Question 25 (continued)

(b) State the FOUR observations predicted by Maxwell's electromagnetic theory. **4**

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End of Question 25

Question 26 (2 marks)

Outline how emission and absorption spectra are produced and whether the emission and absorption spectra of an element produce the same or different spectral lines. **2**

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Question 32 (3 marks)

The carbon-oxygen-nitrogen (CNO) cycle occurs in stars that are at least 1.3 times heavier than the Sun. The first step in the cycle can be represented by the nuclear fusion equation.

$$C_6^{12} + H_1^1 \rightarrow N_7^{13} + \gamma_0^0$$

The exact masses of these isotopes are shown in the table.

Isotope	*Exact mass*
^{12}C	12.000
^{1}H	1.0078
^{13}N	13.0057

(a) Using the equation, calculate the mass defect of the first step of the CNO cycle in megaelectron volts. **2**

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(b) Using the equation, calculate the energy released during of the first step of the CNO cycle in joules. **1**

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Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 32	
(a) The mass defect will be equivalent to the energy of the gamma ray produced. $\text{initial mass} = \text{mass}\left({}^{12}\text{C}\right) + \text{mass}\left({}^{1}\text{H}\right)$ $= 13.0078 \text{ amu}$ $\text{final mass} = \text{mass}\left({}^{13}\text{N}\right)$ $= 13.0057 \text{ amu}$ $\text{mass difference} = 13.0057 - 13.0078$ $= -0.0021 \text{ amu}$ Hence, this is equivalent to $0.0021 \times 931.5 = 1.956 \text{ MeV}.$	Mod 8 From the Universe to the Atom PH12–6, PH12–15 Bands 4–6 • Calculates the correct mass defect . . . . . 2 • Gives some relevant information 1
(b) $1.956 \times 10^{6} \times 1.602 \times 10^{-19} = 3.13375 \times 10^{-13} \text{ J}$	Mod 8 From the Universe to the Atom PH12–6, PH12–15 Bands 4–6 • Calculates the correct value 1
Question 33	
For example: Rutherford's model of the atom was the first nuclear model. It placed electrons circulating (or orbiting) the central nucleus at some distance. Although this helped to explain the results of the Geiger–Marsden experiments, it did not explain the stability of the electrons in orbit. In other situations, charges in orbits are accelerated and therefore are expected to lose energy. Consequently, these orbits should decay, which was not reflected in Rutherford's model. Although this was a serious negative limitation, Rutherford's model was still an important improvement and allowed the search to continue for a more accurate model.	Mod 8 From the Universe to the Atom PH12–7 Bands 3–5 • Describes a limitation of Rutherford's model. AND • Assesses the usefulness of the model . . . . . 3 • States a limitation of Rutherford's model. AND • Assesses the usefulness of the model . . . . . 2 • Gives some relevant information 1