7 Two vertical metal plates are separated by a distance d in a vacuum, as shown in Fig. 7.1.

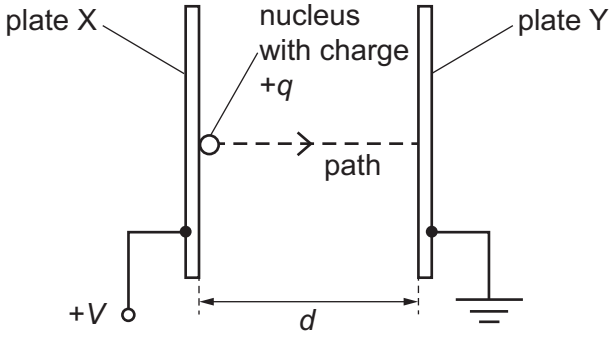

Fig. 7.1 (not to scale)

The potential difference (p.d.) between the plates is V. A nucleus with charge $+q$ is initially at rest on plate X. The nucleus is accelerated by the uniform electric field from plate X along a horizontal path to plate Y.

(a) State expressions, in terms of some or all of d, q and V, for:

(i) the magnitude of the electric field strength

electric field strength = ... [1]

(ii) the magnitude of the electric force acting on the nucleus

force = ... [1]

(iii) the kinetic energy of the nucleus when it reaches plate Y.

kinetic energy = ... [1]

(b) State the change, if any, in the kinetic energy of the nucleus on reaching plate Y when the following separate changes are made.

(i) The distance d is halved, but the p.d. V remains the same.

..... [1]

(ii) The nucleus is replaced by a different nucleus that is an isotope of the original nucleus with fewer neutrons.

..... [1]

(c) The nucleus is carbon-14 ($^{14}_{6}C$). This nucleus decays to form a new nucleus by releasing a β^- particle and only one other particle of negligible mass.

(i) Calculate the nucleon number and the proton number of the **new** nucleus.

nucleon number = ...

proton number = ...
[1]

(ii) State the name of the particle of negligible mass.

..... [1]

[Total: 7]