

## STEP II, 2010, Q10

- 10 (i) In an experiment, a particle  $A$  of mass  $m$  is at rest on a smooth horizontal table. A particle  $B$  of mass  $bm$ , where  $b > 1$ , is projected along the table directly towards  $A$  with speed  $u$ . The collision is perfectly elastic.

Find an expression for the speed of  $A$  after the collision in terms of  $b$  and  $u$ , and show that, irrespective of the relative masses of the particles,  $A$  cannot be made to move at twice the initial speed of  $B$ .

- (ii) In a second experiment, a particle  $B_1$  is projected along the table directly towards  $A$  with speed  $u$ . This time, particles  $B_2, B_3, \dots, B_n$  are at rest in order on the line between  $B_1$  and  $A$ . The mass of  $B_i$  ( $i = 1, 2, \dots, n$ ) is  $\lambda^{n+1-i}m$ , where  $\lambda > 1$ . All collisions are perfectly elastic. Show that, by choosing  $n$  sufficiently large, there is no upper limit on the speed at which  $A$  can be made to move.

In the case  $\lambda = 4$ , determine the least value of  $n$  for which  $A$  moves at more than  $20u$ . You may use the approximation  $\log_{10} 2 \approx 0.30103$ .



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