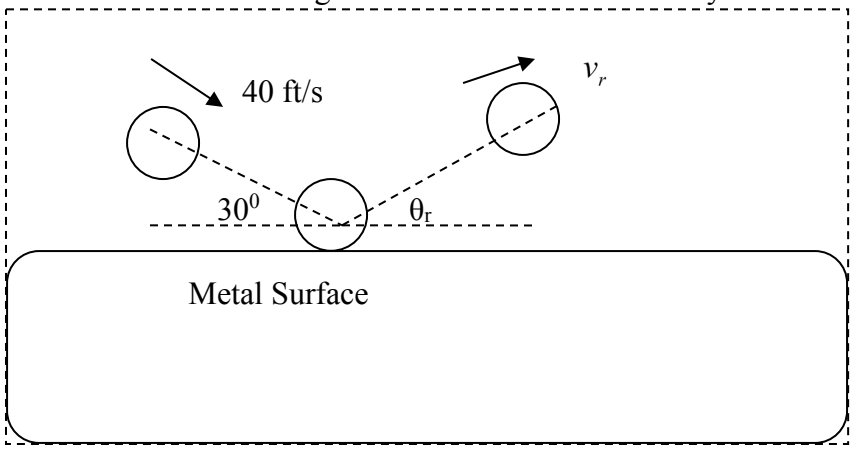
TOPIC

Engineering Mechanics (Statics and Dynamics) – Section VII – Question 13

QUESTION

A steel ball falls on a large metal surface with a velocity of 40ft/s at an angle of 30°.



The rebound velocity in ft/s of the ball is most nearly (assume a coefficient of restitution between the ball and plate to be 0.47)

(A) 9.400
(B) 18.80
(C) 34.64
(D) 35.89

HINT

The coefficient of restitution, e is given by

$$e = \frac{|\text{Relative vertical velocity at separation}|}{|\text{Relative vertical velocity at approach}|}$$

Equate the momentum in the x -direction.

SOLUTION

Assume that the large metal surface is considered to be of infinite mass. Then the velocity of the metal surface after impact is zero. The coefficient of restitution, e is given by

$$e = \frac{|\text{Relative vertical velocity at separation}|}{|\text{Relative vertical velocity at approach}|}$$

Assuming that v_r is the velocity after impact,

$$0.47 = \frac{v_r \sin\theta_r - 0}{40 \sin 30° + 0}$$

$$v_r \sin\theta_r = 9.4\text{ft/s} \qquad (1)$$

Since the component of the momentum parallel to the wall is conserved

$$m(40 \cos 3\,0°) = m(v_r \cos\theta_r)$$

$$v_r \cos\theta_r = 34.64\text{ft/s} \qquad (2)$$

Squaring (1) and (2) gives

$v_r^2 \, sin^2 \, \theta_r + v_r^2 \, cos^2 \, \theta_r = (9.4)^2 + (34.64)^2$
$v_r^2 = 1288$
$v_i = 35.89\text{ft/s}.$

ANSWER
(D)

CONTRIBUTOR
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