**Stage 2 Physics**

**Science as a Human Endeavour**

**Sample question 1 and possible answers**

Students must learn to identify the four SHE key concepts in articles, videos, talks etc. Students must then be taught how to write short explanations that explicitly show how recent innovations, developments or events illustrate particular SHE key concepts.

**Information**

Using one of the most powerful computers in the world to perform complex simulations, scientists have predicted a new type of dibaryon particle - one that has two baryons, with quarks all of the same colour.

The researchers, from the Japanese HAL QCD Collaboration, are calling the particle di-Omega.

But by running simulations based on quantum chromodynamics (QCD), the theory that describes quark interactions, the HAL-QCD Collaboration is able to model potential stable dibaryons.

The researchers employed the [K Computer](http://www.riken.jp/en/research/environment/kcomputer/) at RIKEN's Advanced Institute for Computational Science, which has a computational power of 10 petaflops, or 10 quadrillion operations per second.

The research builds on the collaboration's previous discovery of a [theoretical dibaryon with two up, two down and two strange quarks](http://www.riken.jp/en/research/rikenresearch/highlights/6642/). Since then they have refined their methods, devising a new theoretical framework, and a new algorithm, to allow for more efficient calculations.

Researchers believe their work can be applied to experimental settings to search for evidence of these particles in the real world.

They look forward to working with colleagues who are working on experiments using heavy ion collisions that are planned in Europe to experimentally discover the first dibaryon system outside of deuteron.

The team's work has been published in the journal [Physical Review Letters](https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.120.212001).

Adapted from <https://www.sciencealert.com/strange-theoretical-hexaquark-di-omega-dibaryon-predicted>

Examples of questions that could be based on this information:

**Question 1a**

Use this information to identify and explain two ways in which the *development* of scientific ideas shows the interaction between science and society. (6 marks)

**Examples of answers.**

Any *two* of the following paragraphs would earn 6 marks.

The development and testing that has led to the prediction of a new type of dibaryon particle has made use of an extremely powerful computer. This new technology has enabled the scientists to perform very complex simulations in a time frame that would not have previously been possible. It has then allowed the scientists to reconsider the model that they has originally developed.

The development of this model has been as the result of evidence from different scientists working within a collaboration. It would be quite unusual for the development of a model such as this one to be produced by a single scientist. Complex models need input and evidence from many sources.

These researchers have continued to refine the original model that they developed. They have developed a new theoretical framework and algorithm. It is important for scientists to continue to think about their models and to be prepared to change them in the light of new evidence or new ways of analysing data using, for example, more powerful computers.

**Question 1b**

Discuss how this example illustrates one or more of the key concepts of science as a human endeavour (6 marks)

Any *two* of the following paragraphs would earn 6 marks.

Collaboration is important when scientists are developing ideas. In this project, a group of Japanese scientists worked together in the HAL-QCD Collaboration. Together, they were able to develop and test a new theoretical model for a new type of dibaryon particle. When scientists work together, they are able to share and improve each other’s ideas. This collaboration will be extended to experimental investigations which may demonstrate the existence of the new dibaryons in the real world rather than just being a theory.

The scientists who have modelled the existence of the new type of dibaryon have published their findings in the scientific journal [*Physical Review Letters*](https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.120.212001)*.* By doing this, they open up the opportunity for others to try to verify their findings. If the findings can be independently verified, then it provides much stronger support for the existence of this type of dibaryon. It also allows other scientists to think about the new model and perhaps to come up with other ideas that might be useful in developing the model further.

The model that these scientists have developed has been possible because of new technologies. The computer that they used for their simulations is one of the most powerful computers in the world. This computer has made the calculations required to make the prediction about the new type of dibaryon particle much more efficient. It has also meant that they could refine their model and improve efficiency even further. The continued evolution of models is an important part of scientific progress.