

From the Universe to the Atom

1

What evidence is there for the origins of the elements?

- investigate the processes that led to the transformation of radiation into matter that followed the 'Big Bang'
- investigate the evidence that led to the discovery of the expansion of the Universe by Hubble
- analyse and apply Einstein's description of the equivalence of energy and mass and relate this to the nuclear reactions that occur in stars
- account for the production of emission and absorption spectra and compare these with a continuous black body spectrum
- investigate the key features of stellar spectra and describe how these are used to classify stars
- investigate the Hertzsprung–Russell diagram and how it can be used to determine the following about a star:...
- investigate the types of nucleosynthesis reactions involved in Main Sequence and Post–Main Sequence stars, including but not limited to:...

2

How is it known that atoms are made up of protons, neutrons and electrons?

- investigate, assess and model the experimental evidence supporting the existence and properties of the electron, including:...
- investigate, assess and model the experimental evidence supporting the nuclear model of the atom, including:...

3

How is it known that classical physics cannot explain the properties of the atom?

- assess the limitations of the Rutherford and Bohr atomic models
- investigate the line emission spectra to examine the Balmer series in hydrogen
- relate qualitatively and quantitatively the quantised energy levels of the hydrogen atom and the law of conservation of energy to the line emission spectrum of hydrogen using:...
- investigate de Broglie's matter waves, and the experimental evidence that developed the following formula:...
- analyse the contribution of Schrödinger to the current model of the atom

4

How can the energy of the atomic nucleus be harnessed?

- analyse the spontaneous decay of unstable nuclei, and the properties of the alpha, beta and gamma radiation emitted
- examine the model of half-life in radioactive decay and make quantitative predictions about the activity or amount of a radioactive sample using the following relationships:...
- model and explain the process of nuclear fission, including the concepts of controlled and uncontrolled chain reactions, and account for the release of energy in the process
- analyse relationships that represent conservation of mass–energy in spontaneous and artificial nuclear transmutations, including alpha decay, beta decay, nuclear fission and nuclear fusion
- account for the release of energy in the process of nuclear fusion
- predict quantitatively the energy released in nuclear decays or transmutations, including nuclear fission and nuclear fusion, by applying:...

5

How is it known that human understanding of matter is still incomplete?

- analyse the evidence that suggests:...
- investigate the Standard Model of matter, including:...
- investigate the operation and role of particle accelerators in obtaining evidence that tests and/or validates aspects of theories, including the Standard Model of matter