Physics 112

Impulse

Impulse → The product of the force exerted on an object and the time interval over which it acts.

$$j = F\Delta t$$

j → impulse N·S , kg·m/s

F → force N

Δt → contact time seconds

Example:

A 0.144 kg baseball is pitched at 38 m/s and is struck by a bat with a force of 1.4×10^4 N. What impulse did the bat deliver to the ball if bat and ball were in contact for 0.8 ms?

$$J = F\Delta t$$
$$= 1.4 \times 10^4 \text{ N} \times 0.0008$$
$$= -11 \text{ N}\cdot\text{s}$$

Impulse - momentum theorem

States that the impulse is equal to the change in momentum of an object involved in an interaction.

$$J = \Delta p = p_2 - p_1 = mv_2 - mv_1 = m(v_2 - v_1)$$

Ball $m = 0.144$ kg

$v_i = 0$

38 m/s →

If the bat and ball are in contact for 0.80 ms, determine:

(a) impulse the bat delivered to the ball.

(b) average force exerted by the bat.

$j = F\Delta t = m(v_2 - v_1)$

a) $j = m(v_2 - v_1)$

opposite direction.

$= 0.144\ kg\ (-38 - 38)$

$= 0.144\ kg\ (-76)$

$= -11\ kg \cdot m/s$

or

$-11\ N \cdot s$

(b) $J = F\Delta t = m(v_2 - v_1)$

$F\Delta t = m(v_2 - v_1)$

$F = \dfrac{m(v_2 - v_1)}{\Delta t}$

$F = \dfrac{0.144(-38 - 38)}{0.0008 \text{ sec}}$

$F = -1.4 \times 10^2 \text{ N}$

opposite to the direction the ball was thrown.

Green Text.

P 200 (30, 31)

P 203 (33, 34)

P 209 (42)

P 203 → Read Impulse & Auto Safety.

p 200

30. $j = F\Delta t$

$= 2125\ N \times 0.0205\ sec$

$= 43.6\ N \cdot s$ [down]

31. $j = F\Delta t$ (21 ms ↙)

$= 1.23 \times 10^7\ N \times (0.021\ sec)$

$= 258\,300\ N \cdot s$

$= 2.58 \times 10^5\ N \cdot s$ [South]

p 203

33. $m = 0.060\,kg$

$v_1 = 0\ m/s$

$v_2 = 43\ m/s$

$J = F\Delta t = \Delta p$

$J = \Delta p$

$J = m(v_2 - v_1)$

$= 0.060(43 - 0)$

$= 2.6\ kg \cdot m/s$ (Forward)

34. $m = 0.35\ kg$

$v_1 = 46\ m/s$

$v_2 = -62\ m/s$

$j = m(v_2 - v_1)$

$= 0.35(-62 - 46)$

$= -38\ N \cdot s$

$38\ N \cdot s$ in the direction the ball was hit.

P 209

42.

$$J = F\Delta t$$

$$\frac{J}{\Delta t} = F$$

$$\frac{8.8}{0.023} = F = 3826$$

$$F = 3800 \text{ N}$$