InkPhysics

ANSWER BOOK

Coulomb's law and electric field strength

Electric fields · Year 13

AQA 3.7.3.1, 3.7.3.2 · CIE 18.1, 18.2, 18.3, 18.4 · OCR A 6.2.1, 6.2.2, 6.2.3

10 questions · 30 marks

NAVY EDITION

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SECTION A · Warm-up

A1 The electrostatic force between two point charges is proportional to the product of the charges and inversely proportional to the square of their separation: $F = kQ_1Q_2/r^2$ (with $k = 1/4\pi\varepsilon_0$). [2]

A2 $F = kQ_1Q_2/r^2 = (8.99 \times 10^9 \times (2.0 \times 10^{-6})^2)/0.10^2 = 3.60$ N (repulsive). [2]

A3 $E = F/Q = (6.0 \times 10^{-3})/(2.0 \times 10^{-6}) = 3000$ N C^{-1}. [2]

SECTION B · Standard

B1 $F = ke^2/r^2 = (8.99 \times 10^9 \times (1.60 \times 10^{-19})^2)/(5.3 \times 10^{-11})^2 = 8.19 \times 10^{-8}$ N. [4]

B2 $E = V/d = 2000/0.050 = 40000$ N C^{-1}. $F = EQ = 40000 \times 3.0 \times 10^{-6} = 0.12$ N. [3]

B3 $E = kQ/r^2 = (8.99 \times 10^9 \times 5.0 \times 10^{-9})/0.20^2 = 1124$ N C^{-1}. [3]

B4 $F = kQ_1Q_2/r^2 = (8.99 \times 10^9 \times 3.0 \times 10^{-6} \times 2.0 \times 10^{-6})/0.15^2 = 2.40$ N, attractive (unlike charges). [3]

SECTION C · Stretch

C1 Force $F = eE$, so $a = eE/m = (1.60 \times 10^{-19} \times 1.0 \times 10^4)/(9.11 \times 10^{-31}) = 1.76 \times 10^{15}$ m s^{-2}. [4]

C2 (a) $E = kQ/r^2 = (8.99 \times 10^9 \times 8.0 \times 10^{-9})/0.30^2 = 799$ N C^{-1}. (b) $F = EQ = 799 \times 2.0 \times 10^{-9} = 1.60 \times 10^{-6}$ N. [4]

C3 It follows a parabolic path. The field exerts a constant force (and so constant acceleration) perpendicular to the entry velocity, while the velocity along the entry direction is unchanged; this is analogous to projectile motion under gravity. [3]