**(c) Rolling pair.**

When the two elements of a pair are connected in such a way that one rolls over another fixed link, the pair is known as rolling pair.

Ball and roller bearings are examples of rolling pair.

(**d) Screw pair.**

- When the two elements of a pair are connected in such a way that one element can turn about the other by screw threads, the pair is known as screw pair.

•The lead screw of a lathe with nut, and bolt with a nut are examples

(**e) Spherical pair.**

When the two elements of a pair are connected in such a way that one element (with spherical shape) turns or swivels about the other fixed element, the pair formed is called a spherical pair.

The ball and socket joint, attachment of a car mirror, pen stand etc

## 2. According to the type of contact between the elements.

### (a)Lower pair.

- When the two elements of a pair have a surface contact when relative motion takes place and the surface of one element slides over the surface of the other, the pair formed is known as lower pair.
- It will be seen that sliding pairs, turning pairs and screw pairs form lower pairs.

### (b) Higher pair.

When the two elements of a pair have a line or point contact when relative motion takes place and the motion between the two elements is partly turning and partly sliding, then the pair is known as higher pair

### 3. According to the type of closure. :

### (a)Self closed pair.

When the two elements of a pair are connected together mechanically in such a way that only required kind of relative motion occurs,

it is then known as self closed pair. The lower pairs are self closed pair.

### (b) Force - closed pair.

When the two elements of a pair are not connected mechanically but are kept in contact by the action of external forces, the pair is said to be a force-closed pair.

## Kinematic Chain

When the kinematic pairs are coupled in such a way that the last link is joined to the first link to transmit definite motion (i.e. completely or successfully constrained motion), it is called a kinematic chain.

The total combination of these links is a kinematic chain.

If each link is assumed to form two pairs with two adjacent links, then the relation between the number of pairs ( p ) forming a kinematic chain and the number of links ( l ) may be expressed in the form of an equation

$$: l = 2p - 4 \quad \ldots (i)$$

Since in a kinematic chain each link forms a part of two pairs, therefore there will be as many links as the number of pairs.

Another relation between the number of links (l) and the number of joints ( j) which constitute a kinematic chain is given by the expression

$$: j = \frac{3}{2} l - 2 \ldots\ldots\ldots (ii)$$

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