A ball of mass m= 0.08 kg, starting at rest, is dropped from a height h1= 3.0 meters above the ground and bounces back up to a height h2 = 2.0 meters. The collision with the ground occurs over a time of .005 seconds.

a. what is the momentum of the ball immediately before it hit the ground?

Solution:

The momentum of the ball before it hit the ground = m v_1

$v_1^2 = u^2 + 2gs$ (Since the ball is dropped u = 0)

$v_1^2 = 2 \times 9.8 \times 3 = 58.8$

$v_1 = 7.6$ m/s

Momentum $p_1 = 0.08 \times 7.6$

= - 0.614 kg m/ s

(The momentum is pointing downwards, so Negative)

b. what is the momentum of the ball immediately after it hit the ground?

Solution:

The momentum of the ball after hit the ground = m v_2

$v_2^2 = u^2 + 2gs$

$0 = u^2 - 2gs$ (since 'g' is negative)

$u^2 = 2gs = 2 \times 9.8 \times 2$

= 39.18

u = 6.26 m/s

Momentum $p_2 = 0.08 \times 6.26$

= +0.501 kg m/s(The momentum is pointing upwards, so Positive)

c. what is the average force of the ground on the ball?

Solution:

Average Force F = Change in momentum/ Δt

Since p_1 is acting downwards it posses negative sign.

$F = p_2 - (-p_1) / \Delta t$

$F = p_2 + p_1 / \Delta t$

$F = (0.501 + 0.614) / 0.005$

$F = 1.115 / 0.005$

F = 223 N

d. what impulse is imparted to the ball during its collision with the ground?

Solution:

Impulse = Change in linear momentum

$I = p_2 - (-p_1)$

$I = p_2 + p_1$

$I = (0.501 + 0.614)$

I = 1.115 kg m/s

e. how much energy is lost during the collision with the ground?

Energy lost = Change in Kinetic energy before and after collision

= ½ m (V_2^2 – V_1^2)

= ½ 0.08 (6.26^2 - 7.6^2)

= - 0.786 Joules

Negative sign indicates lost in kinetic energy