(二)

Exercise 1. Starting from a pillar, you run 200 m east (the $+x$-direction) at an average speed of 5.0 m/s, and then run 280 m west at an average speed of 4.0 m/s to a post. Plsease calculate (a) your average speed from a pillar to post and (b) your average velocity from pillar to post.

Solution: The distance you travel is $d = d_1 + d_2 = 480\ m$

The total time you spend is $t = t_1 + t_2 = 110\ s$

The magnitude of displacement is $|\Delta\vec{r}| = 80\ m$

(a) average speed: $\bar{v} = d/t = 48/11$ m/s

(b) average velocity: $|\vec{\bar{v}}| = \frac{|\Delta\vec{r}|}{t} = \frac{8}{11}$ m/s direction: west

Exercise 2. A car is stopped at a traffic light. It then travels along a straight road so that its distance from the light is given by $x(t) = bt^2 - ct^3$, where $b = 2.40\ m/s^2$ and $c = 0.120\ m/s^3$.

(a) Calculate the average velocity of the car for the time interval $t = 0$ to $t = 10.0\ s$.

(b) Calculate the instantaneous velocity of the car at $t = 0$, $t = 5.0\ s$ and $t = 10.0\ s$.

(c) How long after starting from rest is the car again at rest.

Solution: (a) $t=0s$: $x=0$; $t=10s$: $x=120\ m$

average velocity $\vec{\bar{v}} = \Delta x/\Delta t = 12$ m/s

(b) $V_x(t) = dx(t)/dt = 2bt - 3ct^2$; $V_x(0) = 0$; $V_x(5.0) = 15$ m/s; $V_x(10) = 12$ m/s

(c) $V_x(t) = 2bt - 3ct^2 = 0$ $t = 0s$ or $t = \frac{2b}{3c} = \frac{40}{3}\ s$

Exercise 3. A turtle crawls along a straight line, which we will call the x-axis with the positive direction to the right. The equation for the turtle's position as a function of time is $x(t) = 50.0\ cm + (2.00\ cm/s)t - (0.0625\ cm/s^2)t^2$.

(a) Find the turtle's initial velocity, initial position, and initial acceleration.

(b) At what time t is the velocity of the turtle zero?

(c) At what times t is the turtle a distance of 10.0 cm from its starting point? What is the velocity (magnitude and direction) of the turtle at each of these times ?

Solution: (a) $V_x(t) = 2.0 - 0.125t$; $a_x(t) = -0.125\ cm/s^2$;

$V_x(t=0) = 2.0$ cm/s; $x(t=0) = 50.0$ cm; $a_x(t=0) = -0.125\ cm/s^2$

(b) $V_x(t) = 2.0 - 0.125t = 0$ $t = 16s$

(c) $x(t) = 50 + 2t - 0.0625t^2 = 10 + x(t=0)$

$0.0625t^2 - 2t + 10 = 0 \Rightarrow$ $t_1 = 6.2s$ $V_x(t_1) = 1.23$ cm/s

$t_2 = 25.8s$ $V_x(t_2) = -1.23$ cm/s

Exercise 4. The coordinates of a bird flying in the xy-plane are given by $x(t) = \alpha t$ and $y(t) = 3.0\ m - \beta t^2$, where $\alpha = 2.4\ m/s$ and $\beta = 1.2 m/s^2$.

(a) Calculate the velocity and acceleration vectors of the bird as functions of time.

(b) Calculate the magnitude and the direction of the bird's velocity and acceleration at $t = 2.0\ s$.

Solution: (a) $\vec{r}(t) = x(t)\vec{i} + y(t)\vec{j} = \alpha t\vec{i} + (3.0 - \beta t^2)\vec{j}$

$\vec{v}(t) = \alpha\vec{i} - 2\beta t\vec{j}$; $\vec{a}(t) = -2\beta\vec{j}$;

(b) $|\vec{v}(t=2s)| = 2.4\sqrt{5}$ m/s $tg\alpha = 2.0$

$|\vec{a}(t=2)| = 2.4\ m/s^2$ along $-y$ axis.