# CONSTRAINED MOTION

## 1. CONSTRAINED MOTION :

### 1.1 String constraint :

When the two object are connected through a string and if the string have the following properties :

- The length of the string remains constant i.e., it is inextensible string
- Always remains taut i.e., does not slacks.

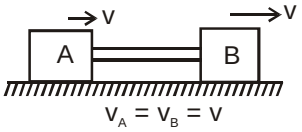
Then the parameters of the motion of the objects along the length of the string have a definite relation between them.

Ist format : - (when string is fixed)


The block B moves with velocity v. i.e. each particle of block B moves with velocity v.

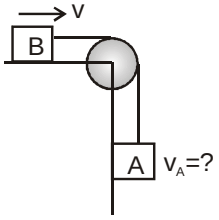
If string remain attached to block B it is necessary that velocity of each particle of string is same = v ($v_s$ = v)

Now we can say that Block A also moves with velocity v.



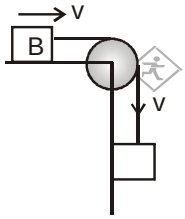

: If pulley is fixed then the velocity of all the particles of string is same along the string.

Ex.1

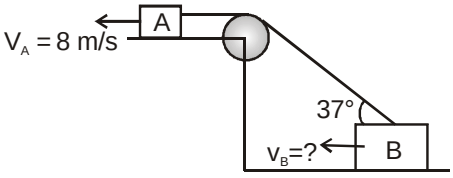



Sol. In the above situation block B is moving with velocity v. Then speed of each point of the string is v along the string.

$\therefore$ speed of the block A is also v



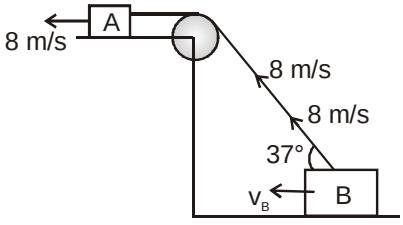

Ex.2




Sol. $\because$ Block A is moving with velocity 8 $ms^{-1}$.

$\therefore$ velocity of every point on the string must be 8m/s along the string.

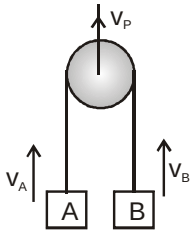
The real velocity of B is $v_B$. Then the string will not break only when the compoent of $v_B$ along string is 8 m/s.



$\Rightarrow v_B \cos 37° = 8 \Rightarrow v_B = \frac{8}{\cos 37°} = 10$ m/sec

II[nd] format (when pulley is also moving)

To understand this format we consider the following example in which pulley is moving with velocity $v_p$ and both block have velocity $v_A$ & $v_B$ respectively as shwon in figure.
If we observe the motion of A and B with respect to pulley. Then the pulley is at rest. Then from first format.




$$v_{AP} = -v_{BP}$$

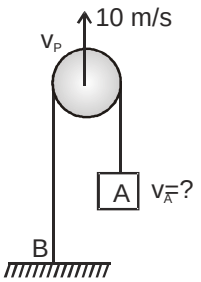
(–ve sign indicate the direction of each block is opposite with respect to Pulley)

$$v_A - v_p = -v_B + v_P$$

$$\Rightarrow v_P = \frac{v_A + v_B}{2}$$

: - To solve the problem put the values of $v_A$, $v_B$, & $v_P$ with sign.

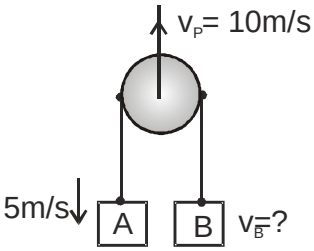
Ex.3




Sol. $v_P = \frac{v_A + v_B}{2}$

Putting $v_p = 10$ ms$^{-1}$, $v_B = 0$,
we get
$v_A = 20$ ms$^{-1}$ (upward direction)

Ex.4




Sol. If we take upward direction as +ve then

$$10 = \frac{-5 + v_B}{2}$$

$v_B = 25$ m/sec (in upward direction)