

### STEP III, 2014, Q3

- 3 (i) The line  $L$  has equation  $y = mx + c$ , where  $m > 0$  and  $c > 0$ . Show that, in the case  $mc > a > 0$ , the shortest distance between  $L$  and the parabola  $y^2 = 4ax$  is

$$\frac{mc - a}{m\sqrt{m^2 + 1}}.$$

What is the shortest distance in the case that  $mc \leq a$ ?

- (ii) Find the shortest distance between the point  $(p, 0)$ , where  $p > 0$ , and the parabola  $y^2 = 4ax$ , where  $a > 0$ , in the different cases that arise according to the value of  $p/a$ . [You may wish to use the parametric coordinates  $(at^2, 2at)$  of points on the parabola.]

Hence find the shortest distance between the circle  $(x - p)^2 + y^2 = b^2$ , where  $p > 0$  and  $b > 0$ , and the parabola  $y^2 = 4ax$ , where  $a > 0$ , in the different cases that arise according to the values of  $p$ ,  $a$  and  $b$ .



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