

55. When the escalator is stalled the speed of the person is  $v_p = \ell/t$ , where  $\ell$  is the length of the escalator and  $t$  is the time the person takes to walk up it. This is  $v_p = (15\text{ m})/(90\text{ s}) = 0.167\text{ m/s}$ . The escalator moves at  $v_e = (15\text{ m})/(60\text{ s}) = 0.250\text{ m/s}$ . The speed of the person walking up the moving escalator is  $v = v_p + v_e = 0.167\text{ m/s} + 0.250\text{ m/s} = 0.417\text{ m/s}$  and the time taken to move the length of the escalator is

$$t = \ell/v = (15\text{ m})/(0.417\text{ m/s}) = 36\text{ s} .$$

If the various times given are independent of the escalator length, then the answer does not depend on that length either. In terms of  $\ell$  (in meters) the speed (in meters per second) of the person walking on the stalled escalator is  $\ell/90$ , the speed of the moving escalator is  $\ell/60$ , and the speed of the person walking on the moving escalator is  $v = (\ell/90) + (\ell/60) = 0.0278\ell$ . The time taken is  $t = \ell/v = \ell/0.0278\ell = 36\text{ s}$  and is independent of  $\ell$ .