VELOCITY OF IMAGE

Velocity Of Image

Recap: Relation between velocity of object, image and mirror

Component of velocity perpendicular to mirror

$$v_{OM} = -v_{IM}$$

For plane mirror $v_I = 2v_M - v_O$

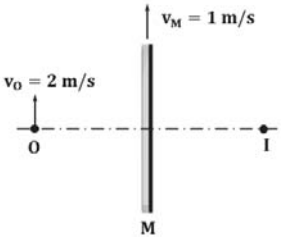
Where,

v_O= Velocity of object v_M = Velocity of mirror v_I = Velocity of image

Component of velocity parallel to mirror

As the creation of the image remains unaffected by the mirror's length, the velocity of the image matches that of an object moving parallel to the mirror. Moreover, this velocity remains unaffected by the mirror's velocity.

Ex. An object and mirror are moving upward as shown. If the velocity of object and mirror are 2 m/s and 1 m/s, respectively, find out the velocity of image,v_I .



Sol. All the velocities,v_O, v_I and v_M are parallel to the surface of the plane mirror. Thus, velocity of image is same as that of object.

$$v_I = v_O = 2 \text{ m/s}$$

Also, the direction of the velocity of image remains same as the direction of the velocity of object.

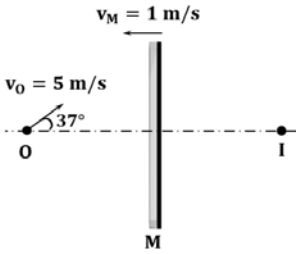
Ex. An object and mirror are moving in the directions as shown. If the velocity of object and mirror are 5 m/s and 1 m/s, respectively, find out the speed of image,v_I.

Sol. The component of velocity of the object towards +ve x-axis will be, $v_{ox} = 5\cos 37° = 4\text{m/s}$

The component of velocity of the object towards +ve y-axis will be, $v_{oy} = 5\sin 37° = 3 \text{ m/s}$

Component of velocity of image perpendicular to mirror,

$$V_I = 2V_M - V_0$$
$$= 2(-1) - 4 = -6\text{m/s}$$



As the component of velocity of image parallel to mirror is same as that of object,

$$v_{II} = 3 \text{ m/s}$$

Thus, the resultant velocity of image,

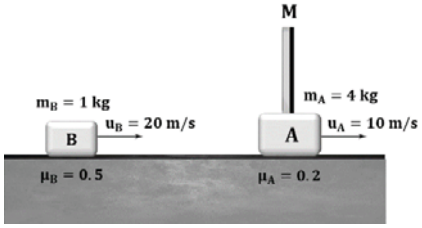
$$\vec{V}_I = -6\hat{\imath} + 3\hat{j}$$

Magnitude of the image velocity,

$$v_I = \sqrt{36 + 9}$$
$$v_I = \sqrt{45} \text{ m/sec}$$

Ex. Two blocks A and B of masses 4 Kg and 1 Kg are moving in the directions as shown. A mirror is mounted over block A. Initial velocities of blocks A and B are 10 m/s and 20 m/s, respectively. Given that the coefficient of friction for blocks A and B are 0.2 and 0.5, find out the speed of image of block *B* after t = 2 s. Take g = 10 m/s^2.

Sol. Here, velocities of the object and mirror will change with time due to the friction force acting on the blocks.



Acceleration of blocks, $a = \frac{f}{m} = \frac{\mu mg}{m} = \mu g$

$$a_A = 0.2g = 2 \text{ m/s}^2$$
$$a_B = 0.5g = 5 \text{ m/s}^2$$

For block A, Initial velocity, $u_A = 10$ m/s

Thus, the velocity of block A after 2 s will be,

$$v_A = 10 - 2 \times 2 = 6 \text{ m/s}$$

This is the velocity of the mirror also. Thus,

$$v_M = v_A = 6 \text{ m/s}$$

For block B,

Initial velocity, $u_B = 20\text{m/s}$

Thus, the velocity of block B after 2s will be,

$$v_B = 20 - 5 \times 2 = 10\text{m/s}$$

Therefore, the velocity of the image of block B is

$$v_I = 2v_M - v_O$$
$$v_I = 2v_M - v_B$$
$$v_I = 2 \times 6 - 10$$
$$v_I = 2\ m/s$$