



## **GCE PHYSICS**

S21-A420QS

### **Assessment Resource number 12**

### **Electricity and the Universe Resource C**

1.

- (a) (i) Use the Principle of Conservation of Energy to show that the critical density,  $\rho_c$ , of the universe is given by: [4]

$$\rho_c = \frac{3H_0^2}{8\pi G}$$

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- (ii) Use the above equation to show that the critical density of the universe corresponds to approximately 5 atoms of hydrogen per  $\text{m}^3$ . [2]

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- (b) Astronomers analysing the wavelengths of the dark lines from the line spectrum of a distant galaxy note that they are increased by 16% compared with their normal wavelengths.

- (i) State why there is an increase in wavelength. [1]

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- (ii) Calculate the distance of the galaxy from Earth. [3]

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- (c) Stating an assumption, estimate the age of the universe in years. [3]

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- (c) For centuries scientists have attempted to measure the Sun's diameter accurately. The following article is taken from a scientific paper written in 2004:

*The solar diameter, and its possible variation, have been the subject of careful measurements for over 350 years, with ever increasing accuracy. Different techniques have been used, and the instrumentation has evolved in time. However, the long-term evolution of the Sun is still a controversial subject. Even for the short term, the results are inconsistent even with the most advanced instruments presently in use. These discrepancies probably have several origins.*

*[Past, present and future measurements of the solar diameter: Gerard Thuillier, Sabatino Sofia, Margit Haberreiter November 2004]*

Suggest two reasons why it has been difficult for scientists to determine an accurate value for the Sun's diameter. [2]

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