

Solutions

2.1 Electrons were transferred from the cloth to the rod; the rod gained electrons (negative charge) and the cloth lost the same number, leaving it positively charged.

2.2 X and Y have the **same** type of charge (like charges repel); Y and Z have **unlike** charges (attract); so Z is positive, and X (negative) would **attract** Z.

2.3 An electric field is a region where a (charged) object feels a (non-contact) force. Strongest close to the sphere's surface / close to the charged object.

3.1 (a) Electrons transfer onto the student from the dome, so the hair strands each carry the same (negative) charge; like charges repel; neighbouring strands push apart and rise – the hair stands on end. (b) The field is strongest at a sharp point (greatest curvature); there the air's breakdown happens first – the field is large enough to make air conduct, so the spark starts from the point.

3.2 (a) The charged rod's field affects the paper: it attracts the opposite charge within each neutral piece to the near side and repels like charge to the far side (induced charge separation); the nearer opposite charges feel a stronger attraction than the repulsion of the further like charges, so the paper is pulled to the rod. (b) The force decreases: the field weakens with distance from the rod, so the force on the paper's charges is smaller.

3.3 (a) The overhead line has an electric field around it; the cable sits inside that field, so charges in the cable feel a force and the cable's near side gains an induced opposite charge; if the field between line and cable is strong enough (about 11 kV across a small gap), air becomes conducting and a spark jumps without contact. (b) Earthing gives the cable a path to earth at 0 V; any induced or transferred charge drains away, so no large potential difference can build up between cable and surroundings and no spark can jump; the fitter touching the earthed cable is at the same potential as the cable – no potential difference means no current through them.