5.1 Electric Fields

Question Paper

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

Time allowed: 80

Score: /61

Percentage: /100

Question 1a

(a)
Define the coulomb.

[2]

[2 marks]

Question 1b

(b)
A charge of 60×10^{-6} C flows through a given section of a conductor in 140×10^{-3} s. Calculate the electric current, stating the final answer in mA.

[2]

[2 marks]

Question 1c

(c)
Use words from the list below to complete the description of the movement of charge carriers in a conductor.

average current	**delocalised**	**electric force**
electric field	**randomly**	**drift**

The charge carriers in a metal conductor are _____ electrons.

Normally the electrons move _____ in all directions, but if a potential difference is applied between two points on the conductor, then an _____ is created.

This causes an _____ to act on on the charge carriers, causing them to _____ along the conductor in a resultant direction.

Therefore we can say that a steady _____ flows through the conductor.

[4]

[4 marks]

Question 1d

One equation for electric current states that

$$I = nAvq$$

(d)
Define the four terms used here to calculate current.

[3]

[3 marks]

Question 2a

(a)
Define electrical current.

[2]

[2 marks]

Question 2b

(b)
Define potential difference.

(i)
State the definition in words.

[1]

(ii)
State the equation, defining all terms.

[2]

[3 marks]

Question 2c

A current of 3.0 A flows in a copper wire of cross-sectional area $1.5 \times 10^{-6}\ m^2$. Assume that the charge carriers are delocalised electrons with a charge of -1.6×10^{-19} C, moving with an average drift velocity of $1.0 \times 10^{-4}\ ms^{-1}$.

(c)
Calculate the charge density of the wire.

[3]

[3 marks]

Question 2d

When working with the very small energies needed to move electrons, the unit electronvolt (eV) is often used rather than the joule (J).

(d)
Convert 4.6 MeV into joules.

[3]

[3 marks]

Question 3a

(a)
For the point charges shown sketch a diagram showing the electric field lines.

[4]

[4 marks]

Question 3b

(b)
Indicate, by drawing a circle around an area on your diagram from part (a) where the field lines are more dense and explain why they look like this.

[2]

[2 marks]

Question 3c

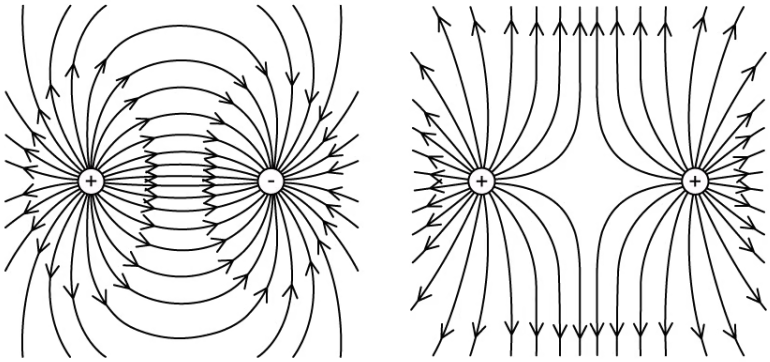
(c)
Sketch a diagram showing the electric field lines for the point charges shown.

[3]

[3 marks]

Question 3d

(d)
Identify the differences between the central area of both the diagrams below.



[2]

[2 marks]

Question 4a

The following descriptions apply to either direct current (dc), alternating current (ac) or both.

(a)
For each row in the table, identify which of the options (ac, dc or both) best fits the description.

Description	ac, dc, or both
energy is carried by electrons moving in wires	
supplied by cells or batteries	
typically used in high voltage devices	
typically used in low voltage devices	
charge carriers have a drift velocity	
current flows from positive to negative	
current changes direction with high frequency	
a potential difference across a conductor causes current to flow	

[4]

[4 marks]

Question 4b

(b)
Distinguish between the following pairs of terms

(i)
Conventional current and electron flow

[2]

(ii)
Delocalised electrons and charge carriers

[2]

[4 marks]

Question 4c

(c)
Complete the sentence stating Coulomb's Law by using words from the text box.

directly	**electrostatic force**	**inversely**
sum	**product**	**separation**

The attractive or repulsive _____ _____ between two point charges is _____ proportional to the _____ of the charges and _____ proportional to the square of their _____ .

[3]

[3 marks]

Question 4d

(d)
Coulomb's Law is represented by the equation

$$F = k\frac{q_1 q_2}{r^2}$$

Define each of the terms used in this equation and state the units.

[4]

[4 marks]

Question 5a

When calculating the electrostatic force between two charged bodies, a constant *k* called Coulomb's constant is taken into account.

(a)
State the relationship, name and the factor that affects the magnitude of k.

[3]

[3 marks]

Question 5b

An electron experiences a force of 0.3 N in an electric field.

(b)
Calculate the field strength of the field.

[3]

[3 marks]

Question 5c

In a vacuum, an alpha particle approaches an aluminium nucleus.

(c)
State:

- The charge on the nucleus
- The charge on the alpha particle
- The nature of the force between them

[3]

[3 marks]

Question 5d

(d)

Calculate the magnitude of the electrostatic force acting on each of the charges from part (c).

- $q_1 = 3.2 \times 10^{-19}\,\text{C}$
- $q_2 = 2.08 \times 10^{-18}\,\text{C}$
- $r = 2.0 \times 10^{-3}\,\text{m}$
- $k = 8.99 \times 10^{9}\,\text{N m}^2\,\text{C}^{-2}$

[4]

[4 marks]