Momentum & Impulse Worksheet

① (a) $12 \text{ km/h} = 3.33 \text{ m/s}$

$p = mv$

$= 100(3.33)$

$= \underline{333 \text{ kg m/s}}$

(b) $30 \text{ km/h} = 8.33 \text{ m/s}$ $\quad 150 \text{ tonnes} = 150 \times 10^3 \text{ kg}$

$p = mv$

$= (150 \times 10^3)\, 8.33$

$= \underline{1.25 \times 10^6 \text{ kg m/s}}$

(c) $28\,000 \text{ km/h} = 7778 \text{ m/s}$

$p = mv$

$= (8.7 \times 10^6)\, 7778 \text{ m/s}$

$= \underline{6.8 \times 10^{10} \text{ kg m/s}}$

② $\Delta p = m \Delta v$

$= (0.050 \text{ kg})\, 32$

$= \underline{1.6 \text{ kg m/s}}$

$F \Delta t = \Delta p$

$F(.05) = 1.6$

$\underline{F = 32 \text{ N}}$

③ bending knees

$\Delta p = m \Delta v$

$= 80(-10)$

$= -800 \text{ kg m/s}$

$F \Delta t = \Delta p$

$F(.8) = -800$

$\underline{F = -1000 \text{ N}}$

straight

$\Delta p = -800 \text{ kg m/s}$

$F \Delta t = \Delta p$

$F(0.05) = -800$

$\underline{F = -16\,000 \text{ N}}$

④ A large change in momentum requires a large impulse. "Following through" increases the amount of time a force is exerted on an object maximizing the impulse.

(5) (a) $v_i = 0$
$v_f = 7.5$ m/s
$a = ?$
$t = ?$

$v_f = v_i + at$
$7.5 = at$

$\text{Impulse} = F\Delta t \qquad F = ma$
$= mat$
$= 50(7.5)$
$= \underline{375 \text{ Ns}}$

(b) $v_f = 0$
$v_i = 12$ m/s

$v_f = v_i + at$
$0 = 12 + at$
$-12 = at$

$\text{Impulse} = mat$
$= 50(-12)$
$= \underline{-600 \text{ Ns}}$

(c) $v_i = 2.2$ m/s
$v_f = 6.3$ m/s

$v_f = v_i + at$
$6.3 = 2.2 + at$
$4.1 = at$

$\text{Impulse} = mat$
$= 50(4.1)$
$= \underline{205 \text{ Ns}}$

(d) $v_i = 2.5$ m/s
$v_f = -2.5$ m/s (rebound is in opposite direction)

$v_f = v_i + at$
$-2.5 = 2.5 + at$
$-5 = at$

$\text{Impulse} = mat$
$= 50(-5)$
$= \underline{-250 \text{ Ns}}$

⑥ Impulse $= F\Delta t$

(a) $375 = F(.45)$ $\quad F = 833\ N$

(b) $-600 = F(.45)$ $\quad F = -1333\ N$

(c) $205 = F(.45)$ $\quad F = 456\ N$

(d) $-250 = F(.45)$ $\quad F = -556\ N$

⑦

paint

$m = 5.0g = 5\times10^{-3}\ kg$

$p = mv$

$= (5\times10^{-3}\ kg)(8.1\times10^{3}\ m/s)$

$= 40.5\ kg\ m/s$

golf ball

$m = 45g = 45\times10^{-3}\ kg$

$p = mv$

$40.5 = (45\times10^{-3})v$

$v = 900\ m/s$

$v = 3240\ km/h$

⑧ (a) $v_i = 350\ m/s$

$v_f = 0$

$d = .15\ m$

$a = ?$

$v_f^2 = v_i^2 + 2ad$

$0 = (350)^2 + 2a(.15)$

$a = -4.08\times10^{5}\ m/s^2$

$F = ma$

$= 1.05(4.08\times10^{5})$

$= 20\,400\ N$

* direction is not important for our purposes.

(b) Impulse $= F\Delta t$

$= 20\,400(8.58\times10^{-4})$

$= 17.5\ Ns$

$v_f = v_i + at$

$0 = 350 + (-4.08\times10^{5})t$

$t = 8.58\times10^{-4}\ s$

(c) Impulse $= \Delta p$

$\Delta p = 17.5\ kg\ m/s$