Unit 20 · Electric Field

WORKSHEET

Full marks 37

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

1 Key words [4]

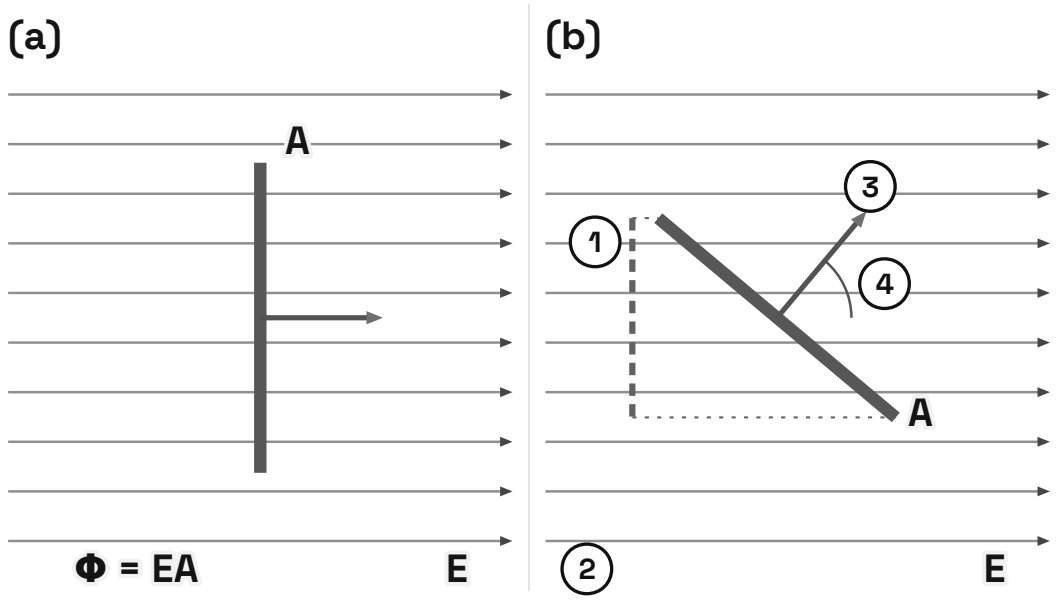
Fill in the blanks with words from the box. Two words in the box are not needed. Each blank carries 0.5 mark.

equipotential	**field**	**field strength**	**flux**	**Gaussian surface**	**magnetic flux**	**meter**	**radial**	**test charge**	**uniform**

The region round a charged object in which another charge feels a force is its electric _____. A small positive charge used to explore it is a _____. The force per unit positive charge at a point is the electric _____, measured in newtons per coulomb or volts per _____. Between two parallel plates the field is _____. The field of an isolated point charge, with lines going straight out, is a _____ field. The product of the field strength and the area at right angles to it is the electric _____. An imaginary closed surface chosen to apply Gauss's law is a _____.

2 Label the diagram [2]

The diagram shows a uniform field passing through a flat surface of area A, square to the field in (a) and tilted in (b). 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. Electric field lines: [1]

a. start on negative charges and end on positive ones

b. can cross where two fields overlap

c. meet the surface of a conductor at 90°

d. always show the path a free charge follows

ii. Two parallel plates 2.5 cm apart have a p.d. of 500 V between them. The field between them is: [1]

a. 12.5 V/m

b. 200 V/m

c. 2.0×10^4 V/m

d. 1.25×10^4 V/m

iii. An electron enters the uniform field between two plates, moving parallel to them. While between the plates its path is: [1]

a. a straight line

b. a circle

c. a parabola

d. a hyperbola

iv. The field 10 cm from a point charge is 4.0×10^3 N/C. At 20 cm from it, the field is: [1]

a. 2.0×10^3 N/C

b. 1.0×10^3 N/C

c. 8.0×10^3 N/C

d. 4.0×10^3 N/C

v. A closed surface encloses $+3\ \mu C$ and $-3\ \mu C$. The total flux through it is: [1]

a. zero, though there is a field at the surface

b. $6\ \mu C/\varepsilon_0$

c. $3\ \mu C/\varepsilon_0$

d. impossible to find without knowing the shape

4 Very short answers [3]

Write very short answers to the following questions.

a. State Gauss's law. [1]

b. Why can two field lines never cross? [1]

c. What is the unit of electric flux? [1]

5 Short answers [6]

Write short answers to the following questions.

a. Show that the volt per meter is the same unit as the newton per coulomb. **[2]**

b. Why is the weight of an electron ignored when it is deflected between charged plates? **[2]**

c. The field of a long line of charge falls off as $1/r$, but that of a point charge as $1/r^2$. Explain the difference in terms of field lines. **[2]**

6 Long answer [4]

Write a long answer to the following question.

Use Gauss's law to show that the field of an infinite sheet with surface charge density σ is $E = \sigma/(2\varepsilon_0)$. What does the result say about the field at different distances from the sheet?

7 Numerical problems [10]

Solve the following problems. Show your working. Take k = 9.0×10^9 N m^2/C^2, $\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/(N m^2), e = 1.6×10^{-19} C and the mass of an electron 9.11×10^{-31} kg.

a. A small positive test charge of 3.0 nC, placed 30 cm from a charged sphere's center, feels a force of 6.0×10^{-4} N away from it. Find the field strength there and the charge on the sphere. **[3]**

Answer: _____

b. An electron moving at 3.0×10^7 m/s enters, parallel to the plates, the field between two plates 4.0 cm long and 1.0 cm apart, with a p.d. of 50 V between them. **[4]**

i. Find the field between the plates.

ii. Find the electron's sideways deflection as it leaves the plates, and which plate it moves towards.

Answer: _____

c. A flat sheet of paper 30 cm × 20 cm lies in a uniform field of 400 N/C, its normal at 30° to the field. **[3]**

i. Find the flux through it.

ii. A closed box has a total flux of 2.26×10^5 N m^2/C out of it. Find the net charge inside.

Answer: _____

8 Think [3]

A car is struck by lightning, yet the people inside are usually unharmed. Use what you know about the field inside a conductor to explain why. Would sitting in a car with a plastic body be as safe?

9 Activity: Seeing a field's shape (not marked)

You need a shallow dish, cooking oil, semolina (suji) or grass seeds, two pieces of wire and a high-voltage source run by your teacher (or a well-rubbed plastic comb). Pour oil into the dish and sprinkle semolina on it. Dip the wires into the oil and, with your teacher, connect them.

Electrodes in the oil	Pattern the grains make	Where the grains are closest together
one point (one wire)		
two points, opposite charges		
two straight strips facing each other		

How does the pattern between the two strips differ from the pattern near one point?