

MCT4C CLA Applications of Geometry to Construction - Initial Planning

Using Section 2 of Applications in Geometry

Activity: Design and cost rooms and roof of a bungalow.

- Materials and costs required for floor, wall and roof coverings

Required:

- Plan of a bungalow (internet)
- GSP instructions (included)
- Pricing information from local flooring and decorating companies (eg. Rona, Home Depot)
- BLM #1, BLM #2, BLM#3
- Computer access
- Manipulatives
- Conversion chart from metric to metric, Imperial to metric, Imperial to Imperial
- Working with scale drawings
- Digital projector, lap top with Internet access or overhead projector
- Tape measures, meter sticks

To Be Included

- Computer lab time to get pricing info and work with Geometer's Sketchpad (2 days)
- Guest speaker: could be from construction industry or interior design (1 day)
- Course/curriculum expectations (see CLA template)
- Assessment rubric

Lessons (5-7 days)

Day 1 Preview activity. Review of basic skills (finding area and perimeter of composite shapes, conversions from Imperial to metric, metric to metric, Imperial to Imperial, volume) using BLM #1&2

Day 2, 3 Go to lab (at least computer access) or look at plans in classroom. Hand out or post 2 GSP worksheets on first day (& costing worksheets on second day). Select a design and begin pricing materials (May want to suggest a budget for practical purposes.)

Day 4 Guest Speaker; reflection on guest speaker

Day 5 Costing and summary (include BLM #3)

[Teachers may wish to have students present their findings.]

[Jazz days (2), if necessary to complete work and submit portfolio.]

BIG PICTURE:

In this activity, students will work with applications of measurement and geometry as they relate to the construction industry. Students will calculate perimeter, area and volume, convert between Imperial and metric systems and cost out materials. Students will use trigonometry to verify some of their calculations.

Portfolio Checklist

Day	Work To Be Completed	☺
Day 1	Minds On (conversions, review of area, perimeter, volume)	
	Home Activity	
Day 2	Minds On (more conversions, area, perimeter of composite shapes)	
Day 3	Minds On (volume of composite shapes)	
Day 2, 3	GSP Sketch	
	Floor Plan	
	Costing information for flooring, paint and shingles	
Day 4	Minds On (cost of painting)	
	Reflection questions from guest speaker	
Day 5	Minds On (cost of flooring and shingles)	
	Costing sheet and summary of activity	
	Assessment Rubric	

Day 1

Minds On: What do you need to know to build a house? (group brainstorming-list on board or chart paper or placemat activity). Measurement will undoubtedly come out of this discussion. Hand out warm-up. In pairs or groups of 3, have students complete the warm-up activity on conversions. Do an example with them on the board first.

Ex. $50 \text{ cm} = x \text{ in.}$

Solution: Write your conversion fact, then line up the values in the question underneath it. Cross-multiply and solve for x.

$$\frac{2.54 \text{ cm}}{50 \text{ cm}} = \frac{1 \text{ inch}}{x \text{ in}}$$

$$2.54x = (50)(1) \text{ in}$$

$$x = \frac{50}{2.54} \text{ in}$$

$$x = 19.685 \text{ in}$$

$x \approx 19.7$ inches or about $19\frac{11}{16}$ in (You may wish to discuss with students at this point that the metric system uses decimals, while the Imperial system uses fractions. Look at a measuring tape that has both.)

To convert inches to a fraction, for now just have students do a trial and error to find out (ex.) what .685 is in 16ths (ex. $11 \div 16 = 0.6875$).

Action: Finding the volume of your classroom

Also in pairs or groups of 3, investigate the Imperial and metric measurement systems with examples taken from the construction industry. (Resources: measuring tapes in centimeters)

1. Measure the length, width, and height of the room. Record measurements in centimeters. Convert to meters, feet and yards using the conversion table provided (see BLM #1). Use a chart similar to the one in the handout.
2. Find the volume of the classroom in cubic feet, cubic yards, cubic meters and cubic centimeters.
3. What size of ventilation fan (normally rate in cubic feet per minute or cfm) that will be needed to give two air changes per hour in the classroom?

Consolidate and Debrief:

Area and perimeter deal with 2D. Volume deals with 3D.

Perimeter: how far around something

Area: how much is needed to cover something

Volume: how much will something hold; the area of the base of a figure times the height

Units of measurement in the construction industry may be either in metric or Imperial. You will need to be able to go back and forth accurately between both. Easy conversion charts available online.

Minds On Activity (in-class): BLM #1

This handout has some practice with conversions, plus a follow-up to the above Action activity.

Home Activity; BLM #2

This handout has two footprints of the ground floors of houses (which are composite shapes), with questions regarding area and perimeter.

1. Perform the following conversions. Round metric answers to one decimal place. Round Imperial measurements to the nearest sixteenth.

a) 400 cm = _____ m

b) 18 in = _____ cm

c) $30\frac{1}{2}$ ft = _____ m

three conversions:
ft → in → cm → m

Useful	Conversion Facts
100 cm	1 m
2.54 cm	1 inch (in)
3 feet (ft.)	1 yard (yd)
12 in	1 ft

d) 2 m = _____ ft

convert m → cm → in → ft, keep the whole # for number of ft, take the decimal part & find the # of 16ths that come closest to that decimal – ex. 0.69 ≈ 11/16

e) 8 m = _____ ft _____ in

convert, keep the whole # for number of ft, take the decimal x 12, then convert the remaining decimal to a fraction

f) $6\frac{3}{4}$ ft = _____ m

2. a) Find the volume of a room 10m by 12 m by 3.5m in cubic feet (remember: $V = lwh$). (Convert the dimensions to cm, ft, and yd, then find the volume in cm^3 and m^3 , then convert to ft^3 and yd^3) Round all final results to one decimal place.
 b) Find the size of ventilation fan (normally rated in cubic feet per minute or cfm 's) that will be needed to give two air changes per hour in the room (round up to the nearest 100 cfm).

Room/dimensions	cm	m	ft	yd
Length				
Width				
Height				
Volume (calculate)	cm^3	m^3	ft^3	yd^3

2. a) Volume problem (show your work as you fill in the table)

2. b) Size of fan:

Day 1 BLM #2 (Home Activity)

Name: _____

Each diagram below is the footprint for the ground floor of a custom-built house. For house insurance you need to know the area (square footage). For an upcoming renovation you need to know the perimeter. Calculate the **perimeter** and **area** of each footprint.

Useful formulas (be careful how you use these – especially the perimeter ones!)

Area of a circle: $A = \pi r^2$

Perimeter of a circle: $P = 2\pi r$

Area of a rectangle: $A = lw$

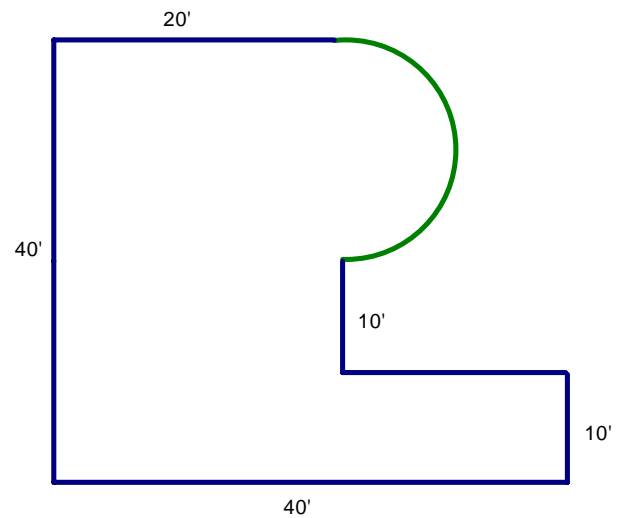
Perimeter of a rectangle: $P = 2(l + w)$

Area of a triangle: $A = \frac{1}{2}bh$

Area of a parallelogram: $A = bh$

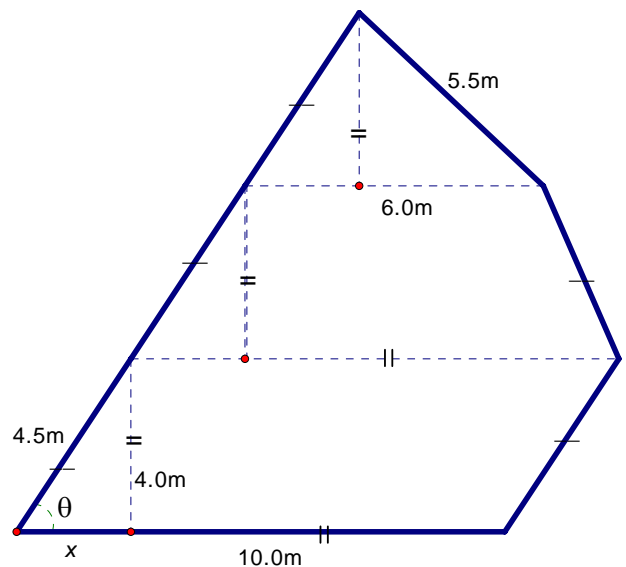
Area of a trapezoid: $A = \frac{1}{2}(a + b)h$

Plan A (All dimensions in feet)



Plan B (All dimensions in meters; answer to 1 decimal place)

For Plan B, also find the length of x and the value of θ (use the Pythagorean Formula and Trigonometry).



MCT4C CLA – Geometry (technology component) using *The Geometer's Sketchpad* (GSP)

Note to Teachers: The activity on the following pages is meant to be a one-day computer-lab assignment that is as close to self-instructional as possible. It is a component of the MCT4C CLA for Section 2 of the curriculum in *Applications in Geometry*.

Since it is meant to be done at least somewhat independently, there may be a need for students to review some basic math skills (ex. Pythagorean Theorem, trigonometry, unit conversions, etc.). A good source for this is one of the thousands of free PowerPoint presentations available on the Internet. Examples are:

For *many* topics, 2 good sources are <http://www.pppst.com/themes.html> or <http://geometrycrusher.com/powerpoints.aspx>

For *Geometry*, students could look at: <http://math.pppst.com/geometry.html> and then (ex.) *Pythagorean Theorem* and then choose (ex.) PowerPoint Presentation which is at <http://www.vegaspbs.org/DocumentView.asp?DID=183>

For *trigonometry*, a quick summary of grade 12 functions is at <http://www.rockfordschools.org/staff/brownk/TrigFunctionFactSheet.htm> and a full explanation at <http://geometrycrusher.com/Documents/GCH8L2%20SLideShow.ppsx>

For *unit conversion*, try <http://www.slideshare.net/lauracstelling/units-of-measurement-powerpoint> or for an easy on-line conversion tool (to convert just about anything!): <http://convertplus.com/en/>

There are several freely-available tutorials on *The Geometer's Sketchpad* that can be accessed if a student needs more background or is wanting to develop further skills. Two good ones are: <http://www.etc.net/techfellow/sketch.htm> and <http://math.escweb.net/sketchpadtutorial/>

MCT4C – Geometry & Geometer's Sketchpad Project Rubric

NAME: _____

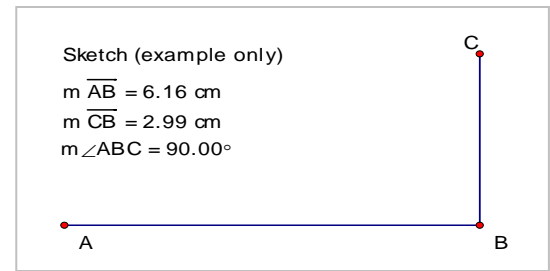
Category↓ Level→	1	2	3	4
Knowledge and Understanding Follows the activities as stated; demonstrates understanding of topic.	Student has completed about half of the assigned tasks – diagrams, labels, calculations, etc & shows limited understanding.	Student has completed the assigned tasks satisfactorily & demonstrates some understanding of the topic.	Student has completed most of the assigned tasks well & demonstrates considerable understanding.	Student has done all of the assigned tasks, correctly & demonstrates thorough understanding.
Communication Demonstrates facility with the GSP program.	Drawings or constructions have numerous errors and clearly show an limited ability to use the software.	Drawings or constructions have some errors but clearly show some ability to use the software.	Drawings or constructions have few errors and clearly show considerable ability to use the software.	Drawings or constructions have no errors and clearly show a complete ability to use the software.
Thinking/ Inquiry Calculations & scales (both by hand and in GSP) are correct.	Calculations & scales show many errors, or are incomplete. Limited processing skills.	Calculations show some errors, or are not fully complete. Some processing skills are evident.	Calculations & scales show few errors. Considerable processing skills are evident.	Calculations & scales are all correct. A high degree of processing skills evident.
Applications Finds & calculates reasonable cost estimates.	Cost estimates & calculations show numerous errors, or are incomplete.	Cost estimates & calculations show some errors, and/or are not fully complete.	Cost estimates & calculations are reasonable & show few errors.	Cost estimates & calculations are excellent & show no errors.

MCT4C CLA – Geometry (technology component) using The Geometer’s Sketchpad (GSP)

1. **Introduction to GSP.** In your computer lab, click on *The Geometer’s Sketchpad*. What follows is a tool kit for those who have not used this computer-aided mathematical design program, using Dynamic Geometry Software, before (an important skill in both math and construction is the ability to follow a set of instructions!):

- In the left side you will see the 6 buttons that are your ‘Tools’. Experiment with these for a couple of minutes to find out what you can (and can not) do. When done, go to *File* and click on *New Sketch*.
- Now to business. First, construct a horizontal ‘line segment’ (use fourth button down – they call it the *Straightedge Tool*). Return to the *Selection Arrow Tool* – this is your main tool to work with. Click anywhere on the screen to get rid of all pink highlighting (get in the habit of doing this on a regular basis). Now click on your line segment to highlight it, then go to the Command line at the top, choose *Measure*, then *Length*. You should have a pink box show up showing the length (in cm), plus the program has assigned letters to the points (ex. A,B). Change these letters to your initials (unless your name is Ann Bay!) by putting the arrow on the letter (do you see a little hand?), then double-left-click on the letter and type in your initial.
- At the right end of your segment, construct another segment a different way: place a point (*Point Tool!*) near the segment, then use the arrow to highlight the right point of the original segment, go to *Construct*, then *Segment*. Did the 2nd segment appear (if not, go back & make sure you’ve only highlighted the 2 points in question)? To give the new point a letter, click on the *Text Tool*, then point to the new point and left-click. While you’re on this tool, drag a text box on the top right corner of your page, then type in a title, name, and date. Finally, measure the length of this new segment too.

- Now highlight the 3 points on your diagram in the order you made them. Go to *Measure* and *Angle*. The angle between the 2 segments will be given. Using the arrow, move the last point (C in diagram at right – make sure this is the only thing highlighted) until the angle given is as close to 90° as you can get it, and the length is 3.0 cm. The last thing is to complete a Δ by drawing a segment from (ex.) A to C. Measure (ex.) ∠ CAB. As an option, show how to get the angle using trigonometry.

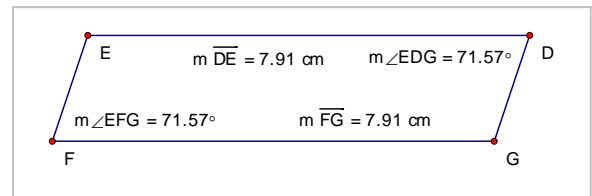


If you put a text box on your sketchpad, you can use the symbols at the bottom to make something that looks like the box at right. Use a calculator to get the correct values. Of course, your value should match the measured one!

$$\begin{aligned} \tan \angle CAB &= 3.0/6.2 \\ &= 0.48 \\ \therefore \angle CAB &= 30^\circ \end{aligned}$$

[Reminder: keep clicking on your sketchpad to “un-highlight”!]

- Some more skills that we’ll need to ‘build’ our house: On the same pad, draw another segment. Place a point near it. Make a line that is parallel to the first segment by highlighting it, then the point, then going to *Construct* and *Parallel Line*. Oops! – the line goes on forever! To make this work, 1st measure the length of the original segment, then use the *Straightedge tool* to draw a segment on the new line. Measure it, then drag one of its points so that both segments are the same length. Now *right* click on the line (not the segment) and click *Hide Line*. Complete this ‘parallelogram’ by closing the 2 ends, as shown. Measure the opposite angles to confirm the shape (what *is* the definition of a parallelogram?).



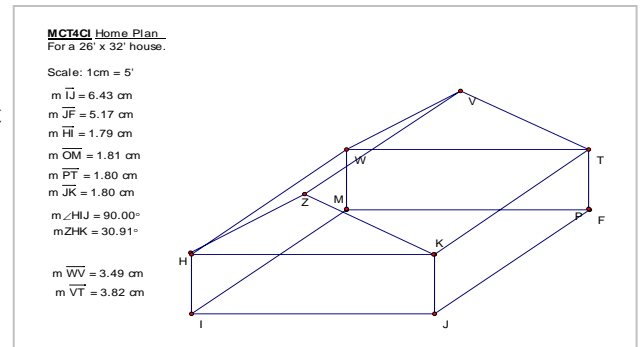
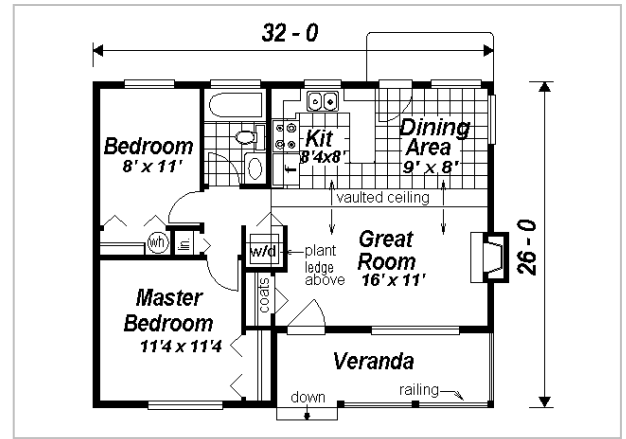
2. **‘Constructing’ your house:**

- To start your actual home design, you need to have a design in mind so you know proper dimensions, and a suggested ‘floor plan’ (which shows the layout of rooms, etc). The easiest way to get these is to search (*Google*) for it. For simplicity, we’ll be ‘constructing’ a bungalow (basically a one-story rectangular home - house plans are usually given in the Imperial system, in square feet or ft²; try for one that’s between 800 and 1500 ft², or say 30’ x 40’). When searching online, you’ll need to find a plan that you can copy & paste (C&P) into Word. It’s OK if there is an attached deck or garage – we’ll just ignore them for this project. Try to get one that shows the overall dimensions; now open a Word document, *Insert a Text Box*, then C&P your floor plan into the box (this way you can move it around your page, and reduce its size easily – see example below). If you can, follow the same process for a picture/sketch of the house too.

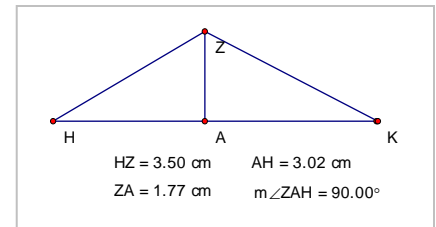


2. ‘Constructing’ your house (cont.):

- On your sketchpad, you need to make room for one more (bigger) sketch. Move your previous 2 sketches to the top with the arrow by ‘dragging’ a box around the *entire* shape (are all parts of the diagram highlighted?), then just moving it to a convenient spot at top. Undo if you make a boo-boo!
- You’re going to draw the basic shape of your house in GSP now, in 3D. First, find out what the minimum ‘pitch’ (angle) of a house’s roof in Ontario must be, and what height walls need to be. Add these facts under your floor plan in Word.
- Start by drawing the front wall of the house (HIJK in this diagram). Use the same technique as before for the parallelogram (don’t worry about what letters GSP uses – or you can change them if you like). Measure all 4 lengths and widths, plus the bottom left angle. Using a scale (ex. as shown), calculate what each dimension should be to scale (ex. in the diagram to right, 1 cm = 5’ means that the 32’ in the plan must be 6.4 cm). To make your rectangle the right size, highlight the side you want to move, *plus* its endpoints, *then* move it. You can always undo. Make sure the angle stays at 90°.
- Now do the back wall. Since it is the same as the front, highlight your rectangle, then *Edit, Copy, Paste*. Move the copy to the ‘back’, join all 4 corners with segments to make the sides of your house, and measure one length on each side. To get the correct dimensions of the house, highlight all 4 corners *and* segments of the *back*, and move it until the sides are the correct length (in the example, 26’ = 5.2cm).



- Next we’ll make the roof. Using the *Point Tool*, place a point around where Z is in the diagram. Construct 2 segments by clicking on this and each corner as shown, using the *Straightedge Tool*. Measure the 2 lengths, and the pitch (angle) of each lower vertex of the ‘gable’ (that’s the triangle!). Click on your peak point (i.e. Z) and move it until the angles are at least the minimum pitch angle you found before, and the Δ is as close to isosceles as you can get it. Repeat this process at the back of the house – both gables must be equal (“congruent”). Join the 2 peak points with a segment (ex. VZ).
- The last diagram is a detail of the gable. Copy the front Δ by highlighting all 3 vertices and segments. Paste it to a free spot on the page. Click on the base (ex. HK) and the peak (Z), then *Construct a Perpendicular Line*. Click on both this line and the base, then *Construct an Intersection*. Join the peak to this point with a segment. *Hide* the original perpendicular line.



Measure the same dimensions as you see in the diagram. Now do 2 calculations:

1. use the Pythagorean Formula ($a^2 + b^2 = c^2$) to show that you (hopefully!) have a right-angled Δ ;
 2. use trig to show that the \tan^{-1} of the ratio (ex. ZA/AH) equals the previously measured vertex (ex. $\angle ZHK$).
- To show your calculations, it’s OK to hand-write them on the sheets after you print the sheets out.

- This completes the required GSP diagrams. You may, if time allows, add doors, windows, etc. (as shown on your diagram), in scale. You can also *Hide* any lines in your house diagram that wouldn’t normally be visible, and colour different parts (ex. highlight all 4 vertices of one side of the rectangular roof, in order, then *Construct a Quadrilateral Interior*). GSP can do many other cool things too, but that’s for another time. (OK – here’s one more – try, on a New Sketch, to do a full “perspective” 3D drawing of your house. Repeat the drawing of your front wall, then go to *Help, Toolbox*, and Search for the word ‘dilate’, then follow the info).
- If you *still* have some time, in GSP reproduce the floor plan (that you pasted to Word), and make sure it’s to scale. Include appropriate labels and dimensions (including windows & doors, if possible).
- You now have 2+ sheets that you’ve been working on (one in GSP, the other in Word). Make sure both sheets have your name, date, and title. To print a GSP page, ALWAYS *Print Preview* first. If your diagrams are not all on 1 page, click on *Fit To Page*. If that doesn’t work, manually lower the *Scale #* until you have 1 page. Now print out both pages. Don’t forget to complete those previous calculations for your gable.

Acknowledgement: thanks to <http://www.houseplans.com> for permission to use one of their plans for this project.

Flooring

Room 1: _____

Floor covering: ceramic tile

Manufacturer's name: _____

Area to be covered:

Cost (per square foot installed)

Total cost for room 1

Calculations for Room 1:

Room 2: _____

Floor covering: carpet and underlay

Manufacturer's name: _____

Area to be covered:

Cost (per square foot installed)

Total cost for room 2

Calculations for Room 2:

BLM #3 (page 1)

Painting

(one coat of primer, two finish latex coats)

Master Bedroom

Area to be covered in ft ²(show your calculations)

Coverage: Assume 1L covers about 100 ft²

Cost of primer (per gallon or 3.7 L)

Amount of primer required

Cost of latex (per gallon or 3.7 L)

Amount of finish required (remember you need two coats)

Calculations for Painting:

Roofing

Square footage of roof

Weight, style and colour of shingle

Cost per 'square' (1 bundle)

Number of squares required (Find out what area is covered by one bundle of shingles.)

Installation

Total cost

Calculations for Roofing:

Journal Entry: Reflection on Guest Speaker

Name: _____

Complete the following activity as part of your work for this unit.

List three things that you learned from today's speaker that you can use in the future.

1.

2.

3.

List one thing you did not find relevant.

1.

If you were to go into the same career as our guest speaker, what skills would you need to have?

1.

2.

3.

What aspects of the guest speaker's work surprised you and why?

1.

2.

In what ways was math used/useful in the guest speaker's work?

1.

2.

3.