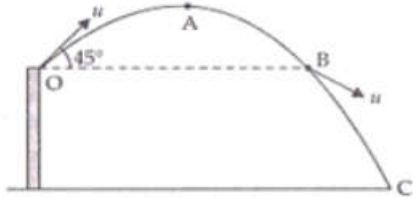
Q 05 A ball is thrown from a rooftop at an angle of 45° above the horizontal. It hits the ground a few seconds later. At what point during its motion, does the ball have

i. greatest speed
ii. smallest speed
iii. greatest acceleration? Explain.

Sol. A ball is projected from O at an angle of 45° with horizontal. From O to A body rises up, height increases so its speed & hence KE (speed) decreases. From A to B it's speed again increases as its height decreases and become equal to its's initial speed at O, because O and B are on the same horizontal line.



From B to C, its height again decreases so its speed from B to C increases and become maximum at C

$v_y = v_x = u\cos(45) = \frac{u}{\sqrt{2}} m/s$ at Point B.

Now for motion along BC, $v'_x = \frac{u}{\sqrt{2}}$ remains constant but

$v'_y = v_y + gt$ thus velocity along y - axis changes.

net velocity $v = \sqrt{(v'_x)^2 + (v'_y)^2}$ become maximum at point C

$v = \sqrt{\frac{u^2}{2} + \frac{u^2}{2} + g^2t^2}$

$v = \sqrt{u^2 + g^2t^2}$

Hence,

i. Greatest speed of ball is at C .
ii. The smallest speed will be at A . Where at maximum height and $v_y = 0$ and has the only horizontal speed of constant value $u_x = \frac{u}{\sqrt{2}}$.
iii. For motion between O to A, acceleration a = -g and for A to C acceleration a = +g and is constant during AC.