MODEL ANSWER
A2 PHYSICS
ELECTRIC FIELD & CAPACITOR

JUNE 2007 PHY5

2. (i) Both arrows at A and B are pointing upward, directly away from the nucleus.

(ii) Force acting on the alpha particle at point A, $F = k Q_1 Q_2 / r^2$

$$\mathbf{F = k Q_1 Q_2 / r^2}$$
$$\mathbf{= [9 \times 10^9 \times 2 \times 1.6 \times 10^{-19} \times 79 \times 1.6 \times 10^{-19}] / [1.5 \times 10^{-13}]^2}$$
$$\mathbf{= \underline{1.62\ N}}$$

(iii) As the alpha particle moves from A to B, the speed decreases at A because at that particular point, the particle is moving rightwards, but there's a leftward force of repulsion due to the gold nucleus having the positive like charges. As a result, the motion is slowed down. Meanwhile, at point B, the particle is moving rightward and the rightward force of repulsion is adding the motion to the right, therefore the velocity increases.

3. (a) (i) Box A - parallel arrangement
Box B - series arrangement

(ii) Both arrangement have the same potential difference across the identical capacitors arrangement. There are more energy stored in capacitors in box A as the total capacitance is of larger magnitude compared to the total capacitance in box B. Based on the formula, $W = \frac{1}{2} CV^2$. We find that,

$$\mathbf{\frac{1}{2} C_A V^2 > \frac{1}{2} C_B V^2}$$

(b) For the addition of large resistor in discharging unit, the lamp wouldn't light as brightly as the amount of charge it receives, per unit time, is smaller due to the large resistance. However the resistor will increase the time it takes for the capacitors to fully discharge, resulting in the lamp illuminating for longer duration.

Without any resistance a capacitor would essentially charge instantly, but if a large value resistor had been connected between S_1 and the cell in each circuit, the capacitor would charge up at a slower rate, so it will gain the same amount of charge over a longer time.

PREPARED BY MR.DERYK NG
UCSI UNIVERSITY
A LEVEL ACADEMY