Performance Based Learning and Assessment Task

Build-a-Toy

I. ASSESSMENT TASK OVERVIEW & PURPOSE:

This performance task is planned to give learners an opportunity to design a new toy. Learners will be challenged to design their toy, draw their toy to scale, and calculate the volume of their toy in order to determine the amount of material necessary to build it. Additionally, learners will calculate the surface area of their toy in order to decorate all surfaces. Lastly, learners will be tasked to calculate the cost to build and ship their toy and calculate a sales price using real-world material costs.

II. UNIT AUTHOR:

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III. COURSE:

Geometry

IV. CONTENT STRAND:

Three-Dimensional Figures

V. OBJECTIVES:

The learner will be able to:

- Draw a three-dimensional object to scale
- Use formulas for the volume and surface area of three-dimensional objects to solve real-world problems
- Use similar geometric objects in two- or three-dimensions to determine how changes in one or more dimensions of an object affect area and/or volume of the object
- Organize and communicate results

VI. REFERENCE/RESOURCE MATERIALS:

Teachers will need access to the warm-up exercises, the warm-up solutions, the assessment rubric, and the rubric category descriptions. Students will need access to the Build-a-Toy activity packet, the Materials List, a *2009 Mathematics Standards of Learning* Geometry Formula Sheet, graph paper for drawing, a writing utensil, a ruler, and a calculator. Students may also need access to a computer in order to look up alternative materials.

VII. PRIMARY ASSESSMENT STRATEGIES:

The task includes an assessment component that performs two functions: (1) for the student it will be a checklist and provide a self-assessment and (2) for the teacher it will be used as a rubric. Students will be assessed on the inclusion of at least four different right solids in their toy design, on their scaled drawings, and on their volume calculations. Furthermore, students will be assessed on their surface area calculations and on how effectively they communicate and justify their toy cost, shipping cost, and sales price. In final, students will be assessed on their neatness, creativity, participation, and

self-evaluation.

VIII. EVALUATION CRITERIA:

A self-assessment and a teacher assessment are attached below. A benchmark is also included at the end of the document in order to demonstrate the level of quality that is expected from each group of students.

IX. INSTRUCTIONAL TIME:

The performance task should take no longer than two ninety-minute blocks or four forty-five minute periods.

- Block Bell Schedule: The first block should be used for students to receive teacher instruction, design their toy, draw their toy to scale, and calculate the necessary materials needed in order to build their toy. The second block should be used to calculate the necessary materials in order to decorate their toy and to determine the cost to make their toy, ship their toy, and sell their toy. Additionally, students will complete a self-assessment.
- Traditional Bell Schedule: The first period should be used for students to receive teacher instruction, design their toy, and begin to draw their toy to scale. The second period should be used for students to complete their toy drawing to scale and calculate the necessary materials needed in order to build their toy. The third period should be used to calculate the necessary materials in order to decorate their toy. The fourth period should be used to calculate the cost to make their toy, ship their toy, and sell their toy. Additionally, students will complete a self-assessment.

Build-a-Toy

Strand
Geometry: Three-Dimensional Figures

Mathematical Goals and Objective(s)
The mathematical objectives for this activity include using appropriate formulas for the surface area and volume of three-dimensional objects to solve real-world problems and using similar geometric objects in two- or three-dimensions to determine how changes in one or more dimensions of an object affect area and/or volume of the object.

Related SOL
- 8.7a The student will investigate and solve practical problems involving volume and surface area of prisms, cylinders, cones, and pyramids.
- 8.7b The student will describe how changing one measured attribute of a figure affects the volume and surface area.
- G.13 The student will use formulas for surface area and volume of three-dimensional objects to solve real-world problems.
- G.14b The student will use similar geometric objects in two- or three-dimensions to determine how changes in one or more dimensions of an object affect area and/or volume of the object.

NCTM Standards
- Apply and adapt a variety of appropriate strategies to solve problems
- Understand measurable attributes of objects and the units, systems, and processes of measurement
- Apply appropriate techniques, tools, and formulas to determine measurements
- Use visualization, spatial reasoning, and geometric modeling to solve problems
- Communicate mathematical thinking coherently and clearly to peers, teachers, and others

Materials/Resources
Teachers will need access to the warm-up exercises and the warm-up solutions in order to facilitate a classroom introduction to the goals and objectives of the Build-a-Toy activity. The assessment rubric and the category descriptions will aide teachers in evaluating students individually at the end of the Build-a-Toy activity. Students will need access to the Build-a-Toy activity packet to ensure all objectives are met according to the timeline set forth. Students will need graph paper, a writing utensil, and a ruler for their scaled drawings. Additionally, students will need access to a Geometry Formula sheet for the volume and surface area formulas. A calculator will be needed in order to assist in the volume and surface area calculations. Students will need a Materials List in order to decide what materials will be used in their toy design. The Materials List will also aid students in calculating their toy cost, shipping cost, and sales price. Lastly, students may need access to a computer in order to look up alternative materials.

Assumption of Prior Knowledge
- The students should be familiar with how to accurately find measurements to the appropriate levels of precision using a ruler. The students should be familiar with the six solids covered on the *2009 Mathematics Standards of Learning* Geometry Formula Sheet. Similarly,

students should be familiar with how to use the volume and surface area formulas for the six solids covered on the *2009 Mathematics Standards of Learning* Geometry Formula Sheet. Students should also be able to solve real world problems using their volume and surface area calculations (e.g. finding cost). Thus, students should be operating on at least the third level of the Van Hiele scale. If students are not, more scaffolding from the teacher and more time on the task may be required.

- Students may have difficultly drawing the solids on graph paper and have difficulty drawing their toy design to scale. The teacher may need to provide additional examples and justification as to why this step is important. Furthermore, teachers may need to provide tangible examples in order to assist students in calculating the volume and surface area of their toy. Teachers will need to stress the importance of using the appropriate volume and surface area formulas for each solid. Lastly, teachers may need to provide additional guidance when students are calculating their toy cost, shipping cost, sales price, as well as unit conversions.

Introduction: Setting Up the Mathematical Task

In this activity, you are being tasked with building a new, three-dimensional toy. The Build-a-Toy activity should take no longer than two ninety-minute blocks (four forty-five minute periods). In phase 1, you will be challenged to design and plan the material involved in building your toy. In phase 2, you will make a plan to decorate, create, and ship your toy to consumers.

At this point, the teacher should ask the students, "What are some ways we use volume calculations in the real world?" Allow the students time to think and respond. The teacher can help to initiate the discussion by giving an example. For instance, volume calculations are important for filling up a car's gas tank. The teacher then should ask the students, "What are some ways we use surface area calculations in the real world?" Allow the students time to think and respond. Again, the teacher can help to initiate the discussion by giving an example. For instance, surface area calculations are important for installing new carpet into a living room. At this point, it is a good time to review where to locate volume and surface area formulas.

Another recommendation, in order to eliminate confusion, is for the teacher to have students practice calculating the volume and surface area of right solids prior to starting the Build-a-Toy activity. Warm-up exercises and solutions are included below. The teacher will need to emphasize the importance of using the appropriate formulas dependent on the solid. After the initial fifteen-minute discussion, the teacher will place students in pairs in order to create workable, productive groups. The groups will then obtain a detailed timeline of what is expected. The students will have three minutes to read through the instructions and discuss them amongst themselves. The teacher will then hold a two-minute question and answer session prior to allowing the pairs to get started. The detailed timeline of what is required is below:

Phase 1:

- **Teacher Instruction (20 minutes)**
- **Design the toy (10 minutes)**
  - Brainstorm the design and name of your toy.
  - Your group should decide on at least four right solids to use in your toy design. *Prior to drawing, confirm your toy design with your teacher.*
- **Draw the toy (35 minutes)**

- You must create at least five drawings to scale with inches as your units.
- One drawing is for each solid as an independent unit with dimensions. The drawings need to be three-dimensional.
- Your last drawing can either be an isometric drawing of the toy or a side view of the toy. Be sure to include the dimensions.

- **Material Calculations (25 minutes)**
  - Decide on the materials you will use to build your toy. *Refer to the Materials List included in your packet.*
  - Calculate the amount of material you will need for each solid. Use your dimensional drawings in your calculations. *Refer to the Geometry Formula Sheet included in your packet for the volume formulas.*
  - Calculate the total amount of material you will need to build your three-dimensional toy.

Phase 1 must be completed and turned in by the end of the 1st block/2nd period.

Phase 2:

- **Decoration Calculations (40 minutes)**
  - Brainstorm the materials you will use to decorate your toy. *Refer to the Materials List included in your packet.*
  - Calculate the amount of material you will need to cover all surfaces of your toy. Use your dimensional drawings in your calculations. *Refer to the Geometry Formula Sheet included in your packet for the surface area formulas.*
  - Calculate the total amount of material you will need to decorate your toy.
- **Toy Cost (20 minutes)**
  - Determine the total amount of money that it will take to build your toy. *Refer to the Materials List included in your packet.*
- **Shipping Cost (15 minutes)**
  - Determine the box option that is most appropriate to ship your toy and determine if you would change your toy dimensions based on the box options. Justify your answers. *Refer to the Materials List included in your packet.*
- **Sales Price (10 minutes)**
  - Calculate the cost of your toy for consumers and justify your answer.
- **Self-Assessment (5 minutes)**
  - Individually complete a self-assessment.

Phase 2 must be completed and turned in by the end of the 2nd block/4th period.

Student Exploration

Student/Teacher Actions:
Students will be collaborating in pairs as determined by the teacher. Groups should be paired such that one mathematical mind is with one creative mind. The goal is for both partners to have the opportunity to lead their group, showcase their talent, and teach their partner something new while completing the Build-a-Toy activity.

The first day, the teacher will invite students to draw upon their prior knowledge by facilitating a discussion of the importance of volume and surface area in the real world. The teacher also has the ability to review volume and surface area formulas with students prior to the start of the activity. Warm-up exercises and solutions are included below. The teacher will explicitly state the expectations for each class and provide constructive feedback along the way. The teacher will also act as a mentor and coach as students design their toy, calculate their materials, and determine the toy cost, shipping cost, and sales price. Teachers will encourage students to draw

on their partner's knowledge first, prior to seeking out prompting from the teacher and/or class notes. Lastly, teachers will be vigilant to keep groups from getting off track and falling behind as each step depends on the last.

Monitoring Student Responses

- Students are to communicate their thinking by actively participating in the activity with their partner. Similarly, students are to communicate with each other respectfully and supportively.
- Students must clearly communicate their knowledge in regards to their toy design and calculations on their activity worksheets. Tasks must be submitted by the deadlines set forth.
- Teachers are to highlight and clarify frequently asked questions to the class as they emerge and provide problem-solving strategies to groups in order to resolve difficult situations.
- Teachers should encourage all students to be engaged within their group and therefore, discourage students from moving forward without their group member. If a group is ready to move on before the timeline states, encourage the group to get a head start on the next task at hand.

In order to summarize the Build-a-Toy activity, the teacher should plan to recap on the strengths and feedback from the self-assessments. The teacher should focus on how groups overcame difficult tasks and which problem-solving techniques to carry forward. The teacher should also reflect on the content knowledge that was reviewed and applied. Lastly, students could be given the opportunity to present their work.

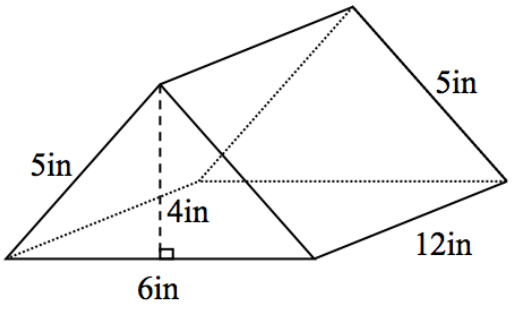
Assessment List and Benchmarks

Groups will complete the Build-a-Toy activity packet according to the two-block/four-period timeline set forth. Unlike that of the partner work, students will individually complete a self-assessment at the end of the two-day activity. The teacher will use the same rubric to assess each student and will give extra points for creativity, quality work, and exemplary partner participation.

Warm-up Exercises

<u>Instructions</u>: Find the Volume (V) and Surface Area (SA) for each figure below. Round your answers to the nearest hundredth if necessary. Use 3.14 for π. *Make sure all answers are properly labeled.*

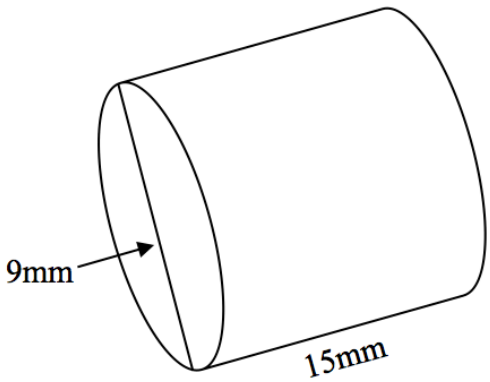
1.)



V = _____

SA = _____

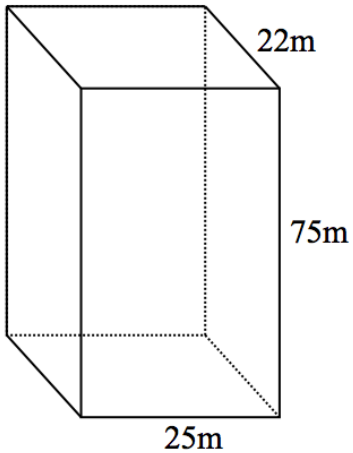
2.)



V = _____

SA = _____

3.)



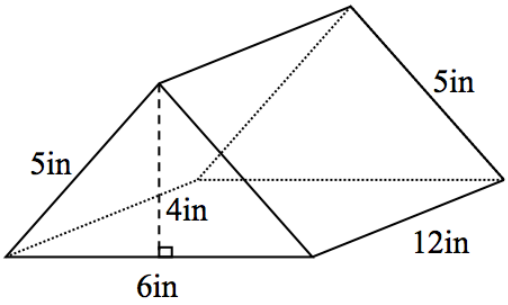
V = _____

SA = _____

Warm-up Solutions

<u>Instructions</u>: Find the Volume (V) and Surface Area (SA) for each figure below. Round your answers to the nearest hundredth if necessary. Use 3.14 for π. *Make sure all answers are properly labeled.*

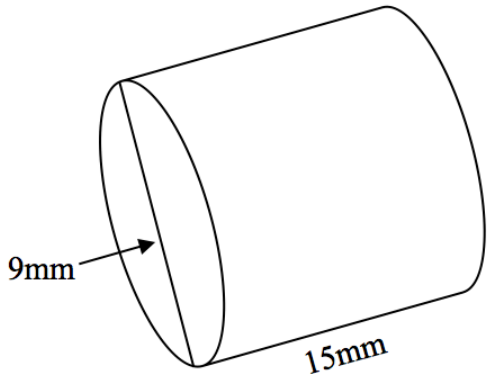
1.)



$V = 144in^3$

$SA = 216in^2$

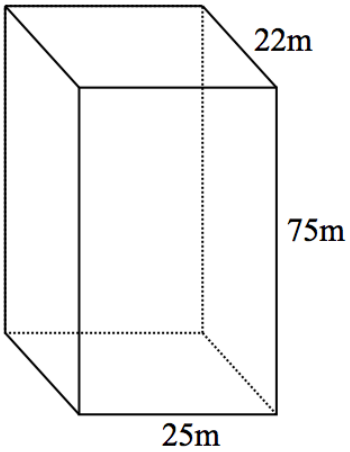
2.)



$V = 953.78mm^3$

$SA = 551.07mm^2$

3.)



$V = 41{,}250m^3$

$SA = 8{,}150m^2$

Build-a-Toy

Challenge:

You and an assigned partner are being tasked with building a new, three-dimensional toy. In phase 1, you will be challenged to design and plan the materials involved in building your toy. In phase 2, you will make a plan to decorate, create, and ship your toy to consumers.

PHASE 1: Design & Draw

Complete all parts of phase 1 described below. Be sure to include details in your calculations. You will have ***90 minutes*** to complete phase 1.

I. DRAWINGS

You and your partner are going to begin by brainstorming the design for your toy. This toy must be created using at least four different right solids: prism (describe the bases), pyramid (describe the base), cylinder, cone, and/or sphere. You must then create 5 drawings on graph paper: 1 for each solid as an independent unit with dimensions (must be three-dimensional) and 1 for the toy as a whole with dimensions (isometric or side view). Items must be drawn to scale with inches as your units. Describe each solid in your drawings below.

- The name of our toy in drawing 1 is _____.
- Solid A in drawing 2 is a _____.
- Solid B in drawing 3 is a _____.
- Solid C in drawing 4 is a _____.
- Solid D in drawing 5 is a _____.

II. MATERIALS

The next step is to decide what materials you and your partner will use to build your toy. For instance, will it be stuffed or will it be solid? Each item must be chosen from the "Materials List" included at the end of this packet. If there is a material not included on the list that you would like to use, you may research it and add it to the list. You will be required to provide the item description, unit dimensions, unit price, store location, and your source.

a) What is each solid going to be made out of or stuffed with?

- Solid A, will be made out of/stuffed with _____.
- Solid B, will be made out of/stuffed with _____.
- Solid C, will be made out of/stuffed with _____.
- Solid D, will be made out of/stuffed with _____.
- Any remaining solids will be made out of/stuffed with _____.

b) How much of each material will you need to create your solids? The dimensions in your drawings will determine your calculations.

Solid A Calculation:	**Solid B Calculation:**
Solid C Calculation:	**Solid D Calculation:**
Any Remaining Solids:	

c) What is the total amount of material(s) necessary to build your toy?

Total Material(s) Calculation:

PHASE 2: Decorate & Create

Complete all parts of phase 2 described below. Be sure to include details in your calculations. You will have ***90 minutes*** to complete phase 2.

III. DECORATIONS

Your next task is to dress up your toy to make it attractive to consumers. Each exposed surface of your toy must be either painted or covered with a material chosen from the "Materials List" included at the end of this packet. If there is a material not included on the list that you would like to use, you may research it and add it to the list. You will be required to provide the item description, unit dimensions, unit price, store location, and your source.

a) What materials will you use?

- Solid A will be decorated with _____ .
- Solid B will be decorated with _____ .
- Solid C will be decorated with _____ .
- Solid D will be decorated with_____ .
- Any remaining solid will be decorated with _____ .

b) How much of each material will you need to decorate your solids? *Remember, all surfaces may not be exposed*. This is important to your calculations.

Solid A Calculation:	**Solid B Calculation:**
Solid C Calculation:	**Solid D Calculation:**

Any Remaining Solids:

c) What is the total amount of material(s) necessary to decorate your toy?

Total Material(s) Calculation:

IV. TOY COST

Now it is time to determine how much it will cost to make your toy. Considering your materials, provide a total cost calculation below.

Total Cost Calculation:

V. SHIPPING COST

In order to make a profit on the sale of your toy, you must consider the cost to ship your toy to consumers.

a) Visit the "Materials List" again. Which box option will you need to ship your toy? *Justify your answer*.

b) If you were mass-producing this toy, would you adjust any initial dimensions based on the various box options? *Explain why or why not.*

VI. SALES PRICE

The last task is to decide on a sales price for your toy and *justify it*.

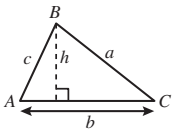
Materials List

Item Description	Unit Dimensions	Unit Price	Source (e.g. URL)
Block of Wood	4” x 4” x 8”	$10.98	
Block of Styrofoam	8” x 8” x 8”	$10.99	
Fleece Fabric (solid color)	3’ x 3’	$3.99/yard	
Fleece Fabric (with design)	3’ x 3’	$6.49/yard	
Flannel Fabric	3’ x 3’	$6.99/yard	
Faux Fur Fabric	3’ x 3’	$14.99/yard	
Polyester Fiberfill	32oz (fills 57.75in^3)	$6.49	
Spray Paint (any color)	12oz (covers up to 12ft^2)	$3.88	
Glitter	4oz (covers 0.11112in^2)	$5.99	
Box A	16” x 12” x 12”	$0.72	
Box B	16” x 18” x 18”	$1.16	
Box C	24” x 18” x 18”	$1.40	
Box D	22” x 22” x 21.5”	$2.27	
OTHER			

Again, if there is a material not included on the list that you would like to use, you may research it and add it to the list. You will be required to provide the item description, unit dimensions, unit price, store location, and your source.

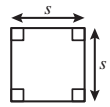
Geometry Formula Sheet
2009 *Mathematics Standards of Learning*

Geometric Formulas



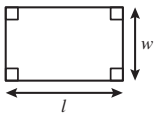
$A = \frac{1}{2}bh$

$A = \frac{1}{2}ab \sin C$



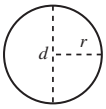
$p = 4s$

$A = s^2$



$p = 2l + 2w$

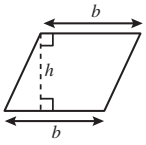
$A = lw$



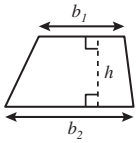
$C = 2\pi r$

$C = \pi d$

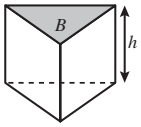
$A = \pi r^2$



$A = bh$



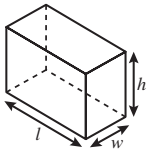
$A = \frac{1}{2}h(b_1 + b_2)$



$V = Bh$

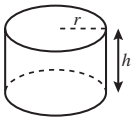
$L.A. = hp$

$S.A. = hp + 2B$



$V = lwh$

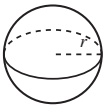
$S.A. = 2lw + 2lh + 2wh$



$V = \pi r^2 h$

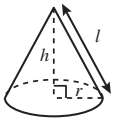
$L.A. = 2\pi rh$

$S.A. = 2\pi r^2 + 2\pi rh$



$V = \frac{4}{3}\pi r^3$

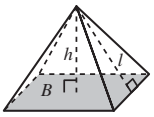
$S.A. = 4\pi r^2$



$V = \frac{1}{3}\pi r^2 h$

$L.A. = \pi rl$

$S.A. = \pi r^2 + \pi rl$



$V = \frac{1}{3}Bh$

$L.A. = \frac{1}{2}lp$

$S.A. = \frac{1}{2}lp + B$

Abbreviations

Area	*A*
Area of Base	*B*
Circumference	*C*
Lateral Area	*L.A.*
Perimeter	*p*
Surface Area	*S.A.*
Volume	*V*

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Performance Assessment Task – Geometry
Build-a-Toy Activity
Assessment Rubric

Name: _____
Date: _____

			Earned Assessment	
Num	**Element**	**Point Value**	**Self**	**Teacher**
1	A toy name is provided.	1		
2	Four different right solids are in the toy design.	2		
3	3-D figure in drawing 1 has accurate dimensions on graph paper.	2		
4	3-D figure in drawing 2 has accurate dimensions on graph paper.	2		
5	3-D figure in drawing 3 has accurate dimensions on graph paper.	2		
6	3-D figure in drawing 4 has accurate dimensions on graph paper.	2		
7	Drawing 5 is the entire toy with accurate dimensions on graph paper.	2		
8	Material described for solid 1.	1		
9	Material described for solid 2.	1		
10	Material described for solid 3.	1		
11	Material described for solid 4.	1		
12	Amount of material accurately calculated for creation of solid 1.	2		
13	Amount of material accurately calculated for creation of solid 2.	2		
14	Amount of material accurately calculated for creation of solid 3.	2		
15	Amount of material accurately calculated for creation of solid 4.	2		
16	Total amount of material accurately calculated for creation of toy.	2		
17	Phase 1 is completed on time.	1		
18	Decoration described for solid 1.	1		
19	Decoration described for solid 2.	1		
20	Decoration described for solid 3.	1		
21	Decoration described for solid 4.	1		
22	Amount of material accurately calculated for decoration of solid 1.	2		
23	Amount of material accurately calculated for decoration of solid 2.	2		
24	Amount of material accurately calculated for decoration of solid 3.	2		
25	Amount of material accurately calculated for decoration of solid 4.	2		
26	Total amount of material accurately calculated for decoration of toy.	2		
27	Total cost of creation material accurately calculated.	2		
28	Total cost of decoration material accurately calculated.	2		
29	Total cost of toy accurately calculated.	2		
30	The appropriate shipping box was chosen.	2		
31	The appropriate shipping box was accurately justified.	2		
32	Proper justification for possible adjustment to toy dimensions.	2		
33	Sales price provided.	2		
34	Sales price appropriately justified.	2		
35	Phase 2 is completed on time.	1		
36	Student actively and respectfully participated in the activity.	2		
37	All materials are neat and well organized.	2		
38	Self-assessment is completed on time.	1		
	Total	64		

Performance Assessment Task – Geometry
Build-a-Toy Activity
Rubric Category Descriptions

Name: _____
Date: _____

Num	Element	Point Value	Point Value Breakdown		
			0	**1**	**2**
1	A toy name is provided.	1	No toy name is provided	A toy name is provided	
2	Four different right solids are in the toy design.	2	No appropriate solids are in the toy design.	Less than four different solids are in the toy design.	Four different solids are in the toy design.
3	3-D figure in drawing 1 has accurate dimensions on graph paper.	2	There are no dimensions in the drawing.	Dimensions are given but not accurate.	Accurate dimensions are provided on graph paper.
4	3-D figure in drawing 2 has accurate dimensions on graph paper.	2	There are no dimensions in the drawing.	Dimensions are given but not accurate.	Accurate dimensions are provided on graph paper.
5	3-D figure in drawing 3 has accurate dimensions on graph paper.	2	There are no dimensions in the drawing.	Dimensions are given but not accurate.	Accurate dimensions are provided on graph paper.
6	3-D figure in drawing 4 has accurate dimensions on graph paper.	2	There are no dimensions in the drawing.	Dimensions are given but not accurate.	Accurate dimensions are provided on graph paper.
7	Drawing 5 is the entire toy with accurate dimensions on graph paper.	2	There are no dimensions in the drawing.	Dimensions are given but not accurate.	Accurate dimensions are provided on graph paper.
8	Material described for solid 1.	1	No material is described for the solid.	Material is described for the solid.	
9	Material described for solid 2.	1	No material is described for the solid.	Material is described for the solid.	
10	Material described for solid 3.	1	No material is described for the solid.	Material is described for the solid.	
11	Material described for solid 4.	1	No material is described for the solid.	Material is described for the solid.	
12	Amount of material accurately calculated for creation of solid 1.	2	No details of calculation are provided.	Calculation is provided but not accurate.	Accurate calculation is provided.
13	Amount of material accurately calculated for creation of solid 2.	2	No details of calculation are provided.	Calculation is provided but not accurate.	Accurate calculation is provided.
14	Amount of material accurately calculated for creation of solid 3.	2	No details of calculation are provided.	Calculation is provided but not accurate.	Accurate calculation is provided.
15	Amount of material accurately	2	No details of	Calculation is	Accurate

	calculated for creation of solid 4.		calculation are provided.	provided but not accurate.	calculation is provided.
16	Total amount of material accurately calculated for creation of toy.	2	No details of calculation are provided.	Calculation is provided but not accurate.	Accurate calculation is provided.
17	Phase 1 is completed on time.	1	Phase 1 is not completed on time.	Phase 1 is completed on time.	
18	Decoration described for solid 1.	1	Decoration not described for the solid.	Decoration is described for the solid.	
19	Decoration described for solid 2.	1	Decoration not described for the solid.	Decoration is described for the solid.	
20	Decoration described for solid 3.	1	Decoration not described for the solid.	Decoration is described for the solid.	
21	Decoration described for solid 4.	1	Decoration not described for the solid.	Decoration is described for the solid.	
22	Amount of material accurately calculated for decoration of solid 1.	2	No details of calculation are provided.	Calculation is provided but not accurate.	Accurate calculation is provided.
23	Amount of material accurately calculated for decoration of solid 2.	2	No details of calculation are provided.	Calculation is provided but not accurate.	Accurate calculation is provided.
24	Amount of material accurately calculated for decoration of solid 3.	2	No details of calculation are provided.	Calculation is provided but not accurate.	Accurate calculation is provided.
25	Amount of material accurately calculated for decoration of solid 4.	2	No details of calculation are provided.	Calculation is provided but not accurate.	Accurate calculation is provided.
26	Total amount of material accurately calculated for decoration of toy.	2	No details of calculation are provided.	Calculation is provided but not accurate.	Accurate calculation is provided.
27	Total cost of creation material accurately calculated.	2	No details of calculation are provided.	Calculation is provided but not accurate.	Accurate calculation is provided.
28	Total cost of decoration material accurately calculated.	2	No details of calculation are provided.	Calculation is provided but not accurate.	Accurate calculation is provided.
29	Total cost of toy accurately calculated.	2	No details of calculation are provided.	Calculation is provided but not accurate.	Accurate calculation is provided.
30	The appropriate shipping box was chosen.	2	No shipping box was chosen.	The wrong shipping box was chosen.	The appropriate shipping box was chosen.
31	The appropriate shipping box was accurately justified.	2	The shipping box was not justified.	The shipping box was justified, but inaccurately.	The appropriate shipping box was accurately justified.
32	Proper justification for possible adjustment to toy dimensions.	2	No justification was provided.	An inaccurate justification was provided.	A proper justification was provided.
33	Sales price provided.	2	No sales price was provided.	An inaccurate sales price was provided.	An accurate sales price was provided.

34	Sales price appropriately justified.	2	No justification provided for the sales price.	An inaccurate justification was provided for the sales price.	An accurate justification was provided for the sales price.
35	Phase 2 is completed on time.	1	Phase 2 is not completed on time.	Phase 2 is completed on time.	
36	Student actively and respectfully participated in the activity.	2	Student did not actively or respectfully participate in the activity.	Student somewhat participated in the activity.	Student actively and respectfully participated in the activity.
37	All materials are neat and well organized.	2	Materials are not neat and well organized.	Materials are somewhat neat and well organized.	Materials are neat and well organized.
38	Self-assessment is completed on time.	1	Self-assessment is not completed on time.	Self-assessment is completed on time.	

Build-a-Toy

Benchmark

Challenge:

You and an assigned partner are being tasked with building a new, three-dimensional toy. In phase 1, you will be challenged to design and plan the materials involved in building your toy. In phase 2, you will make a plan to decorate, create, and ship your toy to consumers.

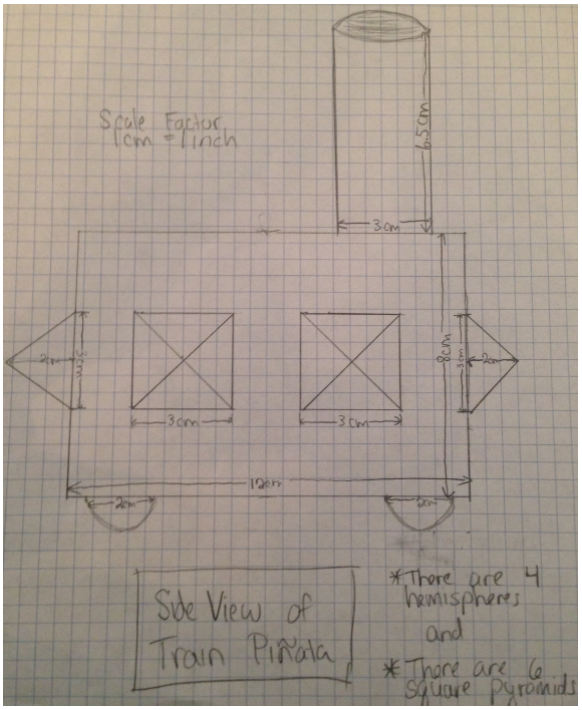
PHASE 1: Design & Draw

Complete all parts of phase 1 described below. Be sure to include details in your calculations. You will have ***90 minutes*** to complete phase 1.

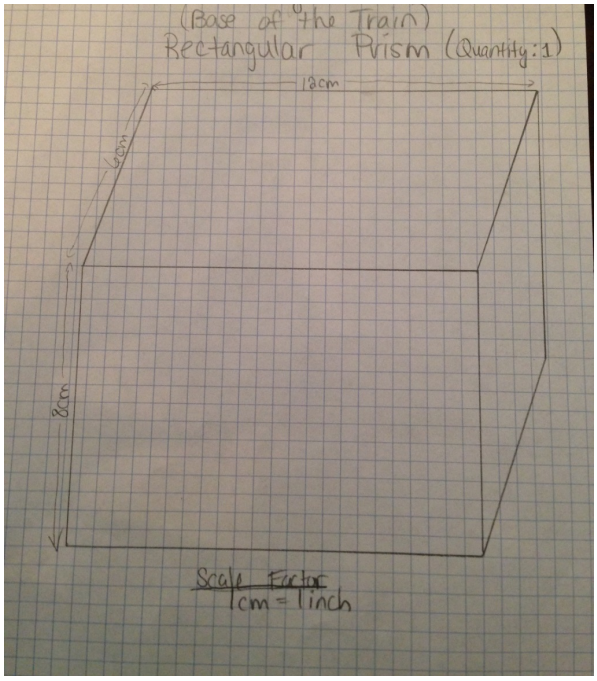
I. DRAWINGS

You and your partner are going to begin by brainstorming the design for your toy. This toy must be created using at least four different right solids: prism (describe the bases), pyramid (describe the base), cylinder, cone, and/or sphere. You must then create 5 drawings on graph paper: 1 for each solid as an independent unit with dimensions (must be three-dimensional) and 1 for the toy as a whole with dimensions (isometric or side view). Items must be drawn to scale with inches as your units. Describe each solid in your drawings below.

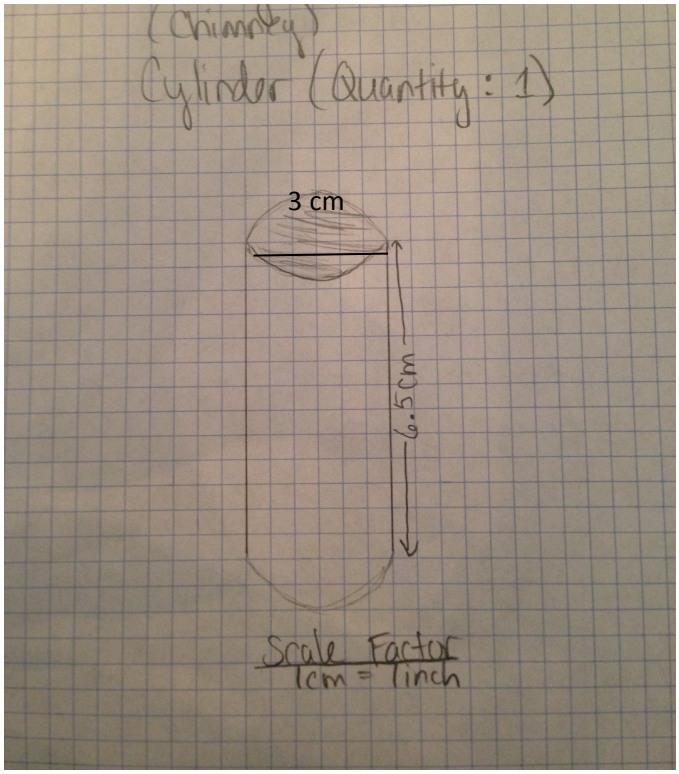
Drawing 1: The name of our toy is Train Piñata.



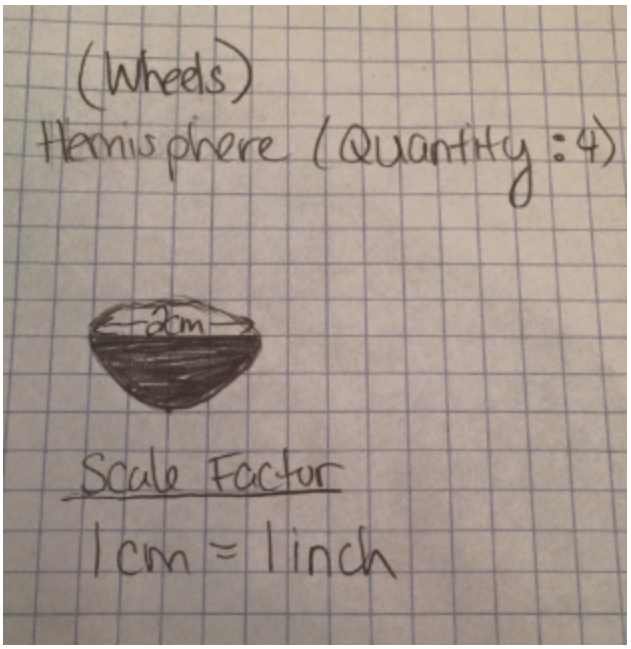
Drawing 2: Figure A is a rectangular prism



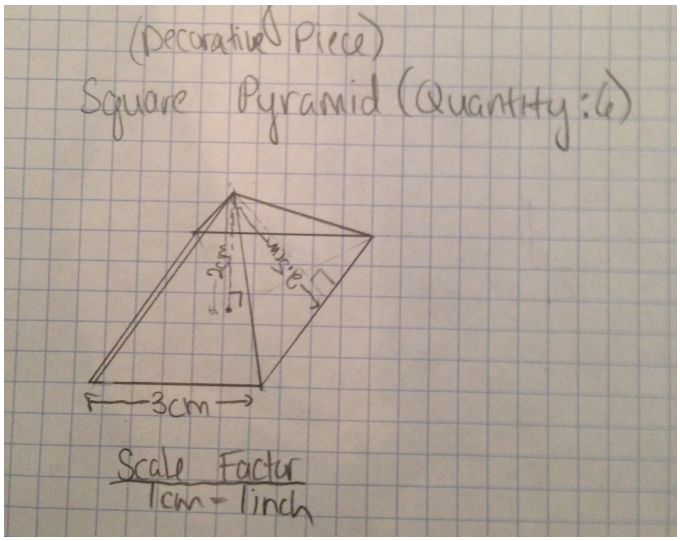
Drawing 3: Figure B is a cylinder.



Drawing 4: Figure C is a hemisphere.



Drawing 5: Figure D is a square pyramid.



II. MATERIALS

The next step is to decide what materials you and your partner will use to build your toy. For instance, will it be stuffed or will it be solid? Each item must be chosen from the "Materials List" included at the end of this packet. If there is a material not included on the list that you would like to use, you may research it and add it to the list. You will be required to provide the item description, unit dimensions, unit price, store location, and your source.

a) What is each solid going to be made out of or stuffed with?

- Solid A, the rectangular prism, will be stuffed with piñata candy and toy assortment (addition to the materials list).
- Solid B, the cylinder, will be stuffed with Pixie Stix (addition to the materials list).
- Solid C, the hemispheres, will be made out of Styrofoam.
- Solid D, the square pyramids, will be made out of Styrofoam.
- There are no remaining solids.

b) How much of each material will you need to create your solids? The dimensions in your drawings will determine your calculations.

(3.14 was used for π and all calculations were rounded to the nearest hundredth)

Solid A Calculation:	**Solid B Calculation:**
$V = lwh$ $V = 6 \bullet 8 \bullet 12$ $V = 576in^3$ Assume each candy is no larger than 1.5" x 1.5" x 1.5". The volume of 1 candy is: $V = lwh$ $V = 1.5 \bullet 1.5 \bullet 1.5$ $V = 3.38in^3$ Since 1 bag contains 100 pieces. The volume of one bag will fill 338in^3. There is enough space within the rectangular prism to hold approximately 1.7 bags of candy and toys. Therefore, we would need to buy 2 bags.	$V = \pi r^2 h$ $V = 3.14 \bullet 1.5^2 \bullet 6.5$ $V = 45.92in^3$ 24 Pixie Stix per 2 oz bag 1oz = 1.80469in^3 How many Pixie Stix can fit in the cylinder? $\frac{24stix}{2oz} \bullet \frac{1oz}{1.8049in^3} \bullet \frac{45.92in^3}{cyl}$ $= 305.34stix/cyl$ 305 Pixie Sticks or 12.72 bags of Pixie Sticks can fit in the cylinder. Thus, we would need to buy 13 bags.
Solid C Calculation:	**Solid D Calculation:**
$V_{sphere} = \frac{4}{3}\pi r^3$ $V_{hemisphere} = \frac{2}{3}\pi r^3$ $V_{hemisphere} = \frac{2}{3} \bullet 3.14 \bullet 1^3$ $V = 2.09in^3$ Since there are 4 hemispheres, we will need 8.37in^3 of material.	$V = \frac{1}{3}Bh$ $V = \frac{1}{3} \bullet 9 \bullet 2$ $V = 6in^3$ Since there are 6 square pyramids, we will need 36in^3 of material.

Any Remaining Solids:
There are no remaining solids.

c) What is the total amount of material(s) necessary to build your toy?

Total Material(s) Calculation:

Solid A materials: 2 bags of Piñata Toy & Candy Assortment = $27.00
Solid B materials: 13 bags of Pixie Stix at $2.19 per bag = $28.47
Solid C + Solid D materials: $8.37in^3 + 36in^3 = 44.37in^3$
1 block of Styrofoam contains $512in^3$ (8x8x8), which is more than sufficient for solids C and D = $10.99

TOTAL = $27.00 + $28.47 + $10.99 = $66.46

PHASE 2: Decorate & Create

Complete all parts of phase 2 described below. Be sure to include details in your calculations. You will have ***90 minutes*** to complete phase 2.

III. DECORATIONS

Your next task is to dress up your toy to make it attractive to consumers. Each exposed surface of your toy must be either painted or covered with a material chosen from the "Materials List" included at the end of this packet. If there is a material not included on the list that you would like to use, you may research it and add it to the list. You will be required to provide the item description, unit dimensions, unit price, store location, and your source.

a) What materials will you use?

- Solid A will be decorated with red spray paint
- Solid B will be decorated with black spray paint.
- Solid C will be decorated with black spray paint.
- Solid D will be decorated with blue spray paint.
- Solids A and B will need to be built using boxes to house the filling.

We are using spray paint, a cheap material, to drive the cost down.

b) How much of each material will you need to decorate your solids? *Remember, all surfaces may not be exposed*. This is important to your calculations.

(3.14 was used for π and all calculations were rounded to the nearest hundredth)

<table>
<tr>
<td>Solid A Calculation:

$SA = 2lw + 2lh + 2wh$
$SA = 2 \bullet 8 \bullet 6 + 2 \bullet 8 \bullet 12 + 2 \bullet 6 \bullet 12$
$SA = 432in^2$

The rectangular prism is covered by other shapes, so we must subtract:

the 4 circles from the hemispheres,
$4 \bullet 3.14 \bullet 1^2 = 12.56$

the 6 squares from the square pyramids,
$6 \bullet 9 = 54$

and the circle from the cylinder.
$3.14 \bullet 1.5^2 = 7.065$

$SA = 432 - 12.56 - 54 - 7.065$
$SA = 358.38in^2$</td>
<td>Solid B Calculation:

$SA = 2\pi r^2 + 2\pi rh$
$SA = 2 \bullet 3.14 \bullet 1.5^2 + 2 \bullet 3.14 \bullet 1.5 \bullet 6.5$
$SA = 75.36in^2$

One circle of the cylinder is not exposed, so we must subtract:
$3.14 \bullet 1.5^2 = 7.065$
$SA = 75.36 - 7.065$
$SA = 68.30in^2$</td>
</tr>
<tr>
<td>Solid C Calculation:

$SA_{sphere} = 4\pi r^2$
$SA_{hemisphere} = 2\pi r^2$

The flat circles of the hemispheres are not exposed, so those surfaces do not need to be added into the calculations.
$SA_{hemisphere} = 2\pi r^2$
$SA_{hemisphere} = 2 \bullet 3.14 \bullet 1^2$
$SA_{hemisphere} = 6.28$

Since there are 4 hemispheres:
$SA = 25.12in^2$</td>
<td>Solid D Calculation:

The bases of the square pyramids are not exposed, so the lateral surface area formula is used.
$LA = \frac{1}{2}lp$
$LA = \frac{1}{2} \bullet 2.5 \bullet 12$
$LA = 15in^2$

Since there are 6 square pyramids:
$SA = 90in^2$</td>
</tr>
<tr>
<td colspan="2">Any Remaining Solids:
There are no remaining solids.</td>
</tr>
</table>

c) What is the total amount of material(s) necessary to decorate your toy?

Total Material(s) Calculation:

Cardboard to enclose the Rectangular Prism and Cylinder:

Cardboard for Solid A ($SA_{whole} = 432in^2$) + Solid B ($SA_{whole} = 75.36in^2$) = $507.36in^2$

Price of Recycled Cardboard= $0.00

Spray Paint for all Solids:

Since 1 can of spray paint covers up to 12ft^2, it can cover up to 1,728in^2.

Solid A ($SA = 358.38in^2$), 1 can of red spray paint = $3.88

Solid B ($SA = 68.30in^2$) + Solid C ($SA = 25.12in^2$) = 93.42in^2, 1 can of black spray paint = $3.88

Solid D ($SA = 90in^2$), 1 can of blue spray paint = $3.88

TOTAL = $0.00 + $3.88 + $3.88 + $3.88 = $11.64

IV. TOY COST

Now it is time to determine how much it will cost to make your toy. Considering your materials, provide a total cost calculation below.

Total Cost Calculation:

TOTAL MATERIALS = Filler Materials + Surface Materials

TOTAL MATERIALS = $66.46 + $11.64

TOTAL COST TO CREATE TOY = $78.10

V. SHIPPING COST

In order to make a profit on the sale of your toy, you must consider the cost to ship your toy to consumers.

a) Visit the "Materials List" again. Which box option will you need to ship your toy? *Justify your answer*.

Since the dimensions of the toy are 10" x 15.5" x 16", the toy will fit in Box B. This will add $1.16 to the cost of our toy, making it $79.26.

b) If you were mass-producing this toy, would you adjust any initial dimensions based on the various box options? *Explain why or why not.*

In order to reduce the shipping costs, we would need to scale down the toy to fit into Box A which is 16" x 12" x 12". This would save $0.44 per box. The easiest solution would be to adjust the rectangular prism's height and width. This, however, would have an effect on the other shapes, as they may not fit on the new surface.

For example, the current length of the train is 12 inches. Each square pyramid is 3 inches, which allows there to be a 2-inch gap on either side of the square pyramid and between the two square pyramids. By reducing the length of the prism to 8.5 inches, this only allows 2.5 inches total to be split between the 3 gaps. Ultimately, the size of the square pyramids would also need to be smaller.

VI. SALES PRICE

The last task is to decide on a sales price for your toy and *justify it*.

The current price to produce this toy, including a box, is $79.26. Assume a well-trained person could make the toy in thirty minutes with the help of state-of-the art manufacturing equipment. Also, assume that the worker is paid $10.00 per hour. This would make the new price of the toy $84.26. Desiring a profit margin of 50% would require we sell the toy for $126.39.

Knowing this is an unrealistic price for a piñata, we would need to complete some drastic changes to our design and research better costs of materials (e.g. buying in bulk) to drive down the price. We would also need to consider left over material and waste when creating our piñata.

Materials List

Item Description	Unit Dimensions	Unit Price	Source (e.g. URL)
Block of Wood	4” x 4” x 8”	$10.98	
Block of Styrofoam	8” x 8” x 8”	$10.99	
Fleece Fabric (solid color)	3’ x 3’	$3.99/yard	
Fleece Fabric (with design)	3’ x 3’	$6.49/yard	
Flannel Fabric	3’ x 3’	$6.99/yard	
Faux Fur Fabric	3’ x 3’	$14.99/yard	
Polyester Fiberfill	32oz (fills 57.75in^3)	$6.49	
Spray Paint (any color)	12oz (covers up to 12ft^2)	$3.88	
Glitter	4oz (covers 0.11112in^2)	$5.99	
Box A	16” x 12” x 12”	$0.72	
Box B	16” x 18” x 18”	$1.16	
Box C	24” x 18” x 18”	$1.40	
Box D	22” x 22” x 21.5”	$2.27	
OTHER			
Pixie Stix	24 Pixie Stix (2oz bag)	$2.19 From Old Time Candy	http://www.oldtimecandy.com/walk-the-candy-aisle/pixy-stix/pixy-stix-bag
Pinata Toy and Candy Assortment	100 pieces	$13.50 From Oriental Trading	http://www.orientaltrading.com/web/browse/processProductsCatalog?Nrpp=10000&sku=5%2F1581&BP=PS490&ms=search&source=google&cm_mmc=Google-_-242030648-_-20452888088-_-Pi%F1ata+Toy+%26+Candy+Assortm

			ent&cm_mmca1=OTC%2BPLAs&cm_mmca2=GooglePLAs&cm_mmca3=PS490&cm_mmca4=FS39&cm_mmca5=Shopping&cm_mmca6=PLAs&cm_mmc10=Shopping&cm_mmca11=5%2F1581&cm_mmca12=Pi%F1ata+Toy+%26+Candy+Assortment&gclid=CP_MrKe77swCFYsehgodxcEDhw&categoryId=377320&Nrpp=10000

Again, if there is a material not included on the list that you would like to use, you may research it and add it to the list. You will be required to provide the item description, unit dimensions, unit price, store location, and your source.