

18.1 Electric fields and field lines

Name: _____ Class: _____ Date: _____

Total: 24 marks

KEY WORDS electric field 电场 • field line 场线 • force 力 • electric field strength 电场强度
• point charge 点电荷

Objective

Build the skills to answer exam questions on the **electric field** — its definition and field lines.

You must be able to:

- define **electric field strength** as force per unit positive charge
- use $F = qE$
- represent an electric field with **field lines**

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

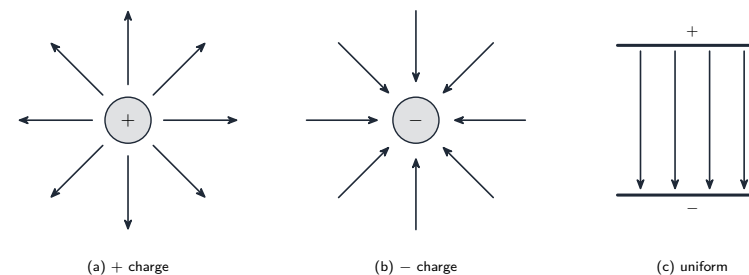
■ Field strength

The **electric field strength** is the force per unit **positive** charge:

$$E = \frac{F}{q} \quad (\text{N C}^{-1} = \text{V m}^{-1}), \quad F = qE.$$

■ Field lines

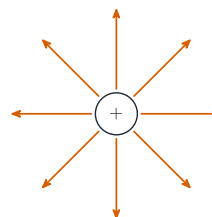
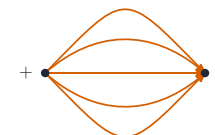
Field lines point the way the force acts on a **positive** charge:



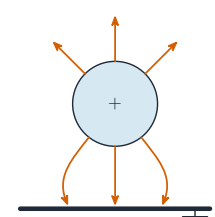
a) parallel plates (uniform field)



b) dipole (+ and -)



c) point charge (radial)



d) sphere above earthed plate

Electric field line patterns

Outward from +, inward to -, and uniform between charged plates. Closer lines → stronger field.

2 Practice

Now apply the methods above.

2.1 Define electric field strength.

[1]

2.2 State the unit of electric field strength. [1]

2.3 Write the equation for the **force** on a charge q in a field E . [1]

2.4 State the **direction** of the field lines around a **positive** point charge. [1]

3 Exam-style questions

3.1 Electric field strength is the force per unit: [1]

- | | |
|---|---|
| A | B |
| C | D |
- A mass
B positive charge
C area
D length

3.2 A charge of 2.0×10^{-6} C experiences a force of 0.10 N in a field. Find the **field strength**. [2]

3.3 Sketch the field lines around (a) a positive and (b) a negative point charge. [2]

3.4 Two parallel horizontal metal plates are 0.067 m apart in a vacuum, with a potential difference of 430 V between them. The upper plate is positive. An electron travels horizontally into the region between them at 2.6×10^7 m s⁻¹. Take $e = 1.60 \times 10^{-19}$ C.

(a) **Define** electric field strength. [1]

(b) **Describe** the pattern of the electric field between the plates, away from their edges, and **state** the direction of the field. [3]

(c) **Determine** the electric field strength between the plates. [2]

(d) **Determine** the magnitude and direction of the electric force on the electron. [3]

(e) **Describe** the path of the electron while it is between the plates, and after it leaves them. [3]

(f) A uniform magnetic field is now applied in the same region so that the electron passes through **undeviated**. **Determine** the flux density required, and **state** how the magnetic force must be directed. [3]