USE OF CALCULUS IN MOTION IN ONE DIMENSIONS

Example 1. The displacement of a particle is given by y = a + bt + ct² + dt⁴. Find the acceleration of a particle.

Solution. $v=\frac{dy}{dt}=\frac{d}{dt}\left(a+bt+ct^2+dt^4\right)=b+2ct+4dt^3$

So, acceleration is $a=\frac{dv}{dt}=2c+12dt^2$

Example 2 If the displacement of a particle is $(2t^2+t+5)$ meter then, what will be acceleration at t = 5 sec.

Solution. $v=\frac{dx}{dt}=\frac{d}{dt}\left(2t^2+t+5\right)=4t+1\,m/s$ and $a=\frac{dv}{dt}=\frac{d}{dt}\left(4t+1\right)$ a = 4 m/s^2

Example 3. The velocity of a particle is $V=V_0+gt+ft^2$. If its position is x = 0 at t =0, then its displacement after unit time (t=1)is **[AIEEE 2007]**

(a) $V_0+2g+3f$ **(b)** $V_0+\frac{g}{2}+\frac{f}{3}$ **(c)** $V_0+\frac{g}{2}+f$ **(d)** V_0+g+f

Solution. $\because \frac{dx}{dt}=V=V_0+gt+ft^2 \quad \Rightarrow dx=(V_0+gt+ft^2)\,dt$

Integrating both the sides, we get $\int_0^x dx=\int_0^t (V_0+gt+ft^2)\,dt$

Or $x=V_0+g\frac{t^2}{2}+f\frac{t^3}{3}$

So, at t =1 , we get x = $V_0+\frac{g}{2}+\frac{f}{3}$

Example 4. The motion of a particle along a straight line is described by equation $x=8+12t-t^3$. Where, x is in metre and t is in sec. The retardation of the particle when its velocity becomes zero, is **[AIPMT 2012]**

(a) 24 m/s^2 (b) zero (c) 6 m/s^2 (d) 12 m/s^2

Solution. Since $x=8+12t-t^3$.