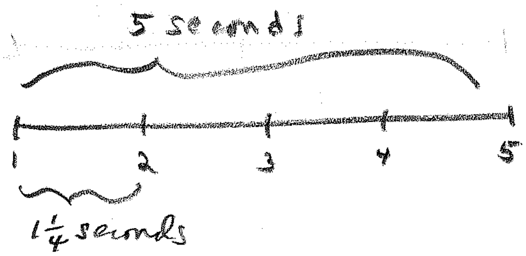
(1) a) <u>$11\frac{1}{4}$ seconds</u>. If there are five chimes, there are 4 intervals between chimes:



This would be 5/4 second per interval. For 10 chimes, we need 9 intervals, for a total of $9 \cdot \frac{5}{4} = \frac{45}{4} = 11\frac{1}{4}$ seconds.

b) <u>Yes</u>. Select a fruit from the APPLES-AND-ORANGES box. It will be either an apple or an orange. Let's say it's an apple. Then the <u>correct</u> label for the box has to be either APPLES or APPLES-AND-ORANGES. Since we know APPLES-AND-ORANGES is <u>not</u> correct, it must be the APPLES box. Also, the box labeled ORANGES can only really be APPLES or APPLES-AND-ORANGES. But since we've already identified the APPLES box, the correct label for the box labeled ORANGES is APPLES-AND-ORANGES. That leaves ORANGES for the label on the remaining box. It's similar if the selected fruit was an orange.

c) <u>17</u>. Since Sven finished <u>exactly</u> in the middle, the number of people in the race must be an odd number. Since Dan in 10^{th} place finished after Sven, Sven's position number must be less than 10, so it's 9, 7, 5, 3, or 1. But if Sven's position is 7 or less, then there 15 or fewer people in the race. (For example, with 15 people, the position number exactly in the middle would be 7.) But Lars was in position 16, so there are at least 16 people in the race. That leaves 9 as Sven's only possible position, and 17 people in the race.

② a) $m = \frac{8-5}{-2-3} = -\frac{3}{5}$, so the equation is $y = -\frac{3}{5}x + b$ for some b. Since $(3,5)$ is on the line, $5 = -\frac{3}{5}\cdot 3 + b$, and $b = \frac{34}{5}$. The equation is $\underline{y = -\frac{3}{5}x + \frac{34}{5}}$.

b) The slope of the line containg $(6,4)$ and $(-1,2)$ is $\frac{4-2}{6+1} = \frac{2}{7}$. The slope of the line containing $(6,4)$ and $(12,7)$ is $\frac{7-4}{12-6} = \frac{1}{2}$. If the point were colinear, the slopes would be the same. Since the slopes are not the same, the points are not collinear.

c) $f(10) = 3\cdot 10^2 + 5\cdot 10 + 1 = 351$, not 349, so $(10, 349)$ is NOT on the graph.

d) To find x-coordinates of points where $y = 3$, solve
$3x^2 + 5x + 1 = 3 \Rightarrow 3x + 5x - 2 = 0 \Rightarrow (3x-1)(x+2) = 0$
$\Rightarrow x = \frac{1}{3}$ or $x = -2$. The points on the graph are
$(\frac{1}{3}, f(\frac{1}{3}))$ and $(-2, f(-2))$, that is $\underline{(\frac{1}{3}, 3), (-2, 3)}$.

e) $(1, f(1)) = (1, 9)$ and $(3, f(3)) = (3, 43)$. So the slope is $\frac{43-9}{3-1} = \underline{17}$,

so $y = 17x + b$
$9 = 17\cdot 1 + b$
$-8 = b$

Equation: $\underline{y = 17x - 8}$

f) $(-1,1)$ is a point on the tangent line. It looks like $(0, \frac{3}{2})$ is also on the line, giving a slope $\frac{3/2 - 1}{0+1} = \frac{1}{2}$.
This is an approximation, since we can't be sure that $(0, \frac{3}{2})$ is exactly on the line. [In fact, if the slope were $\frac{1}{2}$, then $(-3, 0)$ would be on the line, and it's clearly not on the line.]

g) I estimated $(2, 1\frac{3}{4})$ is the point on the graph and $(3,0)$ is another point on the tangent line giving an approximate value for the slope as $\frac{0 - 1\frac{3}{4}}{3-2} = \underline{\underline{-\frac{7}{4}}}$.

Had to estimate line and points!

(3) The paradox of the arrow in flight seems to me to raise a real question. It seems like an arrow doesn't move "at" a single moment of time — it moves <u>between</u> <u>two</u> moments. But if you ask what comes between two moments, it's just an infinite number of individual moments (moments at which the arrow is not moving??),

(4) a) The total distance traveled by the ball would be given by an infinite sum

$$4+4+2+1+\tfrac{1}{2}+\tfrac{1}{4}+\tfrac{1}{8}+\tfrac{1}{16}+\cdots$$

If you add up some terms of this sum, it looks like the answer is approaching 12. You could check this by noting that each term that is added cuts the remaining distance to 12 in half. Or consider this calculation, where D is the total distance traveled:

$$\begin{array}{rl} 2D = & 8+8+\cancel{4}+\cancel{2}+\cancel{1}+\cancel{\tfrac{1}{2}}+\cancel{\tfrac{1}{4}}+\cancel{\tfrac{1}{8}}+\cancel{\cdots} \\ -\quad D = & 4+\cancel{4}+\cancel{2}+\cancel{1}+\cancel{\tfrac{1}{2}}+\cancel{\tfrac{1}{4}}+\cancel{\tfrac{1}{8}}+\cancel{\tfrac{1}{16}}+\cdots \\ \hline D = & 8+8-4=12 \end{array}$$

b) Without knowing more about the physics of bouncing, it's impossible to say whether the ball bounces forever or not. Both are plausible. Let's say every bounce takes the same amount of time — then an infinite number of bounces take infinite time. But in fact, the times get shorter and shorter, so they might add up to a finite number, just like the infintely many distances add up to 12.