Raw amplitude

$$\frac{e^2}{16\pi^4} 1 \int \frac{d^d p}{(2\pi)^4} \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)\gamma^{mu}\left(m + \left(k_{sigma_1} + p_{sigma_1}\right)\gamma^{sigma_1}\right)\left(m + p_{sigma_1}\gamma^{sigma_2}\right)\gamma^{nu}}{\left(-m^2 + \left(k_\eta + p_\eta\right)\left(k^\eta + p^\eta\right)\right)\left(-m^2 + p_\eta p^\eta\right)} \right) \tag{1}$$

Simplified numerator

$$\frac{e^2}{16\pi^4} 1 \int \frac{d^d p}{(2\pi)^4} \left(\frac{1}{\left(-m^2 + \left(k_\eta + p_\eta\right)\left(k^\eta + p^\eta\right)\right)\left(-m^2 + p_\eta p^\eta\right)} \left(\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)m^2\gamma^{mu}\gamma^{nu} + \epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)mk_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{nu} + \epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)mp_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{nu} \right.\right.$$
$$\left.\left. + \epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)mp_{sigma_1}\gamma^{mu}\gamma^{sigma_2}\gamma^{nu} + \epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)k_{sigma_1}p_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{sigma_2}\gamma^{nu} + \epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)p_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{sigma_2}\gamma^{nu}\right)\right) \tag{2}$$

Feynman parameterization

Here, we perform the following expansion:

$$\frac{1}{A_1}\cdots\frac{1}{A_n} = (n-1)! \int_0^1 dz_1 \int_0^{1-z_1} dz_2 \cdots \int_0^{1-z_1-\cdots-z_{n-1}} dz_n \frac{1}{(z_1 A_1 + \cdots + z_n A_n)^n}$$

We use this form because a single denominator raised to a power can be simplified with the Golden Integral.

$$\frac{0.0625e^2}{\pi^4} 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \int \frac{d^d p}{(2\pi)^4} \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)m^2\gamma^{mu}\gamma^{nu} + \epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)mk_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{nu} + \epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)mp_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{nu} + \epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)mp_{sigma_1}\gamma^{mu}\gamma^{sigma}}{(-m^2 z_1 - m^2 z_2 + z_1 k_\eta k^\eta + z_1 k_\eta p^\eta + z_1 k^\eta p_\eta + z_1 p_\eta} \tag{3}$$

Expanded numerator

We split the numerator into additive terms, to process individually. The following is a list of such terms:

$$\frac{0.0625e^2}{\pi^4} 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \int \frac{d^d p}{(2\pi)^4} \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)m^2\gamma^{mu}\gamma^{nu}}{\left(-m^2 z_1 - m^2 z_2 + z_1 k_\eta k^\eta + z_1 k_\eta p^\eta + z_1 k^\eta p_\eta + z_1 p_\eta p^\eta + z_2 p_\eta p^\eta\right)^2} \right) \tag{4}$$

$$\frac{0.0625e^2}{\pi^4} 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \int \frac{d^d p}{(2\pi)^4} \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)mk_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{nu}}{\left(-m^2 z_1 - m^2 z_2 + z_1 k_\eta k^\eta + z_1 k_\eta p^\eta + z_1 k^\eta p_\eta + z_1 p_\eta p^\eta + z_2 p_\eta p^\eta\right)^2} \right) \tag{5}$$

$$\frac{0.0625e^2}{\pi^4} 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \int \frac{d^dp}{(2\pi)^4} \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m p_{sigma_1} \gamma^{mu} \gamma^{sigma_1} \gamma^{nu}}{(-m^2 z_1 - m^2 z_2 + z_1 k_\eta k^\eta + z_1 k_\eta p^\eta + z_1 k^\eta p_\eta + z_1 p_\eta p^\eta + z_2 p_\eta p^\eta)^2} \right) \tag{6}$$

$$\frac{0.0625e^2}{\pi^4} 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \int \frac{d^dp}{(2\pi)^4} \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m p_{sigma_1} \gamma^{mu} \gamma^{sigma_2} \gamma^{nu}}{(-m^2 z_1 - m^2 z_2 + z_1 k_\eta k^\eta + z_1 k_\eta p^\eta + z_1 k^\eta p_\eta + z_1 p_\eta p^\eta + z_2 p_\eta p^\eta)^2} \right) \tag{7}$$

$$\frac{0.0625e^2}{\pi^4} 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \int \frac{d^dp}{(2\pi)^4} \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) p_{sigma_1} \gamma^{mu} \gamma^{sigma_1} \gamma^{sigma_2} \gamma^{nu}}{(-m^2 z_1 - m^2 z_2 + z_1 k_\eta k^\eta + z_1 k_\eta p^\eta + z_1 k^\eta p_\eta + z_1 p_\eta p^\eta + z_2 p_\eta p^\eta)^2} \right) \tag{8}$$

$$\frac{0.0625e^2}{\pi^4} 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \int \frac{d^dp}{(2\pi)^4} \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) k_{sigma_1} p_{sigma_1} \gamma^{mu} \gamma^{sigma_1} \gamma^{sigma_2} \gamma^{nu}}{(-m^2 z_1 - m^2 z_2 + z_1 k_\eta k^\eta + z_1 k_\eta p^\eta + z_1 k^\eta p_\eta + z_1 p_\eta p^\eta + z_2 p_\eta p^\eta)^2} \right) \tag{9}$$

Golden Integral

We resolve internal momentas with this transformation:

$$\int \frac{d^dq}{(2\pi)^d} \frac{(q^2)^a}{(q^2+D)^b} = i \frac{\Gamma(b-a-\frac{1}{2}d)\Gamma(a+\frac{1}{2}d)}{(4\pi)^{d/2}\Gamma(b)\Gamma(\frac{1}{2}d)} D^{-(b-a-d/2)}$$

After this section, all internal momenta should disappear. We will now resolve each term in a queue. Each term may produce additional terms, which are pushed to the back of the queue and resolved later.

Evaluating internal momenta in this term (5 terms left)

$$\frac{0.0625e^2}{\pi^4} 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \int \frac{d^dp}{(2\pi)^4} \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m^2 \gamma^{mu} \gamma^{nu}}{(-m^2 z_1 - m^2 z_2 + z_1 k_\eta k^\eta + z_1 k_\eta p^\eta + z_1 k^\eta p_\eta + z_1 p_\eta p^\eta + z_2 p_\eta p^\eta)^2} \right) \tag{10}$$

Integrating over p
Completing the square

$$A = z_1 + z_2 \tag{11}$$

$$B = 2z_1 k^{\eta} \tag{12}$$

$$C = -m^2 z_1 - m^2 z_2 + z_1 k_{\eta} k^{\eta} \tag{13}$$

After $p \to q_1$ substitutions

$$\frac{0.0625e^2}{\pi^4} 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \int \frac{d^d q_1}{(2\pi)^4} \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m^2 \gamma^{mu} \gamma^{nu}}{(z_1 + z_2)^{0.5} \left(-m^2 z_1 - m^2 z_2 - \frac{z_1{}^2 k_{\eta} k^{\eta}}{4z_1 + 4z_2} + z_1 k_{\eta} k^{\eta} + q_{1\eta} q_1{}^{\eta} \right)^2} \right) \tag{14}$$

Expanding numerator into 1 term(s)

$$\frac{0.0625e^2}{\pi^4} 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \int \frac{d^d q_1}{(2\pi)^4} \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m^2 \gamma^{mu} \gamma^{nu}}{(z_1 + z_2)^{0.5} \left(-m^2 z_1 - m^2 z_2 - \frac{z_1{}^2 k_{\eta} k^{\eta}}{4z_1 + 4z_2} + z_1 k_{\eta} k^{\eta} + q_{1\eta} q_1{}^{\eta} \right)^2} \right) \tag{15}$$

Integrating this term:

$$\frac{0.0625e^2}{\pi^4} 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \int \frac{d^d q_1}{(2\pi)^4} \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m^2 \gamma^{mu} \gamma^{nu}}{(z_1 + z_2)^{0.5} \left(-m^2 z_1 - m^2 z_2 - \frac{z_1{}^2 k_{\eta} k^{\eta}}{4z_1 + 4z_2} + z_1 k_{\eta} k^{\eta} + q_{1\eta} q_1{}^{\eta} \right)^2} \right) \tag{16}$$

Found 0 q-vector terms in the numerator.
Apply golden integral

$$\frac{1249999896.56489i}{\pi^2} e^2 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m^2 \gamma^{mu} \gamma^{nu}}{(z_1 + z_2)^{0.5}} \right) \tag{17}$$

Evaluating internal momenta in this term (5 terms left)

$$\frac{0.0625e^2}{\pi^4} 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \int \frac{d^d p}{(2\pi)^4} \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m k_{sigma_1} \gamma^{mu} \gamma^{sigma_1} \gamma^{nu}}{(-m^2 z_1 - m^2 z_2 + z_1 k_{\eta} k^{\eta} + z_1 k_{\eta} p^{\eta} + z_1 k^{\eta} p_{\eta} + z_1 p_{\eta} p^{\eta} + z_2 p_{\eta} p^{\eta})^2} \right) \tag{18}$$

Integrating over p
Completing the square

$$A = z_1 + z_2 \tag{19}$$

$$B = 2z_1k^\eta \tag{20}$$

$$C = -m^2z_1 - m^2z_2 + z_1k_\eta k^\eta \tag{21}$$

After $p \to q_1$ substitutions

$$\frac{0.0625e^2}{\pi^4}1\int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \int \frac{d^dq_1}{(2\pi)^4}\left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)mk_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{nu}}{(z_1+z_2)^{0.5}\left(-m^2z_1 - m^2z_2 - \frac{{z_1}^2k_\eta k^\eta}{4z_1+4z_2} + z_1k_\eta k^\eta + {q_1}_\eta {q_1}^\eta\right)^2}\right) \tag{22}$$

Expanding numerator into 1 term(s)

$$\frac{0.0625e^2}{\pi^4}1\int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \int \frac{d^dq_1}{(2\pi)^4}\left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)mk_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{nu}}{(z_1+z_2)^{0.5}\left(-m^2z_1 - m^2z_2 - \frac{{z_1}^2k_\eta k^\eta}{4z_1+4z_2} + z_1k_\eta k^\eta + {q_1}_\eta {q_1}^\eta\right)^2}\right) \tag{23}$$

Integrating this term:

$$\frac{0.0625e^2}{\pi^4}1\int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \int \frac{d^dq_1}{(2\pi)^4}\left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)mk_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{nu}}{(z_1+z_2)^{0.5}\left(-m^2z_1 - m^2z_2 - \frac{{z_1}^2k_\eta k^\eta}{4z_1+4z_2} + z_1k_\eta k^\eta + {q_1}_\eta {q_1}^\eta\right)^2}\right) \tag{24}$$

Found 0 q-vector terms in the numerator.
Apply golden integral

$$\frac{1249999896.56489i}{\pi^2}e^21\int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)mk_{sigma_1}}{(z_1+z_2)^{0.5}}\gamma^{mu}\gamma^{sigma_1}\gamma^{nu}\right) \tag{25}$$

Evaluating internal momenta in this term (5 terms left)

$$\frac{0.0625e^2}{\pi^4}1\int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \int \frac{d^dp}{(2\pi)^4}\left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)mp_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{nu}}{\left(-m^2z_1-m^2z_2+z_1k_\eta k^\eta+z_1k_\eta p^\eta+z_1k^\eta p_\eta+z_1p_\eta p^\eta+z_2p_\eta p^\eta\right)^2}\right) \tag{26}$$

Integrating over p
Completing the square

$$A = z_1 + z_2 \tag{27}$$

$$B = 2z_1k^\eta \tag{28}$$

$$C = -m^2z_1 - m^2z_2 + z_1k_\eta k^\eta \tag{29}$$

After $p \to q_1$ substitutions

$$\frac{0.0625e^2}{\pi^4}1\int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \int \frac{d^dq_1}{(2\pi)^4}\left(-\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)m\left(z_1\left(z_1+z_2\right)^{0.5}k_{sigma_1}-2\left(z_1+z_2\right)q_{1\,sigma_1}\right)\gamma^{mu}\gamma^{sigma_1}\gamma^{nu}}{2\left(z_1+z_2\right)^{2.0}\left(-m^2z_1-m^2z_2-\frac{z_1{}^2k_\eta k^\eta}{4z_1+4z_2}+z_1k_\eta k^\eta+q_{1\,\eta}q_1{}^\eta\right)^2}\right) \tag{30}$$

Expanding numerator into 3 term(s)

$$\frac{0.0625e^2}{\pi^4}1\int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \int \frac{d^dq_1}{(2\pi)^4}\left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)mz_1q_{1\,sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{nu}}{\left(z_1+z_2\right)^{2.0}\left(-m^2z_1-m^2z_2-\frac{z_1{}^2k_\eta k^\eta}{4z_1+4z_2}+z_1k_\eta k^\eta+q_{1\,\eta}q_1{}^\eta\right)^2}\right) \tag{31}$$

$$\frac{0.0625e^2}{\pi^4}1\int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \int \frac{d^dq_1}{(2\pi)^4}\left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)mz_2q_{1\,sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{nu}}{\left(z_1+z_2\right)^{2.0}\left(-m^2z_1-m^2z_2-\frac{z_1{}^2k_\eta k^\eta}{4z_1+4z_2}+z_1k_\eta k^\eta+q_{1\,\eta}q_1{}^\eta\right)^2}\right) \tag{32}$$

$$\frac{0.0625e^2}{\pi^4}1\int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \int \frac{d^dq_1}{(2\pi)^4}\left(-\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)mz_1k_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{nu}}{2\left(z_1+z_2\right)^{1.5}\left(-m^2z_1-m^2z_2-\frac{z_1{}^2k_\eta k^\eta}{4z_1+4z_2}+z_1k_\eta k^\eta+q_{1\,\eta}q_1{}^\eta\right)^2}\right) \tag{33}$$

Integrating this term:

$$\frac{0.0625e^2}{\pi^4} 1 \int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \int \frac{d^d q_1}{(2\pi)^4} \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m z_1 q_{1\,sigma_1} \gamma^{mu}\gamma^{sigma_1}\gamma^{nu}}{(z_1+z_2)^{2.0} \left(-m^2 z_1 - m^2 z_2 - \frac{z_1{}^2 k_\eta k^\eta}{4z_1+4z_2} + z_1 k_\eta k^\eta + q_{1\eta} q_1{}^\eta\right)^2} \right) \tag{34}$$

Found 1 q-vector terms in the numerator.
Term vanishes due to Ward identity

Integrating this term:

$$\frac{0.0625e^2}{\pi^4} 1 \int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \int \frac{d^d q_1}{(2\pi)^4} \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m z_2 q_{1\,sigma_1} \gamma^{mu}\gamma^{sigma_1}\gamma^{nu}}{(z_1+z_2)^{2.0} \left(-m^2 z_1 - m^2 z_2 - \frac{z_1{}^2 k_\eta k^\eta}{4z_1+4z_2} + z_1 k_\eta k^\eta + q_{1\eta} q_1{}^\eta\right)^2} \right) \tag{35}$$

Found 1 q-vector terms in the numerator.
Term vanishes due to Ward identity

Integrating this term:

$$\frac{0.0625e^2}{\pi^4} 1 \int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \int \frac{d^d q_1}{(2\pi)^4} \left(-\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m z_1 k_{sigma_1} \gamma^{mu}\gamma^{sigma_1}\gamma^{nu}}{2\,(z_1+z_2)^{1.5} \left(-m^2 z_1 - m^2 z_2 - \frac{z_1{}^2 k_\eta k^\eta}{4z_1+4z_2} + z_1 k_\eta k^\eta + q_{1\eta} q_1{}^\eta\right)^2} \right) \tag{36}$$

Found 0 q-vector terms in the numerator.
Apply golden integral

$$\frac{1249999896.56489i}{\pi^2} e^2 1 \int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \left(-\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m z_1 k_{sigma_1}}{2\,(z_1+z_2)^{1.5}} \gamma^{mu}\gamma^{sigma_1}\gamma^{nu} \right) \tag{37}$$

Evaluating internal momenta in this term (5 terms left)

$$\frac{0.0625e^2}{\pi^4} 1 \int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \int \frac{d^d p}{(2\pi)^4} \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m p_{sigma_1} \gamma^{mu}\gamma^{sigma_2}\gamma^{nu}}{\left(-m^2 z_1 - m^2 z_2 + z_1 k_\eta k^\eta + z_1 k_\eta p^\eta + z_1 k^\eta p_\eta + z_1 p_\eta p^\eta + z_2 p_\eta p^\eta\right)^2} \right) \tag{38}$$

Integrating over p
Completing the square

$$A = z_1 + z_2 \tag{39}$$

$$B = 2 z_1 k^\eta \tag{40}$$

$$C = -m^2 z_1 - m^2 z_2 + z_1 k_\eta k^\eta \tag{41}$$

After $p \to q_1$ substitutions

$$\frac{0.0625e^2}{\pi^4} 1 \int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \int \frac{d^d q_1}{(2\pi)^4} \left(-\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m \left(z_1 (z_1+z_2)^{0.5} k_{sigma_1} - 2(z_1+z_2) q_{1\,sigma_1} \right) \gamma^{mu}\gamma^{sigma_2}\gamma^{nu}}{2(z_1+z_2)^{2.0} \left(-m^2 z_1 - m^2 z_2 - \frac{z_1{}^2 k_\eta k^\eta}{4z_1+4z_2} + z_1 k_\eta k^\eta + q_{1\,\eta} q_1{}^\eta \right)^2} \right) \tag{42}$$

Expanding numerator into 3 term(s)

$$\frac{0.0625e^2}{\pi^4} 1 \int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \int \frac{d^d q_1}{(2\pi)^4} \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m z_1 q_{1\,sigma_1} \gamma^{mu}\gamma^{sigma_2}\gamma^{nu}}{(z_1+z_2)^{2.0} \left(-m^2 z_1 - m^2 z_2 - \frac{z_1{}^2 k_\eta k^\eta}{4z_1+4z_2} + z_1 k_\eta k^\eta + q_{1\,\eta} q_1{}^\eta \right)^2} \right) \tag{43}$$

$$\frac{0.0625e^2}{\pi^4} 1 \int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \int \frac{d^d q_1}{(2\pi)^4} \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m z_2 q_{1\,sigma_1} \gamma^{mu}\gamma^{sigma_2}\gamma^{nu}}{(z_1+z_2)^{2.0} \left(-m^2 z_1 - m^2 z_2 - \frac{z_1{}^2 k_\eta k^\eta}{4z_1+4z_2} + z_1 k_\eta k^\eta + q_{1\,\eta} q_1{}^\eta \right)^2} \right) \tag{44}$$

$$\frac{0.0625e^2}{\pi^4} 1 \int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \int \frac{d^d q_1}{(2\pi)^4} \left(-\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m z_1 k_{sigma_1} \gamma^{mu}\gamma^{sigma_2}\gamma^{nu}}{2(z_1+z_2)^{1.5} \left(-m^2 z_1 - m^2 z_2 - \frac{z_1{}^2 k_\eta k^\eta}{4z_1+4z_2} + z_1 k_\eta k^\eta + q_{1\,\eta} q_1{}^\eta \right)^2} \right) \tag{45}$$

Integrating this term:

$$\frac{0.0625e^2}{\pi^4}1\int\limits_0^1 dz_1\int\limits_0^{-z_1+1} dz_2\int\frac{d^dq_1}{(2\pi)^4}\left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)mz_1q_{1\,sigma_1}\gamma^{mu}\gamma^{sigma_2}\gamma^{nu}}{(z_1+z_2)^{2.0}\left(-m^2z_1-m^2z_2-\frac{z_1{}^2k_\eta k^\eta}{4z_1+4z_2}+z_1k_\eta k^\eta+q_{1\,\eta}q_1{}^\eta\right)^2}\right) \tag{46}$$

Found 1 q-vector terms in the numerator.
Term vanishes due to Ward identity

Integrating this term:

$$\frac{0.0625e^2}{\pi^4}1\int\limits_0^1 dz_1\int\limits_0^{-z_1+1} dz_2\int\frac{d^dq_1}{(2\pi)^4}\left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)mz_2q_{1\,sigma_1}\gamma^{mu}\gamma^{sigma_2}\gamma^{nu}}{(z_1+z_2)^{2.0}\left(-m^2z_1-m^2z_2-\frac{z_1{}^2k_\eta k^\eta}{4z_1+4z_2}+z_1k_\eta k^\eta+q_{1\,\eta}q_1{}^\eta\right)^2}\right) \tag{47}$$

Found 1 q-vector terms in the numerator.
Term vanishes due to Ward identity

Integrating this term:

$$\frac{0.0625e^2}{\pi^4}1\int\limits_0^1 dz_1\int\limits_0^{-z_1+1} dz_2\int\frac{d^dq_1}{(2\pi)^4}\left(-\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)mz_1k_{sigma_1}\gamma^{mu}\gamma^{sigma_2}\gamma^{nu}}{2\,(z_1+z_2)^{1.5}\left(-m^2z_1-m^2z_2-\frac{z_1{}^2k_\eta k^\eta}{4z_1+4z_2}+z_1k_\eta k^\eta+q_{1\,\eta}q_1{}^\eta\right)^2}\right) \tag{48}$$

Found 0 q-vector terms in the numerator.
Apply golden integral

$$\frac{1249999896.56489i}{\pi^2}e^21\int\limits_0^1 dz_1\int\limits_0^{-z_1+1} dz_2\left(-\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)mz_1k_{sigma_1}}{2\,(z_1+z_2)^{1.5}}\gamma^{mu}\gamma^{sigma_2}\gamma^{nu}\right) \tag{49}$$

Evaluating internal momenta in this term (5 terms left)

$$\frac{0.0625e^{2}}{\pi^{4}}1\int_{0}^{1}dz_{1}\int_{0}^{-z_{1}+1}dz_{2}\int\frac{d^{d}p}{(2\pi)^{4}}\left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)p_{sigma_{1}}\gamma^{mu}\gamma^{sigma_{1}}\gamma^{sigma_{2}}\gamma^{nu}}{\left(-m^{2}z_{1}-m^{2}z_{2}+z_{1}k_{\eta}k^{\eta}+z_{1}k_{\eta}p^{\eta}+z_{1}k^{\eta}p_{\eta}+z_{1}p_{\eta}p^{\eta}+z_{2}p_{\eta}p^{\eta}\right)^{2}}\right) \tag{50}$$

Integrating over p
Completing the square

$$A=z_{1}+z_{2} \tag{51}$$

$$B=2z_{1}k^{\eta} \tag{52}$$

$$C=-m^{2}z_{1}-m^{2}z_{2}+z_{1}k_{\eta}k^{\eta} \tag{53}$$

After $p\rightarrow q_{1}$ substitutions

$$\frac{0.0625e^{2}}{\pi^{4}}1\int_{0}^{1}dz_{1}\int_{0}^{-z_{1}+1}dz_{2}\int\frac{d^{d}q_{1}}{(2\pi)^{4}}\left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)\left(z_{1}\left(z_{1}+z_{2}\right)^{0.5}k_{sigma_{1}}-2\left(z_{1}+z_{2}\right)q_{1\,sigma_{1}}\right)^{2}\gamma^{mu}\gamma^{sigma_{1}}\gamma^{sigma_{2}}\gamma^{nu}}{4\left(z_{1}+z_{2}\right)^{3.5}\left(-m^{2}z_{1}-m^{2}z_{2}-\frac{{z_{1}}^{2}k_{\eta}k^{\eta}}{4z_{1}+4z_{2}}+z_{1}k_{\eta}k^{\eta}+{q_{1}}_{\eta}{q_{1}}^{\eta}\right)^{2}}\right) \tag{54}$$

Expanding numerator into 3 term(s)

$$\frac{0.0625e^{2}}{\pi^{4}}1\int_{0}^{1}dz_{1}\int_{0}^{-z_{1}+1}dz_{2}\int\frac{d^{d}q_{1}}{(2\pi)^{4}}\left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)q_{1\,sigma_{1}}\gamma^{mu}\gamma^{sigma_{1}}\gamma^{sigma_{2}}\gamma^{nu}}{\left(z_{1}+z_{2}\right)^{1.5}\left(-m^{2}z_{1}-m^{2}z_{2}-\frac{{z_{1}}^{2}k_{\eta}k^{\eta}}{4z_{1}+4z_{2}}+z_{1}k_{\eta}k^{\eta}+{q_{1}}_{\eta}{q_{1}}^{\eta}\right)^{2}}\right) \tag{55}$$

$$\frac{0.0625e^{2}}{\pi^{4}}1\int_{0}^{1}dz_{1}\int_{0}^{-z_{1}+1}dz_{2}\int\frac{d^{d}q_{1}}{(2\pi)^{4}}\left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k){z_{1}}^{2}k_{sigma_{1}}\gamma^{mu}\gamma^{sigma_{1}}\gamma^{sigma_{2}}\gamma^{nu}}{4\left(z_{1}+z_{2}\right)^{2.5}\left(-m^{2}z_{1}-m^{2}z_{2}-\frac{{z_{1}}^{2}k_{\eta}k^{\eta}}{4z_{1}+4z_{2}}+z_{1}k_{\eta}k^{\eta}+{q_{1}}_{\eta}{q_{1}}^{\eta}\right)^{2}}\right) \tag{56}$$

$$\frac{0.0625e^{2}}{\pi^{4}}1\int_{0}^{1}dz_{1}\int_{0}^{-z_{1}+1}dz_{2}\int\frac{d^{d}q_{1}}{(2\pi)^{4}}\left(-\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)z_{1}k_{sigma_{1}}q_{1\,sigma_{1}}\gamma^{mu}\gamma^{sigma_{1}}\gamma^{sigma_{2}}\gamma^{nu}}{\left(z_{1}+z_{2}\right)^{2.0}\left(-m^{2}z_{1}-m^{2}z_{2}-\frac{{z_{1}}^{2}k_{\eta}k^{\eta}}{4z_{1}+4z_{2}}+z_{1}k_{\eta}k^{\eta}+{q_{1}}_{\eta}{q_{1}}^{\eta}\right)^{2}}\right) \tag{57}$$

Integrating this term:

$$\frac{0.0625e^2}{\pi^4} 1 \int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \int \frac{d^d q_1}{(2\pi)^4} \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) q_{1sigma_1} \gamma^{mu} \gamma^{sigma_1} \gamma^{sigma_2} \gamma^{nu}}{(z_1 + z_2)^{1.5} \left(-m^2 z_1 - m^2 z_2 - \frac{z_1{}^2 k_\eta k^\eta}{4z_1 + 4z_2} + z_1 k_\eta k^\eta + q_{1\eta} q_1{}^\eta\right)^2} \right) \tag{58}$$

Found 0 q-vector terms in the numerator.
Apply golden integral

$$\frac{1249999896.56489i}{\pi^2} e^2 1 \int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) q_{1sigma_1} \gamma^{mu}}{(z_1 + z_2)^{1.5}} \gamma^{sigma_1} \gamma^{sigma_2} \gamma^{nu} \right) \tag{59}$$

Integrating this term:

$$\frac{0.0625e^2}{\pi^4} 1 \int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \int \frac{d^d q_1}{(2\pi)^4} \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) z_1{}^2 k_{sigma_1} \gamma^{mu} \gamma^{sigma_1} \gamma^{sigma_2} \gamma^{nu}}{4(z_1 + z_2)^{2.5} \left(-m^2 z_1 - m^2 z_2 - \frac{z_1{}^2 k_\eta k^\eta}{4z_1 + 4z_2} + z_1 k_\eta k^\eta + q_{1\eta} q_1{}^\eta\right)^2} \right) \tag{60}$$

Found 0 q-vector terms in the numerator.
Apply golden integral

$$\frac{1249999896.56489i}{\pi^2} e^2 1 \int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) z_1{}^2 k_{sigma_1}}{4(z_1 + z_2)^{2.5}} \gamma^{mu} \gamma^{sigma_1} \gamma^{sigma_2} \gamma^{nu} \right) \tag{61}$$

Integrating this term:

$$\frac{0.0625e^2}{\pi^4} 1 \int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \int \frac{d^d q_1}{(2\pi)^4} \left(-\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) z_1 k_{sigma_1} q_{1sigma_1} \gamma^{mu} \gamma^{sigma_1} \gamma^{sigma_2} \gamma^{nu}}{(z_1 + z_2)^{2.0} \left(-m^2 z_1 - m^2 z_2 - \frac{z_1{}^2 k_\eta k^\eta}{4z_1 + 4z_2} + z_1 k_\eta k^\eta + q_{1\eta} q_1{}^\eta\right)^2} \right) \tag{62}$$

Found 1 q-vector terms in the numerator.
Term vanishes due to Ward identity

Evaluating internal momenta in this term (6 terms left)

$$\frac{0.0625e^2}{\pi^4} 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \int \frac{d^d p}{(2\pi)^4} \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) k_{sigma_1} p_{sigma_1} \gamma^{mu} \gamma^{sigma_1} \gamma^{sigma_2} \gamma^{nu}}{\left(-m^2 z_1 - m^2 z_2 + z_1 k_\eta k^\eta + z_1 k_\eta p^\eta + z_1 k^\eta p_\eta + z_1 p_\eta p^\eta + z_2 p_\eta p^\eta\right)^2} \right) \tag{63}$$

Integrating over p
Completing the square

$$A = z_1 + z_2 \tag{64}$$

$$B = 2 z_1 k^\eta \tag{65}$$

$$C = -m^2 z_1 - m^2 z_2 + z_1 k_\eta k^\eta \tag{66}$$

After $p \to q_1$ substitutions

$$\frac{0.0625e^2}{\pi^4} 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \int \frac{d^d q_1}{(2\pi)^4} \left(-\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) \left(z_1 \left(z_1 + z_2\right)^{0.5} k_{sigma_1} - 2\left(z_1 + z_2\right) q_{1\,sigma_1}\right) k_{sigma_1} \gamma^{mu} \gamma^{sigma_1} \gamma^{sigma_2} \gamma^{nu}}{2\left(z_1 + z_2\right)^{2.0} \left(-m^2 z_1 - m^2 z_2 - \frac{z_1{}^2 k_\eta k^\eta}{4z_1 + 4z_2} + z_1 k_\eta k^\eta + q_{1\,\eta} q_1{}^\eta\right)^2} \right) \tag{67}$$

Expanding numerator into 3 term(s)

$$\frac{0.0625e^2}{\pi^4} 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \int \frac{d^d q_1}{(2\pi)^4} \left(-\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) z_1 k_{sigma_1} \gamma^{mu} \gamma^{sigma_1} \gamma^{sigma_2} \gamma^{nu}}{2\left(z_1 + z_2\right)^{1.5} \left(-m^2 z_1 - m^2 z_2 - \frac{z_1{}^2 k_\eta k^\eta}{4z_1 + 4z_2} + z_1 k_\eta k^\eta + q_{1\,\eta} q_1{}^\eta\right)^2} \right) \tag{68}$$

$$\frac{0.0625e^2}{\pi^4} 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \int \frac{d^d q_1}{(2\pi)^4} \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) z_1 k_{sigma_1} q_{1\,sigma_1} \gamma^{mu} \gamma^{sigma_1} \gamma^{sigma_2} \gamma^{nu}}{\left(z_1 + z_2\right)^{2.0} \left(-m^2 z_1 - m^2 z_2 - \frac{z_1{}^2 k_\eta k^\eta}{4z_1 + 4z_2} + z_1 k_\eta k^\eta + q_{1\,\eta} q_1{}^\eta\right)^2} \right) \tag{69}$$

$$\frac{0.0625e^2}{\pi^4} 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \int \frac{d^d q_1}{(2\pi)^4} \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) z_2 k_{sigma_1} q_{1\,sigma_1} \gamma^{mu} \gamma^{sigma_1} \gamma^{sigma_2} \gamma^{nu}}{\left(z_1 + z_2\right)^{2.0} \left(-m^2 z_1 - m^2 z_2 - \frac{z_1{}^2 k_\eta k^\eta}{4z_1 + 4z_2} + z_1 k_\eta k^\eta + q_{1\,\eta} q_1{}^\eta\right)^2} \right) \tag{70}$$

Integrating this term:

$$\frac{0.0625e^2}{\pi^4} 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \int \frac{d^d q_1}{(2\pi)^4} \left(- \frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) z_1 k_{sigma_1} \gamma^{mu} \gamma^{sigma_1} \gamma^{sigma_2} \gamma^{nu}}{2 (z_1 + z_2)^{1.5} \left(-m^2 z_1 - m^2 z_2 - \frac{z_1{}^2 k_\eta k^\eta}{4z_1 + 4z_2} + z_1 k_\eta k^\eta + q_{1\eta} q_1{}^\eta \right)^2} \right) \tag{71}$$

Found 0 q-vector terms in the numerator.
Apply golden integral

$$\frac{1249999896.56489i}{\pi^2} e^2 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \left(- \frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) z_1 k_{sigma_1}}{2 (z_1 + z_2)^{1.5}} \gamma^{mu} \gamma^{sigma_1} \gamma^{sigma_2} \gamma^{nu} \right) \tag{72}$$

Integrating this term:

$$\frac{0.0625e^2}{\pi^4} 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \int \frac{d^d q_1}{(2\pi)^4} \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) z_1 k_{sigma_1} q_{1\,sigma_1} \gamma^{mu} \gamma^{sigma_1} \gamma^{sigma_2} \gamma^{nu}}{(z_1 + z_2)^{2.0} \left(-m^2 z_1 - m^2 z_2 - \frac{z_1{}^2 k_\eta k^\eta}{4z_1 + 4z_2} + z_1 k_\eta k^\eta + q_{1\eta} q_1{}^\eta \right)^2} \right) \tag{73}$$

Found 1 q-vector terms in the numerator.
Term vanishes due to Ward identity

Integrating this term:

$$\frac{0.0625e^2}{\pi^4} 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \int \frac{d^d q_1}{(2\pi)^4} \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) z_2 k_{sigma_1} q_{1\,sigma_1} \gamma^{mu} \gamma^{sigma_1} \gamma^{sigma_2} \gamma^{nu}}{(z_1 + z_2)^{2.0} \left(-m^2 z_1 - m^2 z_2 - \frac{z_1{}^2 k_\eta k^\eta}{4z_1 + 4z_2} + z_1 k_\eta k^\eta + q_{1\eta} q_1{}^\eta \right)^2} \right) \tag{74}$$

Found 1 q-vector terms in the numerator.
Term vanishes due to Ward identity

Evaluating internal momenta in this term (6 terms left)

$$\frac{1249999896.56489i}{\pi^2} e^2 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m^2 \gamma^{mu} \gamma^{nu}}{(z_1+z_2)^{0.5}} \right) \tag{75}$$

Evaluating internal momenta in this term (5 terms left)

$$\frac{1249999896.56489i}{\pi^2} e^2 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m k_{sigma_1}}{(z_1+z_2)^{0.5}} \gamma^{mu} \gamma^{sigma_1} \gamma^{nu} \right) \tag{76}$$

Evaluating internal momenta in this term (4 terms left)

$$\frac{1249999896.56489i}{\pi^2} e^2 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \left(-\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m z_1 k_{sigma_1}}{2(z_1+z_2)^{1.5}} \gamma^{mu} \gamma^{sigma_1} \gamma^{nu} \right) \tag{77}$$

Evaluating internal momenta in this term (3 terms left)

$$\frac{1249999896.56489i}{\pi^2} e^2 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \left(-\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m z_1 k_{sigma_1}}{2(z_1+z_2)^{1.5}} \gamma^{mu} \gamma^{sigma_2} \gamma^{nu} \right) \tag{78}$$

Evaluating internal momenta in this term (2 terms left)

$$\frac{1249999896.56489i}{\pi^2} e^2 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) q_{1\,sigma_1} \gamma^{mu}}{(z_1+z_2)^{1.5}} \gamma^{sigma_1} \gamma^{sigma_2} \gamma^{nu} \right) \tag{79}$$

Evaluating internal momenta in this term (1 terms left)

$$\frac{1249999896.56489i}{\pi^2} e^2 1 \int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) {z_1}^2 k_{sigma_1}}{4\left(z_1+z_2\right)^{2.5}} \gamma^{mu}\gamma^{sigma_1}\gamma^{sigma_2}\gamma^{nu} \right) \tag{80}$$

Evaluating internal momenta in this term (0 terms left)

$$\frac{1249999896.56489i}{\pi^2} e^2 1 \int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \left(-\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) z_1 k_{sigma_1}}{2\left(z_1+z_2\right)^{1.5}} \gamma^{mu}\gamma^{sigma_1}\gamma^{sigma_2}\gamma^{nu} \right) \tag{81}$$

Final amplitudes after momenta integration

$$\frac{1249999896.56489i}{\pi^2} e^2 1 \int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m^2 \gamma^{mu}\gamma^{nu}}{\left(z_1+z_2\right)^{0.5}} \right) \tag{82}$$

$$\frac{1249999896.56489i}{\pi^2} e^2 1 \int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m k_{sigma_1}}{\left(z_1+z_2\right)^{0.5}} \gamma^{mu}\gamma^{sigma_1}\gamma^{nu} \right) \tag{83}$$

$$\frac{1249999896.56489i}{\pi^2} e^2 1 \int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \left(-\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m z_1 k_{sigma_1}}{2\left(z_1+z_2\right)^{1.5}} \gamma^{mu}\gamma^{sigma_1}\gamma^{nu} \right) \tag{84}$$

$$\frac{1249999896.56489i}{\pi^2} e^2 1 \int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \left(-\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m z_1 k_{sigma_1}}{2\left(z_1+z_2\right)^{1.5}} \gamma^{mu}\gamma^{sigma_2}\gamma^{nu} \right) \tag{85}$$

$$\frac{1249999896.56489i}{\pi^2} e^2 1 \int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) q_{1\,sigma_1} \gamma^{mu}}{(z_1+z_2)^{1.5}} \gamma^{sigma_1} \gamma^{sigma_2} \gamma^{nu} \right) \tag{86}$$

$$\frac{1249999896.56489i}{\pi^2} e^2 1 \int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) {z_1}^2 k_{sigma_1}}{4(z_1+z_2)^{2.5}} \gamma^{mu} \gamma^{sigma_1} \gamma^{sigma_2} \gamma^{nu} \right) \tag{87}$$

$$\frac{1249999896.56489i}{\pi^2} e^2 1 \int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \left(-\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) z_1 k_{sigma_1}}{2(z_1+z_2)^{1.5}} \gamma^{mu} \gamma^{sigma_1} \gamma^{sigma_2} \gamma^{nu} \right) \tag{88}$$

Integrating cutoffs

Here we integrate all t-variables, which represent the upper and lower cutoffs.

Integrating this term

$$\frac{1249999896.56489i}{\pi^2} e^2 1 \int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m^2 \gamma^{mu} \gamma^{nu}}{(z_1+z_2)^{0.5}} \right) \tag{89}$$

Denominator only

$$1 \tag{90}$$

Integrating this term

$$\frac{1249999896.56489i}{\pi^2} e^2 1 \int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m k_{sigma_1}}{(z_1+z_2)^{0.5}} \gamma^{mu} \gamma^{sigma_1} \gamma^{nu} \right) \tag{91}$$

Denominator only

$$1 \tag{92}$$

Integrating this term

$$\frac{1249999896.56489i}{\pi^2}e^2 1\int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \left(-\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m z_1 k_{sigma_1}}{2\left(z_1+z_2\right)^{1.5}}\gamma^{mu}\gamma^{sigma_1}\gamma^{nu}\right) \tag{93}$$

Denominator only

$$1 \tag{94}$$

Integrating this term

$$\frac{1249999896.56489i}{\pi^2}e^2 1\int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \left(-\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m z_1 k_{sigma_1}}{2\left(z_1+z_2\right)^{1.5}}\gamma^{mu}\gamma^{sigma_2}\gamma^{nu}\right) \tag{95}$$

Denominator only

$$1 \tag{96}$$

Integrating this term

$$\frac{1249999896.56489i}{\pi^2}e^2 1\int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) q_{1\,sigma_1}\gamma^{mu}}{\left(z_1+z_2\right)^{1.5}}\gamma^{sigma_1}\gamma^{sigma_2}\gamma^{nu}\right) \tag{97}$$

Denominator only

$$1 \tag{98}$$

Integrating this term

$$\frac{1249999896.56489i}{\pi^2}e^2 1\int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) {z_1}^2 k_{sigma_1}}{4\left(z_1+z_2\right)^{2.5}}\gamma^{mu}\gamma^{sigma_1}\gamma^{sigma_2}\gamma^{nu}\right) \tag{99}$$

Denominator only

$$1 \tag{100}$$

Integrating this term

$$\frac{1249999896.56489i}{\pi^2} e^2 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \left(-\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) z_1 k_{sigma_1}}{2\left(z_1+z_2\right)^{1.5}} \gamma^{mu}\gamma^{sigma_1}\gamma^{sigma_2}\gamma^{nu} \right) \tag{101}$$

Denominator only

$$1 \tag{102}$$

Integrating z-variables

Here we integrate all z-variables, the Feynman parameters.

Integrating this term

$$\frac{1249999896.56489i}{\pi^2} e^2 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m^2 \gamma^{mu}\gamma^{nu}}{\left(z_1+z_2\right)^{0.5}} \right) \tag{103}$$

Integrating wrt z_2...

$$-2\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m^2 \sqrt{z_1}\gamma^{mu}\gamma^{nu} + 2\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m^2 \gamma^{mu}\gamma^{nu} \tag{104}$$

Integrating wrt z_1...

$$\frac{2m^2}{3}\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)\gamma^{mu}\gamma^{nu} \tag{105}$$

Integrating this term

$$\frac{1249999896.56489i}{\pi^2} e^2 1 \int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k) m k_{sigma_1}}{\left(z_1+z_2\right)^{0.5}} \gamma^{mu}\gamma^{sigma_1}\gamma^{nu} \right) \tag{106}$$

Integrating wrt z_2...

$$-2\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)m\sqrt{z_1}k_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{nu} + 2\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)mk_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{nu} \tag{107}$$

Integrating wrt z_1...

$$\frac{2m}{3}\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)k_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{nu} \tag{108}$$

Integrating this term

$$\frac{1249999896.56489i}{\pi^2}e^2 1\int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \left(-\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)mz_1k_{sigma_1}}{2\left(z_1+z_2\right)^{1.5}}\gamma^{mu}\gamma^{sigma_1}\gamma^{nu}\right) \tag{109}$$

Integrating wrt z_2...

$$-\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)m\sqrt{z_1}k_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{nu} + \epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)mz_1k_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{nu} \tag{110}$$

Integrating wrt z_1...

$$-\frac{m}{6}\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)k_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{nu} \tag{111}$$

Integrating this term

$$\frac{1249999896.56489i}{\pi^2}e^2 1\int_0^1 dz_1 \int_0^{-z_1+1} dz_2 \left(-\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)mz_1k_{sigma_1}}{2\left(z_1+z_2\right)^{1.5}}\gamma^{mu}\gamma^{sigma_2}\gamma^{nu}\right) \tag{112}$$

Integrating wrt z_2...

$$-\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)m\sqrt{z_1}k_{sigma_1}\gamma^{mu}\gamma^{sigma_2}\gamma^{nu} + \epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)mz_1k_{sigma_1}\gamma^{mu}\gamma^{sigma_2}\gamma^{nu} \tag{113}$$

Integrating wrt z_1...

$$-\frac{m}{6}\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)k_{sigma_1}\gamma^{mu}\gamma^{sigma_2}\gamma^{nu} \tag{114}$$

Integrating this term

$$\frac{1249999896.56489i}{\pi^2}e^2 1\int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)q_{1\,sigma_1}\gamma^{mu}}{(z_1+z_2)^{1.5}}\gamma^{sigma_1}\gamma^{sigma_2}\gamma^{nu}\right) \tag{115}$$

Integrating wrt z_2...

$$-2\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)q_{1\,sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{sigma_2}\gamma^{nu} + \frac{2q_{1\,sigma_1}}{\sqrt{z_1}}\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)\gamma^{mu}\gamma^{sigma_1}\gamma^{sigma_2}\gamma^{nu} \tag{116}$$

Integrating wrt z_1...

$$2\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)q_{1\,sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{sigma_2}\gamma^{nu} \tag{117}$$

Integrating this term

$$\frac{1249999896.56489i}{\pi^2}e^2 1\int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \left(\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k){z_1}^2 k_{sigma_1}}{4(z_1+z_2)^{2.5}}\gamma^{mu}\gamma^{sigma_1}\gamma^{sigma_2}\gamma^{nu}\right) \tag{118}$$

Integrating wrt z_2...

$$\frac{1}{6}\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)\sqrt{z_1}k_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{sigma_2}\gamma^{nu} - \frac{1}{6}\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k){z_1}^2 k_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{sigma_2}\gamma^{nu} \tag{119}$$

Integrating wrt z_1...

$$\frac{1}{18}\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)k_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{sigma_2}\gamma^{nu} \tag{120}$$

Integrating this term

$$\frac{1249999896.56489i}{\pi^2}e^2 1\int\limits_0^1 dz_1 \int\limits_0^{-z_1+1} dz_2 \left(-\frac{\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)z_1 k_{sigma_1}}{2(z_1+z_2)^{1.5}}\gamma^{mu}\gamma^{sigma_1}\gamma^{sigma_2}\gamma^{nu}\right) \tag{121}$$

Integrating wrt z_2...

$$-\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)\sqrt{z_1}k_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{sigma_2}\gamma^{nu} + \epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)z_1k_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{sigma_2}\gamma^{nu} \tag{122}$$

Integrating wrt z_1...

$$-\frac{1}{6}\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)k_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{sigma_2}\gamma^{nu} \tag{123}$$

Final amplitudes after z-variable integration

$$\frac{1249999896.56489i}{\pi^2}e^21\left(\frac{2m^2}{3}\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)\gamma^{mu}\gamma^{nu}\right) \tag{124}$$

$$\frac{1249999896.56489i}{\pi^2}e^21\left(\frac{2m}{3}\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)k_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{nu}\right) \tag{125}$$

$$\frac{1249999896.56489i}{\pi^2}e^21\left(-\frac{m}{6}\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)k_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{nu}\right) \tag{126}$$

$$\frac{1249999896.56489i}{\pi^2}e^21\left(-\frac{m}{6}\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)k_{sigma_1}\gamma^{mu}\gamma^{sigma_2}\gamma^{nu}\right) \tag{127}$$

$$\frac{1249999896.56489i}{\pi^2}e^21\left(2\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)q_{1\,sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{sigma_2}\gamma^{nu}\right) \tag{128}$$

$$\frac{1249999896.56489i}{\pi^2}e^21\left(\frac{1}{18}\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)k_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{sigma_2}\gamma^{nu}\right) \tag{129}$$

$$\frac{1249999896.56489i}{\pi^2}e^21\left(-\frac{1}{6}\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)k_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{sigma_2}\gamma^{nu}\right) \tag{130}$$

Evaluating spins and gamma matrices

TODO jk do it yourself you slags, here's the sum, have fun. Don't forget to take traces/multiply by -1 for internal fermion loops.

$$\begin{aligned}
&\frac{1249999896.56489i}{\pi^2}e^2 1\left(\frac{2m^2}{3}\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)\gamma^{mu}\gamma^{nu}\right) + \frac{1249999896.56489i}{\pi^2}e^2 1\left(\frac{2m}{3}\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)k_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{nu}\right)\\
&+\frac{1249999896.56489i}{\pi^2}e^2 1\left(-\frac{m}{6}\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)k_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{nu}\right) + \frac{1249999896.56489i}{\pi^2}e^2 1\left(-\frac{m}{6}\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)k_{sigma_1}\gamma^{mu}\gamma^{sigma_2}\gamma^{nu}\right)\\
&+\frac{1249999896.56489i}{\pi^2}e^2 1\left(2\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)q_{1\,sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{sigma_2}\gamma^{nu}\right) + \frac{1249999896.56489i}{\pi^2}e^2 1\left(\frac{1}{18}\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)k_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{sigma_2}\gamma^{nu}\right)\\
&+\frac{1249999896.56489i}{\pi^2}e^2 1\left(-\frac{1}{6}\epsilon_{nu}(k)\bar{\epsilon}_{mu}(k)k_{sigma_1}\gamma^{mu}\gamma^{sigma_1}\gamma^{sigma_2}\gamma^{nu}\right)
\end{aligned} \tag{131}$$