

## STEP II, 2007, Q9 MS

**Q9** The greatest problem with marking mechanics questions on the STEPs is that candidates seem to be so unwilling, or unable, to mark up a decently labelled diagram with all relevant forces on them, or, in this case, relevant velocities and angles. On the face of it, this is just a collisions question dressed up a bit, and there really are only the two mechanical principles to be applied here: *Conservation of Linear Momentum* (CLM) and *Newton's Experimental Law of Restitution* (NEL or NLR). If you take a side-on view of the cone, then the collision – at the moment of impact – is effectively the same as would be given by a plan view of a particle striking a vertical wall: directly, in the first instance, and then obliquely in the second. Applying CLM parallel to this line of impact (which is very easy in the first case and, in fact, the reason why you were asked for an explanation to begin with so that you were pointed in the right direction) and NEL perpendicular to it are essential steps in both parts of the question. In order to prevent you worrying about how the cone might bounce off the plane, you are told that this does not happen. So there is no point considering CLM vertically for the particle-cone collision, but there is still the horizontal motion of the cone to consider.

In (ii), the collision is oblique to the line of the cone's side, so there are two angles involved, and a bit of trig. work might be needed to sort things out. Alternatively, rather than re-doing (i)'s working in this separate case, one could simply consider the components of the "incoming" velocity, and the second answer for  $w$  is exactly the same as the first, but with  $u$  replaced by ..... For the very final part of the question, a little calculus is in order.



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