

Examples

# MathML in ConTeXt

Hans Hagen

PRAGMA ADE

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## Integrals

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wh-g-004	wh-g-008	wh-g-012	wh-g-016

# Colofon

This document shows a few formulas coded in MATHML and typeset by  $\text{CON}\text{T}_{\text{E}}\text{X}\text{T}$ . The examples are taken from an old copy of ‘Handbook of Chemistry and Physics’ as well as ‘Wiskunde voor het HBO (R. van Asselt et al.)’. We assume no responsibility for the coding being 100% all correct.

These examples are typeset using the default settings. There are several ways to influence the look and feel of a formula. Details on how to process MATHML can be found in the XML related documentation that comes with  $\text{CON}\text{T}_{\text{E}}\text{X}\text{T}$ .

You can get more information on  $\text{CON}\text{T}_{\text{E}}\text{X}\text{T}$  at our website, in  $\text{T}_{\text{E}}\text{X}$  usergroup publications and in (the archives of) the  $\text{CON}\text{T}_{\text{E}}\text{X}\text{T}$  mailing list.

Hans Hagen

Hasselt, January 2001 / June 2008

[www.pragma-ade.com](http://www.pragma-ade.com)

# Derivatives

pc-d-001	pc-d-004	pc-d-007	pc-d-010	pc-d-051
pc-d-002	pc-d-005	pc-d-008	pc-d-011	
pc-d-003	pc-d-006	pc-d-009	pc-d-043	

$$\frac{da}{dx} = 0$$

```
<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <eq/>
    <apply> <diff/>
      <bvar> <ci> x </ci> </bvar>
      <ci> a </ci>
    </apply>
    <ci> 0 </ci>
  </apply>
</math>
```

$$\frac{dx}{dx} = 1$$

```
<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <eq/>
    <apply> <diff/>
      <bvar> <ci> x </ci> </bvar>
      <ci> x </ci>
    </apply>
    <cn> 1 </cn>
  </apply>
</math>
```

$$\frac{dau}{dx} = a \frac{du}{dx}$$

```
<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <eq/>
    <apply> <diff/>
      <bvar> <ci> x </ci> </bvar>
      <apply> <times/>
        <ci> a </ci>
        <ci> u </ci>
      </apply>
    </apply>
    <apply> <times/>
      <ci> a </ci>
      <apply> <diff/>
        <bvar> <ci> x </ci> </bvar>
        <ci> u </ci>
      </apply>
    </apply>
  </apply>
</math>
```

$$\frac{du + v + w}{dx} = \frac{du}{dx} + \frac{dv}{dx} + \frac{dw}{dx}$$

```
<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <eq/>
    <apply> <diff/>
      <bvar> <ci> x </ci> </bvar>
      <apply> <plus/>
        <ci> u </ci>
        <ci> v </ci>
        <ci> w </ci>
      </apply>
    </apply>
    <apply> <plus/>
      <apply> <diff/>
        <bvar> <ci> x </ci> </bvar>
        <ci> u </ci>
      </apply>
      <apply> <diff/>
        <bvar> <ci> x </ci> </bvar>
        <ci> v </ci>
      </apply>
      <apply> <diff/>
        <bvar> <ci> x </ci> </bvar>
        <ci> w </ci>
      </apply>
    </apply>
  </math>
```



$$\frac{duv}{dx} = u \frac{du}{dx} + v \frac{dv}{dx}$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <eq/>
    <apply> <diff/>
      <bvar> <ci> x </ci> </bvar>
      <apply> <times/>
        <ci> u </ci>
        <ci> v </ci>
      </apply>
    </apply>
    <apply> <plus/>
      <apply> <times/>
        <ci> u </ci>
        <apply> <diff/>
          <bvar> <ci> x </ci>
          </bvar> <ci> u </ci>
        </apply>
      </apply>
      <apply> <times/>
        <ci> v </ci>
        <apply> <diff/>
          <bvar> <ci> x </ci>
          </bvar> <ci> v </ci>
        </apply>
      </apply>
    </apply>
  </math>

```

$$\frac{duvw}{dx} = uv \frac{dw}{dx} + vw \frac{du}{dx} + uw \frac{dv}{dx}$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>  </apply>
<apply> <eq/>                                           </math>
  <apply> <diff/>
    <bvar> <ci> x </ci> </bvar>
    <apply> <times/>
      <ci> u </ci>
      <ci> v </ci>
      <ci> w </ci>
    </apply>
  </apply>
<apply> <plus/>
  <apply> <times/>
    <ci> u </ci>
    <ci> v </ci>
    <apply> <diff/>
      <bvar> <ci> x </ci> </bvar>
      <ci> w </ci>
    </apply>
  </apply>
<apply> <times/>
  <ci> v </ci>
  <ci> w </ci>
  <apply> <diff/>
    <bvar> <ci> x </ci> </bvar>
    <ci> u </ci>
  </apply>
</apply>
<apply> <times/>
  <ci> u </ci>
  <ci> w </ci>
  <apply> <diff/>
    <bvar> <ci> x </ci> </bvar>
    <ci> v </ci>
  </apply>
</apply>
</apply>

```

$$\frac{d}{dx} \frac{u}{v} = \frac{v \frac{du}{dx} - u \frac{dv}{dx}}{v^2} = \frac{1}{v} \frac{du}{dx} - \frac{u}{v^2} \frac{dv}{dx}$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <eq/>
    <apply> <diff/>
      <bvar> <ci> x </ci> </bvar>
      <apply> <divide/>
        <ci> u </ci>
        <ci> v </ci>
      </apply>
    </apply>
    <apply> <divide/>
      <apply> <minus/>
        <apply> <times/>
          <ci> v </ci>
          <apply> <diff/>
            <bvar> <ci> x </ci> </bvar>
            <ci> u </ci>
          </apply>
        </apply>
        <apply> <times/>
          <ci> u </ci>
          <apply> <diff/>
            <bvar> <ci> x </ci> </bvar>
            <ci> v </ci>
          </apply>
        </apply>
      </apply>
      <apply> <power/>
        <ci> v </ci>
        <cn> 2 </cn>
      </apply>
    </apply>
    <apply> <diff/>
      <bvar> <ci> x </ci> </bvar>
      <ci> v </ci>
    </apply>
  </math>

```

$$\frac{du^n}{dx} = n(u)^{n-1} \frac{du}{dx}$$

```
<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <eq/>
    <apply> <diff/>
      <bvar> <ci> x </ci> </bvar>
      <apply> <power/>
        <ci> u </ci>
        <ci> n </ci>
      </apply>
    </apply>
    <apply> <times/>
      <ci> n </ci>
      <apply> <power/>
        <ci> u </ci>
        <apply> <minus/>
          <ci> n </ci>
          <cn> 1 </cn>
        </apply>
      </apply>
    </apply>
    <apply> <diff/>
      <bvar> <ci> x </ci> </bvar>
      <ci> u </ci>
    </apply>
  </apply>
</math>
```

$$\frac{d\sqrt{u}}{dx} = \frac{1}{2\sqrt{u}} \frac{du}{dx}$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <eq/>
    <apply> <diff/>
      <bvar> <ci> x </ci> </bvar>
      <apply> <root/>
        <ci> u </ci>
      </apply>
    </apply>
    <apply> <times/>
      <apply> <divide/>
        <cn> 1 </cn>
        <apply> <times/>
          <cn> 2 </cn>
          <apply> <root/>
            <ci> u </ci>
          </apply>
        </apply>
      </apply>
    </apply>
    <apply> <diff/>
      <bvar> <ci> x </ci> </bvar>
      <ci> u </ci>
    </apply>
  </apply>
</math>

```

$$\frac{d\frac{1}{u}}{dx} = -\frac{1}{u^2} \frac{du}{dx}$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <eq/>
    <apply> <diff/>
      <bvar> <ci> x </ci> </bvar>
      <apply> <divide/>
        <cn> 1 </cn>
        <ci> u </ci>
      </apply>
    </apply>
    <apply> <times/>
      <apply> <minus/>
        <apply> <divide/>
          <cn> 1 </cn>
          <apply> <power/>
            <ci> u </ci>
            <cn> 2 </cn>
          </apply>
        </apply>
      </apply>
      <apply> <diff/>
        <bvar> <ci> x </ci> </bvar>
        <ci> u </ci>
      </apply>
    </apply>
  </math>

```

$$\frac{d \frac{1}{u^n}}{dx} = - \frac{n}{(u)^{n+1}} \frac{du}{dx}$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <eq/>
    <apply> <diff/>
      <bvar> <ci> x </ci> </bvar>
      <apply> <divide/>
        <cn> 1 </cn>
        <apply> <power/>
          <ci> u </ci>
          <cn> n </cn>
        </apply>
      </apply>
    </apply>
    <apply> <times/>
      <apply> <minus/>
        <apply> <divide/>
          <ci> n </ci>
          <apply> <power/>
            <ci> u </ci>
            <apply> <plus/>
              <ci> n </ci>
              <cn> 1 </cn>
            </apply>
          </apply>
        </apply>
      </apply>
      <apply> <diff/>
        <bvar> <ci> x </ci> </bvar>
        <ci> u </ci>
      </apply>
    </apply>
  </math>

```

$$\frac{d}{dx} = \frac{d \log(u + \sqrt{u^2 + 1})}{dx} = \frac{1}{\sqrt{u^2 + 1}} \frac{du}{dx}$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <eq/>
    <apply> <diff/>
      <bvar> <ci> x </ci> </bvar>
      <apply> <inverse/>
        <apply> <sinh/>
          <ci> u </ci>
        </apply>
      </apply>
    </apply>
  <apply> <diff/>
    <bvar> <ci> x </ci> </bvar>
    <apply> <log/>
      <apply> <plus/>
        <ci> u </ci>
        <apply> <root/>
          <apply> <plus/>
            <apply> <power/>
              <ci> u </ci>
              <cn> 2 </cn>
            </apply>
            <cn> 1 </cn>
          </apply>
        </apply>
      </apply>
    </apply>
  </math>

```



$$\frac{d \int_p^q f(x, a) dx}{da}$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <eq/>
    <apply> <diff/>
      <bvar> <ci> a </ci> </bvar>
      <apply> <int/>
        <lowlimit> <ci> p </ci> </lowlimit>
        <uplimit> <ci> q </ci> </uplimit>
        <bvar> <ci> x </ci> </bvar>
        <apply>
          <fn> <ci> f </ci> </fn>
          <ci> x </ci>
          <ci> a </ci>
        </apply>
      </apply>
    </apply>
  </math>

```

# Integrals

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$$\int \left( \frac{1}{x\sqrt{\pm a^2 x^2}} \right) dx = -\frac{1}{a} \log \frac{a + \sqrt{\pm a^2 x^2}}{x}$$

```
<math xmlns='http://www.w3c.org/mathml' version='2.0'>
```

```
<apply> <eq/>
```

```
<apply> <int/>
```

```
<bvar> <ci> x </ci> </bvar>
```

```
<apply> <divide/>
```

```
<cn> 1 </cn>
```

```
<apply> <times/>
```

```
<ci> x </ci>
```

```
<apply> <root/>
```

```
<apply> <fn> <ci> &plusminus; </ci> </fn>
```

```
<apply> <power/>
```

```
<ci> a </ci>
```

```
<cn> 2 </cn>
```

```
</apply>
```

```
<apply> <power/>
```

```
<ci> x </ci>
```

```
<cn> 2 </cn>
```

```
</apply>
```

```
</apply>
```

```
</apply>
```

```
</apply>
```

```
</apply>
```

```
</apply>
```

```
<apply> <minus/>
```

```
<apply> <times/>
```

```
<apply> <divide/>
```

```
<cn> 1 </cn> <ci> a </ci>
```

```
</apply>
```

```
<apply> <log/>
```

```
<apply> <divide/>
```

```
<apply> <plus/>
```

```
<ci> a </ci>
```

```
<apply> <root/>
```

```
<apply> <fn> <ci> &plusminus; </ci> </fn>
```

```
<apply> <power/>
```

```
<ci> a </ci>
```

```
<cn> 2 </cn>
```

```
</apply>
```

```
<apply> <power/>
```

```
<ci> x </ci>
```

```
<cn> 2 </cn>
```

```
</apply>
```

```
</apply>
```

```
</apply>
```

```
</apply>
```

```
<ci> x </ci>
```

```
</apply>
```

```
</apply>
```

```
</apply>
```

```
</apply>
```

```
</apply>
```

```
</math>
```

$$\int \left( \frac{1}{\cos(ax)(\pm 1 \sin(ax))} \right) dx = \left( \mp \frac{1}{2a(\pm 1 \sin(ax))} \right) + \frac{1}{2a} \log \tan \left( \frac{\pi}{4} + \frac{ax}{2} \right)$$

<math xmlns='http://www.w3c.org/mathml' version='2.0'>

<apply> <eq/>

<apply> <int/>

<bvar> <ci> x </ci> </bvar>

<apply> <divide/>

<cn> 1 </cn>

<apply> <times/>

<apply> <cos/>

<apply> <times/>

<ci> a </ci>

<ci> x </ci>

</apply>

</apply>

<apply> <fn> <ci> &plusminus; </ci> </fn>

<cn> 1 </cn>

<apply> <sin/>

<apply> <times/>

<ci> a </ci>

<ci> x </ci>

</apply>

</apply>

</apply>

</apply>

</apply>

</apply>

<apply> <plus/>

<apply> <fn> <ci> &minusplus; </ci> </fn>

<apply> <divide/>

<cn> 1 </cn>

<apply> <times/>

<cn> 2 </cn>

<ci> a </ci>

<apply> <fn> <ci> &plusminus; </ci> </fn>

<cn> 1 </cn>

<apply> <sin/>

<apply> <times/>

<ci> a </ci>

<ci> x </ci>

</apply>

</apply>

</apply>

</apply>

</apply>

</apply>

<apply> <times/>

<apply> <divide/>

<cn> 1 </cn>

<apply> <times/>

<cn> 2 </cn>

<ci> a </ci>

</apply>

</apply>

<apply> <log/>

<apply> <tan/>

<apply> <plus/>

<apply> <divide/>

<ci> &pi; </ci>

<cn> 4 </cn>

</apply>

<apply> <divide/>

<apply> <times/>

<ci> a </ci>

<ci> x </ci>

</apply>

<cn> 2 </cn>

</apply>

</apply>

</apply>

</apply>

</apply>

</apply>

</apply>

`</math>`

# Series

pc-s-001

pc-s-002

pc-s-003

wh-s-001

wh-s-002

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$$1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \dots = \frac{\pi}{4}$$

```
<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <eq/>
    <apply> <plus/>
      <cn> 1 </cn>
      <apply> <minus/>
        <apply> <divide/>
          <cn> 1 </cn>
          <cn> 3 </cn>
        </apply>
      </apply>
    <apply> <divide/>
      <cn> 1 </cn>
      <cn> 5 </cn>
    </apply>
    <apply> <minus/>
      <apply> <divide/>
        <cn> 1 </cn>
        <cn> 7 </cn>
      </apply>
    </apply>
    <ci> &cdots; </ci>
  </apply>
  <apply> <divide/>
    <ci> &pi; </ci>
    <cn> 4 </cn>
  </apply>
</apply>
</math>
```

$$1 + \frac{1}{2^2} + \frac{1}{3^2} + \frac{1}{4^2} + \dots = \frac{\pi^2}{6}$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <eq/>
    <apply> <plus/>
      <cn> 1 </cn>
      <apply> <divide/>
        <cn> 1 </cn>
        <apply> <power/>
          <cn> 2 </cn>
          <cn> 2 </cn>
        </apply>
      </apply>
      <apply> <divide/>
        <cn> 1 </cn>
        <apply> <power/>
          <cn> 3 </cn>
          <cn> 2 </cn>
        </apply>
      </apply>
      <apply> <divide/>
        <cn> 1 </cn>
        <apply> <power/>
          <cn> 4 </cn>
          <cn> 2 </cn>
        </apply>
      </apply>
      <ci> &cdots; </ci>
    </apply>
    <apply> <divide/>
      <apply> <power/>
        <ci> &pi; </ci>
        <cn> 2 </cn>
      </apply>
      <cn> 6 </cn>
    </apply>
  </apply>
</math>

```



$$1 - \frac{1}{2^2} + \frac{1}{3^2} - \frac{1}{4^2} + \dots = \frac{\pi^2}{12}$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>      <cn> 12 </cn>
  <apply> <eq/>                                              </apply>
    <apply> <plus/>                                          </apply>
      <cn> 1 </cn>
      <apply> <minus/>
        <apply> <divide/>
          <cn> 1 </cn>
          <apply> <power/>
            <cn> 2 </cn>
            <cn> 2 </cn>
          </apply>
        </apply>
      </apply>
    <apply> <divide/>
      <cn> 1 </cn>
      <apply> <power/>
        <cn> 3 </cn>
        <cn> 2 </cn>
      </apply>
    </apply>
    <apply> <minus/>
      <apply> <divide/>
        <cn> 1 </cn>
        <apply> <power/>
          <cn> 4 </cn>
          <cn> 2 </cn>
        </apply>
      </apply>
    </apply>
    <ci> &cdots; </ci>
  </apply>
  <apply> <divide/>
    <apply> <power/>
      <ci> &pi; </ci>
      <cn> 2 </cn>
    </apply>
  </apply>

```

$$\forall x \in \left| e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \dots + \frac{x^n}{n!} + \dots \right.$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <forall/>
    <condition>
      <apply> <in/>
        <ci> x </ci>
        <ci> &reals; </ci>
      </apply>
    </condition>
    <apply> <eq/>
      <apply> <power/>
        <ci> &exponentiale; </ci>
        <ci> x </ci>
      </apply>
      <apply> <plus/>
        <cn> 1 </cn>
        <ci> x </ci>
        <apply> <divide/>
          <apply> <power/>
            <ci> x </ci>
            <cn> 2 </cn>
          </apply>
          <apply> <factorial/>
            <cn> 2 </cn>
          </apply>
        </apply>
      </apply>
      <apply> <divide/>
        <apply> <power/>
          <ci> x </ci>
          <cn> 3 </cn>
        </apply>
        <apply> <factorial/>
          <cn> 3 </cn>
        </apply>
      </apply>
    <ci> &cdots; </ci>
  </math>

```

```

<math>
  <forall>
    <condition>
      <in>
        x
        reals
      </in>
    <eq>
      <power>
        &exponentiale
        x
      </power>
      <plus>
        1
        x
        <divide>
          <power>
            x
            2
          </power>
          <factorial>
            2
          </factorial>
        </divide>
      </plus>
      <divide>
        <power>
          x
          3
        </power>
        <factorial>
          3
        </factorial>
      </divide>
    &cdots
  </forall>
</math>

```

$$\forall x \in \left| (e)^{-x} = 1 - x + \frac{x^2}{2!} - \frac{x^3}{3!} + \dots + (-1)^n \frac{x^n}{n!} \dots \right.$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <forall/>
    <condition>
      <apply> <in/>
        <ci> x </ci>
        <ci> &reals; </ci>
      </apply>
    </condition>
    <apply> <eq/>
      <apply> <power/>
        <ci> &exponentiale; </ci>
        <apply> <minus/>
          <ci> x </ci>
        </apply>
      </apply>
      <apply> <plus/>
        <cn> 1 </cn>
        <apply> <minus/>
          <ci> x </ci>
        </apply>
        <apply> <divide/>
          <apply> <power/>
            <ci> x </ci>
            <cn> 2 </cn>
          </apply>
          <apply> <factorial/>
            <cn> 2 </cn>
          </apply>
        </apply>
      </apply>
      <apply> <minus/>
        <apply> <divide/>
          <apply> <power/>
            <ci> x </ci>
            <cn> 3 </cn>
          </apply>

```

```

        <apply> <factorial/>
          <cn> 3 </cn>
        </apply>
      </apply>
    </apply>
    <ci> &cdots; </ci>
    <apply> <times/>
      <apply> <power/>
        <apply> <minus/>
          <cn> 1 </cn>
        </apply>
        <ci> n </ci>
      </apply>
      <apply> <divide/>
        <apply> <power/>
          <ci> x </ci>
          <ci> n </ci>
        </apply>
        <apply> <factorial/>
          <ci> n </ci>
        </apply>
      </apply>
      <ci> &cdots; </ci>
    </apply>
  </math>

```

# Logs

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+

$$\forall a > 0 \wedge b > 0 \mid \log_g (gab) = \log_g ga + \log_g gb$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <forall/>
    <condition>
      <apply> <and/>
        <apply> <gt/>
          <ci> a </ci>
          <cn> 0 </cn>
        </apply>
        <apply> <gt/>
          <ci> b </ci>
          <cn> 0 </cn>
        </apply>
      </apply>
    </condition>
    <apply> <eq/>
      <apply> <log/>
        <logbase> <ci> g </ci> </logbase>
        <apply> <times/>
          <ci> a </ci>
          <ci> b </ci>
        </apply>
      </apply>
      <apply> <plus/>
        <apply> <log/>
          <logbase> <ci> g </ci> </logbase>
          <ci> a </ci>
        </apply>
        <apply> <log/>
          <logbase> <ci> g </ci> </logbase>
          <ci> b </ci>
        </apply>
      </apply>
    </apply>
  </math>

```

$$\forall a > 0 \wedge b > 0 \mid \log_g g \frac{a}{b} = \log_g g a - \log_g g b$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <forall/>
    <condition>
      <apply> <and/>
        <apply> <gt/>
          <ci> a </ci>
          <cn> 0 </cn>
        </apply>
        <apply> <gt/>
          <ci> b </ci>
          <cn> 0 </cn>
        </apply>
      </condition>
    <apply> <eq/>
      <apply> <log/>
        <logbase> <ci> g </ci> </logbase>
        <apply> <divide/>
          <ci> a </ci>
          <ci> b </ci>
        </apply>
      </apply>
      <apply> <minus/>
        <apply> <log/>
          <logbase> <ci> g </ci> </logbase>
          <ci> a </ci>
        </apply>
        <apply> <log/>
          <logbase> <ci> g </ci> </logbase>
          <ci> b </ci>
        </apply>
      </apply>
    </apply>
  </math>

```

$$\forall b \in \mathbb{R} \wedge a > 0 \mid \log_g (ga^b) = b \log_g ga$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <forall/>
    <condition>
      <apply> <and/>
        <apply> <in/>
          <ci> b </ci>
          <ci> &reals; </ci>
        </apply>
        <apply> <gt/>
          <ci> a </ci>
          <cn> 0 </cn>
        </apply>
      </apply>
    </condition>
    <apply> <eq/>
      <apply> <log/>
        <logbase> <ci> g </ci> </logbase>
        <apply> <power/>
          <ci> a </ci>
          <ci> b </ci>
        </apply>
      </apply>
      <apply> <times/>
        <ci> b </ci>
        <apply> <log/>
          <logbase> <ci> g </ci> </logbase>
          <ci> a </ci>
        </apply>
      </apply>
    </apply>
  </math>

```

$$\forall a > 0 \left| \log_g ga = \frac{\log_p pa}{\log_p pg} \right.$$

```
<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <forall/>
    <condition>
      <apply> <and/>
        <apply> <gt/>
          <ci> a </ci>
          <cn> 0 </cn>
        </apply>
      </apply>
    </condition>
    <apply> <eq/>
      <apply> <log/>
        <logbase> <ci> g </ci> </logbase>
        <ci> a </ci>
      </apply>
      <apply> <divide/>
        <apply> <log/>
          <logbase> <ci> p </ci> </logbase>
          <ci> a </ci>
        </apply>
        <apply> <log/>
          <logbase> <ci> p </ci> </logbase>
          <ci> g </ci>
        </apply>
      </apply>
    </apply>
  </math>
```



# Goniometrics

wh-g-001	wh-g-005	wh-g-009	wh-g-013
wh-g-002	wh-g-006	wh-g-010	wh-g-014
wh-g-003	wh-g-007	wh-g-011	wh-g-015
wh-g-004	wh-g-008	wh-g-012	wh-g-016

$$\sin(x + y) = \sin x \cos y + \cos x \sin y$$

```
<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <eq/>
    <apply> <sin/>
      <apply> <plus/>
        <ci> x </ci>
        <ci> y </ci>
      </apply>
    </apply>
    <apply> <plus/>
      <apply> <times/>
        <apply> <sin/>
          <ci> x </ci>
        </apply>
        <apply> <cos/>
          <ci> y </ci>
        </apply>
      </apply>
      <apply> <times/>
        <apply> <cos/>
          <ci> x </ci>
        </apply>
        <apply> <sin/>
          <ci> y </ci>
        </apply>
      </apply>
    </apply>
  </math>
```

$$\sin (x - y) = \sin x \cos y - \cos x \sin y$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <eq/>
    <apply> <sin/>
      <apply> <minus/>
        <ci> x </ci>
        <ci> y </ci>
      </apply>
    </apply>
    <apply> <minus/>
      <apply> <times/>
        <apply> <sin/>
          <ci> x </ci>
        </apply>
        <apply> <cos/>
          <ci> y </ci>
        </apply>
      </apply>
      <apply> <times/>
        <apply> <cos/>
          <ci> x </ci>
        </apply>
        <apply> <sin/>
          <ci> y </ci>
        </apply>
      </apply>
    </apply>
  </math>

```

$$\cos(x + y) = \cos x \cos y - \sin x \sin y$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <eq/>
    <apply> <cos/>
      <apply> <plus/>
        <ci> x </ci>
        <ci> y </ci>
      </apply>
    </apply>
    <apply> <minus/>
      <apply> <times/>
        <apply> <cos/>
          <ci> x </ci>
        </apply>
        <apply> <cos/>
          <ci> y </ci>
        </apply>
      </apply>
      <apply> <times/>
        <apply> <sin/>
          <ci> x </ci>
        </apply>
        <apply> <sin/>
          <ci> y </ci>
        </apply>
      </apply>
    </apply>
  </math>

```

$$\cos(x - y) = \cos x \cos y + \sin x \sin y$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <eq/>
    <apply> <cos/>
      <apply> <minus/>
        <ci> x </ci>
        <ci> y </ci>
      </apply>
    </apply>
    <apply> <plus/>
      <apply> <times/>
        <apply> <cos/>
          <ci> x </ci>
        </apply>
        <apply> <cos/>
          <ci> y </ci>
        </apply>
      </apply>
      <apply> <times/>
        <apply> <sin/>
          <ci> x </ci>
        </apply>
        <apply> <sin/>
          <ci> y </ci>
        </apply>
      </apply>
    </apply>
  </math>

```

$$\tan(x + y) = \frac{\tan x + \tan y}{1 - \tan x \tan y}$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <eq/>
    <apply> <tan/>
      <apply> <plus/>
        <ci> x </ci>
        <ci> y </ci>
      </apply>
    </apply>
    <apply> <divide/>
      <apply> <plus/>
        <apply> <tan/>
          <ci> x </ci>
        </apply>
        <apply> <tan/>
          <ci> y </ci>
        </apply>
      </apply>
      <apply> <minus/>
        <cn> 1 </cn>
        <apply> <times/>
          <apply> <tan/>
            <ci> x </ci>
          </apply>
          <apply> <tan/>
            <ci> y </ci>
          </apply>
        </apply>
      </apply>
    </apply>
  </math>

```

$$\tan(x - y) = \frac{\tan x - \tan y}{1 + \tan x \tan y}$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <eq/>
    <apply> <tan/>
      <apply> <minus/>
        <ci> x </ci>
        <ci> y </ci>
      </apply>
    </apply>
    <apply> <divide/>
      <apply> <minus/>
        <apply> <tan/>
          <ci> x </ci>
        </apply>
        <apply> <tan/>
          <ci> y </ci>
        </apply>
      </apply>
      <apply> <plus/>
        <cn> 1 </cn>
        <apply> <times/>
          <apply> <tan/>
            <ci> x </ci>
          </apply>
          <apply> <tan/>
            <ci> y </ci>
          </apply>
        </apply>
      </apply>
    </apply>
  </math>

```

$$\sin p + \sin q = 2 \sin \frac{p+q}{2} \cos \frac{p-q}{2}$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <eq/>
    <apply> <plus/>
      <apply> <sin/>
        <ci> p </ci>
      </apply>
      <apply> <sin/>
        <ci> q </ci>
      </apply>
    </apply>
    <apply> <times/>
      <cn> 2 </cn>
      <apply> <sin/>
        <apply> <divide/>
          <apply> <plus/>
            <ci> p </ci>
            <ci> q </ci>
          </apply>
          <cn> 2 </cn>
        </apply>
      </apply>
      <apply> <cos/>
        <apply> <divide/>
          <apply> <minus/>
            <ci> p </ci>
            <ci> q </ci>
          </apply>
          <cn> 2 </cn>
        </apply>
      </apply>
    </apply>
  </math>

```



$$\sin p - \sin q = 2 \cos \frac{p+q}{2} \sin \frac{p-q}{2}$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <eq/>
    <apply> <minus/>
      <apply> <sin/>
        <ci> p </ci>
      </apply>
      <apply> <sin/>
        <ci> q </ci>
      </apply>
    </apply>
    <apply> <times/>
      <cn> 2 </cn>
      <apply> <cos/>
        <apply> <divide/>
          <apply> <plus/>
            <ci> p </ci>
            <ci> q </ci>
          </apply>
          <cn> 2 </cn>
        </apply>
      </apply>
    </apply>
    <apply> <sin/>
      <apply> <divide/>
        <apply> <minus/>
          <ci> p </ci>
          <ci> q </ci>
        </apply>
        <cn> 2 </cn>
      </apply>
    </apply>
  </apply>
</math>

```

$$\cos p + \cos q = 2 \cos \frac{p+q}{2} \cos \frac{p-q}{2}$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <eq/>
    <apply> <plus/>
      <apply> <cos/>
        <ci> p </ci>
      </apply>
      <apply> <cos/>
        <ci> q </ci>
      </apply>
    </apply>
    <apply> <times/>
      <cn> 2 </cn>
      <apply> <cos/>
        <apply> <divide/>
          <apply> <plus/>
            <ci> p </ci>
            <ci> q </ci>
          </apply>
          <cn> 2 </cn>
        </apply>
      </apply>
      <apply> <cos/>
        <apply> <divide/>
          <apply> <minus/>
            <ci> p </ci>
            <ci> q </ci>
          </apply>
          <cn> 2 </cn>
        </apply>
      </apply>
    </apply>
  </math>

```

$$\cos p - \cos q = -2 \sin \frac{p+q}{2} \sin \frac{p-q}{2}$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <eq/>
    <apply> <minus/>
      <apply> <cos/>
        <ci> p </ci>
      </apply>
      <apply> <cos/>
        <ci> q </ci>
      </apply>
    </apply>
    <apply> <minus/>
      <apply> <times/>
        <cn> 2 </cn>
        <apply> <sin/>
          <apply> <divide/>
            <apply> <plus/>
              <ci> p </ci>
              <ci> q </ci>
            </apply>
            <cn> 2 </cn>
          </apply>
        </apply>
      </apply>
      <apply> <sin/>
        <apply> <divide/>
          <apply> <minus/>
            <ci> p </ci>
            <ci> q </ci>
          </apply>
          <cn> 2 </cn>
        </apply>
      </apply>
    </apply>
  </math>

```

$$2 \sin \alpha \cos \beta = \sin (\alpha + \beta) + \sin (\alpha - \beta)$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <eq/>
    <apply> <times/>
      <cn> 2 </cn>
      <apply> <sin/>
        <ci> &alpha; </ci>
      </apply>
      <apply> <cos/>
        <ci> &beta; </ci>
      </apply>
    </apply>
    <apply> <plus/>
      <apply> <sin/>
        <apply> <plus/>
          <ci> &alpha; </ci>
          <ci> &beta; </ci>
        </apply>
      </apply>
      <apply> <sin/>
        <apply> <minus/>
          <ci> &alpha; </ci>
          <ci> &beta; </ci>
        </apply>
      </apply>
    </apply>
  </math>

```

$$2 \cos \alpha \sin \beta = \sin(\alpha + \beta) - \sin(\alpha - \beta)$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <eq/>
    <apply> <times/>
      <cn> 2 </cn>
      <apply> <cos/>
        <ci> &alpha; </ci>
      </apply>
      <apply> <sin/>
        <ci> &beta; </ci>
      </apply>
    </apply>
    <apply> <minus/>
      <apply> <sin/>
        <apply> <plus/>
          <ci> &alpha; </ci>
          <ci> &beta; </ci>
        </apply>
      </apply>
      <apply> <sin/>
        <apply> <minus/>
          <ci> &alpha; </ci>
          <ci> &beta; </ci>
        </apply>
      </apply>
    </apply>
  </math>

```

$$2 \cos \alpha \cos \beta = \cos (\alpha + \beta) + \cos (\alpha - \beta)$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <eq/>
    <apply> <times/>
      <cn> 2 </cn>
      <apply> <cos/>
        <ci> &alpha; </ci>
      </apply>
      <apply> <cos/>
        <ci> &beta; </ci>
      </apply>
    </apply>
    <apply> <plus/>
      <apply> <cos/>
        <apply> <plus/>
          <ci> &alpha; </ci>
          <ci> &beta; </ci>
        </apply>
      </apply>
      <apply> <cos/>
        <apply> <minus/>
          <ci> &alpha; </ci>
          <ci> &beta; </ci>
        </apply>
      </apply>
    </apply>
  </math>

```

$$-2 \sin \alpha \cos \beta = \sin(\alpha + \beta) - \sin(\alpha - \beta)$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <eq/>
    <apply> <minus/>
      <apply> <times/>
        <cn> 2 </cn>
        <apply> <sin/>
          <ci> &alpha; </ci>
        </apply>
        <apply> <cos/>
          <ci> &beta; </ci>
        </apply>
      </apply>
    </apply>
    <apply> <minus/>
      <apply> <sin/>
        <apply> <plus/>
          <ci> &alpha; </ci>
          <ci> &beta; </ci>
        </apply>
      </apply>
      <apply> <sin/>
        <apply> <minus/>
          <ci> &alpha; </ci>
          <ci> &beta; </ci>
        </apply>
      </apply>
    </apply>
  </math>

```

$$\forall ABC \left| \frac{a}{\sin \alpha} + \frac{b}{\sin \beta} + \frac{c}{\sin \gamma} \right|$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <forall/>
    <condition>
      <mrow>
        <mi> &triangle; </mi>
        <mi> A </mi>
        <mi> B </mi>
        <mi> C </mi>
      </mrow>
    </condition>
    <apply> <plus/>
      <apply> <divide/>
        <ci> a </ci>
        <apply> <sin/>
          <ci> &alpha; </ci>
        </apply>
      </apply>
      <apply> <divide/>
        <ci> b </ci>
        <apply> <sin/>
          <ci> &beta; </ci>
        </apply>
      </apply>
      <apply> <divide/>
        <ci> c </ci>
        <apply> <sin/>
          <ci> &gamma; </ci>
        </apply>
      </apply>
    </apply>
  </math>

```



$$\forall ABC \left| \begin{array}{l} a^2 = b^2 + c^2 - 2bc \cos \alpha \\ b^2 = a^2 + c^2 - 2ac \cos \beta \\ c^2 = a^2 + b^2 - 2ab \cos \gamma \end{array} \right.$$

```

<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <forall/>
    <condition>
      <mrow>
        <mi> &triangle; </mi>
        <mi> A </mi>
        <mi> B </mi>
        <mi> C </mi>
      </mrow>
    </condition>
    <apply> <eq/>
      <apply> <power/>
        <ci> a </ci>
        <cn> 2 </cn>
      </apply>
      <apply> <plus/>
        <apply> <power/>
          <ci> b </ci>
          <cn> 2 </cn>
        </apply>
        <apply> <power/>
          <ci> c </ci>
          <cn> 2 </cn>
        </apply>
        <apply> <minus/>
          <apply> <times/>
            <cn> 2 </cn>
            <ci> b </ci>
            <ci> c </ci>
          <apply> <cos/>
            <ci> &alpha; </ci>
          </apply>
        </apply>
      </apply>
    </apply>
  </apply>
  </apply>
  <apply> <eq/>
    <apply> <power/>
      <ci> b </ci>
      <cn> 2 </cn>
    </apply>
    <apply> <plus/>
      <apply> <power/>
        <ci> a </ci>
        <cn> 2 </cn>
      </apply>
      <apply> <power/>
        <ci> c </ci>
        <cn> 2 </cn>
      </apply>
      <apply> <minus/>
        <apply> <times/>
          <cn> 2 </cn>
          <ci> a </ci>
          <ci> c </ci>
        <apply> <cos/>
          <ci> &beta; </ci>
        </apply>
      </apply>
    </apply>
  </apply>
  <apply> <eq/>
    <apply> <power/>
      <ci> c </ci>
      <cn> 2 </cn>
    </apply>
    <apply> <plus/>
      <apply> <power/>
        <ci> a </ci>

```

```

      <cn> 2 </cn>
    </apply>
  <apply> <power/>
    <ci> b </ci>
    <cn> 2 </cn>
  </apply>
  <apply> <minus/>
    <apply> <times/>
      <cn> 2 </cn>
      <ci> a </ci>
      <ci> b </ci>
      <apply> <cos/>
        <ci> &gamma; </ci>
      </apply>
    </apply>
  </apply>
</math>

```

# Derivatives

$$\frac{da}{dx} = 0$$

$$\frac{dx}{dx} = 1$$

$$\frac{da u}{dx} = a \frac{du}{dx}$$

$$\frac{du + v + w}{dx} = \frac{du}{dx} + \frac{dv}{dx} + \frac{dw}{dx}$$

$$\frac{duv}{dx} = u \frac{dv}{dx} + v \frac{du}{dx}$$

$$\frac{duvw}{dx} = uv \frac{dw}{dx} + vw \frac{du}{dx} + uw \frac{dv}{dx}$$

$$\frac{d \frac{u}{v}}{dx} = \frac{v \frac{du}{dx} - u \frac{dv}{dx}}{v^2} = \frac{1}{v} \frac{du}{dx} - \frac{u}{v^2} \frac{dv}{dx}$$

$$\frac{du^n}{dx} = n(u)^{n-1} \frac{du}{dx}$$

$$\frac{d\sqrt{u}}{dx} = \frac{1}{2\sqrt{u}} \frac{du}{dx}$$

$$\frac{d\frac{1}{u}}{dx} = -\frac{1}{u^2} \frac{du}{dx}$$

$$\frac{d\frac{1}{u^n}}{dx} = -\frac{n}{(u)^{n+1}} \frac{du}{dx}$$

$$\frac{d}{dx} = \frac{d \log \left( u + \sqrt{u^2 + 1} \right)}{dx} = \frac{1}{\sqrt{u^2 + 1}} \frac{du}{dx}$$

$$\frac{d \int_p^q f(x, a) dx}{da}$$

## Integrals

$$\int \left( \frac{1}{x \sqrt{\pm a^2 x^2}} \right) dx = -\frac{1}{a} \log \frac{a + \sqrt{\pm a^2 x^2}}{x}$$

$$\int \left( \frac{1}{\cos(ax)(\pm 1 \sin(ax))} \right) dx = \left( \mp \frac{1}{2a(\pm 1 \sin(ax))} \right) + \frac{1}{2a} \log \tan \left( \frac{\pi}{4} + \frac{ax}{2} \right)$$

## Series

$$1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \dots = \frac{\pi}{4}$$

$$1 + \frac{1}{2^2} + \frac{1}{3^2} + \frac{1}{4^2} + \dots = \frac{\pi^2}{6}$$

$$1 - \frac{1}{2^2} + \frac{1}{3^2} - \frac{1}{4^2} + \dots = \frac{\pi^2}{12}$$

$$\forall x \in \left| e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \dots + \frac{x^n}{n!} + \dots \right.$$

$$\forall x \in \left| (e)^{-x} = 1 - x + \frac{x^2}{2!} - \frac{x^3}{3!} + \dots + (-1)^n \frac{x^n}{n!} \dots \right.$$

## Logs

$$\forall a > 0 \wedge b > 0 \mid \log_g(gab) = \log_g ga + \log_g gb$$

$$\forall a > 0 \wedge b > 0 \left| \log_g g \frac{a}{b} = \log_g ga - \log_g gb \right.$$

$$\forall b \in \wedge a > 0 \left| \log_g (ga^b) = b \log_g ga \right.$$

$$\forall a > 0 \left| \log_g ga = \frac{\log_p pa}{\log_p pg} \right.$$

## Goniometrics

$$\sin (x + y) = \sin x \cos y + \cos x \sin y$$

$$\sin (x - y) = \sin x \cos y - \cos x \sin y$$

$$\cos (x + y) = \cos x \cos y - \sin x \sin y$$

$$\cos (x - y) = \cos x \cos y + \sin x \sin y$$

$$\tan (x + y) = \frac{\tan x + \tan y}{1 - \tan x \tan y}$$

$$\tan (x-y)=\frac{\tan x-\tan y}{1+\tan x \tan y}$$

$$\sin p+\sin q=2 \sin \frac{p+q}{2} \cos \frac{p-q}{2}$$

$$\sin p-\sin q=2 \cos \frac{p+q}{2} \sin \frac{p-q}{2}$$

$$\cos p+\cos q=2 \cos \frac{p+q}{2} \cos \frac{p-q}{2}$$

$$\cos p-\cos q=-2 \sin \frac{p+q}{2} \sin \frac{p-q}{2}$$

$$2 \sin \alpha \cos \beta=\sin (\alpha+\beta)+\sin (\alpha-\beta)$$

$$2 \cos \alpha \sin \beta=\sin (\alpha+\beta)-\sin (\alpha-\beta)$$

$$2 \cos \alpha \cos \beta=\cos (\alpha+\beta)+\cos (\alpha-\beta)$$

$$-2 \sin \alpha \cos \beta = \sin (\alpha + \beta) - \sin (\alpha - \beta)$$

$$\forall ABC \left| \frac{a}{\sin \alpha} + \frac{b}{\sin \beta} + \frac{c}{\sin \gamma} \right.$$

$$\forall ABC \left| \begin{array}{l} a^2 = b^2 + c^2 - 2bc \cos \alpha \\ b^2 = a^2 + c^2 - 2ac \cos \beta \\ c^2 = a^2 + b^2 - 2ab \cos \gamma \end{array} \right.$$