Grade 11 Physics, Explained

Unit 21 · Potential, Potential Difference and Potential Energy

HARDER PRACTICE QUESTIONS

Full marks 29

Write your answers on separate paper. Show your working. Take $k = 9.0 \times 10^9$ N m^2/C^2, $e = 1.6 \times 10^{-19}$ C, 1 eV $= 1.6 \times 10^{-19}$ J and the mass of an electron 9.11×10^{-31} kg.

1 Spot the error [3]

Find the mistake in the working and correct it.

Charges of +2.0 nC are fixed at two corners of an equilateral triangle of side 0.30 m. Ritesh found the potential at the third corner:
"Each charge gives $9.0 \times 10^9 \times 2.0 \times 10^{-9} \div 0.30 = 60$ V. The two make 60° with each other, so $V = 2 \times 60 \times \cos 30° =$ **104 V**."

2 Two answers [4]

A charge of +6.0 nC is at O and a charge of −2.0 nC is at A, 40 cm away. Find every point on the line through O and A where the potential is zero. Explain why there is no such point on the far side of O.

3 Work backwards [3]

At a point near an isolated point charge the potential is 900 V and the field is 4500 V/m. How far is the point from the charge, and what is the charge?

4 A real setting [3]

In Rutherford's experiment an alpha particle (charge +2e) with 5.0 MeV of kinetic energy heads straight for a gold nucleus (charge +79e).

i. Find how close it gets before it stops and turns back.
ii. What does the answer tell us about the size of the gold nucleus?

5 Reading a graph [3]

A graph of potential V against distance x along a line shows V = 0 V at x = 0, rising steadily to 60 V at x = 3.0 cm, staying at 60 V to x = 5.0 cm, then falling steadily to 0 V at x = 9.0 cm.

i. Find the field (size and direction) in each of the three stretches.
ii. Where would a free electron placed at x = 4.0 cm go?

6 Estimate it [3]

Walking on a carpet on a dry day, Sneha's body (treat it as a sphere of radius 0.5 m) picks up a charge of about 0.5 μC.

i. Estimate her potential.
ii. Estimate the energy in the spark when she touches a door handle, taking it as about half of Q × V.

7 Predict, then explain [3]

Write your prediction first, then explain it.

A proton and an electron are both released from rest between two parallel plates, 12 V apart. Predict which way each moves, which gains more kinetic energy by the time it reaches a plate, and which is moving faster. Then explain.

8 Correct the misconceptions [3]

The paragraph has three mistakes. Write each mistake and correct it.

> Bibisha wrote: “Where the potential is zero the field must be zero too. The electron volt is a unit of potential. A positive charge released in a field moves to higher potential.”

9 Think [2]

Inside a closed metal box the potential is the same everywhere. What does that tell you about the field inside it? Explain using the potential gradient.

10 Make your own [2]

Choose two parallel plates (their gap and the p.d. across them) so that the field between them is 5,000 V/m. Then find the kinetic energy, in eV, an electron gains crossing your gap from rest.