InkPhysics

ANSWER BOOK

Electric potential

Electric fields · Year 13

AQA 3.7.3.3 · CIE 18.5 · OCR A 6.2.4

10 questions · 30 marks

NAVY EDITION

SECTION A · Warm-up

A1 The absolute electric potential at a point is the work done per unit positive charge in bringing a small test charge from infinity to that point. The zero is taken at infinity. [2]

A2 $V = kQ/r = (8.99 \times 10^9 \times 5.0 \times 10^{-9})/0.10 = 449.5$ V. [2]

A3 They are concentric spheres (circles in a plane) centred on the charge. They are everywhere perpendicular to the (radial) field lines, and no work is done moving a charge along an equipotential. [2]

SECTION B · Standard

B1 $V = kQ/r = (8.99 \times 10^9 \times (-3.0 \times 10^{-9}))/0.20 = -134.8$ V (negative, because the charge is negative). [3]

B2 $V_{0.10} = 449.5$ V, $V_{0.30} = 149.8$ V, so $\Delta V = 299.7$ V. Work = $Q\Delta V = 2.0 \times 10^{-9} \times 299.7 = 5.99 \times 10^{-7}$ J. [4]

B3 $E = \Delta V/\Delta r = 200/0.050 = 4000$ V m^{-1}. [3]

B4 $V = kQ/r$ for each, added: $V = 2 \times (8.99 \times 10^9 \times 4.0 \times 10^{-6}/0.20) = 3.60 \times 10^5$ V. [3]

SECTION C · Stretch

C1 Potential energy = $QV = 5.0 \times 10^{-6} \times 2000 = 0.01$ J. The work done to bring it from infinity equals this, 0.01 J. [4]

C2 $V = kQ_1/r + kQ_2/r = (8.99 \times 10^9 \times 6.0 \times 10^{-6}/0.30) + (8.99 \times 10^9 \times (-6.0 \times 10^{-6})/0.30) = 0$ V. The equal and opposite contributions cancel, because potential is a scalar that can be positive or negative. [4]

C3 The field strength is the magnitude of the gradient of the potential–distance graph ($E = \Delta V/\Delta r$), directed from high to low potential. Equivalently, the change in potential is the area under the field–distance graph. [3]