INKPHYSICS FLASHCARDS

Electric fields

Year 13 · 8 cards · fronts and backs

Print double-sided, flipping on the long edge, and each answer lands behind its question. Cut along the card borders.

Definitions in mark-scheme wording, the equations that are not on the data sheet, each lesson's check question, and the misconceptions that lose marks. The same cards run on the website with spaced-repetition scheduling, at inkphysics.co.uk/flashcards.

DEFINITION

Define: Electric field strength.

COULOMB'S LAW AND ELECTRIC FIELD STRENGTH

CHECK YOURSELF

Two plates 4.0 cm apart carry a potential difference of 500 V. Find the field strength between them and the force on an electron in the gap.

Hint: Uniform field first, then force per charge read backwards.

COULOMB'S LAW AND ELECTRIC FIELD STRENGTH

SPOT THE ERROR

Say what is wrong with this claim:

Field lines are the paths charges follow.

COULOMB'S LAW AND ELECTRIC FIELD STRENGTH

DEFINITION

Define: Electric potential.

ELECTRIC POTENTIAL

CHECK YOURSELF

A point charge of +2.0 nC sits in air. Find the potential 0.30 m away, and the work needed to bring a +1.5 nC charge from far away to that point.

Hint: Radial potential first; then joules per coulomb times the coulombs.

ELECTRIC POTENTIAL

SPOT THE ERROR

Say what is wrong with this claim:

A volt is an amount of energy.

ELECTRIC POTENTIAL

CHECK YOURSELF

Two protons sit 1.0 fm apart. Using data-booklet values, find the electric and gravitational forces between them and the ratio of the two. Why, despite this ratio, does gravity and not electricity shape galaxies?

Hint: Same r in both laws, so the ratio outlives it.

COMPARING ELECTRIC AND GRAVITATIONAL FIELDS

SPOT THE ERROR

Say what is wrong with this claim:

Gravity is the strongest force.

COMPARING ELECTRIC AND GRAVITATIONAL FIELDS

CHECK YOURSELF

$E = V/d = 500 / 0.040 = 1.25 \times 10^4$ V m^{-1}.

$F = EQ = 1.25 \times 10^4 \times 1.60 \times 10^{-19} = 2.0 \times 10^{-15}$ N, directed towards the positive plate because the electron's charge is negative.

Tiny in newtons, enormous per kilogram: on an electron's mass this force produces an acceleration around 10^{15} m s^{-2}.

COULOMB'S LAW AND ELECTRIC FIELD STRENGTH

DEFINITION

The force per unit charge on a small positive test charge placed in the field: $E = F/Q$, in N C^{-1} or V m^{-1}.

COULOMB'S LAW AND ELECTRIC FIELD STRENGTH

DEFINITION

The work done per unit positive charge to move a small test charge from infinity to that point.

ELECTRIC POTENTIAL

SPOT THE ERROR

Field lines map the force's direction at each point, not trajectories. A charge entering a uniform field at right angles crosses the field lines in a parabola — exactly as a projectile crosses gravity's field lines.

COULOMB'S LAW AND ELECTRIC FIELD STRENGTH

SPOT THE ERROR

The volt is a rate of exchange, not a stockpile: one joule per coulomb. How much energy actually moves depends on how much charge moves — $W = QV$ needs them both.

ELECTRIC POTENTIAL

CHECK YOURSELF

$V = Q/4\pi\varepsilon_0 r = (8.99 \times 10^9 \times 2.0 \times 10^{-9}) / 0.30 = 60$ V.

Coming from infinity, $\Delta V = 60$ V, so $\Delta W = Q\Delta V = 1.5 \times 10^{-9} \times 60 = 9.0 \times 10^{-8}$ J.

Positive work, supplied by whatever does the pushing: both charges are positive, so the arrival is uphill all the way.

ELECTRIC POTENTIAL

SPOT THE ERROR

Between two protons, electrical repulsion beats gravitational attraction by a factor of about 10^{36} — gravity is by far the weaker force. It only rules the cosmos because matter is neutral in bulk, cancelling electricity and leaving gravity's unopposed pull.

COMPARING ELECTRIC AND GRAVITATIONAL FIELDS

CHECK YOURSELF

Electric: $F = Q_1Q_2/4\pi\varepsilon_0 r^2 = (8.99 \times 10^9 \times (1.60 \times 10^{-19})^2) / (1.0 \times 10^{-15})^2 \approx 230$ N, repulsive.

Gravitational: $F = Gm^2/r^2 = (6.67 \times 10^{-11} \times (1.67 \times 10^{-27})^2) / (1.0 \times 10^{-15})^2 \approx 1.9 \times 10^{-34}$ N.

Ratio $\approx 1.2 \times 10^{36}$, independent of r. Galaxies still belong to gravity because bulk matter is neutral: charges cancel and electric forces screen themselves out, while masses only ever add.

COMPARING ELECTRIC AND GRAVITATIONAL FIELDS