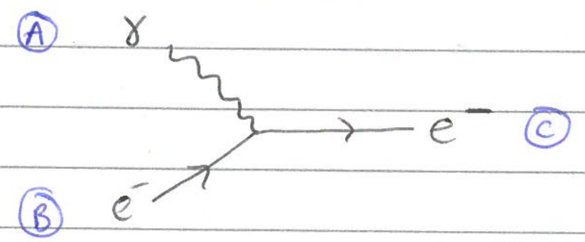
SECTION 4

slide 9 — draw these on board as explain

slide 10 — draw diagram on board as set up.

slide 19

A free electron absorbs a photon



Assume e⁻ at rest initially.

Initial state $M_i^2 = (E_A + E_B)^2 - (\vec{p}_A + \vec{p}_B)^2$

$= E_A^2 + E_B^2 + 2E_AE_B - \vec{p}_A^{\,2} - \vec{p}_B^{\,2} - 2\vec{p}_A\vec{p}_B$

$= \underbrace{m_A^2}_{m_\gamma = 0} + m_B^2 + 2E_AE_B - 2\vec{p}_A\underbrace{\vec{p}_B}_{0}$

$= m_B^2 + 2E_AE_B$

Final state $M_f^2 = E_c^2 - \vec{p}_c^{\,2} = m_c^2$

Lorentz Invariance $M_i^2 = M_f^2$

$m_B^2 + \underbrace{2E_AE_B}_{>0} = m_c^2$

$\therefore M_i > M_f \quad \therefore E, \vec{p}$ not conserved!

BUT if we allow $m_c \neq m_e$ ie. off-shell electron

$m_c^2 > m_B^2$ ie C is a virtual electron

NOT a physical process
Need a second vertex in the Feynman diagram

nb e⁻ in atoms are bound & can absorb single γ as they have internal degrees of freedom