

Charging objects and the force between charges

AP Physics 2 (algebra-based) · Test answers (mark scheme)

Award marks as shown for method, substitution and answer. In explanation questions, accept any wording that gives the correct physical idea. Do not penalise the same unit mistake twice, and allow answers within 2 % of the values given.

Level: AP Physics 2 (algebra-based) · **Curriculum:** AP P2 Unit 10

Question 1 Glass rod and silk (2 marks)

(a) $Q = Ne = 3.0 \times 10^{10} \times 1.60 \times 10^{-19} = \mathbf{+4.8 \times 10^{-9} \text{ C}}$.

(b) $\mathbf{-4.8 \times 10^{-9} \text{ C}}$, because charge is conserved.

Marking: 1 mark for each part, including sign and unit.

Question 2 Attractive force (3 marks)

$F = (8.99 \times 10^9)(2.0 \times 10^{-6})(6.0 \times 10^{-6}) / (0.15)^2 = 0.1079 / 0.0225 = \mathbf{4.8 \text{ N}}$, attractive on both charges.

Marking: 1 mark for correct substitution in SI units; 1 mark for the value; 1 mark for stating attractive.

Question 3 Tripling the distance (2 marks)

The force is inversely proportional to r^2 , so it is divided by $3^2 = 9$. $F = 0.90 / 9 = \mathbf{0.10 \text{ N}}$.

Marking: 1 mark for the inverse square relation; 1 mark for the value.

Question 4 Induction (3 marks)

The rod repels electrons in the sphere to the far side, so the near side is positive. The sphere is briefly connected to the earth, which lets electrons flow away. The earth connection is removed first and then the rod, leaving a net **positive charge**.

Marking: 1 mark for charge separation; 1 mark for earthing; 1 mark for removing earth before the rod.

Question 5 Balanced forces (3 marks)

From the $+4.0 \mu\text{C}$ charge: $F = (8.99 \times 10^9)(4.0 \times 10^{-6})(1.0 \times 10^{-6}) / (0.20)^2 = 0.90 \text{ N}$

towards $-x$. From the $+1.0 \mu\text{C}$ charge: $F = (8.99 \times 10^9)(1.0 \times 10^{-6})(1.0 \times 10^{-6}) / (0.10)^2 = 0.90 \text{ N}$ towards $+x$. The forces are equal and opposite, so the net force is **0 N**.

Marking: 1 mark for each force with direction; 1 mark for the conclusion.

Question 6 Touching spheres (2 marks)

The total charge is $+6.0 \mu\text{C}$ and is shared equally, so each sphere has **$+3.0 \mu\text{C}$** .

Marking: 1 mark for conservation of charge; 1 mark for equal sharing.

Question 7 Paper and a comb (2 marks)

The comb polarises the paper, so the side of the paper nearer the comb has the opposite charge. That charge is closer, so the attractive force is larger than the repulsion from the more distant like charge. **Net attraction.**

Marking: 1 mark for polarisation; 1 mark for the distance argument.

Question 8 Electric and gravitational forces (3 marks)

(a) Ratio = $ke^2 / (Gm^2) = (8.99 \times 10^9 \times 2.56 \times 10^{-38}) / (6.67 \times 10^{-11} \times 8.30 \times 10^{-61}) = \mathbf{4.2 \times 10^{42}}$.

(b) It does **not** change, because both forces vary as $1/r^2$ and r cancels.

Marking: (a) 1 mark for the ratio set-up, 1 mark for the value; (b) 1 mark.