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7. Answer the following questions in your own words. Extended quotes from the original article will not be awarded marks.

(a) Calculate the maximum force required to separate two Magdeburg hemispheres of radius 10 cm (atmospheric pressure = 1.01×10^5 Pa, see paragraph 2). [2]

(b) Suggest why lightning discharge travels further at low pressures (see paragraphs 4 & 5). [2]

(c) (i) Calculate the distance of nearest approach for a 4.7 MeV alpha particle when fired at gold foil (the charge on a gold nucleus is $+79e$, see paragraph 6). [3]

(ii) State why your answer to *(c)*(i) and the results of the alpha particle scattering experiment contradict the "plum-pudding" model (see paragraphs 5 & 6). [2]

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(d) A student claims that a 4 keV electron is suitable for atomic diffraction experiments. Determine whether or not she is correct (see paragraphs 6 & 8). [4]

(e) Explain why the strong nuclear force is required to hold nuclei together (see paragraphs 6 & 9). [1]

(f) A typical thermal electron has a rms speed of approximately 100 000 m s^{-1}. When a positron annihilates an electron at room temperature, two photons of wavelength 2.43×10^{-12} m are produced. Explain, using conservation of momentum, why these photons travel in opposite directions (see paragraph 10). [3]

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(g) Explain why the quark make up of a π^- meson is $\bar{u}d$. [1]

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(h) Calculate the mass of a top quark in kg (see paragraph 15).

Note that 1 u ≡ 931 MeV if required. [2]

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END OF PAPER

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