SNS COLLEGE OF ENGINEERING<br>Kurumbapalayam (Po), Coimbatore - 641107<br>Accredited by NAAC-UGC with 'A' Grade Approved by AICTE \& Affiliated to Anna University, Chennai

Problem 1: The position of a particle which move along a straight line is defined by $x=t^{3}-6 t^{2}-$ $15 t+40$ where $x$ is in $m, t$ is in sec. Determine the following
a. The time at which the velocity will be zero
b. The position and distance travelled by the particle at that time
c. Acceleration of the particle at that time
d. The distance travelled by the particle $\mathrm{t}=4 \mathrm{sec}$ and $\mathrm{t}=6 \mathrm{sec}$

## Solution:

Displacement $\mathrm{x}=\mathrm{t}^{3}-6 \mathrm{t}^{2}-15 \mathrm{t}+40$
We know that,
Velocity, $v=\frac{d x}{d t}=3 t^{2}-12 t-15 \rightarrow(1)$
Also we know that
Acceleration, $a=\frac{d v}{d t}=6 t-12 \rightarrow$ (2)
a) Time at which velocity will be zero

By equating eqn (1) to zero

$$
\begin{gathered}
3 \mathrm{t}^{2}-12 \mathrm{t}-15=0 \\
\mathrm{t}^{2}-4 \mathrm{t}-5=0 \\
\mathrm{t}=+5 \sec (\mathrm{t}=-1 \text { sec is not practically possible })
\end{gathered}
$$

b) Position and distance travelled when $\mathrm{v}=0$ when $\mathrm{t}=5, \mathrm{v}=0$ (zero velocity)

Position of particle at $\mathrm{t}=5 \mathrm{sec}$

$$
\begin{gathered}
x_{5}=5^{3}-6(5)^{2}-15(5)+40 \\
=125-150-75+40=-60 \mathrm{~m}
\end{gathered}
$$

Initial position of particle at $\mathrm{t}-0$ sec

$$
\begin{gathered}
x_{0}=0^{3}+6(0)^{2}-15(0)+40 \\
x_{0}=40 \mathrm{~m}
\end{gathered}
$$

Distance travelled $=x_{5}-x_{0}=-60-40=-100 \mathrm{~m}$ i.e 100 m in the negative direction
c) Acceleration when $v=0$

$$
\begin{gathered}
v=0 \text { at } t=5 \mathrm{sec} \\
a=6 t-12
\end{gathered}
$$

$a=6(5)-12=18 \mathrm{~m} / \mathrm{sec}^{2}$
d) Distance travelled by the particle when
$\mathrm{t}=4 \mathrm{sec}$ and $\mathrm{t}=6 \mathrm{sec}$
Position at $\mathrm{t}=4 \sec x_{4}=4^{3}-6(4)^{2}-15(4)+40=-52 m$
Position at $\mathrm{t}=6 \sec x_{6}=6^{3}-6(6)^{2}-15(6)+40=-50 m$
Position at $\mathrm{t}=5 \sec x_{5}=-60 \mathrm{~m}$

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Distance trance travelled when $\mathrm{t}=5 \mathrm{sec}$ to $\mathrm{t}=6 \mathrm{sec}$

$$
\begin{gathered}
=x_{6}-x_{5} \\
=-50-(-60)
\end{gathered}
$$

$=10 \mathrm{~m}$ (Positive Displacement)
Distance travelled when $\mathrm{t}=4 \mathrm{sec}$ to $\mathrm{t}=5 \mathrm{sec}$

$$
\begin{gathered}
=x_{5}-x_{4} \\
=(-60)-(-52) \\
=8 \mathrm{~m} \text { (Negative Displacement) }
\end{gathered}
$$

