

Solutions

2.1 Like poles repel; unlike poles attract.

2.2 Iron, steel, cobalt, nickel.

2.3 Near a magnet the needle aligns with the magnet's field lines; the compass works anywhere on Earth because the Earth itself has a magnetic field.

3.1 (a) They attract; a non-contact force. **3.1** (b) Any two: a permanent magnet produces its own field while an induced magnet is magnetic only inside one; induced magnetism always causes attraction while permanent poles repel or attract; an induced magnet loses its magnetism when removed from the field. **3.1** (c) The first clip becomes an induced magnet by the bar magnet's field; its near end is an induced opposite pole, which induces the second clip in turn and attracts it.

3.2 (a) Place the compass at a point near the pole; mark the needle ends with dots; move the compass so the tail dot sits on the previous tip dot; repeat along the whole field line; join the dots smoothly. **3.2** (b) At the poles; the field lines are closest together there.

3.2 (c) Advantage: shows the whole two-dimensional pattern instantly; limitation: no direction (the needle gives it) / only coarse detail.

3.3 The Earth has a magnetic field, as if a huge bar magnet were inside it; the compass needle, itself a small magnet, experiences a force aligning it with the field lines, pointing approximately geographic north. Near a large iron structure, the iron becomes an induced magnet whose stronger local field deflects the needle away from north.