Answer on Question #51362-Physics, Mechanics-Kinematics-Dynamics

The position of a particle moving along the x axis depends on the time according to the equation $x = ct^2 - bt^5$, where x is in meters and t in seconds. Let c and b have numerical values $2.5\frac{m}{s^2}$ and $1.6\frac{m}{s^5}$, respectively. From $t = 0.0\ s$ to $t = 1.3\ s$,

(a) what is the displacement of the particle?

Find its velocity at times

(b) 1.0 s, (c) 2.0 s, (d) 3.0 s, and (e) 4.0 s.

Find its acceleration at

(f) 1.0 s, (g) 2.0 s, (h) 3.0 s, and (i) 4.0 s.

Solution

(a) The displacement of the particle is

$$x(1.3) - x(0.0) = (c1.3^2 - b1.3^5) - (c0.0^2 - b0.0^5) = 2.5 \cdot 1.3^2 - 1.6 \cdot 1.3^5 = -1.7\ m.$$

The velocity is

$$v(t) = \frac{dx}{dt} = \frac{d}{dt}(ct^2 - bt^5) = 2ct - 5bt^4.$$

(b)

$$v(1.0) = 2 \cdot 2.5 \cdot 1.0 - 5 \cdot 1.6 \cdot 1.0^4 = -3\frac{m}{s}.$$

(c)

$$v(2.0) = 2 \cdot 2.5 \cdot 2.0 - 5 \cdot 1.6 \cdot 2.0^4 = -118\frac{m}{s}.$$

(d)

$$v(3.0) = 2 \cdot 2.5 \cdot 3.0 - 5 \cdot 1.6 \cdot 3.0^4 = -633\frac{m}{s}.$$

(e)

$$v(4.0) = 2 \cdot 2.5 \cdot 4.0 - 5 \cdot 1.6 \cdot 4.0^4 = -2028\frac{m}{s}.$$

The acceleration is

$$a(t) = \frac{d}{dt}v(t) = \frac{d}{dt}(2ct - 5bt^4) = 2c - 20bt^3.$$

(f)

$$a(1.0) = 2 \cdot 2.5 - 20 \cdot 1.6 \cdot 1.0^3 = -27\frac{m}{s^2}.$$

(g)

$$a(2.0) = 2 \cdot 2.5 - 20 \cdot 1.6 \cdot 2.0^3 = -251 \frac{m}{s^2}.$$

(h)

$$a(3.0) = 2 \cdot 2.5 - 20 \cdot 1.6 \cdot 3.0^3 = -859 \frac{m}{s^2}.$$

(i)

$$a(1.0) = 2 \cdot 2.5 - 20 \cdot 1.6 \cdot 4.0^3 = -2043 \frac{m}{s^2}.$$