

In[179]:= **(Vsoft + VsoftC) [[1, 1]] // Simplify**

$$\begin{aligned} \text{Out[179]} = & A0 (-H10 H20 + H1m H2p) S + \frac{A3 S^3}{6} + A0 (-H10C H20C + H1mC H2pC) SC + \frac{A3 SC^3}{6} + \frac{1}{2} A2 SC \text{sn}[3]^2 + \frac{1}{2} A2 S \text{snC}[3]^2 + \\ & A1[1] \text{snC}[3] (-H2p s\epsilon[1] + H20 s\nu[1]) + A1[2] \text{snC}[3] (-H2p s\epsilon[2] + H20 s\nu[2]) + A\tau \text{seC}[3] (H10 s\epsilon[3] - H1m s\nu[3]) + \\ & A1[3] \text{snC}[3] (-H2p s\epsilon[3] + H20 s\nu[3]) + A1[1] \text{sn}[3] (-H2pC s\epsilon C[1] + H20C s\nu C[1]) + A1[2] \text{sn}[3] (-H2pC s\epsilon C[2] + H20C s\nu C[2]) + \\ & A\tau \text{se}[3] (H10C s\epsilon C[3] - H1mC s\nu C[3]) + A1[3] \text{sn}[3] (-H2pC s\epsilon C[3] + H20C s\nu C[3]) + Abtm \text{sdC}[3] (H10 s\delta[3] - H1m s\nu[3]) + \\ & A\text{top} \text{suC}[3] (-H2p s\delta[3] + H20 s\nu[3]) + Abtm \text{sd}[3] (H10C s\delta C[3] - H1mC s\nu C[3]) + A\text{top} \text{su}[3] (-H2pC s\delta C[3] + H20C s\nu C[3]) \end{aligned}$$

In[180]:= **Vd[[1, 1]] // Simplify**

$$\begin{aligned} \text{Out[180]} = & \frac{1}{72} \left(-9 g2^2 (H10C H1m - H10 H1mC - H20C H2p + H20 H2pC - s\epsilon C[1] s\nu[1] - s\epsilon C[2] s\nu[2] - s\epsilon C[3] s\nu[3] + s\epsilon[1] s\nu C[1] + \right. \\ & s\epsilon[2] s\nu C[2] + s\epsilon[3] s\nu C[3] - s\delta C[1] s\nu[1] - s\delta C[2] s\nu[2] - s\delta C[3] s\nu[3] + s\delta[1] s\nu C[1] + s\delta[2] s\nu C[2] + s\delta[3] s\nu C[3])^2 + \\ & 9 g2^2 (H10C H1m + H10 H1mC + H20C H2p + H20 H2pC + s\epsilon C[1] s\nu[1] + s\epsilon C[2] s\nu[2] + s\epsilon C[3] s\nu[3] + s\epsilon[1] s\nu C[1] + s\epsilon[2] s\nu C[2] + \\ & s\epsilon[3] s\nu C[3] + s\delta C[1] s\nu[1] + s\delta C[2] s\nu[2] + s\delta C[3] s\nu[3] + s\delta[1] s\nu C[1] + s\delta[2] s\nu C[2] + s\delta[3] s\nu C[3])^2 + \\ & g1^2 (-3 H10 H10C - 3 H1m H1mC + 3 H20 H20C + 3 H2p H2pC + 2 \text{sd}[1] \text{sdC}[1] + 2 \text{sd}[2] \text{sdC}[2] + 2 \text{sd}[3] \text{sdC}[3] + 6 \text{se}[1] \text{seC}[1] + 6 \text{se}[2] \text{seC}[2] + \\ & 6 \text{se}[3] \text{seC}[3] - 4 \text{su}[1] \text{suC}[1] - 4 \text{su}[2] \text{suC}[2] - 4 \text{su}[3] \text{suC}[3] + s\delta[1] s\delta C[1] + s\delta[2] s\delta C[2] + s\delta[3] s\delta C[3] - 3 \text{se}[1] \text{seC}[1] - \\ & 3 \text{se}[2] \text{seC}[2] - 3 \text{se}[3] \text{seC}[3] - 3 s\nu[1] s\nu C[1] - 3 s\nu[2] s\nu C[2] - 3 s\nu[3] s\nu C[3] + s\nu[1] s\nu C[1] + s\nu[2] s\nu C[2] + s\nu[3] s\nu C[3])^2 + \\ & 9 g2^2 (H10 H10C - H1m H1mC - H20 H20C + H2p H2pC - s\delta[1] s\delta C[1] - s\delta[2] s\delta C[2] - s\delta[3] s\delta C[3] - s\epsilon[1] \text{seC}[1] - s\epsilon[2] \text{seC}[2] - \\ & s\epsilon[3] \text{seC}[3] + s\nu[1] s\nu C[1] + s\nu[2] s\nu C[2] + s\nu[3] s\nu C[3] + s\nu[1] s\nu C[1] + s\nu[2] s\nu C[2] + s\nu[3] s\nu C[3])^2 \Big) \end{aligned}$$

In[181]:= **Vf[[1, 1]] // Simplify**

$$\begin{aligned} \text{Out[181]} = & \frac{1}{4} \left(2 H10C H20C \kappa 0 - 2 H1mC H2pC \kappa 0 - SC^2 \kappa 3 - \kappa 2 \text{sn}[3]^2 \right) \left(2 H10 H20 \kappa 0 - 2 H1m H2p \kappa 0 - S^2 \kappa 3 - \kappa 2 \text{snC}[3]^2 \right) + \\ & (H1mC Yb\text{tm} \text{sd}[3] - H20C Y\text{top} \text{su}[3]) (H1m Yb\text{tm} \text{sdC}[3] - H20 Y\text{top} \text{suC}[3]) + (H10C Yb\text{tm} \text{sd}[3] - H2pC Y\text{top} \text{su}[3]) (H10 Yb\text{tm} \text{sdC}[3] - H2p Y\text{top} \text{suC}[3]) + \\ & (-H20 S \kappa 0 + Yb\text{tm} \text{sdC}[3] s\delta[3] + Y\tau \text{seC}[3] s\epsilon[3]) (-H20C SC \kappa 0 + Yb\text{tm} \text{sd}[3] s\delta C[3] + Y\tau \text{se}[3] s\epsilon C[3]) + \\ & Y\tau^2 (H10 s\epsilon[3] - H1m s\nu[3]) (H10C s\epsilon C[3] - H1mC s\nu C[3]) + Yb\text{tm}^2 (H10 s\delta[3] - H1m s\nu[3]) (H10C s\delta C[3] - H1mC s\nu C[3]) + \\ & Y\text{top}^2 (H2p s\delta[3] - H20 s\nu[3]) (H2pC s\delta C[3] - H20C s\nu C[3]) + \\ & (H2p S \kappa 0 - Y\tau \text{seC}[3] s\nu[3] - Yb\text{tm} \text{sdC}[3] s\nu[3]) (H2pC SC \kappa 0 - Y\tau \text{se}[3] s\nu C[3] - Yb\text{tm} \text{sd}[3] s\nu C[3]) + \\ & H20 H20C \text{sn}[3] \text{snC}[3] \kappa 1[1]^2 + H2p H2pC \text{sn}[3] \text{snC}[3] \kappa 1[1]^2 + H20 H20C \text{sn}[3] \text{snC}[3] \kappa 1[2]^2 + H2p H2pC \text{sn}[3] \text{snC}[3] \kappa 1[2]^2 + \\ & (H1mC Y\tau \text{se}[3] - H20C \text{sn}[3] \kappa 1[3]) (H1m Y\tau \text{seC}[3] - H20 \text{snC}[3] \kappa 1[3]) + (H10C Y\tau \text{se}[3] - H2pC \text{sn}[3] \kappa 1[3]) (H10 Y\tau \text{seC}[3] - H2p \text{snC}[3] \kappa 1[3]) + \\ & (H1m S \kappa 0 - Y\text{top} \text{suC}[3] s\delta[3] - \text{snC}[3] (s\epsilon[1] \kappa 1[1] + s\epsilon[2] \kappa 1[2] + s\epsilon[3] \kappa 1[3])) \\ & (H1mC SC \kappa 0 - Y\text{top} \text{su}[3] s\delta C[3] - \text{sn}[3] (s\epsilon C[1] \kappa 1[1] + s\epsilon C[2] \kappa 1[2] + s\epsilon C[3] \kappa 1[3])) + \\ & (S \kappa 2 \text{snC}[3] - H2p (s\epsilon[1] \kappa 1[1] + s\epsilon[2] \kappa 1[2] + s\epsilon[3] \kappa 1[3]) + H20 (s\nu[1] \kappa 1[1] + s\nu[2] \kappa 1[2] + s\nu[3] \kappa 1[3])) \\ & (SC \kappa 2 \text{sn}[3] - H2pC (s\epsilon C[1] \kappa 1[1] + s\epsilon C[2] \kappa 1[2] + s\epsilon C[3] \kappa 1[3]) + H20C (s\nu C[1] \kappa 1[1] + s\nu C[2] \kappa 1[2] + s\nu C[3] \kappa 1[3])) + \\ & (-H10 S \kappa 0 + Y\text{top} \text{suC}[3] s\nu[3] + \text{snC}[3] (s\nu[1] \kappa 1[1] + s\nu[2] \kappa 1[2] + s\nu[3] \kappa 1[3])) \\ & (-H10C SC \kappa 0 + Y\text{top} \text{su}[3] s\nu C[3] + \text{sn}[3] (s\nu C[1] \kappa 1[1] + s\nu C[2] \kappa 1[2] + s\nu C[3] \kappa 1[3])) \end{aligned}$$

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In[182]:= Vmass[[1, 1]] // Simplify
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Out[182]= (H10 H10C + H1m H1mC) mH12 + (H20 H20C + H2p H2pC) mH22 + MS2 S SC + MD[1, 1]2 sd[1] sdC[1] + MD[2, 2]2 sd[2] sdC[2] + MD[3, 3]2 sd[3] sdC[3] +
ME[1, 1]2 se[1] seC[1] + ME[1, 2]2 se[2] seC[1] + ME[1, 3]2 se[3] seC[1] + ME[1, 2]2 se[1] seC[2] + ME[2, 2]2 se[2] seC[2] + ME[2, 3]2 se[3] seC[2] +
ME[1, 3]2 se[1] seC[3] + ME[2, 3]2 se[2] seC[3] + ME[3, 3]2 se[3] seC[3] + MN[3, 3]2 sn[3] snC[3] + MU[1, 1]2 su[1] suC[1] + MU[2, 2]2 su[2] suC[2] +
MU[3, 3]2 su[3] suC[3] + ML[1, 1]2 (se[1] seC[1] + sv[1] svC[1]) + ML[1, 2]2 (se[2] seC[1] + sv[2] svC[1]) + ML[1, 3]2 (se[3] seC[1] + sv[3] svC[1]) +
ML[1, 2]2 (se[1] seC[2] + sv[1] svC[2]) + ML[2, 2]2 (se[2] seC[2] + sv[2] svC[2]) + ML[2, 3]2 (se[3] seC[2] + sv[3] svC[2]) +
ML[1, 3]2 (se[1] seC[3] + sv[1] svC[3]) + ML[2, 3]2 (se[2] seC[3] + sv[2] svC[3]) + ML[3, 3]2 (se[3] seC[3] + sv[3] svC[3]) +
MQ[1, 1]2 (sδ[1] sδC[1] + sν[1] sνC[1]) + MQ[2, 2]2 (sδ[2] sδC[2] + sν[2] sνC[2]) + MQ[3, 3]2 (sδ[3] sδC[3] + sν[3] sνC[3])
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In[183]:= Wf[[1, 1]] // Simplify
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Out[183]= fS (-fH20 H10 + fH2p H1m) κ0 + fS (-fH10 H20 + fH1m H2p) κ0 + (-fH10 fH20 + fH1m fH2p) S κ0 +  $\frac{1}{2}$  fS2 S κ3 +  $\frac{1}{2}$  S κ2 nC[3]2 +
fS κ2 nC[3] snC[3] + Yτ eC[3] (fH10 se[3] - fH1m sv[3]) + Ybtm dC[3] (fH10 sδ[3] - fH1m sν[3]) + Ytop (-fH2p sδ[3] + fH20 sν[3]) uC[3] +
nC[3] (-fH2p se[1] + fH20 sv[1]) κ1[1] + nC[3] (-fH2p se[2] + fH20 sv[2]) κ1[2] + nC[3] (-fH2p se[3] + fH20 sv[3]) κ1[3] +
snC[3] κ1[1] (-fH2p e[1] + fH20 v[1]) + nC[3] κ1[1] (-H2p e[1] + H20 v[1]) + snC[3] κ1[2] (-fH2p e[2] + fH20 v[2]) + nC[3] κ1[2] (-H2p e[2] + H20 v[2]) +
Yτ seC[3] (fH10 e[3] - fH1m v[3]) + snC[3] κ1[3] (-fH2p e[3] + fH20 v[3]) + Yτ eC[3] (H10 e[3] - H1m v[3]) + nC[3] κ1[3] (-H2p e[3] + H20 v[3]) +
Ybtm sdC[3] (fH10 δ[3] - fH1m ν[3]) + Ytop suC[3] (-fH2p δ[3] + fH20 ν[3]) + Ybtm dC[3] (H10 δ[3] - H1m ν[3]) + Ytop uC[3] (-H2p δ[3] + H20 ν[3])
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