

## STEP II, 2004, Q4

4

Figure 1

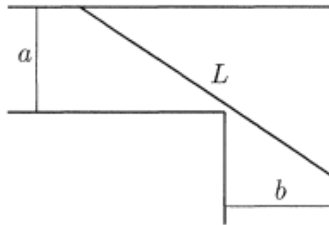
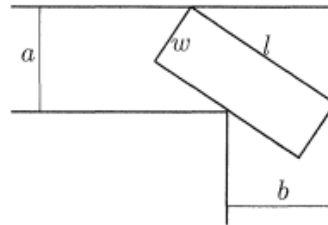


Figure 2



- (i) An attempt is made to move a rod of length  $L$  from a corridor of width  $a$  into a corridor of width  $b$ , where  $a \neq b$ . The corridors meet at right angles, as shown in Figure 1 and the rod remains horizontal. Show that if the attempt is to be successful then

$$L \leq a \operatorname{cosec} \alpha + b \sec \alpha,$$

where  $\alpha$  satisfies

$$\tan^3 \alpha = \frac{a}{b}.$$

- (ii) An attempt is made to move a rectangular table-top, of width  $w$  and length  $l$ , from one corridor to the other, as shown in the Figure 2. The table-top remains horizontal. Show that if the attempt is to be successful then

$$l \leq a \operatorname{cosec} \beta + b \sec \beta - 2w \operatorname{cosec} 2\beta,$$

where  $\beta$  satisfies

$$w = \left( \frac{a - b \tan^3 \beta}{1 - \tan^2 \beta} \right) \cos \beta.$$



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