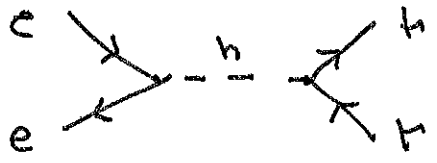
1. c



$$\sim y_{ee}\, y_{\mu\mu}\, [\bar{\psi}_{(e)}\psi_{(e)}]\, \frac{1}{(p_1+p_2)^2 - m_h^2}\, [\bar{\psi}_{(\mu)}\psi_{(\mu)}]$$

the problem boils down to understanding this matrix multiplication.

$$\bar{\psi}_{(e)}\psi_{(e)} = \begin{pmatrix} e_R^{*\uparrow} & e_R^{*\downarrow} & e_L^{*\uparrow} & e_L^{*\downarrow} \end{pmatrix} \begin{pmatrix} e_L^{\uparrow} \\ e_L^{\downarrow} \\ e_R^{\uparrow} \\ e_R^{\downarrow} \end{pmatrix}$$

$$= e_R^{*\uparrow} e_L^{\uparrow} + e_R^{*\downarrow} e_L^{\downarrow} + e_L^{*\uparrow} e_R^{\uparrow} + e_L^{*\downarrow} e_R^{\downarrow}$$

So: the [spin-0] — spin-$\frac{1}{2}$ — spin-$\frac{1}{2}$ vertex couples:

- OPPOSITE CHIRALITY ($R \nleftrightarrow L$, not $R \updownarrow R$)
- SAME spin in z-dir ($\uparrow$ w/ $\uparrow$, not $\uparrow \nleftrightarrow \downarrow$)

CONTRAST THIS TO A [spin-1] particle like A_μ.

↳ in HW 7, WE SAW THAT THIS ONLY COUPLES

- SAME CHIRALITY
- SAME or OPPOSITE spin-in-z-dir. DEPENDING ON THE VALUE OF μ.

a) $e_L^{\uparrow}$ + $e_R^{*\uparrow}$ → **yes**

b) $e_L^{\uparrow}$ + $e_L^{*\uparrow}$ → **no** only opposite CHIRALITY.

c) $H_L^{\uparrow}$ + $H_R^{*\downarrow}$ → **no** only same spin (in z dir)

d) spin-0: couples 2 fermions w/
- OPPOSITE CHIRALITY
- SAME SPIN IN z-DIR.

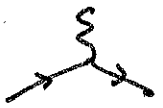
spin-1: couples 2 fermions w/
- SAME CHIRALITY
- SAME or OPP. SPIN IN z-DIR DEPENDING ON POLARIZ OF SPIN-1 (value of μ)

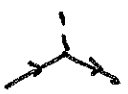
↑

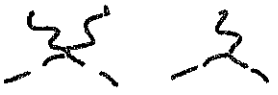
SPIN-0 HAS NO POLARIZATION!

2. $\mathcal{L} = -\frac{1}{4} F_{\mu\nu} F^{\mu\nu}$ ← eg  (OR ANY 3, 4 POINT GAUGE BOSON VERTEX)

ϕ is over H ↗

$+ i\bar{\psi} \not{D} \psi$ ←  from $-igA$ term in D

$+ \psi_i y_{ij} \psi_j \phi + h.c.$ ← 

$+ |D_\mu \phi|^2$ ← 

$- V(\phi)$ ← 

HIGGS VEV

3. Standard model in your life

IF THE HIGGS INTERACTED MORE STRONGLY W/ UP VS. down, then the UP QUARK WOULD BE HEAVIER THAN THE DOWN.

$y_u\, u_L u_R h \longrightarrow \boxed{\frac{y_u v}{\sqrt{2}}}\, u_L u_R$ (with $h \to \frac{v}{\sqrt{2}}$)

$\boxed{\frac{y_u v}{\sqrt{2}}} = m_u$

$y_d\, d_L d_R h \longrightarrow \boxed{\frac{y_d v}{\sqrt{2}}}\, d_L d_R$

$\boxed{\frac{y_d v}{\sqrt{2}}} = m_d$

since the proton is uud
& the neutron is udd

making $y_u > y_d \Rightarrow m_u > m_d \Rightarrow \boxed{m_p > m_n}$

$\Rightarrow$ PROTON IS HEAVIER THAN NEUTRON!

then all protons would eventually decay via β decay into neutrons.

→ all hydrogen ends up decaying!!