• Pick a single question from the five (A - E) given in the following pages and give your answer to it.

• Send your answer by email to mori@icepp.s.u-tokyo.ac.jp and masaya.ishino@cern.ch or bring it to the secretary in the Room 1015 on the 10th floor.

• Deadline: Noon, August 6th (Tuesday)

• To get the credits for this course, you must send your answer in time, however short or long it might be.

• Web page of this lecture: https://twiki.cern.ch/twiki/bin/view/Main/ParticlePhysicsIII2019
QUESTION A

• Read the “Final Report of the Committee on Future Projects in High Energy Physics” that is available both in English and Japanese at: https://twiki.cern.ch/twiki/bin/view/Main/JapanHepFuture2016

• What future project, apart from the one you are currently in, are you interested in working for? Explain why.

• What will you aim to achieve if you lead that project? What important roles will it play in the evolving history of elementary particle physics?

• State your own opinions that may differ from those written in the Report and make suggestions if any.
QUESTION B

• It was reported in 1984 [Physics Letters B 139 (1984) p.115] that several events were found in the (then) highest energy proton-antiproton collisions which could be interpreted as production of supersymmetric particles.

• Explain why they cannot be considered as Standard Model processes. But then what are they? Did they really discover SUSY particles?

[This experiment discovered the W and Z bosons in 1983, which lead to the Nobel Prize in 1984.]
QUESTION C

- It is rumored that there may be hidden chambers inside some of the pyramids in Egypt. Use particle detectors to search for a hidden chamber as illustrated below. Describe what detectors you will use and how long it may take to confirm its existence. Assume the chamber has an approximate volume of 20m x 20m x 20m. Be as specific as possible.
QUESTION D

• The precise inputs of the Parton Distribution Function (PDF) are one of the key elements for success of the hadron collider experiments.

• Review the definitions of F1, F2, (and F3) and explain the meaning for each.

• How have the predictions of cross-sections of physics processes been developed as the measurement of PDF has improved?

• Read the following reference article and pick up important topics and explain why/how they are important.

The reference article [in Japanese only]
There are three kinds of oscillations among the three neutrino species ($\theta_{12}$, $\theta_{23}$, $\theta_{13}$). All these oscillations may be individually observed in the atmospheric neutrinos at different neutrino energies.

Which oscillations may be observed at what neutrino energies in the atmospheric neutrinos?

Explain how they are really seen in the atmospheric neutrino data of the Super-Kamiokande.