Examples

MathML in ConTEXt

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PRAGMA ADE

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This document shows a few formulas coded in MathML and typeset by ConTEXt. 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 ConTEXt.

You can get more information on ConTEXt at our website, in TEX usergroup publications and in (the archives of) the ConTEXt mailing list.

Hans Hagen
Hasselt, January 2001 / June 2008 / June 2015
www.pragma-ade.com

Derivatives

pc-d-001
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pc-d-006
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pc-d-008
pc-d-009
pc-d-010
pc-d-011
pc-d-043
pc-d-051

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

```
<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>
```

$$\frac{d\,(au)}{dx} = a\frac{du}{dx}$$

```
<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>
```

$$\frac{d\left(u+v+w\right)}{dx} = \frac{du}{dx} + \frac{dv}{dx} + \frac{dw}{dx}$$

```
<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>
  </apply>
</math>
```

$$\frac{d\,(uv)}{dx} = u\frac{du}{dx} + v\frac{dv}{dx}$$

```
<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>
  </apply>
</math>
```

$$\frac{d\,(uvw)}{dx} = vw\frac{du}{dx} + uw\frac{dv}{dx} + uv\frac{dw}{dx}$$

```
<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>
        <ci> w </ci>
      </apply>
    </apply>
    <apply> <plus/>
      <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> <times/>
        <ci> u </ci>
         <ci> v </ci>
        <apply> <diff/>
          <bvar> <ci> x </ci> </bvar>
          <ci> w </ci>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

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

```
<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> <minus/>
      <apply> <times/>
        <apply> <divide/>
          <cn> 1 </cn>
          <ci> v </ci>
        </apply>
        <apply> <diff/>
          <bvar> <ci> x </ci> </bvar>
          <ci> u </ci>
        </apply>
      </apply>
      <apply> <times/>
        <apply> <divide/>
          <cn> u </cn>
          <apply> <power/>
            <ci> v </ci>
            <cn> 2 </cn>
          </apply>
        </apply>
        <apply> <diff/>
          <bvar> <ci> x </ci> </bvar>
          <ci> v </ci>
        </apply>
      </apply>
    </apply>
  </apply>
</math>
```

$$\frac{d\left(u^{n}\right)}{dx} = n\left(u\right)\frac{du}{dx}$$

```
<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> <diff/>
        <bvar> <ci> x </ci> </bvar>
        <ci> u </ci>
      </apply>
    </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> <diff/>
        <bvar> <ci> x </ci> </bvar>
        <ci> u </ci>
      </apply>
    </apply>
  </apply>
</math>
```

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

```
<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>
  </apply>
</math>
```

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

```
<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>
  </apply>
</math>
```

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

```
<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>
    </apply>
    <apply> <times/>
      <apply> <divide/>
        <cn> 1 </cn>
        <apply> <root/>
          <apply> <plus/>
            <apply> <power/>
              <ci> u </ci>
              <cn> 2 </cn>
            </apply>
            <cn> 1 </cn>
          </apply>
        </apply>
      </apply>
      <apply> <diff/>
        <bvar> <ci> x </ci> </bvar>
        <ci> u </ci>
      </apply>
    </apply>
  </apply>
</math>
```

$$\frac{d\left(\int_{p}^{q} f(x,a)\ dx\right)}{da}$$

```
<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>
  </apply>
</math>
```

Integrals

pc-i-022

pc-i-380

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

```
<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>
```

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

```
<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

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

```
<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>
```

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

```
<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>
```

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

```
<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <eq/>
    <apply> <plus/>
      <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>
      <cn> 12 </cn>
    </apply>
  </apply>
</math>
```

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

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

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

```
<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> <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>
      </apply>
    </apply>
  </apply>
</math>
```

Logs

wh-l-001 wh-l-002 wh-l-003 wh-l-004

$$\forall\, a > 0 \wedge b > 0 \,\Big|\, \log_g ab = \log_g a + \log_g b$$

```
<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>
      </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>
  </apply>
</math>
```

$$\forall\, a > 0 \wedge b > 0 \;\Big|\; \log_g \frac{a}{b} = \log_g a - \log_g b$$

```
<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/>
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          <cn> 0 </cn>
        </apply>
      </apply>
    </condition>
    <apply> <eq/>
      <apply> <log/>
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        <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>
  </apply>
</math>
```

$$\forall\, b \in \mathbb{R} \wedge a > 0 \,\Big|\, \log_g a^b = b \log_g a$$

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

$$\forall\, a > 0 \;\Big|\; \log_g a = \frac{\log_p a}{\log_p g}$$

```
<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>
  </apply>
</math>
```

Goniometrics

wh-g-001
wh-g-002
wh-g-003
wh-g-004
wh-g-005
wh-g-006
wh-g-007
wh-g-008
wh-g-009
wh-g-010
wh-g-011
wh-g-012
wh-g-013
wh-g-014
wh-g-015
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/>
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        <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>
  </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>
  </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>
  </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>
  </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>
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        <cn> 1 </cn>
        <apply> <times/>
          <apply> <tan/>
            <ci> x </ci>
          </apply>
          <apply> <tan/>
            <ci> y </ci>
          </apply>
        </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>
  </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>
  </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> <sin/>
        <apply> <divide/>
          <apply> <minus/>
            <ci> p </ci>
            <ci> q </ci>
          </apply>
          <cn> 2 </cn>
        </apply>
      </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>
  </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> <sin/>
          <apply> <divide/>
            <apply> <minus/>
              <ci> p </ci>
              <ci> q </ci>
            </apply>
            <cn> 2 </cn>
          </apply>
        </apply>
      </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>
  </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>
  </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>
  </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>
  </apply>
</math>
```

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

```
<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <forall/>
    <condition>
      <mrow>
        <mi> &bigtriangleup; </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>
  </apply>
</math>
```

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

```
<math xmlns='http://www.w3c.org/mathml' version='2.0'>
  <apply> <forall/>
    <condition>
      <mrow>
        <mi> &bigtriangleup; </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> <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>
   <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>
    </apply>
  </apply>
</apply>
</math>
```

Derivatives

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

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

$$\frac{d\,(au)}{dx} = a\frac{du}{dx}$$

$$\frac{d\,(u+v+w)}{dx} = \frac{du}{dx} + \frac{dv}{dx} + \frac{dw}{dx}$$

$$\frac{d\,(uv)}{dx} = u\frac{du}{dx} + v\frac{dv}{dx}$$

$$\frac{d\,(uvw)}{dx} = vw\frac{du}{dx} + uw\frac{dv}{dx} + uv\frac{dw}{dx}$$

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

$$\frac{d\,(u^n)}{dx} = n\,(u)\,\frac{du}{dx}$$

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

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

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

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

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

Integrals

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

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

Series

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

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

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

$$\forall\, x \in \mathbb{R} \,\Big|\, e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \cdots + \frac{x^n}{n!} + \cdots$$

$$\forall\, x \in \mathbb{R} \,\Big|\, (e) = 1 - x + \frac{x^2}{2!} - \frac{x^3}{3!} + \cdots + (-1)\,\frac{x^n}{n!} \cdots$$

Logs

$$\forall\, a > 0 \wedge b > 0 \,\Big|\, \log_g ab = \log_g a + \log_g b$$

$$\forall\, a > 0 \wedge b > 0 \,\Big|\, \log_g \frac{a}{b} = \log_g a - \log_g b$$

$$\forall\, b \in \mathbb{R} \wedge a > 0 \,\Big|\, \log_g a^b = b \log_g a$$

$$\forall\, a > 0 \;\Big|\; \log_g a = \frac{\log_p a}{\log_p g}$$

Goniometrics

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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