7.13 With reference to Fig. 7.6 of a cube of edge a and mass m, state whether the following are true or false. (O is the centre of the cube.)

(a) The moment of inertia of cube about z-axis is
$I_z = I_x + I_y$

(b) The moment of inertia of cube about z′ is

$I'_z = I_z + \dfrac{m\,a^2}{2}$

(c) The moment of inertia of cube about z″ is

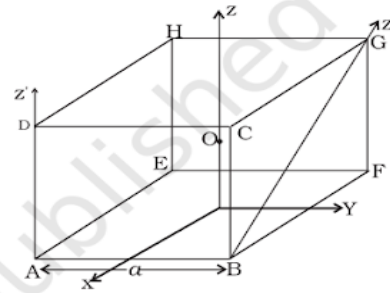$= I_z + \dfrac{m\,a^2}{2}$

(d) $I_x = I_y$

Fig. 7.6

Sol: (b, d) We can apply the concept of symmetry to calculate the net moment of inertia. Moment of inertia about two symmetrical axes are the same.

(a) Theorem of perpendicular axes is applicable only for laminar (like plane sheet) objects. Therefore, option (a) is false.

(b) As z′ and z are parallel and distance between them $= a\dfrac{\sqrt{2}}{2} = \dfrac{a}{\sqrt{2}}$

Now, by theorem of parallel axes

$$I_{z'} = I_z + m\left(\dfrac{a}{\sqrt{2}}\right)^2 = I_z + \dfrac{ma^2}{2}$$

Hence, choice (b) is true.

(c) z″ and z are not parallel. Hence, theorem of parallel axis cannot be applicable here. Thus, option (c) is false.

(d) x-axis and y-axis are symmetrical for the cube, $I_x = I_y$. Therefore, option (d) is true.