Module 02

Position, Velocity, and Acceleration

QUESTIONS

Question 1 (LV1): While chasing its prey in a short sprint, a cheetah starts from rest and runs 40 m in a straight line, reaching a final speed of 70 km/h. What is the cheetah's average acceleration during the sprint?

Question 2 (LV2): A self-driving car travels in a straight line along the x-axis. The graph in Fig. 1 shows the car's position-time graph. Find the car's instantaneous velocity at points A, B, and C.

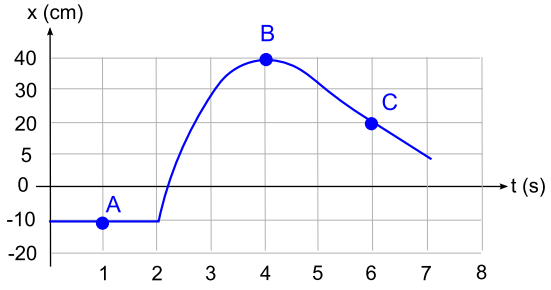

FIG. 1: The position-time diagram of a self-driving car

Question 3 (LV3): A car enters a freeway ramp with an initial speed. The car's speed is increased along the ramp and has a final speed of 90 km/h when it reaches the end of the 150-m-long ramp. Find the initial speed of the car, considering it takes 5 s to ramp to its final speed.

Question 4 (LV4): Fig. 2 shows the acceleration-versus-time graph of a horse moving along a trail the x-axis. Its initial velocity is $v_{xi} = 2.0$ m/s at $t_i = 0$ s. What is the horse's velocity at $t = 3.0$ s?

Question 5 (LV5): A pelican was taken from its nest, flown 6050 km away, and released. The bird found its way back to its nest 12.5 days after release. If we place the

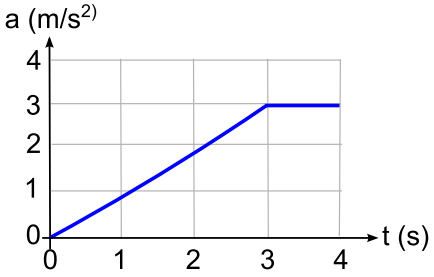

FIG. 2: The acceleration-time diagram of a horse

origin in the nest and extend the x-axis to the release point, what constant velocity would be required to complete the return flight? Describe qualitatively how the bird's actual velocity will differ from this calculated constant velocity.

Question 6 (LV6): A baseball is thrown directly downward with an initial speed of 6.00 m/s, from the top of the First Canadian Place building (a height of 298 m).How long does it take for the ball to hit the ground?

PROBLEMS

Problem 1 (LV1): A box attached to a spring oscillates along the x-direction. The box's position as a function of time is given by $x(t) = x_0 \cos \omega t$ where $x_0 = 2$ m and $\omega = 0.5$ rad/s. (a) Find expressions for the velocity and acceleration as functions of time. (b) What are the maximum values of velocity and acceleration?

Problem 2 (LV6): A particle leaves its initial position $x_0 = 2.0$ m at time $t = 0$ s moving in the positive x-direction with speed $v_0 = 3.0$ m/s an under an acceleration of magnitude $a = 0.5$ m/s^2 in the negative x-direction. Find(a) the time when the particle returns to its initial position x_0 and (b) the speed of the particle when it passes again by its initial position.

Problem 3 (LV5, LV6): Two physics students plot to drop water balloons on friends entering their dorm. Their window is 20 m above the side-walk. They plan to place a mark on the side-walk for the spot a student must be when they drop the balloon. They note that most students are walking at about 2 m/s. How far from the impact point do they have to place the mark?