Q- At what speed an ice bullet (0^oC) is to be fired on a target so that the whole ice in it is vaporized (100^oC)? Consider the whole energy of bullet remains in it after hitting the target. (specific heat of water = 4.18 J/g/^{0}C; Latent heat of ice = 334 J/g and latent heat of steam = 2272 J/g)

Let the mass of the bullet is m. To convert the bullet into the steam the heat required can be calculated in different stages

(i) Heat required to melt the ice at 0^0C (melting point of ice)

$Q_1 = m*L_{ice}$ = (m grams)*(334 J/g) = (334*m) J

(ii) Heat required raising temperature of water from 0 to 100^0C

$Q_2 = m*C*\Delta t$ = (m grams)*(4.18 J/g/^{0}C)*(100 -0) = (418*m) J

(iii) Heat required to evaporate the water at 100^0C (boiling point)

$Q_3 = m*L_{vapor}$ = (m grams)*(2272 J/g) = (2272*m) J

Hence the total heat required

Q = (334 + 418 + 2272)*m = 3024*m J

This energy is supplied by the loss of kinetic energy of the bullet and if the whole energy after hitting the target remains with bullet.

Let the velocity of the bullet is v, then we have

Loss in KE = heat required

Or ½ mv^2 = 3024*m

Gives $v = \sqrt{2*3024} = 77.77$ m/s