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Deep inelastic scattering

1) The Bjorken variable x can be identified as what?

2) In the quark-proton model, derive an expression for the fraction of momentum of the proton carried by a struck quark.

3) Before the interaction, describe the nature of the quarks inside the proton.

4) Using

$$F_2^{ep}(x, Q^2) = 2xF_1^{ep}(x, Q^2) = x \sum_i Q_i^2 q_i^p(x) \tag{1}$$

Derive an expression for F_2^{ep} in terms of light flavours.

4i) Expand to yield an expression including valence and sea quarks.

5) Which collider provided precise measurements of the proton structure function?

Symmetries

1) What is meant by *isospin*?

2) Consider a two-particle non-interacting fermion system. The non-interacting implies that the two-particle wave function can be written as the product of two single particle wave functions:

$$\psi_I(r_1, r_2) = \psi_a(r_1)\psi_b(r_2) \tag{2}$$

$$\psi_{II}(r_1, r_2) = \psi_a(r_2)\psi_b(r_1) \tag{3}$$

where a and b label two different single particle states.

The system is either ψ_I or ψ_{II}. True or False?

2i) Write the symemetric and anti-symmetric case.   2ii) In the case of fermions, $\psi = 0$. What does this imply?

3) By considering the isospin states, show that the rates for the following strong interaction decays occur in the ratios

$$\Gamma(\Delta^- \to \pi^- n) : \Gamma(\Delta^0 \to \pi^- p) : \Gamma(\Delta^0 \to \pi^0 n) : \Gamma(\Delta^+ \to \pi^+ n) :$$
$$\Gamma(\Delta^+ \to \pi^0 p) : \Gamma(\Delta^{++} \to \pi^+ p) = 3 : 1 : 2 : 1 : 2 : 3 \tag{4}$$