CURRENT ISSUES:

* Replacement issues
* ISSUES WITH NEGATIVES!!!!

QUESTION — should outside brackets have to be \( ????

\partial\_{\mu} A \(Y \partial\_{\nu}h^{\mu \nu} + X \partial^{\mu} h^{\nu }\_{\nu}\)

\partial\_{\mu}\(YA \partial\_{\nu}h^{\mu \nu} +XA \partial^{\mu}h\_{\nu}^{\nu} \)

Contract:

\partial\_{\mu} A \(Y \partial\_{\nu}h^{\mu \nu} + X \partial^{\mu} h^{\nu }\_{\nu}\)

\(A^{\mu} + C^{}\(A^{\gamma} – B^{\zeta}\) \) -> INCORRECT

A^{\mu} + C^{}\(A^{\gamma} – B^{\zeta}\) -> NOT WORKING

\(A^{\gamma} - B^{\zeta}\) - WORKS

Reading in and understanding equations (display initial equation)

A^{\alpha}\frac{1}{3}B\_{\gamma}→ breaks (is this good or no??)

Equation: pop from empty list

A^{\alpha}3B\_{\gamma} → this one seems to work…

 A^{\alpha} B\_{\gamma}

QUESTION: does multiplication always need brackets? If no, when does it need them? Why does the whole number work but the fraction breaks….  
  
Please email jbrucero@uwo.ca for if you think this is a bug

\*\*\*\*\*things that shouldn’t work

\*\*\* uneven brackets

\(A + B → WORKING (though the message could be greatly improved)

"Equation:

Please email jbrucero@uwo.ca for if you think this is a bug”

\*\*\* uneven index brackets

A^{\gamma  → Working in that it should error but again the issue could probably be caught earlier and a better message given)

"Equation: string index out of range  
Please email jbrucero@uwo.ca for if you think this is a bug”

A^{\gamma} + B^{ → this one reads the equation fine - is this an issue???

\( A^{\gamma} + B^{} \)

\*\* multiple coefficients

\(XY Z \partial\_{\nu}h^{\mu \nu} + 6bX \partial^{\mu} h^{\nu }\_{\nu}\) -> WORKS

\(XY Z \partial\_{\nu}h^{\mu \nu} +6 bX \partial^{\mu}h\_{\nu}^{\nu} \)

\(XY \partial\_{\nu}h^{\mu \nu}Z + b6X \partial^{\mu} h^{\nu }\_{\nu}\) -> WORKS

\(XY Z \partial\_{\nu}h^{\mu \nu} +6 bX \partial^{\mu}h\_{\nu}^{\nu} \)

**Multiply**

**FOIL out terms, distributing derivatives when necessary (recommended)**

Basic case:

\(A^{}\) \partial\_{\mu} \(Y \partial\_{\nu}h^{\mu \nu} + X \partial^{\mu} h^{\nu }\_{\nu}\)   (NOT working) → \( A^{} \partial\_{\nu}\partial\_{\mu}h^{\mu \nu} + A^{} \partial^{\mu}\partial\_{\mu}h\_{\nu}^{\nu} \)

Also need to test adding summations, with and without partials, and subtracting summations, with and without partials

**distribute partial derivatives**

Basic case:

\partial\_{\mu} \(Y \partial\_{\nu}h^{\mu \nu} + X \partial^{\mu} h^{\nu }\_{\nu}\)  (Now WORKING) → \(Y \partial\_{\nu}\partial\_{\mu}h^{\mu \nu} +X \partial^{\mu}\partial\_{\mu}h\_{\nu}^{\nu} \)

\*\* number coefficients

\partial\_{\mu} \(5 \partial\_{\nu}h^{\mu \nu} + 3 \partial^{\mu} h^{\nu }\_{\nu}\)  -> WORKING  \(5 \partial\_{\nu}\partial\_{\mu}h^{\mu \nu} +3 \partial^{\mu}\partial\_{\mu}h\_{\nu}^{\nu} \)

\*\* mixed coefficients

\partial\_{\mu} \(5 \partial\_{\nu}h^{\mu \nu} + V \partial^{\mu} h^{\nu }\_{\nu}\) -> WORKING \(5 \partial\_{\nu}\partial\_{\mu}h^{\mu \nu} +V \partial^{\mu}\partial\_{\mu}h\_{\nu}^{\nu} \)

\*\* product rule

\partial\_{\mu} \( A^{\gamma}B^{\zeta}\) -> WORKING

 \( \partial\_{\mu}A^{\gamma} B^{\zeta} + \partial\_{\mu}B^{\zeta} A^{\gamma} \)

\*\* three term product rule

\partial\_{\mu} \( A^{\gamma}B^{\zeta}G^{\alpha}\) -> WORKING

\( \partial\_{\mu}A^{\gamma} B^{\zeta} G^{\alpha} + \partial\_{\mu}B^{\zeta} G^{\alpha} A^{\gamma} + \partial\_{\mu}G^{\alpha} B^{\zeta} A^{\gamma} \)

\*\*\* Distribute through multiple terms

\partial\_{\mu} \( A^{\gamma}B^{\zeta}\) \partial\_{\alpha}\(A\_{\gamma}\) + \partial\_{\alpha}\(G\_{\mu \zeta}\) -> WORKS

\( \partial\_{\mu}A^{\gamma} B^{\zeta} + \partial\_{\mu}B^{\zeta} A^{\gamma} \)\( \partial\_{\alpha}A\_{\gamma} \)+\( \partial\_{\alpha}G\_{\mu \zeta} \)

\*\* multiple partials product rule

\partial\_{\alpha}\partial\_{\gamma} \( A^{\alpha} B^{\gamma}\) -> WORKS

 \( \partial\_{\alpha}\partial\_{\gamma}A^{\alpha} B^{\gamma} + \partial\_{\gamma}B^{\gamma} \partial\_{\alpha}A^{\alpha} + \partial\_{\alpha}\partial\_{\gamma}B^{\gamma} A^{\alpha} + \partial\_{\gamma}A^{\alpha} \partial\_{\alpha}B^{\gamma} \)

\*\* what about squares

ISSUE

\square \(A^{\alpha}B\_{\alpha}\) -> NOT WORKING

\( \square A^{\alpha} B\_{\alpha} + \square B\_{\alpha} A^{\alpha} + \square B\_{\alpha} A^{\alpha} + \square A^{\alpha} B\_{\alpha} \)

\*\*\*\*\*\*\*\* also check with equals signssssss

It appears that numbers are working but symbolic coefficients are not

\*\* non-tensor terms

\*\* only partial terms

ALSO test product rule with multiple tensors!!!!

QUESTION: why num co, symco, AND tensorCos?? What happens with multiple coefficients???

**FOIL out terms without distributing derivatives**

Basic case:

\(A^{}\) \(Y \partial\_{\nu}h^{\mu \nu} + X \partial^{\mu} h^{\nu }\_{\nu}\)   (WORKS) → \(Y A^{} \partial\_{\nu}h^{\mu \nu} +X A^{} \partial^{\mu}h\_{\nu}^{\nu} \)

Alternate cases:

\*\*\* constants that can move through the derivatives

\partial\_{\mu} A \(Y \partial\_{\nu}h^{\mu \nu} + X \partial^{\mu} h^{\nu }\_{\nu}\)  (WORKS) → \partial\_{\mu}\(YA \partial\_{\nu}h^{\mu \nu} +XA \partial^{\mu}h\_{\nu}^{\nu} \)

A \partial\_{\mu} \(Y \partial\_{\nu}h^{\mu \nu} + X \partial^{\mu} h^{\nu }\_{\nu}\)  -> (NOT working) FIXED \partial\_{\mu}\(YA \partial\_{\nu}h^{\mu \nu} +XA \partial^{\mu}h\_{\nu}^{\nu} \)

4 \partial\_{\mu}  \(Y \partial\_{\nu}h^{\mu \nu} + X \partial^{\mu} h^{\nu }\_{\nu}\)  (working) → \partial\_{\mu}\(4 Y \partial\_{\nu}h^{\mu \nu} +4 X \partial^{\mu}h\_{\nu}^{\nu} \)

\*\*\* multiple terms

\(A + 5B + CD \) \partial\_{\mu} \(Y \partial\_{\nu}h^{\mu \nu} + X \partial^{\mu} h^{\nu }\_{\nu}\)  -> WORKS

\partial\_{\mu}\(YA \partial\_{\nu}h^{\mu \nu} +5 YB \partial\_{\nu}h^{\mu \nu} +YCD \partial\_{\nu}h^{\mu \nu} +XA \partial^{\mu}h\_{\nu}^{\nu} +5 XB \partial^{\mu}h\_{\nu}^{\nu} +XCD \partial^{\mu}h\_{\nu}^{\nu} \)

\*\*\* etas and deltas

\delta^{\gamma}\_{\zeta} \eta^{\nu \alpha} \partial\_{\mu} \(Y \partial\_{\nu}h^{\mu \zeta} + X \partial^{\mu} h^{\zeta }\_{\nu}\) -> WORKS

\partial\_{\mu}\(Y \delta\_{\zeta}^{\gamma} \eta^{\nu \alpha} \partial\_{\nu}h^{\mu \zeta} +X \delta\_{\zeta}^{\gamma} \eta^{\nu \alpha} \partial^{\mu}h\_{\nu}^{\zeta} \)

\*\*\* sum of mixed constants

\(A \eta^{\gamma \epsilon} + A5B + 56 \delta^{\phi}\_{\xi} \) \partial\_{\mu} \(Y \partial\_{\nu}h^{\mu \nu} + X \partial^{\mu} h^{\nu }\_{\nu}\) -> WORKS

\partial\_{\mu}\(YA \eta^{\gamma \epsilon} \partial\_{\nu}h^{\mu \nu} +5 YAB \partial\_{\nu}h^{\mu \nu} +56 Y \delta\_{\xi}^{\phi} \partial\_{\nu}h^{\mu \nu} +XA \eta^{\gamma \epsilon} \partial^{\mu}h\_{\nu}^{\nu} +5 XAB \partial^{\mu}h\_{\nu}^{\nu} +56 X \delta\_{\xi}^{\phi} \partial^{\mu}h\_{\nu}^{\nu} \)

TODO: decide on how partials behave then implement test cases for them

Question: do all nodes have summation objects or do some have multgroup objects?? – they appear to all be summation objects

\*\*\* derivative is attached to a multgroup and doesn’t need to be distributed

 \partial\_{\gamma}A^{\gamma}  \(Y \partial\_{\mu}\partial\_{\nu}h^{\mu \nu} + X \partial\_{\mu}\partial^{\mu} h^{\nu }\_{\nu}\)  (WORKS) →  \(Y \partial\_{\gamma}A^{\gamma} \partial\_{\mu}\partial\_{\nu}h^{\mu \nu} +X \partial\_{\gamma}A^{\gamma} \partial\_{\mu}\partial^{\mu}h\_{\nu}^{\nu} \)

\*\* with added term at the end

\partial\_{\mu}   A^{\epsilon} \(Y \partial\_{\nu}h^{\mu \nu} + X \partial^{\mu} h^{\nu }\_{\nu}\) + B^{\epsilon} -> WORKING  \(Y \partial\_{\mu}A^{\epsilon} \partial\_{\nu}h^{\mu \nu} +X \partial\_{\mu}A^{\epsilon} \partial^{\mu}h\_{\nu}^{\nu} + B^{\epsilon} \)

\*\*\*with subtracted term at the end

\partial\_{\mu}   A^{\epsilon} \(Y \partial\_{\nu}h^{\mu \nu} + X \partial^{\mu} h^{\nu }\_{\nu}\) - B^{\epsilon} -> WORKING  \(Y \partial\_{\mu}A^{\epsilon} \partial\_{\nu}h^{\mu \nu} +X \partial\_{\mu}A^{\epsilon} \partial^{\mu}h\_{\nu}^{\nu} - B^{\epsilon} \)

\*\*\* test FOIL ability

\*\* 2 terms

\(A^{\epsilon} + B^{\gamma} \) \( \partial\_{\mu}X^{\mu} + M^{\nu \zeta}\_{\gamma} \) -> WORKS

\( A^{\epsilon} \partial\_{\mu}X^{\mu} + A^{\epsilon} M\_{\gamma}^{\nu \zeta} + B^{\gamma} \partial\_{\mu}X^{\mu} + B^{\gamma} M\_{\gamma}^{\nu \zeta} \)

\*\* 3 terms

H \(A^{\epsilon} + B^{\gamma} \) \( \partial\_{\mu}X^{\mu} + M^{\nu \zeta}\_{\gamma} \) \( X + Y\) 🡪 WORKING

\(HX A^{\epsilon} \partial\_{\mu}X^{\mu} +HY A^{\epsilon} \partial\_{\mu}X^{\mu} +HX A^{\epsilon} M\_{\gamma}^{\nu \zeta} +HY A^{\epsilon} M\_{\gamma}^{\nu \zeta} +HX B^{\gamma} \partial\_{\mu}X^{\mu} +HY B^{\gamma} \partial\_{\mu}X^{\mu} +HX B^{\gamma} M\_{\gamma}^{\nu \zeta} \\  
+HY B^{\gamma} M\_{\gamma}^{\nu \zeta} \)

TODO figure out the part with switching and write test cases for it

ALSO etas and deltas

\*\* multgroup also has constant factor

B \partial\_{\gamma}A^{\gamma}  \(Y \partial\_{\mu}\partial\_{\nu}h^{\mu \nu} + X \partial\_{\mu}\partial^{\mu} h^{\nu }\_{\nu}\)  (WORKS) →  \(BY \partial\_{\gamma}A^{\gamma} \partial\_{\mu}\partial\_{\nu}h^{\mu \nu} +BX \partial\_{\gamma}A^{\gamma} \partial\_{\mu}\partial^{\mu}h\_{\nu}^{\nu} \)

\*\*\*\* Shouldn’t be distributed

A^{\zeta} \partial\_{\mu}  \(Y \partial\_{\nu}h^{\mu \nu} + X \partial^{\mu} h^{\nu }\_{\nu}\)   (WORKS) → A^{\zeta} \partial\_{\mu}\(Y \partial\_{\nu}h^{\mu \nu} +X \partial^{\mu}h\_{\nu}^{\nu} \)

 \partial\_{\mu}  \(Y \partial\_{\nu}h^{\mu \nu} + X \partial^{\mu} h^{\nu }\_{\nu}\) + T^{\gamma} \(A\_{\gamma} + B\_{\gamma}\) -> WORKING \partial\_{\mu}\(Y \partial\_{\nu}h^{\mu \nu} +X \partial^{\mu}h\_{\nu}^{\nu} \)+\( T^{\gamma} A\_{\gamma} + T^{\gamma} B\_{\gamma} \)

\*\*\* with added term at the end

A^{\epsilon} \partial\_{\mu}  \(Y \partial\_{\nu}h^{\mu \nu} + X \partial^{\mu} h^{\nu }\_{\nu}\) + B^{\epsilon}  WORKING( shouldn’t combine) 🡪 A^{\epsilon} \partial\_{\mu}\(Y \partial\_{\nu}h^{\mu \nu} +X \partial^{\mu}h\_{\nu}^{\nu} \)+ B^{\epsilon}

\*\*\* with subtracted term at the end

A^{\epsilon} \partial\_{\mu}  \(Y \partial\_{\nu}h^{\mu \nu} + X \partial^{\mu} h^{\nu }\_{\nu}\) - B^{\epsilon}  WORKING( shouldn’t combine) 🡪 A^{\epsilon} \partial\_{\mu}\(Y \partial\_{\nu}h^{\mu \nu} +X \partial^{\mu}h\_{\nu}^{\nu} \)- B^{\epsilon}

Is this sensical or non-sensical???

\( \partial\_{alpha} \) \(A^{\gamma}B\_{\gamma}\) -> LEADS TO

\partial\_{alpha}\( A^{\gamma} B\_{\gamma} \)

What about…

\( \partial\_{\alpha} \) \partial^{\alpha}\(A^{\gamma}B\_{\gamma}\) -> LEADS TO

\partial\_{\alpha}\partial^{\alpha}\( A^{\gamma} B\_{\gamma} \)

Also need to test adding summations, with and without partials, and subtracting summations, with and without partials

**Contract**

 contract etas and deltas

\delta^{\gamma}\_{\beta} \eta^{\nu \alpha} \partial\_{\mu} h^{\mu}\_{\alpha}\partial\_{\nu} h^{\beta}\_{\gamma}  (WORKS) →  \partial\_{\mu}h^{\mu \nu} \partial\_{\nu}h\_{\gamma}^{\gamma}

 contract only deltas

Basic case:

\delta^{\nu }\_{\alpha} \partial\_{\mu} h^{\mu}\_{\alpha}\partial\_{\nu} h^{\gamma}\_{\gamma}  (WORKS) → \partial\_{\mu}h\_{\alpha}^{\mu} \partial\_{\alpha}h\_{\gamma}^{\gamma}

 contract only etas

Basic case:

\eta^{\nu \alpha} \partial\_{\mu} h^{\mu}\_{\alpha}\partial\_{\nu} h^{\gamma}\_{\gamma}  (WORKS) →  \partial\_{\mu}h^{\mu \nu} \partial\_{\nu}h\_{\gamma}^{\gamma}

Alternative cases:

**Factor**

 factor out GCF

Basic case:

 \(3Y \partial\_{\nu}h^{\mu \nu} + Y \partial^{\mu} h^{\nu }\_{\nu}\) → WORKING

 Y \(3 \partial\_{\nu}h^{\mu \nu} + \partial^{\mu}h\_{\nu}^{\nu} \)

Alternative cases:

\(X \partial\_{\nu}h^{\mu \nu} + Y \partial\_{\nu} h^{\mu \nu}\) → WORKING

\partial\_{\nu}h^{\mu \nu} \(X +Y \)

\*\*\* sum

\(X A^{\alpha}\_{\alpha} + Y A^{\alpha}\_{\alpha}\) → WORKING

A\_{\alpha}^{\alpha} \(X +Y \)

\*\*\*  no outer brackets…

X A^{\alpha}\_{\alpha} + Y A^{\alpha}\_{\alpha}→ STILL WORKS

A\_{\alpha}^{\alpha} \(X +Y \)

\(X \partial\_{\gamma}h^{\mu \gamma} + Y \partial\_{\nu} h^{\mu \nu}\) → WORKING

\partial\_{\gamma}h^{\mu \gamma} \(X +Y \)

\(X \partial\_{\gamma}h^{\mu \gamma} A^{\alpha}\_{\alpha} + Y \partial\_{\nu} h^{\mu \nu}\) → WORKING

 \partial\_{\gamma}h^{\mu \gamma} \(X A\_{\alpha}^{\alpha} +Y \)

\(X \partial\_{\gamma}h^{\mu \gamma} + Y h^{\gamma \nu}\) → WORKING

\(X \partial\_{\gamma}h^{\mu \gamma} +Y h^{\gamma \nu} \)

\(\frac{1}{2} \partial\_{\gamma}h^{\mu \gamma} + \frac{1}{4}  h^{\gamma \nu}\) → WORKING

\frac{1}{4} \(2 \partial\_{\gamma}h^{\mu \gamma} + h^{\gamma \nu} \)

\*\*\* factor of 1 (implied)

\(X \partial\_{\nu}h^{\mu \nu} + \partial\_{\nu} h^{\mu \nu}\) → WORKING

\partial\_{\nu}h^{\mu \nu} \(X +1 \)

 factor out user specified term

\*\*\* smaller numerical

\(\frac{1}{2} \partial\_{\gamma}h^{\mu \gamma} + \frac{1}{4}  h^{\gamma \nu}\) , \frac{1}{8} → WORKING

\frac{1}{8} \(4 \partial\_{\gamma}h^{\mu \gamma} +2 h^{\gamma \nu} \)

\*\*\* bigger numerical

\(\frac{1}{2} \partial\_{\gamma}h^{\mu \gamma} + \frac{1}{4}  h^{\gamma \nu}\) , 8 → WORKING

8 \(\frac{1}{16} \partial\_{\gamma}h^{\mu \gamma} +\frac{1}{32} h^{\gamma \nu} \)

\*\*\* smaller tensor

\(X \partial\_{\gamma}h^{\mu \gamma} A^{\gamma} + Y \partial\_{\nu} h^{\mu \nu}A^{\gamma}\) , A^{\gamma} → WORKING

A^{\gamma} \(X \partial\_{\gamma}h^{\mu \gamma} +Y \partial\_{\nu}h^{\mu \nu} \)

\*\*\* not included tensor

X \partial\_{\mu} \partial\_{\nu}h^{\mu \nu} +Y \partial\_{\nu}h^{\mu \nu}  , A^{alpha} → WORKS

\(X \partial\_{\mu}\partial\_{\nu}h^{\mu \nu} +Y \partial\_{\nu}h^{\mu \nu} \)

\*\*\* different index

\(X \partial\_{\gamma}h^{\mu \gamma} A^{\gamma} +Y \partial\_{\nu}h^{\mu \nu} A^{\gamma} \), A^{\alpha} → (\*\*\*decide if this should be the expected behaviour (tensor logic question))

\(X \partial\_{\gamma}h^{\mu \gamma} A^{\gamma} +Y \partial\_{\nu}h^{\mu \nu} A^{\gamma} \)

\*\*\* make sure it’s recognizing not to factor out tensors under partials

\(X \partial\_{\mu} \partial\_{\nu}h^{\mu \nu} +Y \partial\_{\nu}h^{\mu \nu} A^{\gamma} \), \partial\_{\nu}h^{\mu \nu} → WORKING

\partial\_{\nu}h^{\mu \nu} \(Y A^{\gamma} \)+\(X \partial\_{\mu}\partial\_{\nu}h^{\mu \nu} \)

\*\*\* what about if there’s a different index with the same sum pattern, and what about coefficient of 1

\(X A^{\alpha}\_{\alpha} + A^{\alpha}\_{\alpha}\) , A^{\beta}\_{\beta} → WORKS

A\_{\beta}^{\beta} \(X +1 \)

— variation, no brackets…

X A^{\alpha}\_{\alpha} + A^{\alpha}\_{\alpha} , A^{\beta}\_{\beta} → STILL WORKS

A\_{\beta}^{\beta} \(X +1 \)

**Replace**

 replace indices

Basic case:

\*\*\* single replacement

4X \partial\_{\mu} \partial\_{\nu}h^{\mu \nu} +Y \partial\_{\nu}h^{\mu \nu} A^{\gamma} , \mu → \alpha → WORKING

\(4 X \partial\_{\alpha}\partial\_{\nu}h^{\alpha \nu} +Y \partial\_{\nu}h^{\alpha \nu} A^{\gamma} \)

\*\*\* list replacement

4X \partial\_{\mu} \partial\_{\nu}h^{\mu \nu} +Y \partial\_{\nu}h^{\mu \nu} A^{\gamma} , \mu, \nu, \gamma → \alpha, \beta, \xi → WORKING

 \(4 X \partial\_{\alpha}\partial\_{\beta}h^{\alpha \beta} +Y \partial\_{\beta}h^{\alpha \beta} A^{\xi} \)

\*\*\* replace index that doesn’t exist

4X \partial\_{\mu} \partial\_{\nu}h^{\mu \nu} +Y \partial\_{\nu}h^{\mu \nu} A^{\gamma} , \mu, \nu, \xi → \alpha, \beta, \chi → WORKING

\(4 X \partial\_{\alpha}\partial\_{\beta}h^{\alpha \beta} +Y \partial\_{\beta}h^{\alpha \beta} A^{\gamma} \)

\*\*\* what if it’s not there but it’s one of the replacement indices

4X \partial\_{\mu} \partial\_{\nu}h^{\mu \nu} +Y \partial\_{\nu}h^{\mu \nu} A^{\gamma} , \mu, \nu, \alpha → \alpha, \beta, \xi → WORKING

\(4 X \partial\_{\alpha}\partial\_{\beta}h^{\alpha \beta} +Y \partial\_{\beta}h^{\alpha \beta} A^{\gamma} \)

\*\*\* long number of indices (mismatched list lengths)

 replace terms

Basic case:

\*\*\* direct replacement

4X \partial\_{\mu} \partial\_{\nu}h^{\mu \nu} +Y \partial\_{\nu}h^{\mu \nu} A^{\gamma} , A^{\gamma} → B^{\gamma} → WORKING

\(4 X \partial\_{\mu}\partial\_{\nu}h^{\mu \nu} +Y \partial\_{\nu}h^{\mu \nu} B^{\gamma} \)

\*\*\* more complicated replacement term

4X \partial\_{\mu} \partial\_{\nu}h^{\mu \nu} +Y \partial\_{\nu}h^{\mu \nu} A^{\gamma} ,  \partial\_{\nu}h^{\mu \nu}

→ \partial\_{\gamma} V^{\mu \gamma}  ISSUE:" Equation: indices to replace do not match in length!

Please email jbrucero@uwo.ca for if you think this is a bug"

4X \partial\_{\mu} \partial\_{\nu}h^{\mu \nu} +Y \partial\_{\nu}h^{\mu \nu} A^{\gamma} ,  \partial\_{\nu}h^{\mu \nu}

→  V^{\mu} → ISSUE:" Equation: indices to replace do not match in length!

Please email jbrucero@uwo.ca for if you think this is a bug"

— \*\*\*probably one of the most complicated algorithms, need to look over in detail then finish cases\*\*\*

**Sort**

 combine like terms differing only by a numerical factor

Basic case:

3A^{\gamma} + \frac{5}{7} A^{\gamma} → WORKING

\(\frac{26}{7} A^{\gamma} \)

\*\*\* fraction simplification

3A^{\gamma} + \frac{4}{2} A^{\gamma}  → WORKING

\(5 A^{\gamma} \)

\*\*\* coefficient of 1 (implied)

A^{\gamma} + A^{\gamma} → WORKING

\(2 A^{\gamma} \)

\*\*\* more complicated term

3\partial\_{\gamma}A^{\gamma} + \frac{5}{7} \partial\_{\beta}A^{\beta} → WORKING

\(\frac{26}{7} \partial\_{\gamma}A^{\gamma} \)

3\partial\_{\gamma}\partial^{\mu}A^{\gamma}\_{\nu \mu} + 7 \partial\_{\beta}\partial^{\zeta}A^{\beta}\_{\nu \zeta} → WORKING

 \(10 \partial\_{\gamma}\partial^{\mu}A\_{\nu \mu}^{\gamma} \)

\*\*\* not all terms combine

3\partial\_{\gamma}A^{\gamma} + 4 A^{\chi}+ \frac{5}{7} \partial\_{\beta}A^{\beta} → WORKING

 \(\frac{26}{7} \partial\_{\gamma}A^{\gamma} +4 A^{\chi} \)

\*\*\* things that shouldn’t combine

\*\*\* different tensors

3A^{\gamma} + \frac{5}{7} B^{\gamma} → WORKING

\(3 A^{\gamma} +\frac{5}{7} B^{\gamma} \)

\*\*\* not differing only by numerical factor

3XA^{\gamma} + 7 A^{\gamma}  → WORKING

\(3 X A^{\gamma} +7 A^{\gamma} \)

\*\*\*different free indices

A^{\beta} + A^{\alpha} → WORKING

\( A^{\beta} + A^{\alpha} \)

\*\*\*different number of partials

3\partial\_{\gamma}A^{\gamma}\_{\nu} + 7 \partial\_{\beta}\partial^{\zeta}A^{\beta}\_{\nu \zeta} → WORKING

\(3 \partial\_{\gamma}A\_{\nu}^{\gamma} +7 \partial\_{\beta}\partial^{\zeta}A\_{\nu \zeta}^{\beta} \)

\*\*\* different position of free index

3\partial\_{\gamma}\partial^{\mu}A^{\gamma}\_{\nu \mu} + 7 \partial\_{\beta}\partial^{\zeta}A^{\beta}\_{\zeta \nu} → WORKING

\(3 \partial\_{\gamma}\partial^{\mu}A\_{\nu \mu}^{\gamma} +7 \partial\_{\beta}\partial^{\zeta}A\_{\zeta \nu}^{\beta} \)

\*\*\*(Unless A is a symmetric tensor, in which case):

3\partial\_{\gamma}\partial^{\mu}A^{\gamma}\_{\nu \mu} + 7 \partial\_{\beta}\partial^{\zeta}A^{\beta}\_{\zeta \nu} → WORKING

\(10 \partial\_{\gamma}\partial^{\mu}A\_{\nu \mu}^{\gamma} \)

 combine like terms differing by any (numerical or symbolic) coefficient

\*\*\* basic case

3XA^{\gamma} + 7 A^{\gamma}  → WORKING

\(\(3X+7\) A^{\gamma} \)

\*\*\* more complicated term

3B \partial\_{\gamma}A^{\gamma} + \frac{5}{7} V \partial\_{\beta}A^{\beta} → WORKING

\(\(3B+\frac{5}{7}V\) \partial\_{\gamma}A^{\gamma} \)

3B \partial\_{\gamma}A^{\gamma} + \frac{5}{7} B \partial\_{\beta}A^{\beta} → WORKING

\(\frac{26}{7}B \partial\_{\gamma}A^{\gamma} \)

3M\partial\_{\gamma}\partial^{\mu}A^{\gamma}\_{\nu \mu} + 7X \partial\_{\beta}\partial^{\zeta}A^{\beta}\_{\nu \zeta} → WORKING

\(\(3M+7X\) \partial\_{\gamma}\partial^{\mu}A\_{\nu \mu}^{\gamma} \)

\*\*\* not all terms combine

3V\partial\_{\gamma}A^{\gamma} + 4 ZA^{\chi}+ \frac{5}{7} N \partial\_{\beta}A^{\beta} → WORKING

\(\(3V+\frac{5}{7}N\) \partial\_{\gamma}A^{\gamma} +4Z A^{\chi} \)

\*\*\*shouldn’t combine

3B \partial\_{\gamma}A^{\gamma} + \frac{5}{7} V^{\alpha}\_{\alpha} \partial\_{\beta}A^{\beta} → WORKING (I think this is what I want but should double check/ see if an improvement combine these too → would this be helpful?)

\(3B \partial\_{\gamma}A^{\gamma} +\frac{5}{7} V\_{\alpha}^{\alpha} \partial\_{\beta}A^{\beta} \)

\*\*\* different tensors

3CA^{\gamma} + \frac{5}{7} DB^{\gamma} → WORKING

\(3C A^{\gamma} +\frac{5}{7}D B^{\gamma} \)

\*\*\*different free indices

XA^{\beta} + A^{\alpha} → WORKING

\(X A^{\beta} + A^{\alpha} \)

\*\*\*different number of partials

3\partial\_{\gamma}A^{\gamma}\_{\nu} + 7M \partial\_{\beta}\partial^{\zeta}A^{\beta}\_{\nu \zeta} → WORKING

\(3 \partial\_{\gamma}A\_{\nu}^{\gamma} +7M \partial\_{\beta}\partial^{\zeta}A\_{\nu \zeta}^{\beta} \)

\*\*\* different position of free index

3V\partial\_{\gamma}\partial^{\mu}A^{\gamma}\_{\nu \mu} + 7L \partial\_{\beta}\partial^{\zeta}A^{\beta}\_{\zeta \nu} → WORKING

\(3V \partial\_{\gamma}\partial^{\mu}A\_{\nu \mu}^{\gamma} +7L \partial\_{\beta}\partial^{\zeta}A\_{\zeta \nu}^{\beta} \)

\*\*\*(Unless A is a symmetric tensor, in which case):

3V\partial\_{\gamma}\partial^{\mu}A^{\gamma}\_{\nu \mu} + 7L \partial\_{\beta}\partial^{\zeta}A^{\beta}\_{\zeta \nu} → WORKING

\(\(3V+7L\) \partial\_{\gamma}\partial^{\mu}A\_{\nu \mu}^{\gamma} \)

 sort the tensors in each term by number of derivatives (least to greatest)

\partial\_{\gamma} \square G^{\nu \gamma} \partial\_{\beta}\partial^{\xi} M^{\beta}\_{\xi}   \square \square \partial\_{\chi} X^{\kappa \zeta}\_{\nu}  \partial\_{\mu}T^{\mu} → WORKING

\partial\_{\mu}T^{\mu} \partial\_{\beta}\partial^{\xi}M\_{\xi}^{\beta} \partial\_{\gamma}\square G^{\nu \gamma} \partial\_{\chi}\square \square X\_{\nu}^{\kappa \zeta}

\*\*\*What about with coefficients

4A\partial\_{\gamma} \square G^{\nu \gamma} \partial\_{\beta}\partial^{\xi} M^{\beta}\_{\xi}   \square \square \partial\_{\chi} X^{\kappa \zeta}\_{\nu}  \partial\_{\mu}T^{\mu} → WORKING

4 A \partial\_{\mu}T^{\mu} \partial\_{\beta}\partial^{\xi}M\_{\xi}^{\beta} \partial\_{\gamma}\square G^{\nu \gamma} \partial\_{\chi}\square \square X\_{\nu}^{\kappa \zeta}

\*\*\*What about multiple terms and coefficients

4A\partial\_{\gamma} \square G^{\nu \gamma} \partial\_{\beta}\partial^{\xi} M^{\beta}\_{\xi} +

  \frac{7}{8} C \square \square \partial\_{\chi} X^{\kappa \zeta}\_{\nu}  \partial\_{\mu}T^{\mu} → WORKING

\(4 A \partial\_{\beta}\partial^{\xi}M\_{\xi}^{\beta} \partial\_{\gamma}\square G^{\nu \gamma} +\frac{7}{8} C \partial\_{\mu}T^{\mu} \partial\_{\chi}\square \square X\_{\nu}^{\kappa \zeta} \)

\*\*\*And with brackets

\( 4A\partial\_{\gamma} \square G^{\nu \gamma} \partial\_{\beta}\partial^{\xi} M^{\beta}\_{\xi}\)\(

  \frac{7}{8} C \square \square \partial\_{\chi} X^{\kappa \zeta}\_{\nu}  \partial\_{\mu}T^{\mu} \) → WORKING

\(4 A \partial\_{\beta}\partial^{\xi}M\_{\xi}^{\beta} \partial\_{\gamma}\square G^{\nu \gamma} \)\(\frac{7}{8} C \partial\_{\mu}T^{\mu} \partial\_{\chi}\square \square X\_{\nu}^{\kappa \zeta} \)

 sort terms by number of derivatives (least to greatest)

\partial\_{\gamma} \partial\_{\kappa}A^{\gamma} + \partial^{\chi}B\_{\chi} + C^{} → WORKS

\( C^{} + \partial^{\chi}B\_{\chi} + \partial\_{\gamma}\partial\_{\kappa}A^{\gamma} \)

\*\*\*with brackets

\(\partial\_{\gamma} \partial\_{\kappa}A^{\gamma} + \partial^{\chi}B\_{\chi} + C^{}\)  → WORKS

\( C^{} + \partial^{\chi}B\_{\chi} + \partial\_{\gamma}\partial\_{\kappa}A^{\gamma} \)

\*\*\*with coefficients

\(  9\partial^{\chi}B\_{\chi} +\frac{1}{2}T \partial\_{\gamma}\partial\_{\kappa}A^{\gamma} +M C^{} \) → WORKS

\(M C^{} +9 \partial^{\chi}B\_{\chi} +\frac{1}{2} T \partial\_{\gamma}\partial\_{\kappa}A^{\gamma} \)

\*\*\* with multiplied terms

\(\partial\_{\gamma} \partial\_{\kappa}A^{\gamma}  + \partial\_{\omega}G^{} \)\( \partial^{\chi}B\_{\chi} + C^{} \) → WORKS

\( \partial\_{\omega}G^{} + \partial\_{\gamma}\partial\_{\kappa}A^{\gamma} \)\( C^{} + \partial^{\chi}B\_{\chi} \)

\*\* with multiple tensors per term (I think it goes by either least or greatest…)

\(\partial\_{\gamma} \partial\_{\kappa}\square A^{\gamma}\partial\_{\omega}G^{} + \square \partial^{\chi}B\_{\chi} + \square X\_{\xi}+ \square V\_{}C^{} \) → WORKS

\( \square X\_{\xi} + \square V^{} C^{} + \partial^{\chi}\square B\_{\chi} + \partial\_{\gamma}\partial\_{\kappa}\square A^{\gamma} \partial\_{\omega}G^{} \)

 \partial\_{\xi}H^{}\partial\_{\omega}G^{}\partial^{\xi}M^{} + \square A^{} →WORKS (must sort by total)

\( \square A^{} + \partial\_{\xi}H^{} \partial\_{\omega}G^{} \partial^{\xi}M^{} \)

\*\*\* interesting thing with brackets - should look into at some point

→ At the very least it should be a warning and not make it look like it worked...

\*\*\* same idea but with summation → INTERESTING BRACKET STUFF - is it important??

(X A^{\alpha}\_{\alpha} + Y A^{\alpha}\_{\alpha}) → NOT WORKING

(X + Y ) A\_{\alpha}^{\alpha} A\_{\alpha}^{\alpha}

— variations on above:

(X \partial\_{\mu}A^{\alpha}\_{\alpha} + Y \partial\_{\mu} A^{\alpha}\_{\alpha}) → same issue

(X + Y ) \partial\_{\mu}A\_{\alpha}^{\alpha} \partial\_{\mu}A\_{\alpha}^{\alpha}

(X \partial\_{\alpha}A^{\alpha} + Y \partial\_{\alpha} A^{\alpha}) → ISSUE

(X + Y ) \partial\_{\alpha}A^{\alpha} \partial\_{\alpha}A^{\alpha}

(X \partial\_{\alpha}h^{\alpha} + Y \partial\_{\alpha} h^{\alpha}) → (X + Y ) \partial\_{\alpha}h^{\alpha} \partial\_{\alpha}h^{\alpha}

(X \partial\_{\alpha}h^{\alpha \beta} + Y \partial\_{\alpha} h^{\alpha \beta}) →

(X + Y ) \partial\_{\alpha}h^{\alpha \beta} \partial\_{\alpha}h^{\alpha \beta}

\*\*\*\*