

Problems/questions: Introductory particle physics

1. Natural units.
2. Basic interactions. Electricity and magnetism: unification.
3. Virtual particles and Heisenberg uncertainty.
4. Beta decay, lepton number conservation.
5. Colour in QCD. Some arguments for it (theoretical, experimental).
6. Effective electric charge: running of fine structure constant
7. Quarks confinement, asymptotic freedom
8. Elementary particles: quarks, leptons.
9. Which particles are responsible for exchange of fundamental interactions?
10. Why exploration of matter at smaller and smaller scale requires higher and higher energies? Is it any alternative?
11. Relative strength of basic interactions (gravity, weak, electromagnetic, strong)
12. Basic interactions, coupling constants.
13. Conservation laws.
14. Lepton and baryon numbers.
15. Isospin, strangeness, charm, hypercharge.
16. Rutherford experiment, atom models (Thomson, Rutherford).
17. $SU(2)$ and $SU(3)$ groups. Mesoscopic and baryonic multiplets.
18. Continuity equation, Schrödinger equation.

19. Klein-Gordon equation.
20. Dirac equation, Dirac matrices.
21. Spin and Dirac equation. Helicity.
22. Feynman rules.
23. Cross section, decay width.
24. Kinematics and Mandelstam variables.
25. Structure of hadrons. Formfactors.
26. Deep inelastic scattering.
27. Feynman parton model. Valence quarks, sea quarks.
28. Gauge invariance and basic interactions.
29. Spontaneous symmetry breaking.
30. Mass generation in the Standard Model.
31. Neutrino oscillations.
32. GUT models, supersymmetry, extra dimensions.
33. Elementary particles and cosmology.

Enjoy and good luck!
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