12–1.

Starting from rest, a particle moving in a straight line has an acceleration of $a = (2t - 6)\ \text{m/s}^2$, where t is in seconds. What is the particle's velocity when $t = 6$ s, and what is its position when $t = 11$ s?

SOLUTION

$a = 2t - 6$

$dv = a\,dt$

$$\int_0^v dv = \int_0^t (2t - 6)\,dt$$

$v = t^2 - 6t$

$ds = v\,dt$

$$\int_0^s ds = \int_0^t (t^2 - 6t)\,dt$$

$$s = \frac{t^3}{3} - 3t^2$$

When $t = 6\ s$,

$v = 0$ **Ans.**

When $t = 11\ s$,

$s = 80.7$ m **Ans.**

Ans:
$s = 80.7$ m

12–2.

If a particle has an initial velocity of $v_0 = 12\ \text{ft/s}$ to the right, at $s_0 = 0$, determine its position when $t = 10\ \text{s}$, if $a = 2\ \text{ft/s}^2$ to the left.

SOLUTION

$(\overset{+}{\rightarrow})$ $\quad s = s_0 + v_0 t + \frac{1}{2} a_c t^2$

$= 0 + 12(10) + \frac{1}{2}(-2)(10)^2$

$= 20\ \text{ft}$ **Ans.**

Ans:
$s = 20\ \text{ft}$

12–3.

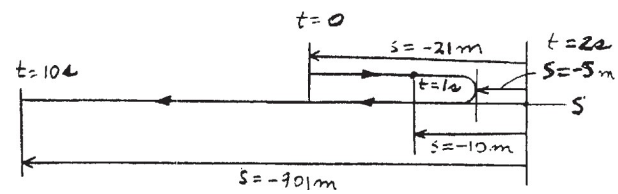
A particle travels along a straight line with a velocity $v = (12 - 3t^2)$ m/s, where t is in seconds. When $t = 1$ s, the particle is located 10 m to the left of the origin. Determine the acceleration when $t = 4$ s, the displacement from $t = 0$ to $t = 10$ s, and the distance the particle travels during this time period.

SOLUTION

$v = 12 - 3t^2$ **(1)**

$a = \dfrac{dv}{dt} = -6t|_{t=4} = -24 \text{ m/s}^2$ **Ans.**

$\int_{-10}^{s} ds = \int_{1}^{t} v\,dt = \int_{1}^{t} (12 - 3t^2)\,dt$



$s + 10 = 12t - t^3 - 11$

$s = 12t - t^3 - 21$

$s|_{t=0} = -21$

$s|_{t=10} = -901$

$\Delta s = -901 - (-21) = -880 \text{ m}$ **Ans.**

From Eq. (1):

$v = 0$ when $t = 2s$

$s|_{t=2} = 12(2) - (2)^3 - 21 = -5$

$s_T = (21 - 5) + (901 - 5) = 912 \text{ m}$ **Ans.**

Ans:
$a = -24 \text{ m/s}^2$
$\Delta s = -880 \text{ m}$
$s_T = 912 \text{ m}$

***12–4.**

A particle travels along a straight line with a constant acceleration. When $s = 4$ ft, $v = 3$ ft/s and when $s = 10$ ft, $v = 8$ ft/s. Determine the velocity as a function of position.

SOLUTION

Velocity: To determine the constant acceleration a_c, set $s_0 = 4$ ft, $v_0 = 3$ ft/s, $s = 10$ ft and $v = 8$ ft/s and apply Eq. 12–6.

$$(\overset{+}{\rightarrow}) \qquad v^2 = v_0^2 + 2a_c(s - s_0)$$

$$8^2 = 3^2 + 2a_c\,(10 - 4)$$

$$a_c = 4.583 \text{ ft/s}^2$$

Using the result $a_c = 4.583$ ft/s^2, the velocity function can be obtained by applying Eq. 12–6.

$$(\overset{+}{\rightarrow}) \qquad v^2 = v_0^2 + 2a_c(s - s_0)$$

$$v^2 = 3^2 + 2(4.583)\,(s - 4)$$

$$v = \left(\sqrt{9.17s - 27.7}\right) \text{ ft/s}$$ **Ans.**

Ans:
$v = \left(\sqrt{9.17s - 27.7}\right)$ ft/s