5. A bullet of mass m fired at 30° to the horizontal leaves the barrel of the gun with a velocity v. The bullet hits a soft target at a height h above the ground while it is moving downward and emerges out with half the kinetic energy it had before hitting the target. Which of the following statements are correct with respect to the bullet after it emerges out of the target?

i. The velocity of the bullet will be reduced to half its initial value.
ii. The velocity of the bullet will be more than half of its earlier velocity.
iii. The bullet will continue to move along the same parabolic path.
iv. The bullet will move in a different parabolic path.
v. The bullet will fall vertically downward after hitting the target.
vi. The internal energy of the particles of the target will increase.

Sol. From law of conservation of energy,

$(P.E.)_i + (K.E.)_i = (P.E.)_f + (K.E.)_f$

$\Rightarrow 0 + \frac{1}{2}mv^2 = mgh + \frac{1}{2}mv'^2$

$\Rightarrow \frac{v'^2}{2} - \frac{v^2}{2} = -gh$

$\Rightarrow v' = \sqrt{v^2 - 2gh}$ . .(i)

it is given that while it is moving downward it emerges out with half the kinetic energy

$\Rightarrow \frac{1}{2}mv''^2 = \frac{1}{2}\left(\frac{1}{2}mv'^2\right)$

$\Rightarrow v'' = \sqrt{\frac{v^2}{2} - gh}$ (substituting the value of v' from eq (i) ... (ii)

from eq (i) and (ii)

$\frac{v'}{v''} = \sqrt{\frac{v^2-2gh}{v^2-2gh}}$

$\Rightarrow v' = v''\sqrt{2}$

$\therefore$ velocity of the bullet is more than half of its earlier velocity.

Hence, the bullet will move in a different parabolic path and internal energy of the particle will increase.

option (ii, iv, vi) is correct