4. A force $F = -K(y\hat{i} + x\hat{j})$ (where K is a positive constant) acts on a particle moving in the xy plane. Starting from the origin, the particle is taken along the positive x axis to the point $(a, 0)$, and then parallel to the y axis to the point (a, a), The total work done by the force F on the particle is

[1998S - 2 Marks]

Ans

(a) $-2Ka^2$ (b) $2Ka^2$ (c) $-Ka^2$ (d) Ka^2

(c) $dW = \vec{F} \cdot d\vec{S}$ and $\vec{F} = -K(y\hat{i} + x\hat{j})$ given

$$d\vec{S} = dx\,\hat{i} + dy\,\hat{j} + dz\,\hat{k}$$

$$dW = -K(y\hat{i} + x\hat{j}) \cdot (dx\,\hat{i} + dy\,\hat{j} + dz\,\hat{k})$$

$$= -K(ydx + xdy) = -K[d(xy)]$$

$$\therefore \quad \int_{0,0}^{a,a} dW = -K \int_{0,0}^{a,a} d(xy)$$

or $W = -K[xy]_{0,0}^{a,a}$ or $W = -Ka^2$.

Hence total work done by the force on the particle,

$$W = -Ka^2$$