Formula:

E_p or = W

$PE_e = \vec{F}_e \cdot d$

$PE_e = q\vec{E}d$

$PE_e = qV$

Variable:	PE_e	q	V
Quantity:	electric potential energy	charge	voltage or electric potential
Units:	J	C	$\boxed{\frac{J}{C}} = V$
Type:	scalar	scalar	scalar

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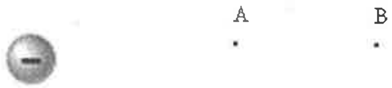
1. How much work is done in moving +5.0 C of charge through a potential difference of 12 volts?



$PE_e = qV \quad (5.0\cancel{C})(12 \frac{J}{\cancel{C}})$

$= \boxed{60.\,J}$

Unit of Energy

2. An electron gains 4.8 x 10^{-17} joule of energy moving between two points in an electric field. What is the electric potential difference between these two points?

$V = \frac{PE_e}{|q|} = \frac{4.8\times10^{-17}\,J}{|1.6\times10^{-19}\,C|}$

$= \boxed{3.0\times10^{2}\,V}$

Electronvolt: = "MINI-JOULE" The amount of energy gained moving one electron through a potential difference of one volt.

3. Determine the conversion factor between joules and electronvolts.

one electron volt (e.V.) = $(1.6\times10^{-19}\,C)(1V)$ $\quad PE_e = qV$

1 e.V. $= \boxed{1.6\times10^{-19}\,J}$

4. An external force does 4.0 eV of work moving an electron between two points in an electric field. How much energy in joules does the electron gain?

$4.0\,\cancel{e.V.} \times \frac{1.6\times10^{-19}\,J}{1\,\cancel{e.V.}} =$

$\boxed{6.4\times10^{-19}\,J}$

5. A proton falls through a potential difference of 30. volts. How much kinetic energy does the proton gain? Express your answer in both joules and electronvolts.

$1\,e.c. \times 30V = 30\,eV$

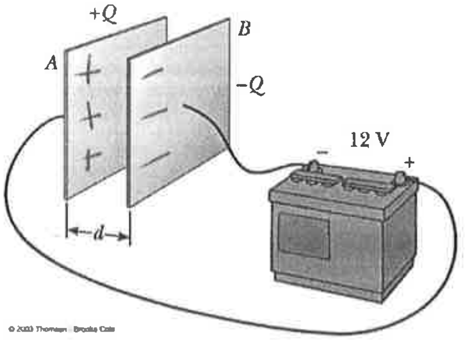
$30\,\cancel{eV} \times \frac{1.6\times10^{-19}\,J}{1\,\cancel{eV}} =$

$\boxed{4.8\times10^{-18}\,J}$

Two Parallel Plates

IB 11

Two identical metal plates, each with area A, are set a distance d apart. They are each charged by connecting them to a source of potential difference V like a battery, as shown in the diagram.



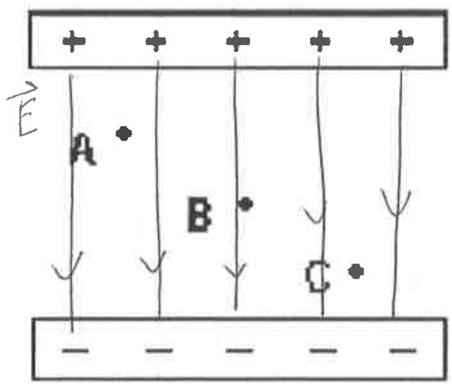
Charge on the plates = q, Q

Area of the plates = A

1. a) Where is equipment like this used? capacitor

   b) What is the purpose of this equipment? to store charge or electric potential energy

2. A positive test charge is placed at each of three locations between two charged metal parallel plates: A, B, and C.



   a) At which location is the electric force on the test charge greatest?

   $\vec{E}$ is constant $\vec{a}$ = constant F_e = constant same

   b) At what location is the electric field strongest?

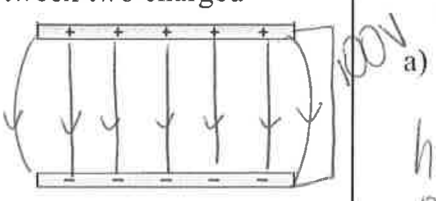
   same for all points

   c) If the charge of the test charge is doubled, what effect will this have on the:

   i) electric field? remains the same

   ii) electric force? $(2)\vec{F}_e = (2)q\vec{E}$ doubles F_e

3. Draw the electric field between two charged metal parallel plates.



Uniform field: same strength at all points between the plates

dge effects: non-uniform field at edges

4. The electric potential difference between these plates is 100 volts.

   a) Which plate is at a higher electric potential? Why? positive test charge would have the greatest PE_e at the positive plate

   b) What is the electric potential of each plate?

   $\Delta V = 100V$ cannot determine difference between plates has to add up to 100V

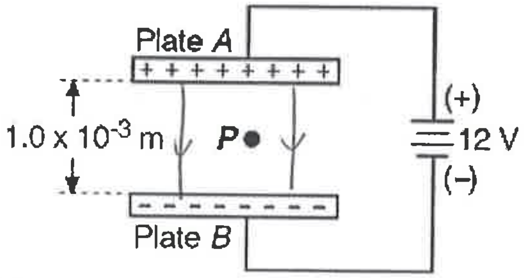
$\vec{E} = \frac{\Delta V}{d}$

Parallel Plate Formulas: Electric Field: $\vec{E} = \frac{V}{d}$ IB 11

Potential difference: $V = \vec{E} \cdot d$

Variable:	V	$\vec{E}$	d
Quantity:	potential difference or voltage	electric field strength	distance between the two plates
Units:	$[V] = [\frac{J}{C}]$	$[\frac{V}{m}] = [\frac{N}{C}]$	[m]
Type:	scalar	⊛ treat as scalar	scalar

5. Two parallel plates are connected to a 12-volt battery as shown.

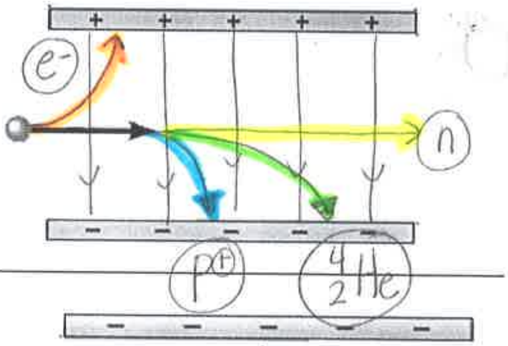


a) What is the magnitude and direction of the electric field between the two plates?

$$\vec{E} = \frac{V}{d} = \frac{12V}{1.0\times10^{-3}m} = \boxed{1.2\times10^{4}\ \frac{V}{m}}$$

6. Sketch the trajectory of a proton, a neutron, an electron, and an alpha particle if they are all shot with the same initial velocity into the plates.

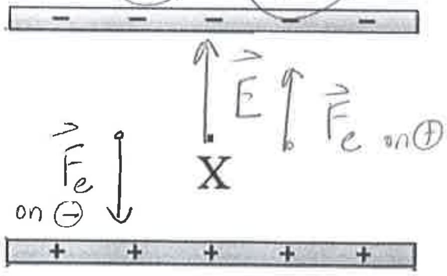
^4_2He alpha particle = helium nucleus with no electrons



7. a) At point X, draw and label a vector to represent the electric field from the plates.

b) At point X, draw and label a vector to represent the electric force on

i) a proton ii) an electron



c) Compare the electric force on the proton and electron.

same $\vec{E}$; same charge

d) Compare the resulting accelerations of the proton and electron.

$a = \frac{F}{m}$ $a = \frac{F}{(\approx\frac{1}{2000})(m)}$ electron

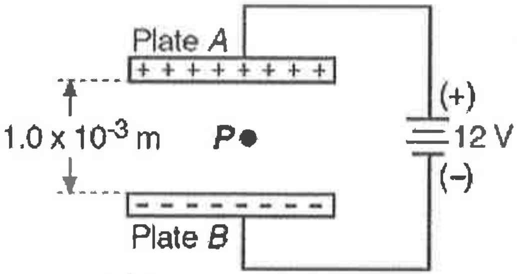
e) An alpha particle is placed at point X. What is an alpha particle? proton

$^4_2 a$

f) Compare the alpha particle to a proton. Compare the:

i) charge	ii) mass	iii) force on each	iv) acceleration of each
$\boxed{2x}$	$\boxed{4x}$ 2p+2n	$\boxed{2x}$ $a = \frac{F}{m}$	$\frac{2(F)}{4(m)}$ 12 $\frac{1}{2}$ a of proton

8. A proton is released from rest at the positive plate.



What is the acceleration

a) ~~How fast will it be traveling~~ when it strikes the negative plate?

$$\vec{E} = \frac{V}{d} = 1.2\times10^{4}\ \frac{V}{m} \text{ or } \frac{N}{C}$$

$$\vec{F}_e = q\vec{E} = (1.6\times10^{-19}\cancel{C})(1.2\times10^{4}\frac{N}{\cancel{C}}) = 1.92\times10^{-15}N$$

$$a = \frac{F_e}{m_p} = \frac{1.92\times10^{-15}N}{1.67\times10^{27}Kg} = \boxed{1.15\times10^{12}\frac{m}{s^2}}$$

b) How fast will it be traveling when it strikes the negative plate?

$$V_f^2 = \cancel{V_i^2} + 2ad \qquad V_i = 0\frac{m}{s}$$

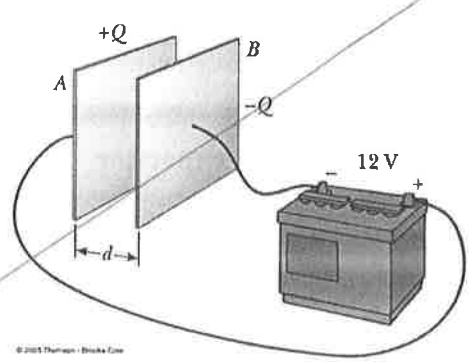
$$V_f = \sqrt{2ad} = \sqrt{2(1.15\times10^{12}\frac{m}{s^2})(1.0\times10^{-3}m)} = \boxed{4.8\times10^{4}\frac{m}{s}}$$

NOTE: Energy equations can be used. PE_e at top = KE at bottom $\quad q\overset{\text{voltage}}{V} = \frac{1}{2}m\underset{\text{velocity}}{v}^2$

Capacitor

Capacitor:

Example:



Capacitance

Meaning:

Definition:

Formula:

Units:

Variable:	C	Q	V
Quantity:			
Units:			
Type:			

1. The potential difference measured across a 100 pF capacitor is 25 mV. Determine the charge and number of electrons stored in the capacitor.

Equations

$1\ e.c. = 1.6\times10^{-19}\ C$

$\vec{F}_e = q\vec{E} = \frac{kq_1q_2}{r^2}$

$PE_e = qV = \frac{1}{2}mv^2 = q\vec{E}d = \frac{1}{2}CV^2$

$\vec{E} = \frac{V}{d}$ or $V = \vec{E}d$

$C = \frac{q}{V}$ or $\frac{Q}{V}$

conversions

$pm = 10^{-12}\ m$

$\mu m = 10^{-6}\ m$

$nF = 10^{-9}\ F$

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symbol	units
q, Q = electric charge	C - coulomb
$\vec{F}_e$ = electric force	N - newton
$\vec{E}$ = electric field strength	$\frac{N}{C}$ or $\frac{V}{m}$
PE_e = electric potential energy	J - Joule
V = voltage or electric potential	$\frac{J}{C}$ or $\frac{N\cdot m}{C}$
C = capacitance	F - farad or $\frac{C}{V}$ - $\frac{\text{coulomb}}{\text{volt}}$