

# Algorithmic Variables

Last Modified on 05/04/2016 3:45 pm EDT

The Algorithmic Variable tool allows authors to create, edit, and insert algorithmic variables ("algos") into Smartwork5 problems in order to create dynamically generated content. In Smartwork5, an algorithmic variable is a set of values where one value from the variable is randomly selected for each view of the problem. Values are words or numbers that are written by the author of the problem. This means that when an algo is placed in a problem, each student will see a different word or number in its place. Algos therefore assist in reducing student cheating because students each receive a slightly different problem based on the values loaded for their view.

[Hide All Answers](#)

## Setting up the Algorithmic Variables

1. Open up the Algorithm Editor by checking the box next to "Algorithm Editor."

Please note that unchecking this box does not delete the Algos you created—it just hides the Algo editor from view in the Edit Question screen.



☐ Introduction



**Question Text\***



2. Determine whether you want the system to use significant figures in calculations, or decimals in calculations. **This setting affects Range and Equation variables only, and this topic is explored further in the "Creating Number Algos" section. Please note that selecting Significant Figures does not mean students will be graded on them.**

**Algorithm Editor**

☐ Use significant figures in calculations  
☒ Use decimal places in calculations  
 2 decimal places

Name	Value	Type	Subtype
No data available in table			

Configuration

Name

Is this variable a String or a Number?  
☐ String ☒ Number

Select a type  
☐ List ☐ Range ☐ Equation ☐ Constant

Is this variable DEPENDENT on others?  
☐ Yes ☒ No

3. To add an algorithm, click on the + button in the upper-right-hand corner of the editor. Once this is done, the Configuration tab will accept edits. This is where you will start defining your algo.

**Algorithm Editor**

☐ Use significant figures in calculations  
☒ Use decimal places in calculations  
 2 decimal places

Click on the + button to add an algorithmic variable; click on the - button to delete the highlighted algo

Name	Value	Type	Subtype
No data available in table			

Configuration

Name

Is this variable a String or a Number?  
☐ String ☒ Number

Select a type  
☐ List ☒ Range ☐ Equation ☐ Constant

Is this variable DEPENDENT on others?  
☐ Yes ☒ No

The Algorithm Editor allows you to create **String Algos** and **Number Algos**. Both kinds can be displayed to the student in any text area of the question, including in modules where the answer options are text-based. The system recognizes String values as text only. Number values may be used with mathematical expressions to define other algos (of the Equation type), and they may be set as the answer to a Numeric Entry module.

String and Number Algos also fall into one of four different Algo types: List types, Range types, Equation types, and Constant types. String Algos are always List Types, but Number Algos may be any of the four subtypes.

**List Types** are values that are manually listed out by the author. List Types can either be String Algos or Number Algos.

**Range Types** allow you to tell the system to generate numbers for students within a specific interval. Range Types are always Number Algos.

**Equation Types** allow you to put existing numeric algorithmic variables into an equation and manipulate them mathematically. Equation Types are always Number Algos.

**Constant Types** allow you to define constants that can be used in Equation Algos and throughout the question text/module. Constant Types are always Number Algos.

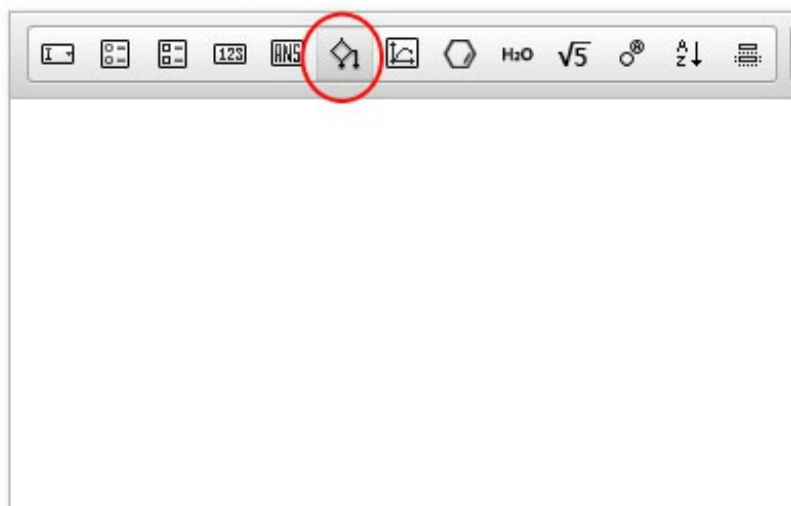
Furthermore, Algos can be independent, or in other words, stand alone, or can be dependent on other Algos.

## Inserting Algos into Questions

After you create your algos, you can insert them into the Question Text Section, the Hint, the Introduction, and the Part and Summary Solutions by doing the steps outlined below. Furthermore, after creating your algos, you should always check to see that they are working correctly by inserting them into the question text.

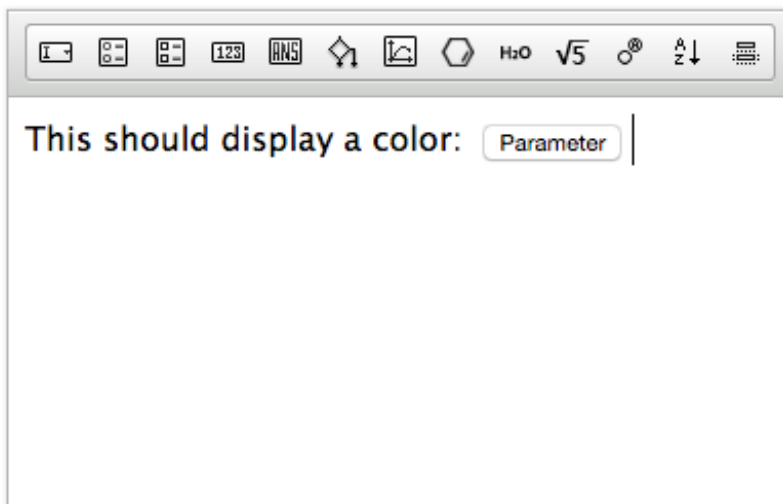
1. Insert the algo into the Question Text section, the Hint, the Introduction, or the Solution. The Algorithm button contains a picture of a diamond.

### Question Text\*



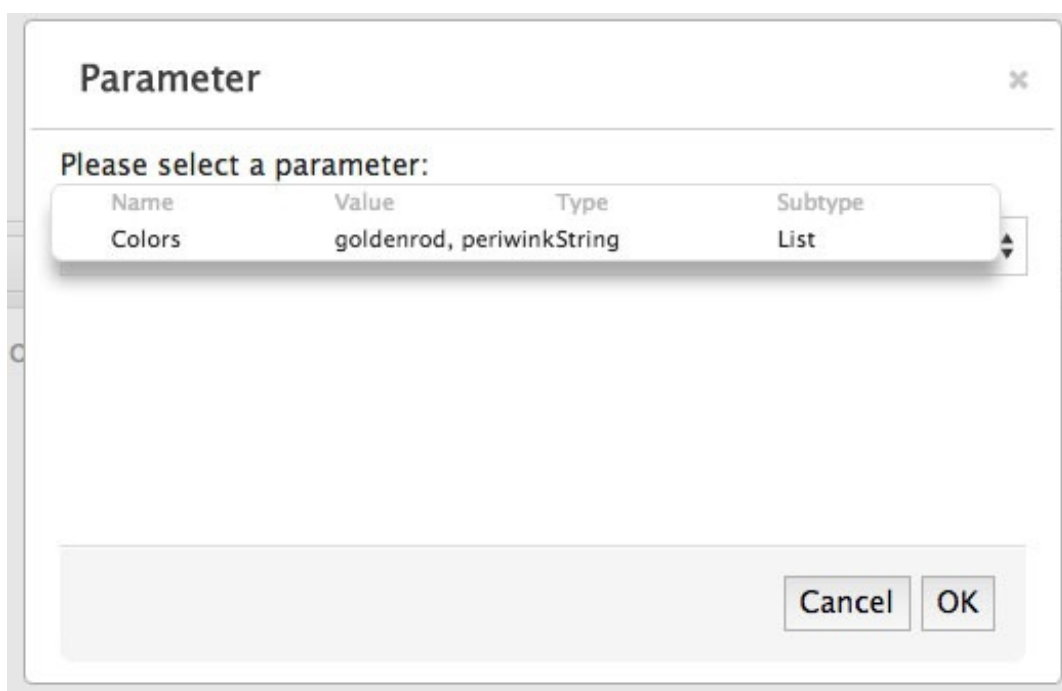
2. When you insert the algo, a rectangle that says "Parameter" appears.

## Question Text\*



This should display a color: Parameter |

3. Double-click on it to select which algorithmic variable you want to insert into the question. A popup window will appear. Select the algo you want to test from the dropdown menu and click “OK.”



**Parameter** [X]

Please select a parameter:

Name	Value	Type	Subtype
Colors	goldenrod, periwinkString		List

[Cancel] [OK]

4. In the Question Text section, the word “Parameter” should be replaced by the algo’s name.

**Question Text\***

This should display a color: Colors

- Save the question. Click “Preview” to view the question as a student. One of the values from the algo list should replace the rectangle that says the algo’s name. A newly randomized value should appear each time you refresh the preview.

REFRESH PREVIEW

Question (0 point)

> Solution

⚡

▾ 1st attempt

⬆

This should display a color: amber

## Creating List Algos

For List Algos, the system displays a random value taken from a list of items provided by the author.

Furthermore, all List Algos can be **Independent**, meaning they stand alone, or **Dependent**, meaning the value that the system generates is dependent on the value it generates for another algorithmic variable. We will discuss the differences between independent and dependent list algos in-depth in the “Creating Numeric Lists” section.

## Creating String Algos

The values in String Algos can either be text, or numerals that the system does not

**evaluate mathematically. Furthermore, numbers entered into String Algos do not contribute to sig figs or decimal point calculations.**

**In order to create an Independent String Algo, do the following:**

1. In the configuration tab, type out the name of your variables. This name will identify the variable to the author in the Edit Question view. The student will never see the variable name.
2. Under “Is this variable a String or a Number,” select “**String**.” Once “String” is selected, the system will auto-populate the selection for “Type.”
3. Because we want this particular example to be independent, select “No” for “Is this variable DEPENDENT on others?”

The screenshot shows a software interface with two tabs: "Configuration" and "List Value". The "Configuration" tab is active. On the left, there is a red text box that reads: "Name for variables" and "When you select 'String,' the system auto-populates the variable type and the variable dependency settings". To the right of this text is a form with the following fields:

- A "Name" field with the text "Colors" entered.
- A question "Is this variable a String or a Number?" with two radio buttons: "String" (selected) and "Number".
- A question "Select a type" with four radio buttons: "List" (selected), "Range", "Equation", and "Constant".
- A question "Is this variable DEPENDENT on others?" with two radio buttons: "Yes" and "No" (selected).

4. Click on the “List Value” tab.
5. Begin creating a list of values you want students to see when they open up the question.
  - a. In the editable text field under “Enter the acceptable values as below,” type out one of the values.
  - b. Using the Text Formatting Palette, format the text. From left to right, the Text Formatting Palette allows you to do the following:

**B** *I* U  $x_2$   $x^2$   $\Omega$   $f_x$

i.Bold text

ii.Italicize text

iii.Underline text

iv.Insert a subscript

v.Insert a superscript

vi.Insert special characters

vii.Insert Mathematical Expressions using LaTeX

The screenshot shows a web interface with two tabs: 'Configuration' and 'List Value'. The 'List Value' tab is active. It features a text input field containing the word 'lavender', an 'Update' button, and two buttons labeled '+' and '-'. Above the input field is a 'Text Formatting Palette' with icons for Bold (B), Italic (I), Underline (U), subscript ( $x_2$ ), superscript ( $x^2$ ), special characters ( $\Omega$ ), and mathematical expressions ( $f_x$ ). A label 'Below:' is positioned to the right of the palette. Three red arrows point from text annotations to the interface: one from 'Type the value here' to the input field, one from 'Text Formatting Palette' to the palette itself, and one from 'Click + to add the value to the list' to the '+' button. Below the input field, a message box states 'No data available in table'.

Configuration List Value

Below:

lavender Update + -

No data available in table

Type the value here

Text Formatting Palette

Click + to add the value to the list

- c. Once you have finished editing the value, click the + button. This will add your value to the list of values that the system may show a student. All successfully uploaded values will appear in this table.

Configuration

List Value

Enter the acceptable values as below:

Update

+

-

**List, or table, of values**

lavender
goldenrod
periwinkle
mauve
emerald

- d. Values added to the table will also appear as “values” in the list of algos included in the question.

#### ☒ Algorithm Editor

- ☐ Use significant figures in calculations  
☒ Use decimal places in calculations  
 decimal places

These values correspond to what is in the table of values

+

-

Name	Value	Type	Subtype
Colors	goldenrod, periwinkle, mauve, <u>emerald</u>	String	List

5. You may add as many values to the table as you wish, but check with your editor for best practices.
6. To delete a value from the table, highlight the value you want to delete and click the “-” button.

#### ☒ Algorithm Editor

- ☐ Use significant figures in calculations  
☒ Use decimal places in calculations  
 decimal places

Click the “+” button to create an algo; highlight the algo you want to delete and click the “-” button to delete that algo

+

-

Name	Value	Type	Subtype
Colors	goldenrod, periwinkle, mauve, <u>emerald</u>	String	List
CatsandColors	1, 2, 3, ...	Numeric	List

7. To update the wording or formatting of an existing value, select the value you want to update. In the text editor, re-format or retype the value as desired. Once you make the changes, click “Update.” This will update the value in the table with the edits you



just made.

Enter the acceptable values as below:

<input type="text" value="emerald"/>	Update	+	-
<div><div>emerald</div><div>sapphire</div><div>rose</div><div>amber</div><div>chartreuse</div></div>			

Click here to alter an existing value

8. Test that your algo is working correctly by inserting it into the Question Text section and previewing it in student mode. For an in-depth look at how to do this, please refer to the “Inserting Algos into Questions” section.

## Numeric List Types

Unlike with String Algos, the system recognizes the numeric worth of the values in Numeric List Algos, as well as all Number Algos. This allows the system to perform mathematical calculations with the values.

Numeric List values will always be displayed to the student exactly as you input them. The algorithm editor’s settings for significant figures or decimal places only come into play when Numeric List values are used as inputs into Equation Algos.

As mentioned earlier, all List Algos, including String Algos, can be independent or dependent.

### Independent Numeric List Types

**To create an Independent Numeric List Algo, do the following:**

1. In the Configuration tab, name your algorithmic variable.
2. Under “Is this variable a String or a Number,” select “**Number**.” Under “Select a type” select “**List**.” For this example, under “Is this variable DEPENDENT on others?” select “**No**.”

Configuration List Value

Name

Is this variable a String or a Number?

☐ String ☒ Number

Select a type

☒ List ☐ Range ☐ Equation ☐ Constant

Is this variable DEPENDENT on others?

☐ Yes ☒ No

20

3. Go to the List Value Tab. Begin adding numbers to the table. For an in depth look at how to add values to a table, please refer to steps 4-7 in *Creating String (Text) Algos*. However, please note the following differences:
  - a. For Numeric List types, the editable text field under “Enter the acceptable values as below” only accepts numerals in the form of whole numbers, decimals, and numbers in scientific notation. For scientific notation, the system uses E notation---for example, to insert  $2 \times 10^{15}$ , you must type 2E15. This value will still display to the student as  $2 \times 10^{15}$ .
  - b. When creating variables for Numeric List Types, there is no Text Formatting Palette in the editable text field.

Configuration List Value

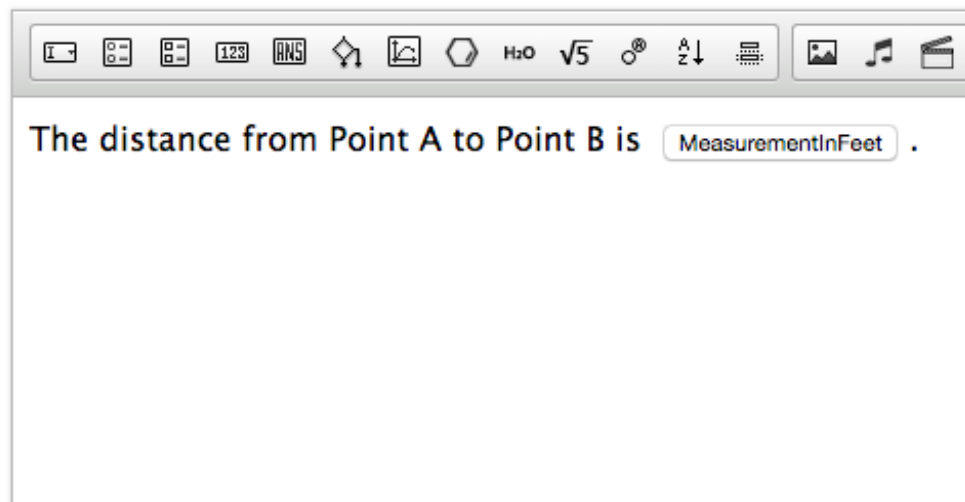
Enter the acceptable values as below:

23.7
2.5
12.3
82.8

4. Check that the algo is working correctly by inserting it into the Question Text

section and previewing it as a student. For an in-depth look at how to do this, please refer to “Inserting Algos into Questions.”

### Question Text\*



The distance from Point A to Point B is  .

**REFRESH PREVIEW**

**Question** (0 point)

> **Solution**

Value from the value list

⚡

▼ **1st attempt**

The distance from Point A to Point B is 12.3.

Student view

↗

### Dependent List Types

List types can also be dependent on what the system generates for other list values. Any list variable can be made dependent on any other list variable. This means that a Numeric List Variable can be dependent on a Sting Variable, a String Variable can be dependent on another String Variable, etc.

**To create a dependent, Numeric List Algo, do the following:**

1. In the Configuration tab, name your algorithmic variable.
2. Under “Is this variable a String or a Number, select “**Number**.” Under “Select a type” select “**List**.” For this example, under “Is this variable DEPENDENT on others?” select “**Yes**.”

Configuration

List Value

Name

Is this variable a String or a Number?

☐ String
☒ Number

Select a type

☒ List
☐ Range
☐ Equation
☐ Constant

Is this variable DEPENDENT on others?

☒ Yes
☐ No

- In the List Value Tab, select the name of the algo you want your dependent List Algo to depend on. For the purposes of this demonstration, we will refer to the algo you select here as the “independent algo.” The dropdown menu will auto-populate with all the Numeric List values and String (list) values you already created for the problem. The independent values will then auto-populate in the right hand column of the value table.

Configuration

List Value

Select the name of the algo you want to depend on

☒ Colors
☐ NumberOfCats

Select an index, enter a value, and click "Update"

Update

goldenrod

periwinkle

mauve

emerald

sapphire

Select the value you want this new value to depend on

- In the table, click on the row with the independent value you want your dependent value to depend upon. Every time this independent value is generated, this particular dependent value will also be generated.

5. In the text field underneath “Select an index, enter a value, and click ‘Update,’” enter in your dependent value. When you are finished, click “Update.” Your dependent value will be in the left hand column of the value table. Your dependent value will always correspond to the independent value that is in the same row.

Configuration List Value **Type your dependent value here**

Select the name of the algo you want to depend on Select an index, enter a value, and click "Update" Colors

4 Update **Click here to create your dependent value**

Dependent Values	Independent Values
1	goldenrod
2	periwinkle
3	mauve
4	<u>emerald</u>
5	sapphire

6. Continue creating dependent values.
- Make sure you create as many dependent values as there are independent values.** The system will not prevent you from creating fewer dependent values than there are independent values. However, in instances where no dependent value is specified, the system will not generate a value. This means that some of your students will be presented with a broken question.
  - You may edit existing dependent values in the table by highlighting the row of the value you want to change, editing the value in the text field, and clicking “Update.”
5. Check that the algo is working correctly by inserting it into the Question Text section and previewing it as a student. For an in-depth look at how to insert an algo into a question, please refer to “Inserting Algos into Questions.”

## Question Text\*

123

ANS

H<sub>2</sub>O

√5

z↓

**B** *I* U

If I get this color,  , I should get this number of cats,  .

**Question** (0 point) Student View

> **Solution**

< **1st attempt**

If I get this color, mauve , I should get this number of cats, 3 .

Independent value

Dependent Value

6. Once you have previewed the algorithm as a student, confirm that the system is producing the correct variable by checking the table in the List Value tab of the Algorithm Editor.

Configuration

List Value

Select the name of the algo you want to depend on

Select an index, enter a value, and click "Update"

1	goldenrod
2	periwinkle
3	mauve
4	<u>emerald</u>
5	sapphire

## Range Algos

Range Algos allow you to tell the system to generate numbers for students within a specific interval. Range Algos are a subset of numeric types, so they will always be evaluated mathematically.

**To create a Numeric Range Algorithm, do the following:**

1. At the top of the Algorithm Editor, select how you want the system to display the algorithmic variable to students. It can do this by using significant figures, or by displaying the number to a certain number of decimal places. **Please note that selecting significant figures only affects the way the system uses these values in calculations and how the solution is displayed. It does not affect how the system grades students' answers.**

For significant figures, we use standard significant figure rules, which are explained here: [http://en.wikipedia.org/wiki/Significance\\_arithmetic](http://en.wikipedia.org/wiki/Significance_arithmetic)



**Note: Currently, Range values are not displaying to students to the correct number of Significant Figures. Please contact your editor for further instructions.**

In the Configuration tab, name your algorithmic variable.

3. Under “Is this variable a String or a Number,” select “**Number**.” Under “Select a type” select “**Range**.” Range variables are never dependent on others, so that setting will automatically be defined.

Configuration Acceptable Range

Name

Is this variable a String or a Number?

☐ String ☒ Number

Select a type

☐ List ☒ Range ☐ Equation ☐ Constant

Is this variable DEPENDENT on others?

☐ Yes ☒ No

**This setting will always be "No" for Range values**

4. Go to the Acceptable Range tab.
5. Enter the minimum value and the maximum value of your range.
6. **You may input any number, positive or negative, in these fields, including decimals. For decimals, please include leading zeros.**
  - a. **If you are using Significant Figures**, it is good practice to make sure your minimum, maximum, and increase values contain the same number of sig figs. If they're different, the system will display your range value to the lowest number of significant figures used. So, for example, if your minimum value contains three sig figs, and your max value contains eight sig figs, the system will display to three sig figs.
  - b. **If you are using Significant Figures**, use "E" to write numbers in scientific notation. For example, if you wanted to write  $5.25 \times 10^{55}$ , type out "5.25E55" in the editable text field. This will display as  $5.25 \times 10^{55}$  in student view.
  - c. **If you are using Decimals**, please note that in a Range algo, any value inputted using Scientific Notation will always display as a decimal. For example, if you insert 5E4 in one of the range fields while decimal places is selected, the value will be displayed as 50000.0000 in student view. Therefore, if you want the system to display your values in scientific notation, you should set your algos to Significant Figures.
7. Enter the interval by which you want the variables to increase within your range. For





**Question** (0 point)

> **Solution** A value within our range, to the appropriate number of sig figs. ⚡

▼ **1st attempt** ↗

There are  $7.75 \times 10^{55}$  HCl molecules in the aqueous solution.

Student View

## Equation Algos

Equation Algos allow you to put existing numeric algorithmic variables into an equation and manipulate them mathematically. Equation Algos are a subset of Numeric Algos.

**To create a Numeric, Equation Algorithm, do the following:**

1. At the top of the Algorithm Editor, select whether you want the system to use significant figures or decimals in calculations. This will affect how the Equation algorithm displays the completed calculation to students. **Please note that selecting significant figures affects the way the system uses these values in calculations, and the way it displays the values. It does not affect how the system grades students' answers.**

Furthermore, the number of significant figures you use in your equation affects the way the the system calculates your equation. As a rule, the system always calculates to the least number of significant figures; this includes numbers used within the calculations. So, for example, if you multiply a number by "2" while writing the equation algo, the system will calculate your equation algo to one significant figure because you use a number with one significant figure in the equation.

Again, for significant figures, we use standard significant figure rules, which are explained here: [http://en.wikipedia.org/wiki/Significance\\_arithmetic](http://en.wikipedia.org/wiki/Significance_arithmetic)

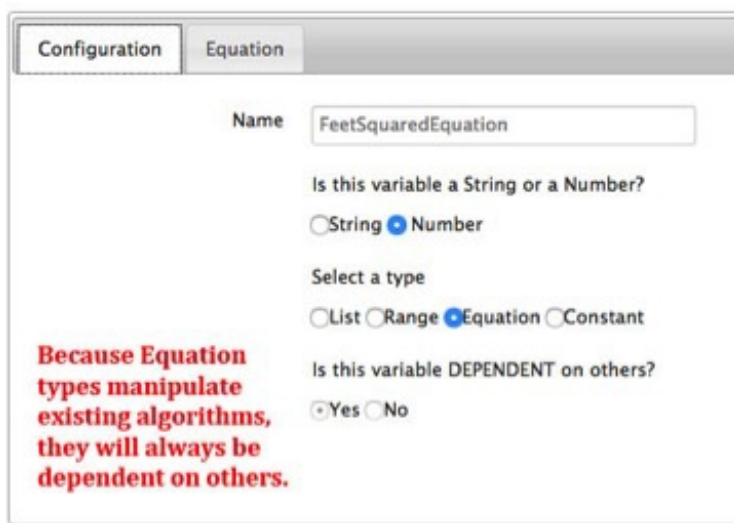
### ✓ Algorithm Editor

- ☐ Use significant figures in calculations
- ☒ Use decimal places in calculations
- decimal places

**In this example, we want the system to calculate the equation to four decimal places**

**Note: Currently, Equation algos are not displaying to students to the correct number of Significant Figures. Please contact your editor for further instructions.**

2. In the Configuration tab, name your variable.
3. Under “Is this variable a Sting or a Number,” select “**Number**.” Under “Select a type,” select “**Equation**.” Once “Equation” is selected, the system will auto-populate the selections for the variable’s dependency. Because Equation types mathematically manipulate existing algorithms, they will always be dependent on others. You cannot manually override this selection.



Configuration Equation

Name FeetSquaredEquation

Is this variable a String or a Number?

☐ String ☒ Number

Select a type

☐ List ☐ Range ☒ Equation ☐ Constant

Is this variable DEPENDENT on others?

☒ Yes ☐ No

**Because Equation types manipulate existing algorithms, they will always be dependent on others.**

4. Click on the Equation tab.
5. Begin building your equation in the editable text field.
  - a. You may build your equation by typing the following symbols:
    - i.Addition: +
    - ii.Subtraction: -
    - iii.Multiplication: \*
    - iv.Division: /
    - v.Parenthesis: ( )

Configuration Equation

Algo: Math Functions

- Exponents
- Square roots
- Cube roots
- Fourth roots
- Absolute value
- Log
- Ln
- Exp
- Sin
- Cos
- Tan
- ASin
- ACos
- ATan

☐ Introduction

Part 1 0 points

Question Text\*

b. You may also use the pre-programmed math functions in the “Math Functions” drop-down menu. The pre-programmed Math Functions are:

i.Exponents:  $\text{pow}(a, b) = a^b$

ii.Square roots:  $\text{sqrt}(2)$  or  $\text{pow}(a, 1/2) = a^{1/2}$

iii.Cube roots:  $\text{pow}(a, 1/3)$

iv.Fourth roots:  $\text{pow}(a, 1/4)$

v.Absolute value:  $\text{abs}(x) = |x|$

vi.Log:  $\log(a, b) = \text{the logarithm of } a \text{ to the base } b.$

vii.Ln:  $\ln(x) = \text{the natural logarithm of } x$

viii.Exp:  $\exp(x) = \text{natural exponential function } e^x$

ix.Sin:  $\sin(x)$

x.Cos:  $\cos(x)$

xi.Tan:  $\tan(x)$

xii.Arc sine:  $\sin(x)$

xiii.Arc cosine:  $\cos(x)$

xiv.Arc Tangent:  $\tan(x)$

c. Please note that SW5 doesn't support omitted multiplication signs. An expression such as  $3\exp(a)$  must be entered as  $3*\exp(a)$

d. You can use the subtraction symbol to create a negative value.

6. Add the algorithmic variable(s) you would like to manipulate mathematically by inserting it into the equation via the “Algo” drop-down menu. This dropdown menu will pre-populate with all of the Numeric Algos you created for this question.

7. You can type numbers directly into the equation. If significant figure rules are being applied, the number of sig figs in these directly input numbers will help determine the result of the equation. For example, the term “ $1/x$ ” will be computed to one significant figure. If the algo x has three sig figs, and you want the equation to also result in three sig figs, type in “ $1.00/x$ ” instead.
8. Test your equation algo by inserting it into the Question Text section and previewing it as a student. For in-depth instructions on how to do this, please refer to “Inserting Algos into Questions.”

MeasurementInFeet  $\text{ft}^2$  = FeetSquaredEquation ft

Question (0 point)

Student View

>

Solution

⚡

1st attempt

⬆

MeasurementInFeet Algo

$12.3 \text{ ft}^2 = 151.2900 \text{ ft}$

FeetSquaredEquation Algo, calculated to four decimal places

## Constant Algos

Constant Algorithms allow you to define constants that can be used in Equation Algorithms and throughout the question text/module.

To create a Constant Algorithm, do the following:

1. In the Configuration tab, name your constant algorithmic variable.
2. Under “Is this variable a String or a Number,” select “**Number.**” Under “Select a type,” select “**Constant.**” Once “Constant” is selected, the system will auto-populate the selections for the algo’s dependency. Constant types are always independent algos. You cannot manually override this selection.
3. In the Configuration tab, type out the value of your constant algo.
  - a. **You may input any number, positive or negative, in these fields, including decimals. For decimals, please include leading zeros.**
  - b. Constant values will always be displayed to the student exactly as you input

them. The algorithm editor's settings for significant figures or decimal places only come into play when Constant values are used as inputs into Equation Algos.

- c. Use "E" to write numbers in scientific notation. For example, if you wanted to write  $6.022 \times 10^{23}$ , type out "6.022E23" in the editable text field. This will display as  $6.022 \times 10^{23}$  in student view. Unlike Equation and Range types, constants will display in scientific notation regardless of whether you are using Significant Figures in calculations, or Decimals. However, if you are using scientific notation throughout your equation, it is usually good practice to tell the system to use Significant Figures. Check with your editor for best practices.

Configuration

Name

Pi

Is this variable a String or a Number?

☐String ☒Number

Select a type

☐List ☐Range ☐Equation ☒Constant

Value

3.1415926

Is this variable DEPENDENT on others?

☐Yes ☒No

Type out your constant value here

4. Test that your algo is working correctly by inserting it into the Question Text section and previewing it as a student. For in-depth instructions on how to do this, please refer to "Inserting Algos into Questions."

**Question Text\***

**Pi**

**Question** (0 point)

### ➤ Solution

1st attempt

### Student View

3.1415926

## Using Algos in Questions

You can insert Algorithms in all fields of the question editor, including the Introduction, the Question Text, the Hint Text, the Part Solution, and the Summary Solution.

Currently, you can insert algorithmic variables as answer choices in the following



modules:

- Multiple Choice
- Multiple Select
- Numeric Entry (Numeric Algos only)
- Short Answer\*
- Labeling
- Ranking
- Sorting (both as a category and as an item)
- Symbolic Equation

\*While you technically can insert algorithmic variables into the Short Answer module, algos make it very difficult to use synonyms, which are variations of the coded answer that you can tell the system to recognize as correct. Furthermore, the Short Answer module allows authors to insert Numeric Algorithmic Variables as correct answers, instead of only String Variables. Therefore, we strongly encourage you to check with your editor for best practices before creating a Short Answer module that uses Algos.

You can also insert algorithmic variables into the feedback text of any module.

## *Sample Algo Question*

Recreate the following Chemistry problem to practice building algorithmic variables and using them in questions. In recreating this question, use algorithms to give students (1) a range of initial values, and (2) at least three different Elements.

### **Question:**

You have **[Initial Value]** particles/L of **[Element]** in an aqueous solution. What is this in g/L?

### **Objectives:**

- Build a Numeric Range Algorithmic Variable
- Build a String Algorithmic Variable
- Build a Dependent Numeric List Algorithmic Variable
- Build a Numeric Constant Algorithmic Variable
- Build a Numeric Equation Algorithmic Variable using the other algos, and trace how the system evaluates the other algos mathematically

- Use Scientific Notation in Algorithmic Variables
- Use Significant Figures in calculations

### Collect and Organize:

1. The purpose of this question is to have students convert particles/L of an Element to g/L. We would like to use algos to give students (a) a range of possible initial values to use in their calculations and (b) one of three possible Elements to convert.
2. This problem will require students to give their answer in the form of a number, so **Numeric Entry** will be the most appropriate module to use when defining our answer.
3. To give students a **range of initial values** to use in their calculations, we will need to create a **Range Algo**.
4. To give students a variety of possible **Elements**, we will need to create a **String Algo**.
5. Since students will each see a different number for the initial value, as well as a different Element, **students will give a variety of correct answers**. In order to account for every correct answer, we will need to create an **Equation Algo** to place in the correct answer tab of the Numeric Entry Module Editor.
  - a. **We can model our Equation Algo off of the math students will use to solve the problem.** To solve the problem, students will have to use the following stoichiometric equation:
 
$$[InitialValue] \frac{\text{particles}}{L} \times \frac{1\text{mol}}{[Avogadro'sNumber]\text{particles}} \times \frac{[MolarMassofElement]g}{1\text{mol}} = [FinalAnswer] \frac{g}{L}$$
  - b. To complete this Equation Algo, we will need to create a **Constant Algo** to account for **Avogadro's Number**.
  - c. We will also need to create a **Dependent List Algo** to account for the **Molar Mass of the Element**. This list algo is dependent because the molar mass that students will use in their calculations will depend on what Element they see in the question stem.

To summarize, we need to create the following Algos in order to write this problem successfully:

Algo Name	Algo Type
Initial Value	Range
Elements	String
Molar Mass	Dependent List (dependent on Elements Algo)
Avogadro’s Number	Constant
Final Answer	Equation

We may also want to create additional Equation algorithms to trap for specific incorrect answers. However, we will do that only after we create the values in the above table and set the correct answer.

**Create:**

1. In the Question Text section of the Question Editor, type out your question stem, using placeholder text for your algos.
2. Insert a Numeric Entry Module into the Question Text section. We will fill in the answer choices and feedback for this module once we create our Algos.

## Question Text\*

Placeholder text for algos

The screenshot shows the top part of a question editor. At the top is a toolbar with various icons for text formatting and insertion. Below the toolbar is a text input field containing the question text: "You have [Initial Value] particles/L of [Element] in an aqueous solution. What is this in g/L?". Below the text field is a small rectangular box for the answer. A red arrow points from the text "[Initial Value]" to the text "Placeholder text for algos". Another red arrow points from the text "[Element]" to the same text. A third red arrow points from the answer box to the text "Numeric Entry Module Editor".

Question Text

You have [Initial Value] particles/L of [Element] in an aqueous solution. What is this in g/L?

Numeric Entry Module Editor

3. Expand the Algo Editor. Tell the system to use significant figures in calculations. This will affect how the system calculates the Final Answer Algo.

### ☒ Algorithm Editor

The screenshot shows the 'Algorithm Editor' section. It has a red border. Inside, there are two radio button options. The first option, 'Use significant figures in calculations', is selected and has a red box around it. The second option, 'Use decimal places in calculations', is not selected. Below the second option is a text input field containing the number '2' and the text 'decimal places'.

☒ Use significant figures in calculations

☐ Use decimal places in calculations

2 decimal places

4. Create your Initial Value Algorithmic Variable. We want this to be a range value. For an in-depth look at how to do this, refer back to the **Range Types** section of this document.

The screenshot shows a configuration window with two tabs: 'Configuration' and 'Acceptable Range'. The 'Acceptable Range' tab is selected. Below the tabs is a text input field with the text 'Enter minimum and maximum value, and increment as below:'. Below this text are three text input fields. The first is labeled 'Minimum value' and contains '5.98E20'. The second is labeled 'Maximum value' and contains '9.52E20'. The third is labeled 'Increase by' and contains '1.65E20'. Below the input fields is a red text label: 'Students will see values within this range for their Initial Value'.

Configuration Acceptable Range

Enter minimum and maximum value, and increment as below:

Minimum value 5.98E20

Maximum value 9.52E20

Increase by 1.65E20

Students will see values within this range for their Initial Value

5. Create your Elements algorithmic variable. We want this to be a String value. For an in-depth look at how to do this, refer back to the **String Types** section of this document.

Configuration

List Value

Enter the acceptable values as below:

Update

+

-

Ca
Cl <sup>-</sup>
F <sup>-</sup>

6. Create your Molar Mass algorithmic variable. We want this to be a Numeric List Type that depends on the Elements algo. For an in-depth look at how to do this, refer back to the **Dependent List Types** section of this document.

Configuration

List Value

Select the name of the algo you want to depend on

Select an index, enter a value, and click "Update"

Update

40.078	Ca
35.4527	Cl <sup>-</sup>
18.998403	F <sup>-</sup>

7. Create your algo for Avogadro's Number. We want this to be a Constant Type. For an in-depth look at how to do this, refer back to the **Constant Types** section of this document.

Configuration

Name

Avogadro's Number

Is this variable a String or a Number?

☐String
☒Number

Select a type

☐List
☐Range
☐Equation
☒Constant

Value

6.022E23

Is this variable DEPENDENT on others?

☐Yes
☒No

8. Create your Final Answer Algo using the algorithmic variables you just created. We want this to be an Equation Type. For an in-depth look at how to do this, refer to the **Equation Type** section of this document.

Configuration

Equation

InitialValue/Avogadro's Number×Molar Mass

Be mindful of how the equation calculates sig figs. If you type Initial Value \* (1/Avogadro'sNumber), the system will calculate this equation algo as 1 sig fig (because it takes the 1 in the numerator into account).

Algo:

Math Functions:

9. Test that all of the algos you created are working properly by inserting them into the Question Text section of the document and hitting preview. Use this time to make sure the system is calculating the correct number of Significant Figures as well.

## Question Text\* Author View

You have  particles/L of  in an aqueous solution. What is this in g/L?

$[InitialValue] \frac{\text{particles}}{L} \times \frac{1 \text{ mol}}{[Avogadro'sNumber]} \times \frac{[MolarMassofElement]}{1 \text{ mol}} = [FinalAnswer] \frac{g}{L}$  Equation we are using

Initial Value  (particles/L) of  \* (1 mol/ ) \* (  g/ 1 mol) =

**It is good practice to calculate the equation yourself to ensure that everything is working properly**

**Question** (1 point)

> **Solution** The Equation algo is working properly and displaying answers to the correct number of significant figures ⚡

▼ **1st attempt** ↗

You have  $2.271 \times 10^{20}$  particles/L of  $F^-$  in an aqueous solution. What is this in g/L?

Initial Value  $2.271 \times 10^{20}$  (particles/L) of  $F^-$  \* (1 mol/ $6.022 \times 10^{23}$ ) \* (18.998403 g/1 mol) =  $7.165 \times 10^{-3}$

- Go back to the Question Text section and replace your placeholder text with the appropriate algos.

## Question Text\*

You have  particles/L of  in an aqueous solution. What is this in g/L?

- In the Numeric Entry module, set the “Final Answer” algo as the Correct Answer. Create feedback for the correct answer, save the module, and test that the module is working correctly in Preview mode.

Numeric Entry

Options

Feedback

Units

☐ Show Units
☐ Graded
☐ Use Dollar Units

Correct

☐ Value
☒ Algo

Final Answer

Tolerance

+

2

%

-

2

%

☐ Exact
☐ Numeric
☒ Percent

Save

Cancel

REFRESH PREVIEW

Question (1 point)

Solution

1st attempt

Feedback

You have  $9.391 \times 10^{20}$  particles/L of  $F^-$  in an aqueous solution. What is this in g/L?

2.963

$\times 10^{-2}$

$2.963 \times 10^{-2}$

For the purposes of testing, you may want to have the final answer close at hand

12. If desired, you can use algorithmic variables to trap for specific incorrect answers students may use. To do this, do the following:
  - a. Determine what common mistake a student might make when solving this problem. In this example, we will pretend that a student multiplies by Avogadro's Number instead of dividing by it.
  - b. In the Algorithm Editor, create a new Equation Algo. Name it "IncorrectAns1."
  - c. In the Equation Tab of the Algo Editor, create an equation that represents this common student mistake. In this example, we are building "IncorrectAns1" with



the existing algos; however, you can also create new algos to build other incorrect answers.

Avogadro's Number	6.022E22	Numeric	Constant
Final Answer		Numeric	Equation
IncorrectAns1		Numeric	Equation

Configuration

Equation

InitialValue × Avogadro's Number × Molar Mass

**The algo "IncorrectAns1" accounts for students accidentally multiplying by Avogadro's number instead of dividing by it.**

Algo:  Math Functions:

- d. In the Numeric Entry Module editor, insert this algo into an incorrect feedback tab. Create feedback around it.

1

2

+

## Numeric Entry

Options

Feedback

Rule Type

Incorrect Value

☐ Value
 ☒ Algo

IncorrectAns1

Tolerance

+ 2 %

- 2 %

☐ Exact
 ☐ Numeric
 ☒ Percent

$\text{H}_2\text{O}$

**B**
*I*
U
 $\times_2$ 
 $\times^2$ 
 $f_x$ 
 $\Omega$ 
 $I_x$

Check your math. Did you multiply by Avogadro's number, or divide by it?

Save

Cancel

e. Save the module.

f. Save the question and test your algo in preview mode.

▼

1st attempt

✕

Feedback

You have  $9.740 \times 10^{19}$  particles/L of Ca in an aqueous solution. What is this in g/L?

✕

2.351

$\times 10^{45}$

$2.351 \times 10^{45}$