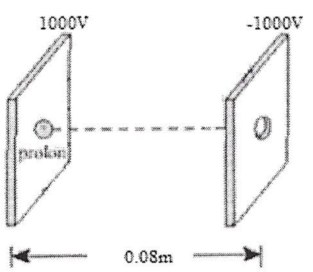
Name: ______________________________ Period: ________ Date: __________

Electrostatics: 4 – Electric Field in Uniform Electric Fields problems II

Electric Field (Plates)	Electrostatic Force	Electric Potential Energy	Electric Field
$E_{avg} = \frac{-\Delta V}{d}$	$F_E = \frac{kq_1q_2}{r^2} = qE$	$U_E = \frac{Kq_1q_2}{r} = qV$	$E = \frac{F_E}{q}$

I. Answer the following problems. Show all your work to get full credit.

1. A proton is accelerated from rest by the charged plates as shown. At what speed does it leave the right hand plate?



$U_E = q \cdot \Delta V$

$U_E = (1.6\times10^{-19})(-2000)$

$U_E = -3.2\times10^{-16}$ J

$\Delta K = -\Delta U$

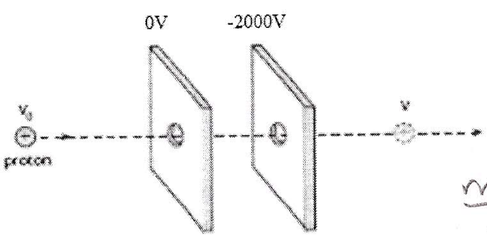
$K - K_0 = -\Delta U$

$\frac{mv^2}{2} = -\Delta U$

$V = \sqrt{\frac{-2\Delta U}{m}} = \sqrt{\frac{-2(-3.2\times10^{-16})}{1.67\times10^{-27}}}$

$V = 6.19\times10^5$ m/s

2. A proton is traveling at a speed of 6.4 x 105 m/S when it is accelerated through a potential difference of 2000V. What is its final speed?



$\Delta U_E = q \cdot \Delta V = (1.6\times10^{-19})(-2000)$

$\Delta U_E = -3.2\times10^{-16}$ J

$\Delta K = -\Delta U$

$K - K_0 = -(-3.2\times10^{-16}\text{ J})$

$\frac{mv^2}{2} - \frac{mv_0^2}{2} = 3.2\times10^{-16}$

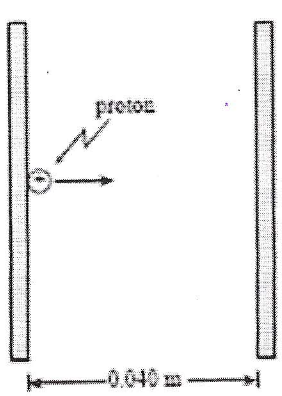
$\frac{m}{2}[v^2 - v_0^2] = 3.2\times10^{-16}$

$v^2 - v_0^2 = \frac{2[3.2\times10^{-16}]}{m}$

$V = \sqrt{\frac{2[3.2\times10^{-16}]}{1.67\times10^{-27}} + (6.4\times10^5)^2}$

$V = 8.9\times10^5$ V

3. A proton leaves the left hand plate with an initial velocity of 1.1 x 107 m/s. What is the minimum potential difference between the plates such that the proton does not reach the right hand plate?



$K_0 = \frac{mv_0^2}{2} = \frac{(1.67\times10^{-27})(1.1\times10^7)^2}{2}$

$K_0 = 1.01\times10^{-13}$ J

$\Delta U_E = -\Delta K$

$q \cdot \Delta V = -[\cancel{K} - K_0]$

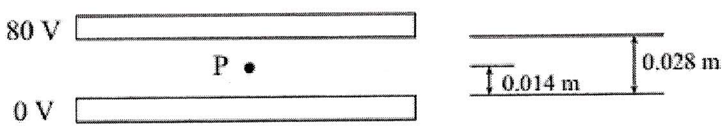
$\Delta V = \frac{K_0}{q}$

$\Delta V = \frac{1.01\times10^{-13}}{1.6\times10^{-19}} = 6.31\times10^5$ V

4.Two parallel plates 4.0 ×10−2m apart have a potential difference of 1000 V. An electron is released from *the negative plate at the same instant* that a proton is released from the positive plate. Which of the following best compares their speed and kinetic energy as they strike the opposite plate?

	SPEED OF ELECTRON AND PROTON	KINETIC ENERGY OF ELECTRON AND PROTON
A.	same	same
B.	same	different
C.	different	same
D.	different	different

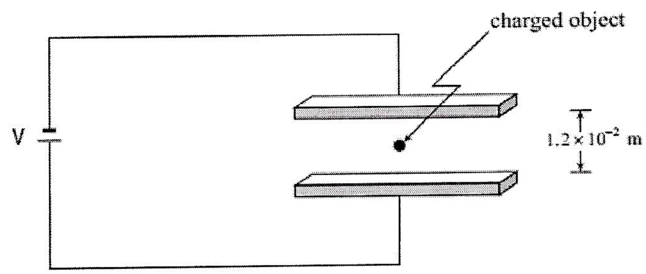
5. Two long, parallel plates are separated by 0.028 m and have a potential difference between them of 80 V, as shown below.



6. Point P is located midway between the plates. What is the potential difference between point P and one of the plates?

A. 0 V B. 40 V C. 80 V D. 160 V

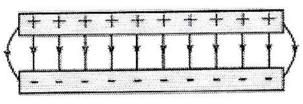
7. An object with a charge of +4.0 ×10−18 C and a mass of 1.1×10−15 kg is held stationary by balanced gravitational and electric forces midway between horizontal charged plates as shown. What is the applied voltage V?



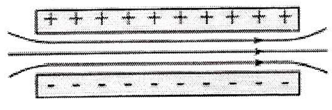
A. 16 V B. 32 V C. 65 V D. 2.7×102 V

8. Which diagram shows the electric field between a pair of charged parallel plates?

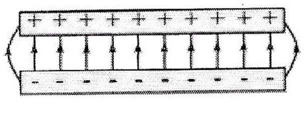
A.



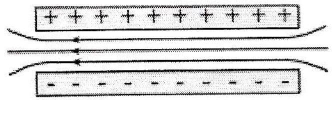
B.



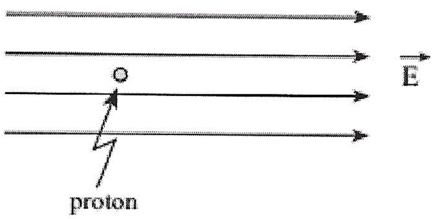
C.



D.

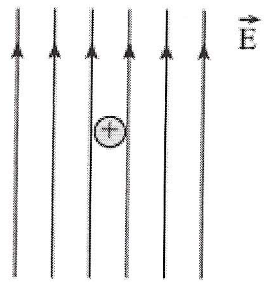


9. What is the acceleration of a proton in a uniform 2.5×105 N C electric field as shown below?



	MAGNITUDE OF ACCELERATION	DIRECTION OF ACCELERATION
A.	2.4×10^{13} m/s^2	Right
B.	2.4×10^{13} m/s^2	Left
C.	1.5×10^{32} m/s^2	Right
D.	1.5×10^{32} m/s^2	Left

10. In an experiment, a positively charged oil droplet weighing 6.5×10−15 N is held stationary by a vertical electric field as shown in the diagram. If the electric field strength is 5.3×10 E 3 N C, what is the charge on the oil droplet?



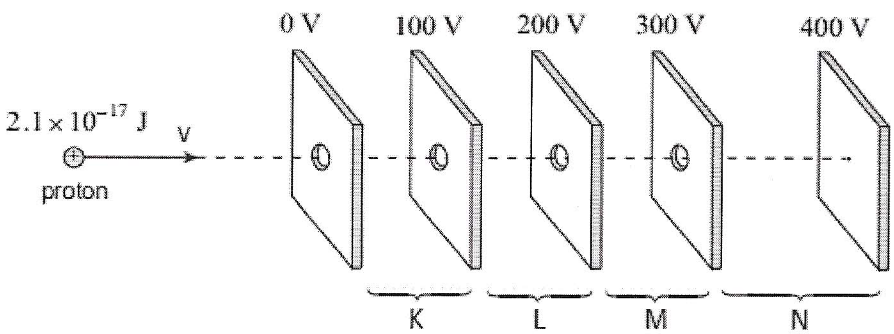
A. 1.2 ×10−18 C

B. 3. 4 ×10−11 C

C. 4.1×104 C

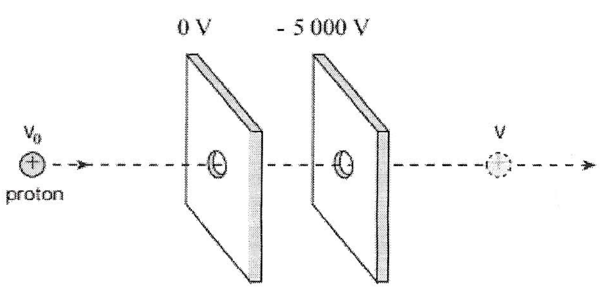
D. 8.2 ×1017 C

11. A proton with kinetic energy of 2.1×10−17 J is moving into a region of charged parallel plates. The proton will be stopped momentarily in what region?



A. Region K **B. Region L** **C. Region M** **D. Region N**

12. A moving proton has 6. 4 ×10−16 J of kinetic energy. The proton is accelerated by a potential difference of 5 000 V between parallel plates.

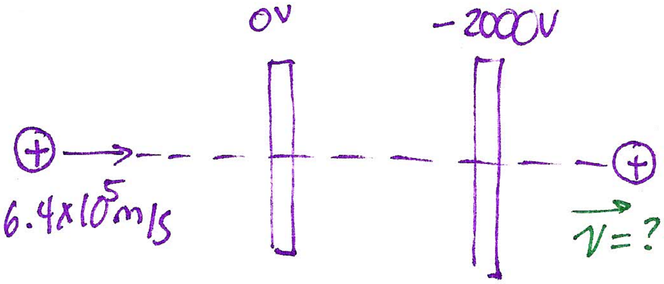


13. The proton emerges from the parallel plates with what speed?

A. 8.8×105 m /s **B. 9.8×105 m/ s** **C. 1.3×106 m/ s** **D. 1.8×106 m /s**

problems II

(2)



Proton accelerates
⇓
Velocity <u>increases</u>

If Kinetic E increases
⇓
Potential E decreases

$\Delta U_E = q \cdot \Delta V$

$K = \frac{mv^2}{2}$

$\Delta K = -\Delta U_E$

$K - K_0 = -q \cdot \Delta V$

$\frac{mv^2}{2} - \frac{mV_0^2}{2} = -q \cdot \Delta V$

$\frac{m}{2}\left[V^2 - V_0^2\right] = -q \cdot \Delta V$

$V^2 - V_0^2 = \frac{-2q \cdot \Delta V}{m}$

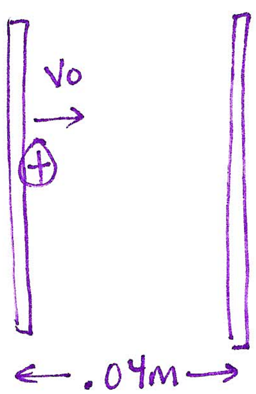
$\sqrt{V^2} = \sqrt{\frac{-2q\Delta V}{m} + V_0^2}$

$q_p = 1.6 \times 10^{-19} C$

$\Delta V = -2000V$

$m_p = 1.67 \times 10^{-27} Kg$

(3)



$V_0 = 1.1 \times 10^7 m/s$

$\Delta V = ?$

Velocity of proton → decreases
ΔK → decreases
⇓
ΔU → increase

$-\Delta K = \Delta U$

$-\left[K^0 - K_0\right] = q \cdot \Delta V$

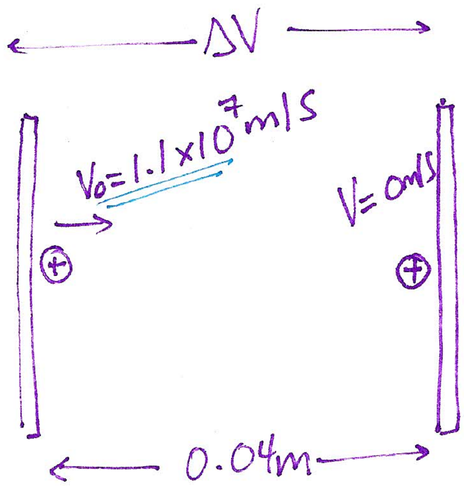
$K_0 = q \cdot \Delta V$

$\frac{mV_0^2}{2} = q \cdot \Delta V$

$\Delta V = \frac{mV_0^2}{2q}$

$\frac{\frac{mV_0^2}{2}}{q}$

3



Velocity decreases, so Kinetic energy decreases.
the loss in K is the same as the gain in U

$$-\Delta K = \Delta U_E$$

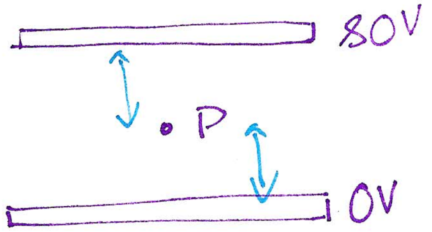
$$-[\cancel{K}^{0} - K_0] = q \cdot \Delta V$$

$$K_0 = q \cdot \Delta V$$

$$\frac{m v_0^2}{2} = q \cdot \Delta V$$

$$\Delta V = \frac{m v_0^2}{2q}$$

5



$\Delta V = -80V$

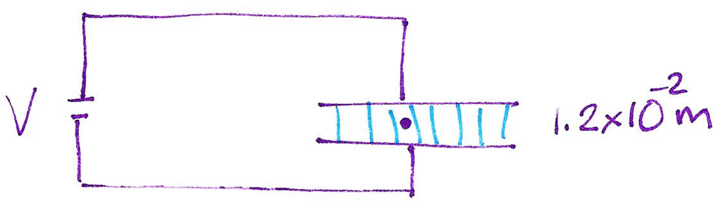
Zero

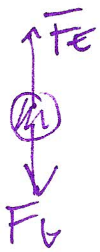
7

$q = 4 \times 10^{-18}$ C

$\Delta V = ?$

$m = 1.1 \times 10^{-15}$ kg





$F_G = F_E$

$(1.1 \times 10^{-15}\ kg)(10)$

$1.1 \times 10^{-14}\ N = F_E$

Step 1: Get F_E

plates

Step 2: Get E

$$E = \frac{F_E}{q}$$

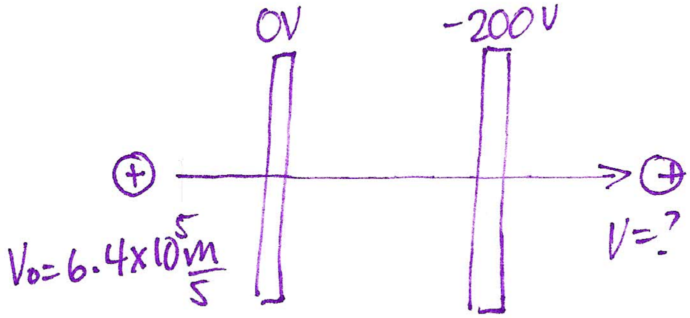
$$E_{AVG} = \frac{-\Delta V}{d}$$

Step 3: Get ΔV

$$\Delta V = -E_{AVG} \cdot d$$

Electric field with plates II

(2)



Kinetic energy ↑

so

Potential energy ↓

$$\Delta K = -\Delta U_E$$

$$K - K_0 = -q \cdot \Delta V$$

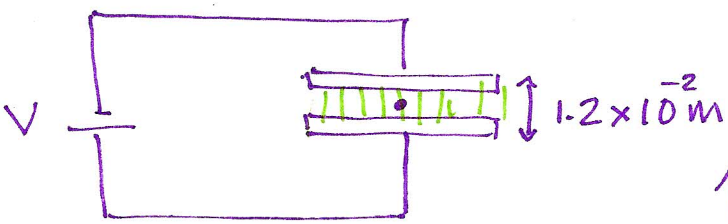
$$\frac{mV^2}{2} - \frac{mV_0^2}{2} = -q \cdot \Delta V$$

$$\frac{m}{2}\left[V^2 - V_0^2\right] = -q \cdot \Delta V$$

$$V^2 - V_0^2 = \frac{-2q \cdot \Delta V}{m}$$

$$\sqrt{V^2} = \sqrt{\frac{-2q\Delta V}{m} + V_0^2}$$

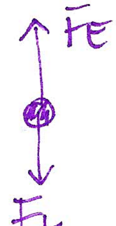
(7)



$q = 4 \times 10^{-18}$ C

$m = 1.1 \times 10^{-15}$ kg

$\Delta V = ?$



STEP 1: Get F_E

$$F_E = F_G$$

$$F_E = 1.1 \times 10^{-15}\,\text{kg}(10)$$

$$\underline{F_E = 1.1 \times 10^{-14}\,N}$$

$$E_{AVG} = \frac{-\Delta V}{d}$$

STEP 3: Get ΔV

$$\Delta V = -E_{AVG} \cdot d$$

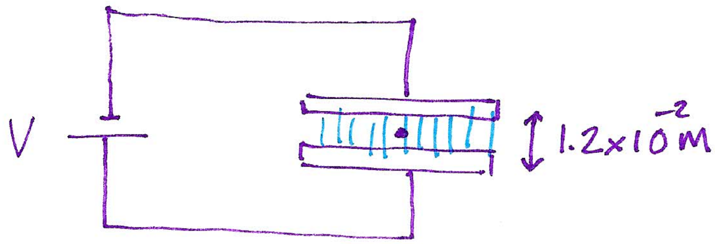
?

distance between plates

STEP 2: Get E

$$E = \frac{F_E}{q}$$

(7)



$q = 4\times10^{-12}$ C

$m = 1.1\times10^{-15}$ kg

$\Delta V = ?$

STEP 1: Find F_E

$F_E = F_G$

$F_E = (1.1\times10^{-15}\text{ kg})(10)$

$\underline{F_E = 1.1\times10^{-14}\text{ N}}$

STEP 2: Find $\vec{E}$

$$\vec{E} = \frac{F_E}{q}$$

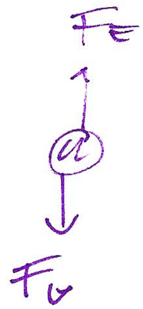
$$\vec{E}_{AVG} = \frac{-\Delta V}{d}$$

STEP 3: Find ΔV

$$\Delta V = -\vec{E}_{AVG}\cdot d$$

? ✓

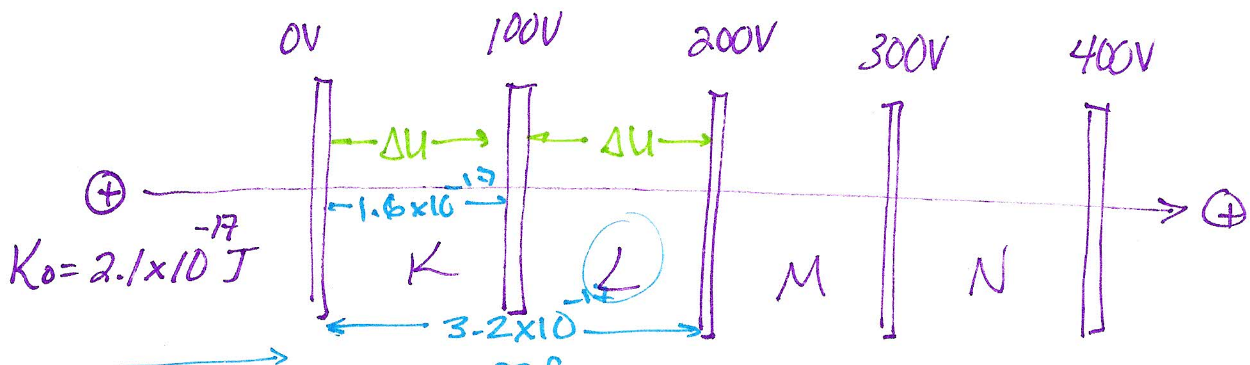
(10)



$F_E = F_G$

$E\cdot q = F_G$

(11)



velocity decreases

$$\Delta U_E = q\cdot\Delta V$$

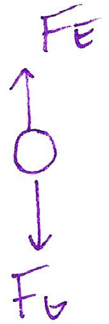
$$-\Delta K = \Delta U_E$$

= [illegible]rement per section

$$\Delta U_E = q\cdot\Delta V = (1.6\times10^{-19})(100\text{V}) = \underline{1.6\times10^{-17}}\text{ J}$$

PROTON will stop in REGION $\underline{L}$

(10)

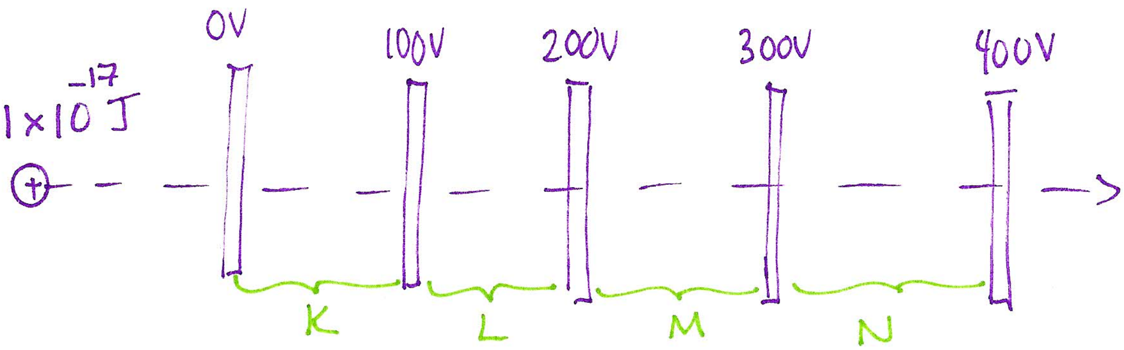


$F_G = F_E$

$F_G = E \cdot q$

(11)

$K = 2.1 \times 10^{-17}$ J



$-\Delta K = \Delta U_E$ The loss in Kinetic is the gain in potential

$\Delta U_E = q \cdot \Delta V$

REGION K $\Delta U_E = (1.6 \times 10^{-19})(100\,V) = \underline{\underline{1.6 \times 10^{-17}\ J}}$

REGION L $\Delta U_E = (1.6 \times 10^{-19})(200\,V) = \underline{\underline{3.2 \times 10^{-17}\ J}}$ ← Greater than 2.1×10^{-17} J Proton stops in region L

(12) Proton is accelerating → Gain in Kinetic & Loss in Potential

$$\Delta K = -\Delta U_E$$

$$K - K_0 = -q \cdot \Delta V$$

$$\frac{mv^2}{2} - K_0 = -q \cdot \Delta V$$

$$v = \sqrt{\frac{[-q \cdot \Delta V + K_0]\,2}{m}}$$