KEY

First Name:_____ Last Name:_____

$\Delta E_p = W$ $\quad \Delta V = \frac{\Delta E_p}{q}$ $\quad |\vec{E}| = \frac{\Delta V}{\Delta d}$

Potential Difference or "Voltage"

L07 – Worksheet – Parallel Plates

Textbook Questions

Pg 565 #1: In moving a charge of 5.0 C from one terminal to the other, a battery raises he electric potential energy of the charge by 60 J. Determine the potential difference between the battery terminals.

$q = 5.0\ C$
$\Delta E_p = 60\ J$
$\Delta V = ?$

$\Delta V = \frac{\Delta E_p}{q} = \frac{60\ J}{5.0\ C} = 12\ V$

Pg 565 #2: A charge of 2.00×10^{-2} C moves from one charged plate to an oppositely charged plate. The potential difference between the plates is 500 V. How much electric potential energy will the charge gain?

$q = 2.00 \times 10^{-2} C$
$\Delta V = 500\ V$
$\Delta E_p = ?$

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

$500\ V = \frac{\Delta E_p}{2.00 \times 10^{-2} C}$ $\quad \Delta E_p = 10.0\ J$

Pg 566 #1: A sphere with a charge of magnitude 2.00 C is moved between two positions between oppositely charged plates. It gains 160 J of electric potential energy. What is the potential difference between the two positions?

$q = 2.00\ C$
$\Delta E_p = 160\ J$
$\Delta V = ?$

$\Delta V = \frac{\Delta E_p}{q} = \frac{160\ J}{2.00\ C} = 80.0\ V$

Pg 566 #2: An electron moves between two positions with a potential difference of 4.00×10^4 V. Determine the electric potential energy gained by the electron, in joules (J) and electron volts (eV).

$\Delta V = 4.00 \times 10^4\ V$
$q = 1.60 \times 10^{-19} C$
$\Delta E_p = ?$

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

$4.00 \times 10^4\ V = \frac{\Delta E_p}{1.60 \times 10^{-19} C}$

$\Delta E_p = 6.40 \times 10^{-15}\ J$

$\frac{6.40 \times 10^{-15}\ J}{1} \times \frac{1\ eV}{1.60 \times 10^{-19}\ J} = 4.00 \times 10^4\ eV$

KEY

Pg 568 #1: Two charged parallel plates, separated by 5.0×10^{-4} m, have an electric field of 2.2×10^{4} V/m between them. What is the potential difference between the plates?

$\Delta d = 5.0 \times 10^{-4}\ m$

$|\vec{E}| = 2.2 \times 10^{4}\ V/m$

$\Delta V = ?$

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

$2.2 \times 10^{4}\ V/m = \frac{\Delta V}{5.0 \times 10^{-4}\ m}$

$\Delta V = 11\ V$

Pg 568 #2: Spark plugs in a car have electrodes whos faces can be considered to be parallel plates. These plates are separated by a gap of 5.00×10^{-3} m. If the electric field between the electrodes is 3.00×10^{6} V/m, calculate the potential difference between the electrode faces.

$\Delta d = 5.00 \times 10^{-3}\ m$

$|\vec{E}| = 3.00 \times 10^{6}\ N/C$ or V/m

$\Delta V = ?$

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

$3.00 \times 10^{6}\ N/C = \frac{\Delta V}{5.00 \times 10^{-3}\ m}$

$\Delta V = 15{,}000\ V$ ✓

Pg 569 #4: At a point in Earth's atmosphere, the electric field is 150 N/C downward and the gravitational field is 9.80 N/kg downward.

a. Determine the electric force on a proton (p^+) placed at this point.

$\vec{E} = \frac{\vec{F}}{q_{test}}$ $\quad 150\ N/C\ [down] = \frac{\vec{F}_e}{1.60 \times 10^{-19} C}$ $\quad \vec{F}_e = 2.40 \times 10^{-17}\ N\ [d]$

b. Determine the gravitational force on the proton at this point. The proton has a mass of 1.67×10^{-27} kg.

$\vec{g} = \frac{\vec{F}_g}{m_{test}}$ $\quad 9.80\ N/kg = \frac{F_g}{1.67 \times 10^{-27} kg}$ $\quad \vec{F}_g = 1.64 \times 10^{-26}\ N\ [d]$

Pg 569 #6: What is the electric field intensity 0.300 m away from a small sphere that has a charge of 1.60×10^{-8} C? Point charge! NOT parallel plates.

$r = 0.300\ m$

$q_{source} = 1.60 \times 10^{-8}\ C$

$|\vec{E}| = ?$

$|\vec{E}| = \frac{kq_{source}}{r^2} = \frac{(8.99 \times 10^{9})(1.60 \times 10^{-8})}{(0.300)^2}$

$|\vec{E}| = 1598.2\ N/C$

KEY

Diploma Worksheet Questions – Parallel Plates (Basic Definitions)

Q178: A negatively charged particle with an initial velocity of zero ($v_o = 0$) is placed in a uniform electric field. If no other forces are present, the particle subsequently will

a. Lose charge
b. Lose momentum
c. Gain kinetic energy
d. Gain potential energy

Electric field causes a Force $\vec{F} = q\vec{E}$
Forces cause acceleration $a = \frac{F_{net}}{m}$
Acceleration causes change in velocity $v_f^2 = v_i^2 + 2ad$
Larger v_f means more $E_K = \frac{1}{2}mv^2$

Q179: A charged plastic sphere is midway between two parallel plates that are connected to a battery. The action that will NOT double the force on the sphere is

~~a.~~ Halving the distance between the plates
~~b.~~ Doubling the voltage of the battery
~~c.~~ Doubling the charge on the sphere
d. Halving the area of the plates

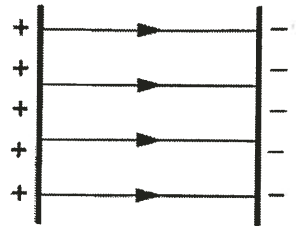
$|\vec{E}| = \frac{\Delta V}{\Delta d}$ $|\vec{F}| = q|\vec{E}|$

Q180: The electric field between charged parallel plates is

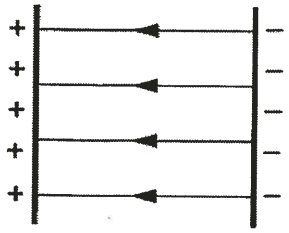
a. Uniform
b. Strongest near each plate
c. Dependent on the area of the plates
d. Strongest midway between the plates

Q185: The direction of the electric field between two charged, parallel, metal plates is shown by

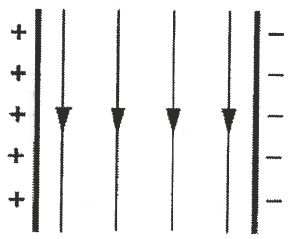
A.



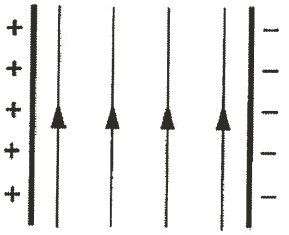
B.



C.



D.



KEY $\Delta V = \frac{\Delta E_P}{q}$ $|\vec{E}| = \frac{\Delta V}{\Delta d}$

Diploma Worksheet Questions – Parallel Plates (Calculations)

Q186: The electric field between two parallel plates that are 5.0 cm apart is 1.0×10^2 N/C. The potential difference across the plates is

a. 2.0×10^3 V
b. 5.0×10^2 V
c. 2.0×10^1 V
(d.) 5.0×10^0 V

$\Delta d = 0.05m$
$|\vec{E}| = 1.0 \times 10^2$ N/C
$\Delta V = ?$

$|\vec{E}| = \frac{\Delta V}{\Delta d} \Rightarrow 1.0 \times 10^2 = \frac{\Delta V}{0.05}$

$\Delta V = 5V$

↑ very rare that the diploma has an exponent of zero.

This is an old question.

Q187: The electric field between two parallel plates that are 0.20 m apart and have a potential difference of 6.0×10^2 V is

a. 3.0×10^1 N/C
b. 1.2×10^2 N/C
(c.) 3.0×10^3 N/C
d. 1.5×10^4 N/C

$\Delta d = 0.20m$
$\Delta V = 6.0 \times 10^2 V$
$|\vec{E}| = ?$

$|\vec{E}| = \frac{\Delta V}{\Delta d} = \frac{6.0 \times 10^2}{0.2}$

$|\vec{E}| = 3000$ N/C
$= 3.0 \times 10^3$ N/C

Use the following information to answer Q190:

> Two parallel metal plates are 1.5 cm apart and are maintained at a potential difference of 2.5×10^2 V

Q190: The magnitude of the electrical force on an alpha particle when the alpha particle is between the plates is

(a.) 5.3×10^{-15} N
b. 2.7×10^{-15} N
c. 5.3×10^{-17} N
d. 2.7×10^{-17} N

$\Delta d = 0.015m$
$\Delta V = 2.5 \times 10^2$ V
$|\vec{E}| = ?$
$q = 2e = 2(1.60 \times 10^{-19}) = 3.2 \times 10^{-19}$ C
$\vec{F} = ?$

$|\vec{E}| = \frac{\Delta V}{\Delta d} = \frac{2.5 \times 10^2}{0.015} = 16,666.\bar{6}$ N/C

$\vec{F} = q\vec{E}$
$= (3.2 \times 10^{-19})(16,666.\bar{6})$
$= 5.3 \times 10^{-15}$ N

KEY

Diploma Worksheet Questions – Parallel Plates (Graphing and Algebra)

Use the following information to answer Q192:

A charged sphere, located in the space between two flat parallel plates connected to a battery, experiences an electrical force of 3.32×10^{-3} N.

Q192: The plates are kept at the original separation. If the charge on the sphere is reduced to exactly one-half and the potential difference between the plates is exactly tripled, then the force on the charged sphere will be ***b*** $\times 10^{-3}$ N. The value of ***b*** is ____.

*(Record your **three digit** answer in the Numerical Response boxes below)*

4	.	9	8

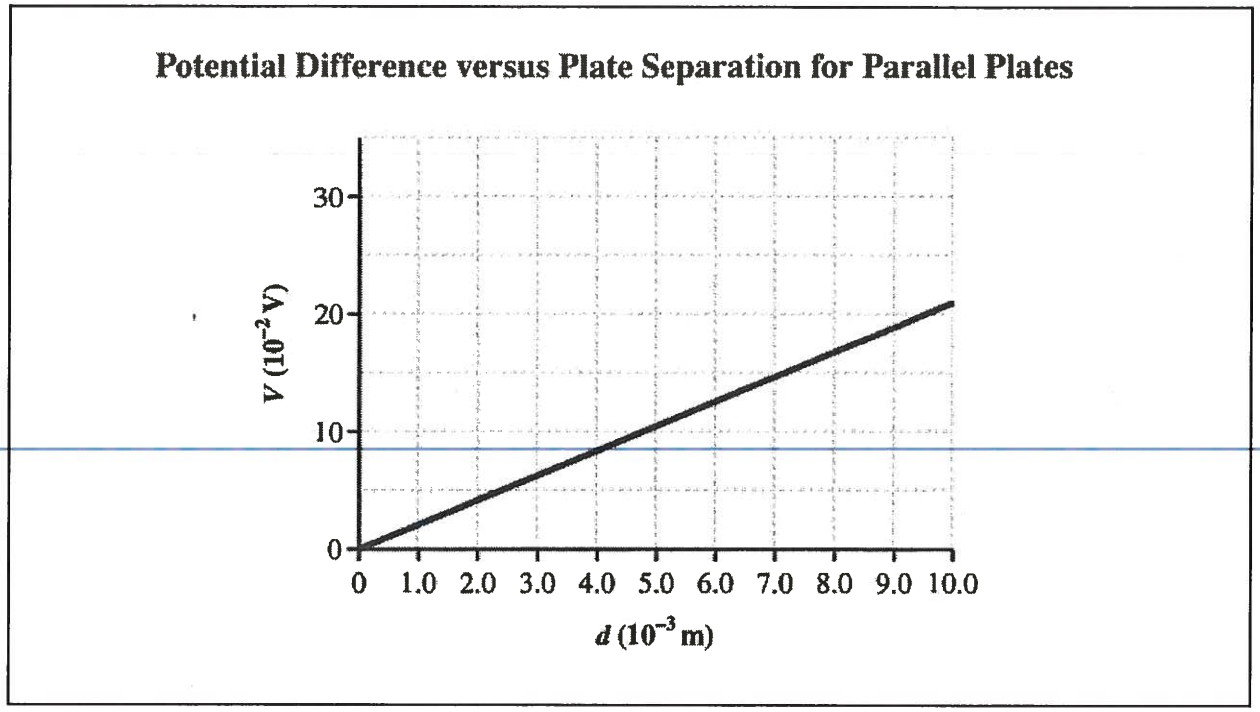
$|\vec{E}| = \frac{\Delta V}{\Delta d}$ $\quad \vec{F} = q\vec{E}$ $\quad$ so $\vec{F} = \frac{q\Delta V}{\Delta d}$

$F_{new} = \frac{(\frac{1}{2}q)(3\Delta V)}{\Delta d} = \frac{3}{2}\left(\frac{q\Delta V}{\Delta d}\right) = \frac{3}{2}(3.32\times10^{-3}\,N)$

$= 4.98\times10^{-3}\,N$

KEY

Use the following information to answer Q193 – Q195:



Q193: The rate of change of potential different with respect to the plate separation, (*d*), in SI units, is

Slope

a. 0.048
b. 0.48
c. 2.1
(d.) 21

$\text{Slope} = \frac{\text{rise}}{\text{run}} = \frac{21 \times 10^{-2}\ \text{V}}{10 \times 10^{-3}\ \text{m}} = 21\ \text{V/m}$

Q194: The proper SI units for the slope of the line on the graph are

a. J/m
(b.) V/m
c. V/s
d. N/s

Q195: The physical quantity that the slope represents is the electric

$|\vec{E}| = \frac{\Delta V}{\Delta d}$ ← Volts / meter

a. Force
b. Power
(c.) Field strength
d. Potential energy

KEY

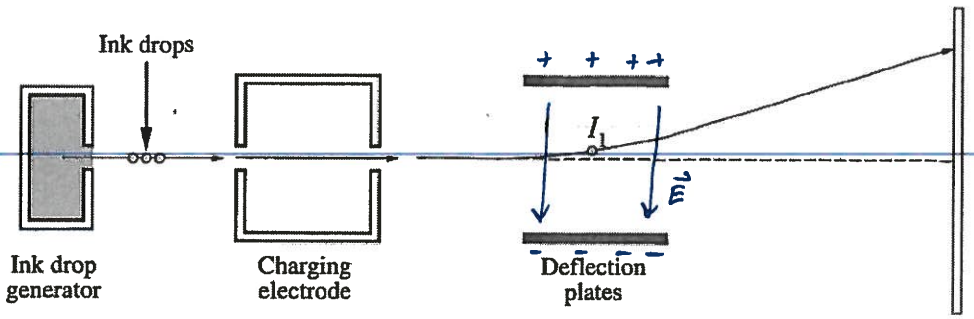
Diploma Worksheet Questions – Parallel Plates (Case Studies)

#200,201,203

Use the following information to answer Q200 – Q203:

Side View of the Components of an Ink-Jet Printer

The essential components of one type of ink-jet printer are shown below.



Ink drops from the generator pass through a charging electrode. By means of a signal from a computer, the charging electrode controls the charge given to the ink drops. Ink drops are deflected between the deflection plates. The amount each drop is deflected determines where it strikes the paper. A typical ink drop has a mass of 1.32×10^{-10} kg. Approximately 100 ink drops are needed to form a single letter on paper.

Ink drop I_1 has a charge of -1.51×10^{-13} C.

Q200: The number of excess electrons given to ink drop I_1 expressed in scientific notation, is ***a.bc*** x 10^{d} electrons. The values of ***a, b, c,*** and ***d*** are ___, ___, ___, and ___.

*(Record your **four digit** answer in the Numerical Response boxes below)*

9	4	4	5

$q = -1.51 \times 10^{-13}\,C \times \frac{1e}{1.60 \times 10^{-19}\,C} = 943{,}750e$

$= 9.44 \times 10^{5}\,e$

Q201: The deflection plates are 0.100 mm apart, and there is a potential difference of 120 V across them. The magnitude of the electric field between the plates is

a. 1.20 x 10^{6} N/C
b. 1.20 x 10^{3} N/C
c. 1.20 x 10^{1} N/C
d. 1.20 x 10^{-2} N/C

$\Delta d = 0.10 \times 10^{-3}$ m
$\Delta V = 120$ V
$|\vec{E}| = ?$

$|\vec{E}| = \frac{\Delta V}{\Delta d} = \frac{120}{0.1 \times 10^{-3}}$

$|\vec{E}| = 1{,}200{,}000$ N/C

$\approx 1.20 \times 10^{6}$ N/C

KEY

Q203: To cause ink drop I_1 to follow the path shown, the direction of the **electric field** between the charged deflection plates must be toward the

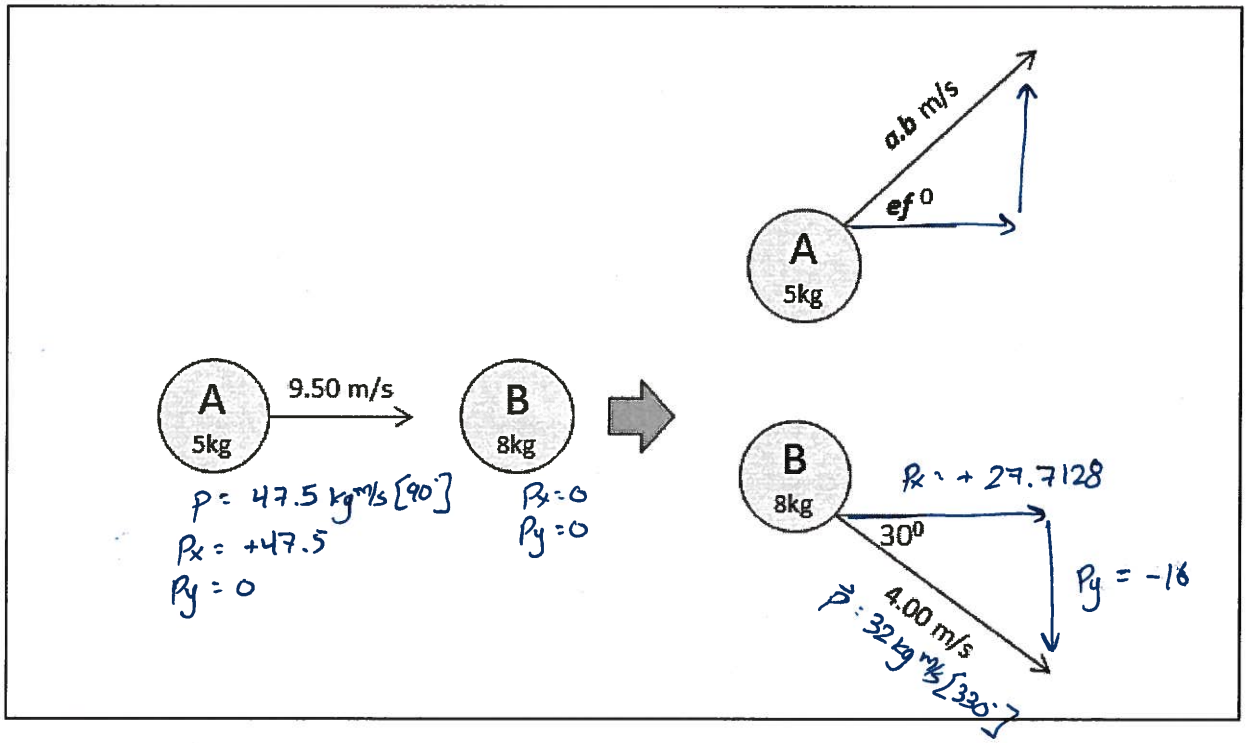
a. Bottom of the page
b. Top of the page
c. Right of the page
d. Left of the page

Challenge Questions

None

Cumulative Review from Previous Units

Use the following information to answer Q1:



Q1: Object *A* rebounds with a velocity of ***a.b*** m/s [***ef*** °], where ***a, b, e,*** and ***f*** are ___, ___, ___, and ___.

*(Record your **four digit** answer in the Numerical Response boxes below)*

5	1	3	9

x-comp

$P_i = P_f$

$47.5 + 0 = 27.7128 + P_{Af}$

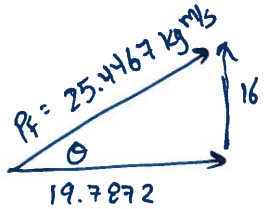
$P_{Af} = +19.7872$

y-comp

$P_i = P_f$

$0 + 0 = -16 + P_{Af}$

$P_{Af} = +16$



$\vec{v}_f = 5.1$ m/s [39°]