1. Test **sin** function

Normal case: `sin(2x)`

New Problem ⓘ

Sample Problems | Math Objects | POD | PGML | Author Info

```
31  Context( Numeric );
32
33  $showPartialCorrectAnswers = 1;
34  $f = Formula("cos^2(x)+sin^2(x)");
35  $fs = Formula("sin(2x)");
36  $fsa = Formula("sin(2x)");
37
38  TEXT(beginproblem());
39
40 ▾ BEGIN_PGML
41  The number twelve is [_____]{12}___
42  Type the  formula [`1+\frac{x}{2}`] [_____]{"1+x/2"}
43
44  Twelve is [_____]{Real(12)}___
45  2 mod 10 is [_____]{Real(2)->with(period=>10)}
46  [`[$f]`] is equal to [_____]{Real(1)}
47  Twelve is [_____]{num_cmp(12)}
48
49  Test the formula [`[$fs]`] [_____]{Formula("sin(2x)")}
50
51  Show the parsed formula: [`[$fsa]`]
52
53  The number 12 is [____]{answer=>12,width=>10}
54  END_PGML
55
56 ▾ BEGIN_PGML_SOLUTION
57  You can use PGML in your solution if you use the structure
```

Results for this submission

7 of the questions remain unanswered.

The number twelve is ☐

Type the formula $1 + \frac{x}{2}$ ☐

Twelve is ☐

2 mod 10 is ☐ $\cos^2(x) + \sin^2(x)$ is equal to ☐   Twelve is ☐

Test the formula $\sin(2x)$ $\boxed{\sin(2x)}$ ✅

Show the parsed formula: $\sin(2x)$

The number 12 is ☐

Solution ⌄

You received a score of 13% for this attempt.

You can earn partial credit on this problem.

Your score was not recorded.

Parsed as: `sin(2x) -> sin(2x)`

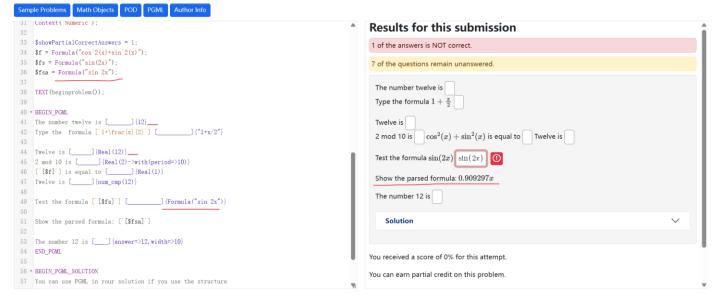**Case 1:** `sin 2x`

New Problem ❓

*Editing **new problem** template "[TMPL]/tmpEdit/blank.Undefined_Set.goliathli.tmp".*

[Sample Problems] [Math Objects] [POD] [PGML] [Author Info]

```
31  Context( Numeric );
32
33  $showPartialCorrectAnswers = 1;
34  $f = Formula("cos^2(x)+sin^2(x)");
35  $fs = Formula("sin(2x)");
36  $fsa = Formula("sin 2x");
37
38  TEXT(beginproblem());
39
40 ▼ BEGIN_PGML
41  The number twelve is [_____]{12}
42  Type the  formula [`1+\frac{x}{2}`] [_____]{"1+x/2"}
43
44  Twelve is [_____]{Real(12)}
45  2 mod 10 is [_____]{Real(2)->with(period=>10)}
46  [`[$f]`] is equal to [_____]{Real(1)}
47  Twelve is [_____]{num_cmp(12)}
48
49  Test the formula [`[$fs]`] [_____]{Formula("sin 2x")}
50
51  Show the parsed formula: [`[$fsa]`]
52
53  The number 12 is [____]{answer=>12,width=>10}
54  END_PGML
55
56 ▼ BEGIN_PGML_SOLUTION
57  You can use PGML in your solution if you use the structure
```

Results for this submission

1 of the answers is NOT correct.

7 of the questions remain unanswered.

The number twelve is ☐
Type the formula $1 + \frac{x}{2}$ ☐

Twelve is ☐
2 mod 10 is ☐ $\cos^2(x) + \sin^2(x)$ is equal to ☐ Twelve is ☐

Test the formula $\sin(2x)$ [$\sin(2x)$] ⊘

Show the parsed formula: $0.909297x$

The number 12 is ☐

Solution ⌄

You received a score of 0% for this attempt.

You can earn partial credit on this problem.

Parsed as: `sin 2x -> (sin 2)x`

Case 2: `sin2x`

New Problem ❓

*Editing **new problem** template "[TMPL]/tmpEdit/blank.Undefined_Set.goliathli.tmp".*

[Sample Problems] [Math Objects] [POD] [PGML] [Author Info]

```
31  Context( Numeric );
32
33  $showPartialCorrectAnswers = 1;
34  $f = Formula("cos^2(x)+sin^2(x)");
35  $fs = Formula("sin(2x)");
36  $fsa = Formula("sin2x");
37
38  TEXT(beginproblem());
39
40 ▼ BEGIN_PGML
41  The number twelve is [_____]{12}
42  Type the  formula [`1+\frac{x}{2}`] [_____]{"1+x/2"}
43
44  Twelve is [_____]{Real(12)}
45  2 mod 10 is [_____]{Real(2)->with(period=>10)}
46  [`[$f]`] is equal to [_____]{Real(1)}
47  Twelve is [_____]{num_cmp(12)}
48
49  Test the formula [`[$fs]`] [_____]{Formula("sin2x")}
50
51  Show the parsed formula: [`[$fsa]`]
52
53  The number 12 is [____]{answer=>12,width=>10}
54  END_PGML
55
56 ▼ BEGIN_PGML_SOLUTION
57  You can use PGML in your solution if you use the structure
```

Results for this submission

1 of the answers is NOT correct.

7 of the questions remain unanswered.

The number twelve is ☐
Type the formula $1 + \frac{x}{2}$ ☐

Twelve is ☐
2 mod 10 is ☐ $\cos^2(x) + \sin^2(x)$ is equal to ☐ Twelve is ☐

Test the formula $\sin(2x)$ [$\sin(2x)$] ⊘

Show the parsed formula: $0.909297x$

The number 12 is ☐

Solution ⌄

You received a score of 0% for this attempt.

You can earn partial credit on this problem.

Parsed as: `sin2x -> (sin 2)x`

Case 3: `sin 2 x`

New Problem ❓

`Sample Problems` `Math Objects` `POD` `PGML` `Author Info`

```
36   $fsa = Formula("sin 2 x");
37
38   TEXT(beginproblem());
39
40 ▾ BEGIN_PGML
41   The number twelve is [_____]{12}___
42   Type the formula [`1+\frac{x}{2}`] [_____]{"1+x/2"}
43
44   Twelve is [_____]{Real(12)}___
45   2 mod 10 is [_____]{Real(2)->with(period=>10)}
46   [`[$f]`] is equal to [_____]{Real(1)}
47   Twelve is [_____]{num_cmp(12)}
48
49   Test the formula [`[$fs]`] [_____]{Formula("sin 2 x")}
50
51   Show the parsed formula: [`[$fsa]`]
52
53   The number 12 is [____]{answer=>12,width=>10}
54   END_PGML
55
56 ▾ BEGIN_PGML_SOLUTION
57   You can use PGML in your solution if you use the structure
58   above.  There is currently no short cut.
59   END_PGML_SOLUTION
60
61   ENDDOCUMENT();
62
```

Results for this submission

1 of the answers is NOT correct.

7 of the questions remain unanswered.

The number twelve is ☐
Type the formula $1 + \frac{\pi}{2}$ ☐

Twelve is ☐
2 mod 10 is ☐ $\cos^2(x) + \sin^2(x)$ is equal to ☐ Twelve is ☐

Test the formula $\sin(2x)$ $\sin(2x)$ ⊘

Show the parsed formula: $0.909297x$

The number 12 is ☐

Solution ⌄

You received a score of 0% for this attempt.

You can earn partial credit on this problem.

Parsed as: `sin 2 x -> (sin 2)x`

Case 4: `sin2 x`

New Problem ❓

`Sample Problems` `Math Objects` `POD` `PGML` `Author Info`

```
31   Context( Numeric );
32
33   $showPartialCorrectAnswers = 1;
34   $f = Formula("cos^2(x)+sin^2(x)");
35   $fs = Formula("sin(2x)");
36   $fsa = Formula("sin2 x");
37
38   TEXT(beginproblem());
39
40 ▾ BEGIN_PGML
41   The number twelve is [_____]{12}___
42   Type the formula [`1+\frac{x}{2}`] [_____]{"1+x/2"}
43
44   Twelve is [_____]{Real(12)}___
45   2 mod 10 is [_____]{Real(2)->with(period=>10)}
46   [`[$f]`] is equal to [_____]{Real(1)}
47   Twelve is [_____]{num_cmp(12)}
48
49   Test the formula [`[$fs]`] [_____]{Formula("sin2 x")}
50
51   Show the parsed formula: [`[$fsa]`]
52
53   The number 12 is [____]{answer=>12,width=>10}
54   END_PGML
55
56 ▾ BEGIN_PGML_SOLUTION
57   You can use PGML in your solution if you use the structure
```

Results for this submission

1 of the answers is NOT correct.

7 of the questions remain unanswered.

The number twelve is ☐
Type the formula $1 + \frac{\pi}{2}$ ☐

Twelve is ☐
2 mod 10 is ☐ $\cos^2(x) + \sin^2(x)$ is equal to ☐ Twelve is ☐

Test the formula $\sin(2x)$ $\sin(2x)$ ⊘

Show the parsed formula: $0.909297x$

The number 12 is ☐

Solution ⌄

You received a score of 0% for this attempt.

You can earn partial credit on this problem.

Parsed as: `sin2 x -> (sin 2)x`

Except for normal case, the other cases will be parsed as `(sin 2)x`.

Elaborate this section:

B. redefine()

To make the operator **available again**, use **redefine**, e.g.

```
Context()->operators->redefine("^","**");
```

Note that **multiplication** and **division** have several forms (in order to make a non-standard precedence that allows things like `sin(2x)` to be entered as `sin 2x`). So if you want to disable them you need to **include all of them**. E.g.,

```
Context()->operators->undefine('*',' *','* ');
Context()->operators->undefine('/',' /','/ ','//');
```

which would be required in order to **make multiplication and division unavailable**.

WeBWorK's parser supports **implicit multiplication** (e.g., **2x** instead of **2*x**) and **flexible spacing**. To achieve this, the parser defines **multiple operator variants** for ***** and **/** to handle different spacing scenarios.

For example:
- ➤ "*****": **Explicit multiplication** (e.g., **2*x**).
- ➤ " *****" and "***** ": Allow for optional spacing (e.g., **2 * x** or **2* x**).

These variants ensure natural student input but require you to **disable all forms** to **fully remove** an operator. (If you only undefine '*****', expressions like **2 *x** or **2* x** would still parse as valid multiplication!)

Difference between "/" and "//":

```
37
38  $div_t1 = Formula("12x/123");
39  $div_t2 = Formula("12x//123");
40
41  TEXT(beginproblem());
42
43 ▼ BEGIN_PGML
44  The number twelve is [_____]{12}____
45  Type the  formula [`1+\frac{x}{2}`] [_____]{"1+x/2"}
46
```

Test the formula $\sin(2x)$ ☐

Show the parsed formula: $0.909297x$

Show division test 1: $\frac{12x}{123}$

Show division test 2: $12x/123$

The number 12 is ☐

2. Search Specification on the Forum

Draggable Question:

Drag each of the the below words to classify them as a color or a fruit.

orange

blue

apple

Color

Fruit

Reset

Preview My Answers   Check Answers   Show Correct Answers

UsingWW: Non-exclusive draggable subsets

3. Write Some Questions of Discrete Structure using PGML

A2 Q3:

Question 3

Let $P(x, y)$ be $x < y$, and the domain be $\mathbb{N}$ (the set of natural numbers). Verify the truth value of the following predicates. Give your reasons.

    (a) $\forall x, \forall y, P(x, y)$
    (b) $\exists x, \forall y, P(x, y)$
    (c) $\forall x, \exists y, P(x, y)$
    (d) $\exists x, \exists y, P(x, y)$
    (e) $\exists x, \forall y, P(y, x)$
    (f) $\forall x, \exists y, P(y, x)$

Ans.

a) False. A counter example is $x = 2, y = 1$
b) False. A counter example is $x = y$ for all x.
c) True. For all x, let $y = x + 1$.
d) True. Let $x = 1, y = 2$.
e) False. The predicate becomes "there is a natural number which is larger than any natural number." (Pay attention to the order of x and y.) So, letting $y = x$ for all x is a counter example
f) False. When $x = 0$, there is no such y.

PGML code:

```
# DESCRIPTION
# A problem from Discrete Mathematics Assignment 2
# WeBWorK problem written by Jason LONG
# ENDDESCRIPTION


## KEYWORDS('Discrete Structure')
## TitleText1('MATH2003 23S A2')
## AuthorText1('Big Brother')
## Author('Jason LONG')
## Institution('BNBU')


DOCUMENT();


loadMacros(
"PGstandard.pl",
"MathObjects.pl",
"PGML.pl",
);


Context("Numeric");
Context()->strings->add("True" => {}, "False" => {});


$ans1 = String("False");
$ans2 = String("False");
$ans3 = String("True");
```

```
$ans4 = String("True");
$ans5 = String("False");
$ans6 = String("False");

TEXT(beginproblem());
```

BEGIN_PGML

Let [`P(x,y)`] be [`x < y`], and the domain be [`\mathbf{N}`] (the set of natural numbers).
Verify the truth value of the following predicates *(Answer "True" or "False")*.

(a) [`\forall x, \forall y, P(x,y)`] [_____]{$ans1}

(b) [`\exists x, \forall y, P(x,y)`] [_____]{$ans2}

(c) [`\forall x, \exists y, P(x,y)`] [_____]{$ans3}

(d) [`\exists x, \exists y, P(x,y)`] [_____]{$ans4}

(e) [`\exists x, \forall y, P(y,x)`] [_____]{$ans5}

(f) [`\forall x, \exists y, P(y,x)`] [_____]{$ans6}

END_PGML

BEGIN_PGML_SOLUTION

a) **False**. A counter example is [`x = 2`], [`y = 1`].

b) **False**. A counter example is [`x = y`] for all [`x`].

c) **True**. For all [`x`], let [`y = x + 1`].

d) **True**. Let [`x = 1`], [`y = 2`].

e) **False**. The predicate becomes "there is a natural number which is larger than any
natural number." (Pay attention to the order of [`x`] and [`y`].) So, letting [`y = x`]
for all [`x`] is a counter example.

f) **False**. When [`x = 0`], there is no such [`y`].

END_PGML_SOLUTION

```
ENDDOCUMENT();
```

A3 Q2:

Question 2

What is wrong with the following proof?

1.	$\exists x, \exists y \, (A(x) \to B(y))$	Premise
2.	$A(a)$	Premise
3.	$\exists y \, (A(a) \to B(y))$	Existential instantiation from 1
4.	$A(a) \to B(b)$	Existential instantiation from 3
5.	$B(b)$	Modus ponens from 2 and 4
6.	$\forall x \, (B(x))$	Universal generalization from 5

■

Ans.

Step 6 is wrong. Universal generalization needs "$B(b)$ is true for any b."

PGML code:

```
# DESCRIPTION
# A problem from Discrete Mathematics Assignment 3
# WeBWorK problem written by Jason LONG
# ENDDESCRIPTION

## KEYWORDS('Discrete Structure')
## TitleText1('MATH2003 23S A3')
## AuthorText1('Big Brother')
## Author('Jason LONG')
## Institution('BNBU')

DOCUMENT();

loadMacros(
"PGstandard.pl",
"MathObjects.pl",
"PGML.pl",
"parserRadioButtons.pl",
);

Context("Numeric");

$ans = RadioButtons(
  ["Step 1", "Step 2", "Step 3", "Step 4", "Step 5", "Step 6"], # Choice declarations
  5,  # Index 5 corresponds to choice value 6
  labels => ["A","B","C","D","E","F"],
);

TEXT(beginproblem());

BEGIN_PGML
What is *wrong* with the following proof?
```

```
[`
\begin{aligned}
1. & \quad \exists x, \exists y (A(x) \rightarrow B(y)) && \text{Premise} \\
2. & \quad A(a) && \text{Premise} \\
3. & \quad \exists y (A(a) \rightarrow B(y)) && \text{Existential instantiation from 1}
\\
4. & \quad A(a) \rightarrow B(b) && \text{Existential instantiation from 3} \\
5. & \quad B(b) && \text{Modus ponens from 2 and 4} \\
6. & \quad \forall x (B(x)) && \text{Universal generalization from 5}
\end{aligned}
`]

Select the incorrect step:
[_]{$ans}
END_PGML


BEGIN_PGML_SOLUTION
Step [`6`] is wrong. Universal generalization needs "[`B(b)`] is true for any [`b`]".
END_PGML_SOLUTION


ENDDOCUMENT();
```

A4 Q1:

Question 1.

List all elements of the following sets.

a) $\{x|x \in \mathbb{N} \text{ and } x \leq 5\}$
Ans.
$\{0,1,2,3,4,5\}$

b) $\{x|x \subseteq \{1, 2, 3\}\}$
Ans.
$\{\emptyset, \{1\}, \{2\}, \{3\}, \{1,2\}, \{1,3\}, \{2,3\}, \{1,2,3\}\}$

c) $P(\{\emptyset\})$
Ans.
$\{\emptyset, \{\emptyset\}\}$

d) $\{(x,y)|x^2 + y^2 = 1\} \cap \{(x,y)|x = y \text{ and } x \in \mathbb{R} \text{ and } y \in \mathbb{R}\}$
Ans.
$\left\{\left(\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right), \left(-\frac{1}{\sqrt{2}}, -\frac{1}{\sqrt{2}}\right)\right\}$

Note: P(S) is the powerset of S. N is the set of natural numbers. R is the set of real numbers.

PGML code (contains error):

```
# DESCRIPTION
# A problem from Discrete Mathematics Assignment 4
# WeBWorK problem written by Jason LONG
# ENDDESCRIPTION

## KEYWORDS('Discrete Structure')
## TitleText1('MATH2003 23S A4')
## AuthorText1('Big Brother')
## Author('Jason LONG')
## Institution('BNBU')

DOCUMENT();

loadMacros(
  "PGstandard.pl",
  "PGML.pl",
  "MathObjects.pl",
  "contextLimitedNumeric.pl",
);
```

```
Context("Interval");
Context()->flags->set(reduceConstants=>0); # Preserve sqrt notation

# Define answers
$ans1 = Set(0,1,2,3,4,5);
$ans2 = Set(
    Set(), Set(1), Set(2), Set(3),
    Set(1,2), Set(1,3), Set(2,3), Set(1,2,3)
);
$ans3 = Set(Set(), Set(Set()));
$ans4 = Set(
    List(1/sqrt(2),1/sqrt(2)),
    List(-1/sqrt(2),-1/sqrt(2))
);
```

```
BEGIN_PGML
List all elements of the following sets.

a) [`\{x \mid x \in \mathbf{N} \text{ and } x \leq 5\}`]
[_]{$ans1}

b) [`\{x \mid x \subseteq \{1,2,3\}\}`]
[_]{$ans2}

c) [`\mathcal{P}(\{\emptyset\})`]
[_]{$ans3}

d) [`\{(x,y) \mid x^2 + y^2 = 1\} \cap \{(x,y) \mid x = y \text{ and } x,y \in \mathbb{R}\}`]
[_]{$ans4}

*Note*: [`\mathcal{P}(S)`] is the power set of [`S`]. [`\mathbf{N}`] = natural numbers,
[`\mathbb{R}`] = real numbers.
END_PGML
```

```
BEGIN_PGML_SOLUTION
*Answers*:

a) [`{$ans1}`]

b) [`{$ans2}`]

c) [`{$ans3}`]

d) [`{$ans4}`]
END_PGML_SOLUTION
```

```
ENDDOCUMENT();
```

A5 Q4:

Question 4.

Rewrite the following formulas in summations

  a) $1 + 2^2 + 3^3 + \cdots + n^n$
  b) $1 + 2 + 4 + 8 + 16 + \cdots$
  c) $a_0 + a_1 x + a_2 x^2 + a_3 x^3 + \cdots$

Ans.

a) $\sum_{k=1}^{n} k^k$

b) $\sum_{k=0}^{\infty} 2^k$

c) $\sum_{k=0}^{\infty} a_k x^k$

REF: Formula_(MathObject_Class)_-_WeBWorK_wiki
Mathematical notation - PGML - WeBWorK_wiki

PGML code (contains error):

```perl
# DESCRIPTION
# A problem from Discrete Mathematics Assignment 4
# WeBWorK problem written by Jason LONG
# ENDDESCRIPTION


## KEYWORDS('Discrete Structure')
## TitleText1('MATH2003 23S A5')
## AuthorText1('Big Brother')
## Author('Jason LONG')
## Institution('BNBU')


DOCUMENT();


loadMacros(
  "PGstandard.pl",
  "PGML.pl",
  "MathObjects.pl",
);


Context("Math");  # Use a math context
# Declare any variables that will appear in the formulas
Context()->variables->add(n => 'PositiveInteger');
Context()->variables->add(k => 'PositiveInteger');
Context()->variables->add(x => 'Real');
Context()->variables->add(a => 'Real');


# Define the correct answers as Formula MathObjects.
# Use \sum_{lower}^{upper} for summations; \infty is used for infinity.
$ans1 = Formula("\\sum_{k=1}^n k^k");              # 1 + 2^2 + ... + n^n
$ans2 = Formula("\\sum_{k=0}^{\\infty} 2^k");       # 1 + 2 + 4 + 8 + ... = sum 2^k from
k=0 to infinity
$ans3 = Formula("\\sum_{k=0}^{\\infty} a_k x^k");   # a_0 + a_1 x + a_2 x^2 + ... = sum
a_k x^k
```

BEGIN_PGML
Rewrite the following formulas in summations

a) [`1 + 2^2 + 3^3 + \cdots + n^n`]
[_____]{$ans1}

b) [`1 + 2 + 4 + 8 + 16 + \cdots`]
[_____]{$ans2}

c) [`a_0 + a_1x + a_2x^2 + a_3x^3 + \cdots`]
[_____]{$ans3}
END_PGML

BEGIN_PGML_SOLUTION
Answers:

a) [`\sum_{k=1}^n k^k`]

b) [`\sum_{k=0}^\infty 2^k`]

c) [`\sum_{k=0}^\infty a_k x^k`]
END_PGML_SOLUTION

ENDDOCUMENT();