Exam Papers Practice

# 5.1 Electric Fields

## Mark Schemes

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| Course | DP IB Physics |
| Section | 5. Electricity & Magnetism |
| Topic | 5.1 Electric Fields |
| Difficulty | Easy |



To be used by all students preparing for DP IB Physics SL
Students of other boards may also find this useful

1

The correct answer is **C** because:

- The coulomb is the derived unit of charge, defined by the statement given
- Coulombs are derived from the SI units Amps and seconds, using the equation $Q = It$

| | |
|---|---|
| **A and B** are incorrect as | current and potential difference are physical quantities, not units |
| **D** is incorrect as | the ampere is a unit but since it is included in the definition, it cannot also be the answer |

Current is the **rate of flow of electric charge**, which is measured using the units **amperes**.

Potential difference is a measure of the work done per unit charge when charged particles such as electrons are moving.

2

The correct answer is **B** because:



- The first equation, $\frac{\Delta q}{\Delta t}$ is the definition of current
- The second equation, $nAvq$ is used in drift velocity calculations and is used to relate current $I$ to the
  - Charge density, $n$ and cross-sectional area $A$ of a conductor
  - And the drift velocity, $v$ and charge $q$ of the charge carriers

3

The correct answer is **D** because:

- Current is defined as the 'rate of flow of charge past a point' using the equation $I = \frac{\Delta q}{\Delta t}$
  - Only **C** or **D** could be correct

- The unit of current is the ampere, $A$
  - Only **D** can be correct

4

The correct answer is **B** because:

- Electric field lines conventionally show the direction that a small positive test charge would move if it was placed in that field
  - Like charges repel and unlike charges attract
- Therefore a positive test charge will **always** be moved **away** from a **positive** charge and **towards** a **negative** one

5

The correct answer is **D** because:

- The particles in the wire are labelled with a minus sign
- This indicates they are electrons
  - Label **1** is pointing in the opposite direction to the electron motion and is therefore current
  - Only **A** or **D** can be correct
- Label **2** indicates the motion of the particles
  - Therefore label **2** is the drift speed
  - Only **D** can be correct

With a question like this, which is testing fairly straightforward knowledge, often the trick is to be flexible in how you approach the answer. Although Label 1 'feels' as though it should be answered, first, actually the answer is only obvious after you have answered the other two.

6

The correct answer is **B** because:

- Drift speed depends on different factors but has an order of magnitude of $\cong 10^{-4}$ m s$^{-1}$

For your examination, you are expected to remember typical orders of magnitude for the drift speed of delocalised electrons moving as an electric current. This is of the order $10^{-4}$ m s$^{-1}$. Note that options like **D** in the question can be immediately eliminated, because $3.0 \times 10^{8}$ m s$^{-1}$ is the **speed of light**. Nothing with mass can accelerate to the speed of light: while electrons do have an extremely small mass, even they are unable to travel this quickly!

7

The correct answer is **C** because:

- The equation given in the data booklet states that $I = nAvq$
  - Rearranging to make drift velocity, $v$ the subject shows that $v = \frac{I}{nAq}$
- The relationships are
  - $v$ is directly proportional to $I$
  - $v$ is indirectly proportional to $n$, $A$ and $q$

Be ready to rearrange equations and always remember that 'indirectly proportional to a variable' is the same as 'directly proportional to $\frac{1}{\text{the variable}}$'

| | |
|---|---|
| **A** is incorrect as | $v$ is directly proportional to current, $I$ |
| **B** is incorrect as | $v$ is indirectly proportional to the charge carrier density, $n$ |
| **D** is incorrect as | $v$ is indirectly proportional to the cross-sectional area of the conductor, $A$ |

8

The correct answer is **A** because:

- The elementary charge (the charge on one electron) = $1.6 \times 10^{-19}$ C (from the data booklet)
- Recall that therefore one electronvolt is equal to $1.6 \times 10^{-19}$ joules
  - Calculate the answer
  - $4 \text{ eV} \times (1.6 \times 10^{-19} \text{ C}) = 6.4 \times 10^{-19}$ J

If you have trouble remembering this conversion there are two solutions which should help.

- Dimensional analysis tells us that, since $V = \frac{W}{q}$ (this is the definition of potential difference) then the units of work, can be found from $W = Vq$, therefore ***joules = volts × coulombs***.
- Alternatively, simply remember that we use the electronvolt because the Joule is too large to be useful when talking about the very small amounts of energy used in charge carrier calculations. So when converting eV to J, you will always be expecting a very, very small number in your answer.

9

The correct answer is **B** because:

- direct current (dc) is generally used in low voltage devices and electronic goods
- alternating current (ac) is used in high voltage items which take their power directly from the mains supply

10

The correct answer is **A** because:

- The equation for electric field strength from the data booklet says that $E = \frac{F}{q}$
  - Only **A** or **B** can be correct
- When drawing diagrams of electric fields it is the convention that the closer the lines, the stronger the field strength being indicated