**Building a Robot**

Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period \_\_\_\_\_\_\_\_\_

**Task 1:** For each of the nets (2-dimensional representations of 3-Dimensional solids), do the followings:

1- Cut out the net and fold it into a 3-Dimensional solid (but do NOT tape it)- draw a sketch of the net and of the solid in the table below. Record the length of the base, height and depth in the table.

2- Determine and record the Surface Area (number of squares it takes to *cover* the solid), by counting squares.

3- Determine and record the Volume (number of cubes it takes to *fill* the object), by filling the solid with cubes.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Number** | **Net** | **3-D Solid** | **Base** | **Height** | **Depth** | **Volume** | **Surface Area** |
| 1. |  |  |  |  |  |  |  |
| 2. |  |  |  |  |  |  |  |
| 3. |  |  |  |  |  |  |  |
| 4. |  |  |  |  |  |  |  |
| 5. |  |  |  |  |  |  |  |

**Task 2:** Volume of a Rectangular Prism

a- How could you determine the Volume of a rectangular prism with dimensions of 5cm, by 4 cm by 6 cm only using *some* cubes? Use the net provided and some CM cubes to test out your idea and be prepared to share with the class.

My idea for finding volume using only *some* cubes:

b- Test out your idea with the rectangular prisms you found the volume for in the previous day’s lesson. Show your math below:

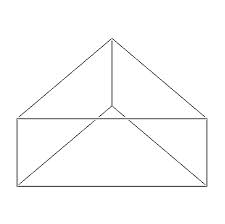
Prism #1:

Prism #2:

Prism #3:

**Conclusion:**

**Formula for finding the volume of a rectangular prism:**

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**Task 3:** Triangular Prism Volume

a-Do you predict your formula will work to find the volume of a triangular prism? Why or why not?

b-Recall from the “Where did that formula come from” the relationship between the area of a triangle and the area of a rectangle with the same base and height. What was that relationship? What is the formula for the area of a triangle?

c- What would the formula for a rectangular prism look like for a triangular prism where the triangular face having a base of 4cm and height of 5 cm and the prism having a height of 6 cm? Calculate the volume using this formula and then we’ll test it out.

Math for predicted volume of the triangular prism:

d. Use play-doh to build a rectangular prism that is 4cm by 5 cm by 6 cm. Use your formula from Task 2 to calculate the volume of this rectangular prism. Show the math below:

Volume of rectangular prism:

e. Use dental floss or a plastic knife to cut the rectangular prism in half diagonally. What are the names of the 2 solids that result from this cut? Do those two solids have equal volumes? Why or why not?

f. Using the volume of the whole rectangular prism from part d, what would the volume of *each* triangular prism be?

g. How does the volume you found in part f compare to the predicted volume you found in part c? Did your predicted formula work?

**Conclusion**

**Formula for finding the volume of a prism:**

**Task 4: Adding more solids for your Robot**

For each of the nets (2-dimensional representations of 3-Dimensional solids), do the followings:

1- Cut out the net and fold it into a 3-Dimensional solid (but do NOT tape it)- draw a sketch of the net and of the solid in the table below. Record the length of the base, height and depth in the table.

2- Determine and record the Surface Area (number of squares it takes to *cover* the solid), by counting squares.

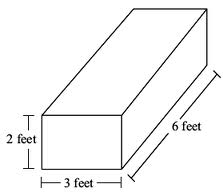
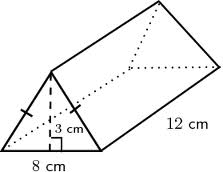
3- Determine and record the Volume (number of cubes it takes to *fill* the object), by USING your formula.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Number** | **Net** | **3-D Solid** | **Base** | **Height** | **Depth** | **Volume** | **Surface Area** |
| 1. |  |  |  |  |  |  |  |
| 2. |  |  |  |  |  |  |  |

**Task 5: Surface Area**

a- How can you find the surface area of a rectangular or triangular prism *without* counting the squares from the net? Write your ideas below.

b- Test out your idea. Show your math to find the surface area of the following two solids.

1. 2.

**Task 6: Building more Robot Pieces, given some information.**

Each row of the table below has enough information for you to be able to fill in all other missing parts. Use your cm cubes, cm grid paper and math reasoning to figure out a solid that has these properties and then fill in the remaining entries in that row. Make sure to also make a net for each row, as you will need these parts for your robot on the final day.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Number** | **Net** | **3-D Solid** | **Base** | **Height** | **Depth** | **Volume** | **Surface Area** |
| 1. |  |  | 5 cm | 1 cm |  | 5cm3 |  |
| 2. |  |  |  | 3 cm | 2 cm |  | 52cm2 |
| 3. |  |  | 4 cm |  | 4 cm | 64cm3 |  |
| 4. |  |  |  |  |  | 8cm3 | 24cm2 |

**Building Your Robot!!!**

**Background:**

You and a partner will be building a robot to enter into the competition. Follow the guidelines below.

**Guidelines:**

1. Your robot must use at least 6 prisms.

2. Your robot must use at least 1 triangular prism.

3. The total volume for your robot must be between 300 and 900 cm3.

4. You must display your robot on a paper that contains the following information: Robot Name, Student Name(s), Total Volume of Robot, Contest Robot is entering, Description of why robot should win this contest.

**Notes:**

* If you color your robot pieces when they are nets (flat) it will be much easier!
* Decide on the contest you are entering before building the robot.
* Take your time in writing up great reasons why your robot should win!
* You may create additional nets for any prisms you would like to use in the robot.

**Contest Options:**

* Best Dressed
* Most Athletic
* Most Likely to Succeed
* Most Creative

**Teacher Directions**

**Materials:**

CM cubes (approximately 50 per student)

Scissors (1 per student)

Colored Pencils (1 pack per pair or 4)

Scotch Tape (1 per pair or 4)

Rulers (1 per student)

Play-doh (1 container per 2-4 students)

Dental Floss or Plastic Knife (1 per student)

Construction Paper (1 per pair)

CM grid paper without nets drawn for Days 3-4 (2 sheets per student)

**Overview:**

**Day 1- Task 1**

**Day 2- Tasks 2-4**

**Days 3-4- Tasks 5-6**

**Day 5: Building the Robot**

**Task 1: Reviewing Concept of Volume and Surface Area (DAY 1)**

Begin this week by letting the students know they will be working in pairs to build paper robots to enter a contest. During the next 4 days, they will be learning about how to create and measure the parts they will use. MAKE SURE STUDENTS (or you) SAVE ALL THE NETS THIS WEEK).

Display net #1 (1 x 1 x 1). Ask the students what we call this (see if they can recall the term “net” from grade 6). If they do not know, tell them it is called a net as it is the 2-dimensional representation of a 3-dimensional solid. Give the students 15 seconds to predict what 3-Dimensional solid the net will make when folded, followed by 15 seconds to tell a neighbor and then choose a few students to state their prediction aloud.

Pass out the first grid page of nets, page 1 of the activity page and scissors to each student. Have students cut out the 1 x 1 x 1 net. Walk them through completing the first row of the table together. To do this, first draw a sketch of the net and then fold your prism. Place it on a document camera and ask students to identify the base, height and depth and record these in the table. Then ask the students what “surface area” is. Give them 30 seconds to think silently and then have some volunteers share ideas. If no one knows, we define surface area as the number of square units it takes to cover an object. Guide the students to recognize that the shape was drawn on “squares”, so they can just count. Record the surface area of 6 cm squares in the first row of the table. Ask students why we write it as cm2 . Help them connect the exponent to the fact that you counted “squares”. Repeat this process for defining volume, with the goal of defining volume as the number of cubic units it takes to fill an object. Again, discuss the fact that the units are cubic and the relation to the filling with “cubes”. Pass out CM cubes to each student and have them “fill” this prism. Agree that the volume is 1 cubic centimeter and record this in the table.

Once students understand the steps for each net, let them work at their own pace to complete the table for the remaining nets. Note: there are 5 total nets and not all students will finish all 5, which is OK! Also, net #5 would need 125 cm cubes to fill; theoretically, a student could fill it, but allow students to struggle and try to come up with an idea of how to determine volume (knowing that this idea will be explored in details in the next lesson).

**Task 2: Formula for Volume (Day 2)**

Pass out the 4 x 5 x 6 net to the students along with scissors and CM cubes. Have the students cut out the net and then ask them if they have enough cubes or time to find the volume. Explain their challenge: determine the volume using only some cubes (note students should not just use l x w x h). Give students about 5 minutes, having them record their ideas. For those who finish early, have them “test out” their idea by applying it to 3 of the prisms from table 1.

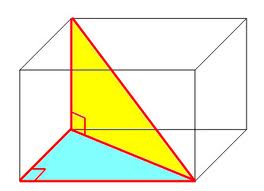
Have students share methods with the class. Praise all correct answers, but conclude with the idea that you can fill 1 row (find the area of the base) and multiply that by the height. Have the students write this as a formula: , where *B* represents the *area* of the base.

**Task 3: Formula for Volume of Triangular Prism (Day 2)**

Now direct the students to consider triangular prisms (new content for grade 7!). Have students silently work on question “a”.

Take a class vote as to if the formula will work for triangular prisms. Give students 1 minutes to complete question b and call on students to share that the area of triangles are half the area of the rectangle with the same base and height.

Now guide students through past c- using the formula  to calculate the predicted volume. Make sure they recall that *B* represents the area of the base (triangle). Explain that we are not yet sure if this formula will work, so we will now test that out, using a rectangular prism with the same base and height.

Pass out rulers, play-doh and dental floss or plastic knives to each student. Instruct students to build a rectangular prism that is 4cm x 5 cm x 6 cm. Have students use the formula  to calculate the volume of this rectangular prism. Now instruct the students to cut the prism in half along a diagonal line across the base. See picture below.

Ask students what two shapes have resulted from this cut and what the dimensions are. Guide students to see that they know have two congruent triangular prisms with the dimensions from part c. Direct the students to complete part f, taking the calculated volume for the rectangular prism and dividing it in half. Conclude that the formula  does work for BOTH rectangular and triangular prisms.

**Task 4: Nets, Surface Area and Volume of Triangular Prism**

Similar to work on day 1, pass out the triangular prism nets and scissors to each student. Have the students cut out both nets and complete the table, using their newly discovered formula to calculate the volume (but still counting the squares to find surface area).

**Task 5: Surface Area (Day 3)**

Give the students a few minutes to consider how they can determine surface area of a prism without counting every square. Then allow the students a few minutes to discuss ideas with a partner, followed by having students present ideas. The goal of this is not to end up with a “formula” but the concept that students can find the area of each face and add those areas.

After the discussion, have students practice on the two solids.

**Task 6: Missing Information (Days 3 & 4)**

Each student will need 2 sheets of CM grid paper (without any nets), CM cubes, and scissors. Explain the task to the students and let them work (and struggle) to figure out the missing parts. Make sure they make a net for each row. Encourage struggling students to use the CM cubes to “build” the prisms and then use CM grid paper to “wrap” the prism to figure out how to make a net. Note that there may be more than 1 solid that will satisfy the given information, such as #3, which could be a rectangular prism (cube) with dimensions of 4 x 4 x 4 or it could be a triangular prism with dimensions of 4 x 8 x 4.

**Final Task: Building Your Robot**

Go over the guidelines and notes with the students. Make sure they understand the categories in which they can compete. Have students pair up to create their robot. Make sure students do all their coloring BEFORE they do any taping.

Students will need colored pencils, tape, and a sheet of construction paper for this task.

The final product should include a robot made from nets, the total volume of the robot and a paragraph describing which category the robot it competing in and why they should win.

It will be up to you to decide how to hold the competition. You can make it just within your class or for all of your classes. Choose some method to have students vote or you can just decide. Regardless of the method, make this fun and give awards to winning robots!