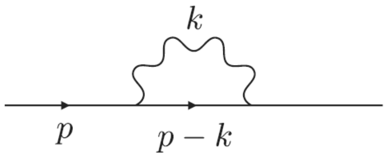
4 Feynman diagrams

Using the Feynman rules (see Appendix) we obtain the expression for the corresponding amplitudes. (In the following expressions we drop external lines.)

a)

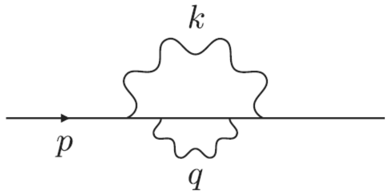
$\mathrm{i}\mathcal{M} =$



$$= (\mathrm{i}e)^2 \int \frac{\mathrm{d}^4 k}{(2\pi)^4} \left(\gamma_\nu \frac{1}{\not{p} - \not{k} - m + \mathrm{i}\epsilon} \gamma_\mu \frac{g^{\mu\nu}}{k^2 + \mathrm{i}\epsilon} \right)$$

b)

$\mathrm{i}\mathcal{M} =$



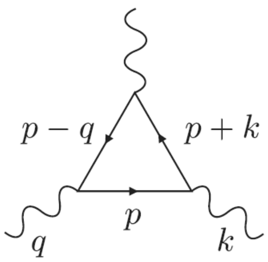
$$= \mathrm{i}(\mathrm{i}e)^4 \int\int \frac{\mathrm{d}^4 k}{(2\pi)^4} \frac{\mathrm{d}^4 q}{(2\pi)^4} \left(\gamma^\mu \frac{1}{\not{p} - \not{k} - m + \mathrm{i}\epsilon} \gamma^\sigma \right.$$

$$\times \frac{1}{\not{p} - \not{k} - \not{q} - m + \mathrm{i}\epsilon} \gamma_\sigma \frac{1}{\not{p} - \not{k} - m + \mathrm{i}\epsilon}$$

$$\left. \times\ \gamma_\mu \frac{1}{k^2 + \mathrm{i}\epsilon} \frac{1}{q^2 + \mathrm{i}\epsilon} \right)$$

c)

$\mathrm{i}\mathcal{M} =$

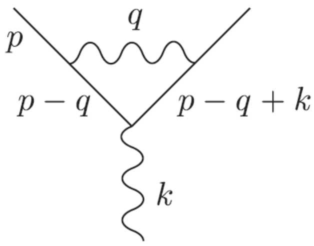


$$= -(\mathrm{i}e)^3 \mathrm{i}^3 \int \frac{\mathrm{d}^4 p}{(2\pi)^4} \mathrm{tr} \left[\gamma^\nu \frac{1}{\not{p} - \not{q} - m + \mathrm{i}\epsilon} \gamma^\rho \right.$$

$$\left. \times\ \frac{1}{\not{p} + \not{k} - m + \mathrm{i}\epsilon} \gamma^\mu \frac{1}{\not{p} - m + \mathrm{i}\epsilon} \right]$$

d)

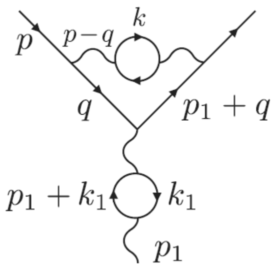
$i\mathcal{M} =$



$$= i(ie)^3 \int \frac{d^4 p}{(2\pi)^4} \left(\gamma^\nu \frac{1}{\not{p} + \not{k} - \not{q} - m + i\epsilon} \right.$$
$$\left. \times\ \gamma^\rho \frac{1}{\not{p} - \not{q} - m + i\epsilon} \gamma_\nu \frac{1}{q^2 + i\epsilon} \right)$$

e)

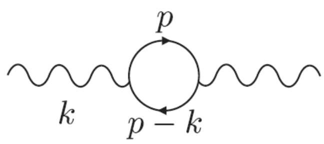
$i\mathcal{M} =$



$$= (ie)^7 i^6 (-i)^3 \int\int\int \frac{d^4 k_1}{(2\pi)^4} \frac{d^4 q}{(2\pi)^4} \frac{d^4 k}{(2\pi)^4}$$
$$\times \left[\gamma^\nu \frac{1}{\not{p}_1 + \not{q} - m + i\epsilon} \gamma^\alpha \frac{1}{\not{q} - m + i\epsilon} \gamma^\mu \right.$$
$$\times \frac{g^{\mu\rho}}{(p-q)^2 + i\epsilon} \frac{g^{\sigma\nu}}{(p-q)^2 + i\epsilon}$$
$$\times \operatorname{tr} \left(\frac{1}{\not{k} - m + i\epsilon} \gamma^\sigma \frac{1}{\not{p} - \not{q} + \not{k} - m + i\epsilon} \gamma^\rho \right)$$
$$\left. \times\ \frac{g^{\alpha\beta}}{p_1^2 + i\epsilon} \operatorname{tr} \left(\frac{1}{\not{p}_1 + \not{k}_1 - m + i\epsilon} \gamma^\delta \frac{1}{\not{k}_1 - m + i\epsilon} \gamma^\beta \right) \right]$$

f)

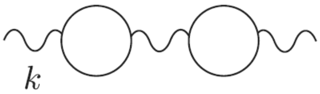
$$-\mathrm{i}\Pi^{\mu\nu}(k) =$$



$$= (\mathrm{i}e)^2 \int \frac{\mathrm{d}^4 p}{(2\pi)^4} \mathrm{tr}\left[\frac{1}{\not p - \not k - m + \mathrm{i}\epsilon}\gamma^\nu \frac{1}{\not p - m + \mathrm{i}\epsilon}\gamma^\mu\right]$$

g)

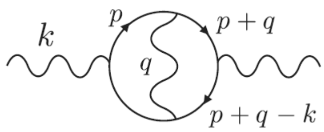
$$-\mathrm{i}\mathcal{M} =$$



$$= (-\mathrm{i})\Pi^{\mu\nu}(k)\frac{-\mathrm{i}g_{\nu\rho}}{k^2 + \mathrm{i}\epsilon}(-\mathrm{i})\Pi^{\rho\sigma}(k)$$

h)

$$-\mathrm{i}\mathcal{M} =$$



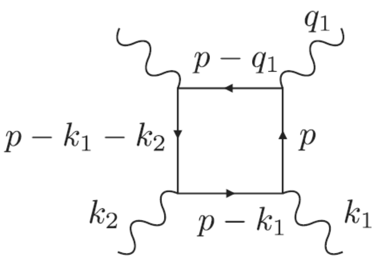
$$= -\mathrm{i}^4(-\mathrm{i})(\mathrm{i}e)^4 \int \frac{\mathrm{d}^4 p}{(2\pi)^4}\frac{\mathrm{d}^4 q}{(2\pi)^4} \mathrm{tr}\left[\frac{1}{\not p - \not k - m + \mathrm{i}\epsilon}\gamma^\sigma\right.$$

$$\times \frac{1}{\not p + \not q - \not k - m + \mathrm{i}\epsilon}\gamma^\nu \frac{1}{\not p + \not q - m + \mathrm{i}\epsilon}\gamma^\rho$$

$$\times \left.\frac{1}{\not p - m + \mathrm{i}\epsilon}\gamma^\mu\right] \frac{g_{\rho\sigma}}{q^2 + \mathrm{i}\epsilon}$$

i)

$$\mathrm{i}\mathcal{M} =$$



$$= -(\mathrm{i}e)^4 \int \frac{\mathrm{d}^4 p}{(2\pi)^4} \mathrm{tr}\left[\frac{1}{\not p - \not k_1 - m + \mathrm{i}\epsilon}\gamma^\mu \frac{1}{\not p - \not k_1 - \not k_2 - m + \mathrm{i}\epsilon}\right.$$

$$\times \left.\gamma^\sigma \frac{1}{\not p - \not q_1 - m + \mathrm{i}\epsilon}\gamma^\rho \frac{1}{\not p - m + \mathrm{i}\epsilon}\gamma^\nu\right]$$