

Part A: Volume of a Prism

What happens to the volume of a prism when its height is doubled?

About the Code: Different computer languages might use different keyboard characters for math calculations, but all languages follow the order of operations (BEDMAS) in their calculations. In Python, one asterisk (*) is used for multiplication.

1. Copy this exact code into a Python console, such as [Google Colab](https://colab.research.google.com/) or <https://cscircles.cemc.uwaterloo.ca/console/> to calculate the volume of a rectangular based prism as its height doubles each time.

```
length = 5
width = 5
height = 10

print ("Height  Prism Volume")

for i in range (0,10):
    baseArea = length * width
    prismVolume = round(baseArea * height)
    print (height, "\t", prismVolume)
    height = height * 2
```

About the Code:

- The values for the length and width both start at 5, and the value for height starts at 10.
- The title for each column of data that will be output are: **Height, Prism Volume.**
- A “for” loop is used to repeat the indented code below it 10 times.

Select *Run* to execute the code.

- a) What does the output look like?

<u>Height</u>	<u>Prism Volume</u>
10	250
20	500
40	1000
80	2000
160	4000
320	8000
640	16000
1280	32000
2560	64000
5120	128000

- b) What happens to the volume of a prism each time the height is doubled?

**Each time the height doubles,
the volume of the prism doubles in value.**

Part B: Volume of a Pyramid

What happens to the volume of a pyramid as its height is doubled?

Let's alter the code from Part A so that it displays the volume of a pyramid with the same base and starting height as the prism.

Recall that the volume of a pyramid is $\frac{1}{3}$ the volume of a prism with the same base and height. So, you just need to divide the volume from Part A by 3.

2. Alter the code for the prism in Part A as shown below.

```
length = 5
width = 5
height = 10

print ("Height  Pyramid Volume")

for i in range (0,10):
    baseArea = length * width
    pyramidVolume = round((baseArea * height)/3)
    print (height, "\t", pyramidVolume)
    height = height * 2
```

a) What does the output look like?

<u>Height</u>	<u>Pyramid Volume</u>
10	83
20	167
40	333
80	667
160	1333
320	2667
640	5333
1280	10667
2560	21333
5120	42667

b) What happens to the volume of the pyramid each time the height is doubled?

Each time the height doubles, the volume of the pyramid doubles.

Note that since the volumes are rounded, they may appear to be slightly off, but they will be approximately twice the previous value.

Part C: Volume of a Cylinder

What happens to the volume of a cylinder as its height is doubled?

Alter the code again to determine the volume of a cylinder.

Recall that the volume of a cylinder, like the volume of a prism, is:
area of base \times height.

The area of the base of a cylinder is the area of a circle:

Area of a circle = πr^2

About the Code:

In Python, two asterisks (**) are used for an exponent.

3. Copy this exact code to calculate the volume of a cylinder as its height doubles each time.

```
radius = 5
height = 10

print ("Height  Cylinder Volume")

for i in range (0,10):
    baseArea = 3.14 * radius**2
    volumeCylinder = round(baseArea * height)
    print (height,"\t", volumeCylinder)
    height = height * 2
```

- a) What does the output look like?

<u>Height</u>	<u>Cylinder Volume</u>
10	785
20	1570
40	3140
80	6280
160	12560
320	25120
640	50240
1280	100480
2560	200960
5120	401920

- b) What happens to the volume of the cylinder each time the height is doubled?
Each time the height doubles, the volume of the cylinder doubles.

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What happens to the volume of a cylinder as its radius is doubled?

4. Alter the code in question 3 so that the radius doubles rather than the height:

```
radius = 5
height = 10

print ("Height   Cylinder Volume")

for i in range (0,10):
    baseArea = 3.14 * radius**2
    volumeCylinder = round(baseArea * height)
    print (height, "\t", volumeCylinder)
    radius = radius * 2
```

a) Before running the code, predict what will happen to the volume of the cylinder as the radius is doubled.

For example: I think the volume will increase 4 times since the area of a circle is πr^2 and the radius is doubling.

b) Execute the code. What does the output look like?

<u>Height</u>	<u>Cylinder Volume</u>
10	785
10	3140
10	12560
10	50240
10	200960
10	803840
10	3215360
10	12861440
10	51445760
10	205783040

c) What happens to the volume of the cylinder each time the radius doubles?

Why does this happen?

The volume of the cylinder is 4 times the previous value each time the radius is doubled. This is because the radius is squared in the formula for the area of the base.

Part D: Volume of a Cone

Recall that the volume of a cone is $\frac{1}{3}$ the volume of a cylinder with the same base and height.

5. Alter the code in Part C to see what happens to the volume of a cone when its radius is doubled.

```
radius = 5
height = 10

print ("Height Cone Volume")

for i in range (0,10):
    baseArea = 3.14 * radius**2
    volumeCone = round((baseArea * height)/3)
    print (height, "\t", volumeCone)
    radius = radius * 2
```

- a) What does the output look like?

<u>Height</u>	<u>Cone Volume</u>
10	262
10	1047
10	4187
10	16747
10	66987
10	267947
10	1071787
10	4287147
10	17148587
10	68594347

- b) What happens to the volume of a cone as the radius is doubled?

The volume of the cone is 4 times the previous value each time the radius is doubled. This is because the radius is squared in the formula for the area of the base.

Reflect and Connect

6. Predict what will happen to the volume of a prism or pyramid when its height is tripled.

The volume of the prism or pyramid will triple.

7. Predict what will happen to the volume of a cylinder or cone when its height is tripled.

The volume of the cylinder or cone will triple.

8. Predict what will happen to the volume of a cylinder or cone when its radius is tripled.

The volume of the cylinder or cone will be 9 times the previous value.

9. Alter the code to explore how changing dimensions affects the area or volume of other 2-D shapes and 3-D objects.

For example: The area of a triangle as its height doubles:

```
base = 5
height = 5

print ("Height  Triangle Area")

for i in range (0,10):
    area = (base * height)/2
    print (height, '\t', area)
    height = height * 2
```

The volume of a triangular prism as its height doubles:

```
base = 5
height = 5
length = 10

print ("Height  Prism Volume")

for i in range (0,10):
    baseArea = (base * height)/2
    prismVolume = baseArea * length
    print (height, '\t', prismVolume)
    height = height * 2
```