The solution for QII (1) is given below. As told in the previous session, there has been a mistake in the rest of its parts due to voltage not given for solving part 2, 3, 4 and 5. As such you will all be compensated for 4 marks.

In a uniform electric field created by two electrodes with separation of 5mm, a sodium ion Na^+ is accelerated by the electric field, which then suffers a collision course with the cathode having work function of 2.08eV. Use concepts of mechanics based on Newton Laws and electromagnetics based on Coulomb Law, choose the correct answer for the followings:

1. The critical velocity needed by the ion to neutralize itself is approximately:
   a. 4.16km/s b. 2.08km/s c. 8.32km/s d. 1.04km/s

Solution Q II gap separation $d = 5mm$.

$$_{23}Na^{11} \longrightarrow Na^+ = {}_{23}Na^{10}$$

① mass $= m = 10(9.1\times10^{-31}) + 23(1.67\times10^{-27})$

$= 38.41\times10^{-27}$ kg (approx)

$KE = \frac{1}{2}mu^2$ ①

To neutralize it need a single electron from cathode material, so that

$KE = \phi_k = 2.08eV$

$= 2.08\times1.6\times10^{-19}$ Joules.

$\therefore \quad 2.08\times1.6\times10^{-19} = \frac{1}{2}\times38.41\times10^{-27}u^2$

$u^2 = \frac{4.16\times1.6\times10^{-19}}{38.41\times10^{-27}} = 0.173\times10^{8}$

$u = 0.416\times10^{4}$ m/s.

$\therefore \boxed{u = 4.16 \text{ km/s}}$