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Homework

1.

Work in detail through the calculations that are summarized on the following slides—show your work:

1.a

64-67 in [astroparticle_instruments.pdf](#)

The importance here is to understand how air shower observations can measure the energy of the initial particle that interacts in the high atmosphere.

1.b

132-137 in [high_energy_neutrinos.pdf](#)

The calculation is also discussed in the pdf accompanying the lectures. Derive Eq.23 in [summary_halzen.ppt](#).

1.c

34-43 in [cosmic_accelerators.pdf](#)

This is the classic calculation of the neutrinos produced in a fireball. It also illustrates how stellar collapses are cosmic accelerators.

2.

Finally, describe in less than one page how a supernova remnant accelerates particles.