

STEP II, 2006, Q9

- 9 A painter of weight kW uses a ladder to reach the guttering on the outside wall of a house. The wall is vertical and the ground is horizontal. The ladder is modelled as a uniform rod of weight W and length $6a$.

The ladder is not long enough, so the painter stands the ladder on a uniform table. The table has weight $2W$ and a square top of side $\frac{1}{2}a$ with a leg of length a at each corner. The foot of the ladder is at the centre of the table top and the ladder is inclined at an angle $\arctan 2$ to the horizontal. The edge of the table nearest the wall is parallel to the wall.

The coefficient of friction between the foot of the ladder and the table top is $\frac{1}{2}$. The contact between the ladder and the wall is sufficiently smooth for the effects of friction to be ignored.

- (i) Show that, if the legs of the table are fixed to the ground, the ladder does not slip on the table however high the painter stands on the ladder.
- (ii) It is given that $k = 9$ and that the coefficient of friction between each table leg and the ground is $\frac{1}{3}$. If the legs of the table are not fixed to the ground, so that the table can tilt or slip, determine which occurs first when the painter slowly climbs the ladder.

[Note: $\arctan 2$ is another notation for $\tan^{-1} 2$.]



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