1. A lower estimate is $0(3) + 10(3) + 25(3) + 45(3) = 240$ feet. An upper estimate is $10(3) + 25(3) + 45(3) + 75(3) = 465$ feet. The average of these is $(240 + 465)/2 = 352.5$ feet.

2. (a) A lower estimate is $45(2)+16(2)+0(2) = 122$ feet. An upper estimate is $88(2)+45(2)+16(2) = 298$ feet.

   (b) See below.

   ![Graph](image)

3. (a) A lower estimate is $37(10) + 41(10) + 77(10) + 77(10) = 2320$ million people, or $2.32$ billion people. An upper estimate is $41(10) + 78(10) + 78(10) + 86(10) = 2830$ million people, or $2.83$ billion people. The average of these is $(2.32 + 2.32)/2 = 2.83$ billion people.

   (b) The true change is $5295 - 2555 = 2740$, so our estimate was a little low – but not very!

4. They say it “increases steadily”, so I will assume that that means a linear growth. Thus, at 6 AM the flow rate is $100$ m³/hr, at 7 AM it is $160$, at 8 AM it is $220$, and at 9 AM it is $280$. A lower estimate is therefore $100(1) + 160(1) + 220(1) = 480$ m³. An upper estimate is $160(1) + 220(1) + 280(1) = 660$ m³. The average of these is $570$ m³. An alternative method would be to find the area of the trapezoid the curve defines.

7. The grid will help us determine the area under the curve, which represents the distance travelled. It looks to me like the area is about $140$, so I estimate that the object travelled $140$ m.

11. (a) Car $A$ attains the maximum velocity since its velocity graph has the higher maximum.

   (b) Car $A$ also stops first; its velocity returns to 0 first.

   (c) Car $B$ travels much farther; the area under its velocity curve is much greater than the area under the velocity curve for Car $A$.

14. I will compute upper and lower estimates with one-second intervals. This is an increasing function, so upper estimates will be from the right endpoint, and lower estimates will be from the left endpoint.

   **Lower:** $(0^2 + 1)(1) + (1^2 + 1)(1) + (2^2 + 1)(1) + (3^2 + 1)(1) + (4^2 + 1)(1) = 35$ meters.

   **Upper:** $(1^2 + 1)(1) + (2^2 + 1)(1) + (3^2 + 1)(1) + (4^2 + 1)(1) + (5^2 + 1)(1) = 60$ meters.

   The average is $(35 + 60)/2 = 47.5$ meters.

15. (a) Lower estimate: $80(2) + 50(2) + 25(2) + 10(2) + 0(2) = 330$ feet.

   Upper estimate: $100(2) + 80(2) + 50(2) + 25(2) + 10(2) = 530$ feet. The average is $430$ feet.

   (b) The data is inconclusive; the lower estimate is below the $400$ feet, and the upper is above. The skunk may also have moved!