Unit 21 · Potential, Potential Difference and Potential Energy

WORKSHEET

Full marks 37

Name _____ Class _____ Roll no. _____ Date _____ Marks _____ / 37

1 Key words [4]

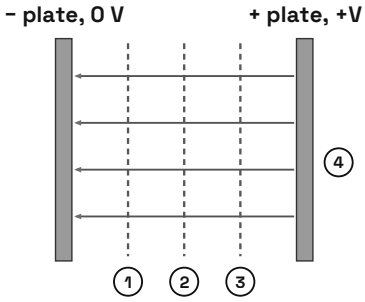
Fill in the blanks with words from the box. Two words in the box are not needed. Each blank carries 0.5 mark.

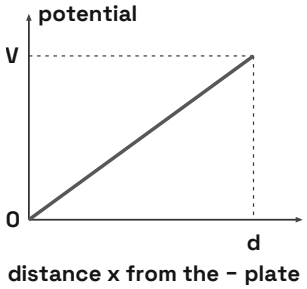
coulomb	**electron gun**	**electron volt**	**equipotential**	**flux**	**gradient**	**negative**
potential	**scalar**	**volt**				

The work done in bringing a unit positive charge from infinity to a point is the electric _____ at that point. Its unit, one joule per coulomb, is the _____. Potential has a size and a sign but no direction: it is a _____. A surface on which the potential is the same everywhere is an _____ surface. The change of potential per unit distance is the potential _____, and the field strength is its _____. The energy a charge e gains when accelerated through 1 V is one _____. In an _____, electrons from a hot filament are accelerated towards an anode.

2 Label the diagram [2]

The diagram shows the equipotentials between two parallel plates with a p.d. V between them. Write the labels that belong in place of 1 to 4. Each carries 0.5 mark.





1. _____ **2.** _____

3. _____ **4.** _____

3 Multiple choice [5]

Choose the correct option for each of the following questions.

i. The potential 20 cm from a point charge of -5.0 nC is: [1]

a. $+225$ V **b.** -225 V

c. -1125 V **d.** -45 V

ii. A charge is moved along an equipotential surface. The work done by the field on it is: [1]

a. positive **b.** negative

c. zero **d.** equal to its potential energy

iii. One electron volt is equal to: [1]

a. 1.6×10^{-19} V **b.** 1.6×10^{-19} J

c. 1 J/C **d.** 9.11×10^{-31} J

iv. Released from rest in an electric field, an electron moves towards: [1]

a. lower potential, gaining potential energy **b.** higher potential, losing potential energy

c. higher potential, gaining potential energy **d.** lower potential, losing potential energy

v. Two parallel plates 1.5 cm apart are joined to a 300 V supply. The potential 0.50 cm from the negative plate (taken as 0 V) is: [1]

a. 50 V **b.** 100 V

c. 150 V **d.** 200 V

4 Very short answers [3]

Write very short answers to the following questions.

a. Define potential difference between two points. [1]

b. Is the electric potential energy of two unlike charges positive or negative? [1]

c. Why do field lines cross equipotentials at right angles? [1]

5 Short answers [6]

Write short answers to the following questions.

a. A bird sits on a power line at 11,000 V and is unharmed. Explain why. [2]

b. Write two similarities and two differences between gravitational and electric fields. **[2]**

c. Two charges of +4 nC and −4 nC are 30 cm apart. Is the potential zero anywhere on the line joining them? Is the field zero there? Explain. **[2]**

6 Long answer **[4]**

Write a long answer to the following question.

Show that the electric field strength equals the negative of the potential gradient, $E = -\Delta V/\Delta x$, and use it to explain why the volt per meter is a unit of field strength.

7 Numerical problems **[10]**

Solve the following problems. Show your working. Take $k = 9.0 \times 10^9$ N m^2/C^2, $e = 1.6 \times 10^{-19}$ C and the mass of an electron 9.11×10^{-31} kg.

a. Charges of +2.0 nC, +2.0 nC, −2.0 nC and +3.0 nC sit at the corners of a square of side 20 cm. Find the potential at the center of the square, and the work needed to bring a +1.0 nC charge there from infinity. **[3]**

Answer:

b. Charges of $+3.0\ \mu C$ and $-4.0\ \mu C$ are held 30 cm apart. Find their electric potential energy, and the work needed to pull them far apart. **[3]**

Answer: _____

c. An electron gun accelerates electrons from rest through 2.5 kV. **[4]**

i. Find their kinetic energy in eV and in joules.

ii. Find their speed.

iii. By what factor would the speed change if the voltage were made 10 kV?

Answer: _____

8 Think **[3]**

On a contour map, closely spaced contour lines mean a steep slope. What do closely spaced equipotentials mean on a map of an electric field? Which way would a positive charge "roll" on such a map, and which way an electron?

9 Activity: Equipotentials in a tray of water (Activity 21) (not marked)

Set up the tray of salty water with two foil strips and a 9 V battery as in the unit (never the mains). Clip the multimeter's black lead to the strip on the − terminal and find points in the water at 2 V, 4 V, 6 V and 8 V.

Reading (V)	Distance from the − strip (cm)	Shape of the line of points
2		
4		
6		
8		

Work out the field between the strips from your readings, in V/m. Is it the same everywhere?