6. An electron falls from rest through a vertical distance h in a uniform and vertically upward directed electric field E. The direction of electric field is now reversed, keeping its magnitude the same. A proton is allowed to fall from rest in it through the same vertical distance h. The time of fall of the electron, in comparison to the time of fall of the proton is
(a) smaller
(b) 5 times greater
(c) 10 times greater
(d) equal (*NEET 2018*)
7. The electrostatic force between the metal plates of an isolated parallel plate capacitor C having a charge Q and area A, is
(a) Independent of the distance between the plates
(b) Linearly proportional to the distance between the plates
(c) Proportional to the square root of the distance between the plates
(d) Inversely proportional to the distance between the plates (*NEET 2018*)
8. A toy car with charge q moves on a frictionless horizontal plane surface under the influence of a uniform electric field $\vec{E}$. Due to the force $q\vec{E}$, its velocity increases from 0 to $6ms^{-1}$ in one second duration. At that instant the direction of the field is reversed. The car continues to move for two more seconds under the influence of this field. The average velocity and the average speed of the toy car between 0 to 3 seconds are respectively
(a) $2ms^{-1}, 4ms^{-1}$
(b) $1ms^{-1}, 3ms^{-1}$
(c) $1ms^{-1}, 3.5ms^{-1}$
(d) $1.5ms^{-1}, 3ms^{-1}$ (*NEET 2018*)
9. A capacitor is charged by a battery. The battery is removed and another identical uncharged capacitor is connected in parallel. The total electrostatic energy of resulting system
(a) decreases by a factor of 2
(b) remains the same
(c) increases by a factor of 2
(d) increases by a factor of4 (*NEET 2017*)
10. Suppose the charge of a proton and an electron differ slightly One of them is $-e$, the other is $(e+\Delta e)$. If the net of electrostatic force and gravitational force between two hydrogen atoms placed at a distance d (much greater than atomic size) apart is zero, then Δe is of the order of [Given: mass of hydrogen $m_h = 1.67\times10^{-27}kg$]
(a) $10^{-23}C$
(b) $10^{-37}C$
(c) $10^{-47}C$
(d) $10^{-20}C$ (*NEET 2017*)

Answers

6. (a): Force experienced by a charged particle in an electric field, $F = qE$

As $F = ma$

$\therefore ma = qE \Rightarrow a = \dfrac{qE}{m} \quad \cdots$(i)

As electron and proton both fall from same height at rest. Then initial velocity $=0$

From $s = ut + \dfrac{1}{2}at^2 \quad (\because u = 0)$

$\therefore h = \dfrac{1}{2}at^2 \Rightarrow \; h = \dfrac{1}{2}\dfrac{qE}{m}t^2$ [Using (i)]

$\therefore t = \sqrt{\dfrac{2hm}{qE}} \Rightarrow t \propto \sqrt{m}$ as ' q ' is same for electron and proton.

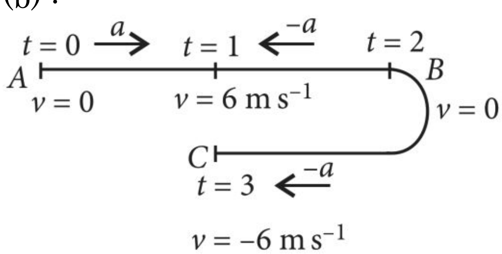
Electron has smaller mass so it will take smaller time.

7. (a) : For isolated capacitor, charge $Q =$ constant.

Electrostatic force, $F_{plate} = \dfrac{Q^2}{2A\varepsilon_0}$

F is independent of the distance between plates.

8. (b) :



Acceleration $a = \dfrac{6-0}{1} = 6ms^{-2}$

For $t = 0$ to $t = 1s, s_1 = \dfrac{1}{2} \times 6(1)^2 = 3m \quad \cdots$(i)

For $t = 1s to t = 2s, s_2 = 6 \times 1 - \dfrac{1}{2} \times 6(1)^2 = 3m \quad \ldots$ (ii)

For $t = 2s to t = 3s, s_3 = 0 - \dfrac{1}{2} \times 6(1)^2 = -3m \cdots$(iii)

Total displacement $s = s_1 + s_2 + s_3 = 3m$

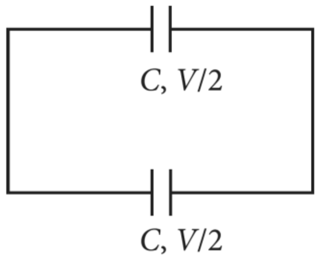
Average velocity $= \dfrac{3}{3} = 1ms^{-1}$

Total distance travelled $= 9m$

Average speed $= \dfrac{9}{3} = 3ms^{-1}$

9. (a) : When the capacitor is charged by a battery of potential V, then energy stored in the capacitor,

$U_j = \frac{1}{2}CV^2 \cdots$(i) When the battery is removed and another identical



uncharged capacitor is connected in parallel Common potential $V' = \frac{CV}{C+C} = \frac{V}{2}$

Then the energy stored in the capacitor,

$U_f = \frac{1}{2}(2C)(\frac{V}{2})^2 = \frac{1}{4}CV^2 \cdots$(ii)

$\therefore$ From eqns. (i) and (ii)

$U_f = \frac{U_i}{2}$

that means the total electrostatic energy of resulting system will decreases by a factor of 2.

10. (b): A hydrogen atom consists of an electron and a proton.

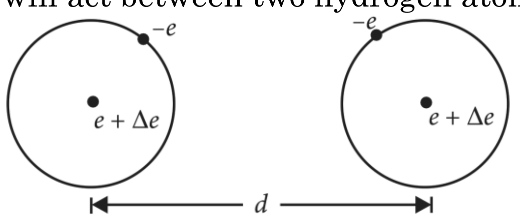
$\therefore$ Charge on one hydrogen atom

$= q_e + q_p = -e + (e + \Delta e) = \Delta e$

Since a hydrogen atom carry a net charge Δe Electrostatic force,

$F_e = \frac{1}{4\pi\varepsilon_o}\frac{(\Delta e)^2}{d^2} \cdots$(i)

will act between two hydrogen atoms.



The gravitational force between two hydrogen atoms is given as

$F_g = \frac{Gm_h m_h}{d^2} \cdots$(ii)

Since, the net force on the system is zero, $F_e = F_g$ Using eqns. (i) and (ii), we get

$\frac{(\Delta e)^2}{4\pi\varepsilon_0 d^2} = \frac{Gm_h^2}{d^2}$

$(\Delta e)^2 = 4\pi\varepsilon_0 Gm_h^2$

$= 6.67\times10^{-11}\times(1.67\times10^{-27})^2\times(9\times10^9)$ $\Delta e = 10^{-37}C$