



Direction: You must show all steps required to arrive at the correct answer for the problem below, including any relevant free body/pseudo free body diagrams. You are graded for your demonstration of physics and problem-solving methods, and not for simply writing the correction answer.

1. Down in Africa, a gazelle and a cheetah are at rest. The cheetah is initially 30 m west of the gazelle. At some time, the gazelle starts running in the eastward direction with a constant acceleration of 2.0 m/s^2 . Two seconds later, the cheetah decides to chase the gazelle and starts from rest with an acceleration given by $a(t) = 0.6t - 1$, where eastward is the positive direction. Determine how far the gazelle will have traveled before the cheetah catches up.

2. A faulty model rocket moves in the x-y plane in a coordinate system in which the positive y direction is vertically upward. The rocket's velocity as a function of time is:

$$v(t) = (8t)\hat{i} + (-2t + 20)\hat{j} \text{ m/s}$$

At time $t = 0$ s, the rocket is at $\vec{r} = (-2\hat{i} + 21\hat{j}) \text{ m/s}$.

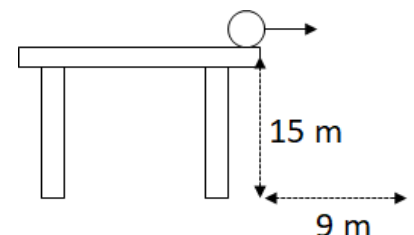
- Determine expressions for the i) acceleration and ii) position of the rocket as functions of time.
- How far from its lift-off point does the rocket hit the ground?
- What is the rocket's maximum speed?

3. A penguin is thrown vertically upward with an initial speed of 30 m/s from ground level. One second later, another penguin is thrown vertically downward with a speed of 10 m/s from the top of 100 m tall building. At what height above the ground will the two penguins hit each other?

4. An artillery shell is fired towards a cliff 200 m away at an angle 60° above the horizontal. The shell strikes the cliff at a point 400 m above the ground.

- With what speed was the shell fired?
- What angle does the shell make with the cliff when it strikes?
- With what angle should the shell be fired, keeping the same speed from a), so that it hits the base of the cliff (has a height of 0 when it reaches the cliff)?
- At the same time, the shell is fired, another shell is to be fired directly upwards a distance of 100 m from the first. With what speed should the second shell be fired upward to intercept the first shell?

5. In order to create a situation appropriate for a high school physics problem, Godzilla rolls a ball off his 15 m high dining table. The ball leaves the table traveling horizontally and lands 9 m away from the base of the table. How fast was the ball traveling when it left the table?



6. A llama starts moving at $t = 0$ s. The position of the llama with respect to time is given by $x(t) = -3t^2 + 8t + 2$. During what time is the speed of the moose decreasing?