a) Problem formulation and mathematical modelling.

- Mathematical translation.

The aim is to describe the vertical motion of a ball dropped from a height subject to

→ Gravitational force

→ Elastic collision with the ground.

- Complete mathematical model.

Acceleration of the ball at initial hight

$a(t) = g$ where g = gravitational force

From Newton's second law.

Therefore, velocity,

$$v(t) = \int a\,dt = \int g\,dt = gt + C = gt + v_0$$

So, ball position,

$$y(t) = \int v(t)\,dt = \int (gt + v_0)\,dt = \frac{1}{2}gt^2 + v_0 t + C$$

$$= \frac{1}{2}gt^2 + v_0 t + y_0$$

Including the coefficient of restitution, e,

e = Measure of how bouncy the collision is.

$e = \frac{v_{after}}{v_{before}}$ (ratio between 0-1)

Velocity after collision,

$v_{new} = v_{old} * -e$.

~~Where~~ → Constraints

~~y~~ → $y(t) \geq 0$

→ Bounces occur at $y = 0$

→ Stop simulation when kinetic energy is zero.