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QUESTION WORKBOOK

Coulomb's law and electric field strength

Electric fields · Year 13

AQA 3.7.3.1, 3.7.3.2 · CIE 18.1.1, 18.1.2, 18.1.3, 18.2.1, 18.2.2, 18.3.1, 18.3.2, 18.4.1
OCR A 6.2.1(a), 6.2.1(b), 6.2.1(c), 6.2.1(d), 6.2.2(a), 6.2.2(b), 6.2.3(a), 6.2.3(c)

19 questions · 52 marks

NAVY SCREEN EDITION

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SECTION A · Warm-up

A1 State Coulomb's law for the force between two point charges. [2]

A2 Two point charges, each of +2.0 μC, are 0.10 m apart. Calculate the force between them.
$k = 8.99 \times 10^{9}$ N m^{2} C^{-2} [2]

A3 A charge of 2.0×10^{-6} C experiences a force of 6.0×10^{-3} N at a point in an electric field. Calculate the electric field strength at that point. [2]

A4 The electrostatic force between two point charges is F. The separation of the charges is doubled. State the new force in terms of F. [1]

A5 Electric field strength can be given in N C^{-1} or in V m^{-1}. Show that these two units are equivalent. [2]

A6 Two charged conducting spheres, each of radius 2.0 cm, are placed with their surfaces 4.0 cm apart. State the separation r that should be used in Coulomb's law for the force between them, and the property of charged spheres that justifies it. [2]

SECTION B · Standard

B1 In a hydrogen atom the electron and the proton are separated by 5.3×10^{-11} m. Calculate the electrostatic force between them.
$e = 1.60 \times 10^{-19}$ C [2]

B2 Two parallel plates separated by 0.050 m have a potential difference of 2000 V across them. Calculate the electric field strength between the plates and the force on a charge of 3.0×10^{-6} C placed between them. [3]

B3 Calculate the electric field strength at a distance of 0.20 m from a point charge of 5.0×10^{-9} C. [2]

B4 A +3.0 μC charge and a −2.0 μC charge are 0.15 m apart. Calculate the magnitude of the force between them and state whether it is attractive or repulsive. [3]

B5 Determine the separation at which the electrostatic repulsion between two protons is 2.3×10^{-4} N.
$k = 8.99 \times 10^{9}$ N m^2 C^{-2}, $e = 1.60 \times 10^{-19}$ C [3]

B6 At a distance of 0.15 m from the centre of a small charged sphere, the electric field strength is 8.0×10^{3} N C^{-1}. Determine the charge on the sphere ($k = 8.99 \times 10^{9}$ N m^2 C^{-2}). [3]

B7 The charge on each of two point charges is doubled and their separation is halved. Determine the factor by which the electrostatic force between them changes. [2]

SECTION C · Stretch

C1 An electron enters a uniform electric field of strength 1.0×10^{4} N C^{-1}. Calculate the acceleration of the electron.
$e = 1.60 \times 10^{-19}$ C, $m_e = 9.11 \times 10^{-31}$ kg [3]

C2 A point charge of 8.0×10^{-9} C is fixed in position. Calculate the electric field strength at a point 0.30 m from the charge, and hence the force on a $+2.0 \times 10^{-9}$ C charge placed at that point. [4]

C3 A charged particle enters a uniform electric field at right angles to the field lines. Describe the path of the particle in the field and explain why it has this shape.

[3]

C4 An electron enters the uniform field between two horizontal parallel plates, midway between them and moving parallel to them at 2.0×10^{7} m s^{-1}. The plates are 40 mm long and 20 mm apart, with a pd of 80 V across them. Assume that gravitational forces are negligible. Determine the deflection of the electron, perpendicular to the plates, by the time it leaves the field.

$e = 1.60 \times 10^{-19}$ C, $m_e = 9.11 \times 10^{-31}$ kg [5]

C5 Air conducts, producing a spark, wherever the electric field strength exceeds 3.0×10^{6} V m^{-1}. The dome of a school Van de Graaff generator is a sphere of radius 15 cm carrying a charge of 8.0 μC. Deduce whether the air at the surface of the dome will break down.

$k = 8.99 \times 10^{9}$ N m^2 C^{-2} [4]

C6 Describe the electric field (a) between two oppositely charged parallel plates and (b) around an isolated positive point charge. In each case state how the field strength varies from place to place. [4]