

## CHEETAH'S LUNCH

The fastest animal in the world is the cheetah. When it hunts, the cheetah can achieve a top speed of approximately 75 miles per hour. Some of its prey are also fast: some antelopes can reach the speeds of nearly 50 miles per hour and zebras are known to reach 30 miles per hour.

It appears that the cheetah can never go hungry—being the fastest animal in the savanna (or anywhere else), it can always outrun its potential dinner, but there is a catch. The cheetah can only run at 75 miles per hour for eight seconds. After that, it slows down to a modest 16 miles per hour. On the other hand, the antelopes can maintain their top speed of 50 miles per hour for several minutes, and both zebras and antelopes can maintain the speed of 30 miles per hour for much longer periods of time (half an hour?).

Faced with such a difficult situation, the cheetah has only one chance to get some food—it must cautiously approach the animal without being seen, heard, or smelled (that is why it always checks the direction of the wind before stalking its prey). Once noticed, it must attack immediately. If it is not close enough, and it tires before catching the other animal, it has no chance to catch it on the run.

1. a. The cheetah is stalking an antelope. Tall grass obscures the cheetah until the distance between the cheetah and the antelope is 880 ft. As soon as the antelope notices the predator, it jumps and starts running away from the cheetah. At the same time, the cheetah starts chasing the antelope. Will the cheetah catch the antelope?
- b. After chasing the antelope for four seconds, the cheetah spots a zebra only 200 ft to the right. It immediately changes direction and heads straight for the zebra. However, the zebra also notices the cheetah and quickly picks up speed heading away from the cheetah. Will the cheetah catch the zebra?
- c. In its second attempt, the cheetah managed to approach the antelope to within 300 ft before being spotted. Would it catch the antelope this time or would it go hungry?

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# Cheetah's Lunch

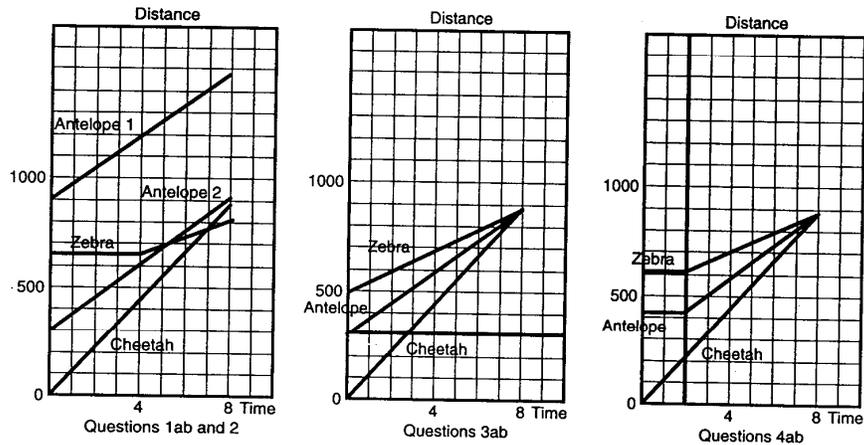
## Task

# A Sample Solution



The problem could be approached either symbolically or graphically. The three groups of graphs below, each respond to some of the questions. The second and third diagram allow us to answer all of the questions of the type presented in 1 and 4. There is no reason to extend the graphs beyond the first eight seconds—once the cheetah tires, it slows down substantially and no longer gains on the other animals. If the graphs intersect before the expiration of the 8 seconds, the cheetah catches its prey, otherwise, it goes hungry.

Part 3 can be answered because any separation short of some yet unknown distance will allow the cheetah to catch its prey. The maximum separation is achieved when the prey is caught at the last moment, so the intersection point needs to be exactly at this time marker. Any distance shorter will result in a kill and any longer distance will allow the animal to escape.



In question 1 and just barely in question 2, the antelope escapes. The zebra, however, is not so lucky.

In 3, the longest separation for an antelope is just short of 300 ft, while the longest separation for a zebra is between 525 and 530 ft. A more detailed diagram may give a more accurate distance.

Advanced High School Package 2

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## Cheetah's Lunch ■ A Sample Solution

In 4, the distance allowed the antelope is just longer than the maximum possible for a catch. Once again, the zebra gets caught.

A symbolic solution would require converting all the data to the same units (as does a graphical solution, under normal circumstances) and writing a set of equations, each representing a particular situation.

If the sum of the initial separation and the distance covered by the prey is less than the distance covered by the cheetah in 8 seconds, then the animal will be caught. Otherwise, it escapes.

$$75 \frac{\text{mi}}{\text{h}} = 110 \frac{\text{ft}}{\text{sec}}$$

$$50 \frac{\text{mi}}{\text{h}} \approx 72.7 \frac{\text{ft}}{\text{sec}}$$

$$30 \frac{\text{mi}}{\text{h}} = 44 \frac{\text{ft}}{\text{sec}}$$

- 1a. In 8 seconds, the cheetah will only get to the point where the antelope started—the antelope is long gone.
- 1b. Now the distance is only 200 ft, but the cheetah has only 4 seconds left to run at full speed. The zebra covers 174 ft. The initial separation is insufficient to prevent its untimely demise.
2. The antelope covers 581.6 ft, therefore escaping the cheetah by less than 2. However, at this point, the cheetah must break off the chase.
- 3a. The maximum separation for an antelope (or a zebra) would put it at the 880-ft mark after 8 seconds of running at full speed. So the distance is  $880 - 8 \times 72.7 = 298.4$  ft.
- 3b. The distance for a zebra would be  $880 - 8 \times 44 = 528$  ft.
- 4a. In both cases, the cheetah is only 230 ft away with 6 seconds left. For the antelope that is a relief:  $230 + 6 \times 72.7 = 666.2 > 660$  ft.
- 4b. The zebra is not so lucky:  $230 + 6 \times 44 = 494 < 660$  ft.

Task



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