

22. We know that the area under curve A between $t = 0$ and $t = x$ is $\int_0^x v_A(t) dt = s_A(x)$, where $v_A(t)$ is the velocity of car A and s_A is its displacement. Similarly, the area under curve B between $t = 0$ and $t = x$ is $\int_0^x v_B(t) dt = s_B(x)$.

- (a) After one minute, the area under curve A is greater than the area under curve B . So A is ahead after one minute.
- (b) The area of the shaded region has numerical value $s_A(1) - s_B(1)$, which is the distance by which A is ahead of B after 1 minute.
- (c) After two minutes, car B is traveling faster than car A and has gained some ground, but the area under curve A from $t = 0$ to $t = 2$ is still greater than the corresponding area for curve B , so car A is still ahead.
- (d) From the graph, it appears that the area between curves A and B for $0 \leq t \leq 1$ (when car A is going faster), which corresponds to the distance by which car A is ahead, seems to be about 3 squares. Therefore, the cars will be side by side at the time x where the area between the curves for $1 \leq t \leq x$ (when car B is going faster) is the same as the area for $0 \leq t \leq 1$. From the graph, it appears that this time is $x \approx 2.2$. So the cars are side by side when $t \approx 2.2$ minutes.