STEP II, 2006, Q10 MS

Q10 The first two collisions, between A and B and then between B and C, each require the application of the principles of *conservation of linear momentum* (CLM) and *Newton's experimental law of restitution* (NEL or NLR). This will give the intermediate and final velocities of B along with the final velocities of A and C (although the latter is not needed anywhere) in terms of u. [It is simplest to take all velocities in the same direction, along AB, so that "opposite" directions will then be accounted for entirely (and consistently) by signs alone.] For a second collision between A and B, $V_A > V_B$ (irrespective of their signs!) and this leads to a quadratic equation in k. Note that any negative solutions are inappropriate here.

Using $k = 1$ (which presumably MUST lie in the range found previously), the velocities of all particles can now be noted less algebraically. The time between contacts is in two parts: the time for B to reach C, and then the time for A to catch up with B (from its new position when B & C collide). After B leaves C, it is only the relative speed of A and B that matters, and this simplifies the working considerably.

Answers: (i) $0 < k < \frac{3}{2}$.