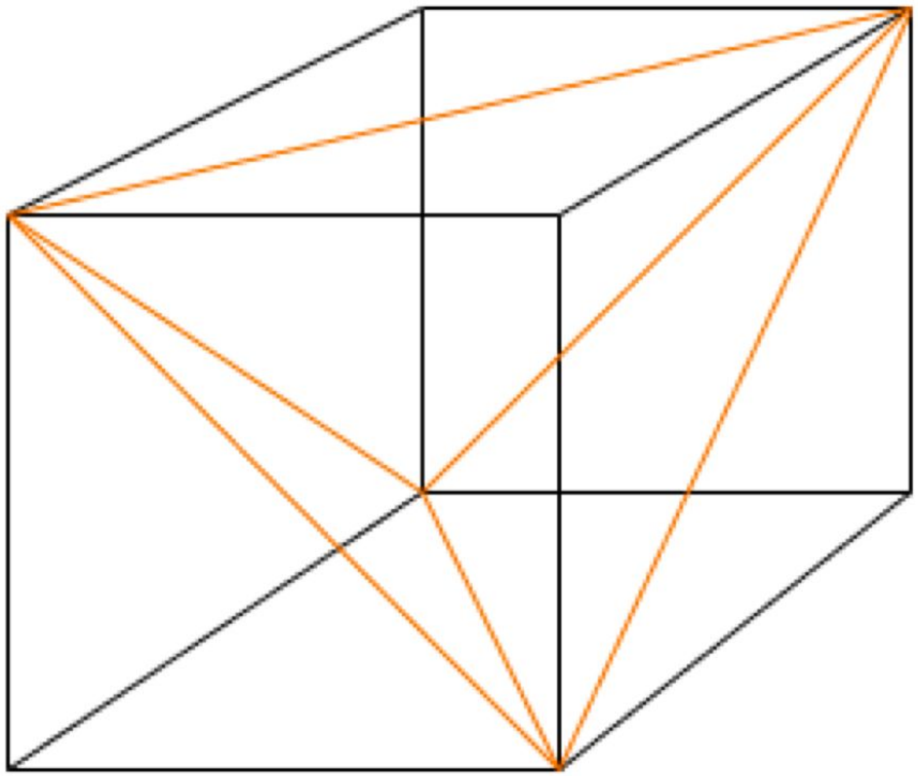
How do we prove this?

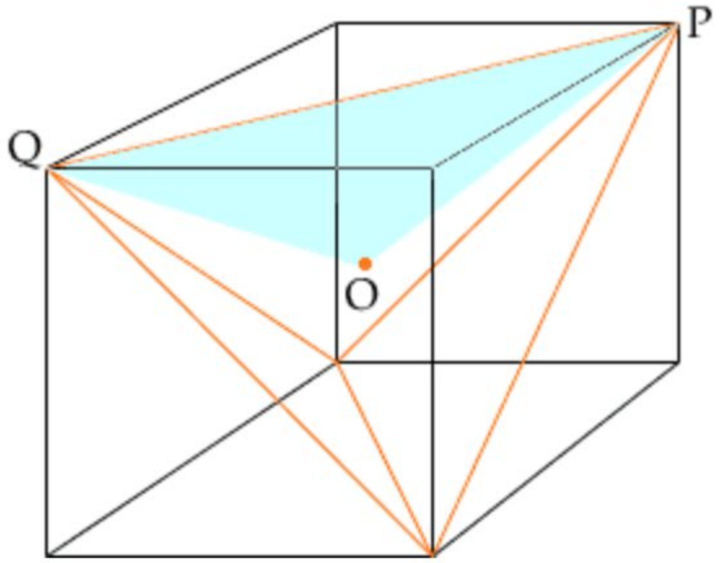
Build the Model to Visualize

http://www.funsci.com/fun3_en/exper2/exper2_17.jpg

http://www.matthewrkennedy.com/pent1medium.jpg

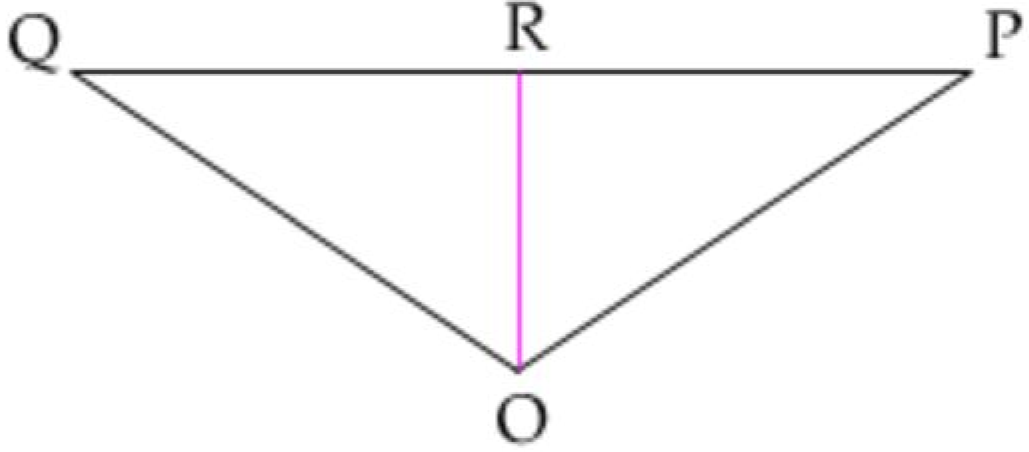
Let's Do Some Math!





Let's assume side length 2. Let O be the point at the center of the cube (equidistant from the eight vertices) as in the diagram above. Construct the triangle OPQ.

Consider the triangle OPQ. Let R be the midpoint of PQ.

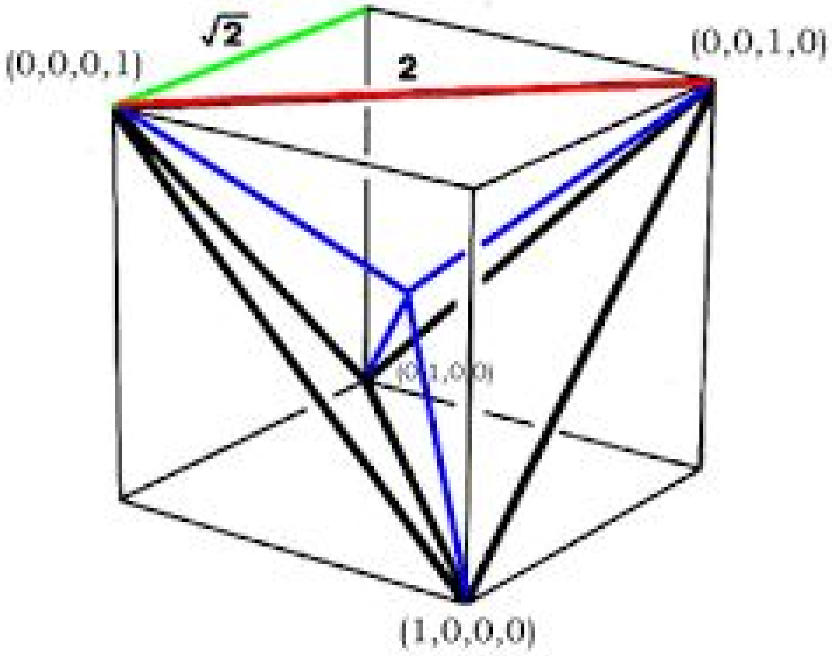


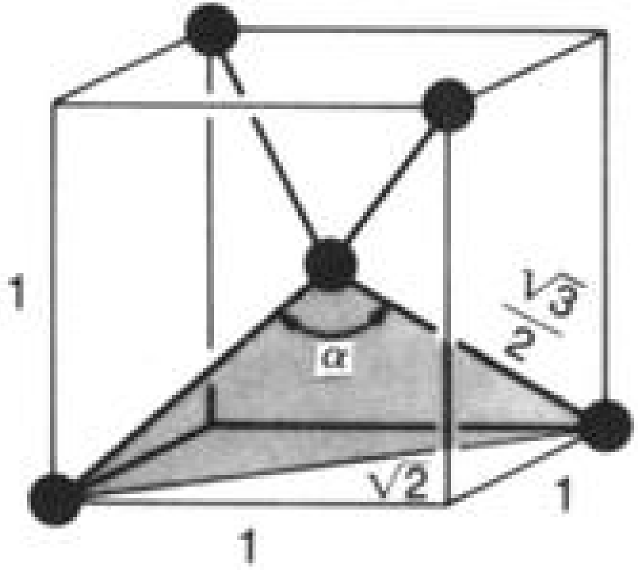
Since the sided of the cube are of length 2, a use of Pythagoras' Theorem gives |PQ| = 2 sqrt 2. Also, since O is at the center of the cube, |OR| = 1. From the diagram the tangent of the angle ROP is sqrt 2. Thus

angle QOP = 2 x angle ROP = 2 x arctan(sqrt 2) = 109.5°

http://mathcentral.uregina.ca/qq/database/qq.09.00/nishi1.html

Different Cases Yield Same Result





$$\alpha = 2 \arcsin \sqrt{\frac{2}{3}} = 109^\circ\, 28'$$

https://aerbook.com/maker/books/8389/assets/reflow_sample/OEBPS/images/e9780486310527_i0031.jpg

3-D Pens - Modeling

Using 3d Pens for Modeling

Template Galleries & Curriculum

- http://edu.the3doodler.com/curriculum/
- http://www.scribbler3dpen.com/stencils/
- http://the3doodler.com/community/type/teach/

Where to buy

- https://smile.amazon.com/Soyan-Standard-Printing-Filament-templates/dp/B00PTW7WEQ/ref=sr_1_6?ie=UTF8&qid=1491584094&sr=8-6&keywords=3d+pens
- Michael's

Read About More Ideas

- http://garyhall.org.uk/3d-pens-classroom.html
- http://www.joycrafty.com/3d-pens-benefit-classroom-teaching/

Ozobots

Using Ozobots in the Classroom

Where to buy

- https://shop.ozobot.com/?_ga=1.240979210.808335140.1488246433
- Barnes & Noble
- Amazon

Classroom Lessons

- http://portal.ozobot.com/lessons
- Pinterest - Ozobot lesson ideas

Ozoblockly: http://ozoblockly.com/

Ozobot Apps: http://ozobot.com/play/apps

EV3 Robots
Lego Robotics

Using EV3s in the Classroom

Where to buy - https://education.lego.com/en-us/middle-school/shop/products

Downloads - Chromebooks, Computers, Tablets (limited programming)

https://education.lego.com/en-us/downloads/mindstorms-ev3

Lesson plans include - Coding, Design Engineering, Science, and Space Challenge - all aligned to CCSSM and NGSS standards

Vex Robots are also a great alternative - https://www.vexrobotics.com/

Additional STEM Lesson Resources

- Discovery Education - STEM - http://www.discoveryeducation.com/what-we-offer/stem/index.cfm
- NASA Education - https://www.nasa.gov/audience/foreducators/index.html
- Shodor MASTER Tools - http://www.shodor.org/master/
- PBS Learning Media (search STEM) - https://pbslearningmedia.org/
- BrainPOP Educators - https://educators.brainpop.com/stem-lesson-plans/
- Mars Education - https://marsed.asu.edu/stem-lesson-plans
- Dayton Regional STEM Center - http://daytonregionalstemcenter.org/

Read More about STEM in Your Classroom!